Abstracts

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1. AQUACULTURE PRODUCTION

Paper ID 15521

Captive maturation and multiple breeding of endangered Golden Mahseer: A Journey of Technology Development and Commercialization

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Golden mahseer has been a pride and glory of the Himalayan sub-continent, generating livelihood through ecotourism and aquaculture. Due to various anthropogenic and species-specific inherent reasons, it has become endangered and listed in IUCN red book. Hence, its conservation and rehabilitation was a grave concern for the scientists/researchers, environmentalists and policymakers. Stock enhancement/ranching of fingerlings produced using captive brooders is one of the best sustainable conservation strategies. Until recently, the breeding and seed production of endangered golden mahseer was being done using wild-collected gravid brooders, a destructive and non-sustainable practice with full of uncertainties and risks. This dependence on wild-collected brooders was because golden mahseer females fail to complete ovarian development and maturation in captive conditions due to endocrine dysfunctions. Recognizing the compounding challenges before the captive maturation and breeding of endangered golden mahseer so as to develop sustainable captive maturation and breeding technological solutions to produce mahseer seed on a large scale for conservation and rehabilitation, ICAR-DCFR, Bhimtal, embarked upon conducting a series of experiments (photo-thermal manipulation, sex segregation, substratum intervention, broodstock diet, etc) for over last seven years and finally succeeded in developing the captive maturation and multiple breeding technology for golden mahseer. This technology has resulted in producing a substantial number of fry of golden mahseer round the year, which otherwise had been a major bottleneck for large scale rehabilitation efforts to conserve this esteemed species. A patent application has been filed, and the commercialization of the technology through ICAR-Agrinnovate is in the final stage.

Keywords : *Tor putitora*, Captive Maturation, Multiple Breeding, Photo-thermal Manipulation, Endangered Species

Paper ID 15540

Egg and larval quality attributes of progeny from wild-collected and captive-matured brooders of endangered Golden Mahseer, *Tor putitora*

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The brooders reproductive performance (fertilization and hatching rates); egg quality (size, total carotenoids, biochemical composition, and ovarian fluid composition & pH); and larval characteristics (growth, survival, organ development, starvation and thermal tolerance) of progeny from captive-matured and wild-collected golden mahseer were evaluated. Fertilization and hatching rates were significantly higher in wild-collected brooders. The eggs of captive brooder were considerably larger and heavier, but their nutrient (total protein, glucose, and triglyceride) stocks and total carotenoids were significantly lower. On the other hand, total protein, glucose, and triglycerides were considerably higher in the ovarian fluid of captive females. During water hardening, the cumulative weight increase due to higher water uptake rate was significantly higher in wild origin eggs than captive brooder eggs. The CT_{max} of captive-origin larvae was lower during the early larval stages (15 dph), but became similar to the CT_{max} of wild brooder's larvae at 35 dph. On contrary, the CT_{min} of larvae from captive brooders was higher at all studied developmental stages as compared to their counterparts in wild. Nevertheless, the wild and captive origin larvae recorded similar starvation tolerance capacity. Micro-anatomical observations showed that the intestinal nutrient absorption and hepatic nutrient accumulating efficiency during early developmental stages was comparatively poor in captive origin larvae, which corresponded to their lower growth observed until 35 dph. In addition, the captive brooder larvae had a lower survival rate (till 90 dph) than their wild counterparts. These findings suggest the potential areas where the captive broodstock management of the endangered cyprinid golden mahseer should be improved.

Keywords : Reproduction, Eggs, Carotenoids, Larvae, Thermal Tolerance, Starvation Resistance

Paper ID 15546

Effects of *Leucas aspera* incorporated feed on the growth, haematology and digestive enzyme activity in Genetically Improved Farmed Tilapia (GIFT)

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The excessive use of antibiotics, hormones and other synthetic drugs to control diseases and improve fish growth in aquaculture is a reason behind the emergence of drug resistant bacteria and production of toxic substances harmful to the environment and human health suppressing immunity in the host. The herbs being cheaper, eco-friendly with minimum side effects can be used as alternative to antibiotics in fish health.This study investigated the effects of *Leucas aspera* on the growth, haematology, and digestive enzyme activities of genetically modified farmed tilapia (GIFT). A total of 120 fish (4.37 ± 0.74 g) were randomly divided into four groups of treatment diets in triplicate and fed respective diets containing a graded level of *L. aspera* at 0% (control), 1.5% (T1), 2% (T2) diet and 2.5% Diet (T3) for 60 days. After 60 days, higher growth was observed in fish fed the T2 diet ($P < 0.05$). The activity of digestive enzymes and haematological parameters in the T3 group increased significantly. Some haematological parameters (Erythrocytes and monocytes) reported higher counts in the T2 group ($P < 0.05$), while the WBC count and differential WBCs in the T3 group were significantly higher. The results showed that 2-2.5% of *L. aspera* is recommended for inclusion in the diet.

Keywords : *Leucas aspera*; Herb; Aquaculture; Growth; Fish Health; GIFT

Paper ID 15548

Impact on water quality of integrating *Gracilaria edulis* with *Litopenaeus vannam*ei in lined pond system

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The rapid development of intensive fed aquaculture (shrimp) is associated with concerns about the environmental impacts of such often monospecific practices. One of the main environmental issues is the direct discharge of significant nutrient loads into coastal waters and for best management practices, the aquaculture industry should develop innovative and responsible practices that optimize its efficiency and create diversification, while ensuring the remediation of the consequences of its activities to maintain the health of coastal waters. The present study describes the effect of *Gracilaria edulis* integrating with *Litopenaeus vannamei* on water quality in lined pond culture system. The experimental study was conducted for a duration of 100 days in 4 lined ponds (300m^2/pond), where, two ponds were selected as treatment ponds (with seaweed *Gracilaria* integration) and the other two were control ponds (without seaweed *Gracilaria* integration). Each pond was stocked with shrimp post-larvae at a stocking density of 60 individuals/m^2. Two square bamboo rafts were used for the cultivation of seaweeds. Each raft was seeded with the seaweed (*Gracilaria edulis*) where the stocking density followed was 6.09±0.14 kg/raft. Seaweed was cultured on rafts in 2 batches in the treatment culture system.Water quality parameters *viz*., temperature, turbidity, salinity, alkalinity, PH, dissolved oxygen, total solids, calcium hardness, magnesium hardness, total hardness, *Vibrio* green colonies were found not significant compared with treatment and control system. ($P>0.05$) but CO_2, Ammonia, Nitrite, Nitrate, Phosphate, Total phosphorus, H_2S, Total dissolved solids, Total Plate Count and *Vibrio* yellow colonies were found to be significantly different ($P\leq0.05$) between treatment and control culture systems. The tissue analysis of seaweed for C:N:P ratio for the seaweed seedlings initially seeded and the final seaweed harvested amid treatment culture system also showed significant difference ($P\leq0.05$). The results show that the red seaweed (*Gracilaria edulis*) could boost the water quality parameters with its bioremediation property.

Keywords : *Gracilaria edulis*, Integrated Aquaculture, *Penaeus vannamei*, Biofiltration, Bio-remediation, Eutrophication, Water Quality, Co-culture

Paper ID 15558

Comparative growth performance of *Channa striata* larvae produced during pre-monsoon season and in the monsoon season under captive condition.

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A 30-days experiment was conducted to determine the comparative growth performance of *Channa striata* larvae produced in the pre-monsoon season and in the monsoon season under captive conditions. Two treatments groups in quadruplicate were, T1 (larvae produced during pre-monsoon season) and T2 (larvae produced during monsoon season) taken for the study. One thousand two hundred *C. striata* larvae were stocked randomly in eight FRP tanks with a standard stocking density of 1 larvae/litre. Then from 10th to 14th day the larvae were provided with the zooplankton mixture filtered with 250 µ nylon mesh plankton net in ad libitum. From 15th days onward weaning was started with powdered feed (trade name Prince™ WEAN#4) @ 10-20% of their biomass, four times a day viz. 7.30 AM, 10.30 AM, 1.30 PM and 4.30PM . Throughout the study, the water quality parameters were congenial for the larvae. The growth performance indices (weight gain, average daily weight gain, feed conversion ratio, specific growth rate, condition factor, survival, thermal growth coefficient (TGC) and cannibalism) were considered as response parameters. At the end of the trial, significantly ($P<0.05$) higher weight gain percent, thermal growth coefficient (TGC), survival and reduced cannibalism were recorded in larvae produced during the pre-monsoon season (T1). From the present study, it is concluded that larvae produced in the pre-monsoon season (T1) showed better growth and survival mainly due to better temperature range during the pre-monsoon period. This also provide an opportunity for the farmers to produce more murrel seed for its propagation of farming as well as additional economical benefit.

Keywords : Pre-monsoon, Cannibalism, *Channa striata*, Specific Growth Rate, Thermal Growth Coefficient

Paper ID 15571

Life cycle analysis for aquaculture system: A case study of biofloc culture unit

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The aquaculture system becomes the sunshine sector in terms of the economic benefit obtained from the successful culture practices, requires major attention in respect to its environmental concern. The present study identifies the potential impacts caused by the biofloc production system which includes shrimp hatchery, biofloc farm, processing plant using life cycle assessment techniques. The suitable study locations were identified and careful data collection were carried out from real time industries. The damage assessment was also carried out to compare different subsystems in biofloc production unit. The Simapro® tool was used to analyse the collected inventories of different subsystems. The results of biofloc production system include 2.3707 kpt of human health hazard, 0.6419 kpt of ecosystem quality, 0.8927 kpt of climate change, 0.7279 kpt of resources on single score scale, out of which farming activity utilizing biofloc production strategies contributing around 70% of all impacts. The damage assessment results were also obtained. The study also recommends clean farming framework (CFF) by utilizing different state of art techniques viz., IoT, AI and other waste utilization strategies to mitigate the risks identified and increasing production efficiency of the system.

Keywords : Life Cycle Assessment, Sustainable Aquaculture, Clean Farming Framework, Impacts of Aquaculture

Paper ID 15575

Effect of different stocking density on growth performance, survival, water quality and body indices of pearl spot (*E.suratensis*) Fingerlings in Biofloc Technology

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This experiment was conducted to evaluate the effect of different stocking density on growth performance, survival, water quality and body indices of *E.suratensis* fingerlings for 90 days at PRFF, Pazhaverkadu. Three different stocking densities are 100, 200, 300 no of fishes/m^3. The fingerlings of pearlspot, *E.suratensis* with an average body weight of 5.05±0.03 g were stocked at a rate of SD-1 (100/m^3), SD-2(200/m^3) and SD-3 (300/m^3) cultures for a period of 90 days. The growth parameters were found to significantly decrease with increasing stocking density in the biofloc rearing system. Results of Nitrite and nitrate concentrations were significantly lower in the BFT treatment with lower stocking density than in higher stocking density ($P < 0.05$). The highest mean body weight gain recorded in SD1 (42.37 ± 0.04g) followed by SD2 (29.98 ± 0.08g) and SD3 (20.85 ± 0.06g). BFT significantly increased fish specific growth rate and net yield. There was no significant difference in hematology analysis (in terms of white blood cell and red blood cell counts, hemoglobin and hematocrit levels), total superoxide dismutase activity of fish between different stocking density ($P > 0.05$).The results of this study indicate that biofloc technology culture with lower stocking density can improve the growth performance and immune response and also the maintenance of good water quality and improvement of feed utilization of pearlspot.

Keywords : Biofloc, *E.suratensis*, Growth, Stocking density, Water quality parameter

Paper ID 15576

Effect of sex ratio on successful captive breeding of estuarine Goby fish Knight goby (*Stigmatogobius sadanundio*)

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The knight goby (*Stigmatogobius sadanundio*), is a potential estuarine fish which is found in Sundarbans, India and fetch high price in international ornamental trade. It is popular among the hobbyist worldwide due to its unique grey body with black dots, distinctive beautifully marked fins and hardy nature. Mature males are having elongated dorsal fin with blue and white colour. Adults (n = 178) of knight goby (ABL: 5.1 ± 1.24 cm) were collected from tidal fed water bodies of sundarbans. These fishes were maintained in captivity (FRP tanks: 500 l) and fed with formulated feed (30% Crude Protein) for maturation. Sexual dimorphism was clearly evident after 4 months of domestication where mature females were appeared with bulged belly and round urogenital papillae and mature males were observed with extended dorsal fin and slender (tube like) urogenital papillae. Monthly studies on oocyte development revealed that mature (vitellogenic) eggs range 580 -670 µm in size and are spherical in shape. Breeding trials were conducted using different sex ratios (T1-1M:1F; T2-1M:2F; T3-1M:3F; T4-1F:2M; T5-1F:3M) for achieving successful spawning. Breeding pair of 1 female: 3 male (Treatment 5) sex ratio resulted in successful egg laying when provided with sandy bottom and an upturned substrate. A female lay 1000 – 2000 fertilized eggs on substrate which are guarded by a male. Male tend to clean and fan the eggs to eliminate any fungus growth. The ovulated fertilized eggs are transparent and ovoid in shape and sticks to the provided substrate with the help of fine threads. Fertilized egg measures 1.2 – 1.4 mm in total length and 0.59 – 0.67 mm in diameter. These eggs develop gradually and after 48 hours turn black in colour due to complete development of embryo. Hatching starts from 72 hours and ends by120 hours. Hatchlings are 2.4 – 2.5 mm in total length. This standardized hatchery technology resulted in achieving 95% hatching rate. The present study provided useful insights to achieve mass scale breeding of knight goby under hatchery conditions.

Keywords: Captive Breeding, Knight Goby, Sex Ratio

Paper ID 15580

Effect of stocking density on growth performance, immune responses and influence on digestive enzyme levels of *P. vannamei* reared in Recirculatory Aquaculture System

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A 60 days experimental trial was conducted to investigate on the effect of varying stocking density on growth performance, immune responses and influence on digestive enzyme levels of *P.vannamei* in indoor recirculatory aquaculture system. The post larvae (PL12) of *Penaeus vannamei* were stocked in the three RAS tanks in duplicates viz.700/m^3 (T_1), 500/m^3 (T_2) and 300/m^3 (T_3). Shrimp were fed with the commercial diet containing 35% crude protein at the feeding rate from 10 to 3.5% based on the body weight. The sampling for assessing growth performance was carried out at fortnightly intervals. At the end of the culture trial, significant differences were observed in final body weight, survival, specific growth rate, and feed conversion ratio in treatment groups, respectively. In the present study, highest total haemocyte count was observed in the PL stocked at 300/m^3 and highest Propenol oxidase activity (ProPo), catalase activity was observed in PL stocked at 700/m^3. Highest digestive enzyme activities were observed in PL stocked at 300/m^3 stocking density. Based on the results of this study it is suggested that the optimum stocking density of 300/m^3 was best and 500/m^3 may be feasible for rearing *P.vannamei* in indoor Recirculatory Aquaculture System (RAS).

Keywords: *Penaeus vannamei*; Recirculatory Aquaculture System; Stocking Density; Immune Response; Digestive Enzyme

Paper ID 15587

Effect of stocking density on stress parameters, texture and flesh quality of Silver Pompano *Trachinotus blochii* (Lacepede, 1801) in indoor rearing

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Silver pompano is eminent promising species due to its delectability, acclimation to culture system, acceptability to formulated feed and fetch high demand in international market. Fish stocking density is a key factor affecting growth as under stocking and overstocking has negative impact on fish health and production, which has to be studied. The present study describes the effect of stocking density on stress parameters, texture, proximate composition, water holding capacity, muscle pH and condition factor of silver pompano *Trachinotus blochii*. Silver pompano juveniles were procured from the Regional Centre of Central Marine Fisheries Research Institute, Mandapam, Tamil Nadu. Stocking density was selected as 48g (T1), 144g (T2) and 192g (T3) /tank (m^3) in indoor culture system. Tissue sample was taken from the gill, liver and muscle of silver pompano to analyse the stress parameters Scheffe multiple range test showed significant difference ($P<0.05$) between T1, T2 and T3 for catalase and lactate dehydrogenase (LDH) enzyme activity. Maximum LDH enzyme activity and catalase activity was observed in T3 in liver (1.6520 U/mg protein) (2.7762 U/mg protein), followed by gill (1.5067 U/mg protein) (2.0469 U/mg protein) and muscle (0.8110 U/mg protein) (0.7864 U/mg protein) respectively. Scheffe multiple comparison test showed insignificant differences between measured mean weight and condition factors. No significant differences ($P>0.05$) were found between T1, T2 and T3 for muscle pH and water holding capacity. Significant difference ($P<0.05$) was found between T1, T2 and T3 for texture profile analysis (hardness, springiness, stiffiness) of silver pompano fillets and no significant difference ($P>0.05$) was found between the cohesiveness, gumminess, and chewiness factors. The T2 group exhibited maximum protein and ash contents and minimum moisture and fat contents when compared with T1 and T3. The highest moisture content and lowest ash contents were recorded in T3. Furthermore present study found that optimum stocking density should be 144g/tank (m^3) based on the protein content.

Keywords : *Trachinotus blochii*, Catalase, Water Holding Capacity, Texture Profile Analysis, Flesh Quality, Indoor Rearing

Paper ID 15592

One time protein rich feed in cage culture, growth and economic analysis

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Cage culture of finfish is currently an important economic activity in estuaries of the Kerala, western coast of India. In this study the growth and techno-economic efficiency of the cage farming were evaluated under the Janakeeya matsya krishi project, a farming developmental initiative for fish farmers during the covid-19 pandemic period. This paper uses farm level data collected from cage-farms in Kerala and examine the feasibility techno economically. The species that was stocked on these cages are pearl spot (*Etroplus suratensis*). In the present study we have collected the data on growth rate, energy utilization and conservation of 1000 seeds, days of culture (DOC) and the economic analysis of cage culture systems. Among the cages, 3 of them were maintained by giving high protein/high cost feed(40%protein) once a day and was harvested at the 6th month itself but the other cages was maintained by low cost low protein feed (28%protein) and harvest was done at the 12th month.

The important thing that we have noticed is the rate of return from the cages also varied according to the type of feed. The mean final body weights and total harvest weights 158±0.04 gm and 298±0.5, from the cages that was maintained by high protein feed the rate of return is about 68.50 within 6 months and from the other cages it was about 45.58 within 1 year. The net profit of the above mentioned 3 cages ranges between Rs 40000 to Rs 200000, while for the others it ranges from Rs 700 to Rs 40000.The cage with high protein feed yielded a higher benefit: cost (BC) ratio (1.54-1.44) and rate of return (78.37-60.367) when compared to the cage with low protein feed, benefit : cost(BC) ratio (1.07-1.008) and rate of return (29.6-29.08). Thus, one time protein rich feed in cage culture could be identified as an alternative way by which fishermen/farmers can make good profit than the traditional method. The study also points out that good feed management, timing of feeding, stocking density and good seeds have a contribution to produce best production.

Keywords : Cage culture, days of culture, protein content in feed, Pearl spot, techno economic efficiency

Paper ID 15594

Evaluation of culture potential of Red seaweed *Gracilaria salicornia (*Gracilariales, Rhodophyta) in brackishwater pond ecosystem

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Gracilaria salicornia, a red macroalgae found in coastal intertidal zones, has been identified as a potential source for agar production, but commercial cultivation of this species is still in the preliminary stage. Therefore, in the present study, an attempt was made to standardize the package of culture practice for this species in the brackish water pond ecosystem. Three experimental trials (minimum biomass density and days of culture, optimization of salinity, and optimum water depth) and one field trial were conducted to evaluate the culture potential of *G. salicornia*. To standardize the minimum biomass density, a CRD experimental trial (trial one) was performed with four treatments of 25, 50, 75, 100, and 150 g m^{-2}. In second trial, growth study was conducted under different salinity treatments of 20 g L^{-1}, 25 g L^{-1}, 30 g L^{-1} and 35 g L^{-1}. A third trial with depths from 0.25m to 2.0m was conducted to determine the optimum water depth. The specific growth rate of seaweed was significantly higher at the biomass densities of 50 and 75 g m^{-2}. The growth rate was significantly reduced after 42 days of cultivation. Seaweeds grown on 25 g L^{-1} salinity showed a significantly higher specific growth rate. A depth zone of 0.5 to 1 m was found to achieve a good growth rate for the species. With these results, a field trial cultivation was conducted in brackishwater earthen pond using net bag method and a total harvested biomass of about 2.50 kg m^{-2} was obtained. Therefore, this study suggests that *G. salicornia* serves as a potential species for cultivation in brackishwater pond ecosystem.

Keywords : Biomass, Brackishwater , Depth , Salinity, Seaweed Farming

Paper ID 15597

Seed production of edible Green seaweed *Ulva lactuca*

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The native edible green seaweed *Ulva lactuca* has high nutritional and medicinal value. To promote the *Ulva* farming and to reduce the wild collection from natural stocks, seed production and supply of seedlings for year-round sea farming is the need of the hour. The initial step is to collect seaweeds from natural stock and wash them with UV sterilized water. Later, the vegetative portion (thalli) of *Ulva* is cut into small pieces. Then it was subjected to temperature shock (0°C) for 12 hrs and subsequently placed them into autoclaved filtered seawater, Walne's medium, TMRL medium and a combination of Ammonium sulphate, Urea and Superphosphate under a 24h light:0h dark photoperiod at 20°C. The cell division (sporulation) is initiated after 48 hrs and huge numbers of seeds are produced. The best and quick results were attained through the Walne's medium followed by TMRL medium. The desired results could not be obtained through a combination of Ammonium sulphate, Urea and Superphosphate and control. This method of seed production of *Ulva lactuca* is very simple and cost effective.

Keywords: Seaweed, Thalli, Temperature Shock, Seeds, *Ulva*

Paper ID 15600

Effect of coconut coir substrate at various densities on growth performance of *Penaeus vannamei* and overall outcome in earthen lined ponds

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An experiment was conducted to evaluate the growth performance of *Penaeus vannamei* with various density of natural substrate (coconut coir) in the earthen lined pond *Penaeus vannamei* culture system. Totally, two Trials were conducted and two earthen lined ponds were used for each trial, one was control pond and another one was treatment pond. In the first Trial, 63 numbers (6.17 m^2- 20.57 % of the total pond area) of coconut coirs were used in the treatment pond and the stocking density of *Penaeus vannamei* was 55 / m^2. In the second Trial, 36 numbers (2.64528 m^2- 11.75 % of the total pond area) of coconut coirs were used and the stocking density of *Penaeus vannamei* was 55 / m^2. The MBW, SGR, FCR, FCE, FER, and ADG showed higher values in the treatment pond of the Trial II than Trial I. Finally, Trial II [with less substrate surface area (2.64528 m^2 – it occupies 11.75 % of the total pond area)] is suggested from this study for commercial application of natural feed based system for *Penaeus vannamei* production.An experiment was conducted to evaluate the growth performance of *Penaeus vannamei* with various density of natural substrate (coconut coir) in the earthen lined pond *Penaeus vannamei* culture system. Totally, two Trials were conducted and two earthen lined ponds were used for each trial, one was control pond and another one was treatment pond. In the first Trial, 63 numbers (6.17 m^2- 20.57 % of the total pond area) of coconut coirs were used in the treatment pond and the stocking density of *Penaeus vannamei* was 55 / m^2. In the second Trial, 36 numbers (2.64528 m^2- 11.75 % of the total pond area) of coconut coirs were used and the stocking density of *Penaeus vannamei* was 55 / m^2. In Trial I, significant differences ($P < 0.05$) were observed in all the growth parameters of *Penaeus vannamei* and growth parameters in control pond was little higher than the treatment pond. In Trial II, no significant differences ($P > 0.05$) were observed in growth parameters of *Penaeus vannamei* culture between control and treatment ponds. The MBW, SGR, FCR, FCE, FER, and ADG showed higher values in the treatment pond of the Trial II than Trial I. Physico - chemical water quality parameters did not show significant differences ($P > 0.05$) between control and treatment pond in Trial I and Trial II. Among the two trials conducted, the better outcome was obtained from Trial II. Finally, Trial II [with less substrate surface area (2.64528 m^2 – it occupies 11.75 % of the total pond area)] is suggested from this study for commercial application of natural feed based system for *Penaeus vannamei* production.

Keywords: Substrate surface area, Coconut coir, *Penaeus vannamei,* Earthen lined pond, Growth parameters

Paper ID 15601

Enhancing the growth of *Etroplus suratensis* using fish waste hydrolysate as plankton booster in outdoor tank systems

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Etroplus suratensis is cherished as a delicacy in many places. The slow growth of *E. suratensis* is one of the major issues. In the present study, a Fish Waste Hydrolysate (FWH) prepared from marine fish trimmings was utilized as a plankton booster to enhance the growth of *E. suratensis* in the outdoor tank system. 90 days experiment was conducted consisting of treatments with different doses of FWH, 0 ppm, 5 ppm, 10 ppm, 20 ppm, 40 ppm, 80 ppm and 160 ppm. The results showed that Specific Growth Rate (SGR), Percentage Weight gain, Average Daily Gain (ADG) and FCR of *E. suratensis* grown in FWH (@ 20 ppm and above) supplemented treatments were significantly improved ($P<0.01$) than control and lower doses of FWH. The highest growth parameters were observed in treatment supplemented with 160 ppm FWH and the parameters like Specific Growth Rate (SGR), Percentage Weight gain and Average Daily Gain (ADG) are significantly higher ($P<0.01$) than in the other treatments including control. A 40% increase in the final body weight of *E suratensis* was observed in 160 ppm FWH supplemented treatments compared to control. Significantly higher floc densities were noticed in all FWH supplemented treatments compared to control. The floc density was increased with the increase in FWH dosage to 80 ppm. The phytoplankton and zooplankton abundance was significantly higher in FWH supplemented treatments than that of the control. The abundance of phytoplankton and zooplankton increased with the FWH does increase. A higher abundance of plankton might have contributed positively to floc formation and improved the growth of *E. suratensis* in the culture system. Hence, it can be concluded that 160 ppm supplementation of FWH can significantly enhance the growth of *E suratensis*, which will help the farmers get higher profits.

Keywords: Fish waste Hydrolysate, Pearlspot, Growth enhancement, Plankton

Paper ID 15622

Energy use in a pond based shrimp aquaculture system and its environmental sustainability

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Aquaculture has become the rapidly growing sector in global food production contributing to the food basket increased nearly 60 - fold over the past decades and becoming more energy intensive, mainly rely on non- renewable sources. The essential factors influencing the intensification are higher feed inputs followed by higher rates of mechanical aeration. The feed production is the major energy-consuming process accounts over 90% for both finfish and crustacean production (GSA, 2010). Next to feed production, the energy required for aerators to provide aeration was comparatively higher and varied from 11.4 to 41.6 GJ/t shrimp production devastating the lion's share in energy consumption typically defined as "Energy eater" by the farmers. The understanding and mitigation of energy use corresponding to the environmental performance of aquaculture production system is the need of the hour to be discussed in order to attain the sustainability. The challenge for the upcoming decade is to accomplish the production with increasing resource use efficiency and minimizing adverse environmental burdens. However, assessment of aquaculture's environmental performance is a difficult task because activities and potential impacts vary. But there is an increasing emphasis on using more holistic approach to compare the overall impact of different aquaculture production systems for the assessment of environmental impacts relevant to resource use in production process thus to identify opportunities for increasing resource use efficiency. Thus, Life Cycle Assessment (LCA) tool can be implemented to attain the edge of perfection in quantitative assessment of materials, energy flows and environmental impacts of production systems amidst providing criteria for decision - making on issues such as environmental product development, policy making and strategic planning.

Keywords: Aquaculture, Energy use, Environmental sustainability, Life cycle assessment

Paper ID 15624

High density biofloc nursery rearing of Pacific white shrimp, *Penaeus vannamei* in two different culture conditions: Estimation of growth, survival and immune potential

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The present study investigated to predict the growth and survival of Pacific white shrimp, *Penaeus vannamei* post larvae in a high density (Super intensive) biofloc nursery system in two different culture conditions for 28 days. The treatments were C: Control, T1: Post biofloc generation system (No addition of carbon sources before stocking), T2: Pre-biofloc generation system (Addition of carbon sources before stocking). Biofloc technology and conventional based nursery rearing system was carried out in cement cisternae (160ton capacity) for a period of 28 days to know the growth and survival. Post larvae (PL7) were stocked with high density of 10000/m^3 in both control and biofloc. After 28 days the growth and survival were calculated in both treatments, the results showed that the pre-biofloc generation system had an average body weight of 0.33±0.05 which was 20% higher than the normal conventional hatchery and 10% higher than the post biofloc generation which was 0.22±005. The survivability not varied significantly ($p<0.05$) between two treatments, but significantly varied between control. The highest survival of 95% was achieved in pre-biofloc generation system and 92% survival achieved in post biofloc generation system and 82% in normal conventional nursery. The water quality mainly NH_4-N and NO_2-N varied significantly ($p<0.05$) in both treatments and other parameters almost same not varied significantly. The total haemocyte count (THC) observed highest (3.53±0.3) in biofloc animals and lowest observed in control (2.46±0.17). The PPO activity ranged from 0.63±0.02 to 0.92±0.03, the highest observed in biofloc reared animal. The total plasma protein observed between 83.00±4.22 to 95.62±3.4, highest observed in pre-biofloc generation tank. Similarly, the lysozyme activity (0.22±0.033) observed significantly ($p<0.05$) higher in pre-biofloc generation tank than control (0.17± 0.01) pond. The SOD activity ranged from 50.66±2.51 to 72.33±3.51, highest observed in control animals. The population of heterotrophic bacteria was significantly ($P < 0.05$) increased in biofloc treatments when compared to control nursery. But higher *Vibrio* load was recorded in the control than BFT water samples. BFT based nursery rearing system improves the water quality parameters when compared to the control.

Keywords : Superintensive; Biofloc; Total Haemocyte Count; SOD Activity; Plasma Protein

Paper ID 15636

Infestation of Dragonfly nymph in low-saline ponds causes early losses to shrimp post larval survival during the post monsoon season

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Dragonflies are heavily bodied, strong flying insects, whose life cycle consists of three stages viz., egg, nymph and adult. Nymph is the aquatic larval stage that are voracious predators of aquatic invertebrates and small fish using its hinged labium. The nymph undergoes several moults (5-16 intermediate nymphal stages), before becoming a fully grown nymph (non-feeding stage) that subsequently crawls out of water and moults to become the dragonfly leaving back the exuviae. Dragonflies normally lay their eggs in stagnant freshwater bodies free from predators and generally do not lay eggs in shrimp growout ponds due to high salinity that causes mortality of egg and larvae. However, during the post monsoon season (September) in South Gujarat, wherein salinities drop to 2-5 ppt as a result of large freshwater influx to creeks, large swarms of dragonflies belonging to the families *Libellulidae* and *Aeshnidae*, were observed to form mating pairs and lay their eggs in shrimp growout ponds filled with low saline water. The laying of eggs was observed in both newly filled and freshly stocked ponds, whereas it was not observed in growout ponds having larger sized shrimp. Cohabitation trials were conducted to study the possible effects of dragonfly nymph on shrimp post larvae (PL). Medium-sized dragonfly nymph collected from the ponds were stocked in to 70 litre (L) tubs (5 nos./tank) containing thirty *Penaeus vannamei* PL10 in triplicate and reared for two weeks along with the control group. The experiment continued until all the nymphs died or exuviae were observed on the aeration tubes. Mean survival rate of PL reared along with dragonfly nymph (66.3±3.76%), was significantly lower ($p<0.05$) as compared to the control group (88.6±2.96%). In another trial, where fully grown nymphs (4 nos./tank), were stocked in 20 L tubs containing twenty *P. vannamei* PL10, no mortality was observed after a week of rearing. The results obtained from the trial clearly indicates that dragonfly nymph can prey on shrimp PL. Farmers from Andhra Pradesh have reported that the survival rate of shrimp PL can drop by 50% in freshly stocked ponds infested with dragonfly nymphs. The present trial suggests that, survival can reduce to 50-70% following two weeks of stocking depending on the infestation rates and nymphal stages of majority of the larvae.

Keywords : Dragonfly, Nymph, Pl, Survival, Salinity

Paper ID 15637

Water quality nutrient dynamics and growth characteristics of indoor *Penaeus vannamei* bioflocs systems integrated with suspended substrates

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In indoor *Penaeus vannamei* bioflocs systems (BFS) the effect of integrating the suspended substrates (SuS) in the water quality, nutrient dynamics and growth characteristics was studied. The experimental design was (i). Bioflocs with suspended substrate (Bws) (ii) Bioflocs without substrates (B_{WoS}) (iii) Clear water systems as control. In treatment i) & ii) three different salinity (35. 20 and 5ppt) and two carbon sources (sugar and rice flour) as variables and in control only three different salinity tanks in triplicates were maintained. Two shade nets/tank with a total surface area of 1.44 m^2 installed as SuS in treatment (i) tanks. The experimental tanks with a capacity of 200 litre was stocked with *P.vannamei* juveniles with 0.2 to 0.23 g size and grown for 56 days. The results revealed that a significant difference was observed in the total ammoniacal nitrogen ($p<0.001$), nitrite nitrogen ($p< 0.05$), nitrate nitrogen ($p<0.01$) values between the treatments and controls and significant differences ($p<0.05$) was also observed within the treatments. The B_{WS} systems performed better with significantly lower ammonia ($p<0.05$) and nitrite nitrogen ($p<0.05$) levels and significantly higher average body weight ($p<0.01$) with an average daily growth of above 0.2g and survival rate ($p<0.001$) of above 89%.

Keywords: Bioflocs Systems, Suspended Substrates, *Penaeus vannamei*, Carbon Sources, Nitrogenous Nutrients, Nutrient Dynamics, Heterotrophic Bacteria.

Paper ID 15644

Effect of natural carotene incorporated diet on pigmentation improvement of indigenous ornamental fishes *Sahyadria denisonii* and *Dawkinsia filamentosa* under captive condition

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The present experiment was conducted to evaluate the impact of natural b-carotene for inducing colouration in indigenous ornamental fishes *Sahyadria denisonii* and *Dawkinsia filamentosa.* Experimental diets were prepared by incorporating the natural carotene sources like Carrot peelings, Curry leaf and Marigold petals at different graded levels (5, 10 and 15%). The proximate analysis of the experimental diet was carried out but doesn't depict any significant changes in their composition. Experiment was designed with 9 different treatment diets and one control in triplicates. The experiment was carried out for 30 days during the due course the control group fishes were be fed with basal diet without supplementation of carotenoid pigments. The colour intensity and prominence in pigmentation was observed in the first sampling onwards i.e. on the 10th day among the different source of carotene used. The significant ($P<0.05$) difference was shown between the treatments and control. Variation in carotene content was observed with variation in level of incorporation of carotene source. Among the test diets experimented marigold at 10% of incorporation showed the high level of carotene increments i.e. 0.856µg/g and 0.79µg/g in *D. filamentosa* and *S. denisonii* respectively. The study revealed that, incorporation of natural carotene enhances the pigmentation of ornamental fishes under captive condition. Hence, from the study it could be concluded that, easily available cost-effective natural carotene sources can be incorporated in ornamental fish feed as a colour enhancer.

Keywords : Carotene, Pigmentation, *Dawkinsia filamentosa*, Colour enhancer, *Sahyadria denisonii*, Ornamental fish.

Paper ID 15648

Use of 2-phenoxyethanol as anaesthetic for pit tagging pearlspot, *Etroplus suratensis* and its effect on the haematological parameters

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Identifying appropriate anaesthetic agents is important as dose and response vary with species, age, size and water quality parameters. 2-Phenoxyethanol is considered an effective synthetic anaesthetic in aquaculture. In this study, the effect of 2-phenoxyethanol on the behaviour of juvenile Pearlspot and its efficiency in PIT tagging was done. The experiment was carried out in triplicate with twelve different concentrations of 2-phenoxyethanol (200, 300, 400, 500, 600, 700, 800, 900, 1000, 1500, 2000, 2500 mg/L) along with control. The duration required to reach various stages of induction and recovery was recorded along with the behavioural changes. The fishes were found unaffected at lower dosages up to 100 mg/L, and they started responding gradually from 200 to 800 mg/L. However, the complete effect of the anaesthetic was obtained with a dosage above 1000 mg/L, and among the tested range, 1500 mg/L was the effective concentration based on induction and recovery along with behavioural responses. The induction time was 118.6.0±1.5sec and recovery at 345.3±1.1sec. Though most fishes exhibited distinct induction and recovery signs, some fishes exhibited varied behavioural responses viz., brief erratic movement, increased gill movement etc. Recovery time varied significantly with higher doses of 2-phenoxyethanol. Dorso-vertically tagged juveniles had a survival of 96.7% with tag rejection of 3.33%. The haematological and biochemical parameters indicated the lower stress condition of fish after anaesthetic induction. The plasma glucose of 0.091 mg/dl at the start of induction declined to 0.066 mg/dl after 48hrs. The plasma glucose of 0.047 mg/dl after tagging declined to 0.025 mg/dl after 24hrs. However, after 48hr post tagging, the plasma protein and alkaline phosphatase levels declined and regained to initial values. These results suggest that 2-phenoxyethanol can be used as an effective anaesthetic for PIT tagging in Pearlspot without any mortality to facilitate selective breeding.

Keywords : Selective breeding, 2-phenoxyethanol, Anaesthetics, Induction, Recovery, Tagging, Stress, Glucose.

Paper ID 15649

Impact of modified cage design on the growth and survival performance of mud crab fattening

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There is a need for improved mud crab fattening, in an economical way, to promote sustainable development of aquaculture, and it could be achieved through an appropriate fishery practice. Therefore, a comparative study was performed to assess the growth and economic feasibility of the existing and modified fiber-reinforced plastic floating cages for crab fattening. For that purpose, mud crabs (370g) were fattened in 10 cages for 27 days. The results of this study showed a significantly (P<0.05) lower growth performance, survival rate and production in the existing cage compared with the modified cage. The survival rate was significantly (P<0.05) differed; the highest of 80.56% was noticed in the modified cage and the lowest of 63.89% was observed in the existing cage. The total production of mud crab was 37% (P<0.05) greater in the modified cage (213.17 kg hec^{-1}) than the existing cage (155.33 kg hec^{-1}). The highest net present value (₹28,903.62), benefit–cost ratio (1.51), payback period (0.24 yr), and internal rate of return (142.63%) were obtained for the modified cage compared to the existing cage (₹4423.79, 1.15, 0.53, and 28.11, respectively). The highest gross income of ₹36,966.00 was obtained in the modified cage and the lowest of ₹14,657.12 in the existing cage, which also differed significantly (P<0.05). The results showed that the existing cages could be replaced with modified cages, which would enhance the production and economic performance of mud crab fattening, thus help to maintain sustainability by the local fisherfolk.

Keywords : Enterprise budget, Fattening, Investment analysis, Mud crab

Paper ID 15650

Evaluation of rearing of indigenous ornamental fishes *Dawkinsia filamentosa* and *Sahyadria denisonii* in advanced raceway systems.

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Ornamental fish culture industry is growing at a faster rate but there is no concern made on expansion of production through advancement in the culture system. In order to produce more and to make more profits, advanced culture systems can be adopted in ornamental fish farming. Race way farming has the potential to boost the sector to a different level in our country. The current study has been conducted to evaluate the growth potential of indigenous ornamental fishes *Dawkinsia filamentosa* and *Sahyadria denisonii* in advanced raceway systems. The experiment was designed with three different stocking density i.e. 500 (T1), 1000 (T2), and 1500 (T3) nos./m^3. The *D. filamentosa* and *S. denisonii* fishes were stocked at 70:30 ratios respectively in raceway tanks. The experiment was conducted in duplicates. During the culture period, the fishes were fed with 5% of its body weight. The experiment was conducted for 30 days and at the end of the trial, survival rate and growth parameters were analysed. Significant differences ($P<0.05$) in the weight gain, percentage weight gain, growth rate, specific growth rate and survival rate was observed between the treatments in both *D. filamentosa* and *S. denisonii*. The lower survival rate was observed in T3 (79 and 65%) with the high stocking density and higher survival rate in T1 (90 and 83) with stocking density of 500 nos/m^3 in *D. filamentosa* and *S. denisonii* respectively. Weight gain at the end of the culture period was higher in T1 at lower stocking density in both *D. filamentosa* (2.06 g) and *S. denisonii* (1.9g). The present study ensured that, advanced technologies such as raceways can be adopted for ornamental fish culture. The current study has also focused to optimize the stocking density for rearing two different barbs in raceways. The present study will introduce the advanced farming technologies for ornamental farmers, breeders and entrepreneurs to enhance and expand their production.

Keywords : Raceway systems, *Dawkinsia filamentosa, Sahyadria denisonii* , Recirculatory systems

Paper ID 15652

Comparative evaluation of feeding and non feeding on the growth performance and meat quality of hybrid tilapia (Red strain) in the treated sewage

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The aim of the present study was to evaluate the growth performance of the hybrid tilapia (red strain) in the treated sewage with and without the supplementary feed. All-male hybrid tilapia seeds with average body weight of 0.204± 0.015 g and average body length of 1.94±0.08 cm were reared at hapa at the stocking density of 10/m^2. Each treatment had duplicates and the culture was done for 60days with and without supplementary feed. During the experimental period, water quality parameters were monitored routinely. At the end of 60 days, it was observed that the fishes reared in T1 group with supplementary feed attained the highest final mean body weight (110.06±0.70 g) while the lowest weight gain (40.42±0.68 g) was recorded in T2 group where fishes reared without supplementary feed, which are statistically significant ($P<0.05$).Similar trends were recorded for daily weight gain and specific growth rate.The microbiological analysis, heterotrophic bacteria count (T1- $10.03\pm0.763\times10^2$ cfu/g ,T2- $8.13\pm1.16\times10^2$ cfu/g) and heavy metals like Copper (T1-22 ppm,T2-14 ppm), Cadmium (T1-30 ppm, T2-38 ppm), Zinc (T1-63 ppm, T2-76 ppm) were detected in all the treatment groups, which were at the permissible limits, while the Lead, Arsenic, Chromium were absent. Although sewage water is rich in nutrient which doesn't require any supplementary feeding for fish production, the present study revealed that the fish reared with feeding showed higher growth than that of the fish reared without feeding, indicating feeding in the sewage pond could be advantage to increase the production. The cost benefit ratio analysis also revealed that the cost that has to be spent for feed is useful and beneficial when the yield due to feed was analysed.

Keywords : Hybrid tilapia, Treated sewage, Body composition, Heavy metals.

Paper ID 15655

Influence of replacing soybean meal by rapeseed meal with the supplementation of DL-methionine in the diets of Gift tilapia

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Aquaculture plays an important role in global food security and employment provision. It is the fastest growing food producing sector. In intensive fish production models, the utilization of nutritionally complete feeds with fish meal as major protein source is critical to the success of the industry. A number of studies have been conducted to evaluate the potential of alternative plant protein sources to replace FM in practical diet for tilapia. Present study was planned to study the performance of GIFT Tilapia when fed with Rapeseed meal instead of soybean meal along with DL-Methionine supplementation. In the present trial, major feed ingredients were mixed in the feed at different concentration viz., 5 %, 10 %, 15 % and 20 %. Every day the fishes were fed at the rate of 5 % of their body weight. The experiment was conducted for a period of 60 days and the sampling was carried out once in a fortnight. The body weight of GIFT tilapia on the first day of stocking in the rape seed meal fed fish at an inclusion level of 5, 10, 15 and 20 % were 0.471, 0.457, 0.470 and 0.443 g respectively. At the end of the trial, growth differences were seen among the fishes fed with rapeseed meal at different concentrations.

Keywords: Soybean meal, Alternative, Rapeseed meal, Gift tilapia, Performance, DL-methionine

Paper ID 15670

Impact of biochar on sediment quality and growth of Genetically Improved Farmed Tilapia (GIFT)

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India has a vast area of Inland saline soil. It is not suitable for agriculture or aquaculture due to a lack of basic nutrients like N, P, and K. This soil has low water holding capacity and a high seepage rate to low organic carbon. Sediment amendment with biochar improves the sediment quality and water quality in Aquaculture system. In this context, 45 days experiment was conducted in ICAR - CIFE Centre Rohtak (Haryana) to study the impact of biochar on sediment quality and GIFT (*Oreochromis niloticus*). Sugarcane bagasse and paddy straw biochar were used in this study. Biochar was applied in sediment @ 9 t/ha and incorporated in commercial feed containing 35% protein @ 0.5% on w/w basis. The basic physicochemical parameters of biochar were analyzed like bulk density, pH, moisture contents, total & available potassium, total calcium, and FTIR. In this study, it was found that sediment quality and growth of (GIFT) were significantly improved. The available potassium, water holding capacity, organic carbon contents, cation exchange capacity were significantly increased, and bulk density was decreased after 45 days of experimental periods. The weight (%) was found in following trends T3 (42%), T4 (35.03%), T2 (12%), and T1 (6%) higher than control. FCR was found in the following trends T3<T4<T2<T1 and control. The highest SGR (%) was found in the T3 (2.61±0.023), and the lowest was found in the control (2.10±0.026). Overall, the study provides substantial data for the validation of the hypothesis that biochar improves the survival, growth of GIFT, and physicochemical properties of inland saline sediment. The study's findings will serve as baseline information for developing a standard protocol for the application of biochar in the inland saline aquaculture system.

Keywords : Biochar, Inland Saline, Tilapia

Paper ID 15682

Captive maturation of striped murrel, *Channa striata* broodstock during pre-monsoon through habitat manipulation

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Difficulty in captive maturation and short spawning season are major problems in the induced breeding and seed production of striped murrel. To overcome these problems, an attempt was made to achieve early reproductive maturity of striped murrels in captive conditions by intervening in the brooder rearing habitat. In this regard, four habitats were tested in duplicates, namely T_1 - Tank with clean reservoir water without macrophytes and soil base, T_2 - Tanks provided with floating (Water hyacinth, *Eichhornia sp*) and submerged (Water thyme, *Hydrilla sp*) aquatic macrophytes without any soil base, T3- Tanks provided with only soil base (15-20 cm) without any macrophytes and T_4 - Tanks provided with both soil base and macrophytes. At the end of the three-months rearing phase, the fishes provided with macrophytes and soil base (T4) resulted in early maturation characterized by an egg size of around 1.29±0.21 mm and the majority of late granular stage oocytes and spermatozoa in ovary and testes, respectively. The histological observation showed that the ovary of T2 consisted of late perinuclear oocytes whereas the ovary in T3 consisted of matured oocytes with yolk vesicles. However, the testes consisted of both spermatid and spermatozoa in T2 and T3. The T1 resulted in the poorest response among all treatment groups with an egg size of around 0.68±0.03 mm. The histological observation of T1 showed chromatin nucleolar to an early peri-nucleolar stage of oocytes in the ovary and the testes consisted majority of spermatogonia. The results concluded that providing a bottom soil base of 15-20 cm and covering the 20-30% water spread area using aquatic macrophytes in the brooder rearing tank helped in the gonadal maturation of striped murrel during pre-monsoon in captive conditions.

Keywords: Pre-spawning, Maturity, Eggs, Ovarian stage, Broodstock, *Channa striata*

Paper ID 15684

High density biofloc based nursery rearing of pacific white leg shrimp, *Penaeus vannamei* in two different combinations of carbon sources

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The biofloc is rich in high nutrients food source such as amino acids, proteins, fatty acids and lipids in the form of a group of microorganisms. The present study investigated to estimate the growth, survival and immune potential of Pacific white leg shrimp, *Penaeus vannamei* post larvae in a high density biofloc nursery rearing system by the use of two different combinations of carbon sources for 28 days. The treatments were C: control, T1: only sugar as carbon source, T2: sugar, rice flour, and DORB powder as carbon sources. Biofloc technology and conventional nursery rearing system (control) was carried out in cement cisternae (160-ton capacity) to know the growth performance, and immune potential of the shrimp. Post larvae (PL7) were stocked with high density of 10,000 m^{-3} in both control and biofloc treatments. After 28 days, the results showed that the mixed carbon sources (T2) system had an average body weight of 0.30 ± 0.04 g, which was 20% higher than the conventional system and 10% higher than the T1 (only sugar system) which was 0.27 ± 0.04 g. The survivability was not significantly different between two treatments; but significantly higher than control. The water quality mainly NH_4-N and NO_2-N was significantly different in both biofloc treatments and found higher T1 compared to T2. The total haemocyte count observed higher in biofloc treated animals compared to control. The enzyme PPO activity total plasma protein showed better in biofloc reared animal than conventional system. Similarly, the lysozyme activity observed significantly higher in mixed carbon system than control and T1. The enzyme SOD inhibition showed the highest value in control animals. The population of heterotrophic bacteria was significantly increased in biofloc treatments compared to control; but higher *Vibrio* load was recorded in the control than bioflocwater samples. It could be concluded that biofloc based nursery rearing system improves the growth, immunity of shrimp and water quality parameters compared to the conventional system.

Keywords: Biofloc; SOD; Lysozyme activity; Conventional system; Carbon sources

Paper ID 15701

Evaluation of microalgal concentrate for the culture of *Brachionus plicatilis*

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Microalgae are an inevitable source of nutrition for the larval rearing of most of the commercially important marine and brackishwater shellfish and finfish. They are used for culturing and enriching the zooplankton live food organisms like rotifers, copepods, cladocerans etc. Supply of the required quantity of microalgae for the larval rearing is often hindered by issues like culture crashes, contamination, increased production cost, lack of technologies to store the fresh culture etc. The present study attempts to standardise the production of microalgae concentrate by flocculation using three strong bases (NaOH, KOH and NH_4OH) and also to evaluate the effect of monospecific microalgal concentrates for the culture of rotifer *Brachionus plicatilis*. An experiment was conducted to find out the flocculation efficiency of these bases at different concentrations (0.1, 0.5, 1, 10 and 20 mM). The results of the experiment clearly showed that NaOH at 10mM attains 94.1% flocculation efficiency in 30 minutes and 99% flocculation efficiency in 120 minutes which is significantly higher ($p < 0.05$) than the other bases irrespective of the doses in all three microalgae. The flocculated microalgae concentrate was used in a 10 days experiment to evaluate the potential to culture the *B. plicatilis*. Various concentrations of microalgal concentrate were used for culturing rotifers and which were compared to the control, where fresh algal cultures were used instead of concentrate. The results of the experiment revealed that there is no significant difference ($p>0.05$) in the number of rotifers per ml in the treatments with microalgae concentrate and fresh microalgae. Hence it can be concluded that the microalgae concentrate developed by chemical flocculation can be used as an economically viable surrogate to fresh algal culture in *B. plicatilis* production.

Keywords : Microalgae concentrate, Flocculation, Larval nutrition, Rotifers

Paper ID 15706

Non-lethal heat shock mitigates stress in *P. vannamei* exposed to potassium deficient inland saline water

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Inland Saline waters (ISW) in Rohtak, India is characterised by low potassium (K^+), variable levels of calcium and other essential ions compared to seawater of same salinity. This ionic imbalance proves to be energy demanding, stressful and sometimes lethal for *P. vannamei,* if the K^+ concentration is less than 50% equivalent to seawater. Western blot analysis showed that, 1-hour Non-Lethal Heat Shock (NLHS) at 36°C and a recovery period (RP) of 8 h at 28°C significantly induced Hsp 70 protein accumulation in the Gill and muscle of *P. vannamei* juveniles (average weight 4.64 ± 0.01g). After the RP, 15 shrimps each were then exposed to different K^+ fortified 10 ppt ISW of 25%, 50% and 75% in triplicates (T25, T50 and T75) and shrimps which did not receive NLHS and RP served as controls (C25, C50 and C75) in triplicates. After 12 h exposure the activity of antioxidant enzymes, SOD (Superoxide Dismutase) in Gills and CAT (Catalase) in both Gill and Hepatopancreas were significantly ($p<0.05$) increased in treatment (T) groups compared to control (C). The Gill SOD and CAT were significantly ($p<0.05$) higher in 25% and lower in 75% K^+ fortified groups. In conclusion, the improved SOD activity in the gills signifies the effect of NLHS mediated Hsp70 accumulation in conferring acute stress tolerance against K^+ deficient ISW via cross-protection in *P. vannamei.*

Keywords : *Penaeus vannamei*, Inland saline water, K+ deficiency, Non-lethal heat shock, HSP 70, Cross protection.

Paper ID 15709

Impact of stocking density on growth, digestive enzyme activity, and gene expression of Asian seabass reared in recirculating aquaculture system

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A 60-day trial was conducted to evaluate the impact of different stocking densities (70, 140, 210, 280, and 350 fish/m^3) on growth, digestive enzyme activity, and gene expression of Asian seabass, (*Lates calcarifer*) in Recirculating Aquaculture System (RAS) by following completely randomized design with four replications. Asian seabass (5.20±0.10 g) were randomly distributed in twenty tanks, each of 500 L capacity, and fed four times a day (6:00, 12:00 18:30 and 23.00 h). The study found that growth performance and feed utilization efficiency were significantly decreased with increasing stocking density. A significantly higher survival (95.00 ± 1.25%) was recorded in the low stocking density group (70 fish/m^3). On the other side, fish reared in 70 fish/m^3 displayed higher digestive enzyme activities such as protease (15.45±2.5 U/mg protein), amylase (0.53±0.02 U/mg protein), lipase (1.63 ± 0.14 U/mg protein) and cellulase (5.089 ± 0.32 U/mg protein) in the stomach. The relative gene expression of GH/IGF axis and myostatin (MSTN) was significantly down-regulated and up-regulated, respectively, with the increasing stocking density. Significantly higher relative gene expression of GH (1..42 ± 0.14 folds) /IGF (1.11 ± 0.19 folds) was recorded in 70fish/m^3, and MSTN (2.18 ± 0.02 folds) recorded in 350 fish/m^3. Overall, the study found that the increasing stocking density produced chronic stress which negatively affected the growth performance of the fish. Therefore, the study suggests rearing of Asian seabass at a stocking density of 70 fish/m^3 in a recirculatory aquaculture system could improve the growth performance, metabolic and molecular activities of the fish.

Keywords: Digestive enzyme activity, Fish growth, Gh/igf Axis, Recirculating aquaculture system, Seabass

Paper ID 15710

Effects of dietary protein and lipid levels on growth, feed utilization, growth-related gene expression, and digestive enzyme activity of Asian seabass (*Lates calcarifer*) reared in freshwater earthen pond

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A 60-day feeding trial was conducted using 3X3 factorial design to evaluate the effects of different dietary protein (40, 45 and 50%) and lipid (7, 9, and 11%) levels on growth and digestive enzyme specific activities of Asian seabass (*Lates calcarifer*) under field conditions. Nine experimental diets, with different combinations of protein and lipid levels, were prepared and randomly assigned to triplicate group of fish. The experimental design consists of 27 uniform size cages (1 m × 1 m × 1 m), installed in an earthen pond, in which fish (mean± SE 0.80 ±0.1 g) were stocked at 80 fish/m^3 and fed thrice a day (6:00, 12:00 and 17:30 h) at 5% of their body weight. The results showed that increasing dietary protein and lipid levels were significantly improved the growth performance of fish. Fish fed with P50-L9 diet exhibited significantly higher body weight (6.14±0.05 g), SGR (3.58±0.01 % day^{-1}), survival (96.67±2.81%) and better feed conversion ratio (1.88±0.02). On the other side, relative expression of myostatin was higher and Growth Hormone (GH) and Insulin-like Growth Factor-1 (IGF-1) expressions were lower in the P40-L9 diet-fed group fish liver and muscle. The digestive enzyme specific activities of protease (6.89±0.06 U/mg protein), amylase (0.520 ± 0.003 U/mg protein), lipase (1.70±0.15 U/mg protein) and cellulase (5.20±0.28 U/mg protein) were significantly higher in the P50-L9 group fish liver. Hence, the present study proved that Asian seabass could grow well in field conditions, with better feed utilization and produce nutritious meat, when fed with a diet containing 50% protein and 9% lipid, as optimal dietary protein and lipid levels.

Keywords : Seabass, Digestive enzyme activity, Gh/igf Axis, Growth performance, Myostatin, Proximate composition

Paper ID 15711

Physiological response of Asian seabass reared in Recirculating aquaculture system under different stocking density: Effect on digestive enzyme activity, biochemical and stress gene expression

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Stocking density is one of the critical factors that influence the production and health status of fish in aquaculture practices. In this 60-day trial, effect of different stocking densities (70, 140, 210, 280 and 350 fish/m^3) on digestive enzyme activity, biochemical and stress gene expression of Asian seabass, (*Lates calcarifer*), was studied using Recirculating Aquaculture System by following completely randomized design with four replications. Asian seabass (5.20 ± 0.10 g) were randomly distributed in 20 tanks, each of 500-L capacity, and fed four times a day (6:00, 12:00 18:30 and 23.00 h). The study found that, fish held at 350 fish/m^3 significantly higher haemoglobin and red blood cells, compared with other stocking densities. In the case of biochemical parameters, total protein, Albumin, Globulin were lower in the 70 fish/m^3 than other stocking density and Blood Urea Nitrogen, cholesterol and triglycerides were significantly higher 350 fish/m^3 treatment. The relative gene expression of HSP70, HSP90A and GST was significantly up-regulated, with the increasing stocking density. Overall, the study found that the increasing stocking density produced chronic stress which negatively affected the growth performance of the fish. Therefore, the study suggests that rearing of Asian seabass at a stocking density of 70 fish/m^3 in a recirculatory aquaculture system could improve the growth performance, metabolic and molecular activities of the fish.

Keywords : Seabass, Biochemical parameter, Hsp70, Hsp90a And Gst

Paper ID 15717

Effect of live feed, (*Artemia* Nauplii) and farm made feed on the growth and survival of Zebra fish, *Danio rerio* Fry

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In the present study, the effect of live feed (Artemia Nauplii) and farm-made feed on the growth and survival of the Zebra Fish, Danio ratio fry was investigated. The mean value of water temperature, pH, dissolved oxygen, total alkalinity, ammonia (NH3) nitrite (NO2), and nitrate (NO3) in live feed (Artemia Nauplii) in the experimental tank was observed as 28^{o}C, 8.4, 4.5 mg/l, 140 mg/l, 0.02mg/l, 0.04 mg/ and 0.12 mg/l respectively. Whereas the farm-made feed tank registered the mean value of water temperature 28.5^{o}C, pH 8.5, dissolved oxygen 4.0mg/l, Ammonia (NH3) 0.09mg/l, Nitrite (NO2) 0.06 mg/l. The specific growth rate was a maximum of 405.28 in the live feed tank than in the farm-made feed tank at 351.88. The maximum SGR is 405.28. The highest survival 98% was achieved in the live feed experiment tank than in the farm-made feed tank. A major factor in the cultivation of the early stages of zebra fish fry is the availability of artemia live food organisms in sufficient quantity. Farm-made feed, also known as supplement feed, has been widely used in aquaculture because of its ease of availability and low storage maintenance. The present study indicated a significant effect of live feed on the growth and survival of zebra fish fry as compared to farm-made feed. Thus, it can be concluded that live feed is better suited than farm-made feed for sustainable and economically viable fish culture.

Keywords : Zebra fish, Artemia nauplii, Farm made feed, Growth and survival

Paper ID 15737

Development of decision support system to demarcate potential aquaculture sites in Nagapattinam district through Remote Sensing And GIS

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The aim of this study is to develop a multi-criteria decision support system to find out the possible aquaculture sites available in Nagapattinam district of Tamil Nadu, India. The chosen decisive parameters viz., normalized difference vegetation index (NDVI), digital elevation model (DEM), soil type, normalized difference water index (NDWI), land use land cover area, land surface temperature was subjected to the development of decision support system. Four different multi-criteria decision support techniques viz., weighted overlay (WOL), analytical hierarchy process (AHP), fuzzy classified analytical hierarchy process, and fuzzy classified weighted overlay were applied in the present study. The accuracy and reliability of all the models were compared and analyzed. The results obtained from the study rendered that the weighted overlay and the analytical hierarchy process outperform the fuzzy classified models. The suitability ratio of analytical hierarchy process and weighted overlay methods were found to be 12.7 and 12.4. A total of 25 locations were selected and mapped in the Nagapattinam region and their accuracy was checked. The analytical hierarchy process results were obtained with an accuracy of 84 percent. Hence, the analytical hierarchy process provided better results than the weighted overlay technique. The study rendered that the area of 7.22 percent is highly suitable for aquaculture.

Keywords: Remote Sensing, Geographical Information System, Aquaculture, Site selection, Multi-Criteria Decision Support System

Paper ID 15759

Histological analysis of gonadal tissue to study reproductive biology of endemic ornamental fish *Dawkinsia tambraparniei* reared under captive environment

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Dawkinsia tambraparniei is one of the endangered native ornamental fishes, confined only in the zones/tributaries of river Tamiraparani located at Tirunelveli, Tamil Nadu. To develop captive breeding technology of *D. tambraparniei* it is necessary to have a knowledge on size of maturity and maturity stages of brooders. Histological sectioning of gonadal tissue is a powerful tool to understand reproductive development of the fish. The current study was conducted to assess the size of maturity and maturity stages of *D. tambraparniei* under captive environment. *D. tambraparniei* were collected from Tamiraparani river during the month of November 2021. Collected fishes were reared under captive environment for the period of two months. During the rearing period the optimum water quality parmeters were maintained as similar to native environment. Different size male and female gonadal samples were collected and preserved in 10% Buffer Formalin for further histological analysis. Histological examinations confirmed ovaries resembling four different developmental stages including primary growth, cortical alveolar, vitellogenic and maturation. In the testis, primary spermatogonia, secondary spermatogonia, primary spermatocytes, secondary spermatocytes, spermatids and spermatozoa were identified in gonadal samples collected from different size fishes. The results of the study infer that, *D. tambraparniei* matures at the size of 5.0 cm and 3.5 gm. The findings of the study would be beneficial to ornamental fish breeders to understand the brood size of *D. tambraparniei* to be selected for breeding. The study also increases the interest of ornamental fish farmers to undertake breeding of endemic ornamental fishes such as *D. tambraparniei.*

Keywords : *Dawkinsia tambraparniei*, Captive breeding, Gonad histology, Maturation study, Endemic species.

Paper ID 15769

A new model of milkfish farming: Multiple Stocking and Multiple Harvesting (MSMH) Method

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Milkfish, *Chanos chanos* is an economically important and popularly farmed food fish of South-East Asia with a wide distribution in the Indo-West Pacific Ocean. Milkfish is a suitable species for low input-based culture systems practised by small and traditional farmers who subsist on return from aquaculture at regular intervals to meet up their daily needs. In this context, with the objective to develop a new model of milkfish farming, two consecutive trials were conducted with two stocking densities (7500 and 15000/ha) as treatments. Milkfish fingerlings (mean weight: 8 g) were stocked, reared in fertilized ponds (500 m^2) and fed with a formulated feed (Crude protein: 30%) @ 5-3% of biomass daily. After 100 days, partial harvesting was started when the fish attained 150 g body weight and ponds were restocked with same number of advanced fingerlings (mean weight: 35 g) at 15-day intervals keeping the total number of fish same to that of initial stocking. In the first trial, higher productivity of 3.6 ton/ ha in higher density was achieved as compared to 2.8 ton/ ha in the low-density culture in 160 days. In the second trial, there was a higher productivity of 3.8 ton/ ha in higher density compared to 3.0 ton/ ha in the low-density system in 180 days. This model with higher density had a benefit-cost ratio (BCR) of 1.66 suggesting its suitability over the lower density one with BCR of 1.50. Moreover, three out-station demonstration trials indicated the viability and acceptability of this model to farmers of the Sundarban. Findings indicated that MSMH model with stocking density of 15000/ ha can improve productivity and profitability in low input-based milkfish farming. This model could be suitable for small and marginal farmers with several added advantages of continuous return and low risk for short duration rearing.

Keywords : Msmh Model, Low-input based farming, Milk fish, Productivity, Continuous return

Paper ID 15778

Role of gut microbiota in health and production of Indian white shrimp, *Penaeus indicus*

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Gut microbiota is known to influence the health, nutrient absorption, reproduction, and other metabolic activities in both terrestrial and aquatic animals and can be used as biomarker to predict the performance in selective breeding programs. The present study generates information on microbial community structures associated with, developmental stages, dietary modifications, osmotic stress, wild and captive production conditions of Indian white shrimp, *Penaeus indicus,* employing metagenomic approach. The analysis of wild and captive reared *P. indicus* gut microbiota revealed that *Proteobacteria, Fusobacteria, Tenericutes*, and *Bacteroidetes,* were the dominant phyla, indicating host is the major determinant factor in the formation of gut microbiota. Microbes associated with the developmental stages (egg, nauplii, zoea, mysis, PL1, PL6 and PL12) showed that *Proteobacteria* and *Bacteroidetes*, were the two dominant phyla. The bacterial composition was highly dynamic in early stages and our study suggests that the mysis is the critical stage in transforming the microbial composition; which gets stabalised by early post larval stages. To study the effects of the probiotics on the gut microbiota, a combination of *Bacillus subtilis, B. lichiniformis* and *B. pumilus* (5×10^{10} cfu/gram) were added into the rearing environment of shrimp larvae (5000/500L). The analysis showed that the abundance of *Proteobacteria* was higher in probiotic treated group compared to control, indicating the possibilities for microbiota modulation at early stages. Further, understanding how environmental factors influence the shaping of gut microbiota will aid in using gut microbiota as a tool to prevent and control diseases in aquaculture. Intestine of shrimps adapted to two different salinities showed that the dominant phyla recorded was *Proteobacteria* followed by *Bacteroidetes* and *Fusobacteria,* though the abundance of these microbes varied significantly due change in salinity. These observations provide valuable information to device intervention strategies for health and production.

Keywords : Aquaculture, Crustaceans, Microbial diversity, Gut microbiota, Metagenomics

Paper ID 15799

IoT based E-gadget for assessing the quality of fish feed

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Feed is the important component in the shrimp farming when the feed is exposed to actions like loading and unloading, movement, stacking, storing, ware housing and finally delivery, handling and exposure to varying conditions that would affect the quality of feed. Nutrient composition and technical features, as they will have a direct impact on production, determination of the quality right at the purchase point can help the farmers to avoid use of low-quality feed at high price. Approximately 60 % of the cost of the production in aquaculture farms is for feeds. Currently the feed quality is determined by traditional Kjeldahl method and NIR Spectrometry method and there is no instant gadget to check the feed quality right at the purchase point. This work presents a portable IOT based E-Gadget to analyse the crude protein value of pellet feeds. The developed E-Gadget showed an excellent prediction performance (R^2=0.919) and the proposed methodology was validated by comparing with the traditional Analytical method.

Keywords: Feed Quality, Crude Protein, Internet of Things, Data Acquisition

Paper ID 15813

Analysis of land use land cover (LULC) changes in Nagapattinam district using remote sensing technique

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Change analysis of land use and land cover (LULC) is a technique to study the environmental degradation and to control the unplanned development. The study area is chosen as Nagapattinam district, which is located on the Bay of Bengal's coastlines in Tamil Nadu. Spectral Angle Mapping algorithm is used in the LULC map of the year 2020 of Nagapattinam district. The different LULC classes in 2020 are found as vegetation (1164 km^2), followed by built-up (80 km^2), barren lands (70 km^2) and water bodies (64 km^2). Prediction carried out by CA-ANN model using MOLUSCE plugin of QGIS. The analysis of LULC change revealed that the LULC of the study area had changed notably during 2010 to 2018. It is observed that the built-up class had the highest increase area compared to other classes with a total of 44 km^2 between 2010 and 2018. The purpose of this research is to predict LULC change for the year 2026 by classifying 4 LULC classes in Nagapattinam district with the Modules for Land Use Change Simulations (MOLUSCE): Multi-Layer Perceptron Neural Network and Geographic Information System method. The built-up class in 2026 was estimated to increase 39.8 km^2 (2.9 %) but the vegetation, barren lands and water bodies found to decrease by 33.8 km^2, 0.4 km^2 and 5.5 km^2 (2.5 %, 0.03 % and 0.4%) respectively. Water bodies were estimated to decrease from 70.6 km^2 in 2010 to 59 km^2 in 2026. The decrease of water bodies will affect the water source for aquaculture which is the primary source of livelihood of most of the people in Nagapattinam

Keywords : LULC, Multi-layer Perceptron, Mollusc, CA-ANN, Change Analysis, GIS, Remote Sensing

Paper ID 15815

Observations on the horizontal and vertical distribution pattern of rotifers, *Brachionus plicatilis* and *B. rotundiformis* in finfish larval rearing tanks

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The significance of live feeds in marine finfish larval rearing has been well established and rotifers are the most widely used live feeds for the early larval stages of many marine finfish species. The desired rotifer density in the larval rearing tank in a hatchery is maintained by adding mass cultured rotifers to the larval rearing tanks as per the hatchery protocols. However, little is known about the pattern of rotifer density existing at various places in the larviculture tanks. Hence a study was undertaken to assess the distribution pattern of rotifer density at various points in the larval rearing tanks of Silver pompano, *Trachinotus blochii*. The rotifer density at different points on the water surface (horizontal distribution) as well as in the water column (vertical distribution) was studied for two types of tanks with varying depth of the water column. For studying the horizontal distribution, rotifer density (numbers/ml) was estimated near the aeration points and away from aeration points. In case of vertical distribution, rotifer density at 50 cm below the water surface was estimated at three points in the tank. All the observations were taken from triplicate sets for both the type of tanks for 8 consecutive days during the larval rearing period of silver pompano, viz upto 8 DPH (Day Post Hatch). The study revealed that the rotifer density at water surface was more or less uniform in both shallow tank as well as deeper tanks. However the vertical distribution was affected by the depth of the larval rearing tank where the shallow tank offered a better uniform distribution of rotifer density.

Keywords : *Brachionus plicatilis*, *Brachionus rotundiformis*, Live Feed, Rotifer density, Larval rearing

Paper ID 15817

The first successful production of cultchless spat of Indian backwater oyster *Crasssotrea madrasensis* by hormone-induced settlement.

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Oysters remain the king in the global seafood market, and the demand for shucked oysters is consistent. Increased consumption of the "live shellstock" is another opening that demands a whole single oyster with proper shell shape and pleasing appeal. Though Indian backwater oyster has good meat content and grows fast, traditional oyster ren culture could not produce a single oyster with good shape and appeal. This is because the oyster's spats were attached and grown on some other shells as the base. This is where the technology of production of spat without using cultch material will give India a fillip for oyster farming as it can promote the large-scale farming of single oysters that are in high demand in Europe and America. Ripe Indian backwater oyster *Crassostrea madrasensis* collected from the Ashtamudi Lake were brought to the laboratory after proper quarantine and disinfection and was used for stripping. After stripping eggs of females and sperms of males suspended in seawater and the sperm,the suspension was activated using ammonium hydroxide and mixed thoroughly. Later 100-200 ml solution of sperm suspension was added to a beaker containing eggs to fertilize it. To check the fertilization rate, eggs were observed under the microscope. Fertilized eggs were transferred to an incubation tank for hatching. The hatched-out D shaped veliger larvae were reared in 2ton FRP tanks till they reached the eyespot stage (11 dph). Larvae were fed with a combination of microalgae such as *Isochrysis galbana*, *Pavlova*sp and *Dicrateria* sp. Once the larva reached the eyespot stage with 250 µ size, they were filtered using 220 µ mesh and taken for hormone treatment. Eyespot larvae were treated with Epinephrine at the rate of 0.22 mg /5 lakhs larvae. Treated Larvae were settled as single spat 33% success rate. After treatment, the set spats were transferred to the Micro nursery system for further rearing.

Keywords : Edible Oyster, *Crassostrea madrasensis*, Cultchless Spat

Paper ID 15826

Natural spawning vs induced breeding in silver pompano, *Trachinotus blochii*; spawning success and larval survival

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Silver pompano, *Trachinotus blochii* is one of the candidate mariculture species in the tropical and subtropical countries. Its adaptability for culture in brackish and marine waters upraised the value of Silver pompano as a potential marine finfish for grow-out culture. Wild collected brooders were tagged and cannulated to identify the sex, and the sex ratio of 1:1 was maintained at RAS to grow and mature. Fishes were bred initially by hormonal inducement (commercial grade LHRHa @ 150 µl/kg for females and 75 µl/kg for males), and later they started spawning volitionally (after 1.5 years of inducement). Once the brooders have been prompted to breed volitionally, spawning occurs every 9-12 days, and the same cycle continues for 4.5 months in a single pair. The study was conducted on a single pair of brooder (sex ratio 1:1) with a total weight of 2.9 kg female and 3.2 kg male. The analysis illustrated that the highest ever fecundity recorded during natural spawning was 400000 eggs per spawning, and the average fecundity was 350000 ± 18869.12 (mean ± se). While during inducement, the maximum fecundity recorded was 350000 with an average fecundity of 150000 ± 10456.26 per spawning. The fertilization rate during volitional spawning was 95.74 % compared to 90.41 % during induced spawning. The hatching percentage varied from 94.05 % to 96.12 % during natural spawning, while it varied from 75 % to 80 % during inducement. The attainment of metamorphosis also varied where the naturally spawned larvae attained on 18-20 dph while the induced ones on 23-29 dph. The feed transition from rotifer to artemia was reported on 8th dph in the case of naturally spawned larvae while 12 dph in induced ones. The maximum larval survival recorded on 25 dph was 35 %, with an average of 25± 2% during natural spawning and the larval vigor was estimable. While during inducement, the maximum recorded survival was 20%, and the average lay at 15±2%. The demand for the volitionally spawned eggs from the hatcheries was high owing to its fast growth rate, early metamorphosis, and good larval survival. Therefore, it can be concluded that volitional spawning gives a better upshot in fecundity, fertilization rate, hatching %, and larval survival than induced spawning of silver pompano.

Keywords : *Trachinotus blochii*, Natural spawning, Hormonal inducement, Larval survival

Paper ID 15832

Comparison of induced and volitional spawning of silver pompano, *Trachinotus blochii*, with special reference to larval quality

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The development of breeding and seed production technology of silver pompano, *Trachinotus blochii* has helped in the popularization of farming of this species in India. The conventional breeding technology involves broodstock development in onshore tanks under photo-thermal regulations followed by hormonal induction for spawning. However, volitional spawning also happens which may be triggered by favorable environmental cues and physiological factors. Hence a study was undertaken to compare the overall outcome of induced spawning and volitional spawning of silver pompano. The study was carried out for a period of 7 months during which a total of 21 volitional spawnings happened as against 12 induced spawning from among a total of 8 sets of brooders separately maintained under photo-thermal regulations in onshore facility. The larvae produced through volitional spawning were reared separately from that of induced spawning. The same hatchery protocols were followed for both groups in the same larval rearing shed. Both the groups were compared for fecundity, fertilization rate, larval size, survival rate, metamorphosis time etc. The study revealed that the newly hatched yolk sac larvae produced from volitional spawning were comparatively bigger than those produced from induced spawning. Also the survival rate was higher and metamorphosis period was lesser in larvae produced from volitional spawning when compared to induced spawning. However the fecundity was comparatively higher for induced spawning than volitional spawning

Keywords : *Trachinotus blochii,* Volitional spawning, Hormonal induction, Larval survival, Fecundity

Paper ID 15843

Development of culture method for marine polychaete worm, O*nuphis eremita* composed as a first reported worm from the Kovalam seashore of Chennai with its bio-chemical composition.

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The marine Polychaete worms, *Onuphis eremita* were collected from the Kovalam seashore, Tamil Nadu (India) and maintained in the laboratory condition. The worm, *O. eremita* was identified using DNA barcoding (Cytochrome c oxidase subunit I (COI)) and further examined by morphological characters. The DNA was extracted from middle region of *O.eremita*, around 700 bp of the COI gene was amplified using primers poly LCO and poly HCO. Furthermore, bio-chemical composition was analysed and reported as moisture, crude protein, fat, fiber, carbohydrate, and ash were 81.77%, (WWB) 61.92%, 4.58%, 1.12 %, 15.86%, 16.52% (DWB) respectively. The soil characteristics of the *Onuphis* worms collected area was observed as pH 8.14, electrical conductivity, and organic carbon were 5.21(µmhos/cm), 0.16% respectively. Forty adults, *O. eremita* (14 ± 0.3cm) when reared in 100 L tanks, produced 2,500 juveniles (6 ± 0.2 cm & 0.2g ABW) in 4 months with 90% survival. Each adult produced around 55 juveniles within 4 months. The juveniles (6.1 ± 0.1cm, n = 50 (0.20g) were reared in 25 L tubs by feeding CIBA shrimp larvae feed no: 1. The survival rate showed at 95%, with the SGR for a juvenile *O. eremita* was 0.41. The size reached to a length of 18.0cm with increased biomass to 33.25 g after 4 months. Around 500 juveniles were mass-reared in 1000L FRP tanks by feeding with a diatom, *Chaetoceros calciferons* (10^6CFU/ml) and powdered CIBA feed no. 1, which produced 400 adults (biomass 240g) with 80% survival in 4 months (18 ± 0.2cm) with SGR was 0.33. The net weight gained was 0.50g for juveniles. The present study revealed that growing polychaete worms in a controlled condition is advantageous, compared to collection from wild.

Keywords : Grow-out Practices; Marine polychaeta; Soil characteristic; Bio-chemical composition

Paper ID 15845

Successful production of first generation of organic carp seeds

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Organically produced fish is gaining importance and fetching consumer preference like other organic crops as a consensus to healthy diet. Its availability in large scale demands organically produced quality seeds. However, uncertainty in timely and quantum of seed supply is one of the major constraints in aquaculture. Therefore natural farming or organic farming is making a rapid stride in aquaculture. For organic fish farming, the fish seed produced through organic farming protocol is essentially required. Therefore, in the present study, in an attempt to produce the organic seed, the brood fishes of IMCs (Rohu, Catla And Mrigal) were netted out during monsoon season. A trial was undertaken for production of carp seeds organically at organic farm facility, ICAR-CIFA. Females were injected with Pituitary gland (PG) extract twice but males were injected only once through intraperitoneal route. First dose was given in the evening hours to female @ 5-6mg/kg body weight and second dose after 4-6 hours of first injection @ 8-16 mg/kg body weight. Males were injected at the time of second dose of female @ 4-5mg/kg body weight male. Induced breeding was carried out taking two male per female in breeding hapas fixed in organic fish culture ponds. Spawning was done in breeding hapa but hatching was done in incubation pools. Spawn of this three species produced were reared in large concrete (50sq.m) tank with organic protocol up to fry stage. To enhance the fertilisation effect liming was done in cement tanks regularly. For sustained production of natural fish food organisms in the rearing tanks a mixture of mohua oil cake, raw cow dung obtained from cows grazed on wild and natural grass, kalabati rice (organic rice) powder, yeast, jaggery, and organic rock phosphate were applied weekly and spawns were fed daily with supplementary diet of 1:1 ratio (kalabati rice powder: fish meal). The fish meal was produced from the law valued fish caught from deep sea. Subsequently, they were fed with a ground pelleted feed (Crude Protein: 27.72%, Dry Matter: 92%, Ether Extract: 6.31%, Crude Fiber: 7.6 %, Total Ash: 12.0%, Gross Energy (GE): 3.53 Kcal/g) prepared by using locally available organic feed ingredients (Mohula oil cake, Polanga oil cake, wheat flour , organic rice, fish meal). About 50,000, 30,000 and 20,000 advance fry of rohu, catla and mrigal were produced, respectively in the present study. The standardized protocol for production of carp seeds organically can cater the seed demand for organic aquaculture and can provide a boost to healthy organic protein diet.

Keywords : Organic fish, IMC, Pituitary glands, Nursery rearing, Pelleted feed

Paper ID 15869

Effect of stocking density and rearing system on growth performance of Speckled shrimp, *Metapenaeus monoceros*

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Speckled shrimp, *Metapenaeus monoceros* is native penaeid shrimp in India. As stocking density and rearing system plays a crucial role in the growth performance of the cultured shrimp, optimization culture techniques can pave the way for the diversification of *M.moneceros* along the coastal districts of India. The present study was carried out to optimize the stocking density and rearing system for the grow-out culture of *M.monoceros*. A 2 x 3 factorial design was carried out using hatchery-produced juveniles of *M. monoceros* (3.924 ± 0.04g) using a rearing system as first factor (mixotrophic, biofloc, and control with zero water exchange system) and stocking density as the second factor (30 and 60 no/m^3). At the end of 50 days trial, the highest body weight was recorded in the mixotrophic density system (MxT_{18}:7.66 ± 0.33g; MxT_9: 7.4±0.32g), followed by biofloc system (BFT_{18};7.39 ± 0.13; BFT_9: 6.15 ± 0.3) whereas the control group with only zero water exchange recorded the lowest final body weight (C18: 5.81 ± 0.19; C9:6.15 ± 0.34). Similarly, the highest survival (96-100%) was recorded in mixotrophic low and high-density groups, followed by floc-based (81-92%) and control groups (69-92.5%). The study revealed that specked shrimp can be well cultured in mixotrophic and biofloc based units with better growth performance. As *M.monoceros* is a hardy penaeid species with high demand in the domestic market, the culture techniques developed can be explored to devise location-specific farming technology for the species in different coastal parts of India.

Keywords : *M. monoceros*, Mixotrophic system, Biofloc system, Clear Water Zero Water Exchange System, Body weight, Survival.

Paper ID 15876

Effect of different diet on growth, survival and molting pattern of mud crab *Scylla serrata*

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Mud crab, the species of genus *Scylla* has been the focus of diversification of coastal/brackishwater aquaculture in India, and in many South Asian countries. One of the major challenge in developing aquaculture of mud crab has been the lack of formulated diet, and current aquaculture production of mud crab almost exclusively depends on fresh diet. In this context, the effect of different diets on the growth, survival and molting pattern of giant mud crab, *Scylla serrata*, that were individually reared was evaluated. The experiment was conducted in triplicate with four treatments viz, T1- Fish meat, T2-Crab meat, T3- Formulated feed (45% CP) and T4-Clam meat. Crabs with an initial bodyweight (BW-0.98±0.08g) and carapace width (CW-18.52±0.51mm) were stocked individually into shelters made of 10cm long 75mm PVC pipes (n=15) maintained in a 100-litre black coloured FRP tank fitted with seawater (23 ppt) flow through arrangement. During the experimental period, crabs were fed daily with treatment diets at 10% of the body weight and individual shelters were monitored for recording the molting event. The molted crabs were weighed 5 days after the molting to record the average bodyweight (BW), carapace width (CW) and weight gain (WG). The intermolt period and lunar phases were recorded until three sequential molt. The BW (5.39±0.21g) and CW (33.24±0.54mm) was significantly ($P<0.05$) higher in the crabs fed with clam meat at the end of the experiment. WG was significantly ($P<0.05$) improved in the crabs fed with clam (3.97 ± 0.17g) and crab meat (3.02 ± 0.12g). Intermolt period varied significantly ($P<0.05$) during the first and second molt cycle and higher duration was observed in crabs fed with formulated feed. Study on lunar phases revealed that, majority of the molting event occurred during the first quarter and third quarter and the molting pattern was similar between different diets. The final survival was significantly higher ($P<0.05$) in the formulated feed and clam meat fed crabs. Feeding formulated diet resulted in lower growth but produced higher survival, which reveals future scope for improved formulated feed.

Keywords : *Scylla serrata*, Moulting, Growth, Lunar phase, Survival

Paper ID 15878

Enhanced spawning performance of pearlspot, *Etroplus suratensis* in floating net cages and optimization of egg collection time and larval stocking density in RAS system

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Pearlspot, *Etroplus suratensis* is one of the commercially important cichlid species. The study was aimed to investigate scope of stocking varied pair no's of pearlspot brooders in floating net cages to effect spawning efficiency. *E suratensis* brooders male (20.5 ± 0.201 cm & 222 ± 4.33 g) and female (18.57 ± 0.44 cm & 179.15 ± 10.97 g) with ratio (1:1) were stocked in 4 different floating net cages with varied pairs no's 1, 6, 12. In each cage, clay bowls were suspended as substrate for laying eggs. Results revealed that a total of 68.66±2.02 no's of spawning were observed in 120 days from 12 pair of brooders stocked in 4 × 4 × 1.5 m with average fecundity 916±23.70 nos. Each pair has spawned at an interval of 21.53 ± 0.64 days with 5.97±0.12 times in 120 days. Resulted in production of 924.96±22.08 larvae/spawning with 96.49±0.63 % hatching rate. (Experiment-2) optimization of fertilized egg collection time interval for better hatchability showed significant difference ($p<0.05$), it was found that eggs collected at (0- 6 hrs), (6-12 hrs), (12-24 hrs) after spawning resulted in better hatchability (97.43 – 91.29 %) in portable RAS system. (Experiment -3) Hatchlings of *E suratensis* (6.25±0.20 mm & 7.6±0.33 mg) were stocked with four different stocking density 4, 6, 8 and 12 larvae/L in portable tub based RAS system with replication. At the end of 35 days, results revealed stocking density 4, 6, 8 larvae/L had highest specific growth rate and survival rate 85.95±0.97 %, 83.38± 1.48%, 82.38±1.12 %. It is concluded that 8 larvae/L considered as ideal density for pearlspot larval rearing in portable tub based RAS system. A total of 10,500 pearlspot fingerlings were produced at NGRC – CIBA farm with the participation of SCSP beneficiaries. A total of 10,500 pearlspot fingerlings (4.5 – 8 cm) were sold @ Rs 15/fingerling and generated revenue of Rs 1,57,500/-. Capital cost for setting up of 1 unit cage and portable RAS unit for incubation of eggs and larval rearing costs INR 100,000 for production of 50,000 fry/annum. This technology can be propagated to other coastal states of India for mass scale seed production of pearlspot for the benefit of aquafarmers and self-help groups as a livelihood generation activity.

Keywords : Pearlspot, Spawning, Floating Net Cages, RAS system

Paper ID 15880

Sea cucumber aquaculture in India for sustainable development and stock improvement

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India being the second largest aquaculture producer in the world mainly focuses on carps for domestic and shrimps for export consumption purposes. Since there is a growing demand for marine products in the foreign markets, Indians are exploring other alternative cultivable marine aquatic species with fetches good commercial value. Sea cucumbers are one such species which attract very good prices. In India, sea cucumbers are one of the most least exploited aquatic species compared to the others. Although their numbers are low due to over-exploitation in the previous decades, there is a lot of scope for their production on a commercial scale. Sea cucumbers are one of the highest priced fish commodities in the South-East Asian market with China & Japan being the top consumers. The advantage of having many products and by-products derived from sea cucumber coupled with India's fish processing ability makes it easier for us to market the product based on the consumer's requirement. Recirculatory based aquaculture system which is one of the topmost preferred systems for commercial production coupled with the IoT based technologies and various other conservation methods helps in commercialising the production of sea cucumber. This would not cause any significant stress in the natural population and thus not repeat the collapse of the fishery which occurred during the period from 1970's - 2000's.

Keywords : Least Exploited, Commercial, Products, By-products, Recirculatory, Iot, Conservation, Collapse

Paper ID 15884

Integrated Multi-trophic Aquaculture (IMTA) in hybrid biofloc system for bivalve (*Perna viridis* & *Crassostera madrasensis*) nursery rearing along with white leg shrimp *Litopeneus vannamei*

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The present study incorporates the benefits of the above culture systems for rearing bivalve spat (Asian green mussel *Perna viridis* and backwater edible oyster *Crassostrea madrasensis*) along with whiteleg shrimp (*Litopenaeus vannamei*), which is based on the principle of IMTA where we use two or more species belonging to different trophic levels where metabolic wastes by one species are used by other organisms as a source of energy. A substantial cost is involved in the nursery rearing of oysters and mussels for the production of pure algal cultures of different species for feeding the early spat. Then the spat is taken to out-door upweller nurseries or Floating Upweller System, or FLUPSY for further rearing before they are taken for grow-out culture. The present pilot system consists of 4 m diameter biofloc tank, which holds 10000 litres of diluted seawater(25ppt). It is also connected to RAS components like a biological filter and protein fractionators for better control water quality and control algal blooms or excess floc if it accumulates in the system. Two venturi aerators provide aeration in addition to two airoxy-rings connected to the main blower line. An oxygen generator and diffuser cone is also incorporated to provide pure oxygen for emergency.The white shrimp is stocked in the tank at the PL10 stage,and oyster and mussel spat are stocked in downwellers/silos of 30 cm diameter kept partially immersed in the flock water. Floc water and algae inoculated in the tank are constantly circulated in the wells/silos using an airlift system. The study resulted in more than 95 per cent survival and better spat growth compared to the traditional techniques. This is in addition to the production of shrimp stocked in the system at the rate of 200 numbers per m3. Experimental research indicates the possibility of bivalve farming, including onshore pearl production in this type of farming system.

Keywords : Biofloc, IMTA, RAS, *L.vannamei*, Mussel & Oyster Culture

Paper ID 15885

Larval rearing and mass production of *Marphysa gravelyi* using different feed diets

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Polychaete egg mass reared at different salinity range such as 0, 5, 15, 25 and 35ppt for a period of one week in order to find out the survival rate of larvae. A total of 100 numbers of eggs were stocked in 1L plastic tub in triplicate. Eggs were hatched within 24-48hr and diatom *Chaetoceros* sp @ 1-2 $\times 10^5$ cells/ml added as diet once the larval yolk reserves were exhausted. The eggs mass stocked at 0 and 5ppt were not hatched and there is a significant ($p<0.05$) difference in survival rate was found at 25ppt (76±2.7%) compare to 15 and 35ppt (56±1.8 and 37±2.6% respectively). Number of eggs found in an egg mass in a range of 7000 to 25000 nos with egg mass volume of 50-500 ml. The egg mass hatched within 24-48hrs and pass through metatrochophore larvae (310±17µm), Late metatrochophore larvae (425±32µm), nectochaeta larvae (630±42µm) and reaches juvenile stage (1063±30µm) within one week. One week old polychaete juveniles have an average length of 1063±30µm. Mass production of *Marphysa gravelyi* carried out for a period of 150 days using biofloc and shrimp starter feed as control observed significant production in the treatment fed with biofloc with a biomass production of 260 ± 34 g/m^2 with 52±2.1% survival compare to the control with a production and survival rate of 196 ± 12 g/m^2 and 38±2.1% respectively.

Keywords: Polychaete, Diatom, Biofloc, Mass Production, Egg Mass

Paper ID 15887

Breeding of orange chromide, *Pseudetroplus maculatus* in floating net cages and optimization of larval rearing density in RAS System – An Innovative Model for Mass Scale Seed Production

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Orange chromide, *Pseudetroplus maculatus* is considered as one of the potential ornamental fish. *P. maculatus* possess oval shaped body, yellow to orange colouration with black spots makes very attractive *P maculatus* possess oval shaped body, yellow to orange colouration with black spots makes very attractive. Although ample of results are available on *P* maculatus breeding and collection of larvae from brooder pairs. However, there are bottle necks in mass scale seed production of *P.maculatus* due to filial cannibalism, prolong parental care, problems in pair formation etc. Based on these issues, experiment was carried out to optimize the breeding pair density of Orange chromide*, P.maculatus* in floating net cages for enhanced breeding frequency. Orange chromide, *P.maculatus brooders* consist of male (7.42±0.15 cm & 7.87 ± 0.76 g) and female (7.35± 0.13 cm & 8.625±0.625 g ratio (1:1) were stocked in 5 different floating net cages (2 ×1× 1 m) with varied pair no's 1 pair (C1), 5 pairs (T2), 10 Pairs (T3), 15 Pairs (T4) and 20 pairs (T5) . In each cage, clay pots were provided to facilitate spawning. At the end of 60 days of rearing, The results revealed that *P.maculatus* brooders stocked at T4 (10 pairs) had significantly ($p<0.05$) higher spawnings (34 nos ±4.71), shorter inter spawning interval (17±2.13 days), spawning efficiency per pair (3.4) as compared to higher pair nos 15 Pairs (T4) and 20 pairs (T5). From the overall results, it was concluded that 10 pair of *P.maculatus* brooders (10 males and 10 females) in 2 ×1× 1 m floating net cages is ideal for enhanced breeding frequency by curtailing parental care. (Experiment-2) optimization of larval rearing density of *P. maculatus* in tub based RAS system revealed that stocking hatchlings of *P. maculatus* (4.6 ±0.25 mm) @ 6 larvae/L found to be ideal stocking density, *P. maculatus* attained fry (18.5 mm & 215±18.27 mg) with 80 % survival rate in 40 days. *P. maculatus* fry stocked in nylon hapa's (2×1×1 m) @ 300 no's fry/hapa and reared for 60 days, A total of 1972 marketable size *P. maculatus* juveniles (34.2±1.60 mm and 1.8±0.4 g) were produced from 10 pairs of brooders. The above study indicated potential for mass scale breeding and seed production orange chromide and thereby provide livelihood opportunity for the fisher folks.

Keywords: Orange chromide, Spawning, Floating Net Cages, Pair density

Paper ID 15891

On-board breeding of Hilsa, *Tenualosa ilisha* in Narmada estuary, Gujarat and larval rearing of *T. ilisha* in indoor, semi –indoor and outdoor systems.

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The Hilsa shad, *Tenualosa ilisha* is one of the commercially important food fishes of India and Bangladesh. The catch of *T. ilisha* is depleting in Narmada due to obstruction of spawning migration of brood fishes in this region. Therefore, To permute the aquaculture and conservation of this species. ICAR-CIBA, Navsari Gujarat Research Center has attempted first successful on board breeding of *T. ilisha* through artificial stripping method in Narmada estuary, Gulf of Khambat, Gujarat, India. On-board breeding trail was carried out in August month by dry stripping method, where ovulating female (39.5 cm & 850 g) and oozing male (32 cm & 330 g) brooders are stripped, eggs and milt are mixed to effect the fertilization. A total of 60,000 no's hydrated eggs (2.13 ± 0.03 mm) were packed @10,000 nos/5 L in oxygenated freshwater filled in polythene bags and transported to NGRC-CIBA research center. Eggs were incubated for 18 h at 29 ± 0.5^0 C. The fertilization and hatching rates were estimated as 70 % and 65 % respectively. A total of 27,300 no's *T. ilisha* larvae (2.443 ± 0.02 mm) were stocked @ 500 no's/m^3 in different larval rearing systems such as indoor, semi outdoor, outdoor tank, outdoor hapa systems for fry production. The highest total length was observed in *T. ilisha* larvae reared in semi-outdoor tanks (26.66± 0.33 mm) and lowest was recorded in larvae reared in indoor tanks (16.66±0.26 mm). The total body weight and survival rate of *T. ilisha* was found highest in semi-outdoor HDPE tanks(196.26 ± 17.1 mg & 6.77 ±0.14 %), outdoor HDPE tanks (148.33±10.83 & 5.45 ±0.32 %), outdoor hapa system (127.3± 15.43 mg & 5.53 ±0.62 %) and lowest was observed in *T. ilisha* larvae reared in indoor tanks (103.67 ± 8.17 mg & 1.30 ±0.28 %). From the overall results it is concluded that semi-indoor HDPE tanks are suitable for larval rearing of *T. ilisha*. The results of above study has indicated large scale breeding and seed production possibilities of *T. ilisha* in the Narmada estuarine region from the natural stock and subsequently which would help to develop the captive breeding programme to augment the hilsa fish seed production.

Keywords: On-board breeding, *Tenualosa ilisha*, Narmada estuary, Larval rearing systems

Paper ID 15905

Effect of synthetic kisspeptin-10, Hcg and Gnrh on induced breeding of *Epalzeorhynchos frenatum*

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The technique of breeding fish by other than its natural course is known as induced breeding. Induced breeding techniques have been developed for production of quality fish seed of cultivable varieties. These techniques have allowed farmers to profitably breed and raise species that do not naturally reproduce in captivity, and to manipulate the timing of reproduction to suit production cycles. Newly formulated inducing agents are also being tested for the induced breeding performance by various researchers in different parts of the country, under different climatic conditions, with varying degree of success. In the present study, the Rainbow shark, *Epalzeorhynchos frenatum* was induced using three different concentrations of synthetic Kissppetin-10, hCG and GnRH. The breeding performance like number of egg produced, response time, fertilization percentage, hatching percentage was observed. Average hatching rate of 86 %, 81% and 78% was found in the fishes induced with synthetic Kisspeptin-10 (150 IU/kg body weight), GnRH (0.5 mg/kg body weight) and hCG (1500 IU/kg body weight) respectively. This study characterized the variation of the steroid hormones testosterone (T) and 17b-estradiol (E2) during the reproductive cycle and their correlated with ovarian development stage. All the three concentrations used in the present study showed good breeding response hence the study suggests the use of synthetic kisspeptin-10 as a better inducing agent for the breeding of Rainbow shark and other closely related species.

Keywords : Keywords: Induced breeding, Synthetic Kissppetin-10, HCG and GnRH

Paper ID 15918

Evaluation of efficiency of different harvesting techniques on microalgae *Nannochloropsis oculata*

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Microalgae has its own importance with the wide range of commercial applications such as biofuel, human and animal food, high valued products, food supplements, nutraceuticals, pharmaceuticals and water quality restoration. However, microalgae utilization is not economically sustainable due to high cost of harvesting. Harvesting of biomass from microalgal culture needs high energy inputs, as small algal cells need to be separated from a large volume of surrounding media. In our study, comparison of harvesting efficiency of centrifugation, electroflocculation and chemical flocculation was studied on *Nannochloropsis oculata*. During centrifugation of *Nannochloropsis* with different rpm ranging from 1000-7000 for 5 minutes resulted in maximum harvesting efficiency of 99.60% at 7000 rpm. In order to reduce the cost as well as to enable the harvesting of more volume of the culture, electroflocculation method was attempted with different electrodes like Aluminum, Zinc, Copper, Brass and Iron were used as both anode and cathode. The electrodes were connected to DC supply and the flocculation was performed at different voltages viz; 20,40,60,80 and 100 V at constant power (90mA) and time (30 minutes). From this electroflocculation study, it was concluded that Zinc electrodes performed better with 80% harvesting efficiency at 40V. With back drop of this study, chemical flocculation of *Nannochloropsis* was studied with $ZnCl_2$ and $ZnSO_4$ (02, 0.4, 0.6, 0.8 & 1.0g/lit) as flocculants. At the end of the study it is resulted that ZnSO4 with 0.8gm/lit of *Nannochloropsis* culture perform better with 92% of harvesting efficiency. So, chemical flocculation of *Nannochloropsis oculata* with 0.8 g/lit $ZnSO_4$ may be an effective method of harvesting of large volume of microalgae culture with good harvesting efficiency. In addition, this method may be considered as simple, easy, high-efficiency and cost-effective harvesting process to achieve commercial scale algae-based process of *Nannochloropsis* culture.

Keywords : Centrifugation, Electro flocculation, Chemical flocculation, *Nannochloropsis oculata*, Zinc

Paper ID 15922

Impact of stunting on yield characteristics and economics of Snubnose pompano in low saline farming

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In the present study, the effects of short-term stunting (60 days) on compensatory growth was investigated in snubnose pompano (*Trachinotus blochii*), a supreme mariculture candidate. The experiment lasted 270 days and was comprised of three phases namely, stunting (Phase 1, 60 days), post-stunting (Phase 2, 60 days), and grow-out (Phase 3, 150 days). During Phase 1, the control group was stocked at a density of 17.5 fish/ m^3, while the fish of stunted group was stocked at a higher density of 56 fish/ m^3. In both groups, fish were kept at 15 fish / m^3 during the post-stunting period (60 days) and 12 fish / m^3 during the grow-out phase (150 days). All three phases were tested for production indices such as growth, feed utilisation, survival, and biometric features, while the whole body proximate composition and biochemical indices were measured after the grow out period. In terms of final weight, daily weight gain, and SGR, there was no significant difference ($p > 0.05$) in growth. Even though there was a growth lag during the stunting phase, the higher feeding rate during the post-stunting phase compensated the same. Although the feed delivered to stunted fish was significantly lower ($p<0.05$), improved growth efficiency and FCR were reported. In terms of final production and yield, there were no significant variations between the two groups. Except for cholesterol, and triglycerides, there were no significant variations in biometry, morphometry, dressing yield, carcass nutritional composition and serum biochemical markers. Due to a substantial difference ($p<0.05$) in the total feed consumed and the lower unit cost for stunted fingerling production, their farming resulted in a greater net operational revenue (profit) and benefit cost ratio. In conclusion, the stunted fish farming approach can be successfully applied to the farming of snubnose pompano for increased aquaculture profitability.

Keywords : Pompano, Economics, Cage culture, Compensatory growth

Paper ID 15925

Morphological changes and survival during the initial delayed feeding of silver moony, *Monodactylus argenteus*

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The effects of the timing of first feeding, feed resumption on the point-of-no-return (PNR), survival, and growth of *Monodactylus argenteus* larvae were studied under controlled conditions. The onset of first exogenous feeding was observed at 36-48 hours post hatch (hph) and reached PNR by 84-96 hph at 29 ± 1 °C. The yolk absorption in silver moony larvae was accomplished by 96 h, regardless of the differences in the initial feeding. Correspondingly, the oil globule was completely utilized at 120 h after hatching. There was no significant difference in the yolk volume and oil globule utilization on 0, 1, and 2 days post hatch (dph) in larvae among different treatments. The yolk volume of 3 dph larvae initiated first feeding at 24 hours and 48 hours significant differences with yolk volume of larvae initiated first feeding at 72 hours, 96 hours and 120 hours. However, the oil globule of 4 dph varies significantly between the treatments the same as the way of yolk sac volume. The time of first exogenous feeding affected expressively the larvae growth. Faster growth was observed for 1 and 2dph delayed first feeding larvae compared to other delayed first feeding larvae ($P < 0.05$). Survival rate was higher when the silver moony larvae initiated initial feeding with rotifer *Brachionus plicatilis* at 1 and 2 dph compared to 3 and 4 dph. Complete mortality was recorded on 6 dph for the larvae initiated first feeding at 5 dph, and significant differences were observed between the treatments. The present study suggests that, to avoid the potential mortality and gain better development, survival, and growth in industrial production, the *M. argenteus* larvae must establish successful first feeding within 48 hrs (2 dph) after hatching.

Keywords: Delayed feeding, PNR, Growth, Survival, Larvae, *Monodactylus argenteus*

Paper ID 15928

Photo Bioreactor – efficient and reliable technology for high density culture of microalgae, *Nannochloropsis oculata*

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Microalgae are considered as a valuable organic resource with a potential application in finfish, shellfish and molluscan culture. Being, rich source of essential fatty acids (EPA and DHA), the microalgae have very important role even in human nutrition. Uncertainty in continuous production with sufficient biomass become the major bottleneck in conventional culture systems, which requires large areas for commercial operation influenced by several environmental factors. In this juncture, microalgae cultivation in the closed system (photo bioreactors) can prove to be more effective, due to the possibility of better control over the production process in order to increase the productivity. Continuous microalgae production in PBR will be a good prospect for technology with high density culture, because it prevents culture contamination and thereby reduce the operational cost of the microalgae culture including the regular culture maintenance, manpower requirement etc. With this backdrop, *Nannochloropsis oculata* was cultured in vertical photobioreactor with four reactors (R1, R2, R3 & R4) of capacity of 25 litre each. Different parameters including various doses of CO_2 along with second dose of culture medium on different culture days were experimented. Control (R1): without CO_2; R2: 10Kg/cm^2 CO_2 with second dose of culture medium on Day2; R3: 20Kg/cm^2 CO2 with second dose of culture medium on Day3; R4: 40 Kg/cm^2 CO_2 with second dose of culture medium on Day4 were maintained. All reactors were inoculated with 20% *Nannochloropsis* inoculum and standard medium. The culture conditions maintained with light intensity of 2500lux, temperature of 24.5^{0}C and salinity of 29 ppt. During the culture duration of 5 days in photobioreactor, a maximum density of 60 X 10 ^{6} cells/ml was obtained from R2 which was resulted from combined effect of CO_2 and second dose of culture medium. So *Nannochloropsis* culture in photobioreactor with manipulation of culture conditions have the scope of continuous culture with high density and biomass.

Keywords : *Nannochloropsis Oculata*, CO_2, Photobioreactor

Paper ID 15933

Supplementation of potassium and magnesium ions improves growth and survival of whiteleg shrimp, *Penaeus vannamei* post larvae reared in freshwater

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Rearing of whiteleg shrimp, *Penaeus vannamei* in freshwater (FW) is an emerging area of interest among the farming community, whereas little information exists on the suitability of pure FW (TDS < 500 ppm) as a medium to rear marine shrimp. An experiment was performed to evaluate the performance of *P. vannamei* PL in true FW (TDS-367.5 ppm) and compared with FW supplemented with potassium and magnesium ions equivalent to reconstituted seawater (SW) of salinity, 1.0, 1.5, and 2.0 ppt. The study consisted of 8 treatments viz. FW (K^+:4.9 ppm; Mg^{2+}: 18.29 ppm), K1(K^+:11.0 ppm; Mg^{2+}: 18.04 ppm), K2(K^+: 16.7 ppm; Mg^{2+}: 18.04 ppm), K3(K^+:22.7 ppm; Mg^{2+}: 19.02 ppm), M1(K^+:4.9 ppm; Mg^{2+}: 39.45 ppm), M2(K^+:5.3 ppm; Mg^{2+}: 59.26 ppm), M3(K^+:5.0 ppm; Mg^{2+}: 76.82 ppm) and SW of salinity 31 ppt (K^+:311 ppm; Mg^{2+}: 1234.14 ppm). *P. vannamei* PL19 acclimated to FW was stocked to different treatment groups (30 no./tank) in triplicate and reared for 30 days. All the shrimp reared in FW died by 28 days. Supplementation of potassium and magnesium significantly improved survival and growth of shrimp. Highest survival was observed in PL reared in SW (65%), that was similar to survival in potassium supplemented treatments (K2 & K3: 48.7-52.5%). Lower survival of 28.7 to 38.7% was observed in the magnesium supplemented groups (M1, M2 & M3) as compared to the potassium supplemented groups (K1, K2 & K3- 32.5 to 52.5%). However, FW supplemented with magnesium ions (TDS: 468-615 ppm) resulted in numerically higher growth (0.55 to 0.70 g) when compared to potassium supplemented groups (TDS: 380-399 ppm; 0.21 to 0.42 g), and was similar to PL reared in SW (0.46 g). The study clearly indicates that FW (TDS<500 ppm) is not a suitable medium to grow *P. vannamei*. Supplementation of potassium in FW, increases the survival rate, whereas adequate growth in FW clearly requires TDS greater than 500 ppm. Hence, supplementing K^+ and Mg^{2+} ions in FW has a positive impact on growth and survival of shrimp in freshwater.

Keywords: Freshwater, TDS, Potassium, Magnesium, Growth, Survival

Paper ID 15943

Rearing and growth observation of *Mystus cavasius* (hamilton, 1822) in different captive conditions.

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The present research was designed to study the effect of light exposure and shelter on *Mystus cavasius*. Fingerlings were stocked in each tank for the evaluation of growth and survival, continued for six weeks. Fingerlings were reared in two treatments with three replications, first was provided with shelter for hiding and second was completely covered with polythene sheet to provide dark environment and open tank used as control for six weeks during research programme. Specific growth rate, feed conversion ratio, protein efficiency ratio and survival rate were observed at every fifteen days interval. At the end of the experiment result showed that maximum weight was observed in tanks which were provided with hiding space however the length of fish after six weeks of experiment were not varying much.

Keywords: Fingerlings, Food Conversion Ratio, Specific Growth Rate, Survival Rate

Paper ID 15944

Developing intensive culture techniques for the tropical calanoid copepod, *Parvocalanus crassirostris,* as live feed for marine finfish larval rearing

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Copepods are the most common secondary producers in marine environment and the natural prey for the larvae of most marine finfish species. However, utilization of copepod in aquaculture hatcheries is still sporadic, which is largely attributed to difficulties in their culture on mass scale. Thus the present work was undertaken to develop intensive culture techniques to overcome the current constraints hindering a reliable mass production of calanoid copepod *Parvocalanus crassirostris*. Three trials were conducted to find out suitable feed as well as optimal stocking density for the culture of *P. crassirostris.* In the first experiment, the optimal diets for *P. crassirostris* culture was investigated using different feeds such as *Isochrysis galbana*, *Chaetoceros calcitrans*, *Nannochloropsis salina*, The second experiment was focused on identifying the optimal culture density for *P. crassirostris* when the nauplii were not removed from the culture. The third experiment was carried out to find the optimum stocking density for culturing copepod when the nauplii were daily harvested without affecting the adults. Among the five diets tested, the production of eggs and nauplii and the population growth was significantly ($p<0.05$) higher in *Isochrysis sp.* and *Chaetoceros sp.* fed group. However, for longer duration of culture, *Isochrysis* sp. was found to be more suitable than *Chaetoceros sp.* The highest copepod density was achieved at the stocking density of 1.00 mL^{-1} on day 3, when the nauplii were not removed from the culture. However, when nauplii were daily removed from the culture, the highest copepod nauplii density was achieved at the stocking density of 0.25 mL^{-1}. Based on the results of the present study, *Isochrysis* sp. may be recommended for the intensive cultivation of *P. crassirostris* and the stocking density for culture may be 0.25 mL^{-1} when nauplii were harvested daily and 1.0 mL^{-1} when nauplii were not harvested.

Keywords: *Parvocalanus crassirostris;* Micro-algae; *Isochrysis galbana*

Paper ID 15948

Optimizing long distance transportation for seed crab of *Scylla serrata* and *S. olivacea*

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Emerging mud crab aquaculture in Gujarat, is largely dependent on wild caught seed stock sourced from southern India, where an organised fishery and supply chain exist. High mortality and sanitary issues (foul smell) are the major issues during conventional long-distance transportation of seed stock, leading to economic losses, poor survival post stocking and rejection of consignments by airlines. Experiments were carried out to optimize long distance transportation protocols for giant mud crab, *S. serrata* [ABW-114.0±2.8 g; mean carapace width (CW)-8.4±0.07 cm) and orange mud crab, *S. olivacea* (ABW-56.75±3.9; mean CW-7.1±1.8 cm) juveniles. Nine hundred *S. serrata* juveniles obtained from the local backwater fishery of Muttukadu, was divided into three uniform groups (n=300) and subjected to conventional packing, packing post immersion in seawater (flow-through, 100L/min, intense aeration) for 90 minutes and packing post immersion in seawater for two consecutive 90-minute periods separated by 6 hours. All juveniles were packed in polystyrene boxes [53cm x 32.8cm x 21.8cm] provided with 2.5 cm diameter holes on the sides. Each polystyrene box was loaded with approximately 8.5 kg of mud crab arranged in three layers. Each treatment group was replicated in 4 boxes. In conventional packing, crabs were directly packed after moistening them and arranged in layers separated by moist gunny bags. Crabs from seawater immersion groups were stocked in layers separated by banana leaves and the boxes were lined with small meshed soft braided netting. The crabs were air-lifted to Gujarat, and the survival was assessed after 20 hours. Mud crabs subjected to immersion in seawater once and twice for 90 minutes resulted in significantly higher ($p<0.05$) survival of 96.6±1.5% and 98.3±0.6% respectively as compared to the conventional packing that resulted in lower survival (66.3±1.6%). Similar trial conducted for *S. olivacea* (10 kg/box), wherein conventional packing was compared with a single immersion in running seawater for 90 minutes, immersion resulted in 100% survival as compared to 86.6±0.6% in the conventional method. The study was repeated for both the species and single immersion in seawater for 90 minutes prior to shipping, consistently yielded survival ranging between 96-100%. Immersion of crabs in running seawater, helps in excretion of ammonia and release of faecal matter, thereby preventing the build-up of ammonia in body fluids and overcoming the sanitary issues during transport. This methodology significantly reduces mortality of mud crab juveniles and economic losses to the farmer during long distance transportation.

Keywords: Mud crab, Survival, Transportation, Immersion, Packing

Paper ID 15951

Evaluation of altered rotational speeds in the paddle wheel aerators for their efficiency of aeration in aquaculture ponds

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Aerator is an indispensable component in the shrimp farming activity to maintain the dissolved oxygen level and also the temperature management. In intensive culture of fish or shrimp, aeration by some mechanical devices is being done. Among the various aerators, paddle wheels are more popular due to obvious advantages. All the paddle wheel aerators are driven by induction motor of 2HP/3HP capacity, which are power – driven. The cost towards electricity for running the aerators is one of the important costs pushing up the cost of production in Aquaculture. It has been estimated that a 1ha pond with 10 numbers of 2HP aerators would cost approximately Rs. 60,000/- per month. Variable Frequency Drive (VFD) motors help in reducing the electricity cost by operating at variable speeds as per the requirement for optimally oxygenating the ponds considering the biomass, external temperature, water temperature, oxygen solubility rate and efficiency of aerators. A developed paddle wheel aerator driven by VFD motor with necessary modification was tested in a controlled condition in the brick masonry tank of dimensions 5.3m×2.7m×1.1m for different speeds of paddle and spiral wheel aerator. The standard aeration efficiency (SAE) was found to be maximum at the rotational speed of 80 rpm for both the aerators. The power required for driving the paddle wheel at the optimal speed of 80 rpm was found to be 1kW and that for spiral aerator was 1.12kW which are comparatively lower than that required at the maximum speed of 110 rpm (1.44 kW and 1.46kW, respectively). An evaluation was made for the economic benefits that can be derived from the alterations and they are discussed in the light of cost towards power.

Keywords: Shrimp, Aquaculture, Aerators, Power, Variable frequency drive, Motor

Paper ID 15957

Production characteristics, length-weight relationship and growth rhythms of Indian white shrimp *Penaeus indicus* during a commercial growout trial in Gujarat, India

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Shrimp aquaculture in Gujarat, as elsewhere in the country is over-dependent on the non-native, whiteleg shrimp *Penaeus vannamei* which is presently being plagued by several issues, resulting in reduced production and profitability. This study would help to evaluate its suitability as a supplementary species to *P. vannamei* in Gujarat. Disease free *P. indicus* post larvae (PL) (1.28 Lakh, TL: ~10.9 mm; BW: ~14.7 mg) was stocked to a 0.4 ha (4000m^2) earthen pond in Navsari, Gujarat (S.D:32 PL/m^2). PL shipped at 30 ppt was gradually acclimated (4 ppt/hour) to the growout pond of salinity 47 ppt. The shrimp were fed using whiteleg shrimp feed (CIBA-Vanami^{plus}) containing 35% crude protein. Sampling to evaluate the relationship between lunar periodicity and growth increments was carried out on days at or adjacent to different lunar phases. Turbidity of the rearing medium exceeded 100 NTU after 55 DOC due to local soil conditions and vigorous bottom feeding/dwelling habit of *P. indicus*. At the end of 144 DOC, shrimp attained a mean body weight of 16.55±0.31 g with a mean daily and weekly weight gain of 0.13±0.02 g/day and 0.91±0.13 g/week respectively. The grow out trial resulted in a total production of 2053 Kg (5.13 t/ha) with a survival rate of 97.2% and feed conversion ratio of 1.902. Length-weight relationship of *P. indicus* during the trial was, $W=0.0053L^{3.07}$ (n=1075, R^2=0.99), and shrimp demonstrated a positive allometric growth. Feed consumption of *P. indicus* followed an inverse relationship with the rainfall wherein rainier days resulted in reduced feed intake. Evaluation of feed consumption of shrimp in relation to lunar phases indicated that the feed intake increased during the 1st and 3rd quarters whereas it reduced significantly during the new moon phase. *P. indicus* exhibited a growth rhythm that coincided with the lunar phases until 105 DOC, wherein weekly weight gains were highest at periods adjoining the new moon and full moon. Shrimp production from the trial resulted in a total revenue of ₹ 6,36,430 and net profit of ₹ 49,171/acre/crop (₹ 2.5 lakhs/ha/year). Although, *P. indicus* demonstrates a lower growth rate as compared to the exotic genetically improved *P. vannamei*, its high survival rate, excellent market value and reasonable productivity, gives conclusive evidence on its potential future in the Indian shrimp industry.

Keywords: Indian white shrimp, Growth, Lunar, Growout, Commercial

Paper ID 15960

Performance of rainbow trout (*Oncorhynchus mykiss*) and lettuce (*Lactuca sativa*) in a low cost re-circulatory coldwater aquaponic system

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The production performance of rainbow trout (*Oncorhynchus mykiss*) and lettuce (*Lactuca sativa*) were evaluated in a low cost re-circulatory coldwater aquaponic system. A prototype of experimental aquaponics unit was fabricated using low-cost materials comprising fish tanks, swirl separator, sump cum base addition tank with three hydroponic cum bio-filter sub-systems such as river stone bed, crushed stone bed and deep water culture (DWC) system. Vegetable seeds were germinated in two types of units but the germination rate was better in egg trays than plastic trays. During the experimental trial, specific stocking density of rainbow trout juveniles and planting gap of plantlets (1-2 true leaves) were followed and were distributed randomly among the treatment groups. Experimental fish were fed with commercial trout grow-out feed @ 3-5% of their body weight while the plant growth performance was purely subsisted on the fish effluents, with no supplementation of additional input. Fish growth, plant growth and water quality parameters including nutrient removal were estimated to test the proficiency of different sub-systems and their dependence on hydraulic loading rates (HLR). The growth performance of fish were better in higher HLR treatment and in the production of one crop table size rainbow trout, three crops of salad vegetables were harvested. The removal of total ammonia nitrogen (TAN), nitrate and phosphate varied significantly among the treatment groups and follow the order, DWC > crushed stone > river stone. The lettuce performance was good in terms of biomass production with significantly better performance for DWC unit but among two types of media beds, the crushed stone unit performs better. Hence, the DWC method can be recommended for a low-tech rainbow trout-lettuce aquaponic system, taking into account of the proper designing of filtration and hydroponic components.

Keywords: Coldwater aquaponics, DWC, Crushed Stone, River stone, Rainbow trout, Lettuce

Paper ID 15966

Effect of different feeds on offseason breeding and larval rearing in Asian stinging catfish, *Heteropneustes fossilis* (Bloch,1794)

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Heteropneustes fossilis commonly known as stinging catfish is a popular indigenous fish of the Indian sub-continent. The species has a high consumer demand because of its tender flesh, low fat, and high iron content, and is recommended for anemic patients. Although the species has high consumer preference and potential for commercial aquaculture, consistent production of good quality seed is still a major problem. Availability of fish seed for a longer period can increase the popularity of culture, offseason spawning may prove beneficial for round the year availability of seed. In this context, the present study was focused on off-season spawning and larval rearing of Asian stinging catfish with four different feeds (T1-earthworm, T2-chicken viscera, T3-earthworm + chicken viscera, and T4-artificial pelleted feed) for the broodstock maturation under a controlled environment (14 h:10h light: dark and temperature, 27-28°C). The sexual maturity was attained 90 days before the normal breeding season. Five breeding trials were conducted for each treatment group with a male: female ratio of 2:1. The highest absolute fecundity (3150) was observed in the T1 group followed by T3 (2835), T4 (700), and the lowest was observed in T2 (497). Larvae obtained from offseason breeding were reared for 21 days, with different live feeds (T1- moina enriched with krill oil, T2-moina, and T3-*Artemia* nauplii) for growth and survival estimation. The SGR in length and weight was observed significantly highest in T1 whereas lowest in the T3 group. The maximum survival of larvae was recorded in the T3 group followed by T2 and the significantly lowest was observed in T1. The present findings indicate that the earthworm may prove a more suitable diet for early broodstock maturation and spawning whereas, Artemia nauplii are suitable to live feed for larval rearing in terms of survival.

Keywords: *Heteropneustes fossilis,* Offseason breeding, Earthworm, Larval rearing, Artemia nauplii

Paper ID 15968

Seed production of ornamental barbs from western ghats and promotion of captive bred endemic fishes in ornamental trade

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Ornamental aquaculture in India is mainly dependent on trade of exotic fishes like live bearers, cyprinids, tetras, cichlids, etc. This is due to the preference of the hobbyist to keep the compatible fish species in aquarium and long years of domestication in captivity. Several varieties have been developed and trade has boomed to a large extent. However indigenous barbs from western ghats are collected from wild and exported to other countries. Barbs from India are fetching good price for its fusiform shape and varying colourful fins with black bands. This demand has led to the depletion of endemic fish stocks from natural waters. Therefore, need arises to focus on commercial production of such species in captivity which has a greater demand and scope. Breeding and larval rearing of indigenous barbs such as filament barb, tambraparni barb, narayan barb were standardized at ICAR-CIFA, Bhubaneswar. They are batch spawners and are able to release eggs 2-3 times during breeding season, July- November and February- April. Rectangular tanks are preferable, seasoned with infusoria culture two days prior to breeding. Brooders are introduced in 2:1 ratio (Male: Female) into hanging breeding hapas partially submerged into water. Around 73 % of breeding sets spawned within a day, 19% on the second day and rest 8% did not respond. About 50-100 juveniles were produced per female having fecundity of 150-300 eggs/ g body weight. We have standardized the breeding of this fishes using natural simulation after repeated breeding trials. Interventions are needed in general management practices for better growth and survival in different culture system. The need arises for farmer friendly culture approaches for indigenous fishes in a line of rearing techniques used for exotic ornamental fishes. The present study has focussed on easy-to-do culture practices for ornamental barbs to enhance the seed production in captivity.

Keywords: Ornamental fish culture, Barbs, Breeding, Larval rearing

Paper ID 15975

Seaweed aquaculture: A step toward Sustainability

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Seaweed farming is one of the most environmentally sustainable and healthier way to produce food. It has become an alternative livelihood choice in tropical developing nations to improve the socio-economic status of small-scale fishermen, boost the living standard of the coastal population, and promote the sustainable use of coastal and marine resources. It is fastest growing aquaculture sector; seaweeds also have a quicker growth rate and do not require fresh water, land area, harmful industrial fertilisers or pesticides. Hydrocolloids, such as alginates, agars, carrageenans, ulvanes, and fucoidans, are key and commercially important seaweed products that have been widely employed in the food and pharmaceutical, cosmetics industries, as well as other industries. Seaweeds are the only non-fish sources of natural omega-3 long-chain fatty acids and include micronutrient minerals (e.g. iron, calcium, iodine, potassium, and selenium) as well as vitamins (primarily A, C, and B-12). Seaweeds are used to treat iodine deficiency and as a vermifuge in medicine. Seaweeds are also being studied as a salt alternative and in the production of biofuel in the industrial sector. To reduce the problem of plastic pollution scientists have developed fully biodegradable bio plastic made from seaweed. Seaweed farms thrive by absorbing nutrients and CO_2. The seaweeds farms have the potential to enhance water quality and the sea being the major sink of carbon they are well known for their carbon sequestration properties, seaweed have nearly scale of sequester nearly 6500 tonnes of CO_2 per day, adding a huge carbon credit to the nation while providing a climate resilient environment as a result they help to mitigate the local effects of ocean acidification.

Keywords: Seaweed, Sustainability, Ocean acidification

Paper ID 15977

A four species model of freshwater integrated multi-trophic aquaculture (FIMTA) enhances production and provides diversified outputs

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The production performance of a four species combination of Freshwater Integrated Multi-Trophic Aquaculture (FIMTA) was evaluated against monoculture of fish in 100 sqm earthen ponds in duplicate. The ponds were prepared and managed using standard pond management practices. The evaluated FIMTA model included fed species - fish*: Barbonymus gonionotus;* deposit feeders - prawn: *Macrobrachium rosenbergii;* organic extractive species -freshwater mussel: *Lamellidens marginalis* and inorganic extractive species – aquatic plant: *Ipomoea* sp.). The stocking density employed were 1.5 nos./m^2 for fish, 1.0 nos./ m^2 for prawn, 1.0 nos./m^2 for mussel and 0.2 nos./m^2 for plants in treatment ponds. The production efficiency of this system was evaluated against a control system of only fish (stocked at 1.5 nos./m^2 in a monoculture system). The mean size at stocking of fish in control and treatment ponds was 50±20.3g and 48±21.1g respectively. The size at stocking of prawn, mussel and plant saplings were 2.8±1.2g, 66.4±15.8g and 1.2±0.1g respectively in treatments ponds. Floating feed (20% protein) was given to the fed species @5% of body weight in all the ponds. After 120 days, the fish attained a size of 202.35±55.8 and 249.3±61.3g in control and treatments respectively. The harvest size of prawn, mussel and edible leaves were 41.2±0.74g, 68.6±1.78g and 156±8.5g respectively. The fish yield alone from FIMTA ponds (3.0±0.52 t/ha) was significantly higher than the control ponds (2.8±0.02 t/ha) while the survival of fish did not differ significantly. Additional production of 325±25.0 kg prawn and 4750±636 nos. of pearl mussel and 15.6±0.85 kg/ ha edible leaves were obtained from FIMTA ponds. Hence, it is evident that higher yield with diversified outputs (fish, prawn, mussel and edible leaves) is possible in FIMTA system with similar input use by effectively utilising the aquaculture wastes like uneaten feed, faeces etc. in the system.

Keywords: FIMTA, Fish, Prawn, Mussel, Plant

Paper ID 15985

Study on the broodstock development, induced breeding and morphological development of larvae of the Picnic seabream, *Acanthopagrus berda*

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The Picnic seabream, *Acanthopagrus berda* is a potential mariculture candidate species and the present study is the preliminary effort in developing a captive breeding technique for this species. Sixty sub-adults (200-1800 g) of *A. berda* were collected using trap/cast net from the Korapuzha estuary, Kerala during January to December 2021. Males (200-500 g) and females (350-1800 g) were maintained in 5 tonne capacity recirculatory aquaculture system and were fed with fresh squid supplemented with vitamins and minerals @ 5% body weight. Males were examined for free milt. Matured female fishes with an oocyte diameter of 600 ± 5 µm could be successfully induced to breed using GnRH analogue. The inducing agent (WOVA- FH) administered intra-muscularly @ 0.5 ml/ Kg for female and 0.25 ml/ kg for male resulted in successful spawning. Female fishes spawned after 48 hours of hormonal inducement at 28°C. Total fecundity of 1.3 lakh eggs (ova diameter 825 ±12 µm) were obtained with 95% fertilisation rate. Fertilised eggs hatched out (95%) after 18 hours of spawning. The first day planktonic larvae measured 1.47 ± 0.23 mm TL with a large yolksac (790 ±2.8 µm). The larvae were 2.37-2.93 mm TL (mean, 2.74 mm ±0.21) on the second day after hatching. At this time, about two-thirds of the yolk was absorbed, the bladder and intestines had formed, and the mouth and anus were open. The pectoral fins were developed on the third day DPH (2.83±0.04 mm) and about 95% of the yolk was absorbed. Planktonic larvae started active exogenous feeding from the 4th day post hatch (dph) when the mouth opening was 60 ±2.5 µm (TL 2.74 ±0.41 mm). Larval rearing was successful until 5th DPH (2.87± 0.38 mm). The present report indicates the possibility of breeding to develop a standard seed production technology for *A. berda*.

Keywords: *Acanthopagrus berda*, Picnic seabream, Induced breeding, Larval rearing

Paper ID 15989

Amino acid and fatty acid profiles of spontaneous and induced spawn eggs of Asian seabass, *Lates calcarifer* as a tool for egg quality

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Biochemical composition of fertilized eggs reflects the egg quality since the requirements of embryo for nutrition and growth is derived from these biochemical reserves and study of the biochemical composition of an egg is a potential way to assess egg quality. In oviparous species, the yolk is a mix of materials used for embryonic nutrition and development, biochemical composition of eggs may be one of the most studied biomarkers in egg quality for several species. Fatty acids, considered as major source of metabolic energy, polyunsaturated fatty acids (PUFA) is essentially required for growth, development and reproduction of fish hence play an important role in egg quality of fishes. Though many intrinsic and extrinsic characters influence the egg quality, the amino acids also play an important role since it is associated with anabolic and catabolic process in developing embryo and the yolk sac in larvae. An effort was made in the present study to assess the egg quality of Asian seabass *Lates calcarifer* by analyzing the amino acid and fatty acid profiles in the eggs obtained through induced and natural spawning methods. The results revealed that the total amino acid concentration obtained were 69.92±0.32, 62.23±0.86 and 37.39±0.67% in natural, induced and unfertilized eggs respectively. and Similarly, essential amino acid concentration were estimated as 46.09±1.21, 39.66±1.87 and 26.58±1.47 % respectively in natural, induced and unfertilized eggs. The results obtained in the present study showed higher Polyunsaturated Fatty Acid (PUFA) (52.85, 56.32, 51.96%) content than Monounsaturated Fatty Acid (MUFA) (9.6, 8.9 and 30%) and SFA (34.63, 32.40, 9.19 %) in all three (induced, natural and unfertilized respectively) type of eggs.($p>0.05$). Saturated fatty acid also found to be high in naturally spawned eggs (36.40±1.63%) compared to induced spawning (34.63±0.21%) and it was very low in the unfertilized eggs (9.19±0.61%). All the parameters indicated that the eggs that were naturally spawned found to have higher amino and fatty acids indicate better egg quality.

Keywords: Asian seabass, Amino acid, Fatty acid, Fertilized eggs, Induced and spontaneous spawning

Paper ID 15990

Observations on the embryonic development stages of the Picnic seabream *Acanthopagrus berda*

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The cleavage and embryonic phase development stages of picnic seabream (*Acanthopagrus berda*) eggs has been investigated at a temperature of 28°C and salinity of 34 ppt in the Marine hatchery complex of Calicut Regional Station of ICAR-CMFRI. The average diameter of eggs and oil globule were determined and were found to be approximately 825.97±18.5 µm and 155 ±5 µm, respectively. Spawning of eggs took 48:00 hours at this temperature. During incubation, the salinity of seawater maintained was 34 ppt. The oxygen levels ranged between 6.5 and 7.9 ppm. Fertilized eggs hatched out after 18 hours and the hatching rates obtained were 95% at 28°C. Embryonic development was observed every fifteen minutes until morula stage and then on hourly interval. The morphological development changes were examined by detailed photomicrographs. During the incubation two-cell stage was observed at 30 minutes after fertilization; four-cell stage after1 h; 8-cell stage after 1:30 h, 16- cell after 2.00 h and 32-cell stage after 2:30 h of fertilization. This was followed by the morula stage at 3:00 h, blastula stage at 4:00 h, gastrulation stage at 04:30 h and neurula after 08:30h of fertilization. The closing of blastopore was established 12:30 h after fertilization. After 13:30 h of fertilization, somites and kupffer apparatus were observed. Increase in pigmentation was observed clearly at 15:00 h after fertilization. After 17:30 h of fertilization, 10 % of the larvae and after 18:00 h, 100% of the larvae were separated from the corion with the help of the enzyme secretion, excreted from the cranium of larvae and got released from the egg. In this study, 20 stages of embryonic development of picnic seabream were identified through incubation period from fertilization to final hatching. The information gathered through this study is useful for standardizing the artificial reproduction of this commercial species.

Keywords: *Acanthopagrus berda*, Picnic seabream, Embryonic development

Paper ID 15991

Economically viable ameliorated nursery rearing model for Asian seabass, *Lates calcarifer* in backwaters

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Asian Seabass, *Lates calcarifer* is an economically important food fish in India and being reared in brackishwater ponds and cages installed in brackishwater and open sea. Generally, the farmers prefer to stock the fingerlings of seabass above 10 cm size to minimize the cannibalism and better survival. However, availability of these stockable size fingerlings is a constraint for expansion of its farming. Many nursery rearing operators rear seabass fingerlings in the conventional earthen ponds by feeding with low value fishes and shrimps, which is an unsustainable activity. Hence, an improvised scientific rearing method was evaluated for seabass fingerlings in a backwater based nursery rearing with formulated feed. A crab fencing of 30 meter length and 60 meter width (mesh size 25mm) was installed in the creek adjacent to Buckingham canal, Kottaikadu village (12°15'07.4"N 79°59'15.4"E), Cheyyur Taluk, Chengapattu District, Tamil Nadu by involving fisherwomen Self Help Groups (SHGs). Happas of 2 meter length x1.5 meter height x 1 meter width were installed inside the crab fencing and 6000 numbers of seabass fingerlings of 4.40 cm average length and 1.80 grams weight were stocked @300 /happa. The fishes were fed *ad libitum* twice a day with formulated nursery rearing feeds containing crude protein 57% and crude fat 15%. Grading of the seabass fingerlings was done on weekly basis and after rearing for 48 days, the fishes attained a marketable size of 10.52 cm length and 13.50 grams weight. The survival rate was 93.30% and average daily growth was 0.24 grams. This improved nursery rearing method yielded higher survival and better revenue to the SHGs.

Keywords: Asian seabass, *Lates calcarifer*, Nursery rearing

Paper ID 15997

The role of benthic diatoms in bioremediation and purification of fish culture effluent water in RAS

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The present study investigated the growth and bioremediation role of diatoms on improvement of water quality parameters in the fish culture effluent in RAS system. The pure cultures of benthic diatoms namely *Achnanthes subsessilis, Nitzschia longissima* and *Amphora coffaeformis* were isolated and developed to test their photosynthetic efficiency in relation with the production of DO levels. The growth performance of diatoms was observed in the order *N. longssima* > *A. coffaeformis* > *A. subsessilis*. The photosynthetic efficiency was assessed based on the amount of DO content in the system and it was attained the maximum at afternoon, considerably decline during late evening. The levels of nutrients were analyzed on time intervals and revealed the capacity of diatoms to utilize the nutrients for their growth which help to clean culture effluent water before it is recirculated. The concentration of nutrients in the fish culture tank as well as in bioremediation units were high during the initial period of the study and then it declined. In length–weight relationship, the relative growth of the stocked pearl spot seed showed a steady increase with a significant correlation with an isometric growth. The FCR values were showed an increasing trend and values were ranged between 0.55 and 1.12.

Keywords: Aquaculture effluent treatment, Benthic diatoms, Dissolved oxygen, Nutrient removal, Photosynthetic efficiency.

Paper ID 16000

A pilot study on the growth performance of Red seaweed, *Gracilaria corticata* in different salinities

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Seaweeds are excellent source of minerals, nutrients, pharmaceutical compounds, fertilizer and fodder. *Gracillaria corticata* is one of the commercial red seaweed available in India and it is widely present in the rocky intertidal waters of Calicut. Based on the availability of species as well as its potential use in agar production, the present work was carried out to determine the optimal salinity requirement for *G. corticata* under controlled indoor conditions at different salinity levels. The vegetative thalli of *G. corticata* were collected from the intertidal region during low tide from Thikkodi, Calicut, Kerala, India. The trials were carried out in rectangular plastic crates of 60x40x30 cm^3. PVC pipes of 0.5 inch diameter were used for fabricating the rectangular rafts. Ten polypropylene ropes were tied parallel at 10 cm intervals on these rafts and introduced into the plastic crates. Fronds of *G. corticata* weighing 100 g were used as seeding material. The chosen salinities were 5, 10, 15, 20, 25, 30 and 35 ppt and the trials were carried out in triplicates. Thalli growth was recorded and the fastest growth was observed in crates containing full strength seawater (35 ppt) and successively slower in crates with lower salinities. After 30 days of culture period, mean weight of seaweed harvested from each treatment was 108±8.5 g (20 ppt), 155±12.5 g (25 ppt), 156±10.2 g (30 ppt) and 160±12.8g (35 ppt). The results indicated that *G. corticata* can be cultured using raft method at salinity above 25 ppt. The water quality parameters measured weekly has also shown reduction in the level of nutrients like ammonia, silicate and phosphate as the culture progressed. Future studies integrating *G. corticata* in integrated multi-trophic aquaculture (IMTA) would prove its feasibility in nutrient load reduction in the estuarine as well as coastal waters.

Keywords: *Gracilaria corticata*, Integrated Multi-trophic Aquaculture, Salinity Tolerance

Paper ID 16001

Preliminary studies on the reproductive biology of wild caught Goldlined seabream, *Rhabdosargus sarba* (Forsskal, 1775) from Chennai coast

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The Goldlined seabream, *Rhabdosargus sarba* is considered one of the potential white meat fish in India that comes under minor fishing. They are majorly distributed over Subtropical and tropical waters through the Indo-west Pacific region but can be found along with the coastal belts due to their oceanodromous migration. Reports on the captive breeding of this species are meagre. It's because of the lack of information regarding reproductive biology of *R*. sarba. In recent years, *R. sarba* are rarely found in landing. Thus, considering the euryhaline nature of this species, development of breeding and seed production gained importance. In this context, detailed studies on the reproductive biology of *R. sarba* would help for artificial propagation for seed production. In this study, 200 specimens were collected from August 2021 to March 2022**.** Maturity stages were assessed morphologically and histologically on monthly basis. The results revealed that *R.sarba* is female dominant population in the study area. Highest GSI estimation observed during December (female: 4.7542 ± 0.31935 and male: 2.1208 ± 0.07800). Although, availability of mature males and females synchronised in all the months except October and November where mature males could not be noticed**.** Male and female fishes were higher during November to December which indicates the spawning season in wild. The males were in the weight of 125-694g, and that of females were from 215 – 1348g. The overall ratio of male: female was 1:1.98, and was confirmed with Chi square test. Thus, the preliminary study indicated November – December as the peak season of breeding in *R. sarba.* The present study suggest that the captive breeding and seed production programme can be planned from November to January since higher number of both male and female fishes available during this season.

Keywords: *Rhabdosargus sarba*, Goldlined seabream, Reproductive biology, GSI, Sex ratio

Paper ID 16014

Studies on the transportation of fertilized eggs, hatchlings and fingerlings of silver pompano, *Trachinotus blochii* at various packing densities.

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Fish seed transport is one of the critical procedures in fish farming. Various life stages of *Trachinotus blochii* like fertilized egg (0 dph), hatch out/yolk sac larvae (1stdph), artemia feeding larvae (7-9thdph), metamorphosed larvae (22-24thdph), and juveniles (33-35thdph) were transported from the Vizhinjam Regional Centre of CMFRI (Kerala) to different states including TamilNadu, Andhra Pradesh, Karnataka, Maharashtra and Gujarat. Stages such as 0 dph, 1stdph, 7-9 dph are the stages at which we can transport the larvae with good survival rate. The present study investigated the optimum range of packing densityfor the survival of eggs, yolk-sac larvae and fingerlings during long-distance transportation. Six litres of seawater(of 34 ppt salinity) in a 32' x16.5' polythene bag with 6-7 ppm oxygencon centration is used for transportation of various stages at various packing densities of seed. The results indicated packing density and duration significantly influences survival rate during the transportation of various life stages of silver pompano. Among the various stages, eggs were found to be the stage with maximum survival and followed by metamorphosed larvae, 1stdph larvae, and 7-9 dph larvae, respectively. Maximum survival obtained for various stages like eggs, 1stdph, 7-9 dph, 22-24 dph, 32-34 dph are 4100±65.46 /L,901.5± 33.58/L, 161±7.43/L, 47.4±4.04 /L, 16.8±1.03/L. No tranquillizers were used for this experiment.

Keywords: Fish seed, Transportation, Pompano,

Paper ID 16017

Evaluation of candidate reference genes for Qrt-PCR analysis in Striped murrel, *Channa striata* larvae at their various developmental stages

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Quantitative real-time RT-PCR (qRT-PCR) is the most advanced and commonly used method for quantification of gene expression level because of its high sensitivity, specificity and accuracy. The analytical capability of qRT-PCR, on the other hand, is dependent on precise normalisation by using the most stable reference genes. Screening and evaluation of reference genes for determination of gene expression level in *C. striata* larval stages have not been performed to date. In the present study, the efficiency of four reference genes, namely beta actin (β-actin), glyceraldehyde-3-phosphate dehydrogenase (GAPDH), elongation factor 1-alpha (EF1α) and 18S ribosomal protein (18S RNA) as internal controls was examined at 12 different larval stages of *C. striata*. EF1α was observed to be the best suited gene among the four genes after data analysis using statistical techniques such as Delta-cT, NormFinder, and geNorm, whereas, 18S RNA was found to be the most stable reference gene using BestKeeper. However, when using a comprehensive gene stability method, EF1α was found to be the most stable gene for gene expression research. This is the first report on validation of housekeeping genes in *C. striata*, in the context of ontogenic development of gastrointestinal tract.

Keywords: *Channa striata*, Larvae, Developmental stages, Reference Gene, qRT-PCR, Ef1α

Paper ID 16018

Influence of maturation diet treatments on veliger rearing of Green mussel, *Perna viridis* (Linnaeus, 1758) using airlifting downweller recirculation system

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The mussel broodstock were chosen and separated into three clusters of 50 mussels, for conditioning for 20 days in triplicate. They fed with three combinations of microalgal diets as treatment I, II, and III. The algae *Isochrysis galbana* and *Pavlova salina* were fed in a 1:1 ratio in treatment I. In treatment II, *Isochrysis galbana*, *Chaetoceros calcitrans*, and *Pavlova salina* were supplied in a 2:2:1 ratio, while in treatment III, a mixed algal diet was prepared with raw seawater and provided to the mussels. Among the treatments, the mixed algal-fed broodstock mussels (treatment III) released the maximum number of eggs with the best quality compared to the broodstock mussels in the other treatments and also had a higher percentage of fertilisation rate and hatching rate. The newly hatched larvae were transferred to airlifting downweller recirculation system, consisting of cylindrical silos based on different stocking densities 5, 10 and 15 larvae ml^{-1} (SD -5, SD -10 and SD -15) in triplicates with a control. The larvae fed with a mixture of microalgae namely, *Isochrysis galbana*, *Chaetoceros calcitrans*, *Pavlova salina*, *Nannochloropsis* sp. in the ratio 1:1:1:1. Feeding ration of the algal mixture was started at the rate of 5000 cells of algae $larva^{-1}$ and an increase of 1000 cells $larva^{-1}$ in two days. The DVM (dorso-ventral measurement) and survival rate of the larvae were assessed on each day by taking subsamples from silos. The larval growth and survival rate showed a decreasing trend with increasing stocking density and the highest growth rate was exhibited by the lowest stocking density (SD-5) in the airlifting downweller recirculation system

Keywords: Green mussel; Hatching, Algal diet, Stocking Density, Downweller system

Paper ID 16021

Growth performance and survival during seed rearing of commercially important freshwater fishes in inland saline water

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The present study was done to optimise the seed rearing of Jayanti rohu (*Labeo rohita)*, Pabda (*Ompok bimaculatus*) and Striped murrel (*Channa striata*) in inland saline water. The early fry of the above species were reared in FRP tanks (500 litres) for 90 days at five different salinity (0, 2, 4, 6, and 8 ‰) with stoking density 50 no/tank. In pabda significantly higher mean weight (17.49±1.36 g) and length (14.22±0.39 cm) was recorded in 6 ppt but it was not significantly different from control and other treatment, same pattern was also observed in Jayanti rohu. However in C. *striata* the highest mean weight (8.72±0.124 g) and length (11.57±0.110 cm) were recorded in 6 ppt which was significantly different from others. In all three species, there was no significant difference in survival among control, 2, 4 and 6 ppt salinity. The lowest survival (Jayanti rohu: 70%, Pabda: 70% and *C. striata*: 51%) was recorded in 8 ppt and it was significantly lower than control and other treatments in the above species. We concluded that seed rearing of Jayanti rohu, Pabda and Striped murrel can be done upto 6 ppt without compromising survival and growth performance.

Keywords: Inland saline, Growth performance, Survival, Fish

Paper ID 16033

Comparison of growth, and survival of brackishwater candidate species, *P. vannamei* and *P. monodon* at different salinities in relation to optimization of aerators use.

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Indian shrimp aquaculture is nominated by the two major species viz, *P.vannamei* and *P.monodon* under semi-intensive and intensive farming systems. The higher crop biomass and feeding rates in these culture systems require supplemental aeration to maintain adequate dissolved oxygen levels, as too little aeration lead to a hypoxic condition in ponds resulting in mass moralities, and more aeration results in excessive operating expenses and wastage of energy. The study was carried out to assess the oxygen consumption rate, survival, and growth of *P.vannamei and P.monodon* at different salinities and compare it with the energy used in shrimp farms. The trend of oxygen consumption rate (OCR) of *P.vannamei* was high initially, ranging from 0.68-1.01 mgO_2/g/hr in the first month, then reduced to a range of 0.41 - 0.5 mgO_2/g/hr and then increased continuously in the third and fourth months and reached a maximum of 1.38 mgO_2/g/hr. The OCR was minimum at 20 ppt compared to other salinities. The trend of oxygen consumption rate of *P.monodon* revealed that the OCR of shrimp ranged from 0.42 to 0.63 mg O_2/g/hr in the first month, then reduced to a range 0.37 to 0.56 mg O_2/g/hr and then increased continuously in the third and fourth months and reached the maximum of 1.01 mg O_2/g/hr. The highest average body weight (22.7 to 23.3 g) and survival rate (67 % to 87%) were observed at medium salinities than low or high salinities. The actual energy use in shrimp farms operated at different salinities was compared. The farms operated at medium salinities consumed less energy than low or high saline farms. The findings indicate that there is vast scope for energy conservation in shrimp farms by selecting the type of aerators and the calculated use based on the salinity of the culture systems.

Keywords: Shrimp aquaculture, vannamei, monodon, Survival and Growth, Salinities, Aeration, Energy use

Paper ID 16055

Effect of stocking density and microalgal concentration on the production parameters of tropical calanoid copepod, *Pseudodiaptomus annandalei* and first report on its cannibalism

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Production of high-density nauplii from mass culture of copepod, to use as live feed is a major bottleneck in marine fish hatcheries. In the current investigation, experiment-I describes the effect of stocking density (50, 100, 250, 500, 750, and 1000 ind L^{-1}) and algal concentrations $1x10^5$, $5x10^5$, and $10x10^5$ cells mL^{-1} on production parameters (nauplii production, copepodite population and total population growth) of *Pseudodiaptomus annandalei* in mass culture. Data was recorded every alternate day for 11 culture days, and statistically analyzed by one and two way ANOVA using IBM SPSS 26. The maximum production of nauplii (6743 ± 104), copepodite (9594.66 ± 366.66) and population growth (16427 ± 533.03) was recorded with stocking density of 750 ind L^{-1} when fed with $10x10^5$ cells mL^{-1}. The nauplii conversion to copepodite was low in all other combinations of stocking density and feed concentration. Further, to verify this results from the experiment-I, we executed another experiment with three treatments of fully matured adult copepod; T1 (male and female in 1:1), T2 (Ovigerous female only), and T3 (Ovigerous female and male in 1:1) with feed and without feed, in six replicates. The maximum nauplii (74.6±3.89c) were recorded in T3 with T-iso ($10x10^5$ cells mL^{-1}). Contrarily, without feed, T2 group had produced nauplii (17.66±2.96), which were consumed by adults @ 5.14±0.46/day within 3.4 days. Therefore, copepodite production was decreased due to the cannibalistic nature on its own napulii, when fed with low algae concentration at high stocking density. Results from these investigation concluded that copepod cultured with stocking density of 750 ind L^{-1} with algal concentration of $10x10^5$ cells/ml achieved maximum production.

Keywords: Cannibalism, *Pseudodiaptomus annandalei*, Nauplii, Mass culture

Paper ID 16062

Utilization of complex carbon sources on biofloc system and its influence on the microbial composition, growth, digestive enzyme activity of Pacific white shrimp, *Penaeus vannamei* culture

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A 60-day experiment was carried out to assess the impact of complex carbon sources on the biofloc system and their effects on *Penaeus vannamei* culture. The treatments with four carbon (CHO) sources: tapioca flour (BFTf), rice bran (BFRb), wheat flour (BFWf), rice flour (BFRf), and biofloc were generated with the respective carbon sources, and the absence of the CHO served as the control (C). The experiment was carried out in triplicate in 100L FRP tanks, and the post-larvae (ABW- 0.11±0.02 g) were stocked at 400 PL/m3. The results revealed the addition of carbon sources was effectively reduces the TAN level by 62-67% in the biofloc treatments. A significant difference in the average body weight was observed ($P<0.05$) compared treatments and control; specifically, rice flour (BFRf) and wheat flour (BFWf) based treatments were shown to have the highest weight gain. Significantly improved survival up to 81% - 89% was observed. Planktonic communities such as rotifer, copepod, nematodes, diatoms, ciliates, cyanobacteria were the predominant groups found in different biofloc treatments. About 55 bacterial isolates were isolated, and selective strains were identified using the 16s rRNA gene sequencing approach. The presence of beneficial strains like genus *Bacillus sp, photobacterium sp, Pseudoalteromonas sp, Proteobacterim sp,* and other marine bacterium has differed between the treatment and control. The real-time analysis of digestive enzyme-related gene expression was significantly upregulated $P<0.05$) than the control, and carbohydrate utilization was promising. The results indicate that complex carbon sources improved the water quality, which induced beneficial bacterial diversity and enhanced digestive enzyme activity and growth performance of *P. vannamei* culture.

Keywords: *Penaeus vannamei*, Biofloc,16s r RNA, Real-time PCR, Digestive enzymes

Paper ID 16065

Impact of different biofloc media on growth and immuno-physiological performance of *Anabas testudineus* (Bloch, 1792) stocked at different densities

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A lab-scale study was conducted to investigate the effect of different biofloc inoculum media on the growth and immuno-physiological response of *Anabas testudineus*, reared in a biofloc culture system with varying densities. The experimentation initiated with the development of different biofloc media i.e., conventional media (without bioflocculating agents) and novel media (with Bioflocculating agents) in culture units. Then the fingerlings of *A. testudineus* in the size range 1.15-1.95 g were stocked at three treatment densities in triplicates i.e. 150, 250, and 350 fishes/m^3 in 200 L biofloc culture units. The fishes were fed with 40% crude protein commercial feed, and jaggery was used as the carbon source for maintaining the carbon: nitrogen ratio. At the end of 75 culture days, water quality, growth indices, immuno-physiological parameters and proximate composition of fish and biofloc were analyzed. The results unraveled that the microbial flocculation and quality of biofloc were significantly better in the novel media-based biofloc culture system than in conventional media. The fish body indices manifested superior growth and immuno-physiological parameters unveiled good health welfare in novel media. There was no significant difference in growth indices and the immuno-physiological response of fish stocked at different densities. However, the higher density yielded higher biomass production. Thus, the present study reveals that the *A. testudineus* fingerlings can be raised at 350 fishes/m^3 density in a biofloc culture system with improved performance in novel media.

Keywords: *Anabas testudineus*, Biofloc media, Stocking density, Growth, Immuno-physiology

Paper ID 16071

Assessment of growth pattern in *Carassius auratus* with probiotic supplemented diet

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A 90 days experiment was conducted and repeated in subsequent year under laboratory conditions in glass aquaria to study the effect of commercial probiotic Aqualact at different levels on growth pattern of *Carassius auratus*. To elucidate the growth pattern, the length-weight relation, condition factor (Kn) and relative growth co-efficient (b) among experimental fishes were recorded and calculated. The exponent "b" value in the treatments were estimated as 2.257, 2.302, 2.320, 2.357, 2.827 and 2.307 in T_0, T_1, T_2, T_3, T_4 and T_5 respectively. The highest "b" value was obtained from the aquarium treated with diet containing Aqualact @0.6 % (T_4) while lowest value in the untreated aquarium (T_0). The results indicating negative allometric growth of *Carassius auratus* in the control as well as treated aquariums excepting T_4. The results of Length-weight relationship indicated negative allometric growth in the control as well as treated aquariums except T_4 during both the years. The value of "b"in the length-weight relationships remained within the acceptable and expected range of 2.5 and 3.5 with the highest "b" value was obtained from the aquarium treated with diet containing Aqualact @ 0.6 % (T_4) while lowest value in the untreated aquarium (T_0) in both experimental years. The relative condition factor (Kn) was found to be 0.76, 0.79, 0.79, 0.84, 0.93, and 0.78 respectively in T_0, T_1, T_2, T_3, T_4 and T_5 during the first year, while it was 0.78, 0.79, 0.82, 0.81, 0.95 and 0.80 respectively in T_0, T_1, T_2, T_3, T_4 and T_5 during the second year. The Kn value varied between 0.76 and 0.93 during first year, while it varied between 0.78 and 0.95 second year. The positive correlation co-efficient was obtained between the length and relative condition factor indicating a degree of positive association.

Keywords: *Carassius auratus*, Probiotics, growth pattern, length-weight relation, Condition factor (kn), Relative growth co-efficient

Paper ID 16083

Biofloc based intensive nursery rearing of *Penaeus vannamei* using formulated microbial consortium

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A 30 days of indoor insensitive biofloc based nursery rearing of *Penaeus vannamei* was conducted to investigate the efficiency of microbial consortium developed at ICAR-CIBA (CIBAFLOC^{+} consortium is the mixture of beneficial bacteria for biofloc development and scientifically proven for better growth and immunity). The experimental variations were as follows; BFT1- Biofloc generated using consortium developed at CIBA (CIBAFLOC), BFT2- Biofloc developed without consortium. Control- clear water system, (absence of biofloc). Shrimp post-larvae PL-10 (0.6 mg) were stocked @ 2000nos/m^3 in a 5-ton tank. The CN ratio of 15:1 was maintained throughout the experiment by using molasses, rice bran, wheat flour at a 3:4:4 ratio. Nano-tube air diffusers were employed for better aeration and effective suspense in the biofloc. Water quality especially TAN level was maintained at an optimal level in biofloc treatments (BFT1-0.18±0.05ppm, BFT2 (0.76±0.16ppm) than the control (1.49±0.12ppm). The floc volume was observed better in BFT-1 than the BFT-2. The toal *Vibrio* load was higher in control and significantly lowered in BFT-1 and BFT-2 ($p<0.05$). Biofloc system significantly improved the growth and the highest ABW observed in CIBAFLOC consortium supplied BFT1 (0.765g) followed by BFT-2 (0.449g) and CW (0.296g). Survival, FCR, PER was significantly better in BFT-1 treatment followed by BFT-2 than control at ($p<0.01$). In conclusion BFT1, biofloc developed by the microbial consortium (CIBAFLOC^{+}) better performance for nursery rearing of P. *vannamei.*

Keywords: Biofloc technology, C/N Ratio, Bioaugmentation, *Penaeus vannamei*, Nursery rearing

Paper ID 16094

High density poly ethylene (HDPE) raft based tube net method for *Kappaphycus alvarezii* farming in rough sea conditions, Andhra Pradesh coast: A novel region-specific approach

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With increasing demand for products from seaweed, farming of various species has gained importance. Though culture has been successful in calm and protected seas and farming protocols are firmly established; for the majority of the tropical seas with turbulent state, commercial level production has failed due to the absence of appropriate culture method. High Density Poly Ethylene (HDPE) floating raft based tube-net with grid mooring was seeded with *Kappaphycus alvarezii* and evaluated for structural stability, culture and economic feasibility off Visakhapatnam, along north-western Bay of Bengal. Rafts were square-shaped 3 m × 3 m; and seven tube-nets, each of 3 m length and 0.32 m diameter, made of HDPE were tied across the raft for holding the seeded *Kappaphycus alvarezii*. Twenty-five rafts were used for each location, and were anchored using grid mooring. The raft structure, along with anchoring system endured the high waves and underwater currents without any adversity. Five different initial seeding biomass (3.0, 5.0, 6.0, 7.5 and 10.0 kg/tube-net) was assessed for evaluating growth. After culture duration of 45 days, growth parameters were significantly better at the lower seeding densities. Maximum harvestable biomass (175 kg/raft/crop) and economic returns (annual gross revenue of 1.54 lakhs and annual net income of 0.507 lakhs) were at the seeding density of 5.0 kg/tube-net. Growth rate (> 3.5%) was globally comparable. Present methodology developed on *Kappaphycus alvarezii* farming in turbulent tropical Bay of Bengal, when replicated in similar regions worldwide, would catapult farming and production to unexpected highs.

Keywords: Economics, Growth, HDPE Raft, *Kappaphycus alvarezii*, Tube-net

Paper ID 16095

Effect of different stocking densities on growth, physiology, nutrition and economic performance of Indian pompano in grow-out sea cage culture

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Stocking density is recognized as an important technical parameter in fish culture systems, that has high impact on fish welfare, growth, productivity, and economic returns in an intensive, commercial grow-out cage culture system. Indian pompano, *Trachinotus mookalee* is one the emerging candidate marine finfish for culture in sea cages, having good tolerance in intensive culture conditions. Effect of different stocking densities were studied to understand the effect on different parameters like growth, physiology nutrition and economic advantages. Different stocking densities of 15, 20, 25 & 30 nos/m^3 were used in individual cages. Indian pompano of 18 ± 10.0 g in size were stocked at respective stocking densities. Stocked fishes were fed twice a day at 6-1.5% of body weight for 10 months. Growth parameters, physiological, nutrition and economic performance was analysed to compare the best performing feeding methods. Studied growth parameters showed significantly maximum values for cage with low stocking density: Final growth (849 ± 11.02), AGR (2.76 ± 0.85) & SGR (1.22 ± 0.38), whereas it was slightly less for other three stocking densities. However, lowest FCR (1:2.06) recorded for 25 nos/m^3. The physiological status of the fishes represented by level of glucose and cortisol was varied 34.03 to 104.462 mg/dl and 15.36 to 177.715 ng/ml with lowest level at the early culture and highest range in advanced stages of culture, and among all the lowest level of glucose and cortisol were recorded at low stocking density. The economic indicator showed that cage culture of pompano at 25 nos/m^3 could achieve the maximum profit of 12.75 lakhs/year, against 2.48 lakh/year at low stocking density estimated for a cluster of 10 numbers of cages. The result of the study inferred that culture of Indian pompano in marine cages at 25 numbers/m^3 performs better for growth and economic returns

Keywords: Indian pompano, Stocking density, Cage, Growth, Profitability

Paper ID 16098

Artificial intelligence in marine cage culture: Smart auto-feeder for energy efficient and environment-friendly sea cage aquaculture

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Marine cage culture is preferred solution for increasing global cultured fish demand. However, cage culture earning is affected by several adverse climatic conditions and unavailability of skilled manpower. Thus, smart cage culture, especially automation in feeding is considered as an important for environment friendly and profitable culture. A case study was performed with smart auto-feeder for Indian pompano culture in Bay of Bengal, Visakhapatnam Coast. The hatchery produced fish seeds were stocked at 22.0 ± 3.0 g at stocking density of 25 numbers/m^3. Two cages were stocked; one with mobile application based smart-automated feeder and another cage without feeder as control. The feeder was used for increased feeding frequency (5 times/day) in cage and also to study the feasibilities of using the feeder in marine cages. Fishes in cages were fed with high nutritional diet (45% protein and 10% fat), with an equal quantities in both the cages. The feeding rate varied from 6.0 to 1.5% depending on the fish size in different culture period with different feeding frequencies of 2 times/day in control cage (manual feeding) and 5 times/day in automated feeder cage. After 12 months of grow-out culture, a total of 2150 kg of Indian pompano was harvested from cage with smart auto feeder, whereas 1760 kg was harvested from control cage. The cage with automated feeder showed an approximately 19% higher production than control cage with the same ration. Also, it reduces 50% diesel consumption and labours used in daily operation. Use of the smart feeder subsequently reduces 50% of heat production (481 kWh/month), carbon (327 kg/month) and corbondioxide (120 kg/month) emission to the environment by fuel (diesel) consumption by the boat for the daily operation. The study suggested that use of automated feeder helps in maximising production and reduces energy consumption in marine cage culture.

Keywords: Artificial intelligence, Sea cages, Smart auto feeder, Increased production, Energy efficient

Paper ID 16113

Evaluation of growth and survival of Amur carp, C*yprinus carpio haematopterus* during nursery phase in floating net cages in tropical reservoir of India

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The study was conducted to evaluate the growth performance and survival of amur carp during nursery phase at different stocking densities in inland floating cages for a period of 90 days at Maithon reservoir, Jharkhand, India. The fry of Amur carp (4.38±0.19 cm and 2.08±0.28 g) stocked in three different stocking densities viz. 100 numbers/m^3 (SD 100), 200 numbers/m^3 (SD 200) and 300 numbers/m^3 (SD 300) in triplicate in galvanized iron (GI) cages. The fishes were fed with commercial floating pellet feed (32 % crude protein and 4% crude fat) in two splits (9.00 hour and 16.00 hour) @ 5-3% of body weight. Water quality parameters measured at monthly intervals from inside the cage, 50 m and 100 m away from the cages. The study revealed that stocking density had significant impact on growth and survival of the fishes. The lower stocking density of 100 numbers/m^3 (SD 100) achieved significantly ($P<0.05$) highest growth in terms of weight gain (52.14 ± 1.39), absolute growth rate (0.58 ± 0.01), and specific growth rate (3.62 ± 0.03) compared to the higher density of 300 numbers/m^3 (SD 300). Better feed utilization and feed efficiency were observed in lower stocking density (SD 100). The FCR ranged between 2.18 ± 0.11 (SD 100) to 2.92 ± 0.12 (SD 300) showed no significance difference between SD 100 and SD 200. Poor survival rate reported in higher stocking density of SD 300. Condition factor (K) ranged from 2.23 ± 0.22 (SD 300) to 2.57 ± 0.17 (SD 100) with no significance among the treatments. It was observed that, there was no significant variations in growth, survival and feed utilization between stocking densities SD 100 and SD 200. Overall the result indicated that the amur carp exhibit better growth and survival at low to moderate stocking density of 100 - 200 numbers/m^3. This is the first kind of study reporting the feasibility of nursery rearing of amur carp in inland cages.

Keywords: Cage culture, Amur carp, Stocking density, Growth, Species diversification

Paper ID 16114

A unique innovative mud pot technique developed for mixed culture of Pabda with IMC in Haldia, district Purba medinipur, West Bengal, India

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The present case study is based on the successful Pabda fish farming villages of Haldia Block of Purba Medinipur District of West Bengal, India. This article evaluates the impact of a unique innovative mud pot technique developed for mixed culture of Pabda with IMC. Practical field-based information is used to analysis. Finding that farmers practices related to proper resource utilization, interest in species diversification & has the potential to significantly improve productivity in fish production with introducing Pabda fish as well as more profit. Innovative fish farming represents an opportunity to boost local economies, especially when combined with specific policies aimed at social protection and well-being of communities.

Keywords: Pabda, Polyculture, Haldia, Mud pot technique

Paper ID 16129

Development of customized dual powered solar water pumping system for brackishwater hatchery

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Aquaculture has grown rapidly as one of the promising food-producing sectors in the world and electricity has been one of the important factors for the purpose of water pumping, aeration, water purification, and others. The use of renewable energy in aquaculture is expanding rapidly in the form of solar water pumping system, solar-based automatic feeder, solar aerators, solar based fish, and feed driers etc. Even though solar power has been used for many purposes, its usage in wide scale range in coastal environment is limited due to salt-water induced corrosion and high wind speed. In this regard, 5HP solar water pumping system has been custom designed to be operated by dual power mode for the brood stock tanks of fish hatchery at Muttukadu Experimental Station (MES), ICAR-CIBA. It is designed such that water pumping during daytime is with solar power and during night time electric power is utilized. For solar power, 19 solar panels @ 250 watt, 44V each has been connected. And installed in a steel-based solar stand designed with length 11m and breadth 4m, along with six GI pipe support to resist heavy wind and installed with tilt 13 degree towards south direction for maximum sunlight absorption. This model has been designed in Auto CAD and further analyzed for wind resistance before installation. Control system has been made with stainless steel box with automatic timer controller, manual conductor switch and solar based variable frequency drive (VFD) for efficient switching of solar and EB connections. The water discharge was monitored for both powers and observed to be working efficiently. Comparative evaluation showed that solar pumping is much efficient, ecofriendly, energy saving and economical as well.

Keywords: Aquaculture, Coastal ecosystem, Solar water pumping, Solar panel, VFD

Paper ID 16132

Individual growth pattern of juvenile stages of the Mud crab (*Scylla serrata*) reared individually

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Mud crabs are one of the most traded aquaculture crops, and it has been recognized as a priority species for diversification of coastal aquaculture in India and many Asian countries. Cultivation of individual crab in separate compartment has become popular for example: soft shell crab industry and vertical rearing system. Although growth data during communal rearing in pond has been reported, it does not provide accurate estimation of growth. This study, therefore, was aimed to obtain growth and moult pattern of individual crabs, a study has been carried out, growth and moulting data of fifteen crabs from instar 1 onwards were traced individually for a period of 129 days (up to instar 9). Further, a rapid moult staging was also developed for this species. Survival rate form C1 to C8 was very high as expected (93%). Juveniles had a high percentage of wet weight gain, between 98.1% and 226.5% but the percentage weight gain values were highly variable between stages. Specific growth rate was almost similar in all phases except in C1 to C2 phase. The relationship between carapace width and body weight shows negative allometric growth. Up to sixth moult or sixth instar all crabs moulted whereas from sixth to seventh, 50% crab only moulted, and subsequently moulting frequency diminished. The present study provides a guideline for farmers to manage their stock in the individual cages.

Keywords: Mud crab, *Scylla serrata*, Growth cycle, Molting, Instar

Paper ID 16133

Efficacy of *Asparagus racemosus* (Shatavari) root powder as a growth promoting and immuno-modulatory feed additive for Common carp, *Cyprinus carpio* linn.

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Efficacy of shatavari (*Asparagus racemosus*) root powder (SRP) as growth promoting and immuno-modulatory fish feed additive was evaluated by feeding fingerlings of freshwater carp, *Cyprinus carpio* (Linn.) with experimental feeds (180 days) supplemented with SRP @ 1% (SRP_1), 2% (SRP_2), 3% (SRP_3) and 4% (SRP_4). Feed without SRP served as control (SRP_0) feed. Shatavari supplementation improved fish growth performance significantly ($P \leq 0.05$) at all inclusion levels, however best results were recorded at 4% inclusion level (SPR_4), resulting into 50.85% higher net weight gain and improved condition factor (k-value- 1.06) as compared to control (0.89), with an upregulated thyroid hormone (T_4/T_3) profile. SRP also improved fish health status, supported by 2.14 and 1.59 times higher haemoglobin and haematocrit values, respectively; enhanced immunity [serum total protein (55.38%↑), albumin (112.24%↑), globulin (36.55%↑) and total immunoglobulin (66.67%↑)]; antioxidant markers [lipid peroxidation (40.80%↓) and superoxide dismutase (41.82%↑)]; and positive metabolic changes in respect to liver function [serum glucose (16.25%↓), alanine aminotransferase (25.85%↓) and aspartate aminotransferase (20.13%↓)], lipid profile [serum cholesterol (17.98%↓) and triglycerides (18.56%↓)] and digestive enzymes [intestine amylase (29.53%↑), lipase (48%↑) and protease (17.77%↑)]. In addition, SRP feeding improved the fish flesh quality, resulting in 12.31% increase in protein and 26.70% decrease in lipid content. Further, 10-days challenge test of SRP_4 fed fish exhibited relative percent survival (RPS) of 70% against pathogenic bacteria, *Aeromonas hydrophila*, as compared to control fish (SRP_0). The results indicate that *A. racemosus* can serve as a potential organic feed additive to produce 56% more fish with improved flesh quality at 4% incorporation level.

Keywords: Fish, Growth, Immunity, Medicinal, Organic, Physiology, Shatavari

Paper ID 16134

Multi-location trial of Indian white shrimp, *Penaeus indicus* in grow-out ponds at varying densities and salinities: Strategy for its domestication and propagation

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To evaluate the culture potential of Indian white shrimp, *Penaeus indicus,* multi-location grow-out farming trials were carried out under different salinity regimes and stocking densities across the coastal states of India (West Bengal, Odisha, Andhra Pradesh, Tamil Nadu, and Kerala). The growth performance and immunity status were assessed under two different stocking densities (low and high) at different salinity regimes (3- 60 ppt) for a period of 80-120 days. Significantly higher growth was observed in the salinity range of 15 to 35 ppt with average daily growth (ADG) up to 0.195±0.032 compared to low ADG of 0.125 ±0.021 in very low and very high salinity ranges (<7 ppt & >40 ppt). Similarly, the final mean harvest weight of *P. indicus* reared at 15 - 25 ppt salinity was significantly ($P<0.05$) higher than other salinity ranges. The low stocking density treatment ponds demonstrated a higher mean harvest weight (18 -30 g) compared to high density ponds (12 -20 g). The total productivity (Kg/ha) increased significantly ($P< 0.05$) with an increase in stocking density by 20-30 %, while it was comparable between salinity ranges. The prophenoloxidase (PPO) activity gradually increased or decreased correspondingly to the salinity level with significantly lower PPO activity being observed at very low (5ppt) and very high (60 ppt) than other salinity ranges. Similar pattern was observed for serum protein (SP) and lysozyme (Lys). Different stocking densities did not affect immune parameters much, although lower stocking density showed a marginal increase in them. Our study revealed that production of 3 to 7 tons per ha/crop is achievable at a moderate stocking density of 25 to 40 no/m2. The development of domesticated line of *P. indicus* is the crucial step in its genetic improvement program which are being initiated by ICAR-CIBA.

Keywords: *Penaeus indicus*, Salinity, Immunity, Growth, SGR, Plasma Protein, PPO

Paper ID 16135

C:N ratio manipulation enhanced the microbial composition and bioconversion of nutrients in biofloc based culture of Pacific white shrimp, *Penaeus vannamei* culture.

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A nursery experiment was carried out to assess the effect of different CN ratio on growth, nitrogen metabolite conversion, microbial load, and digestive enzyme activity of *Penaeus vannamei* reared in the biofloc system. The experimental variations with different CN ratio as follows; T1-12:1, T2-15:1, T3-20:1, T4-25:1, and control-without CN ratio manipulation. Shrimp larvae (0.03±0.001g) were stocked at the rate of 1600 shrimp m^{-2} in one-ton tanks. The CN ratio manipulation significantly improved the conversion of nitrogen metabolites ($P<0.05$) and enhanced beneficial microbial load (THB, Bacillus) in treatments than the control. CN ratio treatments demonstrated improved growth performance and survival in treatments, highest observed in T2- (0.96 ± 0.02 g; 91±2.0% respectively) ($P<0.05$). Enhanced FCR, PER and proximate composition was observed on CN ratio treatments than control. The mRNA expression level of six immune genes and digestive enzyme-related genes such as alpha-amylase, cathepsin L, cathepsin B, trypsin, chymotrypsin, and lipase have outperformed the control in their expression. Overall, the results show that all CN ratio treatments, particularly T2 (15:1), performed better and cost effective. This CN ratio alteration aids bioremediation, better production performance, improved health and environment, increased nutritional benefits, reducing feed cost, conserved water, and enabled a cleaner environment for sustainable aquaculture.

Keywords: Biofloc, Microbial manipulation, Digestive enzyme activity, *Penaeus vannamei*

Paper ID 16138

Induced breeding, larval rearing and seed production of Mangrove red snapper (*Lutjanus argentimaculatus*) in tank-based system

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Mangrove red snapper (*Lutjanus argentimaculatus*) is an important candidate species suitable for brackishwater aquaculture. It is a high value carnivore fish, tolerate wide range of salinity and fast growing accepts pellet feed under culture conditions. ICAR-CIBA achieved initial breakthrough in captive breeding and seed production of red snapper during July 2020. Captive pond based and land based broodstocks (around 150) of red snapper *L.argentimaculatus* were developed from wild collected juveniles of 40-50 g size and maintained in earthen ponds & 100t capacity RCC tanks since 2015. Mature females (mean oocytes diameter 430-460 µm) and oozing males could be observed when tank based red snapper broodstock (weight 3.6 to 4.8 kg/ total length 52 to 65 cm ; stocking density 1kg/m^3) were examined periodically since 2019. Mature females having oocyte diameter more than 460 µm and males with expressible milt were selected to induce breed with Human Chorionic Gonadotrophin hormone (HCG) injection in 100t broodstock tanks & also separately in 8t tanks in 1: 2 ratio. Initial result suggests relatively higher spawning (after 36h of injection) success observed in community breeding (Fertilization rate 80 %, hatching rate 75%) in 100t capacity tanks. Fertilized eggs (around 820 µm) were pelagic and incubated for 16-18 h to hatch out. Newly hatched larvae was 1.7 mm long (tl.) having large yolk sac and mouth open on 3 dph for exogenous feeding. Red snapper larvae were reared in green water system, fed with copepod nauplii, rotifer till 19-day post hatch (dph), followed by *Artemia* nauplii and weaning diet provided till they reach to fry size (2.5-3 cm) stage in 45 dph. The overall survival rate estimated up to 12%. Further attempt is being made for up-scaling the seed production of *L. argentimaculatus* under captivity.

Keywords: Red snapper, Maturation, Induced breeding, Larvae

Paper ID 16143

Immunomodulatory effect of polyhydroxy butyrate (PHB) in the diets of genetically improved farmed tilapia extracted from the PHB accumulating bacteria isolated from biofloc systems

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PHB producing bacteria isolated from biofloc ponds were tested for its influence on growth, immunology, antioxidant status and disease resistance of GIFT Tilapia was studied. Out of 28 bacterial isolates, 6 isolates namely *Bacillus infantis*, *Exiguobacterium profundum*, *Bacillus subtilis*, *Bacillus megaterium*, *Klebsiella pneumoniae* and *Enterococcus hirae* showed positive results for PHB production against three fluorescent stains. The PHB yield in the range of 0.21-4.2g/L was recorded based on the cell dry weight. Absorption band in the range of 4000cm^{-1} to 650cm^{-1} using FTIR analysis confirmed the C=O group in PHB. The highest recorded PHB yield from *Klebsiella pneumonia* (T1) and *Enterococcus hirae* (T2) were further used for PHB extraction for its supplementation along with the feed (5g/kg) as treatments and without PHB as control (C) in 30 days culture of GIFT Tilapia.Significant difference ($P< 0.05$) in weight gain and specific growth rate were observed between treatments and control with no mortality. Serum protein, Myeloperoxidase activity, RBT,Catalase,Glucose,SOD and increased relative percent survival after 10 dpi of *Aeromonas hydrophila* were significantly different between the treatments and control.Overall improved immune response of GIFT tilapia fed with PHB extracted from biofloc systems exhibited biocontrol effect of PHB producing bacteria.

Keywords : Biofloc, Polyhydroxy Butyrate, Gift Tilapia, Immune Response.

Paper ID 16149

Growth performance of all male Nile tilapia, *Oreochromis niloticus* using different carbon sources in biofloc system

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The aim of the experiment was to assess the effect of different carbon sources *i.e.,* Jaggery and starch on growth performance of Nile tilapia under biofloc culture system. *Oreochromis niloticus* advance fingerlings with average weight of 40.57±10 g were stocked in tanks (10,000 litre and 20 thousands litre capacity) with a density of 100 nos /m^3. The experiment was designed in three treatments including one control group without biofloc and two biofloc treatments by adding Jaggery and rice starch as a carbon sources. Fish were fed with pellet feed at the rate of 2% body weight and this experiment was run for six months. The water quality parameters were monitored weekly. Dissolved oxygen concentrations were significantly higher in the tanks with no bioflocs due to the absence of bacterial biomass. Total ammoniacal nitrogen (TAN) showed a statistical difference ($P \leq 0.05$) between the control and the other treatments with bioflocs, having the lowest concentration of 2.43 mg L-1. Lower pH values were recorded in biofloc tanks may be due to the higher rate of nitrification and respiration by microbes. Besides, the addition of carbohydrate has significantly reduced the total ammonia nitrogen (TAN), and nitrate-nitrogen in water. Survival of tilapia was 85 % in control and was more than 90% survival in both treatments and productivity varied from 32 kg (Jaggery) to 30.5 kg m-3 (Rice starch) ($P \leq 0.05$). The results showed that there were no significant differences ($P > 0.05$) in weight gain, survival rate, average daily weight gain and specific growth rate among treatments. The result of this study concluded that the use of rice starch (carbohydrate source) along with formulated feed has effectively enhanced the biofloc production comparable to Jaggery as a carbon source that contributed effectively in the maintenance of good water quality and higher production of fish .

Keywords : Tilapia, Biofloc, Carbon Sources, Growth, Microbes

Paper ID 16151

Exploring new vistas in open sea cage farming in the north Tamil Nadu Coast

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The long coast line of Tamil Nadu with three distinct geographic zones, has a huge fisherfolk population and several fish landing centres and fishing villages.. Exploring the scope for sustainably augmenting seafood production, ICAR-CMFRI has been spearheading the movement from land-based aquaculture to open sea farming and mariculture systems. With funding assistance from ICAR, NFDB, FIMSUL and TNFD, several demonstration trials have been undertaken in the north Tamil Nadu coastal waters since 2009. Initial attempts were made in Thiruvallur district and later in Kancheepuram district. Rock spiny lobster Panulirus homarus and seabass Lates calcarifer were farmed. The best results came out in the operations in 2010 at Chemmencherry when over 360 kg of spiny lobsters and 3.75 t of seabass were harvested from the cages successfully. Subsequent trials during 2012-2017 were attempted with 2m dia, 4 m dia and 6 m dia GI-frame cages with air-filled HDPE barrel bouys, with spiny lobsters, seabass, orange-spotted groupers, pompano and cobia. Site-specific protocols for stocking densities, depth of cage installation, mooring designs and anchors, net exchange methods, net depths, mesh sizes, feeding ration, live marketing, nursery, transportation methods and net mending and maintenance were standardized. More than 500 fisher youth and other entrepreneurs were trained with hands-on skill development programmes and participatory operations. This paper presents the potential areas and scope of cage farming in coastal waters based on insights gained from trials in north Tamil Nadu.

Keywords : HDPE, NFDB, FIMSUL, Skill Development, Mariculture

Paper ID 16156

Development and techno-commercial assessment of indigenous coldwater recirculating aquaculture systems of different operational scales for intensive production of rainbow trout

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Three coldwater recirculating aquaculture systems (RAS) of different operational scales, namely pilot-scale of 28 m^3 culture volume and two small-scale backyard models of 3 and 7 m^3 capacity were designed in-house, established and complete production cycles were operationally evaluated. The pilot-scale RAS had four triple drain culture tanks; radial flow settlers, swirl separators and micro-screen drum filters; moving-bed biological reactors; UV filter; aeration; and pumps for water circulation. During the operational cycle, trout juveniles (40 g) were initially stocked at 6 kg/m^3, fed to satiation and essential water quality parameters were recorded daily. Freshwater addition was kept at 0.7 m^3/kg feed with 5-10 days hydraulic retention time. Under 12-19^{o}C temperature regime, on average, fish grew to 700 g in six months with final unit productivity of 35-37 kg/m^3 per crop. Cost of fish production was Rs.270/kg and economic payback period was estimated to be four-years for this system. With respect to the small-scale RAS models, the components were locally fabricated to minimize costs, mechanical equipment usage and uncertainties. The filtration unit consisted of swirl separator and static gravel-bed biofilter for solid-removal and nitrification. From 40 g, on average, fishes reached 600 g in seven months with final unit productivity of 29-32 kg/m^3 per crop. Economically, cost of production, cost-benefit ratio and payback period was Rs.244-251/kg, 2.4-2.5 and 2-3 crops, respectively. Water and energy requirements were 0.85-0.89 m^3 and 11.9-11.3 KW per kg of fish. In the indigenous-biofilter, we calculated volumetric nitrification rate to be 400 g TAN/m^3 gravel/day. The predominant nitrifying bacteria were found to be Nitrospira (35-80%) and Nitrosomonas (1-5%), through 16S rRNA NGS-sequencing. Overall, we conclude that intensive production of rainbow trout is techno-economically feasible in these indigenously developed RAS models, using 100 times lesser water volume than conventional flow-through raceway, in nearly half the normal culture duration.

Keywords : Recirculating aquaculture, Climate Resilient Farming, Rainbow trout

Paper ID 16173

Indigenous seaweed *Gracilaria edulis* grows at an unprecedented rate in the lagoons of Lakshadweep atolls

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Gracilaria edulis, an indigenous red alga was grown in different farming techniques viz. rafts (coir rope and polypropylene culture rope), monoline (coir rope), tube net and cages in the lagoons to fix the farming technique suitable for the unique conditions of lagoons of Lakshadweep atolls. The seaweed thallus collected from the wild was used for seeding in all these methods. The grow out experiment was conducted in five atolls for 6 cycles in a year starting from August to May during 2020-21 and 2021-22. The results showed an unprecedented growth rate in all the culture systems with an average 35folds growth and the specific growth rate averaging 12%. Indigenous seaweed species portrays to be an ecologically and economically viable candidate species for the sensitive lagoon ecosystems of Lakshadweep atolls. The floating cage seemed the best method from point of view of growth rate, loss due to breakage, grazing and infestation and in terms of quality of the thallus. Higher durability of PVC cages, convenience of seeding and harvesting and light weight outsets the relatively higher initial investment of cages. The Lakshadweep atolls with a massive 20,000 hectares of potential lagoon area, which is preparing for a fillip in seaweed farming finds its best farming technique to rely.

Keywords : Indigenous seaweed, Lakshadweep atolls, *Gracilaria edulis,* Cages

Paper ID 16178

Sustained exogenous hormone therapy for overcoming multiple reproductive dysfunctions and extension of reproductive period of captive grey mullet, *Mugil cephalus*

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The cosmopolitan flathead grey mullet is an economically important brackishwater food fish farmed mainly for its food value and also for its roe in some countries. Despite its economic significance, the hatchery-based seed production of the species is still largely on an experimental and semi-commercial scale globally due to its multiple reproductive dysfunctions in captivity and its short annual reproductive period. ICAR-CIBA standardised the hatchery-based seed production of grey mullet and efforts now focus on refining existing protocols and extending its captive reproductive period. Optimal broodstock management, high quality broodstock feed, Cephalus^{Plus} and exogenous hormone therapy constituting of cholesterol pellets of GnRHa for female and silastic implants of 17-alpha-methyl-testosterone at periodic sampling intervals helped to sustain oocyte growth rate, enhance overall fish maturity, increase the functional fish maturity percentage and extend reproductive period in captivity. Variation in timing of initiation of exogenous hormone therapy influenced the temporal availability of functionally mature females and males and further helped to stagger the reproductive period under captivity.

Keywords : Grey mullet, *Mugil cephalus*, Reproduction, Captivity, Maturation, Hormones, Reproductive period

Paper ID 16191

Captive breeding and larval rearing of indigenous ornamental fish mascara barb, *Dawkinsia assimilis*

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Mascara barb, *Dawkinsia assimilis* is a popular ornamental fish endemic to Western Ghats. The study describes, first successful captive breeding of mascara barb with captive matured brood male (15.00±0.13 g & 9.81±0.10 cm) and female (16.14±0.14 g & 10.05±0.07 cm). The brood fishes were collected from Karkala, Udapi district, Karnataka, India. The broodstock development was done in FRP circular tanks of 500 litre capacity. The brooders were selected, graded and segregated based on the secondary sexual characters selected brooder were undergone intramuscular hormonal inducement (Dose: 0.025 ml/Individual to both male and female). The breeding was done in glass tank (200 litre) using specially designed breeding hapa with male to female ratio was 1:1. The gonado somatic index for male and female were 1.65±0.14 and 4.26 ±0.10 respectively. The absolute fecundity was 1068.78±1.43 and fertilised eggs were light pale yellow in colour. Hatching of eggs occurred after 60 hours of spawning. Larval density was 3 No./litre in first 2 weeks after that it was reduced to 1 number /litre. Larval rearing was done using egg custard and high protein (35%) commercial powder feed. 3rd week onwards larvae were fed with commercial powder feed only. The larval survival was recorded 54.34±4.04 % in captive breeding of *D. assimilis* from spawn to fry.

Keywords : Mascara barb, Captive breeding of ornamental Fish, *Dawkinsia assimilis* and Indigenous Ornamental Fish

Paper ID 16207

Assessment of carp polyculture in periphyton enhanced system

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Polyculture is the system of culturing more than one species of aquatic organism in the same pond. It motivates the fishes to better utilization of available natural food produced in a pond. Periphytons are various aquatic organisms like group of algae that live while attached to submerged plant stems and leaves as well as other substrates. It plays important roles in providing food for fish and other fauna in natural as well as controlled environment. In the current assessment, catla and rohu were stocked at 1000 Nos (1 No/sq.mt.) in 0.1 Ha earthen ponds for 6 months culture period at ten villages in Kancheepuram district, Tamil Nadu, India. The fish ponds were provided with bamboo poles, sugarcane bagasse as substrates for periphyton enhancement and the remaining ponds (farmers practice) were not provided with any of the substrates. A huge quantity of plankton in periphytic nature and colonised was observed on the sugarcane bagasse substrates than others. The higher fish growth (0.45 kg), survival (85.38 %) and production (3842.88 kg/Ha) was significantly ($p<0.05$) showed in the ponds provided with sugarcane bagasse substrates as compared to the bamboo poles (3497.24 kg/Ha) and without substrates ponds (2555.04 kg/Ha). Therefore, the sugarcane bagasse substrates based periphyton production may be suitable for carp polyculture about higher fish production in a pond based system.

Keywords : Polyculture, Periphyton, Fish, Pond, Bamboo poles, Sugarcane bagasse

Paper ID 16228

Seasonal impact on growth and survival performance of Pacific white leg shrimp (*Penaeus vannamei*, Boon,1931) in HDPE lined culture ponds

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To investigate the differential season impact on the growth and survival of Pacific white shrimp (*Penaeus vannamei*) this study was conducted in both summer and winter seasons in lined ponds. The pond water salinity was observed to peak at a maximum of 39±0.28 ppt during summer and 34±0.28 ppt during winter culture, pH levels in ponds reached a maximum of 8.9±0.05 and 8.4±0.0.65 during summer and winter respectively. Salinity and pH have shown a significant impact on the growth and survival of *P. vannamei.* Pond water temperature was observed as a major changing parameter at 25 to 27°C in winter, whereas it was 29 to 32°C during summer. Further, regression analysis revealed a significant ($p < 0.05$) positive correlation (r = 0.461) between temperature and shrimp growth, while it was an observed negative correlation (r = -0.08) during the summer season. This statistical observation further justifies the causes of higher growth rates during winter than summer, indicating temperature was a determining factor for shrimp growth in lined ponds. Our findings have a good correlation with earlier studies to provide a new systematic view of seasonal influence on the growth and development of *P. vannamei* in HPDE lined ponds.

Keywords : HDPE, Salinity, Temperature, Season

Paper ID 16237

Unprecedented growth of Indian Pompano in marine cages off Bahabalpur, Balasore: A step towards doubling farmers income and blue revolution

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Around 12,000 advanced fingerlings of Indian pompano, produced in the marine hatchery complex at Visakhapatnam Regional Centre of ICAR-Central Marine Fisheries Research Institute, were stocked in seven cages in the marine cage farm off Bahabalapur, Balasore, Odisha.Stocking density in each cage varied between 1650 and 1700 numbers. Average body weight at stocking was 50g. The stocked fishes werefed with artificial pelleted feed containing 40% crude protein and 10% crude fat at 10-7 % of biomass at a feeding frequency of three times a day.All the seven cages were harvested 40 days after stocking. More than 1.70 tonnes of production were achieved from an initial biomass of 0.59 tonnes, indicating close to threefold increase within a period of 40 days.Survival was 87 % and average body weight at harvest was 170g. Daily weight increment was 3g and food conversion ratio was 1:1.4. With Indian pompano, being cultured in most maritime states of the country, such unparalleled daily growth increments and high feed conversions have never been achieved earlier. This maiden experimental demonstration of Indian pompano farming in offshore cages would be an eye- opener, and would play a pivotal role for enhancing productivity from marine cages, as is envisaged under the Pradhan Mantri Matsya Sampada Yojana and would ensure doubling farmers income in the near future. Such enormous weight increments would pave the path for Blue Revolution in the country, and Indian mariculture is poised for new heights.

Keywords : Marine Cages, Indian Pompano

Paper ID 16242

Development and performance analysis of mixing type showering aeration system

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The showering type aeration system developed for providing aeration in nursery system. The present study focuses on development of mixing type showering aeration system, and performance analysis of the developed system based on standard procedures. The mixing procedure in the tank was achieved by specially designed agitator, and operated along with shower system. The aeration tests viz., SOTR, SAE, and other tests includes mixing efficiency, mechanical efficiency of the agitator were analysed. The comparative analysis was carried out between the existing non mixing type showering aeration system (Roshan et al, 2022) and the developed mixing type system. The results presented that, the mixing type showering aeration system performs better in achieving the oxygen level quickly and eliminates thermal and oxygen stratification at different levels in the tank.

Keywords : Showering type aeration, Agitator setup, Aerator design, Performance analysis

Paper ID 16247

Incorporation of periphyton with the culture of *Puntius sarana* in inland open water cages reduces dependency on formulated feed

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Naturally grown periphyton on substrates are a renewable and efficient food source for herbivorous fish. Earlier studies have established the fact that *Puntius sarana*, a medium carp predominantly feeds on periphyton. A study on the culture of *Puntius sarana* (14.38±1.03 g) was conducted in galvanized iron cages (6m length × 6m width × 4m depth) installed in Maithon Dam was conducted for six months. Fingerlings were uniformly distributed in 12 cages. Split bamboo was used to make frames worth 1 m^2 surface area. A total of 8 frames were suspended vertically on surface water in each cage. Fishes were fed with CIFRI CAGEGROW® floating feed. With two replicates each, five treatments such as 0%, 25%, 50%, 75% and 100% were fabricated by supplying the respective amount of daily ration to fish. A control group (C) was also selected with no bamboo frames and supplying 100% of the daily ration. Water quality parameters observed in cages were optimum for the culture of *P. sarana*. The highest Mean body weight (145.23±8.46 g), Specific growth rate (1.32±0.09%) and survival (87.50±2.25%) were observed in cages where 75% daily ration was supplied ($P<0.05$). Similarly, best FCR and FCE was also observed in the same treatment however, it was not significantly different ($P>0.05$) from the cages with 50% daily ration was supplied. The study reveals that the incorporation of periphyton in the cage culture of *P. sarana* can benefit the farmers by reducing the feed requirement by 25%.

Keywords : Periphyton, Cage culture, Substrate, Bamboo, *Puntius sarana*

Paper ID 16249

Optimization of the supplementation of major essential minerals in the diet for Asian seabass (*Lates calcarifer*) in freshwater based recirculating aquaculture system

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An experiment was conducted to optimize the supplementation of major essential minerals in the diet for Asian Seabass (*Lates calcarifer*) in freshwater-based RAS system. The experimental duration was for 60 days. The experiment was carried out in 30 Nos. of rectangular polyethylene (PE) tanks each of 500 liters capacity. The experiment was carried out in triplicates with 10 treatments and 2 controls. The experimental diet was prepared with mineral mix containing major minerals Viz., Magnesium, Sodium, Potassium, Iron, Copper, Zinc, Manganese and Selenium in all treatments. The mineral premix was prepared as per the composition, as average values of the previous studies and the mineral premix were supplemented at 0.2%, 0.4%, 0.6%, 0.8%, 1.0%, 1.2%, 1.4%, 1.6%, 1.8% & 2.0 in the experimental diets. Mortality of 40% was observed in treatment with more than 1.4% of mineral premix supplementation. Fishes were active in treatment with 1% and less percentage of supplementation. Hence, It is suggested to include the mineral premix upto 1% in the diet of Asian seabass for culture in freshwater based RAS system.

Keywords : Minerals, RAS, Asian Seabass, Aquaculture, Nutrition

Paper ID 16252

Continuous culture of marine microalgae *Nannochloropsis gaditana* in open ponds: an effective green production technique

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This study aims to evaluate the performance of an open pond (OP) for producing microalgae paste and powder from Eustigmataceae marine microalgae *Nannochloropsis gaditana* in a continuous culture. The growth performance of *N. gaditana* was assessed in six numbers of oval-shaped cement ponds (150 m^2) lined with food-grade geo-membrane sheets. The culture ponds were enriched with NPK, micro minerals and the required vitamins for microalgae growth in natural light. Paddle wheel aerator of 16 rpm was used to maintain continuous water circulation and suspension of algal cells. Continuous culture of microalgae *N.gaditana* in OP was conducted for 120 days. The intermediate culture maintained in the mother ponds was inoculated (100-120 million cells/ml of 4 days old) in the pond and held for 15 days. The open ponds were injected with one ppm of CO_2 for 3 h per day. Salinity in the range of 35, 40, 50, 55, 60 and 70 ppt were correlated with biomass production to determine the optimal water salinity for better biomass yield. Result showed that microalgae growth (200-220million cells/ml) is more favorable at a salinity of 55 ppt and significantly increases the biomass production of microalgae. During the culture period, pH and temperature were in the range of 8.0-10.4 and 27-33 ˚C were observed, respectively. A total of 10 % volume of microalgae culture (5000 L) was harvested on every two days from the culture ponds by directly pumping the culture into the tubular centrifuge unit which contains 10 microns and 5 microns filters that removes any debris and dirt particles from the culture system. Standard centrifugation was carried out at 16000 rpm for harvesting the microalgae as microalgae paste that was scrapped and collected from the centrifuge tube. The filtered culture water is re-circulated back to the ponds. The cell concentration observed in the microalgae paste samples (n=3) was in the range of 58-60 billion cells/g at 55 ppt salinity. The estimated microalgae algae biomass production on an average was 1.05 $g/m^{-2}/day^{-1}$. The collected microalgae paste was dried in a solar drier (48 °C) attached to a dehumidifier for 24 to 36 hours. The resulted yield of microalgae paste to algae powder was in a ratio of 3.5: 1.

Keywords : Microalgae, Photosynthesis, Lc-pufa, Open Pond, Algae paste

Paper ID 16254

Growth performance of *Kappaphycus alvarezii* in horizontal and vertical monoline plots at Thoothukudi coast of Tamil Nadu, India

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Tuticorin coast of Tamil Nadu is a prospective location for seaweed mariculture of *Kappaphycus alvarezii* in South India. The biomass production and productivity are highly dependent on the proper farming practices based on a suitable culture location, method, seedling variety and season. The monoline method of kappa seaweed cultivation is being practiced in Mullakadu village, Thoothukudi coast of Tamil Nadu. The present study aims to compare the growth rate and biomass production of *K. alvarezii* in horizontal and vertical monoline methods (n=3). The weight gain percentage (WG %), specific growth rate (SGR), daily growth rate (DGR), net production (NP) and productivity were significantly different ($P<0.05$) among the methods studied. The result showed that horizontal monoline plots favoured higher biomass production, weight gain percentage (WG %), specific growth rate (SGR), daily growth rate (DGR), net production (NP) and productivity than the vertical monocline method. The biomass yield was 8.66 ±0.22 tonnes of wet weight from a cultivable area of 750 m^2 (comprising 100 nos of single lines of 15 m attached to the 50 m main lines) with in a culture period of 38 days which was 6.21 ±0.21 tonnes of wet weight for vertical method from the same area (20 numbers of 1.5 m length rope are vertically attached to each single line of 15 m length. The DGR was 4.17±0.09 and 3.37±0.04 (%/day) respectively for horizontal and vertical monoline method. The NP was 9.18 0.26 ± and 5.94 ±0.23 kg/m^2 for horizontal and vertical monoline methods respectively. The higher productivity of 19.34± 0.55 g dwt/ m^2/ day was noticed in horizontal monoline than the vertical monoline plots (12.51±0.49 g dwt/ m^2/ day). In conclusion, horizontal monoline methods are the most appropriate cultivation methods for the environmental conditions of this particular area.

Keywords : Seaweeds, Biomass, *Kappaphycus alvarezii*, Monoline, Productivity

Paper ID 16261

A novel method for continuous production of *Pehtia setnai*, an endemic ornamental barb from the western ghats.

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*Pethai setnai*is a medium sized barb, endemic to the Western Ghat, is having demand in ornamental fish trade but availability is less due to mortality during wild collection and transport. The species is listed as 'Vulnerable' by IUCN. Many species of barbs from the Western Ghats have been bred using hormonal manipulation, which may be relatively costly and complicated for a fish farmer and may cause mortality. For sustainable long-term production, it is important to develop simple and non invasive breeding technique. We developed a simple, non-invasive technique for production of this species in captivity. Broodstock were maintained in a 500L FRP tank provided with filtration and aeration. A spawning plastic tub filled with ceramic rings and topped with spawning mops was placed in the tank which having brooders. The spawning observed within 18-24 hours and hatching in 16-18hr after spawning at water temperature 27.0±0.5ºC. The embryonic development was studied and stages were recorded. The fertilized eggs were adhesive, demersal and attached to substratum. Fecundity ranges 250-300 per female and egg diameter was 730±30 µm. Newly hatched young ones measured 2.5 ±0.50 mm and free swimming hatchlings were transferred into rearing tanks. The hatchlings were initially fed with green water and artemia nauplii. After 10 days, artemia nauplii and microworms were fed till 30 days, and after that finely powdered artificial feed were given. The young ones reached a size of 4cm within 10-12 weeks, with characteristic colour patterns at different sizes. Same brooders again used again with a time gap of 30-45 days. The Fl stock of *Pethia setnai* was bred again and completed the cycle of this species in captivity. This simple technique of breeding will be useful for reducing the pressure from wild collection and conservation of this important species.

Keywords : Indigenous, Ornamental fish, Breeding, Conservation

Paper ID 16264

Stocking strategy for realizing fisheries potential in ox-bow lakes of India: experiences from Koshi-Gandak Basin

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The myriads of wetlands located in the Koshi-Gandak basin are contributing sub-optimally of their potential to the fish basket of the state. Lack of awareness, infrastructure, technological interventions and environmental hazards specially recurring flood are some of the reasons identified for low fish production. Stocking enhancement is one such proven management intervention for improving fish yield from 0.35 m ha floodplain wetlands resources across the country. A guideline/strategy for stocking intervention based on ecological parameters will help realize inherent production potential of the wetlands in a sustainable manner. An attempt was made to develop a rational stocking plan based on the dynamics of key ecological parameters, such as temperature, transparency and detritus load in water phase that determine production functions were recorded from Kararia maun, a perennial, seasonally open, 120 ha oxbow lake in the Koshi-Gandak basin of Bihar. Dynamics of primary productivity through microphytic (plankton) chain recorded highest (2563mgC/m^3/h) during summer and lowest during monsoon (667 mgC/m^3/h). Fishing trend indicated gradual increase in fishing intensity and production from October reaching peak (13269kg) during February-March. The range of temperature, transparency, and detritus load in water phase recorded were 8-41˚C, 13-78cm, and 2.37-10.96g.day^{-1} m^{-2} respectively. Monthly catch distribution pattern of stocked fishes indicated that major harvesting started from November and continued till February-March. Collation of monthly variations of various ecological parameters and productivity pattern revealed that February to August was most productive phase of the wetland, while fishing pattern revealed increasing availability of space and food in the wetland with the onset of harvesting. The study, thus, suggested a seed stocking schedule during January-February as first lot to make use of increasingly available space, food and favourable environment and and second lot during October to avoid seed escape due to flooding for realizing potential and enhanced fish yield.

Keywords : Wetland, Ecology, Stocking Strategy

Paper ID 16277

Hatchery seed production and grow-out culture of Striped murrel, *Channa Striata*: An overview

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Striped murrel (*Channa striata)* is a high-value indigenous food fish (6-10 USD per Kg) of India with good medicinal values. The better growth rate, buyer preference, and high market demand state its candidacy in freshwater aquaculture. Furthermore, striped murrel is suitable for high-density culture due to its air-breathing ability. The decrease in striped murrel capture from the wild also emphasized the need to accelerate its farming. The seed availability for culture mostly depends on the natural collection therefore, the establishment of the striped murrel hatchery should be done to enable a steady seed supply for its grow-out culture. The ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar has developed technology for the captive broodstock development, induced breeding, seed production, and grow-out culture of striped murrel. The institute is keenly involved in the diffusion of the said technology through various field demonstrations, training, and workshops. These continued efforts by the institute helped in spreading awareness and knowledge about the seed production and farming of striped murrel and most importantly many of the stakeholders took up murrel fish farming successfully and generated good profit from this priced fish. At present, murrel farming is spreading fast in India and it is expected to reach 10,000 hectares area in the next 3-4 years therefore, it is an urgent need to establish a large number of hatcheries to meet the increasing seed demand.

Keywords : Striped murrel, *Channa striata*, Induced breeding, Seed production, Growout culture

Paper ID 16279

Breeding and seed production of indigenous ornamental fish, Assamese Snakehead, *Channa stewartii* (playfair, 1867)

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Many of the *Channa* species are in demand as ornamental fish species and exported from India for the last two decades. *Channa stewartii* (Playfair, 1867), found in the beels of North- Eastern states of India has great demand among aquarium hobbyists. Broodstock of *Channa stewartii* was collected from the wetlands of Assam were raised at the farm facility of ICAR-CIFA, Bhubaneswar. Three different breeding sets in duplicate were arranged in rectangular cement tanks and 1000 L of water was maintained in each tank. In the first treatment group (T1), tanks were filled with a soil base of 5-6 inches and six hide-outs made of PVC pipes. In the second treatment group (T2), tanks were filled with a soil base of 5-6 inches, six hide-outs made of PVC pipes, and 10-15 % of the water spread area stocked with floating aquatic macrophytes (*Pistia stratiotes*). In the third treatment group (T3), the tanks were without soil base, hideouts, and aquatic macrophytes. Male and female brooders were selected individually after a physical examination and paired in a ratio of 1:1 in each tank. In the T1 group, one replicate responded after 8 days of stocking, and in the T2 group both the replicates responded (one on the 5th and another on the 7th day of stocking). Fishes in the T3 group did not respond. Since *C. stewartii* is a mouth brooder we did not disturb them until the 3 weeks. The 3 week old *Channa stewartii* fry was collected from the breeding tanks and reared under different feeding treatments, namely plankton, tubifex, and formulated powdered feed in triplicate for 30 days. At the end of 30 days, there was a significant difference in survival and weight gain under different feeding treatments. Final weight and length were significantly higher in tubifex fed treatment.

Keywords : Ornamental fish, Channa Sp., Breeding, Larval rearing

Paper ID 16285

Evaluation of potassium (k+) supplementation on growth enhancement and physiological responses of *Pangasianodon hypophthalmus* (sauvage, 1878) and *Spinacia oleracea* L. in an Aquaponic system

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A 60-day trial was conducted to evaluate the effect of different dosages of potassium supplementation on growth and physiological responses of *Pangasianodon hypophthalmus* and *Spinacia oleracea* L. in aquaponics. The aquaponic system comprised a rectangular fish tank of capacity 168 l (0.78×0.54×0.40 m; adequate water volume = 100 l) stocked with *P. hypophthalmus* at 2.8 kg m^{-3} and Nutrient Film Technique (NFT) hydroponics at 28 spinach plants m^{-2}. The experiment analyzed the effect of four target potassium dosages *viz.,* 90 (T1), 120 (T2), 150 (T3), and 180 mg l^{-1} (T4) on growth and physiological response in aquaponics as compared to control C (0 mg l^{-1}). The mean physico-chemical parameters and nutrient dynamics exhibited no significant variation between the treatment and control groups. The spinach yield at the first harvest (before potassium supplementation; day 30) showed no significant difference while the second harvest (after potassium supplementation; day 60) showed a remarkable increase in yield in treatments, particularly T3 (277.57±3.02 g; 150 mg l^{-1} K^{+}) and T4 (280.07±2.26 g; 180 mg l^{-1} K^{+}) than control (217.83±4.20 g). The fish growth was statistically at par in all the treatments and control. The nutrient analysis manifested that potassium supplementation in aquaponics triggered the synergic nutrient effect resulting in increased nitrogen, potassium, phosphorus, iron, and sulphur content in treatments than control. The physiological responses revealed higher plasma potassium, glucose, and SOD levels in *P. hypophthalmus*, particularly in T4. The experimental findings demonstrated that potassium supplementation at 150 mg l^{-1} is optimum for enhanced growth and physiological wellbeing of *P. hypophthalmus* and *Spinacia oleracea* L. in the aquaponic system.

Keywords : *P. hypophthalmus*, *Spinacia oleracea* L., Aquaponics, Potassium, Physiological responses

Paper ID 16286

Duckweed (*Wolffia globosa*) based fish feed: an approach to environment friendly sustainable aquaculture

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Wolffia globosa (wolffia) known as the smallest angiosperm in the world with the size range of 0.5- 1.5 mm in length that grows very well on lakes, marshes and sewage ponds with high turnover rates in tropical and subtropical agro-climatic conditions. It has a preferable proximate composition with the protein content ranging from 21.95%-33.95%, crude lipid from 1.04% to 4.70%, fibre from 9.78% to 11.99% and Ash content 15 to 17 %. Starch content in duckweed plants is highly variable and values ranging from 33-54% of the DM basis. It is also rich in bioactive components such as vitamin B12, polyunsaturated fatty acid and/or long chain MUFAs like nervonic acid between 48 and 71 % and the high content of n3 fatty acids, flavonoids, pigments and xanthophylls. Accordingly, it can be a potential feed resource or feed supplement in both live and meal form. More remarkably, production of wolffia represents net carbon-sink whereby it removed carbon dioxide from not only the ambient atmosphere through photosynthesis but also from the water as part of the closed loop process. Assuming duckweed carbon content as 40%, 14.5-20 t CO2 can be removed from the atmosphere by 1 ha of duckweed pond in a year, which makes duckweed a highly competitive candidate for CO_2 sequestration. On the other hand, fish production from both capture fisheries and aquaculture have been reported to have relatively high carbon footprints ranging 1-3 kg carbon dioxide per kg meat and 2-7 kg carbon dioxide per kg meat, respectively. Major part of the carbon foot print in aquaculture is linked to artificial feed. Thus, local production and utilization of wolffia in live form as allochthonous feed can be an important tool for reducing the ecological foot print of fed-fish.

Keywords : Duckweed, Fish feed, Proximate composition, Carbon footprints, CO_2 Sequestration

Paper ID 16287

The effect of different drying methods on biochemical composition and color intensity of *Wolffia globosa*

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Wolffia globosa is a known rich source of nutrients including bioactive compounds. The production conditions as well as different post-harvest processing methods can greatly affect nutritional and qualitative characteristics of any plant or fruit products such as moisture, color, proximate composition, total phenolic content and antioxidant activity of final product. Drying is one of the simplest post-harvest processing method for prolonging the shelf-life of wolffia. However, to the best of our knowledge, no comprehensive reports were available on the variations in color characteristics, moisture content, proximate composition, total phenolic content (TPC) and antioxidant activity of W. globosa under different drying methods. Three types of different drying methods were used including Oven drying (OD), Sun drying (SD) and Freeze-drying (FD). For oven drying, the fresh samples were dried in 60-65 0c for 24-30 hours, for both SD and FD; the fresh samples were kept for two (2)-days in sun light and freeze dryer, respectively. The highest crude protein was observed in FD wolffia (29.79±0.31) and the lowest in oven dried wolffia (27.02±0.06), the crude fiber was also highest in FD (9.8±0.23) and the highest crude lipid was observed in SD (4.23±0.28). The highest DPPH scavenging activities were observed in FD (39.86± 0.79) followed by those of SD (29.22±0.47) and OD (27.63 ± 0.58), in order. The total phenolic contents also were highest in FD (2.24± 0.06) followed by that in SD (2.09±0.03). The color intensity by using Colour Flex® EZ colour Analyser indicated that FD sample had significantly higher color intensity compared to SD and OD samples indicating higher amount of chlorophyll's and carotenoids. The results indicated that FD is the least intrusive drying method conserving the nutritional characteristics followed by SD and OD.

Keywords : *Wolffia*, Dpph, Tpc, Proximate composition, Color intensity

Paper ID 16292

First report on induced spawning of the estuarine black clam *Villorita cyprinoides* (gray, 1825)

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The Black Clam *V. cyprinoides* is endemic to Peninsular India and inhabits the brackish water ecosystem tolerating salinity levels up to 34 ppt. This species constitutes one of the significant contributors to clam fishery in India. A decline in the fishery has been reported in the northern region of Lake Vembanad in recent years, although this is the primary fishing ground. A balance between capture fisheries and aquaculture through hatchery is inevitable to ensure sustainable resource use. In advanced shellfish aquaculture, multiple methods are used for induced spawning of molluscs. In the current situation of decreasing population of a natural stock of bivalves mainly due to anthropogenic activities, the present study evaluates the first attempt at chemical-induced spawning in *V. cyprinoides* as a primary step in the culture of species, thereby removing one of the critical bottlenecks in restoring the depleted resources by using aquaculture technologies which would ensure sustainable production and conservation of natural resources. Mature broodstock was collected from Lake Vembanad, Kerala, India, and transported to the hatchery at Vizhinjam Regional Centre of ICAR-CMFRI and maintained at a temperature between 20 and 23 °C. The transported animals were conditioned in a natural state for two days, with proper feeding. Gonadal conditions were observed under the microscope before proceeding with chemical treatment. An intramuscular injection of serotonin was carried out, resulting in the successful release of spermatozoa after 20 minutes, followed by eggs. Later, the animals were removed from the tank, allowing the gametes to fertilize and develop. Fertilization and early development were marked by cleavage with polar lobe formation. Trochophore larvae were observed at 12 hours post spawning, followed by veliger larvae after 24 hours. In addition, successful rearing of larvae up to the umboned veliger stage has been achieved so far.

Keywords : Black clam, Induced spawning, Early-development, Umboned veliger.

Paper ID 16296

Brackishwater nursery raceway technology - An ideal option to achieve high survival and growth of *Penaeus vannamei* (Pacific white Shrimp)

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Shrimp aquaculture with *Penaeus vannamei* farming in India has witnessed promising growth for the past decade. The experiment was aimed to evaluate the water quality parameters, growth performance and survival rate of the *Penaeus vannamei* in the nursery raceway system. This experiment was conducted for 30 days period in two raceway tanks of 65.2m^2 area. The *Penaeus vannamei* seeds negative for the White Spot Syndrome Virus & Taura Syndrome Virus post larvae size 15 were acclimated to a salinity level of 17 - 18 ppt. The seeds were brought from M/s. Shenglong BioTech (India) Pvt. Ltd. hatchery of Marakanam, Vilupuram District. The Fifty thousand seeds were stocked in each tank at a stocking density of 1500/m^2 of raceway 1 and 2. Royal dragon crumble feed from M/s. Shenglong BioTech (India) Pvt. Ltd. was fed to the seeds for four times daily at 7am, 10am, 3pm and 9 pm. Water samples were collected and analysis were carried as per the procedures of APHA standard methods. Water quality parameters such as temperature, salinity, pH, total alkalinity, total hardness, calcium hardness, magnesium hardness, total ammonia, nitrites, and dissolved oxygen was recorded at regular intervals. The results showed that, on the 30th Days of culture animals reached an average final length of 4.5cm and an average body weight of 1 g. All the water quality parameters were found to be at optimum levels throughout the experimental period. The percentage of survival in raceway culture was 92% and 94% in raceway system 1 and 2 respectively. These observations strongly suggest that, good water quality parameters and management practices are highly essential for producing healthy, good quality *Penaeus vannamei* shrimp seeds by brackishwater raceway tanks with high survival rate.

Keywords : Pacific white shrimp, Raceway nursery culture, Growth performance, Survival rate, Water quality parameters

Paper ID 16320

Preliminary studies on captive maturation and induced breeding of Goldlined Seabream *Rhabdosargus sarba* (Forsskål, 1775).

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Rhabdosargus sarba (Forsskål, 1775) is an omnivorous fish belonging to the family Sparidae, are excellent food fish and are of notable importance to both commercial and recreational fisheries throughout their range. The fish is a potential candidate for aquaculture because it has high commercial value in the local market itself. The wild collected juvenile and sub-adult fishes (47 nos.) are being maintained for over a period of 1 year in various rearing systems including cages within the pond; flow through and under RAS facility at Muttukkadu Experimental Station of CIBA. In November 2021, the fishes reared in the cages matured and oozing milt stage was observed in the males. First maturity occurred in male with the size of 19.0 cm length and 320 gram weight and in female with the size of 24.0 cm length and 420 gram weight. This is the first report on the captive maturation of this species globally. Subsequently the fishes with desired gonadal status were given hormonal induction with HCG and maintained in the RAS facility in the month of December 2021 and spawning was obtained in the midnight. The total fecundity of this particular batch spawning was around 40,000 eggs. The average size of spawned eggs was between 920 and 980 microns. Although, the fishes responded to external hormones and spawning occurred successfully, fertilization did not occur. This may be either due to non-synchronisation of males and female gonad releasing or lower salinity prevailing (20 ppt.) in that period of study or both. The significant observation made from this study is that these captive raised sparid breams responded to hormonal induction positively. Further steps will be taken to standardize the breeding technique for seed production of this gold lined seabream *Rhabdosargus sarba*.

Keywords : Goldlined seabream,captive Maturation, Induced breeding

Paper ID 16347

Pilot seaweed farm experiment in Ratnagiri Coast, Maharashtra - A Case Study

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Seaweed farming in India is at a nascent stage and has huge potential in contributing towards the goal of doubling farmers income especially for women communities. Preliminary estimates of potential seaweed sites as identified for the Maharashtra coast is about 2724 ha. In order to find the species suitability and method suitability for seaweed farming in Maharashtra, pilot seaweed cultivation was started at Golap village coast in the Ratnagiri district during January 2022. Species selected for this farm is *Kappaphycus alverazii* and *Gracillaria salicornia*. Cultivation methods such as Bamboo raft and Tube net were tried at this site. In order to promote this seaweed mariculture, Women self-help group (WSHG) from Golap village were identified and about 60 women were trained on seeding, rearing, maintenance and monitoring aspects of the seaweed cultivation. Accordingly, total of 57 rafts and 68 tube nets were stocked with *K.alverazii* and *G.salicornia* were installed with the participation of trained women at the selected site of Golap seashore. After 45 days of successful culture, we found that both raft and tube net methods were suitable for the above two species at the selected site. Suitable water quality parameters for seaweed cultivation was found to be Atmospheric temperature 29-33°C; Surface water temperature 25-26°C; Dissolved oxygen 5-6.5 ppm; pH 7-8.2 and salinity 31-33.8 ppt. This seaweed farm will act as in-situ seed bank for the upcoming seaweed farming in the Ratnagiri coast; its produce will be sold to industries for developing seaweed products and will certainly provide as an alternative source of income for these women SHG groups. This successful seaweed farming model can be adopted for the entire coast of Maharashtra in future.

Keywords : Seaweed cultivation, *Kappaphycus alverazii*, *Gracillaria salicornia*, Ratnagiri

Paper ID 16350

First sponge infestation recorded in tropical inland open water cage culture

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Two species of freshwater sponges (*Spongilla lacustris* and *Eunapius carteri*) were recorded infesting nets of cages in the inland open water reservoir, Salia reservoir, Ganjam district of Odisha. The survey among the cage entrepreneurs confirmed such problems of sponge infestation since the installation of cages. The damages to the cage net due to the growth of sponges were extensive and economically detrimental. Both species were identified based on morphological characteristics like the shape and size of spicules and gemmules, scanning electron microscopic photographs, and COX1 molecular marker. *S. lacustris* and *E. carteri* having accession numbers: MH368293 and MH319717, respectively were the first-ever database in NCBI, recorded in inland open water cage culture. Live specimens of *S. lacustris* and *E. carteri* were green and yellow-brown, respectively. Megascleres of *S. Lacustris* and *E. carteri* were having lengths of 229.76 – 275.56 µm and 316.70 – 374.23 µm, whereas the width was 16.75 – 20.76 µm and 17.17 –26.08 µm, respectively. The spherical gemmules of *S. lacustris* and *E. carteri* were 6-8 mm and 6-9 µm, respectively. At the initial stages, sponges were tiny particles of 0.05±0.01 cm thickness and 0.01±0.00 m circumference. After 240 days of observation, sponges grew to a thickness and circumference of 0.9±0.12 cm and 2.4±0.25 m respectively. Mineral profiling of sponges described that Zinc (26.92 and 19.64 ppm), Manganese (10 and 6.72 ppm), and Copper (3.79 and 3.61 ppm) in *S. lacustris* and *E. carteri*, respectively were the major mineral constituents. The proximate composition analysis explained that *S. lacustris* had higher moisture (72.13%) and ash content (74.15%) whereas *E. carteri* had higher crude protein (16.19%) and crude fat (3.01%) content. The analytical results can help to develop preventive measures against these sponges infestation in inland open water cages.

Keywords : Freshwater Sponges, *Spongilla lacustris*, *Eunapius Carteri*, Spicules, Gemmules, Cages, Inland open water

Paper ID 16354

Evaluation of growth and health status of *Labeo rohita* and *Pangasianodon hypophthalmus* in a cage-based polyculture system using multiple biomarker approach; A Biomanupulation Strategy for Biofouling Control

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The growth of biofouling organisms in inland open water cage culture has been a mounting apprehension. The cage culture of *Pangasianodon hypophthalmus* has been encountering a biofouling issue since the said species is completely dependent on supplementary feed. The damages caused due to biofouling growth are economically extensive. Earlier studies have reflected that Labeo rohita has a tremendous grazing habit of periphyton grown over cage nets. The present study was conducted to obtain a suitable stocking ratio among *P. hypophthalmus* and *L. rohita* in a polyculture system. Based on earlier studies, *P. hypophthalmus* and *L. rohita* were stocked @ 40 m-3 and @ 10 m-3 in two cages each. Three other treatments were made by stocking *P. hypophthalmus* and L. rohita at 5%, 10%, and 15% levels, by naming P95:R5, P90:R10, and P85:R15, respectively. The experiment was carried out in triplicates. After 180 days of the experiment, the growth and survival did not differ significantly ($P>0.05$); however, the biofouling growth was significantly controlled in cages stocked with L. rohita ($P<0.05$). The gut content analysis revealed that similar groups of periphyton were found in L. rohita gut, cage net, and water. The cage net was completely blocked in *P. hypophthalmus* monoculture, whereas the incorporation of *L. rohita* left the cage nets clean. In P85:R15, the highest serum lysozyme activity was observed whereas serum complement activity was the lowest. The serum complement activity was highest in P95:R5. Biofouling accumulation (40.52±3.21 g) was 7-20 times higher than the cages incorporated with *L. rohita*. No significant ($P>0.05$) serum stress responses (oxidative stress, lysozyme activity, immunoglobulin) were recorded in *L. rohita* due to incorporation with *P. hypophthalmus*. It can be concluded that the stocking density ratio of 85:15 is suitable for *Pangasianodon hypophthalmus* and *Labeo rohita* in a cage-based polyculture system.

Keywords : Biofouling, *Labeo rohita, Pangasianodon hypophthalmus*, Cages, Polyculture, Stocking density

Paper ID 16355

Utilization of krill meal as a feed attractant by replacing fishmeal in the diet of orange spotted grouper, *Epinephelus coioides* to enhance growth, feed utilization and metabolism

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Krill meal is an untapped marine protein source and also considered an attractant in fish feeds. Orange spotted grouper is a carnivorous marine predatory fish which needs a very good feed attractant for acceptance of pellet feed. A 90-days feeding trial was conducted to assess the feed attraction and growth promoting effect of krill meal by replacing fishmeal in the diet of *Epinephalus coioides*. Juveniles of orange spotted grouper with the average size of 11.50± 0.50g were stocked in 5 number of treatments each with triplicates. Five experimental diets (48% CP &10% CL) were prepared using krill meal by replacing varying levels of fishmeal protein such as 0,15, 30, 45 and 60% and named as 0KM, 15KM, 30KM, 45KM and 60KM respectively. Growth response and feed utilization parameters showed significant difference among the treatments ($P<0.05\%$). Higher growth response in terms of weight gain percentage (WG %), specific growth rate (SGR), average daily growth rate (ADG), daily growth co-efficient (DGC) and thermal growth co-efficient (TGC) were observed in 60KM treatment. Better feed conversion ratio (FCR), feed intake (FI), protein efficiency ratio (PER), protein productive value (PPV), nitrogen retention efficiency (NRE) and protein retention efficiency (PRE) were recorded in 60KM group. Metabolic enzymes aspartate aminotransferase (AST) and alanine aminotransferase (ALT) showed significant difference ($P<0.05$) among the treatments and higher activities were observed in 60KM group followed by 40KM group. The lactate dehydrogenase (LDH) and malate dehydrogenase (MDH) activities showed better activities in 60KM group followed by 20KM group. This indicates that the diet with krill meal by replacing fishmeal showed better feed attraction, feed intake which in turn enhanced the growth parameters and metabolic enzyme activities in orange spotted grouper

Keywords : Krill Meal, Feed attractant, Carnivorous fish, Coastal aquaculture, Growth

Paper ID 16362

A capture culturing of vinegar eel: A Live-feed For Fish Fry

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The live-feed has concurred an important position in aquaculture as they are the important food organisms for the successful growth and survival of larvae. Weaning with live-feed is an important step in larval culture and the quality of live-feed is a critical criterion which determines the success of the seed production. Vinegar eel is a harmless, non-parasitic, free-living nematode that can be cultured easily because of its wide pH tolerance capacity. This experiment was conducted to observe the efficiency and reproducibility of Vinegar eel under the captive condition. The culture procedure is standardized by using vinegar as a medium and a definite amount of apple pieces with a measured amount of water for 60 days. Sampling was done for every 15days to check the reproducing capacity of the Vinegar eel. As a result, the one vinegar eel from the initial culture has the capacity to multiply into 80-85 vinegar eels in a span of 15days. Therefore, it can be concluded that the Vinegar eel can be a potential live-feed for aquaculture which can be feasible and easily cultured.

Keywords : Live-feed, Weaning, Vinegar eel and Reproducibility

Paper ID 16373

A review on the potential application of biofloc technology in aquaculture

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Over the last six decades, aquaculture has seen rapid development. With the advancement of technology, aquaculture has evolved from flow through, to water exchange, to zero exchange. Biofloc system is based on supporting high-density stocking, better water quality management, less water usage, biosecurity, low feed requirement, and reducing the overall cost of production. Formation of the dense heterotrophic bacterial community by C: N ratio maintenance and carbon addition is the main principle behind the Biofloc system. This bacterial community under optimum C: N ratio (usually 10:1 to 15:1 ratio) immobilizes the inorganic nitrogenous waste into the bacterial cell and utilizes organic nitrogenous waste for metabolism. Biofloc can be said an assemblage of microorganisms like heterotrophic bacteria, algae, fungi, ciliates, detritus, etc. The system requires constant aeration and the addition of carbon sources as organic matter for the bacteria. Biofloc being microbial protein has high nutritional value containing protein, fat, vitamins, minerals, trace elements, and various unknown growth factors. In this review, the potential application of the Biofloc technology in hatchery application, nursery application, broodstock maintenance, as a feed supplement, as a source for fish food organisms, and effluent treatment are discussed.

Keywords : Biofloc, Biofloc technology, biosecuirity, C:N Ratio, Zero water exchange

Paper ID 16377

Pilot scale on-farm production of *Wolffia globosa* in northeast India: A Promising Low-cost local alternative to outsourced artificial feed

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The annual per capita fish consumption (kg/person) in the northeast India is high with three states namely Tripura (29.29), Manipur (14.1 kg) and Assam (11.72 kg) being among the top five (5) highest annual per capita annual fish consuming states of the country. However, the local aquaculture productivity in the region is low and there is a large deficit between local consumption and local production of fish. The region is also deficit in conventional feed ingredients. The outsourced fish feed and feeds ingredients from long distances greatly increases their costs making it unaffordable to the small and marginal farmers who comprise the overwhelming dominant proportion of fish farming community. *Wolffia globosa* (wolffia), an indigenous rootless floating duckweed, has highly preferable nutritional attributes including high protein (25-32%) as well as starch (45-60%) and low fiber (10-15%) content and is consumed voraciously by large number of carps and /or barbs including pengba (*Osteobrama belangeri*), Rohu (*Labeo rohita*), Amur Common Carp (*Cyprinous carpio*), and Silver barb (*Barbonymous gonionotus*), Grass carp (*Ctenopharyngodon idella*), Catlla (*Catla catlla*) could be a low-cost alternative to artificial feed. We undertook pilot scale on-farm production of *Wolffia* in earthen/lined shallow ponds and utilized for feeding carps in live form. The production unit was fertilized on twice-thrice a week basis with urea (16 kg ha -1) and single super phosphate (30 kg ha -1), while muriate of potash (8 kg ha -1) and mineral mixture (1 kg ha -1) was applied fortnightly. No lime was applied. *Wolffia* was harvested daily at 0.1-0.15 kg m -2 and utilised for feeding carps. The input cost including labour cost was ca. Rs. 0.40-0.50 kg -1 . Considering that India major carp (IMC) and exotic carp dominate local fish production, on-farm production and utilization of live *Wolffia* can enhance local fish production and farm income of marginal farmers of the region.

Keywords : *Wolffia*, Northeast India, High feed costs, Carps, Low-cost feed, Farm income

Paper ID 16378

Effect of beneficial bacteria in water quality and pathogen control in shrimp ponds at different C/N Ratio

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Probiotics, live beneficial bacteria that, when administered in adequate amounts, confer a health benefit on the host, offer an alternative to antibiotics and have become popular among shrimp farmers for use in the regulation of pond water quality, promotion of shrimp growth and the prevention of disease. The effect of two different combinations of ammonia and nitrite oxidizers at different C/N ratios on water quality and pathogen control in a shrimp pond was investigated in this study. In all the treatments, the nitrifiers had low survival rate in higher C/N ratio and high survival rate in lower C/N ratio. The reduction of *V.harveyi* in sediments was significant ($P<0.05$) in the treatment of both the experiments set up with sterile soil and water under both C/N ratios tried. NH_3-N and NO_2-N reduced significantly in the microcosm experiment set up using non-sterile soil and water. A similar trend was observed in microcosm set up using sterile soil and water but only when maintained at high C/N ratio (5:1) and inoculated with a combination of nitrifiers and *Bacillus* sp. Total heterotrophic count was lower in the microcosm receiving a high C/N ratio (5:1) compared to the one at low C/N ratio (4:1). Comparative evaluation showed that the different nitrifier combinations had similar effects on microbiological as well as water quality parameters.

Keywords : Beneficial bacteria, Nitrifiers, Shrimp pond, Water quality, Pathogen control

Paper ID 16398

Physio metabolic responses of *Penaeus vannamei* reared in inland saline environment reveal the optimum stocking density for commercial culture

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Salinization is a serious global problem affecting large areas of land, leaving them futile for agricultural use. Soil salinity affects roughly 8.62 million hectares of land in India. The brackishwater culture activities can be implemented with proper ionic amendment in order to make sustainable use of such areas. *Penaeus vannamei* is a favourable candidate species for inland saline aquaculture. Stocking density plays a profound role in growth and survival of shrimp and enzymatic studies can decipher the welfare status. The appropriate stocking density of shrimp for brackishwater culture is known but scarce information is available with respect to optimum stocking density of shrimp in inland saline environment. In present study, the PL8 were reared at three varying stocking densities viz. 30/m^2, 45/m^2, and 60/m^2 in duplicates in 1000m^2 ponds for a period of 90 days. The rearing water had a salinity of 10 ppt with potassium ion at 50% equivalence to that of seawater. The digestive enzyme activity in the hepatopancreas viz. protease, amylase and lipase were downregulated in the higher stocking density. The antioxidant enzymes- catalase and GPx activity were upregulated in gills as compared to hepatopancreas and showed elevated levels in the higher stocking density in both tissues. The haemato-biochemical parameters like haemocyanin and total protein from haemolymph and serum respectively showed higher index in the lower stocking density whereas glucose concentration was elevated in the shrimps reared at higher stocking density. The enzymatic study results are in line with the growth performance of shrimp. The present study concludes that the stocking density of 30/m^2 is optimum at 10 ppt salinity for inland saline environment. However, further molecular studies are required to validate the same.

Keywords : Inland saline, Penaeus vannamei, Stocking density, Protease, Catalase, Glucose

Paper ID 16399

Standardization of captive breeding, seed production and grow-out culture of Gangetic mystus, *Mystus cavasius* for species diversification in India

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Mystus cavasius is a freshwater bagrid catfish having good consumer preference and market demand in India and South Asian countries due to its delicious taste and high nutritional value. *M. cavasius* being a potential species for freshwater aquaculture diversification in India but due to non-availability of package of practices for captive breeding and seed production of the species, the commercial production of this species could not be expanded. The present study was undertaken to standardize the broodstock management, induced breeding, seed rearing, feeding management and grow-out culture of *Mystus cavasius*. The findings of the study elucidate that the species attain maturity in first year and reaches brooder size above 20g and breeds during monsoon season June-August. The optimal dose of sGnRH based hormone required for induced breeding is 1.0-1.5 ml per kg body weight with the latency period of 10-12 hours. The average spawning fecundity is estimated around 15000-26000 per 30-50g brooder size with 70-80% fertilization rate, 60-70% hatching rate and 40-60% larval survival has been observed under captive breeding. The seed rearing protocol has been developed for mass scale seed production of *Mystus cavasius*. The ideal seed stocking density was found to be 5 larvae per litre of water, 50-100 fry per m^2 and 4-6 fingerlings per m^2 for maximum seed production. The best live feed for seed production is suggested to be tubifex worm from 3 dph to 14 dph and the seed can be weaned to formulated diet from 15 dph onwards. The seed rearing could be undertaken in black coloured tanks to get improved growth and survival of *Mystus cavasius* in indoor condition. The grow-out study revealed that the species grows 30-40 g in 8 months of culture period in earthen ponds with the survival of 60-70% and the production can be achieved 1.0-2.0 tonnes per ha per year.

Keywords : Catfish, Broodstock, Hatchery technology, Larviculture

Paper ID 16410

Encouraging growth of 'CIFA-GI scampi ™' in carp-scampi polyculture system in West Bengal

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The performance evaluation of 'CIFA-GI Scampi ™'a selectively bred and fast growing strain of freshwater prawn *Macrobrachium rosenbergii* in carp-scampi polyculture system was conducted in West Bengal in four adopted farmers' ponds in villages namely Haldia township, Barabari, Dighasipur and Debhog of Haldia block, Purba Medinipur District, West Bengal. The size of the selected ponds ranged from 0.12 to 0.38 ha. Inputs for polyculture such as carp and CIFA-GI Scampi seeds, ground nut oil cake (GNOC), floating feed, organic manure (cowdung), inorganic fertilizer (single super phosphate) and lime were supplied to the adopted farmers as per the area of the pond. Technical support was provided by ICAR-CIFA by imparting training and visit to the ponds. The stocking density of scampi was 11,250/ha while the fish stocking density was 6000/ ha. Floating fish feed (containing 30% crude protein) was provided to the stocked fishes@ 3% of body weight twice a day. The average body weight of GI scampi ranged from 80±14.56 g to 130±27.9 g after 140 days of grow out period from an initial weight of 0.75g.The survival of GI scampi ranged from 80% to 90%. The average body weight of *Catla catla* ranged from 1000±111.75 g to1400±206.36 g while the same for *Labeo rohita* ranged from 600±83.74 g to 650±66.72 g from an initial body weight of 60 gm and 100 gm respectively, in the demonstration ponds in West Bengal.The yield of GI scampi ranged from 800 kg to 1200 kg/ha while the same for IMC ranged from 2000 kg to 3000 kg/ha. The net profit of farmers ranged from Rs.3,00,000 to Rs.4,00,000/ha/crop.All the farmers expressed their happiness over the performance of GI scampi and desired to continue its culture during the coming years also.

Keywords : GI-scampi, Carps, Polyculture, Demonstration, Inputs, Growth

Paper ID 16417

Framework Mariculture Development in India

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Mariculture has immense potential in India in the context of fast-growing demand for seafood, which cannot be met by capture fisheries sector alone. The National Policy on Marine Fisheries (NPMF 2017) clearly states that mariculture can play an important role in increasing fish production from the coastal waters. Though India has a projected mariculture production potential of 4 to 8 million tonnes annually, the current mariculture production is less than 0.1 million tonne.The pioneering attempt for mariculture development in the country was initiated by ICAR-CMFRI in the 1970s. Best use of available mariculture technologies developed over the years by various R&D organisations and developmental agencies could be capitalized to boost mariculture production in the country. Commodity based Special Mariculture Zones are to be demarcated for different mariculture activities based on scientific criteria and taking into account the socio-cultural attributes and other logistics. Incentives and special packages to attract entrepreneurs/ cooperatives are to be announced to invest in mariculture zones.To meet the additional requirement for seed of cultivable species and feed for farming in future, innovative measures need to be taken for establishing hatcheries, seed banks, rearing units, SPF/SPR/genetically improved brood banks, feed mills and reduced dependence on fish meal. The economic, technological and sustainability issues of developing offshore mariculture in India needs to be explored for the expansion of mariculture activities farther off the coast.Fish farming favours infectious diseases and therefore requires investment in disease management Preparedness to the emerging diseases in the mariculture sector will be priority area in the development plan. Certification of mariculture produce including marine ornamental species to ensure its environmental and socioeconomic sustainability. It ensures product quality, safety and traceability. Special initiatives to ensure the comprehensive development of Mariculture value chains, developing Infrastructure requirements for Mariculture produce marketing are to be extended to the various stakeholders involved in the value chain. There is growing recognition that mariculture is an emerging sector that will evolve with innovative technologies and inputs as it grows. Sustainable development of mariculture would go a long way in making India a leading seafood producer in the world.

Keywords : Mariculture development, India, Developmental framework

Paper ID 16425

Carcass quality characteristics of *Pangasianodon hypophthalmus* fingerlings reared in different carbon source based biofloc system

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A 90-day experiment was conducted to investigate the carcass quality characteristics (Body composition, texture profile analysis and colour profile analysis) of *Pangasianodon hypophthalmus* fingerlings reared in different carbon source based biofloc systems. Three hundred Sutchi catfish fingerlings (6.40 0.05 g) were used in 15 tanks for the experiment, which included four treatments and a control (clear water) (20 in 100 L). Tapioca, sorghum, pearl millet, and finger millet were given the designations BFT_T, BFT_S, BFT_{PM}, and BFT_{FM}, respectively. The biochemical composition (moisture, crude protein, crude lipid, ash content), texture profile analysis (hardness, chewiness, and springiness), and colour analysis of *P.hypophthalmus* fingerling carcasses were all analysed at the end of the trial (lightness, redness and yellowness). The biochemical composition of the carcasses of *P.hypophthalmus* fingerlings reared in various treatment groups revealed a significant difference between the control and other biofloc treatment groups with various carbon sources. Fish reared in BFT_{FM} (82.10 ± 0.11) treatment groups had significantly reduced moisture content. Significantly higher crude protein was recorded in the BFT_{FM} treatment group (14.87 ± 0.06 %). Crude lipid (1.78 ± 0.02 %) and ash (1.25 ± 0.01 %) content was significantly higher in the control group. he fillet texture of *P. hypophthalmus* fingerlings reared in the four treatment groups did not differ substantially in terms of hardness, chewiness, or springiness. The lightness (L*), redness (a*), and yellowness (b*) fillet chroma metrics all revealed a same pattern. When compared to clear water culture, the data demonstrated that while using biofloc technology with various carbon sources changes the biochemical makeup, it has no negative impact on fillet texture or colour features. This strategy can be recommended to fish farmers based on the findings of this study.

Keywords : Biofloc, Carbon Source, Crude protein, Springiness, Yellowness

Paper ID 16440

Effect of small indigenous fishes (SIFS) as forage fish in polyculture of Asian seabass (*Lates calcarifer*) in a freshwater pond ecosystem

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Asian seabass (*Lates calcarifer*), also known as "Chonak" in Goa, is highly preferred food-fish with high-quality meat and of commercial importance as it is a hardy, eurytopic fish and culture suitable from freshwater to marine systems. With the participation of fish farmer, an experiment was conducted in three treatments to unravel the feasibility and potential of Small Indigenous Fishes (SIFs) in commercial culture of Asian seabass (*Lates calcarifer*) for the enhancement of growth, survival, productivity in freshwater ponds (T1: SIFs and tilapia, T2: Tilapia only, T3: Tilapia only). The survival rates for seabass ranged from 54% in T3 to 72% in T1. Total biomass for T1 was 480 kg with an average weight of 1.25 kg and that for T2 and T3, the values were 1485 kg and 1134 kg, respectively. The specific growth rate in T1 was higher when compared to T2 and T3. The diet content analysis showed that the seabass fed superiorly on SIFs (%N, %W and %F), when compared to tilapia in T1, which highlighted the preference of the species for slender streamlined body fishes. In terms of, the technical parameters like survival, growth rate, productivity and economic viability parameters like benefit-cost ratio, the pay-back period and internal rate of return indicated the viability of the system. This SIFs based polyculture experiment could pave the way for efficient utilization of freshwater as well as low-saline water bodies for fish production and livelihood improvement of coastal farmers. Through this experiment, an environment-friendly aquaculture production system has been developed for the coastal ecosystems.

Keywords : SIFs, Seabass, Aquaculture, Polyculture, Growth, Coastal ecosystem, Productivity

Paper ID 16475

A study on problems and prospects of Mud crab (*Scylla serr*ata) fattening in the East coast of India

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Mud crab (*Scylla serrata*) is an economically important species in aquaculture for its market demand and export value. It has been a promising candidate species in aquaculture for a long time. The process of fattening crabs is a short-term practice and highly lucrative compared to crab and shrimp culture. Due to its lower investment, labor and area requirements, it is affordable for a wide range of farmers. Presently, diseases are the major constraints in aquaculture industry. A mysterious mass mortality has been identified in the different regions of south east coast of India during the study period. A chronic mass mortality was observed in the mud crab fattening pens, moribund crabs were collected and analyzed for the cause of these mass mortalities by RT-PCR, histopathology and ultra-structural techniques such as TEM and SEM. The aetiological agent for the chronic mass mortality is confirmed to be Mud crab Reovirus. This study involves many continuous field experiments to minimize the constraints in the culture system.

Keywords : *Scylla serrata*, Diseases, Mass mortality, RT-PCR, Histopathology, Tem

Paper ID 16481

Performance of dried distillery grain waste on growth of Rohu, *Labeo rohita* larvae

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Now in any aqua feed formulation, fish meals followed by oil cakes are the primary protein sources. High-cost oil cakes and uncertain fish meal (FM) availability have directed to the search for good quality, eco-friendly and locally available alternative protein by-product resources to replace the costly ingredients in the feed production. The present study investigated the performance of dried distiller's grain waste (DDGW) by partial replacement of groundnut oil cake (GNOC) on the growth and survival of *Labeo rohita* in the nursery phase. Three iso-nitrogenous diets incorporating DDGW at (T1) 30%, (T2) 40% and (T3) 50% kg/feed replacement of GNOC were the test diets, and a diet with only GNOC was the control (C). The experimental trial was conducted in duplicate groups of 3000 rohu fry (mean initial weight 0.04±0.03 g) and fed experimental diets for 60 days. The results revealed that dietary DDGW @50% replacement of GNOC showed the highest final weight and specific growth rate. Feed conversion and protein efficiency rates were similar among the dietary treatments. The digestive enzyme activity remained unaffected except amylase activity, which increased significantly in the 50% DDGW replacement group (T3). Whole-body proximate composition and amino acid profile showed no significant differences in the treatments. The present study indicates that DDGW can replace GNOC without altering growth performance and digestive enzyme activity in the diet of *L. rohita*.

Keywords : Dried distiller's Grains waste, Growth performance, *Labeo rohita*, Digestive enzyme

Paper ID 16491

Effect of different salinity on growth, survival and hematological changes in rearing of orange chromide, *Etroplus Maculatus*

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Larval rearing study was conducted to find out the effect of salinity on growth, survival and hematological changes of *E. maculatus* larvae reared in FRP tanks. The study was undertaken in a complete randomized design (CRD), where each treatment was performed in triplicate. The experiment was conducted in three different salinities (0, 10, and 20 ppt) for duration of 60 days. Each tank was stocked with 30 larvae with an average body weight of 0.11±0.88g. At the end of experimental rearing period, fishes reared in 10 ppt salinity had showed an improved growth performance in terms of specific growth rate (1.44±0.21% day^{-1}), Feed conversion ratio (0.11±0.01), Feed efficiency ratio (2.72±0.52) and Protein efficiency ratio (0.10±0.01), followed by 0 ppt and 20 ppt. Physicochemical parameters were within the optimal limit for rearing of fishes. Similarly, fishes reared in10 ppt salinity showed higher levels of haemoglobin (5.43±0.08 gm dl^{-1}), Red blood cell (1.3±0.12 million cumm^{-1}), White blood cell (202000±57735 cells cumm^{-1}) and Packed cell volume (16.63±0.08%). Likewise, low levels of platelet, Mean corpuscular volume (125.80±0.32 Fl), Mean corpuscular haemoglobin (32.53±0.17 pg) and Mean corpuscular haemoglobin concentration (25.46±0.20 gm %)) were observed in 10 ppt reared fishes. The study concluded that *E. maculatus* can adapt well to the new salinity conditions there by suggesting its potential as brackishwater ornamental candidate for fish farming under 10 ppt salinity.

Keywords : Orange chromide, FCR, Mean growth rate

Paper ID 16493

Comparative evaluation of insect larvae meal and crustacean waste meal on the growth and digestive performance of koi carp *Cyprinus carpio var koi* fry in nursery phase

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In the present study, the influence of insect larvae meals such as silkworm pupae meal, black soldier fly larvae meal, and the crustacean waste meals such as shrimp meal, crab meal as a partial fish meal replacement on the growth and digestive performance of koi carp fry was assessed in two experimental trials. Two weeks old koi fry (3.02±0.13 cm, 0.37±0.04 g) and (3.42±0.24 cm, 0.64±0.14 g) were used as the experimental animals for trial 1 and trial 2 respectively, which were stocked into the experimental happas installed in the earthen ponds. Four iso-nitrogenous experimental diets with 35% crude protein were then formulated by replacing 50% of the fish meal with silkworm pupae meal (SWP50), black soldier fly larvae meal (BSF50) for trial 1 and shrimp meal (SM50), crab meal (CM50) for trial 2, with the diet containing only fish meal was used as control. Fishes were fed with the mashed experimental diets at 5% of their body weight, once a day over a period of 60 days. At the end of 60 days feeding trial results revealed that significantly higher ($P<0.05$) bio-growth parameters such as mean length gain, mean weight gain, percentage length gain, specific growth rate, food conversion ratio, feed efficiency ratio, the protein efficiency ratio and survival rate were recorded in SWP50 (3.26±0.01cm, 3.79±0.18g, 108±0.71, 4.03±0.07, 0.89±0.09, 1.12±0.06, 3.18±0.16, 28±0.71) and BSF50 (3.22±0.09cm, 3.56±0.12g, 106±2.83, 3.93±0.06, 1.04±0.04, 0.96±0.04, 2.72±0.09, 29±1.41) diet-fed fishes respectively, than SM50, CM50, and control diet-fed fishes. Higher digestive enzyme activities were also found in SWP50 and BSF50 diet-fed fishes. Hence, insect larvae meals such as silkworm pupae meal and black soldier fly larvae meal can be effectively utilized as a protein source to replace fish meal in the diet of koi carp fry for better growth and survival.

Keywords : Insect larvae meal, Crustacean waste meal, Growth performance, Digestive performance, Koi carp

Paper ID 16495

Analysis of impact of different feed on the visceral features of *Piaractus brachypomus* fed under captivity

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The study was conducted to evaluate the effect of different feeds on the visceral features of *Piaractus branchypomus* fed in captivity. Pacu was fed with three different feeds: Earthworm, Dried fish, and Soya cake (T1, T2, T3), varying in protein content 50%,60%,30%, and the experiment was carried out for 60 days in captivity. *P. branchypomus* growth performance was found to be best when fed a diet of dried fish with a protein level of 60%. Survival rates were best in all the treatments, which showed a 95% survival rate at the end of the experiment.

Keywords : *Piaractus branchypomus*, Earth worm, Dried fish, Soya cake , Visceral feature

Paper ID 16502

Significance of popularising the concept of double-stage rearing of *Penaeus vannamei* with special reference to KUFOS experience

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Worldwide shrimp market value was as high as US$ 18.30 billion in 2020 which is expected to grow to the level of US$23.4 billion by 2026. India has exported 5.9 lakh tonnes of shrimp in the year 2020-21 and Andhra Pradesh is the highest producer in the country. Kerala has a long history and tradition of shrimp culture compared to many other coastal states of the country. Still, the State could not make any impact on the total cultured shrimp production so far, mainly due to the lethargy shown by the farming community to switch over to the scientific farming of Penaeus vannamei. The effort on popularizing the species among the shrimp farmers of Kerala was seriously taken up by the Kerala University of Fisheries and Ocean Studies, Cochin in 2014-15 as part of a planned project funded by the Government of Kerala with limited success. Though hundreds of farmers were got trained under the project, the takers were still remaining low owing to many reasons related to crop failures, higher production cost, poor survival, lower price levels of the product, disease problems, etc. The unexpected environmental and climatic extremities of Kerala also played a negative role for its low level of adoption. To address this issue to a great extent, the two stage rearing of the species can be used as an effective method for improving the survival and attaining the crop success. The trial conducted at the Instructional Farm of KUFOS by the Rural Fisheries Work Experience students of the 2018 BFSc batch throws light on the possibility of reducing the outdoor grow-out period by more than a month which would help the farmers to ensure the profitability and sustainability. The current system is based on rearing the PL-10 of P. vannamei at a stocking density of 10000 nos./m3 for a period of 20 to 25 days in biofloc tanks to attain the weight range of 0.3-0.35 g with a survival of 80%. The shrimp can be stocked in grow-out ponds for further rearing with a semi-floc system. Details are discussed in the paper.

Keywords : *Penaeus vannamei*, Double-stage rearing, Stocking density

Paper ID 16508

Haemotological parameters of *Catla catla* (hamilton 1822) fingerlings reared in biofloc technology

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Application of Biofloc Technology in rearing of fish offers better growth and survival rate compare to the conventional system of seed rearing. The biofloc technology converts toxic waste nitrogen into microbial proteins and helps to improve water quality without refreshing water. *Catla catla* is a commercially important food fish which shows high market demand than other freshwater fishes. Since seed rearing is an integral part of fish production *Catla catla* shows poor survival and growth rate in conventional seed rearing system. The present study was carried out to evaluate the influence of Biofloc Technology on growth performance, haematological parameters of *Catla catla*. The feeding trail was conducted for 60 days, to determine the effect of Biofloc on growth and health status of fish. The haematological parameters such as Total erythrocytes count (RBC), Total leucocytes count (WBC), Hematocrit (Hct), Hemoglobin concentration (Hb), and Hematological indexes (MCHC, MCH and MCV) were examined. According to the results blood cells consisting of RBC 4.59 to 6.70 Million/Cu mm, WBC 12700 to 46600/Cu mm, Hb 14.0 to 15.3 gm%, PVC 37.4 to 44.6 %/dl; MCV 32.0 to 128.5, MCH 33.3 to 57.1 Pg/dl; MCHC 41.5 to 44.4g/dl.

Keywords : *Catla catla*, Biofloc technology, Growth and Survival rate, Haemotological parameters.

2. FISH NUTRITION AND FEEDING

Paper ID 15522

β-d-Glucan Influences Male Gamete Quality Indices and the Expression of Anti-oxidative Genes in Endangered Golden Mahseer, *Tor putitora*

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The impact of dietary β-glucan on seminal plasma composition, sperm characteristics, and expression of anti-oxidative genes of golden mahseer was evaluated. For that, four experimental diets containing 0 (control), 0.5, 1, and 1.5 % β-glucan were fed to male golden mahseer brooders for 130 days. Feeding of 0.5% β-glucan improved sperm characteristics, *viz.* sperm count, motility, viability, and morphology with no effect on gonadosomatic index and seminal plasma energy resources. Further, the mRNA expression of genes encoding anti-oxidant enzymes, namely *gst* and *sod1*, was lowest in 0.5% β-glucan fed brooders. In contrast, control and higher β-glucan (1 and 1.5%) groups displayed relatively higher expression levels of testicular *gst* and *sod1*. On the other hand, the higher seminal plasma total antioxidant capacity observed in 0.5 and 1% β-glucan fed brooders indicated increased scavenging ability of reactive oxygen species. Overall, supplementation of 0.5% β-glucan improved sperm quality and anti-oxidative potential, but the higher inclusion (1.5%) negatively affected sperm characteristics.

Keywords : β-d-Glucan, Gamete Quality, Anti-oxidative Genes

Paper ID 15523

Immune Gene Expression, Thermal Limits, and Growth Performance of Endangered *Tor putitora* Larvae Obtained from Brooders Fed with Different Levels of β-glucan

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In the present study, we aimed to illuminate whether feeding golden mahseer, *Tor putitora* with β-glucan supplemented diets affects larval growth performance, survival, thermal tolerance, and non-specific immunity. Initially, the growth of larvae produced from brooders fed with different levels of β-glucan was non-significant. However, on 15th and 35th DPH, the maximum weight was observed in larvae obtained from the brooders fed with 0.5% followed by 1.0% β-glucan. Furthermore, on 50th DPH, significantly higher weight was registered in the fry from 0.5% β-glucan fed group while 1.0% β-glucan group had no transgenerational effect on growth. The condition factor of fry obtained from golden mahseer brooders fed with a 0.5% β-glucan diet was greater than the control and 1.0% β-glucan fed group. On the other hand, we did not find any significant influence of β-glucan on the survival of the larvae. The thermal tolerance of fry produced from brooders fed with β-glucan was significantly modulated at both end-points (CT_{max} and CT_{min}). Expression of *interleukin-1β* was significantly up-regulated in fry obtained from β-glucan fed brooders. In contrast, expression level of *tumor necrosis factor-α* was significantly higher only in fry produced from 1.0 % β-glucan fed brooders. Expression of *immunoglobulin light chain* and *serum amyloid A* genes was found significantly higher in fry produced from 0.5 % β-glucan fed brooders. Overall results demonstrated that β-glucan supplementation in golden mahseer brooders diet may be a strategy to produce healthy and quality fry in captivity for stock enhancement and conservation programs.

Keywords : *Tor putitora*, β-glucan, Thermal Tolerance, Transgenerational Effect, Immune Genes

Paper ID 15541

Dietary β-glucan Improves Reproductive Performance at Lower Doses but Manifests Spawning Failure at a Higher Level in an Endangered Female Teleost, *Tor putitora* (Hamilton, 1822)

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The effects of β-glucan on reproduction associated cellular and molecular signatures of golden mahseer, *Tor putitora* was investigated for the first time. For 130 days, adults female golden mahseer were fed one of four test diets having 0 (control), 0.5, 1, and 1.5% β-D-glucan. Low dietary intake of β-glucan (0.5%) enhanced fertilization and hatching rates without affecting incubation time or gonado-somatic index. Surprisingly, even after 130 days, spawning did not occur in brooders administered with 1.5% β-glucan. Higher β-glucan intake down-regulated brain *kiss2* mRNA expression. An up-regulation of aromatase genes was found in 1.5% β-D-glucan administered broodstock without a parallel increase in 17β-estradiol. Irrespective of β-glucan intake, all the brooders recorded similar plasma 17β-estradiol and maturation-inducing hormone. However, plasma vitellogenin increased significantly with increasing dietary β-glucan up to 1.0% and then declined at 1.5%. Histologically, a significantly higher follicular atresia was evidenced in 1.5% β-glucan fed broodstock. Further, leaking of coagulated yolk material in the follicular interstices was also observed in the ovarian sections of 1.5% β-glucan fed individuals. Liver histology revealed the highest nutrient accumulation in fish that received 1.0% and 1.5% β-glucan. A higher intake of β-glucan altered kisspeptin expression and caused an increased number of atretic follicles leading to reproductive perturbations in female golden mahseer. Overall, the results demonstrated the stimulatory effect of β-glucan intake at a lower dose (0.5%) on reproduction but have an adverse effect at a higher inclusion level (1.5%). The study open up new research avenues for understanding the basis of spawning failure at higher intake of β-glucan in fish.

Keywords : Reproduction, Sex Hormones, β-glucan, Atresia, Gene Expression

Paper ID 15545

Utilization of Fermented Mixed Leaf Meal in the Diet of *Labeo rohita* (Hamilton, 1822) Fingerlings

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Leaf meal is an unconventional fish feed ingredient that can replace de-oiled rice-bran in aquafeed. To reduce the antinutritional factors and enhance the nutritional profile, five-leaf meals (sweet potato, sesbania, groundnut, ipil-ipil, and lemongrass) were mixed in equal parts and subjected to solid-state fermentation with either *Aspergillus niger* or *Chaetomium globosum*. The results showed that fermentation done with a combination of both the fungus enhanced the protein content of mixed leaf meal (MLM) by 29.98%, reduced the crude fiber by 17.57%, and reduced the anti-nutritional factors such as saponin, tannin and, phytate. Further, a 45-day feeding trial was conducted to study the effect of alternate feeding of fermented mixed leaf meal (FMLM) in *Labeo rohita* fingerlings. Three iso-nitrogenous (30% CP) and iso-caloric diets were formulated in which FMLM was incorporated at 0% (C-control diet with 0% FMLM with 40 % DORB), 30% (T30 with 30% FMLM &10 % DORB) and, 40 % (T40 with 40 % FMLM & 0% DORB). There were six treatments *viz*., C, T30, T40, C/ T30 (alternate day feeding of control and T30), C/T40 (alternate day feeding of control and T40), and T30/T40 (alternate day feeding of T30 and T40). Twelve fingerlings were distributed in triplicates following a completely randomized design (CRD). The estimated WG%, SGR, and PER were significantly higher (p<0.05) in the control and C/T30 groups compared to other groups. Total serum protein contents and RBC values were significantly (p<0.05) higher in the T40 and C/T30 groups. Serum albumin, globulin, and AG ratio were statistically similar in the control and C/T30 groups. Glucose levels were not significantly (p>0.05) different among the groups. The present result concludes that alternate-day feeding of control and 30% fermented mixed leafmeal diet (C/T30) can enhance the nutrient utilization and growth in *Labeo rohita* fingerlings.

Keywords : Aspergillus Niger, Chaetomium Globosum, Growth, Rohu, Solid-state Fermentation

Paper ID 15553

Effect of Jaggery based Biofloc Powder Supplementation on Growth, Digestive Enzyme Activity and Disease Resistance of *Penaeus vannamei* in Recirculatory Aquaculture System

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A 60 days experiment was conducted to evaluate the effect of jaggery based biofloc powder on growth performance, digestive enzyme activity and disease resistance against *V. parahaemolyticus* on *Penaeus vannamei* in Recirculatory Aquaculture system (RAS). The biofloc was developed using jaggery as carbon source at 20:1 C/N ratio in outdoor biofloc development tanks which is graded and powdered used for the preparation of experimental diets at different inclusion *viz* 5 % (T1), 10% (T2) 15% (T3) 20 % (T4) with 0 % Control. The growth experiment had a Completely Randomized design, *Penaeus vannamei* with an average body weight of 0.58±0.4g were stocked with stocking density of 200 /m^3 in indoor RAS (5 x 3= 15) tanks (Length x Breadth x Height: 1x1x1 m) in triplicates. At the end of the experiment period, biofloc supplemented treatments showed a significantly better ($p<0.05$) growth performance. Among the treatment groups, 15 % biofloc powder supplementation showed the highest Mean weigh gain 19.48±0.09 (g), SGR (5.86±0.36), FER (0.69±3.36), PER (0.53±0.01) and lowest FCR (1.44±0.01) followed by T4 in RAS based system. At the end of the experimental trial the digestive enzyme activity of the biofloc powder supplementation fed shrimp possessed an enhanced amylase, protease, and lipase activity compared to control. Moreover, 15% (T3) showed higher disease resistance against *V. parahaemolyticus* with high survival rate and it significantly differs from other treatments and control. The histological alterations on Hepatopancreas of *Penaeus vannamei* fed with 15% (T3) biofloc supplementation showed high number of B and R cells with healthy lumen followed by T4, and T2. Control diet showed high mortality rate with lack of B and R cells, degeneration of tubule lumen and hemocytic infiltration. The study confirmed that the jaggery based biofloc powder at 15 % in shrimp feed could enhance the growth performance, survival and digestive enzyme activity in RAS based system, further this study also revealed that the dietary inclusion of biofloc powder at 15 % level significantly increased the disease resistance against *Vibrio parahaemolyticu*s and biofloc incorporated feed was most suitable for RAS based system.

Keywords : Biofloc Powder, *Peneus vannamei*, Growth Performance, Digestive Enzyme Activity, Jaggery, Recirculatory Aquaculture System

Paper ID 15555

Effect of Replacement of Soybean Meal with Sesame Meal in the Diet of Thai-Chitralada Strain of *Oreochromis niloticus*

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The present study was aimed to determine effect of replacement of soybean meal (SBM) with sesame meal (SSM) in the diet of Juvenile Thai chitralada tilapia. The study was undertaken with different inclusion levels of sesame meal such as T1 (25 % SSM), T2 (30 % SSM), T3 (35 % SSM) and control feed (C) for a period of 90 days. The fishes with mean initial weight of 2.65 g were fed with 5% of body weight daily. Thai-tilapia fed with T3 (35 % SSM) diet attained maximum mean weight gain (28.09 g), highest specific growth rate (2.69 %), best FCR (1.04), maximum average daily growth (0.31 g) and maximum protein efficiency ratio (8.87). The growth rate was poor in the group fed with control diet. Diets with 35 % sesame meal replacement upon soybean meal showed higher amino acid profile than other treatments and control diet. Analysed amino acid profile in T3 – 35 % SSM was Arg - 2.88, Hist - 0.86, Isol - 0.92, Leu - 2.60, Lys - 3.78, Met - 0.39, Cys - 0.38, Phe - 1.77, Thr - 1.08, Val - 0.99, Tyro - 1.09, Trypt - 0.24. The higher DNA / RNA ratio of Thai- tilapia was obtained in T3 - 0.459, followed by T1 - 0.44 and T2 - 0.323. The lower DNA / RNA ratio of Thai-Chitralada was obtained in control - 0.321. One way ANOVA of the data analysis and Duncan Multiple Range Test clearly affirmed that between different experimental diets and sampling periods, Thai-Tilapia fingerlings had significant difference ($P < 0.05$) among the different experimental diets. From the present experiment, it could be concluded that, sesame seed meal can replace 35 % soybean meal in the diets of Thai- tilapia without compromising growth, feed conversion ratio and whole body composition.

Keywords : Thai-chitralada Tilapia, Soybean Meal, Sesame Meal, Bio-growth, Feed Parameters, Amino Acid Profile, Dna/rna Ratio.

Paper ID 15556

Azolla Meal as an Alternative Protein Source in the Diet of *Etroplus suratensis*

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A 60-day feeding trial was carried out to investigate the effect of dietary replacement of fish meal with plant protein source (Azolla meal protein) on bio-growth parameters, enzymatic activity and cost effectiveness of the feed for *Etroplus suratensis* fingerling. Six isonitrogenous and isoenergetic diets were formulated with Azolla protein meal replacing fish meal at 0(To),7.5(T7.5),15(T15) and 22.5(T22.5) concentrations. The mean initial average weight of fish 5.48±0.015g was stocked in tanks (60 l) at a stocking rate of 10 fishes per tank. Each diet was fed to three replicates at the rate of 5% of the total fish biomass, daily for a period of 60 days. *Etroplus suratensis* fed with AZM 15% diet attained highest weight gain, specific growth rate, and average daily growth, protein efficiency ratio ($p<0.05$) and best enzyme activity. Fish fed with AZM 22.5% diet showed the best feed conversion ratio, Feed efficiency ratio, highest survival rate and cost effective diet, there is no significant difference ($p>0.05$) observed. It was concluded that, fish meal can replace with *Azolla* meal without compromising growth performance.

Keywords : *Etroplus suratensis*, Growth, Azolla Meal, Enzymatic Activity, Cost-effective Diet.

Paper ID 15573

Effect of Inulin Fortified Diet on the Growth, Carcass Composition, Haematological Responses and Intestinal Microbiota of GIFT

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This study investigated the effect of inulin on the growth performance, haematology, carcass composition and intestinal microbiota of Genetically Improved Farmed Tilapia (GIFT). Four experimental diets were designed to incorporated with inulin at 0 (basal diet), 0.5 g/kg, 1.0 g/kg and 1.5 g/kg. Fish with initial mean weight 0.85±0.02 g were allotted to 12 tanks of 50 L capacity at a density of 20 fish per tank and fed with 5% of their body weight, two times a day. The growth performance and survival rate were evaluated. Haematology samples were collected from the experimented tilapia, 30th and 60th days of sampling from the onset of the experiment to measure the red blood cell, haemoglobin, haematocrit, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration. Carcass composition and intestinal microbiota were also evaluated. At end of the experiment, the growth performance, feed utilization and haematology parameters were improved in fish fed with inulin at 1.5 g/kg of diet compared to control and other dietary treatments. However, dietary supplementation of inulin had no significant influence on the carcass composition of GIFT. Diet with 1.5 g/kg of inulin improved the total bacteria and lactic acid bacteria in the intestine of GIFT. Substantially dietary inulin at 1.5 g/kg had beneficial effects on the growth performance, haematology and intestinal microbiota of GIFT.

Keywords : Carcass Composition, Gift, Growth, Haematology, Intestinal Microbiota, Inulin.

Paper ID 15578

Effects of Biofloc Meal Incorporated Diet on Growth Performance and Physiological Responses of *Penaeus vannamei* in Outdoor Culture System

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The evaluation of alternative protein source in shrimp feed is a priority in the aquaculture industry. Biofloc meal is a substantial protein source of shrimp feed, which has been examined by various studies under experimental conditions. The present study examined the efficacy of biofloc meal incorporated diet on growth performance, digestive activity and immune response of pacific white shrimp (*Penaeus vannamei)* in 100 m^2 HDPE liner ponds. Healthy post larvae of *P. vannamei* (0.01 ± 0.00 g) were stocked and fed with control diet (without Biofloc meal) and experimental diet (30% incorporated biofloc meal) at 10% of animal body weight, four times a day, for a duration of 6 weeks in duplicate ponds. Among the treatments significantly increased final weight, weight gain, specific growth rate and survival rate were observed in the experimental diet (30% incorporated biofloc meal) treated group (P<0.05). Significantly higher (P<0.05) digestive enzyme activities of protease, lipase and amylase were found in the experimental diet fed group. At the end of the experiment, serum protein, prophenoloxidase and peroxidase were found to be significantly higher in experimental diet-fed group. Findings of the present study revealed that the biofloc meal incorporation at 30% in shrimp diet would potentially improves the growth performance and physiological responses of shrimp.

Keywords : Biofloc, Shrimp Feed, Digestive Enzymes, Growth Parameter, P. Vannamei.

Paper ID 15591

Development of Copper Nanoparticles Delivery Systems using Fisheries Waste and its Application in Alleviation of Multiple Stresses in Fish

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Climate change and water pollution are the major culprits affecting the productive performance of aquatic animals. The arsenic pollution, sudden fluctuations in water temperature, pH and major concern for the aquaculture. Moreover, the aim of the present investigation was to conduct to delineate the role of copper nanoparticles (Cu-NPs) on mitigation of arsenic pollution, low pH and high temperature on *Pangasianodon hypophthalmus*. Four diets containing Cu-NPs at 0, 1.0, 1.5 and 2.0 mg kg-1 diet were formulated and prepared to feed fishes reared under arsenic pollution, low pH and high-temperature stress for 110 days. Anti-oxidative status (catalase, superoxide dismutase, glutathione-s-transferase and glutathione peroxidase), lipid peroxidation, total anti-oxidative capacity and lipid profiling (total lipid, cholesterol, phospholipid, triglyceride and very low-density lipoprotein) were noticeably reduced with stressors groups such as arsenic, low pH and high temperature. Nevertheless, the supplementation of Cu-NPs at 1.5 and 1.0 mg kg-1 diet were remarkably enhanced the anti-oxidative status and anti-oxidative capacity. The group treated with stressors (As+pH+T) were significantly reduced immunity viz. total protein, albumin, globulin, albumin: globulin ratio (A:G ratio), respiratory burst activities, myeloperoxidase, total immunoglobulin and supplementation of Cu-NPs at 1.5 and 1.0 mg kg-1 diet improved the immunity of the fish reared under stress condition. Arsenic, low pH and high temperature were significantly enhanced the tail DNA % (DNA damage), whereas, supplementation of Cu-NPs protect the tissues against DNA damage. The growth index such as final body weight gain %, feed conversion ratio, specific growth rate, protein efficiency ratio, daily growth index, and relative feed intake wee noticeably improved with supplementation of Cu-NPs at 1.5 and 1.0 mg kg-1 diet in fish reared under stressors. Dietary Cu-NPs supplementation protects the fish from bacterial infection and reduced the bioaccumulation of arsenic in different fish tissues. The present results revealed that supplementation of Cu-NPs at 1.5 mg kg-1 diet followed by 1.0 mg kg-1 diet has the potential to mitigate multiple stress in fish.

Keywords : Cu-nanofeed, Arsenic, Ph Stress, Multi-biomarker, Fish

Paper ID 15603

Dietary Alpha Tocopherol Supplementation on Growth, Fatty Acid Composition, Intestinal Architecture and Haemato-immune Indices in Milkfish, *Chanos chanos* Larvae

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A 45 days feeding experiment was conducted to study the effect of dietary vitamin E (alpha tocopherol) supplementation on growth, survival and immunity in milkfish, *Chanos chanos* larvae. Five iso -nitrogenous and iso -energetic (580 g kg^{-1} crude protein and 120 g kg^{-1} crude lipid) experimental diets were prepared with varying levels of vitamin E supplementations at 0 (control E_0), 100 (E_{100}), 200 (E_{200}), 300 (E_{300}) and (E_{400}) 400 mg of α-tocopherol acetate kg^{-1} of larvae diet. Larvae fed with dietary supplementation at 200 mg (E_{200}) of α-tocopherol showed enhanced ($p< 0.05$) growth performance, in terms of final body weight (371.7±12.80 mg), weight gain (320.5±11.18 mg) and specific growth rate [SGR] (4.31±0.80) than the group fed with control diet, E0. Significantly better PER was obtained in E_{200} diet (0.52±0.08) followed by E100 (0.44±0.01) while, the control (E0) recorded lowest PER (0.40±0.01). Alpha tocopherol content of whole larvae was linearly correlated with the dietary α-tocopherol inclusion levels. Fatty acid composition and lipid content of whole larvae showed increasing concentration up to 300 mg kg-1 of α-tocopherol supplementation. Mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) content showed significant difference between control and Vitamin E supplemented group. Total lymphocyte count (TLC) and myelocyte count showed significant differences among the treatment groups. Histological examinations showed loosely packed small, irregular intestinal villi in the small intestine in the groups fed with E_0 and E_{100}. Whereas, the groups fed with E_{200}, E_{300} and E_{400} showed increased lamina propria (LP), increase in the density and height of intestinal villi. The broken line regression analysis revealed that the dietary vitamin E requirement was 248.8 mg α-tocopherol acetate kg^{-1} of diet is optimal for *C. chanos* larvae.

Keywords : Milkfish Larvae; α-tocopherol; Growth; Optimum Requirement; Fatty Acid; Vitamin E

Paper ID 15656

Herbal Feed Additive as Choline Replacer and its Effect on the Growth of Pacific White Shrimp, *Penaeus vannamei*

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A 90-day feeding trial was undertaken to assess the effect of the herbal feed additive as a choline replacer and its effect on the growth of Penaeus vannamei. Six isonitrogenous diets were formulated by adding a synthetic choline source (NRKP-01) and a herbal feed additive (NRKP-02) viz., G1-Control (No choline supplementation), G2 (NRKP-01 at 400g/ton), G3 (NRKP-02 at 1000g/ton), G4 (NRKP-01 at 400g/ton + NRKP-02 at 1000g/ton), while G5 (NRKP-01 at 800g/ton) and G6 (NRKP-02 at 2000g/ton) were formulated to contain twice the dose of G2 and G3 respectively. At the end of the feeding trial, all the growth parameters showed similar patterns and no significant changes ($p>0.05$) were observed among the shrimps fed different treatment diets. Higher final mean weight was observed in shrimps fed NRKP-02 supplemented diets G3 (21.35 g) and G6 (21.10 g). Better FCR of 2.18 (G6) was obtained in shrimps fed NRKP-02 supplemented diets at 2000g/ton. There was also no significant difference ($p>0.05$) observed in the whole-body chemical composition of shrimps. Shrimps fed herbal additive (NRKP-02) resulted in better growth and FCR than synthetic choline (NRKP-01), but without any significant difference. Supplementation of either synthetic choline or a herbal additive has no additional positive effect on the growth. It may be due to the required level of choline already available in the ingredients used.

Keywords : *Penaeus vannamei*, Synthetic Choline, Herbal Feed Additive, Growth Performance, Whole-body Chemical Composition

Paper ID 15661

Evaluation of Complete Replacement of Fish Oil by Algal Oil, Rubber Seed Oil and Cashew Kernel Oil as New Lipid Sources in Practical Diets for GIFT Tilapia (*Oreochromis niloticus*)

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The present investigation was performed to study the effects of dietary lipid sources on the growth response, haemato-biochemical response, muscle antioxidant capacity and fatty acids profile of GIFT tilapia. Four iso-nitrogenous and iso-lipidic diets were formulated with crude protein and lipid levels at 32% and 6.5% respectively. Three vegetable oils such as algal oil (AO), rubber seed oil (RSO) and cashew kernel oil (CKO) were used as major dietary lipid sources in the experimental diets at the inclusion level of 6%. In addition, one control feed was formulated with fish oil (FO). At the end of 8-week, GIFT tilapia fed with AO diet had significantly higher ($P<0.05$) growth response and feed utilization indices. There was no significant difference ($P > 0.05$) in terms of growth response between the RSO, CKO and control groups. The hemato-biochemical and antioxidant capacity were significantly influenced by the vegetable oil incorporated diets and better results obtained. In summary, it is concluded that fish oil could be substituted with vegetable oils without distinct compromise in growth response. However, algal oil incorporated diet exhibited better result than fish oil. Hence, vegetable oils could be supplemented in the diets of GIFT tilapia as an alternative to fish oil.

Keywords : Gift Tilapia, Algal Oil, Growth Response, Antioxidant Capacity, Hemato-biochemical, Fatty Acids

Paper ID 15662

Dietary Plant Protein with Hydrolysate Modulate the Growth, Hemato-biochemical, Immunological Parameters and Antioxidant Status of GIFT Tilapia, *Oreochromis niloticus* Cultured in Floating Cages

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The present study evaluated the effect of replacing fish meal with soy protein concentrate (SPC) and supplementation of tuna (TH) and squid hydrolysate (SH) in SPC diets on the growth response, haemato-biochemical parameters, immunological and antioxidant indicators in GIFT tilapia. There were four diets developed that containing 5g/kg TH, 5g/kg SH, 10 g/kg TH and SH (5g/kg TH + 5g/kg SH), 0g/kg TH or SH in SPC based 320g/kg of crude protein diets. In addition, fish meal with the inclusion level of 50g/kg was used as control without the inclusion of SPC, which were fed thrice a day for 8 weeks. The results showed that the SPC and hydrolysate combinations contributed significantly better results, particularly the fish fed with diet containing SPC with 5g/kg and 5g/kg SH (SPC-Mix) which was significantly ($P<0.05$) showed higher growth performance as compared to all the treatments. The blood and serum indices were significantly ($P<0.05$) influenced by the experimental diets and better results obtained. The immunological and antioxidant indicators exhibited better in those GIFT tilapia fed with hydrolysates supplemented diets. It is concluded that soy protein concentrate can replace fish meal without supplementation of marine hydrolysates. However, to achieve better growth performances, soy protein concentrate supplements marine hydrolysates at 10g/kg is recommended in GIFT strain of tilapia.

Keywords : Gift Tilapia, Marine Hydrolysates, Spc, Growth Performance, Biochemical Parameters, Immune Response

Paper ID 15667

Effect of Single Cell Protein on the Growth and Feed Efficiency of Pacific White Shrimp, *Penaeus vannamei*

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A 90-day feeding trial was undertaken to determine the optimal replacement level of fish meal by a single cell protein (SCP) product from methane-oxidising bacteria *Methylococcus capsulatus* in the diets of juvenile *Penaeus vannamei*. Five isonitrogenous diets were formulated: Control diet (G1) with fishmeal as a protein source, four experimental diets replacing fishmeal with SCP at 16.67% (5% inclusion in diet; G2), 33.33% (10% inclusion in diet; G3), 66.67% (20% inclusion in diet; G4) and 83.33% (25% inclusion in diet; G5). At the end of the feeding trial, shrimps fed SCP at 20% (G4) resulted in higher growth (23.3±0.9g) and better FCR (1.78±0.04) which were significantly different ($p<0.05$) from the other treatment groups except for G3 (1.93±0.09) in FCR. Survival of shrimp was improved by the dietary inclusion of SCP. Based on second-order polynomial regression analysis of weight gain against graded fishmeal replacement levels by SCP, the optimum replacement level was estimated to be 49.6%. It may be concluded that the SCP product from *M. capsulatus* can be efficiently used to replace fishmeal up to 49.6% or up to an inclusion level of 14.9% in the diet of juvenile *P. vannamei.*

Keywords : Single Cell Protein, Methylococcus Capsulatus, Penaeus Vannamei, Growth Performance, Feed Efficiency

Paper ID 15679

Effect of Red Seaweed, *Agarophyton tenuistipitatum* Meal in the Diet of Pacific White Leg Shrimp *Penaeus vannamei* to Augment the Growth and Immunity

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Intensive shrimp farming is being challenged with problems of bacterial and viral diseases, including white spot disease (WSD), resulting in high mortality, heavy economic loss, and environmental deterioration. In this context, sustainable development in shrimp farming assumes paramount importance, and Gracilariacean seaweeds have been recognized as alternative sources for the prevention of disease outbreaks and augmentation of immunity. This study was designed to evaluate the effect of *Agarophyton tenuistipitatum* meal in the diet of *Penaeus vannamei* based on growth performance, feed utilization, survival, and immunity. Five experimental diets were formulated to contain 0% (-ve control), 0% commercial (+ve control), 2%, 4%, and 6% seaweed meal were fed to triplicate groups of shrimps (mean initial weight 6.99 ± 0.08 g) for 60 days. The water quality parameters observed were in the normal range. Results at the end of the feeding experiment revealed that final ABW, SGR, and weight gain of shrimp was higher in +ve control, 4% and 6% diet, compared to 2% and –ve control. The group fed with 6% seaweed meal and the positive control recorded higher growth performance. All the treatment groups recorded more than 85% survival, and there were no significant differences among the treatment. Groups fed with 4% and 6% seaweed meal recorded better FCR; the values are not significantly different with positive control. Total hemocyte and large granular cell count was significantly higher in the 4% and 6% treatment group compared to other groups. The enzyme PO activity of shrimp was found significantly higher in the 6% group compared to other groups. Shrimp fed with 6% seaweed showed the highest crude protein content in their body. The study indicated that the dietary administration of *A. tenuistipitatum* meal at 4 – 6% could significantly enhance the overall growth performance and non-specific immunity of *P. vannamei*.

Keywords : Agarophyton Tenuistipitatum, Growth, Immunity, Meal, Penaeus Vannamei

Paper ID 15685

Banana Peel: An Environment Friendly and Potential Source of Potassium and Magnesium Supplement in Shrimp Culture

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The peel of the banana is discarded as waste after the inner fleshy portion is eaten, thereby constituting a menace to the environment. An experiment was conducted to study the proximate composition (Crude protein, ether extract, total ash and fibre) and mineral profile of the banana peel. The peel was collected from the fresh ripened banana procured from the local market. The banana peel was subjected to two treatments in which one lot was sun dried whereas another lot was oven dried and their nutritional composition and mineral profile were studied. The crude protein, ether extract, total ash and fibre content of the banana peel did not vary significantly ($p>0.05$). The mineral composition shows significantly higher ($p<0.05$) magnesium (Mg), Potassium (K) and Manganese (Mn) content in sundried banana peel and sodium and calcium were significantly higher ($p<0.05$) in oven dried banana peel. Other elements such as cobalt (Co), Copper (Cu), Zinc (Zn) and Selenium (Se) did not vary significantly ($p>0.05$) in either of the two treatments. The lack of an essential ion, such as Potassium and Magnesium has been shown to limit the growth and survival of shrimp postlarvae (PL) and growout culture of shrimp, hence the utilization of this less valued novel source which is considered as waste, for meeting Potassium and Magnesium of growing shrimp is a very good prospect and will certainly help to cut short the meances created by chemical fertilizer which is increasingly being used in shrimp culture.

Keywords : Bana Peel, Mineral Profile, Sun Dried Banana Peel, Oven Dried Banana Peel

Paper ID 15692

Comparative Efficacy of Trash Fish and Commercial Feed On the Growth Performance and Body Composition of Asian Seabass, *Lates calcarifer* Reared in HDPE Marine Cages

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Asian seabass (*L.calcarifer*) is cultured in India and several other East Asian countries in marine cages using low-value fish or trash fish. The procurement and storage of these fish are time-consuming, and their use is also linked to issues of sustainability in farming practices and environmental degradation. As a result, formulated feeds are critical for the propagation of large-scale seabass farming. With this goal in mind, an investigation was carried out to assess the efficacy of commercial pellet feed versus trash fish/low-value fish on the growth performance and body composition of Asian seabass (13.3 ± 0.2 cm) reared in HDPE marine cages for 8 weeks. The growth performance of seabass on commercial feed was superior to or comparable to fish fed trash fish. Feed conversion ratios (FCR) in fish fed pellet feed (3.1 ± 0.2) were significantly higher than in trash fish (4.6 ± 0.3). There were no significant differences in water quality parameters when pellet or trash fish were used. The results, on the whole, indicate that the overall growth performance and fish survival rates of the two feed types were nearly identical. However, better body fatty acid composition and cost-benefit were recorded for fish reared on trash fish or low-value fish. The diet composition was reflected in the composition of the fish at the end of the feeding trial. Feed formulations, therefore, should meet the nutritional requirements of seabass and feeds should contain adequate nutrient density for consistent superior performance and meat quality over trash fish. More research is needed for switching from trash fish to pelleted feeds in order to lessen the pressure on wild fish stocks and to improve the wealth and health of farmers and consumers, respectively.

Keywords : Asian Seabass, Cage, Trash Fish, Commercial Diet, Growth, Body Composition

Paper ID 15734

Optimization of Dietary Inclusion Level of Fish Waste Hydrolysate in Diet of *Penaeus vannamei*

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To determine optimum inclusion level of fish waste hydrolysate (FWH) in diet of *P.vannamei,* feed was prepared with four different level i.e., 0, 2.5, 5 & 7.5 % of FWH on dry basis. All the feed were isoproteinous (CP-34 %) and isolipidic (EE-5%). An experiment was conducted in yard with *P.vannamei* juveniles (Av. Body wt. 4.33±0.09 g). Shrimp juveniles were randomly distributed in 12 tanks (500 L water each) at the rate of 20 juveniles per tank and the feeding trial was carried out in triplicate. Shrimps of group I, II, III and IV were offered feed with 0, 2.5, 5 & 7.5 % of FWH, respectively, at satiety level twice (10 am & 5 pm) daily. After 10 weeks of experiment it was found that average daily gain was higher ($P<0.01$) in groups III and IV. Protein efficiency ratio (PER) was significantly ($P<0.05$) higher and feed conversion ratio (FCR) was lower ($P<0.05$) when shrimps were fed diet with 7.5% FWH but no significant difference in FCR was observed among shrimps fed 5 % and 7.5 % FWH. Nutrient digestibility did not differ significantly among groups. Survival % was similar among the groups. Body composition analysis revealed higher muscle protein content in groups received diet containing 5 & 7.5% FWH. Therefore, it can be concluded that FWH can be incorporated up to 7.5 % level in diet of *P.vannamei* and have potential to replace 7 % fish meal in diet of shrimp.

Keywords : Fish Waste Hydrolysate, *Penaeus vannamei*, Fish Meal Replacement, Inclusion Level, FCR, Growth

Paper ID 15745

Effect of Dietary Chitosan on Survival, Growth and Nutrient Utilization of Pangasius (*Pangasianodon hypophthalmus*)

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The effect of dietary chitosan on the growth, nutrient utilization, body composition of Pangasius (*Pangasianodon hypophthalmus*) was investigated. Different chitosan concentrations T1(0.25%), T2(0.5%), T3(1.0%) and T4(2.0%) and control diet without chitosan were prepared for the experiments. Final fish weight, feed conversion ratio (FCR), specific growth rate (SGR), protein efficiency ratio (PER), protein productive value (PPV), and energy utilization (EU) in Pangasius fed chitosan supplemented diet and the control diet were determined at the end of experiment. Data presents mean ±SD from triplicate determination (n = 3) for 70 days feeding trial. Fish fed with 2% chitosan showed significantly ($p<0.05$) higher weight gain and higher specific growth rate (SGR) was observed in fish fed with 1% and 2% chitosan. The significantly higher nutrient utilization efficiency in terms of feed conversion ratio (FCR), protein efficiency ratio (PER) and lipid efficiency ratio (LER) was obtained in 1% and 2% chitosan fed groups. Proximate composition such as moisture, lipid, protein and ash were statistically significant ($p < 0.05$). Higher ($p<0.05$) body moisture was recorded in T1 and higher protein and lipid in T4, whereas the whole-body ash content was significantly higher ($p<0.05$) in fish fed with T1 and high survival rate (100%) was observed in all treatments. The present investigation concluded that 2% dietary chitosan is required for better growth and nutrient utilization in Pangasius.

Keywords : Pangasius, Chitosan, Growth Performance, Body Composition

Paper ID 15746

Effect of Dietary Chitosan on the Hematological, Biochemical, Histological, and Innate Immune Response of Pangasius (*Pangasianodon hypophthalmus*)

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This study was conducted to investigate the effect of dietary chitosan on haematology, biochemical, histological and immunological response of pangasius (*Pangasianodon hypophthalmus*). Feed of different concentrations of chitosan T1(0.25%), T2(0.5%), T3(1%) and T4(2%) and control without chitosan were fed to fish for a period of 70 days in triplicate groups (18 fish per tank) of 100L capacity. At the end of feeding trial, survival was 100% in all groups. The activities of analysed antioxidant enzyme catalase in the liver was significantly ($p < 0.01$) higher in groups fed on 1% chitosan. However, Superoxide dismutase (SOD), and glutathione peroxidase (GPX) activity were significantly higher in control group. The immunological parameters shown significant difference ($p<0.05$) as follows, respiratory burst showed higher activity in control group, lysozyme activity in 1% chitosan, myeloperoxidase (MPO) and serum antiprotease activity in 0.5% chitosan. Significant difference ($p>0.05$) was observed among the treatments in all the haematological parameters. High glucose and haemoglobin was observed in 2% and 0.25% chitosan fed group. The histopathological condition of liver and intestine showed positive effect in fish fed with 0.25%,1% and 2% chitosan. In conclusion, supplementation of 1% chitosan improved the antioxidant status and immunological responses in pangasius.

Keywords : Pangasius, Chitosan, Antioxidant Ability, Histology, Immunity

Paper ID 15752

Effects of Non-defatted Silkworm Pupae Meal on Growth Performance and Nutrient Utilization Efficiency of Pacific White Shrimp (*Penaeus vannamei*)

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This study was conducted to evaluate the effects of growth performance and nutrient utilization of Pacific white shrimp (*Penaeus vannamei*) fed non-defatted silkworm pupae meal (SWP) instead of fish meal (FM). Six isonitrogenous (36% crude protein) experimental diets were formulated to contain 24% of FM, then 20, 40, 60, 80 and 100% of FM was substituted with non-defatted silkworm pupae meal referred to as Control, SWP 20, SWP 40, SWP 60, SWP 80 and SWP 100. Three replicate groups (20 shrimp per replicate) of shrimp (an average weight of 3.86±0.20 g) were fed experimental diets to apparent satiation thrice a day (08.00, 12.00, 16.00 hours) for 45 days. Among the experimental diets, no significant difference ($p > .05$) was observed in survival rate of *Penaeus vannamei* fed non-defatted silkworm pupae meal and, it was ranged from 90-95%. Significant differences ($p < .05$) were observed in final weight, weight gain, average daily growth, feed conversion ratio, feed efficiency ratio, protein efficiency ratio and specific growth rate of *Penaeus vannamei*. A significantly ($p < .05$) higher growth performance such as, final weight (8.36±0.23 g), weight gain (4.61±0.15 g), average daily growth (0.07±0.002 g), protein efficiency ratio (1.34±0.04 %), specific growth rate (1.78±0.04 % day^{-1}) were observed in *Penaeus vannamei* fed 60% of non-defatted silkworm pupae meal. Moreover, dietary non-defatted silkworm pupae meal did not influence the whole-body proximate composition of experimental shrimp. The best feed conversion ratio (2.07±0.07) and feed efficiency ratio (0.48±0.01) were found in experimental shrimp fed SWP 60 diet. Therefore, it was concluded that, 60% of non-defatted silkworm pupae meal could replace dietary fish meal protein in *Penaeus vannamei* diet, with positive effects of growth performance and nutrient utilization.

Keywords : Feed Conversion Efficiency, Fish Meal, Silkworm Pupae Meal, Nutrient Retention, *Penaeus vannamei*

Paper ID 15762

Dietary Azolla Augments Growth, Feed Utilization, Physio-metabolic Responses and Colouration in Koi Carp (*Cyprinus carpio* L.)

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Azolla is a small, free-floating water fern composed of proteins, fatty acids, amino acids, vitamins and carotenoids, can be an effective source of protein as well as carotene in ornamental fish diets. In the present study, the nutritional potential of azolla as feed ingredient on growth, physio-metabolic changes and coloration in Koi carp (*Cyprinus carpio* L.) was assessed in 120 days feeding trial. Five iso-nitrogenous (34.6–34.9% CP) and iso-lipidic (11.5–11.9% CL) diets were formulated with graded levels of azolla inclusion such as 0%, 5%, 10%, 15% and 20% and designated as Control, T1, T2, T3 and T4 respectively. At the end of the feeding trial, growth indices such as final body weight, weight gain, and specific growth rate indicated that fish fed with 20% level of azolla incorporated diet showed higher growth compared to other treatments. Oxidative stress enzymes like SOD and Catalase were lower in 20% and 15% azolla incorporated diets respectively in both gills and liver. Stress indicators like serum glucose and cortisol activity were found to be higher in control than in diets with 20% (T4) as well as 15% (T3), suggesting the stress-reducing ability of the azolla in fish feed. Relatively higher respiratory burst activity in fishes of T4 group indicated higher immunity status of the fish. Quantitative colour values in terms of redness, chroma in the fin region as well as carotenoid content in scale, skin and muscle of fish were higher in T4 (20% azolla incorporated diet) as compared to T3 (15%). Overall, this study clearly showed that dietary incorporation of 20% azolla is advisable to ornamental fish farmers for enhanced growth, colouration, as well as antioxidant activity in this popular ornamental fish for maximizing their profit.

Keywords : Azolla, Colouration, Koi Carp, Feed Utilization, Antioxidant Activity

Paper ID 15775

Efficacy of Dietary Animal with Vegetable Protein Blend on the Growth and Survival of Asian Seabass, *Lates calcarifer* Reared in Recirculating Aquaculture System

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A six-week feeding trial was performed to determine the efficacy of dietary animal with vegetable protein blend on the growth and survival of Asian seabass, *Lates calcarifer* reared in brackish water Recirculating Aquaculture System (RAS) tanks (600L). A treatment diet was formulated with animal and vegetable protein sources isonitrogenous to a commercial diet (48% crude protein). Six RAS tanks each consisting of 20 fishes (9.8±0.6g) were allotted to two diets in triplicates. An optimal water flow rate of 10L/min/tank was regulated in each tank as it was found to be efficient in removing solid wastes from each tank with an optimal movement of fish. At the end of the feeding trial, all the growth parameters showed a similar pattern and no significant differences were observed between the control and treatment diets. Weight gain of fishes fed commercial and treatment diets was recorded as 38.23 ± 1.16g and 37.59 ± 2.13g respectively, while FCR was found to be 1.16 ± 0.02 and 1.15 ± 0.03 for commercial and treatment diets respectively. The cost of preparation of the treatment diet was calculated to be Rs. 117.89 including production cost and it was 12.67% (Rs. 17.11/kg) lesser than the commercial diet. It can be concluded that high growth and survival of Asian seabass equivalent to that of the commercial feed could be achieved with a diet based on animal and vegetable protein blend relatively at a lower cost.

Keywords : Asian Seabass, Recirculating Aquaculture System (RAS), Animal Protein, Vegetable Protein, Protein Blend, Growth Performances

Paper ID 15786

Effects of Dietary Levels of Protein and Probiotics on Growth, Muscle Quality, Immunity, and Expression of Some Immunity Genes in Nile Tilapia *Oreochromis niloticus*

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This study evaluated the effect of dietary probiotics (P) to enhance the feed quality, growth parameters, muscle fatty acid (FA) profile, immunity, and the stimulation of immune genes in head-kidney of Nile tilapia. Healthy mixed-sex Nile tilapia (47.0 g mean weight), were fed three tilapia commercial feeds; Skretting (S), Arasco (A), and Local feed (L) having 33.3, 32.4, and 13.4% protein, respectively. Dietary supplementation of Bacillus probiotic (P) into the commercial feeds resulting in six experimental feeds (S, S+P, A, A+P, Local, and L+P) were used. The non-probiotic feeds served as controls and each treatment had three replicates. Results showed that fish fed the S+P feed had the highest ($P<0.05$) final mean weight (582.7 g), daily growth rate (2.52 g/fish/day), gross fish yield (44.0 kg/m^3), and best feed conversion ratio (1.9), followed by S (570.4 g, 2.46 g/fish/day, 41.1 kg/m^3, and 2.09, respectively). However, these values were the lowest ($P<0.05$) in tilapia fed L+P and L (362.8 and 366.7 g, 1.48 and 1.49 g/fish/day, 27.4 and 26.8, kg/m^3, 2.16 and 2.18, respectively). The feed A and A+P had intermediate values. Fish fed the S+P feed had the highest ($P<0.05$) muscle ∑n-3 fatty acid (10.5) and ∑n-3/n-6 ratio (0.75). In general, gut bacterial counts, lysozyme activity, phagocytic activity, and hemagglutination titer were highest ($P<0.05$) in tilapia fed the S+P, followed by tilapia fed A+P, but it was the lowest for tilapia fed L and the L+P feeds. Probiotics significantly up regulated β-actin, IgM, IL-β1, Mx, and TNF-α immune genes in the head kidney with better response in fish fed the S+P feed. It can be concluded that improvement in tilapia growth, bacterial colonization, muscle quality, immune parameters, and the up regulation of immune genes in the head kidney due to probiotic supplementation would depend on the protein level of the feed used.

Keywords : Nile Tilapia, Protein Ratio, Probiotics, Growth, Fatty Acids, Immune Response, Immune Genes.

Paper ID 15788

Study on Inclusion Level of Potato Waste Meal in the Diet of *Penaeus vannamei*

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Potato waste meal comprising of unused potatoes, potato pulp and its peeling is a by-product produced by drying and grinding of culls of potatoes, potato trimming, pulp, peeling and off-colour parts of French fries and potato chips. Potato waste meal contains 12.45 ± 0.11 % crude protein, 1.07 ± 0.01% lipid, 1.25 ± 0.05 % ash and 53.75 ± 0.21 % NFE and is a potential energy source and can be considered as an alternate aquafeed ingredient for the conventional cereal grains. Inclusion level of potato waste meal (PWM) was studied in diet of Pacific white leg shrimp, *Penaeus vannamei* in an indoor feeding experiment. Five isoproteionous (CP-35%) and isolipidic (EE-5.5%) experimental diets were prepared incorporating five levels of potato waste meal i.e., 0 (control), 8 (T1), 16(T2), 24 (T3) and 32 (T4) % levels by replacing 0, 25, 50, 75 and 100% of cereal flour, respectively. Experiment was conducted in 500 litre FRP tanks in triplicate. The shrimp with body weight of 10.46-10.60 g were randomly distributed into 12 tanks with 15 shrimps per tank. After 42 days of experiment, it was found that there was no significant difference in weight gain and nutrient digestibility between control and 8% PWM inclusion diet. However a significantly decreased ($P<0.05$) weight gain and nutrient digestibility was observed at 50% and above level of replacement of conventional cereal flour by potato waste meal. It was concluded that PWM can be safely included upto 8% level with replacement of 25% of cereal flour sources in *P. vannamei* diet.

Keywords : *Penaeus vannamei*, Potato Waste Meal, Weight Gain, Digestibility, Inclusion Level

Paper ID 15824

Dietary Supplementation of Onion Peel Extract can Enhance the Feed Intake and Growth of *Labeo rohita* Fingerlings Reared at Low Temperature

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An experiment was conducted to evaluate the effect of dietary crude onion peel extract (COPE) on feed intake and growth in rohu, *Labeo rohita* fingerlings reared at low temperature. Five iso-nitrogenous (30.35 CP %) and iso-caloric (383.50 kcal DE/100g) experimental diets were prepared with graded inclusion of crude onion peel extract viz. 0.0, 0.25, 0.50, 1.0 and 2.0 g/100 g diet. The experimental diets were denoted as C, T1, T2, T3 and T4, respectively and fed to fish for 8 weeks. Feed intake was significantly higher in COPE supplemented fed groups ($P<0.05$) than non-supplemented group (C). Fish fed with T2 and T3 experimental diets exhibited maximum weight gain, growth rates {(weight gain (%) and specific growth rates (SGR)} and feed conversion ($P<0.05$) while minimum in control group ($P<0.05$). Protein efficiency ratio and Lipid efficiency ratio followed the same trend as growth rates ($P<0.05$). Negative linear trend was observed between hepato-somatic index (HSI) and COPE inclusion ($P<0.05$). Survival (%) was higher in COPE supplemented fed groups than control ($P<0.05$). Protease activity was increased with COPE inclusion and were in correlation with growth rates. Amylase activity was decreased with COPE inclusions whereas lipase exhibited an increasing trend with dietary COPE inclusion ($P<0.05$). Alanine aminotransferase (ALT) and malate dehydrogenase (MDH) and citrate synthase (CS) activities exhibited a linear trend in rohu fingerlings fed with COPE ($P<0.05$). Lactate dehydrogenase (LDH), and superoxide dismutase (SOD) activities were maximum in T2, T3 and T4 fed groups ($P<0.05$). Serum total protein, albumin, globulin and albumin-globulin ratio were significantly affected by dietary COPE ($P<0.05$). Based on the results, 0.5 % crude onion peel extract in the diet *L. rohita* fingerlings reared at low temperature could be suggested for enhancing the feed intake and growth performance.

Keywords : COP Extract, Feed Intake, Low Temperature, Growth, *Labeo rohita*

Paper ID 15835

Effect of Solid State Fermentation Ground Nut Oil Cake with Yeast, *Saccharomyces cerevisiae* on growth and Nutrient Utilization in *P. vannamei*

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Ground nut oil cake was fermented with yeast, *Saccharomyces cerevisiae* at 60-65% moisture for three days and was evaluated as a fishmeal alternative in the diet of *Penaeus vannamei*. A 45-days' feeding trail was performed using nine iso-nitrogenous and iso-lipidic diets in 500 l fiber reinforced tanks. Untreated/fermented GNC was included at the rate of 0 (control), 2.5, 5.0, 7.5 and 10.0% by replacing fishmeal (w/w). Each diet was randomly assigned to triplicate group of 20 shrimps. Results revealed that shrimp fed with diets having untreated GNC up to 5.0% has no significant difference in growth, whereas the inclusion level whereas the inclusion level was enhanced to 10.0% with yeast fermented GNC with no deleterious effect. The feed and protein efficiency measures viz., feed conversion ratio, protein efficiency ratio and apparent protein utilization were better in shrimps fed with diets having fermented GNC than those fed the respective level of untreated GNC. Haemolymph indices and O:N ratios showed a significant difference between control and test diets. The present investigation concludes that yeast fermented GNC can be used as a potential alternative to fishmeal rather than untreated ingredient as such in the diet of *P. vannamei*.

Keywords : Groundnut Oil Cake, Haemolymph Indices, O:N Ratio, Penaeus Vannamei, *Saccharomyces cerevisiae*, Shrimp Feed and Solid State Fermentation.

Paper ID 15840

Effect of Flavanone Rich Lemon Peel Extract on Feed Intake and Growth of *Labeo rohita* (Hamilton, 1822) Fingerlings Reared at Low Temperature

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A 60-days feeding trail was conducted with an aim to delineate the effect of dietary lemon peel extract on feed intake and growth in *Labeo rohita* (Rohu) reared at low temperature (18 ± 1 ºC). Aqueous and ethanolic lemon peel extracts were prepared and the antioxidant activity was found to be higher for ethanolic extract. Hence, for feeding trial five isonitrogenous (30.0%) and isocaloric (388.52 Kcal DE/100 g) practical diets with varying levels of ethanolic lemon peel extract viz, Control (0.0% lemon peel extract), LPE0.25 (0.25% lemon peel extract), LPE0.5 (0.5% lemon peel extract), LPE1.0 (1.0% lemon peel extract), LPE2.0 (2.0% lemon peel extract) were prepared. The experiment was conducted in a low temperature (18 ± 1 ºC) recirculatory aquaculture system (RAS) with a flow rate of 1.5 L/min. The result showed that inclusion of lemon peel extract in the diet had a significant increase in feed intake in all extract fed groups and highest feed intake was observed in LPE0.5 fed group. Similarly, highest growth rate was recorded in LPE0.5 group. The protease activity was also significantly higher in LPE0.5 group, whereas amylase activity was higher in control and 2.0% extract fed group and lipase activity showed an increasing trend with the inclusion level. HSI and ISI values were higher in LPE1.0 group. Metabolic enzymes like ALT, MDH and citrate synthase showed an increasing trend up to 1.0% level of inclusion. Serum total protein and albumin also followed the same trend. From these results it can be concluded that feeding lemon peel extract at 0.5-1.0% level had increased feed intake and metabolic activities in rohu reared at low temperature

Keywords : Low Temperature; Winter Rearing; Environment Change; Feed Intake; Growth; Metabolism; Lemon Peel Extract; Antioxidant Properties; *Labeo rohita*.

Paper ID 15857

Evaluation of the Low Protein and High Energy Diets Supplemented With Bile Acid on Growth and Physio-metabolic Changes in GIFT Juveniles Reared in Inland Saline Water

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A-60 days feeding trials was conducted to study the effect of bile acid supplemented low protein and high energy diet on growth, nutrient utilization, and physio-metabolic changes of GIFT (*Oreochromis niloticus*) juveniles reared in 10 ppt inland saline water. Three heteronitrogenous (32, 35, 38% CP), heterolipidic (8, 11, 14% lipid) and heterocaloric (409.54-439.60 Kcal DE/100g) with three different levels of bile acid (0, 0.05 and 0.1%) under each combination were formulated and prepared. Four hundred and five (405) acclimated GIFT juveniles (Avg. b. wt. 2.5±0.01g) with stocking density of 15 fishes per tank were randomly distributed in nine treatment groups *viz*. $P_{38}L_8B_0$, $P_{38}L_8B_{0.05}$, $P_{38}L_8B_{0.1}$, $P_{35}L_{11}B_0$, $P_{35}L_{11}B_{0.05}$, $P_{35}L_{11}B_{0.1}$, $P_{32}L_{14}B_0$, $P_{32}L_{14}B_{0.05}$ and $P_{32}L_{14}B_{0.1}$ in triplicates and fed with respective diet. Result indicated that the whole-body crude protein was not significantly ($p>0.05$) affected by different levels protein-lipid diet with bile acid supplementation. Whereas, whole body lipid content increased with increasing dietary lipid and decreasing dietary protein levels. The fishes fed with 35% protein, 11% lipid and 0.05% supplemented bile acid ($P_{35}L_{11}B_{0.05}$) showed higher WG (g), WG%, SGR, activities of AST and ALT while lower FCR, PER and activities of SOD and CAT activities. The body indices (HSI, VSI) and IPF were found to be significantly increased with increase in lipid and decreasing protein content in diet. The malondialdehyde (MDA) increased significantly ($p<0.05$) with increase in the dietary lipid levels in the diet. The serum cholesterol, triglyceride and LDL cholesterol levels were found to be in an increasing trend with increase in lipid and decreasing protein content in diet, while HDL cholesterol showed reverse trend. From the present study it is concluded that the feeding of 35% crude protein, 11% lipid and 0.05% bile acid can cause better growth, nutrient utilization, and physio-metabolic status of GIFT tilapia reared in inland saline water (10 ppt).

Keywords : Catalase, Specific Growth Rate, Malondialdehyde, Tilapia

Paper ID 15871

Effect of L-carnitine Supplemented Low Protein High Energy Diets on Growth and Nutrient Utilization of *P. vannamei* Juveniles Reared in Inland Saline Water

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Addition of suboptimum protein and higher lipid in the diet can be a better strategy to develop an environment friendly feed for cultured species. But very high amount of dietary lipids can cause metabolic burden to the species leading to growth retardation and lipid accumulation in the body of the animals. In this context, a feeding trial of 60 days was conducted at the wet laboratory of Rohtak Centre, ICAR-CIFE, Haryana, India, to study the effect of L-carnitine supplemented low protein high energy (LPHE) diet on growth and nutrient utilization of P. vannamei reared in ISW of 10 ppt salinity. Nine heteronitrogenous (30-36% Crude protein), heterolipidic (5-8% lipid) and heterocaloric (378-411 Kcal DE/100g) practical diets with three different levels (0, 0.05 and 0.1%) of L-carnitine were formulated and prepared. Six hundred and seventy five (675) acclimated P. vannamei juveniles (average body weight: 4.02 ± 0.01 g) were randomly distributed to nine treatments with different levels of dietary protein-lipid and L-carnitine viz. P36L5C0, P36L5C0.05, P36L5C0.1, P33L8C0, P33L8C0.05, P33L8C0.1, P30L11C0, P30L11C0.05 and P30L11C0.1 in triplicate following a 3×3 factorial design and used for the feeding trial. The P33L8C0.05 group exhibited significantly ($p<0.05$) the highest WG (g), WG (%), SGR, TGC, FER, PER, THC and activities of proPO, AST, ALT, protease, amylase, lipase and lower FCR, activities of SOD and CAT and hepatopancreatic MDA compared to other groups. Significantly ($p<0.05$) lower LER and higher HPSI were found in higher lipid and lower protein consuming group but 0.05% dietary L-carnitine caused increased LER and decreased HPSI significantly. Significantly ($p<0.05$) reduced serum glucose, cholesterol and triglyceride was also found in P33L8C0.05 group. Thus, based on the results, it can be concluded that the diet with 33% crude protein, 8% lipid and 0.05% L-carnitine is ideal for rearing of P. vannamei in inland saline water of 10 ppt salinity for achieving maximum growth and wellbeing of shrimp.

Keywords : Isw, L-carnitine, *P.vannamei*

Paper ID 15923

Effect of Ginger (*Zingiber officinale Roscoe*) Incorporated Diets on Haematological Parameters of Juvenile Striped Catfish, *Pangasianodon hypophthalmus* (Sauvage, 1878)

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The study was aimed at determining the effects of ginger (*Zingiber officinale Roscoe*) as an immunostimulants on striped catfish, *Pangasianodon hypophthalmus*. Experimental diets containing ginger powder at 5, 10, 15, 20 g/kg of diet were fed to the juveniles of striped catfish and the control group was fed without incorporating ginger powder in the diet. The experiment was subjected to five treatments and four replicates using a completely randomized design (CRD). The fishes were fed @ 5% of their body weight twice a day. The feeding experiment was conducted for a period of 90 days. After 90 days of feeding experiment, experimental fishes were challenged intra-peritoneally with pathogenic bacteria, *Aeromonas hydrophila*. Results indicated that fishes fed with 10g kg^{-1} ginger incorporated diet was significantly better Hb, RBC, WBC and Hct in both pre- as well as post-challenge study ($P < 0.05$). The results demonstrated that *Zingiber officinale* powder at 10g kg^{-1} of diet can act as an immunostimulant, potentially improving non-specific immunity and disease resistance in striped catfish infected with *Aeromonas hydrophila*.

Keywords : Feed, Ginger, Striped Catfish

Paper ID 15937

Agricultural Solid Waste Management to Develop Protein Rich Fish Feed Using Black Soldier Fly, *Hermetia illucens*

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Agricultural wastes are being burnt or disposed off resulting in environmental pollution. Aquaculture industries solely rely upon the fish meal as a source of protein for use in fish feeds across the country. In India, the increasing demand for and the decreasing availability of fish meal and soy meal has led to sharp increases in the price of fish meal, and hence, the cost of commercial fish feed production has increased as well. So, there is overwhelming need to use an alternative protein source for fish production. BSF is a fly insect widely used as a protein supplement in feed formulations of aquaculture. This fly is amenable for mass production in the decaying food, agricultural and slaughter house waste. So, it could be a viable alternative substitute to the high-cost fish meal in fish feed formulations. BSF contains 35 to 45% crude protein depending on the rearing medium. Protein from BSF pre-pupae meal contains the essential amino acids for fish nutrition. Fish feed using BSF as protein source was formulated and successfully tested in Nile Tilapia, *Oreochromis niloticus* with food conversion ratio 1.79b±0.046 and specific growth rate 2.39c ± 0.009 which is very well comparable with fish meal diet. The crude protein content of the feed was 29.97% with crude lipid content of 12.9%, moisture 4.47%, ash content 6.54% and total carbohydrate as 50%. The BSF has the potential of organic waste remediation and they could be effective agents to convert 'waste to wealth' thereby reducing the environmental hazard posed by organic waste disposal. BSF rearing provides potential remedy for management of slaughter house wastes, domestic food waste, agricultural wastes, animal manure and kitchen waste preventing the wastes from turning into pollutants. BSF larvae being a detritivore is capable of bioconversion of organic wastes to about 50-90% in a short duration.

Keywords : Protein Source, Feed Formulation, Aquaculture, FCR

Paper ID 15939

Effect of Starvation and Re-feeding on Growth Performance of Indian Pompano (*Trachinotus mookalee*) Fingerlings

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T. mookalee is a potential candidate species for marine and brackish water aquaculture possessing high economic value. It is recognized as promising candidate species for mariculture because of their attractive appearance, fast growth rate, adaptability to culture environment, acceptability to formulated feed, firm white as well as tasty meat and high market demand. The present study aimed to investigate the effect of starvation and refeeding on growth of Indian pompano fingerlings for a period of 60days. For this purpose, a total of 450 fingerlings with an initial mean weight of 28.69 ± 0.22g were divided into 9 tanks (1t) in triplicate groups. During the period of the experiment, the control group (C) was fed to satiation three times a day. The feeding regime of the other two groups were designed as follows: 2days starvation / 5days refeeding (T1), 1 day starvation / 6days refeeding. At the end of the experiment, fingerlings maintained in control fed daily, performed with better WG %, and SGR (259.13, 2.13 resp.). There was no significant difference ($p>0.05$) between fingerlings maintained in T1 and T2 in terms of WG% and SGR. Lowest FCR was recorded in T1 group of fingerlings, whereas fingerlings maintained in control and T2 recorded similar ($p>0.05$) FCR. All treatment groups performed with similar condition factor (1.3±0.01). This feeding strategy can be practically applied in grow out cage culture of Indian pompano, especially where daily feeding practice seldom difficult due to adverse environmental climatic conditions.

Keywords : *Trachinotus mookalee*, Starvation, Refeeding, Compensatory Growth

Paper ID 15955

Replacement of Dietary Fish Meal Using Black Soldier Fly (*Hermetia illucens*) Larval Meal Supplemented With L-taurine in Indian Pompano (*Trachinotus mookalee*, Cuvier, 1832) Juveniles

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Insect proteins are potential alternative protein fish meal (FM) as they do not create adverse effects in fish. In the present study, black soldier fly larvae meal (BSFLM) valorized from fish dressing waste was evaluated in Indian pompano (*Trachinotus mookalee*) juveniles. The fish were randomly distributed (2.08±0.05 g each, 10 fish per tank) into 18 tanks in a recirculatory aquaculture system. Feeding trial was performed with nine treatments with different combinations of FM, BSFL meal and taurine (T): Control (100%FM, 0%BSFLM and 0%T), Treatment 2 (100%FM, 0%BSFLM and 1%T), Treatment 3 (100% FM, 0% BSFLM and 2%T), Treatment 4 (10%FM, 90%BSFLM and 0%T), Treatment 5 (10%FM, 90%BSFLM and 1%T), Treatment 6 (10%FM, 90%BSFLM and 2%T), Treatment 7 (0%FM, 100%BSFLM and 0%T), Treatment 8 (0%FM, 100%BSFLM and 1%T), Treatment 9 (0%FM, 100%BSFLM and 2%T). Sampling was done after 65 days of feeding trial to evaluate the growth, biochemical, and histological responses in different treatments. The highest weight gain and best feed utilization ($p<0.05$) was recorded in Treatment 8 (0%FM, 100%BSFLM and 1%T). The activity of digestive enzymes (amylase, lipase, protease) in the BSFLM treated groups were comparable with that of the control group. The antioxidant enzyme, superoxide dismutase activity in the liver and gill was significantly higher ($p<0.05$) in the control group than other treatments. There were no histopathological changes observed in the liver, stomach and intestine in any of the treatments. According to the current study, it can be concluded that BSFLM can be used as a replacement to FM in the diet of Indian pompano juveniles up to 100% along with supplementation of 1% L-taurine with no adverse effects on growth and feed utilization.

Keywords : Black Soldierfly Larvae, Fish Meal, Marine Fish, Taurine

Paper ID 15963

Digestive and Oxidative Stress Enzyme Profiling of Silver Pompano (*Trachinotus blochii*) Larvae Reared in Standardized Feeding Regime and Hatchery Weaning Protocol

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In the present study, the digestive and oxidative stress enzyme profile of different life stages, up to 32 days post hatch (dph) of silver pompano larvae was evaluated. The larvae were maintained in FRP tanks at a salinity of 35 g L^{-1} at a stocking density of 12 Nos. L^{-1} following standardised weaning and hatchery rearing protocol. The larvae of different life stages from 0 dph (average weight 1 ng, and length 1.5 mm) to 32 dph (average weight 335 mg, and length 2.67 cm) were collected and analyzed. The activity of enzymes varied at different stages of development. The protease activity was significantly highest ($P<0.05$), in the 0 dph (1.04±0.06 units mg protein min^{-1}) which gradually decreased and improved at 18 dph (0.59±0.01units mg protein min^{-1}) before decreasing and improving again at 32 dph (0.78±0.03 units mg protein min^{-1}). The amylase activity was significantly lowest ($P<0.05$) in 0 dph stage (0.97±0.01UL^{-1}) and improved afterwards. Oxidative stress showed higher levels until 10 dph and stabilized subsequently. These findings indicate inefficient carbohydrate utilization and increased oxidative stress in the initial stages. The lipase activity did not reveal a clear pattern, rather with ups and downs depending on the weaning diet and ranged from 8.94±0.01 to 186.42±0.77 UL^{-1}. It was evident that at 27 dph onwards, the oxidative stress level was reduced, which indicates their acclimatisation and normalisation to the hatchery weaning protocol and feeding regime. The data on digestive enzyme profile will aid in the development and improvement of stage specific high quality larval diets for silver pompano.

Keywords : Pompano Larvae; Hatchery Weaning; Digestive Enzymes; Weaning Diet

Paper ID 15969

Black Soldier Fly (*Hermitia illucens*) Larvae Meal Can Partially Substitute Fish Meal in the Diet of Striped Snakehead, *Channa striata* Fingerlings

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A 9-week feeding trial was carried out to evaluate the potential of full-fat black soldier fly larvae meal (BSM) as a protein source in the diet of striped snakehead, *Channa striata* fingerlings. Five iso-nitrogenous (crude protein: 42%) and iso-lipidic (crude lipid: 9%) diets were formulated to replace 0 (control; fishmeal based diet), 25 (BSM25), 50 (BSM50), 75 (BSM75), and 100 percent (BSM100) of fishmeal (FM) with BSM. A total of 450 fingerlings (initial average weight: 16.36±0.09g) were randomly assigned to 15 individual tanks with 30 fingerlings in each tank. The water volume was maintained at 400 litres per tank and fish were fed twice daily till satiety. The results revealed that the weight gain (WG), specific growth rate (SGR), feed conversion ratio (FCR), protein efficiency ratio (PER) and protein retention efficiency (PR) in fish fed BSM 25 and BSM 50 were similar to that of the control diet. The fish fed BSM75 and BSM100 had significantly lower SGR, PER, and PR and higher FCR than those fed the control diet. FM substitution with BSM had no effect on whole body protein, lipid, and ash content ($P>0.05$). Dietary composition had a significant effect on intestinal protease activity with lower activity in fish fed BSM75 and BSM100 in comparison to fish fed the control diet. The dietary treatments did not influence on the intestinal lipase and amylase activity ($P>0.05$). The apparent digestibility coefficient (ADC) of dry matter and crude protein was significantly higher in the control and BSM25 fed fish than that of BSM50, BSM75 and BSM100 fed fish ($P<0.05$). In all diets, the ADC of crude lipid was similar ($P> 0.05$). The results indicate that BSM can replace up to 50% of fish meal in the diet of *Channa striata* fingerlings without compromising growth, nutrient utilisation, and whole body composition.

Keywords : Fishmeal Replacement, Full Fat Black Soldier Fly Larvae Meal, *Channa striata*, Growth, Digestive Capacity

Paper ID 15974

Effect of Dietary N-3/N-6 Fatty Acid on Gonadal Maturation and Larval Survival of *Anabas testudineus*

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The impact of dietary n3/n6 ratio of fatty acids (FA) on gonadal maturation, fecundity, hatching rate and offspring survival was studied in brood fish of *Anabas testudineus*. Five iso-nitrogenous (CP 40%) and iso-lipidic (CL 8%) diets were formulated to contain 0.25 (T_1), 0.5 (T_2), 0.75 (T_3) and 1.25 (T_4) n3/n6 FA ratio and one control (T_0) was formulated with saturated fat (tallow). The brood fish were randomly distributed into 15 tanks (1000L capacity) with 6 males (average weight of 23±3g) and 6 females (average weight of 33±5g) in each tank and the fish were fed the experimental diets for 90 days at 3% of body weight. The results revealed that the gonado somatic index (GSI) was significantly higher in T_2, T_3, and T_4 than that of control and T_1 ($P<0.05$) fed fish. The relative fecundity was increased with increasing levels of n3/n6 ratios with higher values in T_3 and T_4 compared to that in other dietary treatments ($P <0.05$). The dietary treatments did not influence the egg fertilization rate ($P>0.05$). The hatching rate (%) was higher in fish fed T_3 and T_4 in comparison to the control, T_1 and T_2 fed fish. The starvation study with newly hatched larvae (0 day post hatch (dph) up to 11 dph) revealed that increasing n3/n6 ratio in the diet increases the larval survival, with the highest for the larvae fed T3 and T4. The result of the study indicates that the dietary n3/n6 ratio of 0.75-1.25 could be the best inclusion level in the diet of *Anabas tesudineus* brood stock diet to achieve maximum reproductive performance.

Keywords : Anabas, Fatty Acid, N3/n6 Ratio, Maturation, Reproduction, Larval Survival

Paper ID 15994

Study of Postprandial Digestive Physiological Dynamics of Chocolate Mahseer (*Neolissochilus hexagonolepis*) Fingerlings

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Postprandial samples of chocolate mahseer (*Neolissochilus hexagonolepis*) fingerlings were taken (n=8) at 1, 2, 4, 6, 8, 10, 12 and 24 hours of feeding for evaluating the gut evacuation and digestive physiological dynamics. For this relative gut length (RGL) dynamics, food transit in the gut and digestive enzyme (amylase, lipase, total protease, trypsin, chymotrypsin, leucine aminopeptidase and alkaline phosphate) activities were measured. Results revealed that RGL changed with time progression after feeding until 6 hours, following which it started to decline; minimum was recorded at 24 hours after feeding. At six hours, in 50% of the sampled fish, the foregut was empty, and in 8 hours, all the fish samples displayed emptied foregut. Trypsin activity sharply declined from 2 to 4 hours after feeding. It gradually increased from 6 and reached a peak at 12. Chymotrypsin activity gradually declined after feeding until 6 hours. Following that, from 8 hours it increased progressively and reached a peak at 12. Amylase, lipase and total protease did not show a regular postprandial responsive trend. The rise of leucine aminopeptidase and alkaline phosphate activities was recorded at 10 hours after feeding and declined after that. Based on the gut transit, RGL and digestive enzyme activities, the digestive function begins to return for the next meal from 6 to 8 hours of feeding.

Keywords : Chocolate Mahseer, Postprandial, Digestive Physiology, Enzyme Activity.

Paper ID 16009

Effect of Dietary Lipid Level On Growth Performance in Tiger Shrimp, *Penaeus monodon* Reared at Three Different Water Salinities

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Penaeus monodon alone accounts for 12-15% of the farmed shrimp production worldwide. It's production is expected to increase in further years due to its relatively high price, stable markets and the availability of specific pathogen-free (SPF) seeds. Though, *P. monodon* effectively maintains the osmotic pressure and ionic regulation by exhibiting a pattern of hyper and hypo osmosis at low and high saline environment, respectively the growth rate varies according to the salinity. This difference could partly be attributed to the variation in the utilization of energy sources. A 45-day feeding trial was conducted to evaluate the effect of dietary lipid level on growth performance in *Penaeus monodon* reared at 5, 25 and 45‰ salinity. Three iso-nitrogenous (392 g/kg) experimental diets were formulated to contain 30, 58 and 83 g/kg of lipid, respectively. A total of 540 healthy acclimatized shrimps (5.56 g) were transferred into 27 experimental tanks. Results showed a significantly (P<0.05) higher weight gain at 25‰. Shrimp fed with high lipid has improved in weight gain (%) in low salinity from 113.4 to 135.5 and in high salinity from 72.8 to 110.9 from low lipid diets. Results revealed that increasing dietary lipid thereby dietary essential fatty acids enhances the tolerance of *P. monodon* at both hypo (5‰) and hyper (45‰) saline conditions, but would not be beneficial while rearing at 25‰.

Keywords : Dietary Lipid, Essential Fatty Acids, *Penaeus monodon*, Salinity.

Paper ID 16010

Growth Performance, Feed Utilization, Antioxidant Capacity, Hematological Parameters, and Nutrient Metabolism in Pangasius, *Pangasianodon hypophthalmus*, Fed Diet of Different Lipid Levels With L-Carnitine

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An experiment was conducted to study the effect of different levels of lipid with L-carnitine on growth, antioxidant capacity, and nutrient metabolism in the diet of Pangasius (Pangasianodon hypophthalmus). Four isonitrogenous (30% crude protein) diets were formulated to contain three different levels of crude lipid (CL), 10%, 14% and 18%, with supplementation of 1% L-carnitine, labeled as D2, D3, and D4, respectively and one feed with 10% CL which has been proven to be appropriate for the test fish without L carnitine, labeled as D1 was used as the control. The feeding trial was conducted for 60 days in plastic tubs of 100 L capacity. Per tank, 20 fingerlings (avg. initial wt. 2.52±0.94 g) were stocked. A significantly ($P<0.05$) lower and better feed conversion ratio (FCR), and significantly ($P<0.05$) higher specific growth rate (SGR), feed efficiency ratio (FER), protein efficiency ratio (PER), protein retention efficiency (PRE) and lipid retention efficiency (LRE) were observed in pangasius fed with D1. The body composition of pangasius showed significantly higher ($p<.05$) and similar protein levels when fed with D2 and D3. However, the body lipid content of pangasius did not vary among the treatments. In the digestive enzymes, amylase activity was independent of the treatments, but protease activity lowered with higher dietary lipid levels. The antioxidant parameters such as superoxide dismutase and glutathione reductase did not change among the treatments. However, the catalase activity was significantly lower and alike in fishes fed with D3 and D4. The activities of liver metabolic enzymes such as malate dehydrogenase and glutamate dehydrogenase were significantly higher in fishes fed with the high lipid diet. It can be concluded from the study that L-carnitine, as such, does not influence growth performance in pangasius with different levels of dietary lipid. However, it plays a role in maintaining antioxidant status, and regulates nutrient metabolic pathways to facilitate lipid catabolism.

Keywords : High-lipid Diets, L-carnitine, Lipid Metabolism, Pangasius, Hematology

Paper ID 16041

Efficacy of the Seaweed *Turbinaria ornata* extract in enhancing the Growth Potential of the Microalgal Culture

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Biofertilizers are environmentally friendly and inexpensive alternatives to the existing chemical fertilizers and plant growth regulators. In the present study, the Conway-Walne microalgal culture medium was replaced at a uniform level of 50 % by varying concentrations (20 %, 30 %, 40 % and 50 %) of the *Turbinaria ornata* seaweed extract prepared by boiling the dried seaweed (1:20 w/v). The seaweed *T.ornata* was collected from the Rameswaram island of the Bay of Bengal sea of India and shade dried for preparing the extract. Sterile culture flasks containing 250 ml of Conway-Walne medium replaced with seaweed extract were then inoculated with 50 ml of the phytoflagellate *Tetraselmis gracilis* under sterile conditions. The culture flasks were kept under laboratory conditions having constant illumination of 1500 lux and temperature of 26ºC. The growth of the microalgae *T.gracilis* inside the culture flaks was monitored regularly by counting the microalgal cells using Haemocytometer on alternate days for a period of 21 days. Significant difference ($p<0.05$) was observed between the treatment groups with regard to the cell counts obtained. Consistent better performance was achieved in culture medium having 20 % seaweed extract concentration followed by 30 % concentration. A cell count of 6.16×10^5 cells/ml was observed for seaweed extract concentration of 20 %; while for the Conway-Walnes medium (control) a cell count of 5.88×10^5 cells/ml was observed on the 19th day. For the seaweed extract concentration of 50 %, maximum cell density was observed on day 19. Contrarily, 40 % has the lowest densities during the experimental period compared to other groups but with increasing trend. The experiment suggests that biofertilizers like seaweed extract have the potency to enhance the growth of microalgae under culture conditions.

Keywords : Biofertilizer, Seaweed Extract, Microalgal Culture, Turbinaria Ornata, Tetraselmis Gracilis

Paper ID 16050

Solid-state Fermentation and the Yield of Fermented Manure from the Raw Cattle Manure for Use as a Feed Ingredient in Aqua Feed

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Fermentation provides a scope to process waste cattle manure as a fish feed ingredient, as it is a potential bio-resource material. Present investigation was carried out to assess the effect of solid-state fermentation (SSF) on the yield of fermented manure. Fresh cattle manure was processed for 3 days after sun drying. Samples were drawn at intervals of 24h, 48h, 72h and each time pH, Heterotrophic bacterial count (HBC) and carbon to nitrogen ratio were recorded. As a result, the initial HBC (3.8×10^5 CFU/gm) was lowered 85% due to sun drying (5.4×10^4CFU/gm) and further increased to 8.7 $\times10^4$ CFU/gm after 48h of fermentation. The total carbon content of manure decreased with different treatment hours such as 24h, 48h, 72h as 28.57 ± 0.43, 25.43 ± 0.45 and 23.69 ± 0.01 %, respectively. At the same time, the nitrogen level of manure was found to increase 1.13 ± 0.15, 1.3 ± 0.01 and 1.08 ± 0.04 %, respectively. The carbon to nitrogen ratio was the highest after 48 h of SSF and increased to a peak value of 1: 0.0511. The pH of manure decreased (6.4 ± 0.01) after fermentation, and the mean temperature recorded was found elevated with aeration (33.2 ± 1.5, 34.0 ± 1.8 and 33.2 ± 2.2 º C, respectively for 24, 48 and 72 hours), as compared to the temperature recorded in control (30.5 ± 1.2, 30.7 ± 1.5 and 30.2 ± 0.9 º C for 24, 48 and 72 hours, respectively). The SSF yielded fermented manure 55.49% as fine particles and 44.51% as coarse particles, while the control manure had yielded 30.6% as fine and 69.4% as coarse particles. Therefore, this nitrogen enriched fermented manure can be utilized as a feed ingredient to reduces the cost of fish feed.

Keywords : Cattle Manure, Solid-state Fermentation, Heterotrophic Bacterial Count, Yield,

Paper ID 16097

Different Feeding Strategies For Grow-out Culture of Indian Pompano in Sea Cage: Effects on Growth, Physiology, Nutrition And Economic Performance

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Use of appropriate feeding management is necessary to gain a maximum growth, feed conversion efficiency and economic advantage in cage aquaculture systems. Indian pompano, *Trachinotus mookalee* is one the emerging candidate marine finfish for culture in sea cages with good acceptance for pelleted feed. Different feeding strategies: Low protein diet (36% CP and 8% CP), high protein diets (40% CP and 10% CP), mixed feeding (low (50%) & high protein (50%)) and use of light energy (60 W) along with high protein feed. Indian pompano of 25 ± 5.0 g were stocked in all cages at stocking of 25 nos/$m^{3.}$ Stocked fishes were fed twice in a day at 6-1.5% of body weight according to size. Growth parameters, physiological, nutrition and economic performance was analysed to compare the best performing feeding methods. Studied growth parameters showed significantly maximum values for cage with light energy: Final growth (912 ± 15.06), FCR (1:1.907), AGR (2.94 ± 0.55) & SGR (1.15 ± 0.25). The physiological status of the fishes represented by level of glucose and cortisol was varied 57.28 to 263.17 mg/dl and 13.65 to 51.29 ng/ml with lowest level at the early culture and highest range in advanced stages of culture. Whereas, among the treatment the physiological parameter did not varied significantly (<0.05). Estimated different nutritional parameters such as tissue proximate, minerals, amino acids and fatty acids were in optimum range among all the treatment. The economic indicator showed that cage culture of pompano supported with light energy could achieve the maximum profit of 18.35 lakhs/year, estimated for a cluster of 10 numbers of cages in single place. The result inferred that culture of Indian pompano with support of light energy could perform better growth and earn more profit than regular culture methods.

Keywords : Indian Pompano, Feeding Strategy, Cage, Light Energy, Profitability

Paper ID 16099

Efficient Statistical Designs for Sequential Experimentation In Fish Nutritional Trials

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Experiments in fisheries are often designed to find conditions which are most favourable for a particular characteristics or growth parameters of a species. It could be fish feed trials to determine the best combination of ingredients to promote maximum growth, hatching of fish eggs in response to changing temperature and salinity, optimisation of fish larvae rearing conditions, optimisation of the degree of hydrolysis of gelatin from croaker scales, and so on. The classic one-factor-at-a-time (OFAT) and factorial designs were the two different screening and optimisation methodologies utilised for any product and process system. However, it fails to predict the optimum factor level settings in the experimental region to attain the target goal (Ruohonen and Kettunen, 2004). The limitations of the classical methods are eliminated by optimising all the affecting factors collectively using Response Surface Methodology (RSM). RSM has a wide range of applications in fisheries, making it easier to assess variable effects and interactions on the response of interest. When the response from a classical response surface design is modelled using a second-order model, however, the fitted model can sometimes be insufficient in terms of substantial *lack of fit*. Then one may think of a higher-order model to establish a functional relationship between the response and the input variables. Experimenting with a new design in such a situation would be expensive as the responses observed from the first stage runs would be kept underutilised. In this paper, an attempt has been made to introduce the concept of sequential experimentation in fish nutritional trials and illustrate the application and advantages of such designs with the help of simulated data.

Keywords : Response Surface Designs, Sequential Experimentation, Cost-efficient Design, Fish Nutritional Trials

Paper ID 16126

Dietary Extract of Mucuna (*Mucuna pruriens*) Seed Improves Growth Performance and Digestive, Metabolic and Haemato-Immunological Response of Sarsi, *Labeo rajasthanicus* (Datta and Majumdar, 1970) Challenged with *Aeromonas Hydrophila*

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The present study was aimed to assess the effect of dietary supplementation of Mucuna, *Mucuna prurience* seed extract (MSE) on growth performance and digestive, metabolic and haemato-immunological response of *Labeo rajasthanicus*. To this purpose, one hundred and eighty fingerlings of an average size (10.90±0.02 g) were designed into control and three treatment and then stocked in 12 FRP tanks (1000 L capacity) followed by complete randomized design (CRD). Six iso-nitrogenous and iso-caloric (30 % crude protein and 371 kcal / 100 g) diets were prepared with incorporation of different levels of ethanolic MSE viz. 0.00 (control), 2.00 (MSE1), 3.00 (MSE2) and 4.00 (MSE3) g/kg and fed over ninety days and then challenged with *Aeromonas hydrophila*. The physico-chemical parameters of water were favourable during the study. The result revealed a significant ($P<0.05$) growth improvement (weight gain %, specific growth rate, FCR, PER and LER in MSE2 dietary group (3.00 g/kg) than others. The digestive enzymes activities (protease and amylase), metabolic activities (AST in liver, ALT in liver and muscle, LDH, MDH and G6PDH) were significantly ($P<0.05$) better in MSE2 group. The serum-protein biochemistry (total protein, albumin and globulin) and haemato-immunological response (RBA, lysozyme activity, RBC, WBC, Hb and Hct) were also improved in MSE2 group ($P<0.05$). The highest post-challenge survival rate was observed in the MSE2 treatment, whereas the lowest was related to the control. From the results, it can be concluded that 3.00 g/kg ethanolic Mucuna seed extract improves growth performance and digestive, metabolic and haemato-immunological response without any adverse effect; hence it is recommended for *Labeo rajasthanicus* as well as carp diet formulation.

Keywords : Mucuna Seed Extract; Growth; *Labeo rajasthanicus*; Metabolic Activities; Haemato-immunological Response

Paper ID 16155

Fish Meal Alternatives for Sustainable Aquaculture: Potential of a Novel Indigenous Methanotrophic Bacterial Meal in Rainbow Trout, *Oncorhynchus mykiss*

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In this study, we investigated the potential of a novel methanotrophic bacterial meal (BM, String Bio, India), as a fish meal (FM) substitute in rainbow trout feed. A digestibility trial was conducted to determine the apparent digestibility coefficients (ADC) of nutrients and energy of two BM variants. The ADC of dry matter, protein, lipid, energy, ash and phosphorus of the variants ranged between 72-80, 86-87, 60-70, 76-79, 45-89, 64-110%, respectively. The essential amino acid availability was similar to or better than those of selected terrestrial plant and animal protein sources. Subsequently, in a nine-week feeding trial, five iso-nitrogenous (49.4-51.1%) and iso-energetic (21-22.1 MJ/kg) diets containing graded levels of one BM, corresponding to 0, 25, 50, 75 and 100% FM replacement, were fed to triplicate groups of trout juveniles. Growth rates were similar in control and 12.5% BM diet. At dietary BM inclusion ≥ 25%, there was slight reduction in feed intake and a decrease in growth rate, nitrogen gain and whole-body protein. However, feed efficiency (1.2-1.3) and protein efficiency ratio (2.4-2.5) did not differ between dietary groups. At high BM inclusion levels, phosphorus-retention and intestinal ALP activity increased, with a favourable reduction in phosphorus-loss. Compared to control, hepatic mRNA expression of *igf-1* was upregulated at 12.5-37.5% BM levels. Likewise, intestinal *pept1* transcripts were higher at 12.5% BM inclusion, corresponding to elevated leucine aminopeptidase activity. Further, high BM inclusion levels differentially regulated the mRNA expression of hepatic metabolic enzymes, antioxidative enzymes and intestinal immune markers; whereas, leptin and stress response proteins expression were not different. Histological observations of gastrointestinal tract, liver and kidney did not show any notable changes with dietary BM inclusion. Based on these observations at different biological levels, we conclude that the bacterial meal tested can replace at least 25% of FM in the diets of rainbow trout.

Keywords : Single Cell Protein, Methanotrophic Bacterial Meal, Sustainable Feed Ingredients, Rainbow Trout

Paper ID 16157

Effect of Feeding Different Dietary Crude Protein Levels on Growth Performance of Nursery Cultured Pearlspot Fry Provided With and Without Substrates in Hapa in Pond

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In aquatic environment periphyton grows on various substratums and supports fish production. The periphyton based aquaculture technology is low cost eco-model with reduction in feed supplements and pollutants. Pearlspot is omnivorous slow growing fish feeding predominantly on filamentous algae. However, slow growth and high protein feed cost affect the fingerling production of pearlspot in nursery farming. Hence, a 90 days study was undertaken at NGRC, Navsari to evaluate the effect of feeding different dietary crude protein levels feed provided with and without periphyton substrate on nursery culture of pearlspot fry in hapa. pearlspot fry of 0.70± 0.02 g were randomly stocked @ density of 200 nos/hapa (2 x 2 x 1 m) installed in 2,000 m^2 pond. PVC pipe frames of 4 x 2 feet (8 sq.ft) long were fabricated and 16 sugarcane bagasses (1 foot long) were attached to each frame through thread and 10 nos such PVC frames were floated in 10 hapas for development of periphyton. The experimental setup consisted of 7 treatments with triplicates, T_1 (30 % CP feed), T_2 (35 % CP feed), T_3 (40 % CP feed), T_4 (30 % CP feed + sugarcane bagasse substrate), T_5 (35 % CP feed + sugarcane bagasse substrate), T_6 (40 % CP feed + sugarcane bagasse substrate), T_C (Control-only sugarcane bagasse substrate). Throughout study, fishes were fed with formulated different protein levels crude feed @ 8-10 % body weight twice a day. Regularly cleaning of hapa of fishes fed with crude protein feed was done to avoid growth of periphyton and hapa with sugarcane bagasse substrate were not cleaned to promote periphyton growth in hapa. After 90 days of experiment, fish highest mean weight was observed in T_6 (25.4 ± 0.07 g) followed by T_5 (24.3± 0.10 g), T_4 (22.9± 0.10 g), T_3 (18.2± 0.08 g), T_2 (17.1± 0.08 g), T_1 (15.3± 0.08g) and T_C (9.5± 0.07 g), respectively. The results of the study revealed that growth parameters of pearlspot were found significantly ($p < 0.05$) higher in feed treatments provided with sugarcane bagasse substrate in hapa (T_4, T_5 & T_6) as compared to feed fed treatments (T_1, T_2, T_3) and control. The findings of the study suggest that floating feed containing 30% crude protein with provision of periphyton substrate is ideal for commercial nursery culture of pearlspot fry in hapa (2 x 2 x 1 m) for obtaining higher benefits returns to fish farmers.

Keywords : Pearlspot, Fry, Protein, Hapa, Nursery, Periphyton Etc

Paper ID 16158

Growth Performance and Feed Utilization of Grey Mullet Fingerlings Fed With Different Levels of Protein Formulated Feed in Nursery Culture in Pond

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Grey mullet, *Mughil Cephallus* is a high valued food fish and an important component of polyculture in traditional and contemporary farming systems in India. However, very less information is available regarding feed utilization and growth performance of grey mullet fry fed with different levels of protein formulated feed in nursery culture in pond. Hence to optimize the protein requirement and as well as to study the acceptance level of formulated feed, an experiment on growth and survival of grey mullet fry fed with different levels of protein concentration in formulated feed was conducted at NGRC Farm, Matwad. The experiment was conducted in nursery hapa (2 x 1 x 1 m) installed in brackishwater pond (2000 sq.m) for 90 days. The wild collected grey mullet seed in the size range of 2.82 ± 0.07 g were procured from Andhra Pradesh and stocked at density of 200 no.s hapa^{-1}. Four experimental diets were formulated using locally available feed ingredients to contain four graded levels of proteins viz., 30, 35, 40 and 45 % respectively on DM basis and fed to triplicate groups (P30, P35, P40 and P45) of grey mullet fry @ 8-10 % BW twice daily. The water quality parameters such as pH, temperature (^{0}C), salinity (ppt), dissolved oxygen (ppm) were monitored daily whereas ammonia (ppm), nitrite (ppm) estimated weekly and were found to be in the optimal range required for grey mullet nursery culture. After 90 days of experiment, total weight gain recorded in P30, P35, P40 and P45 was 31.99 ± 0.11, 41.76 ± 0.22, 37.50 ± 0.12 and 36.22 ± 0.14 (g) with corresponding feed conversion ratio of 3.87 ± 0.02, 3.17 ± 0.05, 3.76 ± 0.01 and 3.78 ± 0.03, respectively. The best growth performance and lowest feed conversion ratio ($P<0.05$) in *Mugil cephalus* was obtained in group fed with 35% protein diet. However, fish growth and protein efficiency ratio decreased with increasing dietary protein levels (40 and 45 % CP). The results of the study revealed that formulated floating feed containing 35 % protein is ideal and optimum for the nursery rearing of grey mullet fry in hapa in pond.

Keywords : Grey Mullet, Fry, Hapa, Nursery, Protein, Etc

Paper ID 16169

Dietary Tryptophan Requirement of Juvenile Striped Murrel, *Channa Striatus*

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A 60-day indoor feeding trial was conducted to evaluate the effects of dietary tryptophan supplementation on growth performances, whole-body proximate composition and amino acid profile of juvenile striped murrel, *Channa striatus*. Five fish meal and silkworm pupae meal based isonitrogenous and isoenergetic diets were formulated to contain graded levels of dietary tryptophan (3.9, 4.8, 5.6, 6.7 and 7.6 g/kg of diet). Each diet was randomly assigned to triplicate groups of 15 fish per experimental unit, which were fed thrice a day (9:00, 13:00 and 17:00 H). Maximum growth performances, such as weight gain (60.5 ± 3.4 g) and thermal-unit growth coefficient were observed in fish fed tryptophan at 5.6 g/kg of diet compared to fish fed other experimental diets. The best feed conversion ratio (1.1± 0.1) and protein efficiency ratio (2.1± 0.1) were also observed in fish fed tryptophan at 5.6 g/kg of diet. There was no significant (p>0.05) effect on whole-body composition and amino acid profile by dietary tryptophan supplementation. Second-order polynomial regression analysis of weight gain against dietary tryptophan levels indicated that the optimum dietary tryptophan requirement for maximum growth and feed utilization of juvenile striped murrel was 5.8 g/kg of diet.

Keywords : Amino Acid, Feed Utilization, Striped Murrel, Tryptophan, Weight Gain, Whole-body Composition

Paper ID 16171

Effects of Algae Meal on Growth Performances, Whole-body Proximate and Amino Acid Profile and Histological Responses of Pacific White Shrimp, *Penaeus vannamei*

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A 60-day feeding trial was conducted to assess the effects of algae meal on growth performances, whole-body proximate and amino acid profile and histological changes of Pacific white shrimp, *Penaeus vannamei*. A commercial diet was used as control (T0). Two treatment diets with an inclusion of algae meal at 0.5% (T1) and 1% (T2), two treatments diets coated with algae meal at 0.5% (T3) and 1% (T4) on commercial diet, and one test diet coated with algae meal and probiotics on commercial diet (T5) were prepared for indoor feeding trial. Each diet was randomly assigned to triplicate groups of 50 shrimps (3.8±0.2 g) per experimental unit, which were fed thrice a day (9:00, 13:00 and 17:00 H). Maximum growth performances, such as weight gain (16.34 ±0.451), average daily growth (0.27± 0.008) and specific growth rate (3.07± 0.016) were observed in fish fed T5 diet compared to fish fed other experimental diets. The best feed conversion ratio (1.47± 0.043), feed efficiency ratio (0.68 ±0.020) and protein efficiency ratio (1.88± 0.054) were also observed in fish fed T5 diet. However, dietary supplementation of algae meal had no significant influence on the whole-body chemical composition and amino acid profile of Pacific white shrimp. Similarly, no histological changes were observed in the hepatopancreas of Pacific white shrimp fed different experimental diets. It is concluded that, both algae meal and probiotics should be supplemented in the commercial diet to improve the growth performances and feed utilization of Pacific white shrimp.

Keywords : Algae Meal, Histology, Pacific White Shrimp, Probiotics, Weight Gain And Whole-body Composition

Paper ID 16179

Optimization of dietary ingredient composition for Bronze featherback, *Notopterus notopterus*

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A 60-day feeding trial was conducted to standardize the dietary preference of bronze featherback, *Notopterus notopterus* based on its growth performance, digestive enzyme activity and haematological responses. Four different combination of feed ingredients such as T1 (+ fishmeal (FM), - Silkworm pupae (SWP), - Shrimp head meal (SHM)), T2 (-FM, +SWP, -SHM), T3 (-FM, -SWP, +SHM), T4 (+FM, +SWP, +SHM) used for experimental diet preparation. About 450 fingerlings (8.36 ± 0.03 g/fish) were randomly stocked in the four treatments and one control, triplicate and fed twice a day. Weight gain and specific growth rate were significantly ($p<0.05$) increased in the T4 than T2, T3 and control diets fed fish however no significant difference ($p>0.05$) was observed between T4 and T1. Among the treatments, fish fed with T4 diet had revealed better haematological responses through an increment of white blood cell count, red blood count, haemoglobin and haematocrit value. Serum glucose level was significantly ($p<0.05$) increased in the T2 diet fed fish compared to T1, T3 and T4. Higher lipase activity was found in the T2 diet fed fish followed by T1, T4, T3 and control fish. There was no significant difference ($p>0.05$) was observed in the whole-body proximate composition fish from all the treatments and control. The present study found T4 diet composition favour the growth performance of bronze featherback at commercial level

Keywords: Bronze Featherback Nutrition, Dietary Composition, Growth Performance, Haematological Response, Fishmeal, Silkworm Pupae

Paper ID 16181

Effects of Dietary Butyric Acid On Growth Performance, Digestive Enzyme Activities, Haematological Responses and Whole-body Composition of Genetically Improved Farmed Tilapia

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The present study utilized butyric acid as an alternative to antibiotics in GIFT diet. A 60- day feeding trial was conducted to evaluate the effect of butyric acid on growth performance, digestive enzyme activity, and haematological responses. Four isonitrogenous (28% protein content) experimental diets were formulated with graded levels of dietary butyric acid (0, 0.5, 1.0, and 1.5 g kg^{-1} of diet). Each diet was randomly assigned to triplicate groups of 30 fish per experimental tank, which were fed twice a day (09:00 and 17:00 hr). Significantly ($p < 0.05$) higher weight gain was observed in butyric acid 1 g Kg^{-1} of diet-fed fish compared to control and BA 0.5 g Kg^{-1}. Amylase and protease activity were significantly ($p < 0.05$) higher in fish fed BA1.0 g kg^{-1} than other treatments and control. However, dietary supplementation of butyric acid had no significant ($P > 0.05$) influence on the whole-body proximate composition of GIFT. Hence, the present study found that the inclusion of butyric acid at 1 g kg^{-1} in the diet was efficiently utilized and improved the growth performances of GIFT

Keywords : Body Composition, Butyric Acid, Digestive Enzyme Activities, Gift, Growth Performance, Haematology

Paper ID 16204

Impact of Dietary Graded Lipid Levels on Activities of Digestive Enzymes in *Clarias magur* Larvae

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This study was designed to investigate the effects of dietary lipid levels on the digestive enzyme activities of *Clarias magur* (Indian walking catfish). Combinations of experimental diets containing graded lipid (80, 100 and 120 g/Kg) were fed to the *C. magur* (Indian walking catfish) larvae from 14-35 dph. The activities of the digestive enzymes like trypsin, pepsin, total protease, lipase and amylase were analysed in a wide range of stage groups fed with graded levels of dietary lipids. Specific activity of lipase was observed to be significantly high at 8 and 10%, and low at 12% dietary lipid level. The significantly high activity of trypsin at 8 and 10% lipid level followed by a decline with further enhancement in lipid content was found. Pepsin and total protease showed a decrease in specific activities as the lipid level increased from 8-12% in different diets. Similarly, a decline in amylase activity was reflected as the dietary lipid level was increased. Hence, the present study concludes that efficient nutrient utilization occurs at the optimum dietary lipid level of 8% in *C. magur* larvae.

Keywords : Dietary Lipid; Lipase; Trypsin; Pepsin; Amylase; *Clarias magur*

Paper ID 16223

Effect of Fishmeal Replacement With Brewer's Spent Yeast on Growth and Physiology of Climbing Perch (*Anabas testudineus*) Fingerlings

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A 60-day feeding trial was conducted to evaluate the optimal fishmeal protein replacement level for climbing perch (*Anabas testudineus*) fingerling by dietary brewer's spent yeast biomass (BSY) protein. In this study, five isonitrogenous (35% CP) and isocaloric (19.12 MJ/Kg) feeds were prepared by replacing 0 (BSY0), 25% (BSY25), 50% (BSY50), 75% (BSY75) and 100% (BSY100) of fishmeal protein using BSY protein. A total of 225 numbers of uniform-sized climbing perch fingerlings (3.29 ± 0.09g) were randomly stocked in the 15 numbers 150 liters rectangular FRP tanks. The experimental fish were fed up to satiation twice a day. At the end of the feeding trial, the significantly higher ($p<0.05$) growth and feed utilization were observed in the BSY75 (WG% = 179 ± 6.05; FCR = 1.69 ± 0.07; PER =1.86 ± 0.07) than BSY0 (WG% = 153 ± 2.84; FCR = 2.03 ± 0.07; PER = 1.55 ± 0.05). The total serum protein, albumin, respiratory burst activity, lysozyme levels, myeloperoxidase activity were significantly improved in the BSY50 and BSY75 replacement levels compared to BSY0. However, HSI, VSI, serum globulin, A;G ratio, ALT, AST, catalase and whole-body composition were nearly unaffected by dietary inclusion of BSY up to 75% in the climbing perch diet. The serum SOD activity ($y = -0.0124x + 2.888$; $R^2 = 0.8614$) were significantly decreased, whereas the serum uric acid levels ($y = 0.0116x + 1.032$; $R^2 = 0.8852$) were increased with the increasing levels of BSY inclusion in the diets. The BSY100 resulted in an overall poor growth response combined with relatively reduced values in nearly all biochemical parameters. The quadric regression analysis of individual weight gain from the different treatments have shown that the optimal protein replacement level of fishmeal by BSY is around 49.1% which caused an 18% reduction in Economic conversion ratio (ECR) per kg of climbing perch fingerlings production,

Keywords : Climbing Perch, *Anabas testudineus*, Fishmeal Replacement, Brewer's Spent Yeast

Paper ID 16230

Development of Low Cost Feed for Freshwater Prawn, *Macrobrachium rosenbergii* (de Man, 1879) Culture

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In order to promote freshwater prawn, *M.rosenbergii* culture and to reduce the cost of feed, a low cost feed was formulated. The experimental diets were prepared using the locally available cheaper protein sources to evaluate the growth performance and survival under pond conditions (0.02 ha each). Two diets containing 28% crude protein were prepared using locally available ingredients. Post larvae of *M.rosenbegii* stocked 5 per square meter and reared for 180 days. Post larvae were fed @ 20% -2% of body weight during the experimental period. No significant difference ($p>0.05$) between control diet and experimental diet in terms of weight gain, FCR, survival and specific growth rate. The highest weight gain found in control diet (37.11 g) and lowest was found in experimental diet (36.75 g). FCR values of the diets range between 2.06 to 2.12 which were insignificant among the dietary treatments. The survival rate was found between 36-38%. The range of water quality parameters observed in different ponds were: temperature 25-32ºC, p^H 7.4-8.0, alkalinity 280-320ppm, hardness 320-360ppm, ammonia – 0.01ppm, dissolved oxygen 4.2-6.0ppm, free CO_2 - Nil. The final yield of prawn were recorded as 13.77kg/0.02ha (275kg per acre, 688.5 kg per ha) in control pond, 14.01 kg/0.02 ha (280kg per acre, 700 kg/ha) for experimental pond, respectively. The results indicated that by replacing traditional protein sources with locally available low cost ingredients will reduce the cost of production by 17-20% in *M. rosenbergii* culture.

Keywords : *M. rosenbergii*, Feed, Growth, FCR and Survival

Paper ID 16234

Dietary Protein Replacement of Fish Meal with Black Soldier Fly Larvae Meal: Effects on Growth and Digestive Enzyme Activity of Juvenile Goldfish, *Carassius auratus*

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A 60-day indoor growth trial was carried out to investigate the effects of dietary replacement of fish meal (FM) protein with black soldier fly larvae meal (BSFLM) at graded concentrations on bio-growth parameters and digestive enzyme activity of goldish juveniles (*Carassius auratus*). Six isonitrogenous and isoenergetic diets were formulated with BSFLM to substitute FM protein at 0 (T0), 20 (T20), 40 (T40), 60 (T60), 80 (T80), and 100 percent (T100). The aquaria with 20 fishes in each replicate were fed with an experimental diet twice a day. Goldfish juveniles fed the T60 diet exhibited maximum growth performance and feed utilization. However, escalating the percentage of fishmeal substitution with BSFLM above 60 percent led to a significant reduction in growth and feed utilization of goldfish juveniles. The protease activity was high in T60 and T80, wherein the lipase and amylase activity were high in T100. Thus, the fishmeal protein substituted at 60 percent with BSFLM with an inclusion level of 20.1 g/kg of diet will be well suitable for the goldfish juveniles.

Keywords : Black Soldier Fly Larvae Meal, Fish Meal, Goldfish, Lipase, Amylase, Protease

Paper ID 16283

Evaluation of De-oiled Castor Cake on Growth Performance, Nutrient Utilization and Haematological Parameters of Genetically Improved Farmed Tilapia (GIFT) Fingerlings

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The feeding trial was conducted in order to assess the efficacy of nutritional potential of de-toxified de-oiled castor cake (DCC) and its effect on growth, feed utilization, body composition, hematological and biochemical responses of Genetically Improved Farmed Tilapia (GIFT) fingerlings for 90 days. Five isoproteinous (350 g / kg) and isoenergetic (394 Kcal /100 g) diets were used to replace fish meal at 0, 5, 10, 15 and 20 % in five treatment groups in triplicates. Three hundred fingerlings (10.93±0.12 g) were randomly distributed into 15 fiber-reinforced plastic tanks (20 fish / tank) and fed with experimental diets. The inclusion of dietary castor oil cake in the different treatment groups significantly ($p<0.05$) affected the growth and survival (>98%) of fish. Significant ($p<0.05$) difference was observed among the DCC fed treatments in which 20% DCC fed treatment showed the best results with respect to higher body weight (83.80 ±24.11g), specific growth rate (2.25%), protein efficiency ratio (3.11), apparent net protein utilization (30.19%) and lower feed conversion ratio (1.32) as compared to other treatments and control group. Flesh composition, hematological and biochemical parameters revealed higher variability in fish and were significantly ($p<0.05$) affected by the inclusion of DCC in the diets. Based on the results, it can be concluded that the 20% substitution of fish meal with de-oiled castor cake might support higher survival, maximum growth, feed conversion, and good health status in GIFT.

Keywords : De-oiled Castor Cake; Tilapia; Gift; Nutrient Utilization; Physiological Status

Paper ID 16299

Efficacy of Ashwagandha (*Withania somnifera*) Root Powder as an Aphrodisiac Feed Additive for Indian Major Carp, *Labeo rohita* (Ham.)

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Efficacy of ashwagandha (*Withania somnifera*) root powder (ARP) as an aphrodisiac fish feed additive was evaluated by feeding brood stock (yearlings) of Indian major carp, *Labeo rohita* (Ham.) with feeds, containing 0% (ARP_0/Control), 1% (ARP_1), 2% (ARP_2) and 3% (ARP_3) ARP, @ 3% BW for 120 days. Although, ARP improved the growth and reproductive performance of fish at all inclusion levels significantly ($P \leq 0.05$), but best results were recorded with 2% level (ARP_2); and the net weight gain in male and female brood fish increased by 60.53 and 62.46% respectively. The gonado-somatic index (GSI), relative fecundity, ova-diameter and hepatosomatic index (HSI) increased from 16.54 %, 2.0 lakh eggs kg^{-1}, 0.71 mm and 0.85% in control (ARP_0) to 22.64%, 3.34 lakh eggs kg^{-1}, 0.84 mm and 1.11% in ARP_2 fed fish, respectively; with 66.07 and 57.69% increase in serum estradiol and progesterone levels. The GSI and HSI in male increased from 1.72% and 0.81% in control (ARP_0) to 2.15% and 1.08% in ARP_2 fed fish, respectively. Further, protein and lipid content in the eggs increased significantly ($P \leq 0.05$) from 24.85% and 5.17% (wet wt. basis) in control (ARP_0) to 26.68% and 6.97% in ARP_2 fed fish, respectively. The milt quality in terms of milt yield, sperm count and spermatocrit increased by 29.80, 45.04 and 14.85% at 2% ARP inclusion level (ARP_2), respectively; with sperm motility scale of ++++++ and 39.03% increase in serum testosterone level. The results indicate that ARP can be potentially utilized as an aphrodisiac carp fish feed additive at 2% inclusion level.

Keywords : Ashwagandha, Brood Stock, Carp, Growth, Herbal, Reproduction, Rohu

Paper ID 16304

Impact of High Inclusion of Soybean Meal on the Hormonal Profile and Expression Of Biomarker Genes Related to Reproductive Function in Matured Female *Cyprinus carpio*

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Soybean meal (SBM) is one of the most sought protein sources used in aquafeed. Phytoestrogens are estrogenic compounds found in soybean meals that are known to exert endocrine disrupting effects owing to their structural similarity with endogenous estrogen. Hence, the present study aimed to evaluate the extent of the endocrine disruptive effect of soy-phytoestrogens on the reproduction of matured female *Cyprinus carpio* and recommend a safe level of soybean meal inclusion in its broodstock diet. Two hundred and fifty-two adult *C. carpio* were distributed into seven distinct experimental groups, with a female to male ratio of 1:2. The treatment groups received diets with 0% (Control), 15% (SBM-15), 20% (SBM-20), 25% (SBM-25), 30% (SBM-30), 35% (SBM-35) and 40% (SBM-40) soybean meal, following a completely randomized design. The impact of dietary soy-phytoestrogens on the level of major hormones and other reproduction-related genes was assessed. The serum triiodothyronine level in the extracellular fluid was reduced in SBM-35 and 40, while testosterone and 17β-estradiol were increased with increasing inclusion of SBM. Gene expressions of aromatase enzymes (*cyp19a1* and *cyp19b*) were downregulated in SBM-30, 35 and 40 groups. Reduction in the mRNA expression of *erβ and* liver *vtgb2*, serum vitellogenin level, frequency of occurrence, and the size homogeneity of vitellogenic oocytes in the ovary were observed from SBM-30 onwards. The serum cortisol level and the expression pattern of *20β-HSD* in the liver and ovary were gradually reduced with increasing levels of SBM in the feed. The study concluded that the inclusion of 30% or more SBM would disrupt the endocrine regulation of reproductive function in adult female *C. carpio*. Thus, it is recommended that inclusion of SBM below 30% can only be included in the broodstock diet of *C. carpio* for normal functioning of the endocrine axis.

Keywords : Soybean Meal, Phytoestrogens, Gene Expression, Estrogen Receptors, Vitellogenin, Sex Steroid

Paper ID 16307

Fishmeal Replacement Using Cottonseed Meal on Growth, Digestive Enzymology and Muscular Free Gossypol in Snubnose Pompano, *Trachinotus blochii*: An Economic Appraisal

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A 10 week study was conducted in indigenous re-circulatory aquaculture systems to evaluate the effect of fishmeal replacement using cottonseed meal (CSM) on growth, digestive enzymology and feed economics in snubnose pompano, *Trachinotus blochii*. Five isonitrogenous and isolipidic diets with graded level of CSM (0, 8.7, 17.4, 26.0 and 34.7%) as replacement for FM protein (0, 25, 50, 75, and 100%) were formulated and fed to respective treatments (0CSM, 25CSM, 50CSM, 75CSM and 100CSM). The growth response in terms of weight gain percentage (WG%), specific growth rate (SGR), average daily growth (ADG), thermal growth co-efficient (TGC), geometric mean body weight (W_G) and growth rate on metabolic body weight (GR_{MBW}) were assessed and found higher in 0CSM group followed by 100CSM group. Feed intake on % of body weight (FI_{PCT}), feed intake per metabolic body weight (FI_{MBW}) and protein productive value (PPV) showed significant difference ($P<0.05$). Lower FI_{PCT} and FI_{MBW} were observed in 25CSM group, followed by 50CSM group. Among the treatments, better FCR was observed in 100CSM group and better PER and PPV were witnessed in 0CSM group. The intestinal α-amylase, protease and lipase activities showed significant difference ($P<0.05$) among the treatments. The maximum protease and lipase activity were noticed in 0CSM treatment and α-amylase activity was higher in 50CSM treatment. The maximum muscular free gossypol accretion of 1.28 mg kg^{-1} (on wet basis) was recorded in 100CSM group which was very well below the critical limit set by FDA. The relative feed cost of 100CSM diet was 10.08% lower than 0CSM diet. Higher relative feed cost savings of 10.79% was witnessed in 100CSM group. As a conclusion, fishmeal can be completely replaced using cottonseed meal in the diet of pompano without adverse effect on growth, metabolism, meat quality and general health with adequate savings of production cost

Keywords : *Trachinotus blochii*, Sustainable Resource, Palatable Feed Ingredient, Cheaper Protein, Economical

Paper ID 16329

Combinatorial Effects of Dietary Genistein and Daidzein on Sex Steroid Profile in Female *Cyprinus carpio* (Linnaeus, 1758)

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A study was conducted to evaluate the combinatorial effects of genistein and daidzein, which are the major phytoestrogens present in soybean, on female *Cyprinus carpio*. The genistein and daidzein contents were estimated as 22.57mg and 2.156mg per 100gram of soybean meal, respectively. A 45-day feeding experiment was conducted to assess the effects of dietary genistein and daidzein supplementation to the broodstock female common carp. Three different treatments were used namely control (phytoestrogen free purified diet), T1 (purified diet with 50% genistein and daidzein of 17.5% of soybean meal equivalent) and T2 (purified diet with 100% genistein and daidzein of 35% of soybean meal equivalent). Sex steroid profiles viz estradiol (E2), testosterone (T), progesterone (P), cortisol were assayed and ovary histology were examined to understand the reproductive performance of female common carp. Both 50 % and 100 % doses of combined genistein and daidzein treatment showed a significant ($p<0.05$) increased serum estradiol levels whereas there were no significant changed in serum testosterone and progesterone level. There was no difference in cortisol level with combined inclusion of genistein and daidzein. The histology of ovary revealed that the percentage of vitellogenic oocytes increased significantly ($p<0.05$) after a higher combined dose of genistein and daidzein feeding (T2). There was also a noticeable increase in cortical alveoli oocytes with inclusion of combined genistein and daidzein. The GSI of treatment groups did not alter significantly. As a result, the study indicated that inclusion of both of 50% dose of genistein and daidzein and 100% dose of genistein and daidzein has shown no negative impact on sex steroid profile except female hormone estradiol (E2) and drastic increases in vitellogenic oocytes population in female common carp. There is a need of more research to see whether long-term genistein and daidzein combined feeding has any harmful implications.

Keywords : Common Carp, Phytoestrogen, Hormonal Profiles

Paper ID 16332

Zinc Nutrition at Critical Life Stages in Salmonids: Effects on Growth, Nutrient Metabolism, Physiology and Health

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Zinc (Zn) is a vital trace mineral required for the growth and health of salmonids, as in all animals, especially during critical life stages. Swim-up fry, smoltification, early seawater phase and broodstock are crucial life stages in salmonids most susceptible to environmental and nutritional challenges. We have analysed the role of Zn in each of these critical life stages. Firstly, rainbow trout swim-up fry were fed diets with or without Zn supplementation (70 vs. 130 mg/kg diet) for 6-weeks and their impact on growth and lipid metabolism was studied in juveniles. Sub-optimal dietary Zn supply during swim-up fry pre-disposed rainbow trout juveniles to growth suppression upon re-introduction to sub-optimal dietary Zn at a later stage. Regarding nutrient metabolism, *de novo* fatty acid synthesis, elongation and desaturation pathways were affected in juvenile trout by Zn nutritional history at swim-up fry stage. Secondly, Atlantic salmon pre-smolts were fed 6 graded levels of Zn (40 to 250 mg/kg diet) during smoltification. Smolts that were fed sub-optimal levels of dietary Zn (<180 mg/kg) had increased cataracts, and reduced hypo-osmotic ability during smoltification and upon seawater transfer. Thirdly, to study the long-term effects, Atlantic salmon were fed two levels of Zn (150 vs. 200 mg/kg diet), at two temperatures (12 vs. 16 ˚C) during early seawater phase for 12-weeks and later reared until harvest size (~4 kg) in sea cages. High water temperature during early seawater phase induced cataracts immediately and in later life stage but was mitigated by increased dietary Zn. Further, severe cataracts were reduced by increasing Zn supplementation during early seawater stage. Finally, mobilization of Zn during broostock maturation and transfer to offspring is being studied in Atlantic salmon to understand the role of Zn in reproduction. Overall, optimal Zn nutrition at critical life stages improved growth, metabolism and health in salmonids.

Keywords : Minerals, Zinc, Fish, Health, Availability

Paper ID 16343

Bacterial Cellulase Production to Augment Fish Feeds

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Plant protein sources have been identified as the promising candidates for replacing fish meal protein in aquafeeds. Plant biomass is primarily made of cellulose, a resistant polymer consisting of glucose units linked by b-1,4-glucosidic linkages. Ability of fish to use dietary carbohydrates as energy sources for growth is limited and most fish do not digest cellulose. Cellulases are the enzymes that hydrolyze cellulose which can be added to fish diets to improve feed utilisation, and nutrient digestibility, thereby lowering feed costs. The cost-effective generation of cellulases is essential for the efficient utilization of cellulosic resources for fish feed. This necessitates the selection of potential cellulolytic bacterial strains. The current work involved isolating cellulase producing bacteria from soil samples collected from cellulose - rich waste sites. Among the 20 isolates selected, the one strain which had the highest Cellulolytic Index value (CI) of 8.33 was subject to cellulase assay with 5 different substrates (Cellulose powder, Carboxy methyl cellulose, Filter paper, rice straw and pre-treated rice straw). Though a good zone of clearance was observed in solid media, no significant cellulase activity was observed in the crude enzyme samples. Media optimization for cellulase production and species identification is under process. Future work would involve using pretreated lignocellulosic biomass as an economical substrate for cellulase production. The work would also include pre-treating feeds with cellulases and analysing its potential in improving feed utility.

Keywords : Cellulases, Cellulolytic Index, Feed

Paper ID 16358

Algal Meal as a Low Carbon Footprint Sustainable Source of Protein and Lipid in the Diet of Snubnose Pompano, *Trachinotus blochii* for better Growth, Nutrient Quality of Meat and Health

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Marine microalgae have been recognised as a low carbon footprint sustainable alternative source of protein and lipid for replacing most depleting fishmeal and fish oil resource in aquafeeds. *Nannochloprosis oculata* is a unicellular green microalgae of marine origin rich in protein (50-52%) and lipid content (10-14%). A 90-days experiment was conducted to replace fishmeal and fish oil in the diet of juveniles of snubnose pompano, *Trachinotus blochii* to assess the growth performance, feed utilization, nutritive profile and health of fish. Snubnose pompano with the average size of 4.00± 0.20g were stocked in 6 number of treatments each with triplicates. Six iso-nitrogenous (40% CP) and iso-caloric (6% CL) experimental diets were prepared using Nannochloropsis meal (NM) by replacing varying levels of fishmeal protein such as 0, 20, 40, 60, 80 and 100% and named as 0NM, 20NM, 40NM, 60NM, 80NM and 100NM respectively. The study revealed that there was significant difference ($P<0.05$) in the growth performance in terms of weight gain percentage (WGP), specific growth rate (SGR), thermal growth co-efficient (TGC) and feed utilization in terms of feed intake (FI), feed conversion ratio (FCR), protein efficiency ratio (FER) among the treatments. Among the treatments higher SGR, WGP, DGC and TGC was observed in 40NM followed by 80NM group. Better FCR, PER and FER were observed in 60NM and 80NM groups. The fatty acid profile of experimental fishes showed higher eicosapentaenoic acid (EPA) and poly unsaturated fatty acid (PUFA) content in the order of 100NM>80NM>60NM>40NM>20NM>0NM. The study revealed that fishmeal can be effectively replaced using Nannochloropsis meal up to 80% without any adverse effect on growth, health and meat quality of *T. blochii*.

Keywords : Algal Meal Production, Eicosapentaenoic Acid, Sustainable Resource, Renewable Resource, Low Carbon Footprint

Paper ID 16381

Optimization of Mass Production Technology for Copepods, *Thermocyclops hyalinus* (Rehberg, 1880)

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The present study was conducted to evaluate the effect of two microalgal species viz. *Chlorella vulgaris* and *Spirulina platensis* on mass production of copepod (*Thermocyclops hyalinus*) in indoor and outdoor culture systems. The experiment was conducted in 1000-liter capacity fiber reinforced plastic (FRP) tanks. The algal samples were collected from natural ponds, identified and isolated using the microscope and pure strain cultured using agar plating method. Copepods were collected from natural ponds, identified and isolated using the microscope and stocked in one-liter plastic bottles to use as the stock inoculum. Two separate tanks were fertilized using media GNOC, Urea, and SSP at the standardized ratio of 250gm, 10gm and 5gm respectively. The pure strains of *C. vulgaris* and *S. platensis* were inoculated on the same day into the tanks. Copepods were introduced at the rate of 50 to 100 individuals per liter of water in all tanks. The animals were fed daily with *C. vulgaris and S. platensis* at the rate of 25000 ±500 cells/ml. The experiment was conducted in triplicate following completely randomized design (CRD) showing maximum mean population growth on the 12th day reaching up to 16.66±0.57 individuals/mL fed with *C. vulgaris* and 13.66±0.57 individuals/mL fed with *S. platensis* in an indoor culture system in 30 days trials. The present study envisages that in indoor culture system copepod, *Thermocyclops hyalinus* fed with *C. vulgaris* can be mass cultured and the present study is useful in the mass production of copepods enabling larval rearing in aquaculture and aquariculture.

Keywords : Mass Production, Copepod (*Thermocyclops hyalinus*),*Chlorella vulgaris*, *Spirulina platensis*, Culture System.

Paper ID 16385

Bioeconomic Performance and Immune-physiological Status of *Osteobrama belangeri* (Valenciennes, 1844) Fed With Live *Wolffia globosa* and Commercial Feed: A Comparative Study

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Aquaculture growth is driven by fed aquaculture. Ever increasing competition for limited conventional feed ingredients from different animal production sectors has generated both availability and affordability concerns. Quest for low cost sustainable nutrient resource without compromising growth, nutritional value and physiological welfare of the cultured animal is of paramount relevance for sustainable growth of aquaculture. A 18-week trial was conducted in clear water system to evaluate relative efficacy of on-farm produced live *Wolffia globosa* (wolffia; crude protein 29%) and a commercial feed (crude protein 30-32%) on the growth performance, survival, feed utilization, immune-physiological status and economic performance of *Osteobrama belangeri* (pengba). Pengba fed with live wolffia exhibited significantly high final mean weight (FMW), gross yield (GY), weight gain (WG), and specific growth rate (SGR) ($p < 0.05$). There were no significant differences in apparent feed utilization except relatively low ($p < 0.05$) protein efficiency ratio (PER) with live *W. globosa*. Furthermore, no significant ($p > 0.05$) differences in immune-physiological parameters of the test animal were recorded except for low blood glucose and sodium ions concentrations in serum in fish fed with live wolffia revealing comparatively improved health status of the fish. The feed cost of production with live wolffia was significantly reduced ($p < 0.05$). The water quality parameters were found to be suitable for growth and survival in both the treatment groups. The substantially higher growth and reduced cost of production observed in live wolffia-fed fish support the candidature of wolffia as a local on-farm producible alternative feed for pengba.

Keywords : *Osteobrama belangeri*, *Wolffia globosa*, Growth Performance, Economic Performance, Local Alternative Feed

Paper ID 16421

Effect of Different Flake Feeds on Growth, Survival, and Body Pigmentation of Rosy Barb, *Pethia conchonius*

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Rosy barb, *Pethia conchonius* is an indigenous ornamental fish preferred for its unique body colouration. Flake diets are becoming popular in ornamental fish industry and are preferred for aquarium fishes for better body colouration. The present study investigated different flake feeds such as earthworm, artemia, and blackworm flakes and powdered feed (38% CP; 4% CL) was provided (control) to evaluate the growth, survival, and body pigmentation of rosy barb. The study was conducted in triplicate for a duration of 45 days. The initial mean length and mean body weight of rosy barb were 19.2 mm and 116 mg, respectively. The final weight (264.3±4.1 mg), weight gain (148.33±4.1), average daily weight gain, weight gain % (127.9±3.5) were significantly ($p<0.05$) higher in rosy barb fed with artemia flakes compared to other flakes fed group. The significantly ($p<0.05$) improved survival rate (82%) was found in artemia flakes fed group, whereas control had the lowest survival rate (51%). Fish fed with blackworm and artemia flakes had significantly higher body carotenoid content compared to earthworm and the lowest was observed in control group. The results indicate artemia flake are much suitable to improve the body growth, survival and pigmentation in rosy barb.

Keywords : Body Pigmentation, Flake Feed, Rosy Barb

Paper ID 16463

Assessment of Total Aflatoxin (Afb1, Afb2, Afg1 and Afg2) in Fish Feed and Feedstuffs by Using High Performance Thin Layer Chromatography

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Aflatoxin contamination happens if the storage condition of feed is poor or low-quality ingredients were used for the preparation of feed. The present study aimed at evaluating the level of total aflatoxin contamination in the commercial fish feed and feedstuffs collected from Tamil Nadu, India. Total 70 samples comprising 20 fish feed, 10 corn, 10 sunflower meal, 10 soybeans, 10 wheat bran, 10 groundnut oil cake were analyzed for the presence of total aflatoxin. Romer's all-purpose method was used for extraction and aflatoxin levels were detected by HPTLC. The outcome of this study revealed that the fish feed and feedstuffs contaminated with aflatoxin B1, B2, G1 and G2 were ranged between 10 - 80, 10 - 35, 10 - 25, 10 - 25 µg kg-1 and the percentage of contamination was 88%, 84%, 70%, 54.4%, respectively. Out of 70 samples, 45 samples were contaminated with aflatoxin B1 and the detected levels were above the permissible limit recommended by EU and FDA. The study warrants the need for periodical monitoring of fish feed and feedstuffs to aflatoxin analysis, thereby advocate the need to establish a proper regulatory measure for aflatoxin level in aquaculture feed and feedstuffs to ensure food safety.

Keywords : Alfatoxin,feed Stuff,fish Feed

Paper ID 16472

Performance Evaluation of a High-Energy Rainbow Trout Grower Feed Under Different Nutritional and Husbandry Conditions

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We conducted a series of laboratory-scale and farm-scale feeding trials to evaluate the performance efficiency of a high-energy rainbow trout (*Oncorhynchus mykiss*) grower feed with respect to diet composition (protein, lipid and fish meal inclusion levels), husbandry practices (stocking density and fish grading) and genetic background of the fish. While the fishes were fed to visual satiation in the small-scale trials, they were fed a fixed ration adjusted according to biomass and temperature in the farm-level trials. Firstly, when compared to commercially available carnivorous fish feed (40% protein and 10% lipid) formulations, the high-energy rainbow trout specific grower feeds (45% protein and 18% lipid) significantly enhanced growth rate (+20%), feed conversion efficiency (+26%) and flesh quality in 10-weeks culture duration, with a significant reduction in nutrient losses. Secondly, reduction of dietary fish meal inclusion levels from 65 to 20% using a blend of alternative plant and animal protein sources in the high-energy feed did not adversely impact feed intake (13.9-14.7 g/kg/day), feed efficiency (0.8-0.9), protein efficiency ratio (1.8-2), thermal growth coefficient (1.2-1.3), body condition factor, tissue-indices, whole body composition and nutrient retention / loss estimates during a 15-week culture period. Thirdly, with respect to husbandry conditions, stocking density and grading did not alter the feed utilisation indices of the high-energy diet (feed intake, 17.8-18.2 g/kg/day; and feed conversion ratio, 0.8-0.84) in rainbow trout juveniles, during a 10-week experiment. However, high stocking density was found to limit growth performance, regardless of feed quality. Fourthly, in a 7-month on-farm production trial, feed efficiency (0.9-1), protein efficiency (2-2.1), growth performance, carcass nutritional composition, sensory-characteristics and plasma metabolite-enzyme levels did not differ between fishes of two genetic backgrounds (Kashmir or Uttarakhand), when fed the high-energy feed. Overall, we conclude that the high-energy rainbow trout grower-feed was highly efficient, regardless of the different experimental conditions.

Keywords : Rainbow Trout, Nutrition, Growth, Feed Utilization, Flesh Quality

Paper ID 16489

Nutritional Programming In Fish: An Approach To Improve The Utilization Of Sustainable Feed Ingredients In Aquaculture

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"Nutritional programming" is a concept which implies that nutritional stimuli during early developmental stages will trigger short or long-term effects on specific physiological functions of the organism. In farmed animals, this strategy can be used to alter specific metabolic pathways or functions. In fish, several approaches can be followed for inducing a given early nutritional history: during gametogenesis through broodstock maternal and paternal feeding, induce changes in the gametes or through feeding larvae at first feeding or early stages. For instance, microinjection of glucose in embryos has been shown to induce long-term effects on carbohydrate metabolism. It was observed that low fishmeal (FM) / fish oil (FO) diets in early stage of rainbow trout had positive effects on utilization of plant-based diet in later stages and the same phenomenon has been observed in gilthead seabream, Atlantic salmon, European seabass, yellow perch, common carp, and zebrafish. We have shown that providing specially designed diets to broodstock gilthead seabream can induce the offspring to better utilise low and/or even no fish meal and fish oil diets. Such an effect of broodstock nutrition was shown to have long-term effects on utilization of low fish oil diet and improved lipid metabolism even after 16 months. The molecular and physiological mechanisms underlying nutritional programming and the role of epigenetics in this approach are studied in different species.

Keywords : Nutritional Programming, Fm/Fo Replacement, Epigenetics, Plant Based Ingredients

Paper ID 16492

Role of *Lactobacillus acidophilus* as a Probiotic Feed Additive and its Effect on Growth and Survival of *Labeo rohita* (Hamilton) Fingerlings

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The study on the role of *Lactobacillus acidophilus* as a probiotic feed additive and its influence on growth and survival of *Labeo rohita* fingerlings was investigated for 120 days. The basal diet in all trials contained 30% protein with different levels of incorporation of *Lactobacillus acidophilus* at 10^4, 10^6 and 10^8 CFU/g in triplicates with a control diet devoid of *Lactobacillus acidophilus*. Uniform sized fingerlings with an average length and weight of 6 cm and 2g respectively were used for the study. The fish fed with 10^4 CFU/gram of Lactobacillus acidophilus showed significantly higher ($P<0.05$) weight gain, Specific Growth Rate (SGR) (1.19) and significantly lower ($P<0.05$) Feed Conversion Ratio (FCR) (1.95) when compared to the fish fed with control diet. Lactobacillus acidophilus fed fish showed significantly higher survival when compared to the fish fed with control diet. Both the muscle protein and muscle fat composition of the fish fed with the treatment diets F_1, F_2 and F_3 is significantly higher ($P<0.05$) than that of the control diet (F_0) fed fish. However, higher inclusion levels of *Lactobacillus acidophilus* at 10^8 CFU/g have shown lower growth.The study on the role of *Lactobacillus acidophilus* as a probiotic feed additive and its influence on growth and survival of *Labeo rohita* fingerlings was investigated for 120 days. The basal diet in all trials contained 30% protein with different levels of incorporation of *Lactobacillus acidophilus* at 10^4, 10^6 and 10^8 CFU/g in triplicates with a control diet devoid of *Lactobacillus acidophilus*. Uniform sized fingerlings with an average length and weight of 6 cm and 2g respectively were used for the study. The fish fed with 10^4 CFU/gram of Lactobacillus acidophilus showed significantly higher ($P<0.05$) weight gain, Specific Growth Rate (SGR) (1.19) and significantly lower ($P<0.05$) Feed Conversion Ratio (FCR) (1.95) when compared to the fish fed with control diet. Lactobacillus acidophilus fed fish showed significantly higher survival when compared to the fish fed with control diet. Both the muscle protein and muscle fat composition of the fish fed with the treatment diets F_1, F_2 and F_3 is significantly higher ($P<0.05$) than that of the control diet (F_0) fed fish. However, higher inclusion levels of Lactobacillus acidophilus at 10^8 CFU/g have shown lower growth.

Keywords : Probiotics, Lactobacillus Acidophilus, Specific Growth Rate (sgr), Feed Conversion Ratio (fcr), Survival

Paper ID 16506

Effect of Starvation and Refeeding on Growth and Haemato-Serological Parameters of Pond Reared Milkfish *Chanos Chanos* (Forsskal, 1775) Fed with Varying Dietary Protein Levels

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A feeding trial was performed for 420 days in two phases, *i.e.*, stunting (240 days) followed by post-stunting (180 days) with three hetero-nitrogenous diets containing 25% (C), 30% (T1), and 35% (T2) crude protein (CP) levels to evaluate the changes in haemato-serological and growth parameters of *Chanos chanos* fingerlings. Uniform weight of *C. chanos* fingerlings were stocked @ 20 no/m^2 (stunting) and @ 2 no/m^2 (post-stunting) in 0.02 ha ponds. Each treatment (n=3) group was fed at 2% (stunting) and 4% biomass (post-stunting) throughout the experiment. The study found that even though fish were under metabolic stress during stunting, they performed better survival, growth, and haemto-serology with T1 fed groups. Further same diet performed higher SGR (1.11±0.01 $\%d^{-1}$), haemoglobin content (15.13±0.29 g dl^{-1}), white blood cell count (58.83±0.26 $10^3/mm^3$), total serum protein (8.83±0.03 g dl^{-1}), glucose levels (171.67±1.77 mg dl^{-1}) in T1 fed groups during re-feeding significantly. This might be due to metabolic adaptation by fish to balance the nutritional status during the stunting and active compensation of the starvation loss in post stunting phase. It may be concluded that the dietary protein level of 30% CP showed better growth performance and haemoto-serological parameters in milkfish fingerlings during both phases.

Keywords : Keywords: *Chanos chanos*, Haemato-serological Parameters, Food Deprivation, Compensatory Growth, Dietary Protein

3. AQUACULTURE GENETICS, BREEDING AND BIOTECHNOLOGY

Paper ID 15552

Transcriptome Profiling offers Visions into Thermal Stress Response in Indian Catfish, *Clarias magur*

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The Indian catfish, *Clarias magur*, has great aquaculture potential due to its nutritional value with good texture and taste. It has been reported to survive in poor water quality and stressful conditions like thermal stress etc. A short-term exposure for 96 h at high thermal stress (34°C) along with control group (26°C) was conducted in *C. magur* to understand the mechanism and biological pathways responsible for high thermal stress adaptation. Thus, RNA sequencing of liver and muscle tissues was performed in *C. magur* individuals on Illumina HiSeq 2000 using 150 bp pair-end library. The de novo assembly with Trinity V4 software yielded a total 755418 transcripts, covering 634,178,896 bases with 399516 Trinity genes, 839.51 bp average transcript length, 1512 bp N50 value. The transcriptome profiling revealed a total of 5054 and 2348 differentially expressed genes (DEGs) between control and high thermal stress groups in liver and muscle tissues of *C. magur*, respectively. Of the 5,054 liver DEGs, 2,739 were up-regulated and 2,315 down-regulated. Similarly, for 2348 muscle DEGs, 1152 genes were up-regulated and 1196 down-regulated. Of these, 243 down-regulated and 418 up-regulated DEGs were common between muscle and liver tissues. KEGG pathway analysis classified these genes into 146 pathways, such as purine metabolism, amino acid metabolism, cysteine and methionine metabolism, glycolysis pathway etc. Gene Set Enrichment Analysis of the DEGs revealed that most of the gene ontology terms were associated with symbiotic process, oxygen binding, transport and oxygen carrier activity. The study will serve as a valuable genomic resource and offers insights into the cellular adaptations following water temperature stress.

Keywords: *Clarias magur*, Thermal Stress, Transcriptome, RNA-seq.

Paper ID 15554

Growth and Reproductive Performance of Pearlspot (*Etroplus suratensis*) through Environmental Manipulation Using Temperature and Photoperiod

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The experiment was conducted to extend the natural spawning season of pearlspot through environmental manipulation using temperature and photoperiod. The species exhibit complex courtship behaviour involving pairing and nesting. Captive breeding of *E. suratensis* was undertaken. Photoperiod (LED light) combination of 1000 lux / 6 hours, 1000 lux / 8 hours and 1000 lux / 10 hours and temperature (thermostat) combinations viz. 26^0C, 28^0C and 30^0C were tried. Each combination used in the study represented a treatment and each was conducted in triplicates (CRD). The FRP tanks 300L capacity was used for experiment. Each brooder tank was stocked with 4 brooders / tank (2 pairs) with artificial spawning surfaces were mud pots and PVC pipe were kept for egg attachment and hideouts respectively. The brooders were fed with 1.2 mm floating feed twice daily @ 3% of fish body weight. The mean body weight of paired brooders 121.19 ± 0.14 g was selected and stocked in the experimental tanks in the sex ratio of 1:1. The experiment was conducted for a period of 90 days. One way ANOVA of the data clearly affirmed that significant differences ($p<0.05$) was observed. The results revealed that, optimum seed production and continuous spawning frequency is possible when the fishes are exposed to a light intensity of 1000 lux/6 hr and 1000 lux/8 hr and optimum temperature of 28°C and 30°C. This technique is reliable system for large scale production of seeds of this species in under controlled conditions.

Keywords: Breeding, Environmental Manipulation, Growth, Pearlspot, Seed Production

Paper ID 15567

Dietary Antioxidants Supplementation Increases Sperm Motility, Fertility and Oxidative Enzyme Activity During Cryopreservation of Koi Carp (*Cyprinus Carpio L.*)

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World human population is in increasing trend. Enhancing the reproductive performance of fishes is the only way to increase production from aquaculture to meet the demand. However, due to higher amount of polyunsaturated fatty acids in their membranes, fish spermatozoa undergo oxidative stress, which affects the reproductive performance. In aquaculture, oxidative stress is considered as a major problem as it impairs sperm motility and cell viability, especially during cryopreservation. This can be overcome by dietary supplementation of antioxidants which is essential during gametogenesis and spermiation. Hence, the aim of the present study is to evaluate the influence of dietary antioxidants on sperm quality and oxidative enzyme activity during cryopreservation. Experimental fishes (*Cyprinus carpio* L.) were fed with feed supplemented with Vitamin C at 200 mg/kg feed (T1), 400 mg/kg feed (T2) and 600 mg/kg feed (T3) and Vitamin E at 200 mg/kg feed (T4), 400 mg/kg feed (T5) and 600 mg/kg feed (T6) and Control (without vitamin inclusion) was maintained. The experimental feed was fed to the fishes until satiation for 60 days, after which, milt was collected from the fishes and cryopreserved for 30 days. After 30 days of cryopreservation, fertilization was done using cryopreserved milt and fresh milt. The values of motility duration, fertilization and hatching rate showed an overall linear and quadratic significant differences ($p<0.05$) among the treatments. The oxidative enzyme activity such as Glutathione Peroxidase, Catalase and Superoxide dismutase was recorded. Histological analysis of ovary revealed that when fishes were fed with Vitamin E, matured ovary was noticed from 15th day onwards irrespective of the vitamin concentration. Feed supplemented with Vitamin E at 200 mg/ kg (T4) exhibited higher motility value, fertilization and hatching rate and oxidative enzyme activities in comparison to other treatments.

Keywords: Antioxidants, Fertilization, Histology, Koi Carp, Cryopreservation, Oxidative Enzymes

Paper ID 15579

cDNA Cloning, Sequencing, and Expression Analyses of Kiss 2 and GnRH 1 Genes in Pearlspot (*Etroplus suratensis*) during different Gonadal Stages

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Kisspeptin (*Kiss*) and gonadotropin-releasing hormone (*GnRH*) are important neuroendocrine peptides that influence reproduction in fish and other vertebrates. However, characterization and their involvement in fish reproduction has been complicated by the presence of multiple *kiss* and *GnRH* genes. In the present study, we isolated partial cDNAs encoding *kiss* 2 and *GnRH* 1 from the brain of pearlspot (*Etroplus suratensis*) and analyzed their expression changes in relation to reproductive cycle of pearlspot in males and females (male: immature, late spermatogenesis, Spermiation and Post spawning stage; female: immature, Early vitellogenesis; Late vitellogenesis; post-spawning stage). Pearlspot *kiss* 2 and *GnRH* 1 encodes 71 and 124 deduced amino acids, respectively. Expression changes of *kiss* 2 and *GnRH* 1 mRNAs in gonads of both sexes shared a similar pattern with higher expression in males during early spermatogenesis in comparison to spermiation and post spawning stages, implying it is involved in early gonadal maturation in this species. In females higher *kiss* 2 mRNA expression was observed during early vitellogenesis. This study revealed the gonadal expression changes of *kiss* 2 and *GnRH* 1 mRNAs in the brain of both sexes of pearlspot during reproductive cycle.

Keywords: Kisspeptin, Kiss 2, GnRH 1, Pearlspot, Gonadal Stages

Paper ID 15582

Synthetic Kisspeptin Peptide Induces Gonadal Development in Chub Mackerel (*Scomber japonicus*)

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Chub mackerel (*Scomber japonicus*) is one of the commercially important marine teleost fish and has been targeted for aquaculture in recent years due to declines in the wild population. This species expresses two kiss genes in the brain and exhibit sexually dimorphic changes during the seasonal reproductive cycle. Synthetic kisspeptin peptides (Kiss1-15 and Kiss2-12) and GnRH analogue were administered subcutaneously. In sexually immature adult chub mackerel, hormones were administered using Alzet mini-osmotic pumps for 45 days. In Prepubertal fish, hormones were administered using molten cocoa butter for three times (bi-weekly) over six weeks (42 days). On day 45 post-administration, gonadosomatic index (GSI) values of male fish treated with Kiss1-15 increased significantly in comparison to other treatments and control. Surprisingly, the testis of all Kiss1-15 treated fish revealed spermiation. In females, no significant changes in GSI values were found between treatments; however, Kiss1-15 and GnRHa treated fish showed prominent signs of vitellogenic onset, with many early yolk oocytes in their ovaries. In prepubertal fish, GSI of Kiss1-15 treated male fish increased significantly in comparison to other treatments. Both Kiss and GnRHa treated fish showed a significant increase in the perinucleolar oocyte diameter. These results indicate that synthetic kisspeptin peptides can induce gonadal development in adult and prepubertal chub mackerel.

Keywords: Kisspeptin, Induced Breeding, Gonadal Development

Paper ID 15590

The influence of arsenic on antioxidants and cytokines expression on the embryonic phases of zebrafish

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The present study is carried out to investigate the effect of inorganic arsenic on antioxidants and cytokines expression in developmental stages of zebrafish embryo and larvae model. In this study, hatchability, morphological abnormalities, mortality, swimming behaviour, antioxidant enzyme activities such as SOD, CAT, Gpx, and GST, immune gene level of TNF-α, IL-1, IL-6, and COX-2, and TNF-α protein expression were all observed in control and arsenic treated embryo-larvae. In a dose-dependent manner, increased hatchability, abnormalities, and mortality percentages, altered swimming behaviour, and developmental abnormalities such as yolk sac edema, heart edema, and jaw deformation were noted. Increase in concentration of arsenic leads to elevate SOD and GST enzyme activity while reduction in CAT and Gpx enzyme activities were detected. In zebrafish embryo-larvae, NaAsO2 concentration elevated several immune gene transcription levels of TNF-α, IL-1, IL-6, and COX-2 in a dose-dependent manner. Similarly, the protein expression of TNF-α protein expression was upregulated. As a result, the current study concludes that inorganic arsenic compound can affect zebrafish embryogenesis, cellular defense, and immunological systems. The present study is carried out to investigate the effect of inorganic arsenic on antioxidants and cytokines expression in developmental stages of zebrafish embryo and larvae model. In this study, hatchability, morphological abnormalities, mortality, swimming behaviour, antioxidant enzyme activities such as SOD, CAT, Gpx, and GST, immune gene level of TNF-α, IL-1, IL-6, and COX-2, and TNF-α protein expression were all observed in control and arsenic treated embryo-larvae. In a dose-dependent manner, increased hatchability, abnormalities, and mortality percentages, altered swimming behaviour, and developmental abnormalities such as yolk sac edema, heart edema, and jaw deformation were noted. Increase in concentration of arsenic leads to elevate SOD and GST enzyme activity while reduction in CAT and Gpx enzyme activities were detected. In zebrafish embryo-larvae, NaAsO2 concentration elevated several immune gene transcription levels of TNF-α, IL-1, IL-6, and COX-2 in a dose-dependent manner. Similarly, the protein expression of TNF-α protein expression was upregulated. As a result, the current study concludes that inorganic arsenic compound can affect zebrafish embryogenesis, cellular defense, and immunological systems.

Keywords : Zebrafish; Immunotoxicity; arsenic; cellular Toxicity; tnf-α

Paper ID 15593

Accessing Non-additive (maternal & dominance) and Additive Genetic Effects on Body Weight in *Labeo rohita*

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Additive and non-additive genetic component is a very crucial role play in animals or plants selective breeding. Through the proper utilization of genetic variance, we can maximum explore the aim of selective breeding. The current study was aimed at accessing non-additive (maternal & dominance) and additive genetic effects on body weight in *Labeo rohita.* Heritability, non-additive & common environmental variance components were estimated for body weight at one year of communal rearing in *L. rohita*. The study includes observation of 2928 offspring from different full-sib families. Bodyweight data were analysed using REML (Restricted Maximum likelihood) in SAS. SAS 9.0 procedure to fit a mixed linear model to derive the REML estimate of the observational variance component. Standardised data from the two subsequent year classes were used to generate the genetic parameters. The second year is not the direct offspring of the previous year class, as the rohu takes 2 years to breed. Substantial contributions of heritability were observed 0.509 & 0.377 respectively. Maternal ratio m^2 estimate -0.118 & -0.088 in 1995- and 1997-year class respectively. These suggest the maternal effects are smaller than the additive effects. Substantial contributions of the non-additive genetic effects were observed ($P<0.05$) for the traits final body weight (W3). Further, the substantial contribution of maternal variance ($P<0.05$) was observed for final body weight (W3).

Keywords: *Labeo rohita*, Heritability, Non-additive Variance, Common Environmental Variance

Paper ID 15628

Prediction of Antimicrobial Peptides from Rohu (*Labeo rohita*) Transcriptome

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Labeo rohita, commonly known as rohu, is the most preferred table fish among the consumers of the Indian subcontinent and is widely cultured in monoculture and polyculture systems. Currently, the emergence of multidrug resistance to classical antibiotics is the major concern in the clinical infection globally. This necessitates the development of alternative antimicrobial agents. Antimicrobial peptides (AMPs) are short-chain proteins, a part of the immune repertoire to protect against pathogenic microbes such as bacteria, viruses, and parasites. In the present investigation, we performed global transcriptome sequencing of the Indian major carp, *Labeo rohita* using Illumina sequencing by covering almost all tissues. In total, 57.4 Gb of raw data were generated from 20 RNA-seq libraries prepared from cDNA of muscle, liver, kidney, testes, ovary, skin, gill, brain, and intestine tissues. The raw reads were QC checked using the program FASTQC and pre-processed. After filtration and trimming, 54.6 Gb of high-quality data were obtained. The raw reads were assembled using the program Trinity v2.8.6. Trinity resulted in 678,160 transcripts with an N50 value of 1254 bp and an average transcript length of 735 bp. The transcripts were clustered using program cd-hit-est resulting in 639,799 transcripts with an N50 value of 1045 bp and an average transcript length of 680 bp. The transcripts were translated into proteins using TransDecoder and antimicrobial peptides were predicted employing hidden Markov models representing 76 antimicrobial peptide classes downloaded from the Collection of Antimicrobial Peptides (CAMP) database using HMMER. Two antimicrobial peptides such as hepcidin and LEAP2 were predicted in the present study. The hepcidin identified in the present study was observed to be different from the one reported earlier in rohu at the amino acid level. The result of the present study suggests that bioinformatics analysis could be successfully used to mining of antimicrobial peptides from transcriptomes of non-model fish species to be used for aquaculture and human use.

Keywords: RNA-seq, Carp, NGS, Hmm, Antimicrobial Peptide, *Labeo rohita*

Paper ID 15659

Unravelling of the complex genome of Indian white shrimp *Penaeus indicus*

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In this study, we describe the approach, difficulties and the challenges encountered in sequencing and assembly of genome of shrimp. The shrimp genome is complex in nature due to its high repetitive regions and large genome size. These unique features of shrimp genome are particularly challenging to decipher the whole genome assembly. PacBio-Sequel platform and short-read Illumina data was generated for the assembly of whole genome of Indian White Shrimp *Penaeus indicus*. The shrimp genome size was estimated to be 2.47 ± 0.04 pg by flow cytometry analysis. The assembly of *P. indicus* genome was of 1.93 Gb length with scaffold N50 of 34.4 Mb and contained 28,720 protein-coding genes. The high-quality genome assembly obtained for *P. indicus*, is the only Crustacean genome with assembly lengths over 1.5 Gb to meet the standards of 1 Mb contig N50 and 10 Mb scaffold N50. The repeat elements constituted 49.31 % (954 Mb) of the assembly and the *P. indicus* genome assembly was found to have highest (31.99 %) proportion of simple sequence repeats among sequenced animal genomes. On comparison with other sequenced shrimp genomes having less contig lengths, the assembly of *P. indicus* resulted in very high number of 346 un-gapped contigs of over 1 Mb length. This contiguous genome revealed 15,563 coding SNPs of which 2,572 are non-synonymous in nature. The *P. indicus* genome assembly has applications in shrimp genetic improvement programs for increased productivity with desirable traits.

Keywords: Genome, Penaeus Indicus, Genome Assembly

Paper ID 15669

Population genomics of *Labeo catla* based on the genome wide SNP marker inferred from genotyping-by-sequencing

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Labeo catla, commonly known as catla, is the second most promising Indian major carp widely cultured in the Indian subcontinent. In spite of its potential as a candidate species for freshwater aquaculture, population genomics study is lacking. In the present study, large-scale species-specific SNPs have been used for population genomics of catla. Genotyping-by-sequencing was performed by taking 100 individuals from six catla wild populations viz., Cauvery, Godavari, Mahanadi, Krishna, Brahmani and Ganga (Patna) with pair ends (150X2 bp). Mapping of reads of each catla population with the reference catla genome was done using BWA software. A total of 10,485 high quality polymorphic SNPs were identified from all the six populations using stringent criteria for SNP filtration and STACKS pipeline. Within populations variation was found to be high (97.45%) as compared to among populations (2.55%). The nucleotide diversity (π) was highest (0.205) in Godavari population. Genetic differentiation was observed to be low to moderate, with F_{st} value ranging from 0.020 to 0.084, with highest between Brahmani and Krishna population. Bayesian (Population Structure) and multivariate approaches (DAPC) analyses indicated the existence of two distinct genetic clusters. Highest (22) no. of private alleles was observed in Ganga (Patna) population. The results of this work provide a better understanding about the genetic diversity and population structure of wild populations of catla, as well as a useful resource for a new database of informative SNP markers for future aquaculture research.

Keywords: Single Nucleotide Polymorphisms (SNP), Genotyping-by-sequencing, *Labeo catla*, Population Genomics

Paper ID 15671

(Co) variance components and genetic parameters of the body weights and growth efficiency traits in the captive-bred Cobia (*Rachycentron canadum*) through Bayesian analysis

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Genetic analysis in terms of phenotypic and genetic (co)variance for the production traits in Cobia is very much essential to develop a sustainable breeding programme. The aim of this study was to estimate the genetic parameters of growth performance traits in this fast-growing marine food fish. The estimates of heritability (direct additive, maternal and total heritability), repeatability (maternal across year repeatability) and correlation (genetic and phenotypic correlation) were computed for body weights and growth efficiency traits (absolute & relative daily gains and Kleiber ratio) at different ages. The genetic analyses were performed on a total number of 404 individuals comprising 526 pedigree records spanning over a period of 11 years. Single trait analyses were carried out by least squares analysis of variance fitting a general linear model (GLM) to study the effect of various non-genetic factors on each trait. The (co)variance components for heritability estimates were computed by fitting three mixed animal models and for correlation estimates by multivariate analysis using the Bayesian approach. The heritability estimates for growth traits were in a magnitude of low to moderate (0.06 to 0.23), which indicates that there is considerable additive genetic variation and a substantial genetic improvement is possible through selective breeding. The genetic and phenotypic correlations among the traits were moderate to high in magnitude and positive in direction with fewer exceptions. The results revealed that these traits could be selected and improved simultaneously. The study also implies that direct selection of traits like body weight at 3 months, average daily weight gain and relative growth rate during 3 to 6 months of age, which are easily measurable, will be more efficient and economical than selection on Kleiber ratios and body weights at later stages. These findings will be of significance to genetically improve the cobia population for a long-term sustainability.

Keywords: Cobia, Heritability, Genetic Correlation, Bayesian Analysis, Growth Efficiency

Paper ID 15672

Structural Characterization, Computational Analysis and Expression Profiling of Steroid 5 alpha-reductase 1 (SRD5A1) Gene during Reproductive Cycle in Endangered Catfish, *Clarias magur*

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The SRD5A1 enzyme regulates steroid levels by the conversion of testosterone into 5α-dihydrotestosterone (DHT) which is required for the full expression of testosterone actions in neuroendocrine tissues. We cloned and characterized the full coding sequence of *Clarias magur* SRD5A1 gene. The full-length cDNA sequence of SRD5A1 was 836 bp (ORF 795 bp) encoding 265 amino acids. Signal peptide analysis revealed that SRD5A1 is non-secretory protein as in other vertebrates. The hydropathy profiles revealed that SRD5A1 is hydrophobic in nature. SRD5A1 showed lower expression at spawning phase compared to preparatory phase while administration of Ovatide™ (GnRH analogue) resulted in up-regulation of expression after 6h of Ovatide™ injection in ovary. In case of male, the lowest expression was observed at preparatory phase and peaked at the 16h post-Ovatide™ injection in testis. In the brain of female fish, Ovatide™ stimulation resulted in the minor elevation of SRD5A1 expression compared to spawning phase while male brain showed lowest expression at 16h post-Ovatide™ injection stage. This is the first report on cloning and characterization of SRD5A1 full-length cDNA in catfish.

Keywords: Testosterone, 5α-dihydrotestosterone, Ovatide, SRD5A1.

Paper ID 15676

Captive Brood stock development and induced breeding of Yellowfin bream, *Acanthopagrus datnia* in India: A breakthrough

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Yellowfin bream, *Acanthopagrus datnia* is one of India's most important commercial food fish. Aquaculture of this fish is hindered due to unavailability of hatchery produced seed. To increase the aquaculture production through seed production of *A. datnia,* Kakdwip Research Centre of ICAR-CIBA initiated to develop the techniques of captive broodstock development and induced breeding of *A. datnia*. Sub-adult fish (70-500 g) reared in the Recirculatory Aquaculture System (RAS) at 5-7 ppt from February to August. Fish were fed with formulated feed (38% protein) and low-cost fish (Tilapia and Bombay duck) @ 5 % of the body weight. Maturity of the females was assessed through ovarian biopsy. Six females with developing oogonia and twelve males were shifted to breeding RAS, where salinity was gradually increased to 30 ppt (@ 1.5 ppt/day). Salinity of the breeding RAS (8000 L) was maintained at 30 ppt for final maturation and induced breeding (November-December). Mature fish was administered with LHRHa @ 30 µg kg^{-1} body weights to female and half the dose to male. Results of the study showed that the oocyte development commenced in August and attained a maturation size of 400-450 µm during November-December. Fish spawned after a latency period of 55 h and continue for two to three days. Fertilized eggs were transparent, floating, and circular with diameter of 750-830 µm. Rate of fertilization and hatching was 90 and 70%, respectively. Embryonic development showed that the two cells, four cells, morula, blastula, gastrula, neurula and hatching at 45 min, one h, two h, five h, ten h, 21 h, 26 h, respectively at 12-16 ^{0}C of water temperature. Total length of newly hatched larvae was 1.75±0.08 mm. In conclusion, yellowfin bream will mature in brackishwater and induced to spawn with LHRHa 30@ µg kg^{-1} at water salinity of 30 ppt.

Keywords: Broodstock, Captivity, Development, Embryo, Induced Breeding, Yellowfin Bream

Paper ID 15693

Prevalence, Antimicrobial Resistance, and Resistance Gene Cassettes Detection in Bacterial Pathogens Isolated from Bloodfin Tetra

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Antimicrobial resistance (AMR) is a rising concern in the global aquaculture sector. This study was aimed to determine the AMR pattern in Bloodfin tetra (*Aphyocharax anisitsi*). Samples of infected Bloodfin tetra (30 nos.) were collected from ornamental fish farms of Chennai, Tamil Nadu. Clinical signs such as fin rot, lesions on internal organs and skin ulcers were observed in the samples. Based on biochemical test results, the dendrogram consisting of 6 clusters were generated using NTSYSpc, version 2.10e. Shannon Weiner diversity index of resolved isolates was calculated as 1.63 using Primer-E software. 16S rRNA sequences of recovered isolates were identified as *B. cereus*, *B. drentensis, B. subtilis*, *A. hydrophila, Priestia flexa* and *Pseudomonas putida*. Antibiotic susceptibility testing with 36 antibiotic discs showed an elevated resistance pattern for *P. flexa, B. cereus* and *B. subtilis* with higher multiple antibiotic resistance (MAR) index (>0.33). The MAR index of >0.2 indicates a higher risk of AMR and antibiotic contamination in aquaculture systems. In contrast, *B. drentensis* was susceptible to all the antibiotics used in this study. *B. subtilis* exhibited resistance against cefepime, the 4th generation cephalosporin antibiotic. The emergence of AMR towards new generation antibiotics increases the risk and forces the development of better alternatives to antibiotics. All the recovered isolates were susceptible to ceftazidime, cefoperazone, gentamycin, streptomycin, sulphafurazole, nalidixic acid, pefloxacin, norfloxacin and ciprofloxacin. Class 1 integron was detected from both genomic and plasmid DNA of all the isolates except for *P. putida* and *B. drentensis,* which increases the risk of AMR gene dissemination to clinically important bacteria. In contrast, class 2 integron was not detected in all the isolates. Our study provides baseline data on the AMR level in bacterial pathogens from ornamental fish, which will be essential to mitigate the potential risks to human and fish health.

Keywords: Antimicrobial Resistance, Bacterial Pathogens, Ornamental Fish, Multiple Antimicrobial Resistance, Integrons

Paper ID 15698

First report of a chromosome-scale genome assembly for *Mugil cephalus* (Linnaeus, 1758)

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The flathead grey mullet (*Mugil cephalus*) is an important food fish in the family Mugilidae with potential for brackishwater aquaculture. The captive maturation and breeding of grey mullet towards year-round production of seed is a very difficult task. This requires an in-depth biological understanding of the composition of genes in the genome and their regulatory mechanisms. In this context, we have generated a chromosome-scale genome assembly for *M. cephalus* with the sequence data generated using PacBio, Illumina, and Arima Hi-C technologies. Initially, assembly contigs were generated with Pacbio Sequel II reads (257 Gb) which were later polished with Illumina reads (640 million) and further scaffolded to chromosomes with Arima HiC reads (181 million). The k-mer analyses with 21-mer reads indicated a genome length of 594 Mb for grey mullet. The final assembly contained 24 pseudochromosomes representing the haploid chromosome number of the species. The assembly is of 634.8 Mb length with N50 and longest scaffold lengths of 28.3 Mb and 54.4 Mb respectively. The genome was found to be 96% complete when assessed with Actinopterygii_odb10 (2020-08-05) orthologous dataset using BUSCO v5.2.2. The genome was found to contain 11.72% of repetitive elements of which DNA transposons were predominant. We have predicted 27,269 protein-coding genes based on the evidence drawn from Illumina RNAseq reads, PacBio Isosequencing reads, proteins from related species and *ab initio* gene predictions. The whole genome sequence assembly generated for the first time for *M. cephalus* can be used as a reference genome for family Mugilidae. The assembly would help to gain further in-sights for desirable traits in grey mullet through gene expression studies and would provide the baseline information needed to implement genetic improvement programmes for this commercially important resource in future.

Keywords: Whole Genome Assembly, Mugil Cephalus, Repeat Analysis, Long Read Assembly, Grey Mullet, PacBio

Paper ID 15700

Missing Regions Finder (MRF) for swift comparison of virus genomes based on deletions in coding sequences

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Next-generation sequencing has revolutionized virus comparative genomic analysis as global sequencing efforts resulted in tens of thousands of high coverages, complete genomes. The availability of complete genomes in this scale has shifted comparative genomics approaches from between-species to within-species. Several tools currently exist to study genetic variability in viruses, but are specific to one or certain genus and moreover cannot be used to identify structural deletions that play crucial role in fitness and virulence. This deficiency is more evident when analyzing large DNA viruses comprising hundreds of coding sequences (CDS). One such example is white spot syndrome virus (WSSV) where the isolates share high sequence similarity despite large genome length differences. In this regard a new tool, Missing Regions Finder (MRF) was developed, which in contrast to the existing tools relies on differences in genomic and coding regions rather than similarities to classify them. While the web version of the tool does pairwise genome comparison, the command line version can take any number of genomes as input and can quickly identify top *n* genomes deviating from reference. In addition to the standard text outputs, the tool also generates heatmaps and barplots. Analysis of the complete genomes of WSSV has revealed, there are three major deletion hotspots, *wsv481/499, wsv237/241* and *wsv178/180* of lengths about 10kb, 2kb and 1kb respectively. One of this deletion hotspots has key structural proteins such as *vp41* and *vp51*. In the case of African swine fever virus (ASFV), MRF has swiftly identified genes in vaccine strains responsible for conferring protection from virulent strains. MRF was also used to quickly narrow down to top 50 (from 487692 complete genomes) varying from reference in SARS-COV2. MRF is best utilized in comparative analyses of strains/isolates belonging to a single virus species and can handle both DNA/RNA genomes of any length.

Keywords: Comparative Virus Genomics, Virus Analysis Tool, Deletions in Cds, WSSV

Paper ID 15704

Effects of high-protein low-carbohydrate and high-carbohydrate low-protein diets on gonad maturation and visceral fat deposition in *Labeo catla*

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To study the derangement of gonad maturation in case the fish is having fat deposition. So, we need to see (i) What are the condition/factors which induces fat deposition in an adult catla? (ii) In case there is fat deposition, whether the fishes show normal gonad development or not? If not, what are the deficiencies/abnormalities observed which has prevented normal gonad development. To investigate this hypothesis, the role of high dietary protein and carbohydrate on gonad maturation and fat deposition in *Labeo catla* was investigated. 2-year and 4-year-old male and female *Labeo catla* stoked in earthen pond standard stocking density and were fed a diet containing Feed -1(GNOC: RB 3:1), with 43.97% protein, 23.71 CHO, Feed-2 (GNOC: RB 1:1) with 33.67% protein and 26.76% CHO and Feed-3 (GNOC: RB 1:3) with 29.81% CHO and 23.37% protein for an entire reproductive cycle. Effects high-protein low-carbohydrate and high-carbohydrate low-protein diets on derangement of gonad maturation and fat deposition in catla was evaluated by fat content in different tissues, plasma metabolites, liver lipogenic activity and fatty acid composition of various organ e.i. eggs, liver, adipose tissue and muscle tissue, histological changes in liver, adipose tissues and oocytes, serum hormonal changes and breeding performance with respect to three isonitrogenous diets with graded levels of Ground nut oil cack, Rice bran, Fish meal and vitamin mineral mixture in *Labeo catla.* The results showed that nutritional quality of the diet considerably influenced gonad maturation events in the species. The total number of matured females was the highest in fish fed with Feed-2 whereas fishes fed with Feed-1 and Feed-3 showed abnormal gonad development with visceral fat formation. In conclusion, this exploratory work has shown that catla broodstock are not able to recruit normal oocytes, diet containing carbohydrates 29.81%, protein 23.37% (Feed-3) and protein 43.97%, carbohydrates 23.71% can then grow abdominal and visceral fat over an entire reproductive cycle. These results are highly promising and suggest that inappropriate protein and carbohydrate in catla brood fish is not permissible for gonad development.

Keywords: High-protein, High-carbohydrate, Visceral Fat, Gonad Maturation, Histology, Fatty Acid, Adipose Tissues, Liver, Enzymatic Activity, Reproduction, Catla Brood

Paper ID 15713

Pan-genome characterization of potential shellfish allergens from four crustacean species

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Seafood consumption has seen a significant rise in the past decade around the world particularly in coastal areas, it accounts for 17% of world's animal protein consumption. Shellfish contributes to a major portion of seafood, comprising of species from Crustacea and Mollusca. Shellfish is also one of the eight major sources of food allergens and its prevalence is estimated at 0.5-2.5% of the general population worldwide. The taxonomic diversity of the edible shellfish impedes the quick diagnosis and treatment of the allergic reaction due to the unavailability of species-specific allergens data. An omics-based approach is required for the identification of possible food allergens in shellfish. In the current study, we have explored two genome-wide, homology-based approaches to identify and characterize possible allergens in four crustacean species (*Homarus americanus*, *Chionoecetes opilio*, *Penaeus monodon,* and *Penaeus vannamei*). In the first approach, the Immune epitope database and analysis resource was used to curate 15737 epitopes for allergic disease. In the alternate approach, we have curated the allergens from three different allergen databases (IUIS, COMPARE, and AllergenOnline) to obtain 3375 allergen sequences. These datasets were used to identify epitope-containing proteins and possible allergens in the crustacean genomes. The approaches were successful in identifying potential pan-allergens like Tropomyosin, Arginine kinase, and Myosin, as well as species specific allergens like Glutaminase, Elongation Factor 2 like, and Superoxide dismutase. The epitope-based approach also resulted in identifying multiple epitope sites on the proteins Arginine kinase and Tropomyosin.

Keywords: Allergen, Shellfish, Genome, Arginine Kinase, Tropomyosin

Paper ID 15719

Gonadal transcriptome analysis provides insights into differentially expressed genes involved in sex-related differences in Golden Mahseer

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Golden mahseer (*Tor putitora*) is one of the largest freshwater fish with high nutritional and economic value. Skewed sex ratio is a major problem in many teleosts including golden mahseer that affects population structure, viability of sensitive stocks and has negative consequences on reproductive success. Understanding sex-related genes and their expression pattern will provide insight into the molecular mechanisms that establish and maintain the male and female phenotype in golden mahseer. However, no information on the critical genes involved in sex is available in this species. Hence, we employed systematic transcriptome analysis to explore the gene expression difference between the sexes in the gonads. The de novo assembly produced a highly complete reference transcriptome with 316,548 non-redundant transcripts and an N50 of 1327 bp. Differential expression analysis identified a large set of sex-biased transcripts (17,355) between the sexes. Targeted search for candidate genes known for their supposedly conserved role in maintaining the sexual identity of other fish and vertebrate species identified 38 possible homologs that may play an essential role in the *T. putitora* sex determination/differentiation cascade. In addition, several sex-related signaling pathways were observed, including the Wnt signaling pathway. Additional qPCR analysis of ten selected candidate genes showed expression patterns consistent with the transcriptome results. This study represents the first gonadal transcriptomic analysis of *T. putitora* and provides a basis for further investigation of the molecular mechanisms underlying sex determination in mahseer.

Keywords: Golden Mahseer, Skewed Sex Ratio, Transcriptome Analysis, Sex Related Genes, Sex Determination/differentiation.

Paper ID 15722

Mining of antimicrobial peptides from *Clarias magur* (Hamilton, 1822) Transcriptome

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Antimicrobial peptides (AMPs) are promising antibiotic alternatives with unique properties for combating antimicrobial resistance. *Clarias magur*, an Indian catfish, prefers muddy water habitats and could be a potential source of AMPs. The transcriptome data of growth-selected *C. magur* available in the FGB Division, ICAR-CIFE, was mined for AMPs. The 279 fish AMP sequences (retrieved from the APD3 and NCBI) were searched for homology in the magur transcriptome using Local BLAST. Totally 266 hits were found in the *C. magur* contig set, from which nine contigs with the lowest E-value were chosen. All the ORFs in the selected contigs were examined individually using AMP prediction servers (APD3, IASRI Fish AMP Prediction server, ADAM, CAMP, iAMPpred, and Macrel). Seven ORFs were predicted to encode AMPs of 12 to 40 amino acids length. Three putative AMPs [AMP1 (25AA), AMP4 (28AA) & AMP7 (29AA)] were selected based on appropriate physicochemical properties, and 3D structures were predicted in the Pepfold server. After validation by Ramachandran plot, these were used for molecular docking studies with 3D structures of 23 antigens of 8 pathogenic bacterial species retrieved from the AntigenDB database (*Klebsiella pneumoniae, Pseudomonas aeruginosa*, *Streptococcus agalactiae*, *Staphylococcus aureus*, *Bacillus anthracis*, *Listeria monocytogenes*, *Salmonella typhimurium*, *Vibrio cholerae*). All the AMPs showed significant interactions exhibiting the least binding energy (-9 to -14 Kcal/mol) with the antigens of *Listeria monocytogenes*. AMP4 was commercially synthesized at 97.58% purity using Solid Phase Peptide Synthesis, but AMP1 synthesis failed due to internal hydrophobic patches. Wet-lab validation was conducted using broth microdilution assay following CLSI guidelines against *Listeria monocytogenes, Staphylococcus aureus*, *Bacillus subtilis, Aeromonas hydrophila, Edwardsiella tarda, Klebsiella pneumoniae,* and *Salmonella typhi*. Although antimicrobial activity of AMP4 was predicted, it was not observed in wet-lab studies against the pathogens tested at the peptide concentration range 1µM to 500 µM.

Keywords: Fish Antimicrobials, In Silico Amp Prediction, Amp Screening, Computational Tools

Paper ID 15724

Molecular identification and evolutionary relationship of fish fauna from Pulicat lake, Tamil Nadu

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The partial sequences of the mitochondrial gene, cytochrome c oxidase subunit I (COI) were generated and used to determine the phylogenetic relationship of fishes collected from Pulicat Lake, Tamil Nadu. The final length of 620bp DNA barcodes were generated for 29 species of fishes representing seven orders, 28 genera, and 21 families. In the present study, a data set of 1008 mt COI sequences were obtained from published resources and used to screen character-based molecular diagnostic keys for species *in silico* analysis. BLOG 2.0 tool was used to identify different positions of key diagnostic nucleotides for character-based identification. The development of species-specific sequences and key diagnostic nucleotides for fish species would be useful in the successful conservation and management of fishery resources of fishes of Pulicat Lake.

Keywords: Pulicat Lake, Mitochondrial COI Gene, In Silico, Blog 2.0, Conservation

Paper ID 15731

Estimation of repeatability of reproductive traits in Zebrafish (*Danio rerio*)

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Repeatability is a very useful tool for quantifying or measuring the level of magnitude to which an individual's performance remains consistent over a particular period of time. This study was attempted to estimate the repeatability of reproductive traits in Zebrafish (*Danio rerio*). In this experiment, 10 breeding pairs and 11 breeding trials were used. The reproductive traits such as fecundity, fertility, hatchability, and survival rate were calculated estimated. Fecundity ranged from 72 to 685 eggs. The fertility rate ranged from 0.76 to 98.7%. Hatchability ranged from 0.45 to 100% and survival rate ranged from 78.3 to 100%. The repeatability for fecundity, fertility, hatchability of fertilized eggs, hatchability of total eggs, the survival rate of total eggs, and the survival rate of larvae were 0.09±13.68, 0.31±2.09, 0.052±1.96, 0.32±2.01, 0.32±1.92 and 0.04±2.00 respectively. The repeatability was moderately significant for fertility, hatchability, and survival rate of total eggs. The phenotypic correlation between fertility and hatchability of fertilized eggs, the hatchability of total eggs and fertility, and the survival rate of larvae and fertility were highly significant.

Keywords: Zebrafish, Repeatability, Genetic Parameter, Reproduction

Paper ID 15750

Molecular characterization of mullet species using RAPD and RFLP Markers

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Mullet belongs to the family of Mugilidae. Identification of mullet species through the taxonomic key character is difficult because of the possibility of cryptic species and similarity in morphological characters. Hence, the present study was conducted to differentiate the selected mullet species with the help of RAPD and RFLP markers. In total, 95 mullet samples (*Mugil cephalus*, *Liza macrolepis* and *L. tade)* were collected from Tamil Nadu and Kerala. Five RAPD primers (OPA1, OPA10, OPA11, OPA15 and OPA16) were selected from the 30 universal primers to develop the species-specific pattern of RAPD marker. The Nei's unbiased Genetic Distance was calculated with the help of software "POPGEN version 1.32". The lowest distance was observed between *L. tade* and *L. macrolepis* and the highest distance (43.37%) observed between *M. cephalus* and *L. tade*. In case of the species-specific pattern of PCR-RFLP marker, the restriction enzyme was selected based on the in-silico analysis. For 16s rRNA gene, Alu I enzymes showed the species-specific pattern in *M. cephalus* at 190 bp, 200bp and 210bp.

Keywords: Mullet, Markers, RAPD, RFLP, Mugilidae

Paper ID 15760

A meta-analysis approach to identify the intestinal microbial biomarkers of *Litopenaeus vannamei*

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Recent progress in high-throughput sequencing has dramatically increased the availability of metagenomic data. We performed meta-analysis on these metagenomic datasets to identify putative biomarkers related to diseases of pacific white shrimp. We also integrated a genome-scale metabolic modelling approach on metagenomic-based data on healthy vs. diseased taxonomic biomarkers to address the species interactions. Six studies, encompassing 117 healthy and 142 diseased samples were subjected to meta-analysis. The retrieved amplicon data were processed separately and merged using the QIIME2 pipeline. PERMANOVA analysis revealed a significant difference in the microbial communities between the samples in the healthy and diseased groups (p-value <0.05). The most predominant phylum among healthy/diseased groups were Proteobacteria (65% in healthy vs. 72% in diseased) and Firmicutes (30% in healthy vs. 20% in diseased). The Linear discriminant analysis effect size (LEfSe) identified 32 healthy and 73 diseased genera as potential biomarkers with an effect size (LDA score) of greater than two and p-value <0.05. Our meta-analysis-based finding suggests that genera *Acinetobacter* ("biomarker of health") and *Alteromonas (*"biomarker of disease") varied substantially among healthy and diseased groups, respectively. Using a constraint-based approach, we have identified 15 genera naturally residing in healthy shrimp that limited the pathogen's growth and gained growth advantage in the minimal media with glucose as the carbon source. In conclusion, the meta-analysis results on healthy biomarkers can be used for probiotic formulations in *L. vannamei* farming.

Keywords: Meta-analysis, Metagenomics, Biomarker, Probiotic, Genome-scale Metabolic Modelling

Paper ID 15763

Metagenomics reveals dietary C-phycocyanin (CPC) alters the gut microbiota in pacific white leg shrimp, *Penaeus vannamei*

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Phycocyanin, a protein responsible for photosynthesis from Spirulina, has been shown to have a variety of biological activities against diseases. This experiment was performed to examine the impact of dietary C-Phycocyanin (CPC) extracted from *Arthrospira maxima* on the gut microbiome of Pacific whiteleg shrimp, *Penaeus vannamei*. Shrimp (3.99 ± 0.11 g/shrimp) were fed with experimental diets at varying levels of CPC supplementation at 0 (control CPC_0), 200(CPC_{200}), 400 (CPC_{400}), 800 (CPC_{800}) and 1600 (CPC_{1600}) mg of CPC per kg diet for 6 weeks. The gut microbiome of *P. vannamei* was studied using 16S rRNA high-throughput sequencing. To profile bacterial communities, the V3-V4 hyper-variable region (~250 base pairs) of the bacterial 16S rRNA gene was amplified using the primer pairs V4f and V4r. Of the 427 OTUs identified in the genus level, 84 (20%) OTUs were found to be common in all the treatments. The highest level of unique OTUs was found in the CPC_{200} group (50 OTUs) and the lowest level of unique OTUs was found in the CPC_{400} group (13 OTUs). The guts of the control group (CPC_0) were dominated by *Ruegeria* sp. followed by *Rhodobacteraceae_Others* and *Cellulomanadaceae_Others*. The guts of fishes fed with higher CPC concentrations (CPC_{400}, CPC_{800} and CPC_{1600}) were also dominant in *Ruegeria* sp. but followed by *Halocynthiibacter* sp. and *Rhodobacteraceae_Others* and those fed with lower CPC concentration (CPC_{200}) were dominated by *Halocynthiibacter* sp. followed by *Rhodobacteraceae_Others* and *Ruegeria* sp. Shannon's diversity index and evenness (Pielou's index) were found to be lower for control groups than that of the treatment groups and *vice-versa* for species richness. Shannon's diversity index showed high intestinal bacterial diversities in shrimps fed with CPC. The present study demonstrated that CPC supplementation in shrimp diets could modify the profile of dominant intestinal bacterial species and diversities in *P. vannamei*.

Keywords: *Penaeus vannamei*, Metagenomics, Gut Microbiome, Phycocyanin

Paper ID 15771

Horizontal gene transfer and pathogenicity of *Vibrio parahaemolyticus* revealed through pan-genome analysis

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Vibrio parahaemolyticus is a ubiquitous species inhabiting a broad host range, predominantly the marine, estuarine and coastal regions in account to their halophilic nature. The species has been reported to be associated with AHPND and other types of vibriosis causing severe economic loss to the aquaculture industry. It has also been reported to cause sea food related gastro enteritis in humans on consuming raw or undercooked food, in some cases severe wound infections and sepsis have also been reported. *V. parahaemolyticus* comprises both clinical and environmental isolates of pathogenic and non-pathogenic nature featuring a high level of genomic diversity amongst the strains. Therefore, it is important to understand the intra-species genetic diversity to elucidate information on unique, strain-specific, and group-specific features. Here in our study, we have obtained 628 genomes assemblies from the NCBI-GenBank database comprising assemblies having 100 or fewer scaffolds. The pan-genome analysis was carried out using Roary an open-source pangenome pipeline and the downstream analysis was carried out using blast and OmicsBox tools. Results revealed an open pangenome with 39989 genes, out of which 3713, 19698, and 16578 were core, accessory, and unique genes respectively. The downstream analysis revealed 117 virulence genes and 29 antibiotic resistance genes. Overall, the open pangenome analysis indicated a clear representation of horizontal gene transfer which explains its intra-species genomic diversity and its ability to dwell in a varied habitat and infect a broad host range.

Keywords: Pangenome Analysis, Vibrio Parahaemolyticus, Horizontal Gene Transfer, Pathogenicity

Paper ID 15773

Induction of callus in marine macroalgae through tissue culture

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Seaweed farming is considered as environmental friendly aquaculture with no or little input of fertilizers, chemicals or medicine. It can be carried out in coastal waters, near shore, bar mouth and in open sea. There is no requirement of fresh water resources which is considered as the most precious things in earth in near future. World seaweed production is primarily supported by aquaculture. In 1969 with 2.2 million tonnes of world seaweed production mostly from wild collection and cultivation. In 2019, the wild collection remained at 1.1 million tonnes whereas cultivation increased to 34.7 million tonnes, which accounted for 97 percent of world seaweed production in 2019. The production was demand driven and the used of seaweed also increased from 7,546,754 t in 1995 to 20,893,372 in 2012 and this has encouraged seaweed farming in many parts of World like Indonesia, China, and the Philippines and in India. With increase in production through aquaculture, the wild collection of seaweed is drastically reduced, which in terms helps in ecological and economical sustainability. According to FAO (2014), Indian seaweed industries rely heavily on wild harvests for phycocolloid production. The Gulf of Mannar and Palk Bay in Tamilnadu coast harbours luxuriant growth of Sargassum spp., *Turbinaria* spp. and *Gelidiella acerosa*., *Gracilaria edulis,* G. *salicornia* and *G. crassa*. But with the domestication of carrageenan yielding seaweed *Kappaphycus alvarezii* in India the coastal fishers could able to grow the seaweed in raft and longline method and generate an income of 12,000-15,000/month. But for agar yielding and align yielding seaweed still the wild harvest is taking place. With the mega plan of Govt of India there was a concerted and targeted effort to carry out seaweed cultivation all along Indian coast under PMMSY programme. This really open up the requirement and availability of seed material and thus tissue culture of seaweed has got the importance for production of quality seeds in short period of time which requires limited space, quantity and can be easily transported from one place to other. Keeping this in view ICAR-CMFRI has taken up a project and the results are presented in this paper.

Keywords: Tissue Culture, micro-Propagation, Seaweed, Callus

Paper ID 15774

Comparative transcriptome analysis of acute temperature stress on metabolism of farmed shrimp *Penaeus vannamei*

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Deviation from optimal water temperatures cause stress to farmed shrimp which impacts growth and health of the animals. In order to maintain the homeostasis, shrimp metabolic pathways are altered during stress. To understand the metabolic mechanisms in temperature stress, an indoor tank culture experiment was conducted with three groups of varying temperatures and three biological replicates. Acute Temperature stress was created to the animals by suddenly shifting them from control condition (27ºC water temperatures) to the tanks with low temperature (22ºC) and high temperatures (32ºC) conditions. Hepatopancreas from ice-killed animals were aseptically dissected after 3 hours of imposed stress. RNAseq reads generated from the study were quality checked and mapped to reference genome *Penaeus vannamei* using STAR tool. Differentially expressed genes (DEGs) were extracted using DESeq2 software with log2 fold change values ≥2 and adjusted p values set at <0.05. Under low temperature stress 284 transcripts and in high temperature stress 52 transcripts were found to be differentially expressed. Significant GO terms under low salinity include cellular process, organic substance metabolic process, binding, protein binding, intracellular anatomical structure, membrane-bounded organelle representing biological process, molecular functions and cellular components. Where are in case of high temperature, L-methionine salvage from methylethioadenosine, amino acid salvage, Acireductone dioxygenase [iron (II)-requiring] activity, oxidoreductase activity, acting on single donors with incorporation of molecular oxygen, terminal bouton, axon terminus is found to be significant GO terms. Some of the enriched KEGG pathways for low temperature stress include Peroxisome, Cellular senescence, Fatty acid degradation, Autophagy- animal, RNA transport, Caprolactam degradation, Pyrimidine metabolism, Apoptosis - multiple species. While for high temperature stress Autophagy - yeast and Cysteine and methionine metabolism were found to be significantly enriched pathways. Information generated from this study will be useful for planning the possible stress amelioration measures.

Keywords: *Penaeus vannamei*, Temperature Stress, Transcriptome, Differential Genes

Paper ID 15776

Genetic variation of five loaches of western ghats using PCR- RFLP with single restriction enzyme

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DNA- based technique can be applied to identify fish species in any form including egg, embryonic stages or from any part of the fish or any form of fresh and processed fish food and from anywhere. Fish food substitution has become an important threat in both domestic as well as international markets due to increasing international trade, poaching, per capita consumption etc. The fishes were collected from various locations of Western Ghats (Tamil Nadu and Karnataka State). In the present study, a simple method involved a single restriction enzyme-based Polymerase Chain Reaction, i.e., Polymerase Chain Reaction -Restriction Fragment Length Polymorphism (PCR-RFLP) method was developed as a tool for the determination of five important loaches of Western Ghats to avoid substitution of cheaper fish for more expensive loach species when the usual identifying characteristics are removed. The Western Ghats loaches includes *Lepidocephalus thermalis* (Cobitidae)*, Nemachelilus triangularis, N.guentheri, N. semiarmatus* and *Bhavania australis* (Balitoridae). The PCR products of COI gene were digested with a single restriction enzyme (Eco RII) to identify five fish species of loaches. DNA was extracted from fish tissue and DNA amplification was carried out by using the primer of the Cytochrome C oxidase subunit 1 (COI) gene for Polymerase Chain Reaction (PCR). The PCR products were digested with 1µl (10U/ml), 18 µl of nuclease free water and 2 µl of 10X buffer. The restriction enzyme digestion was carried out by incubating at 37ºC for 16h. Finally, the digested samples were separated and confirmed with 10% Polyacrylamide gel electrophoresis by using DNA markers. The Gel was documented and PCR-RFLP was analyzed for single restriction endonuclease, Eco RII and it was able to distinguish between the five fish species of loaches, all five species could be differentiated. Thus, this method can be used to determine the five fish species and also to conserve the species.

Keywords: PCR-RFLP, COI Gene, Loach, Western Ghats, Molecular Markers, Genetic variation

Paper ID 15790

Identification and characterization of Micro-RNA in *Clarias magur* (Hamilton, 1822)

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MicroRNAs regulate about 30% protein-coding genes post-transcriptionally. Totally 66 putative miRNA-target pairs were mined from transcriptomes of the Indian catfish *Clarius magur* generated from brain and gonad tissues collected at four reproductive stages (premature, mature, 6h- and 16h-post-GnRH injection) to identify reproduction related genes regulated by miRNA. The 39738 contigs assembled de novo from 9.5 Gb RNASeq data were used for homology search against mature miRNAs of 17 fish species available in miRBase (22.0, March 2018). Instead of directly using the mature miRNA predicted on one of the two hairpin arms, 5p or 3p, the sequence containing the precursor miRNA hairpin was analysed by miRDuplex SVM tool to obtain the miRNA:miRNA* duplex. The dG value of the 4 nucleotides at the 5' ends of both miRNA strands was calculated using the 'Nearest Neighbor' method, and the one with higher dG value was selected as the likely guide strand. Totally 226 target genes with high seed region complementarity were identified by BLASTx and RNA hybrid tool. Putative target transcripts with >4 fold-change between any two reproductive stages were examined, and 28 showed a reciprocal relation with corresponding miRNAs. qPCR validation was done for 5 miRNAs, 2 reproductive (cma-mir-202-3p, cma-mir-10622-5p), 1 regulatory (cma-mir-30-e3p), 2 immune-related (cma-mir-202-5p and cma-138-2-5p) and their respective targets, cyp11b1 (steroid 11-beta hydroxylase), cyp19 (cytochrome P450 aromatase), dhcr7 (7- dehydrocholesterol reductase), rfx7 (DNA-binding protein RFX7), abcc1 (multidrug resistance protein 1-like isoform X1), prkc (Apoptosis WT1 regulator protein). RNASeq fold changes in target genes cyp11b1 (testis), abcc1 and dhcr7 (female brain), and rfx7 (male brain) between mature and 16hpi stages were confirmed by qPCR. One miRNA - target pair, cyp11b1: miR202-3p could be confirmed. Cyp11b1 plays a significant role in spermatogenesis and glucocorticoid synthesis. Future work could lead to molecular interventions for spontaneous milt release from magur males during induced breeding.

Keywords: Post Transcriptional Gene Silencing, PTGS; Small Non-Coding RNA; Stem Loop; Double Stranded RNA, dsRNA; Bioinformatics.

Paper ID 15792

Simplified cryopreservation of sperm in grey mullet *Mugil cephalus* (Linnaeus, 1758): a robust method for wide adoption

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To date, male gametes of more than 200 fish species have been cryopreserved. Most of the studies aimed at protocol development, commercial and cryobanking development have begun for fishes in recent times. However, development of a widely adaptable method of gametes cryopreservation remains a major challenge. For this reason, the usage of cryopreserved sperm is very limited in aquaculture in contrast to livestock. Therefore, in this study we aimed to develop a simple and robust method of cryopreservation of sperm in *Mugil cephalus*. A series of experiments were conducted by changing the extender, cryoprotectant and freezing height above the liquid nitrogen (LN2) surface. Fresh sperm were diluted 1:1 in a cryomedium (cryomedium = extender + cryoprotectant) containing cryoprotective agents (CPAs) namely, propylene glycol (PG), methanol (MeOH), glycerol (GLY), ethylene glycol (EG), dimethylsulfoxide (DMSO) and dimethylacetamide (DMA). The final concentration of CPAs in cryomedium was 5% and 10% (v/v). The cryovials (2.0 mL) were loaded with diluted samples, fixed in cryocans, and frozen at 4, 6, 8, 10 and 12 cm above the LN2 surface and also by vitrification. After 7 days of storage in LN_2 (-196 °C), the sperm was thawed at 30 °C for 90-120 s and their quality was evaluated. Among the experimented factors, sperm diluted in cryomedium composed of 0.3 M glucose combined with 10% EG and frozen at 4 cm above the LN2 surface recorded significantly ($P < 0.05$) highest post-thaw motility (73 ± 2%) and (71 ± 1%) viability respectively. Thus, the results of the study revealed that using this simplified method of cryopreservation high-quality post-thaw sperm can be obtained. Besides, it is expected that this method can be successfully adoptable at hatchery, farm and on-site cryopreservation of sperm in *M. cephalus*.

Keywords: Mullet, Sperm, Motility, Osmolality, Vapor, Amorphous.

Paper ID 15795

Structure and variation of Carangidae mitochondrial control region

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The vertebrate mitochondrial genome, which plays a crucial role in cell metabolism and organism function, is ~15-20 kb in size and consists of 13 protein-coding genes (PCGs), 22 tRNA genes, 2 rRNA genes and a non-coding region (control region). The PCGs, tRNA and rRNA have a relatively low mutation rate because they are subject to strong purifying selection. In contrast, the control region evolves at a high rate compared to the other parts of the mitogenome, and these high rates of sequence divergence are mostly localized in the variable flanking region, which is adjacent to the conserved sequence motifs. Comparative mitogenomics of 37 carangids revealed high variability in the mitochondrial control region due to length variations and the accumulation of base substitutions, insertions and deletions. We have detected the 3 central conserved sequence blocks (CSB- F, -E, -D) and 3 conserved sequence blocks (CSB- 1, -2, -3) in all taxa. Conserved sequence blocks (CSB-1, -2, and -3) exhibit a higher level of divergence in carangids with interspecies substitutions, insertions, and deletions. The CSB- D was highly conserved among carangids and exhibited high sequence similarity between species and CSB-F and –E showed sequence variation. Some species lacked a 'GTGGG'- box which is a typical feature of CSB- E in teleosts. These variations imply rapid evolution of the primary structure in the Carangidae control region, which can provide information for understanding their structural and functional relationship. Furthermore, these conserved sequence motifs formed similar secondary structures in Carangidae although their primary sequences are not conserved. Therefore, the data reinforce that although there is sequence divergence in the conserved sequence motif, their structural elements and locations appeared to be conserved in Carangidae and some selective constraints on these regions acted to maintain their structure and function.

Keywords: Carangidae, Control Region, Central Conserved Sequence Blocks, Conserved Sequence Blocks

Paper ID 15800

Phylogeny and divergence time estimation of *Nemipterus randalli* based on complete mitochondrial genome

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This work investigated the phylogeny of family Nemipteridae in relation to closely related families using complete mitochondrial genome and compared this to previous phylogenetic hypotheses. In addition to the previously determined complete mitochondrial sequences from 6 families (Centracanthidae + Sparidae, Caesionidae, Haemulidae, Lethrinidae, Lutjanidae, Nemipteridae) and one outgroup (*Neotrygon kuhlii*), we used newly determined complete mitochondrial sequence of *Nemipterus randalli* belonging to family Nemipteridae. The data set comprised of concatenated nucleotide sequence of 13 protein coding genes and these data were subjected to Bayesian and Maximum likelihood analyses. The resultant trees showed congruent topologies and were well resolved with internal branches supported with high statistical values. The phylogenetic tree showed that Nemipteridae clustered together into one clade at the basal portion and other associated families (Centracanthidae, Lethrinidae and Sparidae) formed a separate clade with remaining closely related families (Caesionidae, Haemulidae, and Lutjanidae). Thus, this study rejects the monophyly of superfamily Sparoidea (comprising of Centracanthidae, Lethrinidae, Nemipteridae and Sparidae). Mitogenomic data supported the monophyly of family Nempteridae and its sister-group relation with other families. Since phylogenetic analyses showed a different result with previous hypothesis based on osteological study. The present study rejected the monophyly of superfamily Sparoidea. In addition, divergence time was also estimated with concatenated nucleotide sequence of 13 protein-coding genes using RelTime method by MEGA X. We found out that Nemipteridae diverged at 121.43 mya during the lower Cretaceous period of the Mesozoic era.

Keywords: *Nemipterus randalli*, Nemipteridae, Phylogeny

Paper ID 15808

Comparative *De Novo* transcriptome analysis of Indian oyster *Magallana bilineata* in response to temperature and pH stress.

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Oysters are bivalve molluscs which are widely distributed across the world oceans. As successful colonizers of intertidal zones and estuaries, oysters are resilient against harsh environmental conditions such as fluctuations in temperature, salinity, pH etc. Their success and adaptation to diverse environments suggests that oysters are remarkably adaptive and may possess advanced molecular machineries and mechanisms to thrive against biotic and abiotic stresses. In this study, we performed *de novo* transcriptome sequencing, assembly and annotation in response to temperature and pH stress of Indian oyster *Magallana bilineata* using Illumina sequencing technology to prepare a sustainable resource for the identification of candidate genes involved in stress response. cDNA libraries constructed from mRNAs of control, temperature and pH stressed mantle tissues were sequenced using Illumina HiSeqX platform. After quality check and preprocessing, a total of 30,635,118; 31,339,668 and 21,522,472 high quality pair end reads were obtained from Control, Heat stress and low pH stressed tissues respectively for *denovo* transcriptome assembly. The cleaned reads were assembled and generated nonredundant unigenes which were further annotated by comparing their sequencing to Uniprot database using BLASTX program and the organism's name were also extracted. Furthermore, for the functional classification of transcripts, GO annotation were done and GO terms within molecular processes, cellular processes and biological processes were obtained. In the present work, we generated a *de novo*-assembled transcriptome profile of *M. bilineata* in response to temperature and low pH stress for the first time by using Illumina sequencing technology. This will ultimately lead to a better understanding of the molecular mechanisms by which these animals may tide over unfavorable situations brought about by climatic changes and other anthropogenic factors.

Keywords: Oysters, transcriptomics, Stress Response

Paper ID 15811

Transcriptome analysis of the male and female gonads in Indian oyster *Magallana bilineata* (Roding, 1798)

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Sexual reproduction and the differentiation of two sexes have long fascinated human interest, but we have only limited understanding of how sex is determined and evolved in many taxa. Bivalves exhibit highly diverse sexual systems, ranging from dioecy to simultaneous and sequential hermaphroditism which makes them an ideal group for studying sexual systems. Oysters are members of the family Ostreacea, class Bivalvia, and they could be considered among the best known and most widely cultivated marine animals worldwide. *Magallana bilineata* (formerly known as *Crassostrea madrasensis* (Preston)) is the common backwater oyster found all along the east coast of India, but along the west coast, it is confined mostly to the southern region. Little is known about genetic and phenotypic basis of sex differentiation in oysters. Also, the molecular processes underlying sex determination genes and pathways in bivalves and other molluscs are few and limited. Therefore, the objective of this study is to identify genes associated with ovarian and testicular development. In this study, we sequenced total RNA samples from male and female Indian oyster gonads identified through histological observation, using Illumine Hiseq platform. A transcriptome resulting in 20,740,531 and 22,986,163 contigs from male and female gonads respectively was obtained. The cleaned reads were assembled using Trinity and generated 245,319 transcripts. The assembled transcripts were compared with uniprot database using BLASTX program with E-value cutoff of 10-3 and organism annotation was also done. The gene ontology (GO) terms (Molecular Function (MF), Cellular Component (CC), and Biological Process (BP)) for transcripts were also mapped. These findings provide valuable transcriptomic bio information for further investigation of reproductive biology and applications in sex manipulation. This study will also contribute for the future conservation of the species as well as the exploitation in aquaculture settings.

Keywords: Transcriptomics, oysters, Reproduction, Sex Differentiation Genes

Paper ID 15819

Population genetic structure of grey mullet (*Mugil cephalus*) in Indian waters using mitochondrial Atpase 6/8 Genes

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Genetic diversity studies are of paramount importance for the conservation and breeding programmes of a population. *Mugil cephalus* (flathead grey mullet) is a commercially important brackishwater finfish distributed in tropical and subtropical coastal waters. The genetic structure of grey mullet stock along the Indian coast was examined using the analysis of 842 bp of the ATPase 6/8 genes of mitochondrial DNA. Around 48 samples were collected from the four coastal estuaries of India, namely Chilka (Odisha), Nagayalanka (Andhra Pradesh), Pulicat (Tamil Nadu) and Vypeen (Kerala), were sequenced, aligned and edited at both ends to generate consensus sequences. The analysis of the sequences revealed 14 polymorphic sites, and the total haplotypes were found to be ten with a diversity of 0.343. More diversified haplotypes were found in Chilka stock (six with a diversity of 0.78). Among the stocks, the least haplotype diversity was found in Nagayalanka stock as it was observed to be monomorphic. Pair-wise genetic differentiation study indicated non-significant differences among all the pairs of stocks. Molecular variance analyses (AMOVA) revealed that the variation among individuals (89.5%) in the grey mullet populations contributed more to the total genetic variation than the variation between populations (10.5%). The phylogenetic tree constructed by maximum likelihood clustered all the stocks into a single clade. Median-joining haplotype network also demonstrated a single clade for all the haplotypes. Low haplotype diversity (0.34) and low nucleotide diversity (0.08%) indicated that the grey mullet population had undergone periods of low effective population size within recent thousands or tens of thousands of years. Negative values of neutrality tests like Tajima's D and Fu's FS, unimodal mismatch distribution plot and star-like haplotype network also suggest the same on the grey mullet population demography. The study suggests the grey mullet populations of India from Puri in the East coast to Vypeen in the West coast to be a single panmictic population.

Keywords: *Mugil cephalus*, Mitochondrial DNA, ATP*ase* 6/8, Genetic Diversity

Paper ID 15827

Molecular cloning and sequence analysis of partial Immunoglobulin D heavy chain gene of Asian seabass

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Characterisation of fish immunoglobulins (Ig) can help to elucidate the mechanism, evolution, and diversity of the fish immune system. IgM being omnipresent in all jawed vertebrates, IgD was the first non-IgM isotype discovered in teleosts. Asian seabass (*Lates calcarifer*) is an economically important brackish water fish which is widely distributed in the tropical sub-tropical areas of Asia. To date, cloning and characterization of the IgD gene was carried out in few fish species only. Here we performed molecular characterization of the partial length cDNA of the IgD heavy chain gene of Asian seabass (LCIgD). Around 20 g of Asian seabass fish was infected with Red-spotted grouper nervous necrosis virus intramuscularly. Kidney tissues were collected on day3 post infection and cDNA was synthesized. The predicted complete coding sequence of LCIgD was approximately 3kb. We designed two overlapping primers to amplify 5'end of LCIgD and they are IGD_049 - F: 5′ TGTTYYCTGTAGCTCTGCTGC 3'; IGD_862 - R: 5' CCACTTAGGGTGCAGATGAGT 3' and IGD_820 - F: 5' CACCCTAAGTGGCTTCTTTCC3'; IGD_1715 - R: 5' GTGGTCCTGACTCTTCACTGG3'. The obtained amplicons were cloned using pGEMTeasy vector and sequenced. The overlapping sequences of both the fragments were aligned and a single sequence of 1660bp size was obtained. The partial LCIgD predicted to yield 553 amino acids. Signal peptide was predicted to contain amino acids 1-18. The deduced peptide of IgD predicted to have four domains. They are Viz., heavy chain variable domain (34-112 amino acids), first Constant domain of heavy chain (150-222 amino acids), second constant domain of heavy chain (252-328) and third constant domain (454-525 amino acids). Prosite predicted conserved characteristic cysteine residues which causes five disulfide bridges. NetNGlyc-1.0 predicted five potential N-glycosylation sites. ML tree constructed from deduced peptide sequences revealed LCIgD clustered along with *Paralicthys olivaceus* whereas *Lutjanus sanguineus, Dicentrarchus labrax* and *Siniperca chuatsi* formed another cluster.

Keywords: Immunoglobulin D, Molecular Cloning, Asian Seabass

Paper ID 15830

De Novo reference transcriptome for Indian squid, *Uroteuthis duvaucelii*

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The class Cephalopoda (Octopus, Squid and Cuttlefish) encompasses various model organisms in the field of neuroscience and behavior. Though currently available genomic resources for them particularly squids are scarce or lack completely. So, the main aim of the present study is to generate a de novo reference transcriptome for the Indian squid, *Uroteuthis duvaucelii* (Cephalopoda; Loliginidae) that can be used as a draft representative of large-scale catalogue of genes. RNA was extracted using standard trizol method from the tissues such as gill, gonad, heart, eye and brain of live *U. duvaucelii*. The messenger RNA samples were prepared from pooled tissues and sequencing was performed using Illumina NovaSeq6000. Reads obtained from using Illumina sequencer were de novo assembled using Trinity and generated 188,143 transcripts with longest transcript length (bp) 24510 and the mean GC% 36.32. The assembled transcripts were compared with UniProt database using BLASTX program with E-value cutoff of 10^{-3}. These transcripts were further subjected to organism annotation and functional assignment of gene ontology (GO) terms. Organism annotation revealed that maximum number of transcripts top matches with sequences from the California two-spot octopus "Octopus bimaculoids". According to GO categories, the number of genes assigned to "DNA integration" was the highest under the biological process classification, while "Integral component of membrane" and "ATP binding" were dominant for the cellular component and molecular function categories respectively. We also noticed a high-percentage of genes from categories of "homophilic cell adhesion via plasma membrane adhesion molecules" and "transcription and its regulation (DNA templated)" and almost equal genes from terms of "translation", 'signal transduction", "intracellular signal transduction", "transmembrane transport", "metabolic process" and "intracellular protein transport". Our study has developed an annotated, comprehensive transcriptome reference for *U. duvaucelii* that can aid in determining genetic variation, expression analysis, genome annotation, and gene mapping.

Keywords : Reference Transcriptome, Indian Squid, Loliginidae

Paper ID 15836

Comparative genomic analysis of ostariophysans and non-ostariophysans: Insight into evolution of weberian apparatus

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Ostariophysi, the hearing specialists of the ray-finned world, represents the most species-rich clade in freshwater. This successful diversification in freshwater habitats might have occurred due to the evolvement of Weberian apparatus i.e., modification of anterior vertebral column in ostariophysans. It physically connects dorsal wall of the swim bladder to the membranous labyrinth of inner ear and greatly enhances hearing sensitivity by transferring sound waves between them. In this study, genomic differences between ostariophysi and non-ostariophysi were investigated by comparing genomes of eight ostariphysan and nine non-ostariophysan fishes to obtain insights into the role of any candidate gene responsible for Weberian apparatus development. Protein sequences of both ostariophysi and non-ostariophysi were downloaded from NCBI genome database and compared using Orthovenn2. Comparative genomic analysis identified nine ostariophysi specific genes, which were absent in non-ostariophysi. These nine genes, caskin-2, hif1a, Tgtp1, rxrbb, CD6, Kcna1, TRIM 25, ELFN1, ERMAP are mainly associated with cell-cell adhesion, endothelial cell quiescence regulation, Potassium ion transport, embryonic vascularization and regulation of T-cell response. This study will help furthering our understandings about the evolutionary forces responsible for Weberian apparatus development in ostariophysi.

Keywords: Ostariophysi, Weberian Apparatus, Comparative Genomics

Paper ID 15838

Combination of GnRHa and 17α- Methyl Testosterone induces maturation and extend spawning duration: novel approach for hatchery seed production of Milkfish (*Chanos chanos*)

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Milkfish *Chanos chanos* is one of the most preferred brackishwater food fishes in South-East Asian countries and India. Numbers of experiment were conducted between 2016-2021 to evaluate the optimum hormone dose requirement, delivery method and frequency of implantation of 17α – methyl testosterone (17 α -MT) in combination with GnRHa (Gonadotropin Releasing Hormone analogue) for captive breeding of milkfish. Cholesterol combined with GnRHa and 17 α–MT in equal amount (50µg/kg body weight) as sustained release pellet was found superior to individual treatment in breeding responses (experiment 1, 2015). In experiment -2 (2016-2019) effects of chronic (10 implantations/year) and assisted (4 implantations/year) implantations of combined hormone pellet were evaluated during entire breeding season. Both assisted and chronic implantation resulted in extended spawning frequency for seven months (March–September). Assisted hormone implantation helped to achieve unimodal distribution of mature oocytes (650–750 µm) with increased percentage, inducing final oocyte maturation (FOM) stage along with higher spawning frequency. Assisted type of implantation pattern significantly improved maturation, milting male %, average fecundity, egg diameter, fertilization rate, hatching rate and larval length compared to that of chronic implantation with added benefit of reduced handling stress. Eggs were pelagic and incubated for 24-26 h to hatch out. Total length of the newly hatched larvae is 3.2-3.4 mm. Milkfish larvae were reared in green water system, fed with rotifer and *artemia* nauplii till they reached to weaned fry (2-2.5 cm) stage in 3 - 4 weeks. Low-input nursery in earthen pond can produce stocking size fingerlings (20g ABW, 11 cm TL) in 45 DOC and during monoculture 4.78t/ha productivity could be achieved with stocking density of 1.5 number/$m^{2.}$ Availability of hatchery produced quality milkfish seed during off seasons in CIBA fish hatchery has fulfilled the demand of many farmers and entrepreneurs.

Keywords: Milkfish, Captive Maturation, GnRHa, Induced Breeding, Seed Production, Aquaculture

Paper ID 15861

Impact of human chorionic gonadotropin (HCG) in the maturation and spawning of Mrigal (*Cirrhinus mrigala*)

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Mrigal, *Cirrhinus mrigala* is one among the three Indian Major carp species cultivated widely in Southeast Asian countries as food fish belongs to the family Cyprinidae. Human Chorionic Gonadotropin is an LH – like hormone that mimics LH due to its relatively long retention time in circulation, stimulus the spermiation process by acting on gonadal maturation. The study was undertaken to induce maturation of Mrigal using Human Chorionic Gonadotropin (HCG) implants in captive conditions. An increase in estradiol and testosterone level was observed in all the hCG implanted female and male fishes. Testosterone levels in hCG implanted male fish ranged between 0.6892 and 4.22 ng/ml. Estradiol-17 β level in hCG implanted female fish attained its highest value (4371.19 pg/ml). The fecundity value of 3,17,293 was observed from the hCG implanted female fishes at the end of the study. The maximum GSI value of above 19 was observed from the hCG implanted female fishes, when compare to control fish. A highly significant differences ($p<0.01$) were observed between control and HCG implanted fish.

Keywords : HCG implants, Testosterone, Estradiol, GSI.

Paper ID 15900

Effect of cryopreservation on the spermatological parameters of different strains of *Labeo rohita* (Hamilton, 1822)

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The aim of the study was to document the variations in sperm quality of different strains of *Labeo rohita*. The milt collected from the three different strains of *L. rohita* at Manimuthar, Thanjavur and Mettur was observed for the spermatological parameters like pH, volume, sperm density and spermatozoa motility and seminal plasma composition (Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-). It was then diluted 40 fold using Modified Cortland Medium (MCM) as extender and Dimethyl Sulphoxide (DMSO) as cryoprotectant at 10% concentration (v/v). Rapid freezing of milt was done for 10 min under liquid nitrogen vapour after 10 min of equilibration. The cryopreserved spermatozoa were analysed for the same parameters of the pre-frozen milt once in 15 days (0^{th}, 15^{th} and 30^{th} day) for 30 days. Among the three strains, the spermatozoa of Thanjavur strain exhibited the highest motility duration of 82.33±6.03 s ($p<0.05$). The sperm density of Thanjavur strain was 2.526±0.25 $\times 10^9$ cells ml^{-1} followed by the Mettur (2.079±0.33 $\times 10^9$ cells ml^{-1}) and Manimuthar (1.969±0.18 $\times 10^9$ cells ml^{-1}) strains. With regard to seminal plasma composition, the Na^+ and K^+ concentration of the Thanjavur strain (113.64±4.97 and 149.91±1.67 mmol/L respectively) was higher than the other strains ($p<0.01$). Similarly, Mettur strain exhibited the highest Ca^{2+} concentration of 1.24±0.06 mmol/L ($p<0.01$). Under cryopreservation, statistically significant variations were found in the post thaw motility among three strains ($p<0.05$). Spontaneous sperm activation for 188.5±16.26 s upon thawing was observed on the 30^{th} day in Mettur strain along with drastic reduction of Na^+ (5.83±0.75 mmol/L) and Mg^{2+} (0.35 mmol/L) which was statistically significant ($p<0.05$) than that of Thanjavur strain. The efflux of K^+ from spermatozoa in Thanjavur strain showed steady variation in contrast to the other strains.

Keywords : Rohu, Seminal Plasma, Ionic Composition, Cryopreservation, Cryoinjuries

Paper ID 15912

Evaluation of Mithi river water for genotoxic potential in zebrafish (*Danio rerio*) Embryos

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The Mithi river is a major stormwater drain for Mumbai, with mangroves on both sides acting as a natural flood barrier. The Mithi river is polluted due to industrial and domestic discharges, endangering its ecology and aesthetic aspects. Toxic pollutants in water go up the food chain, posing a major health risk to humans. Continuous monitoring of the water quality of river Mithi is required to control its pollution level. The current study was carried out to determine the genotoxicity of Mithi river water in zebrafish *(Danio rerio)* embryos. Water samples were taken from ten locations. To assess the lethal dilution 50 of samples, a zebrafish embryo toxicity test (ZFET) was performed for 120 hr with eight different dilutions (0, 2, 4, 8, 16, 32, 64, and 128 times) for each sampling location. A total of 30 embryos were exposed to each dilution, and the mortality data were analyzed using the Proc Probit procedure of SAS. The lowest and highest LD50 values of 0.233 & 4.122 were obtained for the S1 (Vihar lake) and S5 (Airport site) respectively. The comet assay was used to assess DNA damage in zebrafish after 120 hr of exposure to selected water samples of S1, S5, S7 (Taximens Colony), and S10 (Mahim Causeway). No significant difference in DNA damage was observed for zebrafish embryo cells exposed to S1 and control cells with OTM (Olive Tail Moment) values of 1.03±0.14 & 0.87±0.04 respectively. Whereas a significant DNA damage was observed in cells exposed to S5 with OTM values of 6.82±0.09. This study indicated that Mithi river samples (except Vihar lake) were polluted and induced genotoxic effects in zebrafish embryos. This information can be used in planning various environmental strategies for removing pollutants from the Mithi River.

Keywords : Zebrafish, Mithi River, ZFET, Lethal Dilution 50, Comet Assay

Paper ID 15915

Biomineralization of Cryopreserved mantle epithelial cells of black lip pearl oyster, *Pinctada margaritifera*

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Nacre is a model of biomineralization process in mollusks comprising of aragonite platelets and organic material. Mantle epithelial cells control nacre formation. Epithelial cells from the mantle tissue of *P. margaritifera* were cultured in-vitro using seawater as the culture medium. Periodic sub-culturing of mantle cells was carried out to establish primary cultures comprising of granulated epithelial cells. The cryoprotective effects of glycerol, dimethyl sulfoxide and a mixture of the two on long term preservation was studied. The mature granulated epithelial cells were mixed with 10% concentrations of the cryoprotective agent, initially stored overnight at -85°c and then subsequently transferred to -196°C. Viability and metabolic activity were equally better in both glycerol, dimethyl sulfoxide treated cells and comparable to that of unfrozen cells. The optimum post thaw cell viability after cryoprotection was 98% and 95 % with glycerol and dimethyl sulfoxide in comparison to unfrozen cells (87%). The combination of the cryoprotectants and the control (frozen without cryoprotectants) were found to be significantly lower in terms of post thaw viability of cells. The cells were further used to induce nacre on nuclear beads in a semi-solid substrate. Brick and mortar pattern characteristic of nacreous layer, comprising of aragonite platelets and matrix proteins were noticed after 60 days of incubation. Cross section of the coated bead revealed a pattern of aragonite tablets arrangement similar to that seen in nacre layer of molluscan shell. Energy dispersive X-ray analysis revealed higher levels of calcium and found to be 89.30% and 63.72% on nuclear bead and its cross section. The major elements were found to be calcium, carbon and oxygen in all the stages. The study shows that mantle epithelial cells cultured in-vitro are amenable for cryopreservation and retain the original functional potential to secrete nacre representing the survival and recovery of activities even after freeze-thawing.

Keywords : Biomineralization, Cryopreservation, Epithelial cells, Nacre, Mantle, *Pinctada margaritifera*

Paper ID 15919

Monoclonal antibody raised against oxolinic acid to detect its residue in edible fish tissue by Immunodot

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Antibody based immunoassays are gaining attention in bio-analytical fields owing to their ability to detect analytes in simple and rapid way. Antibiotics residue in food products is problematic to human health and environment. In recent years, there has been a rapid increase in developing antibiotic residue monitoring tools. Traditional analytical methods are time-consuming, labour-intensive, and often laboratory-bound. Efforts to achieve rapid, simple and sensitive screening of antibiotic residues in the field have become utmost priority to ensure food safety. In this context, a simple, low cost monoclonal antibody based (mAb) IMMUNODOT method for oxolinic acid (OXO) residues detection in edible fish tissues was developed. Artificial immunogens were prepared by conjugating OXO with BSA and OVA. SDS-PAGE and UV-vis spectra identification confirmed that artificial antigen was conjugated successfully and protein concentration was determined by nanodrop-A280. Immunogen was injected (IP) to four BALB/c mice. Antibody titres were checked by IC-ELISA. Three most stable mAb producing clones named 2A2, 6C7 and 4D6 reacting against OXO. Isotyping revealed monoclones belongs to IgG, IgM class, negligible cross reactivity to other quinolones. Highly reactive clone 4D6 (IgG) was employed in immunodot development. Fish samples were validated with this method. Hence the simplicity and low cost of this test would be preferable in comparison of the seldom affordable equipped techniques. Also it would provide a platform to make farmer friendly rapid test kits.

Keywords : Monoclonal antibody, antibiotic, immunodot, rapid detection.

Paper ID 15920

Kisspeptin conjugated chitosan based nanohormonal System: Fabrication, characterization and preliminary assessment as a stable delivery system

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In the light of promising potency of chitosan nanoparticles in drug delivery applications, this study communicates the importance of kisspeptin conjugated nanohormonal system in enhancing the reproductive efficiency in fishes exhibiting slow growth and late maturation. In this regard, kisspeptin-chitosan conjugates with significant particle sizes [139.8 nm (Ch-KISS1) & 178 nm (Ch-KISS2)], stable zeta potentials (+40 mV & +24mV) and polydispersity index of 0.316 were synthesized based on dynamic light scattering (DLS) analysis. The presence of possible functional groups involved in the fabrication of chitosan nanoparticles was elucidated using FTIR spectroscopy. The entrapment efficiency is regarded as one of the most important physicochemical characteristics and illustrates the percentage of drug entrapped in the nanoparticles. The entrapment efficiency ranging between 70% to 84% was calculated using ultracentrifugation for two kisspeptides, KISS-1 & KISS-2 corresponding to different dosages namely 50µg/kg and 100µg/kg body weight. Chitosan nanoparticles enhanced the stability of the kisspeptides owing to hydrophilicity and cationic charge of chitosan. The preliminary results presented herein indicate that the proposed new generation of kisspeptin encapsulated with biocompatible chitosan nanoparticle represent a potential platform for targeted drug delivery. It may find suitable field applications in increasing the global production of late maturing fishes by inducing early maturation through upregulation of HPG axis.

Keywords : Nanoformulation, Kisspeptin, Chitosan, HPG-axis, Drug Delivery

Paper ID 15927

Captive seed production of John's Snapper, *Lutjanus johnii* (bloch, 1792) – a promising candidate species for mariculture

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The present study describes about broodstock development, induced breeding and larval rearing of John's snapper, *Lutjanus johnii*. Adult fish (3-5 kg and 601-748 mm) were collected from wild and after prophylactic treatment stocked @ 1 kg/m^3 in re-circulatory aquaculture system of 125 t capacity for broodstock development. The fishes were fed *ad libitum* twice a day with squid fortified with vitamin E, mineral mix and squid oil. The gonadal status as well as reproductive hormone profile of fish was assessed monthly. The matured female with > 400 µm ova and oozing male were selected and injected with different doses of hCG (500, 1000 and 1500 IU/Kg) and GnRH (50, 100, 200 and 400 µg) and paired with different sex ratio (1:1; 1:2; 1:3; 1:4 and 1:5) to evaluate the dose of the particular hormone and sex ratio for successful induced spawning with maximum fertilization rate. The fish spawned after 36-42 hrs of injection with GnRH and hCG @ 50 µg and 500 IU/kg body weight to female and its half dose to male, with a fertilization rate of 79±6.01% and 83.25 ±4.21% respectively with a sex-ratio of 1:2. Hatching occurred within 12-14 h at 28-30^{o}C, with a hatching rate of 85 ±2.07% and 87.50±1.51% respectively. Larval rearing was carried out in 2 tons capacity FRP tanks using green water system. The mouth opening was formed after 45-46 hrs with 90-95 µm mouth gape at 28-29 ^{0}C. Larval rearing was carried out with copepod nauplii (2nd DPH), screened rotifers < 100 µm (5th DPH), *Artemia* nauplii (11th DPH), inert diet (16th DPH). Metamorphosis of the larvae started from 23rd day onwards and was completed by 28th DPH. Juveniles (2-2.5 cm) were harvested on 36th DPH with a survival rate of 5.30 %. The results of the present study would facilitate mass scale seed production of John's snapper.

Keywords : *Lutjanus johnii*; John's Snapper; Broodstock; Induced Breeding; Larval Rearing

Paper ID 15935

Effect of temperature and salinity on embryonic development of John's snapper – identification of suitable stage for maximising survival in larval rearing

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The present study describes about embryonic development of John's snapper, *L. johnii* and identification of suitable embryonic stage for egg handling. Trials were conducted to evaluate the effect of different temperatures (26, 28, 30 and 32 ^{0}C) and salinity (26, 28, 30 and 32 ppt) on egg development. Temperature strongly correlates with hatching time (R=-0.99, p=0.0051), rate (R=0.97, p=0.028) and larval normality (R= 0.49, p=0.51) compared to salinity. The maximum hatching rate and normality of the larvae was observed at 30 ^{o}C on 30 ppt. For the embryonic study, eggs were collected from spawning tank at 30 minutes interval and incubated at 30 ^{o}C and 30 ppt in six beakers (1 L) for studying the effect of handling stress in terms of hatching rate and simultaneously, the eggs were observed and photographed under a microscope till hatching to record embryonic developmental process with timing. The fertilized eggs were (811.1 ± 2.31 µm dia.) transparent, un-pigmented, spherical, buoyant and with single un-pigmented oil globule (161.2 ± 1.02 µm dia.). The fertilized eggs were identified with perivitelline space after 20 minutes of spawning. The progress of the embryonic development described in 5 phases. Phase I: first cell division was recorded at 40 minutes after fertilization. Phase II: Cleavages (4 to 16 cells) lasted for 48 minutes, Phase III: Morula to blastula in 32 minutes, Phase IV: Gastrula to Neurula in 6 h 31 minutes Phase V: Embryo to Hatching in 4 h 30 minutes. Hatching was started after 12:30 hours post-fertilization (hpf). At 13 hpf, 50% of the eggs were hatched out and complete hatching was recorded 14 hpf. The hatching rate was significantly higher in the group, where eggs were collected at phase V (94.33 ±0.88%) and phase IV (87 ±0.58%) compare to all other group (phase I, II and III).

Keywords : *Lutjanus johnii,* Embryogenesis, Hatching rate

Paper ID 15981

Domestication of Indian White Shrimp, *Penaeus indicus*: reproductive performance of two generations of captive reared broodstocks

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Indian white shrimp, *P. indicus* is selected as a national priority species for the development of genetic improvement program for diversification of shrimp farming. Although the domestication potential of the species has been widely discussed, empirical data on reproductive performance under captivity is limited. The reproductive performances of first (G_N-1) and second (G_N-2) generation broodstocks were compared with wild broodstock (G0). The minimum size at impregnation was 16.45 ± 1.56 and 17.62± 1.90 g in G_N-1 and G_N-2 respectively. The spawning population of wild broodstock (G0) and captive-reared broodstock size ranged from 25 g to 90 g and 25 to 45 g, respectively. While 80 % of the spawning by G0 was complete, the percentage of partial spawning was higher in G_N-1 (62.85 %) and G_N-2 (53.84 %). The average fecundity of G0, G_N-1, and G_N-2 varied significantly ($p<0.01$), with the highest fecundity recorded from wild broodstock (2, 25,110±11173 eggs) followed by G_N-2 (59,923 ± 6512 eggs) and G_N-1 (52,612±5874 eggs). The survival rate of the ablated brooders in maturation units was 89-92% in captive -reared broodstocks whereas wild broodstock recorded only 71.15±0.81% survival subsequent to eyestalk ablation. The latency period and spawning frequency among the generation lines did not have significant difference ($p>0.05$) although captive-reared lines had shorter latency periods (4 to 6 days) and better spawning frequency (up to 3 times) compared to wild ablated broodstocks (G0). The correlation matrix analysis depicted the fecundity of the captive-reared lines had a strong positive correlation with eggs per g body weight ($p<0.05$), hatching % ($p<0.05$) and total nauplius count ($p<0.05$). The present research findings on the reproductive performance of the captive-reared Indian white shrimp can help to form the baseline data and can be a foundation step for future genetic improvement programs for native penaeid.

Keywords : Seed production, native shrimp, closed thelycum, selective breeding

Paper ID 15983

Breeding and seed production of *Siganus vermiculatus*: a promising omnivorous species for Indian mariculture sector

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Vermiculated spinefoot, *Siganus vermiculatus* promises to be an excellent candidate species for Indian mariculture sector by virtue of their omnivorous feeding habit, low protein requirement, faster growth rate and tolerance to wide ranges of environmental conditions. *S. vermiculatus* is an excellent species for polyculture in addition to their use for controlling biofouling of marine and brackishwater cages. Standardisation of breeding and seed production is a prerequisite for the sustainable development of mariculture of this species. In the present study, breeding and seed production technique of *S. vermiculatus* developed at Karwar regional station of CMFRI is described. Broodstocks can be developed in RAS or in cages. Matured female fishes having average ova diameter of 440 microns and male fishes with running milt is found to be ideal for induction. Intramuscular injection of human chorionic gonadotropin (hCG) hormone was administered to female and male @ 500 IU/day and 200 IU/ day respectively on 2 days at 24 h interval. Spontaneous spawning and natural fertilization of the eggs was observed between 18 and 21 h of last injection. Green water using microalgae, *Nanochloropsis salina* and *Isochrysis galbana* is ideal for egg incubation and larval rearing. The fertilised eggs (0.56±0.02 mm) hatched out between 23h to 25 h and the yolksac larvae measured 1.89±0.28 mm in total length. The fertilisation rate and hatching rate varied between 62%-75% and 73%-87% respectively. Nauplii of copepod, *Parvocalanus crassirostris* is ideal as first feed of larvae. Copepodites, enriched rotifers, *Artemia* and artificial pellet feeding regimen was also used during larviculture. The larvae attained metamorphosis after 33-37 days post hatching when the total length reached 25.5±1.85 mm and the final survival ranged between 3.2%-12% till metamorphosis. The trials conducted here confirmed the continuous seed production of this species and an emphasis is needed to popularise the breeding and farming of this species.

Keywords : *Siganus vermiculatus*, Induced breeding, Larviculture, Mariculture

Paper ID 15995

Enzyme mediated synthesis of copper oxide nanoparticles, characterization and its antimicrobial activity against fish pathogens

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Copper oxide nanoparticles were synthesized using potato extract. The nanoparticle formation was predicted by the appearance of reddish-brown precipitate. The biochemical characterization of potato extract revealed that the major enzymes catalase and catecholase present in the extract play a significant role in the copper oxide (CuO) nanoparticle formation. The X Ray diffraction studies depicted the average size of the particle was 32.33 nm in diameter and the Trigravimetric analysis represented the formation of monoclinic nanostructure. Scanning Electron Microscopy analysis exhibited flower petal shaped morphology of CuO nanoparticles. The UV visible spectrophotometry results confirmed the formation of CuO nanoparticle by producing a sharp peak at 230 nm. The Fourier Transform Infra Red spectroscopy studies proposed that the C=O, O-H stretches correspond to few percentile of polyphenols , which was also found to be involved in CuO nanoparticle formation. The surface roughness profile of CuO was studied by Atomic Force Microscopy for cellular interactions. Further, the synthesized CuO nanoparticles were tested for antimicrobial activity against three major fish pathogens, namely, *Aeromonas hydrophila, Vibrio harveyi and Escherichia coli*. The minimum inhibitory concentration was found to be 250 µg/ml, respectively for *Aeromonas hydrophila and Escherichia coli*, whereas 500 µg/ml concentration for *Vibrio harveyi*. This investigation revealed that copper oxide nanoparticle was found to be a potential antimicrobial agent, which could either replace or supplement the role of antibiotics against the infectious fish pathogens. The novelty of the study was found to be that the enzymes were used as reducing equivalents, which might tend to pose the eco-friendly synthesis of copper oxide nanoparticles for biological investigation.

Keywords : Monoclinic nanostructure, Roughness profile, Antimicrobial activity

Paper ID 15999

A status update on 'CIFA-GI ScampiTM' the genetically improved and fast-growing strain of giant river prawn *Macrobrachium rosenbergii* in India

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'CIFA-GI ScampiTM', is the genetically improved and fast-growing strain of giant river prawn *Macrobrachium rosenbergii* developed through systematic selective breeding by ICAR-CIFA in collaboration with World Fish. The base population for selection was established in 2009 by using a full three by three diallel cross among three geographically distant populations of *M. rosenbergii* (Gujarat, Odisha, and Kerala) in India. Selection for body weight at harvest was carried out for the first three generations using BLUP (Best Linear Unbiased Prediction) selection methodology. From the fourth generation onwards, within family selection was implemented. So far 13 generations of selection have been completed and the response to selection ranged from 3.6 to 8.0% per generation. The improved strain is registered as 'CIFA-GI ScampiTM in 2020. 'CIFA-GI ScampiTM recorded 53% higher growth compared to the farmers' stock in Odisha during 2019-2020. During 2021-22, multi-location testing of 'CIFA-GI ScampiTM' was conducted in Andhra Pradesh, Odisha, and West Bengal. In all the locations, polyculture of Indian major carps and GI scampi was demonstrated. The stocking density of scampi ranged from 8500-15,000/ha while the fish stocking density ranged from 5000 to 6000/ha. Only floating feed was provided to the stocked fishes and scampi. The average daily growth (ADG) of GI scampi in Andhra Pradesh (0.38 to 0.57g) was slightly higher compared to the same in Odisha (0.22 to 0.33g) and West Bengal (0.22 to 0.36g). These results indicate that 'CIFA-GI ScampiTM has the potential to perform in all the agro-climatic regions evaluated. So far four scampi hatcheries in Andhra Pradesh have been selected as the multiplier hatcheries of 'CIFA-GI ScampiTM for the wider dissemination of the improved strain across the country.

Keywords : CIFA-GI ScampiTM, Freshwater prawn, Genetically improved strain, *Macrobrachium rosenbergii*

Paper ID 16007

Molecular characterization of Stress induced phosphoprotein (stip1), Hypoxia Up-regulated Protein (hyou1) and Heat Shock Protein 40 (dnajc16) in Rainbow Trout, *Oncorhynchus mykiss*

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In this study, we characterized the mRNA sequences of three potential biomarkers of thermal tolerance in rainbow trout, namely stress induced phosphoprotein (*stip1*; OL539749; complete cds), hypoxia up-regulated protein (*hyou1*; OL539750; complete cds) and heat shock protein 40 family member C16 (*dnajc16*; OL539748; partial cds). The target amplicons were characterized by following standard procedures for RNA isolation from liver; cDNA synthesis by reverse transcription; PCR amplification using specific primers; cloning using zero blunt vector; bidirectional sequencing; in silico analysis; and mRNA expression analysis by quantitative PCR. The *stip1* amplified product was 3096 bp long and contained a 1632 bp ORF region that encodes a putative protein of 544 amino acids (M.W. 61.8 kDa). The *hyou1* amplified product was 3421 bp long and contained a 3063 bp ORF region that encodes a putative protein of 1020 amino acids (M.W. 114.6 kDa). The *dnajc16* amplified product was 2528 bp long and contained a partial ORF of 2356 bp that encoded 785 amino acids. Phylogenetically, *stip1*, *hyou1* and *dnajc16* showed high nucleotide sequence homology with other salmonids. With respect to their transcriptional regulation, the mRNA expression of *stip1*, *hyou1* and *dnajc16* showed significant upregulation in gills, during high temperature acclimation. Likewise, renal transcripts of *stip1* and *hyou1* transcripts showed significant upregulation over the time course of high temperature exposure; while, only *stip1* was upregulated in liver. Interestingly, the tissue-specific regulation of *stip1* expression was found to match the kinetic changes in organismal upper and lower thermal tolerance limits during high temperature acclimation. Overall, these results indicated the potential role of these three molecular markers, especially *stip1*, in the thermal acclimation process in rainbow trout.

Keywords : Rainbow Trout, Thermal Tolerance, Stress Induced Phosphoprotein, Hypoxia Up-regulated Protein, Protein Translation

Paper ID 16011

Differential expression analysis of genes related to body weight trait in improved farmed carp, *Labeo rohita* (Hamilton 1822)

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Harvest body weight is an important performance trait in commercially important aquaculture species. The genetically improved rohu with 18% average genetic gain is a promising candidate for studying genes associated with performance traits. Molecular underplay of genes associated with growth rate is not fully elucidated in major carp species of India. With this aim, mRNAseq(PE 2x150 bp) for 6 low breeding value (LB) and 6 high breeding value (HB) Jayanti rohu individuals belonging to 10th generation was performed using Illumina Hiseq 2500 platform. De novo transcriptome assembly was performed using trinity and identification of Differentially Expressed Transcripts (DEGs) was carried out using DESeq in Bioconductor package. Around 27 Gb of data was generated with 178 million reads, out of which 173 million reads were retained after quality control and trimming. De novo transcriptome assembly produced 14,02,926 transcripts with avg. length of 525 bp. A total of 3816 up- and 4184 down-regulated genes between HB and LB groups were detected. Functional annotation of differentially expressed transcripts revealed that the transcripts belonged to GO terms such as Binding and catalytic activity of 'molecular processes', Protein containing complex of GO term 'Cellular component' and regulation of gene expression under GO term 'Biological process'. A total of 12 up and 6 downregulated genes between HB and LB groups of improved rohu were validated through qPCR. The gene expression pattern was observed to be correlated with the mRNAseq data for genes such as Myogenic factor, Titin isoform and Myo1C isoform. In total, 2,14,655 high quality cSNPs were identified and Ts/Tv ratio was 1.542. Among validated transcripts, four SNP harbouring genes having 16 SNPs were detected which were associated with cellular growth and proliferation. This study will provide pivotal molecular information for developing genomic selection program in genetically improved rohu as well as other carp species.

Keywords : Body weight, mRNA seq, Differentially expressed transcripts, Breeding value, *Labeo rohita*, Jayanti

Paper ID 16013

In-vitro Antioxidant Activities of Aqueous and alcoholic extracts of Ulva species and evaluation of toxic effects using Zebra fish embryos

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Oxidative stress is a major contributor to both health and disease. A plethora of pathologies have been associated with reactive oxygen species. *Ulva lactuca and Ulva reticulata* are marine algae species that have a variety of applications, including feed, manure, herbal remedies, dietary fibre content, and the gelling qualities of their sulfated polysaccharides. Because the circulatory, neurological, and digestive systems of zebrafish are similar to those of humans, toxicity assessments in this animal model can predict possible toxicity in humans. The current study envisages the *in vitro* assessment of antioxidant activity by DPPH radical-scavenging activity, total antioxidant activity and total phenolic content of aqueous and alcoholic extracts of two species viz. *Ulva lactuca and Ulva reticulata.* Out of these two species, *Ulva lactuca* recorded significantly higher ($p<0.05$) total antioxidant activity and total phenol content activity in aqueous extraction (47.86 ± 1.34; 27.36 ± 1.27) than the methanolic (32.77 ± 0.93; 12.44 ± 0.82) extraction. The IC_{50} (mg/ml) of DPPH radical-scavenging activity was observed at lower concentration of 1000 µg/ml in *Ulva lactuca* and 500 µg/ml in *Ulva reticulata* using aqueous extract. Embryonic morphological abnormalities in zebrafish embryos were evaluated, and the results revealed that *Ulva reticulata* was more harmful than *Ulva lactuca*. The current study showed that the extracts of *Ulva* species, have high antioxidant activity and hence it might be used as a natural food preservative in functional foods for health benefits.

Keywords : Ulva Species, Antioxidant Activity, Health Benefits

Paper ID 16042

Identification of a novel cell penetrating peptide from fish virus

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Cell penetrating peptides (CPPs) have gained much importance as a versatile vector for the delivery of biomolecules (i.e. DNA, RNA, proteins etc.) inside cells. Most of the viral proteins derived CPPs in use today are of mammalian virus origin. In the present study, we identified a novel peptide sequence having cell penetrating ability from infectious pancreatic necrotic virus (IPNV). Using this peptide sequence and nucleolus localization signal (NLS) from betanodavirus, a chimeric CPP was constructed. The chimeric CPP was successfully synthesized using Fmoc-chemistry. It was confirmed by mass spectrometry. The CPP was evaluated for its ability to interact with the plasmid DNA vector (pDNA) containing green fluorescent protein gene by gel retardation assay. The peptide could form complex with the DNA evidenced from the retardation in movement of the pDNA. The peptide was also able to release pDNA in reducing environment indicating its potential for releasing cargo inside cells. This was further confirmed by delivering GFP gene inside fish cell, where it gets expressed and produced green fluorescence. The results of this study suggest that the CPP based system may be explored for delivery of various biomolecules inside fish cells. As per our knowledge, this is the first report on CPP derived from fish virus for delivery of gene.

Keywords : Cell Penetrating Peptide, Fish Virus, Gene Delivery, Green Fluorescent Protein Gene, Fish Cells

Paper ID 16122

A Meta-analysis of research productivity and a worldwide assessment of seaweed anticancer potential

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Numerous seaweed-derived functional metabolites, such as fucoidan, fucoxanthin, and phlorotannin, have been shown to inhibit pathogenesis, notably cancer advancement (second leading cause of death globally). Many physicians and patients are turning to alternate preventative measures employing natural products that are crude or pure polysaccharides from various brown, green, and red algae to avoid the unwanted or hazardous side effects observed in conventional cancer therapies. The majority of studies on the anti-cancer mechanism of seaweed products show that it is mediated by radical scavenging, apoptosis, cytotoxicity, anti-proliferative, and antioxidant agents. The research efficiency of seaweed anticancer characteristics was assessed, and it was found that the year 2018 had the largest number of publications accounting for 57 numbers. Based on the total publications, India and South Korea's contributions to seaweed anticancer research are significantly higher than those of other countries. The National Natural Science Foundation of China offered the highest amount of funding to support research into the anti-cancer properties of seaweed. All the top ten organizations published more research papers compared to other types of documents. It is understood from the publications and citations that over the last decade, the importance of marine sources has come into being. The contribution of functional metabolites by signalling cancer treatment pathways to reinforce the therapeutic strategy offers useful insights and reliable sources to explore more natural seaweed products in an attempt to gain clinical utility.

Keywords : Global analysis, Anti–cancer properties, Seaweeds, Functional metabolites, Signalling pathways, Disease Pathogenesis

Paper ID 16140

Evaluation of Biofloc based probiotic isolates on water quality, growth performance and physiological responses in *Penaeus vannamei*

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The aim of this study was to evaluate the water quality, growth performance and physiological responses in *Penaeus vannamei* by supplementing the probiotics isolated from biofloc system incorporated through feed. Bacterial strains with antagonistic activity against the *Vibrio parahaemolyticus* were screened and isolated from previous biofloc system were identified as *Bacillus megaterium, Exiguobacterium profundum, Pseudomonas balearica* and *Pseudomonas stutzeri* incorporated with feed to evaluate effects on water quality and growth performance of *P. vannamei.* Post larvae of shrimp (0.045 ± 0.005g) were stocked at a density of 500/m^3 in FRP tanks (500L) for a period of 60 days. Two groups of treatment (BFT+IP and CW+IP) and two control (CW and BFT) were evaluated in three replicates. Results shows highest weight gain (2.43± 0.005 g), SGR (6.67 ± 0.004), PER (3.24± 0.02) and lower FCR (1.02 ± 0.012) values were recorded in BFT+IP. Lowest values of total *Vibrio* count were found in BFT. Histology analysis revealed that there was a mild increase in the B and R cell vacuoles in hepatopancreas of CW and BFT+IP whereas mild degeneration was found in intestine of CW and CW+IP. Microbiome analysis of the shrimp gut revealed that *Proteobacteria* was found to be the most abundant phylum in all the experimental groups. *P. balearica, P. stutzeri* and *E. profundum* were found to be present in the gut of CW whereas *P. balearica*, and *P.stutzeri* in the gut of CW+IP and BFT+IP. The results proved that the probiotics isolated from biofloc colonized in shrimp gut would pave a promising role in aquaculture.

Keywords : Probiotics, Carbon source, Distillery spent wash, Microbiome, Proteobacteria.

Paper ID 16141

Quantifying the genetic parameters of feed efficiency traits in *Clarias magur*

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Today, a major challenge is to feed the world's rising human population sustainably. Aquaculture is the fastest-growing food animal sector that will contribute more to human food in the coming days. In aquaculture, the genetic improvement of feed efficiency (FE) traits is relevant given their associations with production cost, environmental pollution, and fish quality. The genetically improved FE will lead to enhanced production per unit of feed input and thus is crucial for sustainable production. However, there is a lacuna related to basic information on the genetic parameters of FE traits in fish, which hamper the improvement of these traits by genetic selection. The present study assessed the feed intake of individual fish and estimated the genetic parameters of feed conversion ratio (FCR), average daily gain (ADG), and daily feed intake (DFI) in *Clarias magur* stock from a genetic selection program operated at ICAR-Central Institute of Fisheries Education (CIFE) Balabhadrapuram, Andhra Pradesh, India. The data were recorded on 260 magur from 26 full-sib families with an average weight of 19.30 g at six months of age. The fish were fed with a commercial fish feed ad libitum. The individual FCR of magur ranged from 0.46 to 5.97 with an average of 3.05. The analysis further suggests that genetic and non-genetic factors influence FE traits. Significant variation was observed between and within family FCR. The heritability of FCR was 0.48±0.04. The heritability estimated for other FE traits was also moderate to high (> 0.3). The estimated genetic parameters suggest that genetic selection for feed efficiency in magur will help develop a more economically viable and environmentally sustainable magur aquaculture system.

Keywords : Feed efficiency, Feed conversion ratio, Average daily gain, Daily feed intake, Heritability

Paper ID 16142

Microdynamics of exsitu Biofloc developed using raceway ponds

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The bacterial community characterization of *ex situ* biofloc was carried out to ascertain the dynamics and community structure of the microbiome. The biofloc was developed in 50 tons raceways for a period of 30 days. Distillery spent wash as carbon source was used for maintaining the C: N ratio at 10:1. The harvested biofloc powder was analysed for the mineral profile using MS analysis. Metagenomic profile of the floc was done through shotgun sequencing using Illumina NextSeq500 platform. High quality data of 3.31 GB was obtained consisting 489,136 genes. The kingdom level abundance was found in the order of 62.47% of bacteria, 36.77% of unclassified, 0.4% eukarya, 0.32% of archaea, and 0.04% of viruses. At the generic level composition, *Proteobacteria* and *Leptolyngbya sp.* were the most abundant genus identified. Gene ontology using KEGG and SEED classification revealed predominantly carbohydrate metabolism associated genes. The present study is first of its kind to study the microbial composition in *exsitu* biofloc and to identify the functional attributes of the microbiome in the biofloc system.

Keywords : Biofloc, MS analysis, Metagenomics, Proteobacteria, *Leptolyngbya* sp.

Paper ID 16175

Cell culture based isolation and preliminary characterisation of an iridovirus-like agent from the Malabar grouper *Epinephelus malabaricus* (Bloch & Schneider, 1801)

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Infectious diseases have become a major concern with intensification of aquaculture practices world over and particularly diseases of viral aetiology are becoming increasingly significant. leading to huge economic losses in aquaculture. Among the viruses causing diseases in marine and brackish water fishes, iridoviruses of the genus *Megalocytivirus*, are associated with severe systemic diseases and heavy economic losses in farmed as well as in wild fish. Iridoviruses are icosahedral cytoplasmic DNA viruses having a wide host range including fish, amphibians and insects. Iridoviral pathogens have been identified from more than 30 fish species worldwide in the last decade. A virological survey was conducted using grouper fish cell lines in the Malabar grouper *Epinephelus malabaricus* collected from wild, along the south-west coast of India during 2020 to 2022. Different organs like kidney, spleen, liver, eye, brain and/or pooled viscera from the fish samples were subjected to cell culture-based screening for viruses using 6 grouper fish cell lines developed in our laboratory. One of the viral strain (strain ID: EM1/10/21) isolated from pooled viscera of *E. malabaricus* caused intense cytopathic effect (CPE) on a spleen cell line EM4SpEx. The EM4SpEx cell line used in this study was established from spleen tissue of *E. malabaricus* in our laboratory and the cells were cultured in Leibovitz's L-15 medium containing 2% foetal bovine serum (FBS) at 28$\pm$2°C. The virus stock was propagated in EM4SpEx cells and stored at −80°C and was identified as double-stranded DNA (dsDNA) virus based on treatment with DNAse, RNAse and S1 nuclease. The virus stock was tittered on monolayer of EM4SpEx cell cultures to determine 50% tissue culture infective dose ($TCID_{50}$). The virus particles were concentrated from the cell culture supernatant by ultrafiltration and subjected to morphological and molecular characterisation and the present paper describes the details of characterisation of the virus.

Keywords : Cytopathic effect, Ds DNA virus, Iridovirus, Leibovitz's L-15 medium, Spleen cell line

Paper ID 16183

Comparative analysis of gonadal DNA methylation in striped dwarf catfish (*Mystus vittatus*, Bloch, 1794) wild-caught from river Ganga and reared in hatchery

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Bisphenol A (BPA) is a well-known endocrine-disrupting chemical and for its estrogenic activity, it can regulate the mRNA expression of cytochrome P450 and P450 side-chain cleavage enzyme which is the main regulator of fish steroid biosynthesis. Unfortunately, no data is available about the potential mechanism of the regulation. In the present study aimed to explore the underlying mechanism of BPA in regulating the expression of *CYP17a1* and *CYP11a1* in wild-caught striped dwarf catfish (*Mystus vittatus*) from river Ganga (WC) and sampled from institutional hatchery (IH) facility. Both sample groups consisted of 15 individuals and water samples were collected and BPA content/ accumulation was analyzed using ELISA. Ovarian steroid hormones and mRNA for *CYP11a1* and *CYP17a1* expression levels were detected. We found that the BPA content of both water and fish samples collected from WC was found to be significantly high ($p<0.05$) than that of IH samples. Our results showed that the concentration of plasma estradiol (E_2) and 11-keto-testosterone (11-KT) increased significantly in the WC group when compared to the IH group. Gonadal mRNA expression of *CYP17a1* and *CYP11a1*were significantly downregulated in the RG group than that of the IH group. In comparison with the IH group, DNA methylation levels increased significantly for *CYP17a1* and *CYP11a1* in the ovary of the WC group. No significant changes were observed in gonadal E_2 and 11-KT levels among groups but %GSI was found to be higher in WC than that of the IH group. In addition, we also checked the expression of DNA methyltransferase 1 (DNMT1) expression in the gonads of WC and IH group. DNMT1 expression was found to be highly upregulated in the WC group than in the IH group probably due to the impact of BPA. The present study concludes that DNA methylation appears to alter the regulation of mRNA expression of *CYP17a1* and *CYP11a1* mediated specifically by BPA in striped dwarf catfish.

Keywords : Bisphenol A, P450scc, Cyp17a1, Cyp11a1, Ovary, DNA, Methyltransferase

Paper ID 16213

Transcriptome Profile of *Perna indica* from Kerala coast using NGS technology

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The scarcity in genetic resources of *Perna indica* is one of the major hindrances in its wide usage as a biomonitor. Here we present the first exhaustive transcriptome sequencing study of *Perna indica* collected from the southern part of the Kerala coast using NGS illumina HiSeq 2500 technology. This species belongs to the genus *Perna* (Family; Mytilidae) which occupy a major position in Indian coastline, bestowed with a rich diversity of molluscan species. Aquaculture importance of these species is globally recognized. They are extensively used as pollution indicators as they can accumulate contaminants at levels higher than that present in water. This property has made them valuable biomarkers of environmental pollution. The illumina HiSeq sequencing generated 63705960 raw reads which was assembled into 157203 contigs clustered as 132641 unigenes. 12420 genes were assigned GO terms and 395 KEGG pathways were assigned to 17835 genes. The NGS illumina-seq run generated raw data has been deposited in NCBI SRA database in BioProject PRJNA692331 with SRA accession SRR15968044. Transcriptome data was deposited in NCBI with accession number GJKQ00000000. Domain search using Pfam and InterPro scan revealed that the transcripts which codes for immune related domains in this species were more in number when compared to other domains. This may be due to the presence of complex immune system in mussels than other bivalves. The tissue-wise differential expression analysis resulted in tissue-specific expression data which can be used in gene-selection and marker-assisted research. The transcriptome sequence data and annotation are valuable as it helps in the wide usage of *Perna indica* species as a biomonitor in environmental pollution.

Keywords : Transcriptome, NGS, Biomonitor, Differential gene expression

Paper ID 16220

Development of novel microsatellite markers for aquaculture important species, Milk fish (*Chanos chanos* Forsskål, 1775) for genetic diversity studies

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Milkfish (*Chanos chanos*) is a sole species of the family Chanidae and one of the most important aquaculture species in Southeast Asia. Genetic diversity in wild fish populations and aquaculture stocks must be measured in order to effectively manage the stocks. Highly polymorphic microsatellite markers can be used as genetic tags in aquaculture and fisheries biology and are powerful DNA markers to measure genetic differences within and between populations of species. From NCBI, we accessed the *Chanos chanos* genome assembly, (chromosome: 1 & 14) with the accession number LR697106. The de novo genome assemblies containing putative microsatellite motifs were identified using Microsatellite (MISA) tool. Primers with desired properties (with GC content 40-60%, melting temperatures was within 50 to 60°C, with 2°C maximum difference between primers, the last 2 nucleotides in 3'extremity are G or C) were developed using PRIMER 3 input software (Version 4.1.0). We randomly selected 25 SSRs (with 13 tri and 12 tetra repeats) to test polymorphism in milkfish. Out of twenty-five developed primers, nine polymorphic microsatellite loci were found to be polymorphic while testing with individuals from five geographically distinct locations along the Indian coast. The obtained microsatellite loci showed a high degree of polymorphism with 3–6 alleles per locus. These new microsatellite markers will be used as effective tools for studying genetic variation as well as for elucidating genetic relationships among *C. chanos* along the Indian region. To conserve the naturally available populations and also to implement management measures for sustainable utilization of *C. chanos*, accurate identification of genetic stocks is essential.

Keywords : Simple sequence repeats, *Chanos chanos*, Genetic diversity, Molecular marker, Genetic conservation

Paper ID 16258

Gonadotropin hormone releasing hormone mediated apoptosis promotes precocious spermatogenic cycle in spent Mrigal, *Cirrihinus mrigala*

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Induced bred carp show precocious sperm maturation compared to their non-induced counterpart. Advanced final maturation in carp facilitates multiple uses of males in spawning operation in extended spawning season of an Indian major carp, mrigal *Cirhhinus mrigala*. Although there are a few reports on multiple carp spawning, the mechanisms of multiple maturations of males in a season are not fully understood. In this study, we investigated the spermatogenic cycle of spent mrigals after administration of salmon GnRH analogues (10 µg Kg^{-1}) and after completing the normal process of atresia. Simultaneously we have evaluated the in-vitro effects of sGnRH (10^{-9} M) on the testes collected from spent mrigal. GnRH induced spent fish showed precocious testicular maturation than the non-induced spent fish. The in-vitro study resulted in increased levels of fas (Fas) and fas ligand like proteins (FasL) and elevated activity of caspase 3 and caspase 8. Interestingly GnRH treatment increased VASA and NANOS2 expression in the culture testes sequentially. Resveratrol effectively prevented GnRH-induced FasL protein abundance and down-regulated VASA and NANOS2 gene expression. The results suggest GnRH induced apoptosis occurs through death receptor pathways linked to up-regulation of vasa and NANOS2 genes responsible for renewal of spermatogonial cells and progressive gain of spermatogenesis.

Keywords : Gnrh, Multiple Spawning, Spermatogenesis, Apoptosis, Vasa, Nanos

Paper ID 16284

Combining ability and heritability of body weight in Rohu (*Labeo rohita*)

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Rohu is the primary fish species cultured in India. Government fish hatcheries are the major suppliers of the seed. The reports suggest that the hatchery stocks of rohu are inbred, and their genetic potential is unknown; hence, there is a need to evaluate and compare the performance of hatchery bred stocks. When inbred lines are crossed, the offspring usually express hybrid vigour. A diallel cross is a potential tool to evaluate stocks' performance and determine the proper combination of male and female lines for crossing. In the present study, fish from four different stocks were bred in a 3 X 3 partial diallel mating design, and a total of 37 full-sib families were produced in two batches. A total of 2104 observations were recorded. At four months of pond age, the least-squares mean body weight was 62.18 ± 1.07 g. The effects of non-genetic factors like batch, rearing system and ponds were found to be significant on body weight. Heritability of body weight at four months of pond-age was 0.05 ± 0.03, and the genetic and phenotypic correlation with body weight at stocking was -0.06±0.08 and -0.06±0.01, respectively. Griffing's method-3, models I and II, were employed to estimate the combining abilities for body weight. The general combining ability (GCA) for the body weight at four months pond-age ranged from -0.6 to 7.6 per cent. The highest specific combining ability (SCA) was found for the cross between the males of Stock-2 and the females of Stock-1. The overall heterosis effects for body weight ranged from -5.7 to 7.5 per cent. The result suggests that with a suitable mating design, the heterosis effect can be exploited to enhance the growth rate in rohu.

Keywords : Diallel, Heritability, Combining Ability

Paper ID 16291

Expression profiles of solute carrier transporter genes to understand molecular mechanism of osmoregulation during migrations of hilsa shad, *Tenualosa ilisha*.

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Tenualosa ilisha, commonly known as Hilsa shad, is an anadromous fish, that usually inhabits coastal and estuarine waters, with varying levels of salinity. Declines in the production of Hilsa from the natural population have raised concerns and there is an urgent need for the development of technology for captive breeding, seed production, and culture in a confined water environment. Due to its anadromous nature, captive breeding and farm rearing have long been regarded as a difficult task and it is necessary to study underlying molecular mechanisms of adaptation to salinity fluctuations during migration for spawning and growth. Solute carrier (SLC) transporters, a family of membrane-bound proteins to facilitate transport substrates across biological membranes, play important roles in physiological processes, including homeostasis. In the current study through transcriptome studies, a total of 204 SLC genes were identified, of which 99 genes belong to transmembrane transport, followed by ion transport (37), sodium ion transport (14), calcium ion transport and homeostasis. Differentially expression analysis of gill tissues between marine, brackish and freshwater revealed that only slc4a1b and slc9a3.1are upregulated in fresh water in comparison to marine water. Interestingly 7 SLC genes were upregulated in fresh water in comparison to brackish water i.e., slc4a1b, slc9a3.1, slc7a2, slc7a1, slc9a6b, SLC16A and SLC2A4 for transmembrane transport of sodium and potassium ion. The results provided valuable information about the genes, with the potential to be used as biomarkers of salinity tolerance and to our understanding of the molecular mechanisms and pathways regulating water homeostasis during migration for spawning and growth in Hilsa shad.

Keywords: *Tenualosa ilisha*; Osmoregulation; Solute carrier, Gill, Differentially expression, Sodium and Potassium ion.

The work was done under CRP Genomics project.

Paper ID 16294

Transcriptome analysis identified important regulatory pathways for tolerance to short term ammonia exposures in air-breathing Indian catfish, *Clarias magur*

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*Clarias magur***,** an air-breathing Indian catfish species, is a high value potential aquaculture species in the Indian sub-continent. Extreme tolerance to a low water quality and high concentration of ambient ammonia has been reported for this species. However, the molecular mechanisms of high ammonia tolerance in response to sudden ammonia influx in aquatic environments hitherto are still unknown. In the current study, high-throughput transcriptome sequencing was used to study the differential gene expression patterns in kidney tissues after exposure to 25 mM NH_4Cl for short-term exposures. Transcriptome analysis identified 1065 differentially expressed genes in hyper-ammonia stress for control, 3 and 9 h exposures. Molecular pathways for the 336 mapped genes identified important KEEG pathways, Arginine biosynthesis (3 genes), Arginine and proline metabolism (7), and Protein processing in the endoplasmic reticulum (16). In this study, for the first time, highly connected genes and six differentially expressed potential regulatory hub genes in the gene co-expression network for ammonia tolerance were identified and these regulatory hub genes, which were involved under 15 GO terms and 4 different GO groups, including IL-17 signaling, neuroinflammatory response, regulation of epithelial cell differentiation involved in kidney development etc. The results provided valuable information about the key pathways and regulatory function for ammonia tolerance and contributed to our understanding of the underlying molecular mechanisms and pathways regulation, in response to ammonia fluctuations during its culture, in *Clarias magur.*

Key words: Aquaculture; NH4Cl, differentially expressed genes, Arginine biosynthesis, biomarkers.

Keywords : Aquaculture; NH4Cl, Differentially Expressed Genes, Arginine Biosynthesis, Biomarkers.

Paper ID 16326

Evaluation of stress response in *Cyprinus carpio* (Linnaeus,1758) cultured at various salinities

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In India, 6.47 million ha of land is severely affected by salinity problems, and there is scope to convert them into profitable aquaculture ventures. *Cyprinus carpio* (common carp) is considered a potential candidate species for inland saline aquaculture. Common carp is a freshwater species, and to adapt to salinity conditions, it needs to undergo various physiological changes. In the present study, 216 fish with an average body weight of 15g were collected from a base population assembled to initiate a genetic selection program under the National Agricultural Higher Education Project (NAHEP), ICAR-CIFE, Rohtak, Haryana, India. The fish were reared in 0, 4, 8, and 12ppt inland saline groundwater in 1000L FRP tanks for 30 days. Tissue samples from the liver and gill were collected on the 0, 3rd, 7th, 15th and 30th days. The expression of stress response genes like *sod*, *cat*, *gst*, *gpx, hsp70* and Na^+K^+ ATPase was significantly upregulated in fish reared at 8 and 12 ppt. The *sod, cat, hsp70, gst*, *gpx* showed significant upregulation till the third day, and further downregulation was observed from the 7th day onwards at all salinities. The Na^+, K^+ and ATPase in the gill was upregulated at 8 and 12 ppt until the 30th day. However, there was no significant difference in serum Na^+ and K^+ profiles at sampling points. There was no significant difference in the gene expression in fish reared in 0 and 4 ppt. The results from the present study show that the common carp can adapt up to 12 ppt water and can be a potential candidate for aquaculture in inland saline groundwater.

Keywords : Stress, Salinity, Common Carp

Paper ID 16327

Inheritance of colour pattern in Koi Carp (*Cyprinus carpio* L .1758): A Diallel Study

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Koi carp (*Cyprinus carpio L.*1758) is a colourful and economically valuable ornamental fish species, having numerous strains. Developing new strains with enhanced colour patterns through cross breeding is essential to sustain and enhance the profit of ornamental fish industry. The present study was aimed to understand the genetic aspects of body colour and other phenotypic traits of selected Koi carp strains. In the present study, six strains *viz*., Transparent, Kohaku,1/3 Kohaku, Sanke, Showa and Bekko were used. Each selected strain of Koi carp was bred with all six selected strains of Koi carp using diallel method which resulted in 36 crosses in total. The resulted offsprings were reared for a period of 90 days to study their phenotypic traits. Individuals were separated according to their phenotype and observed. The observed phenotypic ratios were tested against the expected ratios by Chi-square test. Out of the 36 crosses, nine crosses were between Kohaku's parents and only three phenotypes Transparent, Red and Kohaku were found among them. The above results revealed that the red colour is controlled not by a single gene, at least three genes having inter- and intra-locus interactions have involved in controlling the red colour phenotypes. Nine crosses between black parents yielded a ratio of 3:1 (Black/non-Black) and eighteen crosses between black parents and non-black parents resulted in a 1:1 ratio suggesting that the black colour is controlled by a single dominant gene. The Red and Black phenotypes inherited separately suggesting that the two colours are controlled by two unlinked and different loci.

Keywords : Koi carp, breeding, inheritance Pattern

Paper ID 16330

Character-based identification system for scombrids and groupers from Indian waters for conservation and management

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Proper identification of commercially important fish species is essential for the conservation and management of fish genetics resources of the country. There is a pressing need for fast and rapid identification of fish species/products for various purposes like forensic analysis, avoiding adulteration, resolving traceability issues, eco-labelling and reduction of testing time. The commonly used mitochondrial COI region for species identification is proven ineffective in scombrids such as tuna and in taxonomic ambiguity exists in groupers to a greater extent. To overcome the above issues, the character-based identification system (CBIS) was employed for identifying the species formula and subsequently probes for the selected scombrids and groupers. Mitochondrial COI sequences of over 650 sequences for 36 groupers species were downloaded from NCBI were used to develop empirical data set for analysis and checked for the presence of false-positive sequences. Similarly, over 550 sequences of 12 species of scombrids were also downloaded/sequenced for analysis and checked for false-positive sequences. Species formula of species belonging to both the groups were identified using character-based identification tool i.e., BLOG software V.2.0. For scombrids a total of 39 variable sites were identified and 67 variable sites were identified for groupers. The specific region flanking each variable sites were checked for probe designing to obtain maximum unique characters to the particular fish species and other important criteria for probe designing also considered i.e., annealing temperature, GC contents, Secondary structure etc. A total of 22 probes for 12 scombrids and 124 probes for 36 groupers were identified. The CBIS will be useful for fast and accurate identification of the target species for conservation and management purposes.

Keywords : Scombrids, Groupers, CBIS, Blog 2.0, Species formula, Probes

Paper ID 16345

Complete mitochondrial genome and phylogeny of the Indian ocean blue-spotted maskray, *Neotrygon indica* (Myliobatiformes: Dasyatidae)

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Species of the Dasyatidae family, commonly known as maskrays have several morphologically ambiguous species and are often difficult to identify with the traditional tools. The phylogenetic approach using the complete mitochondrial genome would resolve the species ambiguity. The present study characterized the complete mitochondrial genome of the blue-spotted maskray, *Neotrygon indica* and studied the evolutionary relationship within the Dasyatidae family. The total length of the mitogenome was 17,974 bp including 37 genes and a non-coding control region. The average frequency of nucleotides of protein-coding genes was A: 29.1%, T: 30.2%, G: 13.0% and C: 27.7% with AT content of 59.3%. The values of AT and GC skewness were -0.018 and -0.338, respectively. Comparative mitogenomic analyses with the other species of *Neotrygon* showed a large number of average synonymous substitutions per synonymous site (Ks) in gene *NADH4* (5.07) followed by *NADH5* (4.72). High values of the average number of nonsynonymous substitutions per nonsynonymous site (Ka) were observed in genes *ATPase8* (0.54) and *NADH2* (0.44). The genes *NADH4L* and *NADH2* showed high interspecific genetic distance values of 0.224±0.001 and 0.213±0.002, respectively. Heat map analysis showed variation in codon usage among different species of the Dasyatidae family. In the phylogenetic tree, *Neotrygon indica* showed a sister relationship with the clade *N. varidens* and *N. orientalis*. The divergence time estimation showed that around 4.74 million years ago (Pliocene) *Neotrygon indica* would have diverged from the common ancestor of the genus *Neotrygon.*

Keywords : Blue-spot Maskray, Mitochondrial genome, Phylogeny, Biogeography,

Paper ID 16352

Captive breeding and embryonic development of Malabar Labeo, *Labeo dussumieri* (Valenciennes, 1842), an endemic food fish from Kerala

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Labeo dussumieri commonly known as Malabar Labeo (locally called Thooli/ Pullan) is a cultivable, highly revered food fish, endemic to the Western Ghats, which commands a high price. Dependence on the natural stock to support the surging market demand is ushering to overexploitation and ensued ecological damages. As this fish is one of the most important delicacies in the central regions of Kerala, there is an urgent need to standardize mass production of indigenous fish through captive breeding so they can be replenished and restored in natural waters, as well as facilitate their sustainable utilization on a commercial scale. In the present study, we investigated induced breeding techniques and embryonic development of *Labeo dussumieri* in captivity. The brooders were injected with synthetic hormone (Wova FH) to induce the breeding. Fish exhibited courtship behaviour after 5–6 hours post injection. Fish spawned between 7-8 hours post injection and the spawning fecundity was 2.2±0.5 lakhs eggs/kg during the peak spawning season. The eggs were spherical, non-sticky with a diameter of 1.80 ± 0.1 mm. Fertilization and hatching rates observed were respectively 85-90% and70-75%. As the embryo develops, we observed various stages, zygote, blastula, gastrula, and segmentation until hatching. Hatching took place between 16-20 hours at water temperature 26.5-28.5°C. Newly emerged hatchlings measured 3.5±0.2 mm, had a well-defined yolk sac, and a short tail. The yolk fully absorbed in 60-66 hour, and the mouth was fully formed. After this point, the hatchlings become free swimming and started eating exogenous food. The study disclosed the potential of producing *L. dussumieri* under captivity and propagating the species for diversifying aquaculture.

Keywords : Western Ghats, Endemic fish, Spawning, Embryology, Aquaculture diversification

Paper ID 16365

Performance comparison of *Cyprinus carpio* (Linnaeus, 1758) populations reared in inland saline waters at varying salinities

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In India, nearly 6.74 million ha of land has been severely affected by the problem of soil salinity and 1.93 million km^2 area is laden with ground saline water. The development of suitable technologies, to utilise the inland saline groundwater for aquaculture activities, is one of the national priorities of India. Common carp, *Cyprinus carpio* (Linnaeus, 1758), is the third most-produced fish in world aquaculture and is known to exhibit salinity and cold tolerance. However, growth performance studies of common carp in inland saline water are scarce. Hence, the present study evaluated early growth performance of three geographical stocks of common carp *viz*; Andhra Pradesh, Karnataka and Tamil Nadu at two salinities namely, low saline (4 ± 2 ppt) and high saline (8 ± 2 ppt). Traits *viz*; body weight (BW), standard length (SL) and body depth (BD) were recorded to study the early growth performance. Among the two salinities, the stocks reared in low saline ponds performed better than the stocks raised in high saline ponds. The mean BW, SL and BD of common carp stocks reared at low saline was 45.32 ± 0.99 g, 14.46 ± 0.32 cm and 5.73 ± 0.13 cm respectively. Amongst the three stocks, the Karnataka stock performed the best, followed by Tamil Nadu stock. The Karnataka stock attained a mean BW, SL and BD of 55.08 ± 1.26 g, 16.12 ± 0.39 cm and 6.48 ± 0.16 cm, respectively. Three morphometric parameters *viz*; head length, eye diameter and pre-orbital length were significantly higher in fish stocks reared in high saline waters than in low saline waters. All the morphometric parameters were positively correlated with total length. The study concludes that the Karnataka stock (Amur) of common carp is more suited for inland saline areas.

Keywords: Growth performance, Inland saline Aquaculture, Common carp

Paper ID 16370

Transcriptome Analysis of mantle tissue of freshwater pearl mussel *Lamellidens marginalis*

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The freshwater mussel, *Lamellidens marginalis* (Lamarck, 1819), is endemic to Asia and one of the most commonly used molluscs for the production of pearls. In India, *L. marginalis* is abundantly available in natural streams, rivers and ponds. The geographically isolated stocks of the *L. marginalis* would have a genetic variation that could manifest in the form of different quality pearls. It is essential to develop transcriptome resources to develop the type I markers to select the better-quality pearl-producing mussels. In this study, the transcriptome of mantle layer formed around the implanted nucleus was sequenced using the Illumina sequencing platform. Around 1.7 million high-quality reads with an average length of 139 bp were generated and assembled into 44,606 contigs. The minimum and maximum lengths of the contigs were 250bp and 10795 bp, respectively with an average size of 620 bp. In the BlastX analysis with the NCBI molluscs nr (non-redundant) database, around 12,626 contigs showed homology with the previously reported proteins, including biomineralization-associated proteins such as Perlucin-like proteins, Calmodulin-like proteins and Chitinase etc. The Gene Ontology (GO) terms were identified for the above contigs and classified into three categories: biological process, cellular components and molecular function.

Keywords : Freshwater pearl mussel, Next generation sequencing, RNA-seq, Biomineralization

Paper ID 16380

Comparative Evaluation of the physiological traits of triploid and diploid Rainbow trout under sub-optimal rearing conditions

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In this study, we conducted a six-week growth trial at sub-optimal rearing conditions (20±2°C) to comparatively evaluate the physiological responses of triploid and diploid rainbow trout juveniles, in terms of growth, feed utilisation, morphometrics, thermal tolerance limits, metabolic oxygen consumption rates and hepatic mRNA abundance of biomarkers related to growth, intermediary metabolism and cellular stress response. During the trial, triplicate groups of 60 fishes of 4-5 g size were reared in glass aquaria connected to a recirculating water loop and were fed an experimental diet containing 50% protein and 15% lipid, to visual-satiation. At the end of the trial, growth rate, feed and protein efficiency were higher in the triploid fishes than diploids. There were no significant differences in feed intake, survival and body morphometry. Heart-to-somatic index was high and blood haemoglobin content was inversely low in triploid fishes. But with respect to organismal critical thermal tolerance limits, CTmax and CTmin were similar between the two groups. Likewise, maximum metabolic oxygen consumption rates did not differ between the two groups. Corresponding to the observed phenotypic growth differences, the mRNA expression of *igf1* and *igf2* was elevated in triploid fish. Contrarily, the lower transcript abundance of *ampk1a* in triploids indicated a positive cellular energy status. Though hepato-somatic index was lower in triploid fishes than diploids, mRNAs encoding enzymes of the intermediary metabolic pathways showed no remarkable differences. Further, no significant differences were observed in the transcript abundance of stress response biomarkers *hsp70*, *hsp90*, *hsc70*, *hspa5*, *hsp60* and *junb*, suggesting that ploidy status did not alter the heat shock protein response of rainbow trout when reared at temperature above physiological optimum. Overall, we conclude that triploid trout can adapt to chronic high temperature rearing conditions equally or better than diploids.

Keywords : Triploidy, Temperature, Ecophysiology, Morphometry, Transcriptional response

Paper ID 16413

Comparative nutritional profile of wild and cultured Indian spiny loach (*Lepidocephalus thermalis*) by GC/MS and LC/MS/MS

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Fish is a good source of high-quality animal proteins, amino acids, and unsaturated fatty acids that play a vital role in human health and balanced nutrition. In this study, we aimed to determine the essential food components, fatty acids and amino acids, and variations in these components between wild and cultured Indian Spiny Loach (*Lepidocephalus thermalis*), fishing from the Tamirabarani river basin (Thirunelveli, Tamil Nadu). Amino acid composition was analysed by High Performance Liquid Chromatography (Agilent–1200 series) and Tandem Mass Spectrometer – Turbo Ion Spray – API 3000 (LC/MS/MS) Fatty acid composition was determined by an Agilent Gas Chromatograph (Model 6890N) fitted with an Agilent Mass Selective Detector (5973 series). The amino acid analysis showed that the wild species of loach were rich in L-alanine (2231.4 mg/kg), L-glutamic acid (3432.9 mg/kg), L-glycine (1367.8 mg/kg), L-histidine (7723.9 mg/kg), L-leucine (1080.6 mg/kg), L-norleucine (1090.8 mg/kg), L-phenylalanine (2960.4 mg/kg), L-serine (670.50 mg/mg), L-threonine (453.9 mg/kg), L-tryptophan (4614.8 mg/kg), Hydroxy proline (297.7 mg/kg), and proline (1463.6 mg/kg), whereas the cultured species showed L-arginine (276 mg/kg), L-cysteine (123 mg/kg), L- isoleucine (1112 mg/kg), L-lysine (1088 mg/kg), L-methionine (280 mg/kg), L-ornithine (467 mg/kg) and L-valine (470 mg/kg) respectively. The amino acid results revealed a surprising fact: amino acids that are abundant in wild species are not detectable in cultured species and vice versa. The saturated fatty acids named palmitic acid (C16:0), stearic acid (C18:0) were rich in cultured species, whereas unsaturated fatty acids like palmitoleic acid (C16:1c9), oleic acid (C18:1c9), linoleic acid (C18:2n-6), myristoleic acid (C14:1n-5), and linolenic acid (C18:3n-3) were rich in wild species. Elaidic acid, a trans fatty acid, was identified in cultured loach but not in wild fish. Essential nutritional components, fatty acids, and amino acids were all shown to be significantly different ($P<0.05$). To summarise, as compared to cultured species, wild loach species have higher nutritional benefits. The expanded nutrition knowledge base would boost wild loach's value as a source of animal proteins, amino acids, and fatty acids, as well as its application in dietary guidance and specialised nutritional demands for humans.

Keywords : Wild loach, Cultured loach, Fatty acid, Amino acid, GC/MS, LC/MS/MS

Paper ID 16434

First De Novo Transcriptome Assembly and Annotation of the Indian mackerel *Rastrelliger kanagurta* (Cuvier, 1816)

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The Indian mackerel *Rastrelliger kanagurta*, is an important fishery resource of the Indian subcontinent but genomic information such as transcriptomic data is scarce for this highly valuable species. Here, we present the first de novo transcriptome assembly and annotation of *R. kanagurta*. In this study, 41,600,835 read pairs (6.40 GB data) from *R. kanagurta* were produced using Illumina HiSeq2500, de novo assembly resulted in 1,05,184 transcripts with an average length of 1,087.34 bp and N50 of 2,144 bp. Annotation of the transcripts were done using Nr database of NCBI (Blast) and the Blastx hits (8,323) indicated maximum similarity with *Oreochromis niloticus* (Nile Tilapia) followed by *Larimichthys crocea* (large yellow croaker) with 7,587 number of hits. The GO terms were categorized into three main categories i.e., biological process (25,436), molecular function (36,878) and cellular component (20,959). The highly represented terms under biological process include transcription, regulation of transcription, and signal transduction while ATP binding, metal ion binding and nucleic acid binding were mostly present in the molecular function category. Integral membrane components, nucleus, and intracellular components were abundant in the cellular component category. This dataset provides the first reference transcriptome of *R. kanagurta.* The final transcriptome assembly of *R. kanagurta* can be used as a high-quality template for global gene expression profiling, providing a valuable resource for broad and profound molecular research.

Keywords : De Novo Assembly, Reference Transcriptome, *Rastrelliger kanagurta*

Paper ID 16467

Development and characterization of a new cell line AOG from a marine ornamental fish, *Amphiprion ocellaris* (Cuvier, 1830)

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Amphiprion ocellaris, represents the topmost crucial reef fish of tropical water. New cell line AOG was established from the gill of *A. ocellaris*. The developed cell line was maintained in a Leibovitz's – 15 (L-15) with 15 % FBS (Fetal Bovine Serum) supplementation, and subcultured up to 23 passages. The cell line development process was standardized to adjust sodium chloride concentration in the medium for optimal cell growth, which ultimately led to the development of a stable cell line. The cell line was authenticated by PCR amplification of mitochondrial genes viz, cytochrome C oxidase subunit I (COI), and 16S rRNA and karyotyping. Growth characteristics of AOG cell line showed a maximum at temperature 28 ℃, FBS 20 %, and 1 % of 0.2 M NaCl. Karyotyping of the cell line revealed a 2n=48 diploid chromosome. The AOG cell line was tested for the GFP expression with a pmaxGFP vector DNA showed with 6 % transfection efficiency. The developed gill cells were cryopreserved using slow freezing technique at - 80℃ with 70-75 % revival efficiency. The AOG cell line would be an essential tool for conservation and *in vitro* studies, including gene expression and toxicological studies.

Keywords : AOG Cell Line, Characterization, Chromosome, Cryopreservation, Transfection

Paper ID 16473

Establishment of a cell line from the model vertebrate animal zebrafish (*Danio rerio*) and its application in gene expression studies

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Zebrafish as a vital vertebrate model, have advanced in developmental biology, toxicology, and neurobiology. It is mainly because of the fully sequenced, annotated genome, transparent embryos, and the possibility to compare mutants with well-characterized wild-type individuals. Thus, zebrafish form a most promising vertebrate animal model for biomedical applications. Here, we report the cell culture system from the skin tissue by the explant technique and its outcome towards the cell line designated as DRS (*Danio rerio* skin). The cell line has been maintained and passed into five subcultures. The cell line features heterogeneous morphology, i.e., epithelial and fibroblastic morphology. The growth condition of the cell line was determined by incubating the cells at a varied concentration of FBS and temperature and found to be optimum at 20 % FBS and 28° C. The cell line was tested for the presence of mycoplasma using the MycoFluor™ Mycoplasma Detection Kit and found to be negative, indicating that the cultures are devoid of cross-contamination and the authenticity of the cell line was confirmed by the mitochondrial amplification of COI (cytochrome C oxidase) gene and followed by sequencing. The applicability of the cell line was evaluated for its gene expression using $_{p}$maxGFP plasmid under the control of CMV promoter and tested positive for the green fluorescence signals 24 h post-transfection with 12% transfection efficiency.

Keywords : *Danio rerio*, Cell line, Skin, Transfection, Mycoplasma

Paper ID 16474

P450arom gene expression in the brain and ovaries of adult female Indian climbing perch, *Anabas testudineus* is under estrogen regulation

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Cytochrome P450arom (CYP19), a product of the *cyp19a1* gene, catalyses the conversion of androgens to estrogens and is required for vertebrate reproduction. We extracted partial cDNA encoding the ovarian (*cyp19a1a*) and brain (*cyp19a1b*) P450arom genes from adult female perch, *Anabas testudineus*, and studied how estrogen regulates them in vivo. The findings showed that *cyp19a1a* and *cyp19a1b* dominated in the ovary and brain, respectively, with the quantity of both being related to the reproductive cycle. To further understand how estrogen regulates the expression of *cyp19a1b* in the brain and *cyp19a1a* in the ovary, we used estrogen in vitellogenic stage fish in the presence or absence of the particular aromatase inhibitor fadrozole. In a dose- and time-dependent manner, treatment of fish with 17β-estradiol (E_2; 1.0 μM) for 6 days generated considerable elevation of *cyp19a1b* mRNA, aromatase B protein, and aromatase activity in the brain. However, ovarian *cyp19a1a* mRNA, aromatase protein, and aromatase activity were less sensitive to E_2 than brain *cyp19a1a* mRNA, protein, and activity. Treatment of fish with the aromatase inhibitor fadrozole for 6 days reduced the expression of *cyp19a1* mRNA in the brain and ovary, as well as the stimulatory effects of E_2. These findings suggest that *cyp19a1b* expression in the brain and *cyp19a1a* expression in the ovary of adult female *A. testudineus* were linked to plasma E_2 levels and the seasonal reproductive cycle. The results also suggest that E_2/fadrozole modification appears to regulate *cyp19a1a* and *cyp19a1b* expression differently.

Keywords : P450arom, Estrogen, Fadrozole, Reproduction, Brain, Ovary, Anabas

4. AQUATIC ANIMAL HEALTH MANAGEMENT

Paper ID 15524

Emamectin Benzoate as an effective anti-parasitic drug in aquaculture under tropical Indian climate – An overview

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Parasites are foremost concern for health and productivity in aquaculture worldwide and control measures are paramount important. Experimental trials were conducted for biosafety, withdrawal, environmental safety and efficacy of emamectin benzoate (EMB) to use it as an effective in-feed treatment. Biosafety was evaluated with different doses of 0, 50, 250 and 500 µg kg^{-1} of fish body weight (BW) day^{-1} for 21 days *per os* in Asian Seabass, *Lates calcarifer* fingerlings. Withdrawal period was estimated with similar batteries of experiment by feeding for seven days. Samples were collected at seven days interval of post-medication for LC-MS/MS analysis. Acute immobilization test was conducted for environmental safety using daphnid. Efficacy was tested with therapeutic dose in Seabass fingerlings naturally infested with sea louse (*Caligus minimus*). Further, field evaluation in commercial farms of *L. calcarifer*, *Mugil cephalus*, *Etroplus suratensis*, *Labeo rohita*, *Carassius auratus* and *Cyprinus rubrofuscus* naturally infested with *C. minimus*, *Argulus quadristriatus*, *Argulus siamensis*, *Lernanthropsis mugilii* and *Lernaea cyprinacea*, respectively was conducted in different parts of India. No biologically significant adverse changes were observed in gross, haematology and histopathology between control and treated groups in biosafety trials. EMB in whole fish were undetectable by 28th day in withdrawal study. EC_{50} and LC_{50} in daphnid were safe even at 107 and 160 times more than treatment dose, respectively. Efficacy trial showed that there was significant improvement in survival (92.0±2.3%), reduction in parasitic load, percent efficacy (76.2%) and haematological parameters. In field study, EMB was 100% effective against *C. minimus*, *A. quadristriatus*, *A. siamensis*, *L. mugilii* and *L. cyprinacea* with no recurrence for 60 days post medication. It was concluded that there was an adequate margin of safety and 100% efficacy in using EMB medication in aquaculture at proposed therapeutic dose of 50 µg of EMB kg^{-1} fish BW day^{-1} for 7-10 days.

Keywords: Anti-parasitic drug, Emamectin Benzoate, Biosafety, Withdrawal, Crustacean Parasites

Paper ID 15549

Prevalence of Enterocytozoon Hepatopenaei (EHP) in Pacific white shrimp, *Penaeus vannamei* and environmental samples from shrimp farms of Maharashtra and Gujarat

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Diseases are one of the hindering factors in the growth and development of the shrimp farming industry. A spore-forming microsporidian parasite known as *Enterocytozoon hepatopenaei* (EHP) CAUsing Hepatopancreatic Microsporidiosis in cultured *Penaeus vannamei* has been reported in India. EHP infection is limited to shrimp hepatopancreas tubular epithelial cells associated with growth retardation. It is transmitted through cannibalism, cohabitation, and live feed through the soil and the EHP spores remain viable for up to six months to one year in the aqueous condition like pond water or soil. The present study investigated 37 Shrimp farms from Maharashtra and Gujarat from August 2019 to March 2020. EHP screening was carried out using SWP primers designed by Jaroenlak et al. (2016). The overall prevalence of EHP in the *P. vanammei* farms was 10.58%. The prevalence of EHP in the juveniles and adults of cultured *P. vanammei*, Water, and soil was 10.53%, 10.53% and 10.67%, respectively. The average *Vibrio* Count of sediment and water sample from the shrimp farms was additionally done during this study.

Keywords: EHP, *Penaeus vannamei*, eDNA, Swp, Microsporidian infection

Paper ID 15550

Hematological and biochemical profiles of *Oreochromis mossambicus* naturally infected with isopod *Cymothoa eremita*

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Hematological and biochemical profile of *Oreochromis mossambicus* naturally infected with isopod *Cymothoa eremita* was studied. A total of 150 fish of *Oreochromis mossambicus* fish samples were collected from the Pulicat Lake during the period October – December 2021 for the study. The fishes were initially screened for the isopod, *C.eremita* infestation, their prevelance were recorded, segregated and used for the study. The isopods were identified morphologically and by molecular method following PCR amplification of 28S rDNA and sequence analysis and also accession number was acquired. Haemotological parameters viz., Red blood cell, hematocrit, hemoglobin, packed cell volume (PCV), mean corpuscular volume (MCV); mean corpuscular hemoglobin (MCH); mean corpuscular hemoglobin concentration (MCHC) and biochemical parameters viz.,cholesterol, triglyceride, total protein, albumin, globulin were analyzed in *O. mossambicus* infected with *C.eremita* and healthy *O. mossambicus*. Infected fishes had significantly (p<0.05) lower RBC, MCH and PCV, MCHC and MCV level compared to the healthy uninfected fishes. Biochemical analysis revealed that infected fishes had a significantly (p<0.05) decreased triglycerides, cholesterol, total protein, albumin, and globulin levels compared to the uninfected healthy *O. mosambicus*. This is the first report on the hemato-biochemical response of *O.mossambicus* infected with isopod *C.eremita*.

Keywords: Hematological, Biochemical, *Oreochromis mossambicus*, *Cymothoa eremita*, Host response

Paper ID 15559

Pathogenicity and antibiogram of a virulent *Shewanella putrefaciens* isolate infecting Nile Tilapia *Oreochromis niloticus*

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Shewanella putrefaciens (4SK/SRLFDA/19) was isolated from the diseased Tilapia sp. and characterized by biochemical tests and confirmed by 16S rRNA PCR and nucleotide sequence analysis (Accession No MW341434). Intraperitoneal injection of Nile tilapia, *O. niloticus* with (4SK/SRLFDA/19) isolate resulted in LD50 value with 50% mortality at $1.508x10^6$ CFU/ml. The antibiogram of *S. putrefaciens* showed that the isolate was sensitive to Ciprofloxacin (10µg), norfloxacin (10µg), nalidixic acid (30µg), streptomycin (10µg), gentamycin (120µg), oxytetracyclin (30µg) and tetracycline (30µg). Complete resistance against penicillin (10µg) and cephazolin (30µg) was observed. The results concluded that the *S. putrefaciens* isolate (4SK/SRLFDA/19) from Tilapia sp. is a virulent pathogen CAUsing disease and mortality in *O. niloticus*.

Keywords: Shewanellosis, *O. niloticus*, 16s rRNA Gene, Pathogenicity, Antibiogram

Paper ID 15565

Efficacy of selected phytochemical extracts against bacterial pathogens infecting fish

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The phytochemical extracts of selected herbs *viz., Acorus calamus*, *Hybanthus enneaspermus, Calotropis gigantea, Cyperus rotundus, Vitex negundo, Morinda citrifolia, Piper longum* and *Gymnema sylvestre* were screened for their antibacterial activity against bacterial pathogens infecting fish namely *Aeromonas hydrophila* and *Vibrio parahaemolyticus.* Aqueous and methanolic extracts of the herbs were prepared and evaluated for their antibacterial efficacy and compared with the efficacy of the antibiotics (Gentamicin for *A.hydrophila* and Oxytetracycline for *V.parahaemolyticus*) following dot method. Aqueous extracts of *H.enneaspermus* and *C.rotundus* showed antibacterial activity against *A.hydrophila*, whereas aqueous extracts of *A.calamus* and *C.rotundus* exhibited antibacterial activity against *V.parahaemolyticus*. Among the methanolic extracts of the herbs, *V.negundo* and *C.gigantea* showed antibacterial activity against *A.hydrophila*, whereas *A.calamus* and *G.sylvestre* showed comparatively higher antibacterial activity against *V.parahaemolyticus*. Indiscriminate use of chemicals and antibiotics for the treatment of diseases has caused adverse effects on the environment, fish and the consumers due to the development and spread of antibiotic resistance among the microbes in addition to the antibiotic residues. The findings of this study have advocated the use of herbal extracts as an alternate to the chemicals and antibiotics for the treatment of diseases caused by bacterial pathogens in fish.

Keywords: Bacterial pathogens, Fish, Herbal extracts, Antibacterial activity

Paper ID 15568

Cutaneous Leiomyoma localized on the head and dorsal fin of a Goldfish (*Carassius auratus*)

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Goldfish, *Carassius auratus* is a popular freshwater ornamental fish of family *Cyprinidae* with many varieties that varies greatly in size, coloration, shape and fin configuration. Malignancies or the presence of a tumor in human or animal tissue is caused due to the loss of cell cycle control. Leiomyoma is histologically similar to fibroma and schwannoma, which are types of mesenchymal tumors. A case of adult goldfish, *Carassius auratus* with cutaneous leiomyoma is reported in this study. *C. auratus* with two round to spherical gray white colored unencapsulated nodules measuring about 1.2 x 1.3 x 0.9 cm and 0.9 x 0.8 x 0.5 cm in sizes on the dorsal fin and near the mouth in the head region respectively was examined. Histopathological examination of the nodules revealed interlacing bundles of neoplastic smooth muscle cells with cigar shaped nuclei with no mitotic figures. Based on the gross, histopathologial and Picrosirius red special staining examination, the nodules were confirmed as leiomyoma.

Keywords: Goldfish, Leiomyoma, Neoplasm, Pathology

Paper ID 15569

Mass mortalities associated with multiple infections of Tilapia Lake Virus (TiLV), *Aeromonas Veronii and Trichodina Sp*. in cultured Tilapines of *Oreochromis Spp.*

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Tilapia lake virus (TiLV) is an emerging virus infecting tilapines. This study documented mass mortalities in *Oreochromis* spp., due to multiple infections with TiLV, motile aeromonads and *Trichodina* sp. in a commercial tilapia farm in Tamil Nadu, India. TiLV infection was confirmed by semi-nested RT-PCR in the Nile Tilapia (*Oreochromis niloticus*) and Red tilapia (*Oreochromis* sp.) respectively, that exhibited open wounds, ulcers, pale gills and exophthalmia. The severity of disease was more in Nile tilapia with mortalities reaching up to 90% compared to Red tilapia (70%). The histopathological lesions in the liver were typical of TiLV infection with syncytial giant cells. Co-infections due to motile aeromonads particularly *Aeromonas veronii* and *Trichodina* sp. infestation with varying degrees of severity were also confirmed. The TiLV strains from Tamil Nadu had nucleotide sequence homology of 92-97% with the available TiLV sequences in the NCBI GenBank database. It is the first report of TiLV infection in Tamil Nadu, India.

Keywords: *Oreochromis Spp*., Tilapinevirus, *Aeromonas veronii*, Syncytial cells

Paper ID 15570

Occurrence of *Paracapillaria philippinesis* eggs (Capillariidae) in diseased Flower horn fish (*Cichlasoma Sp.*) – A new report from India

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Intestinal capillariasis is a zoonotic infection caused in humans due to consumption of fish carrying the infective larvae of nematode *Paracapillaria philippinesis*. The present study reports the occurrence of eggs of a parasitic nematode *P. philippinensis* in Flowerhorn Cichlid fish. The fish from which the eggs were isolated appeared infected demonstrating clinical symptoms *viz*., dark coloration, poor appetite, lethargy, erratic swimming and white stringy faeces. Microscopic observation of the faeces revealed the presence of embryonated eggs and worms. PCR amplification of 18S rRNA gene and sequence analysis confirmed it as *Paracapillaria philippinesis*. The presence of embryonated eggs indicates that the Flowerhorn Cichlid may acts as a definite host for capillarid worms. As handling of *Paracapillaria philippinesis* infected fishes are likely to transmit the infection to humans, this report alerts the fish handlers and hobbyists to undertake suitable preCAUtionary measures while handling live fishes to prevent possible transmission of paracapillariasis. This is the first report on the occurrence of *Paracapillaria philippinesis* associated with a diseased fish from India.

Keywords: *Paracapillaria Philippinensis*, Capillariasis, Zoonotic, Transmission

Paper ID 15572

A report on *Henneguya Sp*. (Myxosporea) parasitizing Orange-spotted Snakehead (*Channa aurantimaculata*)

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Henneguya sp. is an important myxosporean parasite that causes milky flesh or tapioca disease in the freshwater fish leading to heavy mortalities and production losses in aquaculture. This study documents the *Henneguya* infection for the first time in orange-spotted snakehead (*Channa aurantimaculata*) collected form from an ornamental fish rearing unit in Chennai, Tamil Nadu. The infected fish showed clinical signs which included severe ulceration and open wound in the mouth region and operculum. Microscopic analysis of wet mount from the skin scrapping of the wound showed the presence of numerous parasites of *Henneguya* sp. Necropsy of the infected fish revealed characteristic multifocal whitish oval-shaped nodules measuring 3-5 mm in the spleen. The wet mount squash of nodules showed numerous mature myxosporean spores. The mature spores were elongated, lenticular,oval with the bluntly rounded anterior end gradually tapering off to posterior with a caudal elongation. The spores measured 15.6 ± 1.5 µm × 7.2 ± 0.7 µm with a pyriform polar capsule of 5.9 ± 0.5 µm × 2.4 ± 0.2 µm and a caudal elongation of 12.1 ± 1.2 µm in length. The parasite was confirmed by PCR amplification of DNA extracted from the infected spleen using myxosporean-specific PCR primers. Histopathological changes were observed in the infected tissue of gills, eyes, brain, spleen, liver, kidney and muscle.

Keywords: Henneguya, Myxosporean, Fish parasites, Myxosporidiosis

Paper ID 15574

PCR detection of Tilapia Lake Virus (TILV) and screening for TiLV Genome segments (1-10) in Nile Tilapia (*Oreochromis niloticus)* from Tamil Nadu, India

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Tilapia lake virus (TiLV) has emerged as an important viral pathogen affecting wild and farmed tilapia. At present, TiLV disease has been reported in 16 countries across three continents. Outbreaks of the disease in India have been reported in West Bengal and Kerala. This report documents the TiLV outbreak in a Tilapia farm in Krishnagiri District of Tamil Nadu. The infected Tilapia samples exhibited gross clinical signs and symptoms typical of TiLV, *viz.,* open wounds, ulcers, lethargy, and gasping at the water surface, discoloration, exophthalmia, tail erosion and mortalities reaching up to 60%. The tissue samples *viz.,* gill, brain, intestine, liver and kidney were subjected to histopathological analysis and molecular confirmation by PCR for TiLV (K21/SRLAAH/2021). The histopathological lesions in liver tissue showed syncytial giant cells typical of TiLV infection. The results showed that the all tissue samples were positive for TiLV in RT-PCR. TiLV isolate (K21/SRLAAH/2021) was screened for all the genome segments (1-10) reported earlier. The results showed that the isolate (K21/SRLAAH/2021) had segments 1, 3, 7, 9 and 10. This result highlights the lack of presence of genome segments 2, 4, 5, 6 and 8 in the TiLV isolate (K21/SRLAAH/2021) from Tamil Nadu, India. The presence of all the genome segments (1-10) have been reported in the TiLV isolates from Israel and Thailand. However, the deletion of genome segments 4 and 5 (Uganda and Tanzania); 1, 2, 5, 6, 7, 8 and 10 (Egypt) have also been reported from the TiLV strains from various countries. This is the first report of TiLV disease outbreak in Tamil Nadu and the documentation of the genome segments in the TiLV isolate from India.

Keywords: TiLV, Genome Segments, PCR

Paper ID 15581

Metagenomic study on the influence of *Enterocytozoon hepatopenaei* (EHP) infection in the species richness of the gut microbiota in *Peneaus vannamei*

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Peneaus vannamei (Whiteleg shrimp) is one of the most widely cultured shrimp globally. Disease caused by *Enterocytozoon hepatopenaei* (EHP), a microsporidian parasite in *P.vannamei* causes severe growth retardation in shrimps causing severe production and economic loses in shrimp aquaculture. The influence of EHP infection in the shrimp gut microbiota community is poorly studied and this would be an interesting area to investigate since the gut microbiome of shrimps influences a number of key host processes such as digestion and immunity. Therefore, the prospect of understanding the state of shrimp gut microbiome during an infection such as EHP would provide valuable information on the interaction between a pathogen and microbiota community. In this study, metagenomic approach was followed to compare the overall species richness of gut microbiota of infected and healthy *P.vannamei.* DNA from gut samples of both EHP infected and healthy shrimps were amplified for bacterial 16s rRNA gene, targeting the v3-v4 conserved region. Operational Taxonomic Units (OTUs), an approximation of definitive taxonomic identity, were identified based on the sequence similarity within the sample reads and clustered together using a cut off of 97% identity using UCLUST. The OTUs were then used for computation of alpha diversity for each sample and rarefaction analysis was plotted to find the species richness in healthy and infected samples. From the analysis, mean bacterial richness values were higher in gut samples from healthy shrimp compared to EHP infected sample. Rarefaction curve showed 7000 sequence reads for both the samples but the most shift toward higher OTU richness were seen only in healthy shrimp gut which revealed 3500 OTUs whereas in EHP infected sample, reading of about 1500 OTUs only were obtained. The data from the rarefaction curves gave us a new perspective on decreased species richness and how the microbiota is remodelled in the gut of *P.vannamei* during EHP infection.

Keywords: *Enterocytozoon hepatopenaei*, Microbial abundance, Operational taxonomic units, Rarefaction curves

Paper ID 15583

Variable disease occurrence and drugs use pattern in different fish farms in Andhra Pradesh: A preliminary survey report

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Outbreak of different bacterial and parasitic diseases has been the limiting factor for sustainable development of freshwater fish culture. The impacts of emerging diseases of aquatic animals have been substantial, adversely affecting livelihood security of millions and have impacted regional or national economies. It is estimated that 10-15% production loss occurs due to disease related problems. This has led to use of a wide range of drugs and chemicals including probiotics, bioremediation products in aquaculture to control production loss. A questionnaire based survey was undertaken in 95 freshwater aquaculture farms in Andhra Pradesh and information on culture practices, inputs and annual profit/ loss etc. were collected. Survey conducted on different fish farms located in Krishna and West Godavari districts of Andhra Pradesh to identify fish diseases problems and economic losses. It was observed that very few farmers (around 15-20 %) were able to understand the disease problems and quantify disease-related losses, while the majority (~ 80%) were dependent on friends, consultants, marketing personnel and dealers for advice on disease diagnosis and treatment needed. Ectoparasitic diseases accounted for 60-70% of the problems, while bacterial and fungal diseases account for 20-23% and 5-7%, respectively. The main CAUsative agents were *Argulus sp., Myxobolus spp*. and Gill flukes, observed during the survey. Further in some cases, secondary bacterial infection with columnaris were observed. It is was noted that farmers are in habit of stocking high densities of fry and fingerlings in nursery pond, leading to occurrence of stress to cultured animals. Some farmers were using poultry manure as fertilizers and more cases of disease occurrence were reported in such ponds. During survey, most of the farmers revealed that they faced major problem with labour, feed availability and marketing of fish due to Covid-19 disaster. Major production loss reported due to non-availability of drugs, chemicals, sanitizers etc. due to lockdown imposed in the state. Most of the farmers were unable to sell their products. They kept the harvest size fish in the pond for extra 2-4 months, for fetching better prices but with extra cost for maintenance of stock, thereby minimizing profit margin. The farm sale price was Rs 90 to Rs. 100.00 per Kg, which was much lower compared to the farm price in Odisha (Rs.130 – Rs.140 per kg). The details of disease prevalence, variable culture pattern and use of various drugs and chemicals in fish culture ponds, and related issues have been elaborated in the present paper.

Keywords: Fish disease, Andhra pradesh, Parasitic diseases, Red disease, Aqua drugs

Paper ID 15584

Biomarker based assessment of endocrine disrupting effect of Biphenol A in Genetically Improved Farmed Tilapia (GIFT)

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Bisphenol A (BPA), an organic compound widely used in the production of synthetic polymers and epoxy resins is an ubiquitous contaminant of aquatic environment including surface water, sediments and biota. It is an endocrine disruptor chemical and its continuous exposure could CAUse serious reproductive disorders and health effects in the fishes. The aim of the present study was to investigate the toxicity, health effects and endocrine effects of bisophenol A in Cichlid fish Oreochromis niloticus The 96 h median lethal concentration of Bisphenol A in Oreochromis niloticus was found to be 6.794 mg/L. Fishes were exposed to sublethal concentration of BPA (4, 5 and 6 mg/l) for 7 days to study its effect on haematology, serum biochemistry, plasma hormone profile, gonadal gene expression and histopathology of gill, gonad, kidney and brain. Total erythrocyte count was significantly reduced in BPA exposed fishes. Serum SGOT, globulin and albumin-globulin ratios were altered by BPA exposure. Plasma estrogen Manuscript File Click here to view linked References levels were increased while plasma testosterone and thyoxine levels were decreased by BPA exposure. Increased lipid peroxidation and reduced antioxidants, viz., reduced glutathione and SOD levels were observed in the liver tissues BPA-exposed fish. Increased gonadal expression of GST, OP450 and p53 genes were observed with BPA exposure. Histopathological changes were also observed in the gills, kidney, ovary and brain of O. niloticus exposed to BPA. Based on the results of the present study, we can conclude that the Bisphenol A induces oxidative imbalance, alters plasma steroidal hormonal levels and gonodal gene expression suggest that these can be used as biomarkers to monitor the adverse health effects of BPA.

Keywords: Bpa, Lc50, *Oreochromis niloticus*, Gene expression, Xenoestrogen, Endocrine disruptor

Paper ID 15625

Pathogenicity evaluation study of *Photobacterium Damselae Subsp. Damselae* in Asian Seabass (*Lates calcarifer*)

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Photobacterium damselae subsp. *damselae* (formerly known as *Vibrio damsela*) is an important marine pathogen, causing potential devastation to mariculture systems. *Photobacterium damselae* ssp. *damselae* has been reported to cause wound infections and fatal disease in human and a variety of marine animals such as fish and shellfishes. The objective of this experimental study was to investigate pathogenicity of *Photobacterium damselae* subsp. *damselae* in Asian Seabass. Seabass fingerlings collected from Rajiv Gandhi Centre for Aquaculture, Sirkali was maintained at indoor glass tanks under the laboratory conditions for three days for acclimatization. Three groups of fish in duplicate were intra-peritoneally administered with 50ul of bacterial culture having inoculum strength of $1.05x10^6$, $1.05x10^5$ and $1.05x10^4$ per fish after tenfold serial dilution. In the 5 day observation period, 100 % mortality was observed in the first two higher concentrations and no mortality was noticed in the control tanks and 85% mortality in lowest concentration tank. Bacterial reisolation from dead Asian seabass fish tissues such as kidney, spleen, gill and liver was carried out. Reisolated bacterial colonies were identified by standard biochemical tests and 16S rRNA sequencing and *ureC* multiplex PCR. Tissues such as kidney, spleen, liver and gill from moribund fish samples were subjected to histopathological analysis. Results indicated melanomacrophages and visible glomerulonephritis in kidney, Tissue necrosis was observed in spleen.

Keywords: *Photobactrium Damselae Subsp. Damselae*, Asian seabass, Urec, 16s RRNA, Histopathology

Paper ID 15626

A bacteriological study of Vedaranyam canal water- In view of public health

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Effluent water discharges from shrimp farms are considered as the important potential sources for the spread of AMR to the natural environments. This study evaluates the occurrence of multidrug-resistant *S.aureus* and *E.coli* along the Vedaranyam canal among the various shrimp farm outlets. Five sampling sites in the Vedaranyam canal were assessed for microbial water quality and antimicrobial resistance determinants. The bacterial load during this study ranged from 16×10^4 cfu/ml - 12.4×10^5 cfu/ml, and the coliform count ranged from 3.5×10^3 cfu/ml to 9.0×10^5cfu/ml. All the isolated bacteria were found to be resistant against at least three antibiotics. The antibiogram signature of the isolated bacteria revealed that the highest resistance was recorded against Penicillin, Amoxicillin, Ampicillin, cephalothin, and colistin. Of the obtained 39 multidrug-resistant Staphylococcus aureus from surface waters of the Vedaranyam canal, 42% were ESBL producers, whereas, among the 27 multidrug isolates of E.coli, 35% were ESBL producers. The present study highlights a potential antimicrobial resistance transmission from environmental waters to animal carriers and humans. The MAR index of the *Staphylococcus aureus* and the *E.coli* isolates ranged from 0.2 to 0.99 and from 0.2 to 0.96, respectively, which indicates the highest possible contamination of antibiotic pollution present in this study area. The presence of the mecA gene confirmed the occurrence of 92% methicillin-resistant Staphylococcus aureus from isolated samples. The molecular analysis of the multidrug-resistant bacteria confirms the presence of the blaZ gene and blaTEM gene. The findings from the study have great implications for the AMR spread with the potential threat to humans and the environment.

Keywords: Vedaranyam canal water, Multi drug resistance, ESBL production, Human importance bacteria.

Paper ID 15629

Edwardsiella tarda associated bacterial disease outbreak in Catla (*Labeo catla*)

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Edwarseilla tarda is a bacterial pathogen causing Edwardsiellosis in wild and cultured fish. The present study documented the *E.tarda* infection associated disease outbreak in *Labeo catla* cultured in a commercial farm in Tamil Nadu, India. The infected fish exhibited external signs viz., lethargy, reduced feed intake, excessive mucus secretion and fin erosion. Bacteria were isolated from the kidney of the infected fish, biochemically characterized and confirmed by PCR and nucleotide sequencing as *Edwardsiella tarda* (E4L/SRLAAH/2020). The nucleotide sequence was submitted to Genbank database (Acc No. MT422189.1). Antibiogram analysis for the isolate (E4L/SRLAAH/2020) showed that the isolate was either resistant or intermediately resistant to Chloramphenicol (30 mcg), Ampicillin (10 mcg), Oxytetracycline (30 mcg), Cefotaxime (30 mcg), Vancomycin (30 mcg), Amoxicllin (30 mcg), Erythromycin (15 mcg), Ceftazidime (30 mcg), Kanamycin (30 mcg) and Tetracycline (30 mcg) and sensitive to five antibiotics viz., Norfloxacin (10 mcg), Ciprofloxacin (5 mcg), Nalidixic acid (30 mcg), Oflaxacin (5 mcg) and Co-trimazole (25 mcg). Reinfection studies in *L.Catla* with the *E.tarda* isolate (E4L/SRLAAH/2020) injected at (10^3 CFU) showed clinical signs like lethargy and reduced feed intake from the 4th day after the injection, thereby confirming the pathogenicity of the *E.tarda* isolate.

Keywords: *Edwardsiella tarda*, Fimbrial gene, Antibiotic resistance

Paper ID 15632

Prevalence and Antimicrobial-Resistant profile of selected pathogens in feed samples of shrimp farms in Vedaranyam.

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The incidence of various human pathogenic bacteria in commercially available shrimp feeds used on farms in Nagapattinam was analyzed. The feed samples were collected from the five shrimp farms, and the total heterotrophic bacteria in the commercial feed samples ranged between 10^3 – 10^5cfu g-1. Bacteria of significance to human health were found to be associated in high incidence with the analysed commercial feed samples, which include *Vibrio parahaemolyticus* and *Escherichia coli*. The present study was aimed to study the prevalence of the above bacteria and their antimicrobial resistance pattern associated with them. All the five feed samples were found to be positive for *V. parahaemolyticus* and *E.coli*. Confirmation test performed for pathogenicity of the isolates by Kanagawa phenomenon for *V. parahemolyticus* and 16s rRNA for *E.coli*. Antibiogram study revealed all the E.coli (100%) strains were showing complete resistance to Erythromycin, Vancomycin, and Methicillin. 44% of the *Vibrio parahemolyticus* isolates and 36 % of *E.coli* isolates were showing resistance to the beta-lactam group of antibiotics, which is the highest to exhibit resistance. Following that, 17% of the *Vibrio parahemolyticus* and 15% of *E.coli* shows resistance to the tetracycline group of antibiotics. The MAR index among the *Vibrio parahemolyticus* from the feed samples of the shrimp farms ranged from 0.26 to 0.46. Similarly, for *E.coli* isolates, the MAR index ranged from 0.5 to 0.93. This result shows that there is the highest possible amount of antibiotic contamination among the sampling sites. The occurrence and prevalence of *V. parahaemolyticus* and *E.coli* is a major public health concern; hence, more studies involving feed samples in shrimp farms need to be further investigated.

Keywords: AMR, Shrimp feed samples, Beta lactam group of antibiotics, Mar index.

Paper ID 15635

Antimycobacterial activity of phytochemical extracts from herbs against the Nontuberculous *Mycobacterium fortuitum* infecting fish

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Non – tuberculous mycobacteriosis caused by. *M.fortuitum* is prevalent in wild and cultured food and ornamental fishes. Mycobacteriosis causes clinical signs in fish *viz.,* discoloration and open wounds, which affects the aesthetic value and marketability of fish. In addition mycobacteriosis is also considered a zoonotic disease. The antimycobacterial efficacy of the phytochemical extracts from the whole plants viz., *Acorus calamus, Cinnamomum verum, Foeniculum vulgare, Leucas aspera, Mimosa pudica* and *Tribulus terrestris* were studied against *Mycobacterium fortuitum* isolated from an infected fighter fish, *Betta splendens*. The efficacy of aqueous and methanolic extracts from the above plants was studied *in vitro* by 96-well microplate assay method with Resazurin indicator. Results showed that aqueous extracts of all the above herbal plants at 200ug/ml conc showed inhibitory activity against *M.fortuitum. However,* aqueous extracts of *Acorus calamus, Tribulus terrestris, Mimosa pudica* and *Leucas aspera* showed inhibitory activity even at a lower concentration of 100ug/ml against *M.fortuitum*. Similarly, methanolic extracts of all the above herbs showed inhibitory activity against *M.fortuitum* at a minimum concentration of 100ug/ml. Therefore, the extracts of *Acorus calamus, Cinnamomum verum, Foeniculum vulgare, Leucas aspera, Mimosa pudica* and *Tribulus terrestris* has a potential to be used as an alternate to the antimycobacterial drugs for the control of Mycobacteriosis in fish.

Keywords: *Mycobacterium fortuitum*, Phytochemical analysis, Resazurin, Mic

Paper ID 15640

Distribution of Non-wild Type (NWT) isolates of *E. coli* and *Aeromonas Spp*., in farmed freshwater fish

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Understanding the origin of the resistant bacteria in fish farm settings is vital to devise mitigation strategies to control antimicrobial resistance (AMR) in aquaculture. Antibiotic susceptibility testing (AST) of *E. coli* (n=76) and *Aeromonas* spp. (n=76) isolated from farmed freshwater fish (n=80) of Andhra Pradesh was performed by the disk diffusion method. The cut off wild type (CoWT) value, that differentiates the wild type (WT) from non-wild type (NWT), of *E.coli* and *Aeromonas* spp. was calculated for 11 different antibiotics (Amoxicillin-Clavulanic Acid, Ceftazidime, Ceftriaxone, Cefotaxime, Imipenem, Trimethoprim-Sulfamethoxazole, Ciprofloxacin, Enrofloxacin, Amikacin, Chloramphenicol, and Tetracycline) employing the normalised resistance interpretation (NRI) based on the inhibition zone sizes. The proportion of NWT *E. coli* were relatively higher when tested against Ciprofloxacin (62%), Trimethoprim-Sulfamethoxazole (54%), Enrofloxacin (25%) and Tetracycline (20%). On the other hand, the proportion of NWT *Aeromonas* spp. were higher against Chloramphenicol (34%), Trimethoprim-Sulfamethoxazole (24%) and Tetracycline (18%). Maximum WT *E. coli* were observed towards Imipenem (99%), Amoxicillin-Clavulanic Acid (99%), Ceftriaxone (91%), Chloramphenicol (91%) and Cefotaxime (90%). Higher WT *Aeromonas* spp. were noticed towards Amikacin (100%), Imipenem (99%), Cefotaxime (95%), Ceftazidime (90%) and Enrofloxacin (90%). On the whole, the WT strains of *E.coli* (80%) and *Aeromonas* spp. (82%) appear to be relatively higher in the farmed freshwater fish indicating that majority of the bacterial isolates were intrinsically associated with the aquaculture system.

Keywords: Antimicrobial resistance (AMR), Wild Type (WT), Non-wild Type (NWT), Cut Off Wild Type (COWT), *E. coli, Aeromonas Spp*., Farmed fish

Paper ID 15664

Insights to the shrimp response against White Spot Syndrome Virus during the course of infection

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White spot syndrome virus, continues to cause huge economic loss to aquaculture industry. In the absence of effective therapeutics to control WSSV, it is important to understand the host pathogen interaction at the molecular level. Flow cytometry analysis was carried out to detect the progression of apoptosis in haemocytes of WSSV infected *Penaeus vannamei* at different time-points of infection. Apoptosis in haemocytes was found to increase with time of infectivity. Real time PCR was used for the expression analysis of four apoptosis-related genes such as Death-associated protein 1, caspase-5, translationally controlled tumor protein, and cathepsin D. WSSV was found to induce proliferation of haemocytes, with very high levels of respiratory burst and cytoplasmic free Ca^{2+} concentration in WSSV-infected *P. vannamei*, indicating functional interlink between these parameters which might have a damaging role in WSSV-infected shrimp.

Keywords: *Penaeus vannamei*, WSSV, Host response

Paper ID 15678

Documentation on *Metanophrys Sinensis* (protozoa: Ciliophora: Scuticociliatida) outbreak in Clownfish hatchery and development of eco -friendly protocols towards treating the infestation

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The supply of hatchery produced fishes to the marine aquarium industry is an alternative way to protect the coral reef ecosystem as well as generate constant revenue by the breeders and stakeholders. The present work on *Metanophrys sinensis* outbreak has been documented at theICAR-NBFGR germplasm resource center for marine ornamental fishes, Airoli, Maharashtra, and developed an eco-friendly treatment protocol to control the infection. Abnormal swimming, gasping, rubbing the body and dull appearance were the main symptoms during the infestation. Results of the wet mount technique exhibited the presence of ciliate parasites in gill and body surface of the captive raised infected moribund juveniles, *Amphiprion percula.* PCR amplification and sequencing of 18S rRNA (ss unit) gene was carried out with ciliate specific primers. The sequence analysis using BLAST confirmed the identity of the parasite as *M. sinensis* (Genbank accession number: OM055651). Moreover, parasitic therapeutants, such as copper sulphate (10 ppm), chloroquine phosphate (10 ppm), and formalin (2 ppm) were tested to treat the infected juveniles. In addition, the extracts of the mangrove plant, *Avicennia marina* were tested experimentally against *M. sinensis* infection. The potential fraction was further separated by preparative HPLC & responsible active compounds were characterized by GC-MS. Our preliminary evaluation suggests that the mangrove extracts could be effectively used to treat *M. sinensis* infection in clownfish. This is the first report of *M. sinensis* outbreak in marine ornamental fish host and developed eco-friendly mangrove-based treatment measure could effectively treat this parasitic infection.

Keywords: *Metanophrys sinensis*, 18s rRNA, *Avicennia marina*, HPLC and GC-MS.

Paper ID 15683

Infestation of *Parapetalus occidentalis* (family Caligidae) in wild collected Cobia (*Rachycentron Canadum*) from the East Coast India- A case report

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Broodstock development of marine fishes starts from wild collections of subadults in live condition. Three numbers of cobia *Rachycentron canadum* (total length 90cm, 122 cm and 125 cm and total body weight 6.5kg, 17 kg and 20 kg respectively) were collected from the east coast India by the hook and line method. They were transported to CMFRI, Mandapam Regional Centre, Mandapam and maintained in the conventional recirculation aquaculture system (RAS) in the brood stock bank. On 9th day two fishes showed the clinical signs of altered swimming behaviour, with loss of balance and frequent resting on the floor of the tank. Later frequent scratching of opercular surface on the side of the wall and bottom of the tank as in case of the 'itch disease' and on subsequent day, mortality occurred. Necropsy of the cobia revealed extensive erosion and abrasion wounds on the lower abdomen, near the caudal and pectoral fins. Chest region was with prominent abrasion markings due to the scratching behaviour on the bottom of the floor. Grossly, generalised congestion was noted in all visceral organs. Examination of the gill surface revealed extensive infestation of copepod gill parasites which were visible with naked eye. The head portions of the parasites were firmly attached to the gill lamellae and many copepods also were embedded between the gill lamellae. Few samples from the gills with copepod parasites were fixed in 10% NBF for histopathology and few copepod parasites were fixed and stored in 90% ethanol for molecular characterization. Total 63 parasites were collected (male, 15and female, 48).Later, the parasites were mounted on lactic acid, dissected under a stereo zoom microscope and identified as *Parapetalus occidentalis* Wilson, 1908.The total length of males were 4.0 to 4.5mm and the female was 7.5 to 7.9mm. Most of the females were with broader abdomen often bearing egg sacs and, in the males, the abdomen was smaller. Female cephalothorax was slightly wider than long. Histology of the gill revealed localised necrosis and atrophy of the secondary lamellae with inflammatory cells at the parasite attachment site. Though the infestation of parasite *P.occidentalis* in cobia was not so severe, it could cause mortality of fishes in the confined condition. Based on the morphological features and 28SrDNA sequence the parasite was identified as the family of Caligidae, *Parapetalus occidentalis.*

Keywords: Cobia, copepod infection, *Parapetalus occidentalis*, Caligidae.

Paper ID 15703

Protective immune response against Viral Nervous Necrosis (VNN) in Silver pompano (*Trachinotus Blochii*) following vaccination with inactivated Betanodavirus.

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In India, betanodavirus affects both wild and farmed marine finfish. The Silver pompano *(Trachinotusblochii)* a candidate species for mariculture was chosen, for vaccination l trials.The juveniles of silver pompano (1.5 to 2g body weight,) were screened for VNN by Reverse transcription polymerase chain reaction (RT-PCR) before starting the experiment. Four experimental groups in triplicates were maintained namelyT1- Negative control, T2- Positive control, T3- vaccinated unchallenged and T4- vaccinated challenged (n=20 each)). The Formalin-inactivated VNN vaccine was given at a dose of 0.05 ml intraperitoneally. After two booster doses with 14-day intervals the positive control and vaccinated groups were challenged with live betanodavirus (10^6 $TCID_{50}$) by intraperitoneal injection on 30 DPV (Day Post Vaccination). After 13 days of DPC (Day Post Challenge) the positive control displayed clinical symptoms of viral infection like circling, surfacing and acute death. The mortality was 25% on 16 DPC, 50% on 17DPC, and finally 100% on 20 DPC. To investigate the immune response against VNN virus, samples were collected and analysed for RT-PCR, and immune gene expression (Beta-2-macroglobulin& Lysozyme). On 20 DPC, the vaccinated fish showed 93.5%t RPS (Relative Percentage of Survival), whereas all fish in the positive control group died. The growth metrics, as well as body weight and size, varied significantly ($p<0.05$) between the vaccinated and control groups. The mRNA expression of immune-related gene was analyzed in target organs (brain, spleen, and head kidney) in both experimental and healthy fishes. The vaccinated fish samples from our experiment showed viral neutralization, which has been confirmed by RT-PCR. The vaccinated fish has gained higher protective antibody titers in serum and tissue samples as compared to the positive control fish. Immune gene up regulation was also significantly higher in vaccinated group (T4) than in controls (T1&T2). So the inactivated VNN vaccine has given good protective immune responses against *betanodavirus* in silver pompano juveniles with 93.5 percent RPS and also revealed expression of immune genes as compared to the non-vaccinated fishes.

Keywords: Pompano, Vaccine, Betanodavirus, Immune gene, Protection.

Paper ID 15718

In Vitro Antiviral effect of homeopathy medicines against Tilapia Lake Virus (TiLV)

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Tilapia lake virus (TiLV) is a novel virus that causes large scale mortalities in Tilapia farming and is considered as a threat to the global tilapia industry. In the present study, the antiviral activity of homeopathy medicines against TiLV using SSN1 cell line was attempted. A total of 10 homeopathy medicines *Belladonna* 200C*, Pyrogenium* 200C*, Influenzinum* 200C, *Crotalus horridus* 200C, *Arsenicum album* 200C, *Hepar sulphur* 200C, *Aconitum napellus* 200C, *Tuberculinum* 200C, *Bothrops lanceolatus* 200C and *Nux vomica* 200C were used for screening antiviral activities. Among the 10 medicines, 3 medicines *Crotalus horridus*, *Influenzinum* and *Pyrogenium* inhibited the cytopathic effect caused by TiLV in SSN1 cell line. Further, these three medicines showed antiviral activity at different concentrations *viz*, 100 µl /ml, 250 µl /ml and 500µl /ml of the medium against two different concentrations of virus ($10^{1.0}TCID_{50}\,ml^{-1}$ and $10^{7.3}TCID_{50}\,ml^{-1}$). In this In vitro study, the concentration of homeopathy medicine at 500µl /ml of the medium showed better effect against TiLV in both virus concentrations of $10^{1.0}TCID_{50}\,ml^{-1}$ and $10^{7.3}TCID_{50}\,ml^{-1}$ when compared to the control group. Our study has revealed that homeopathy medicines have potent antiviral effects in fish virus in cell culture. The finding suggests that homeopathy medicines have the potential as a therapeutic agent in the treatment of TiLV infection.

Key words: Tilapia Lake Virus, Homeopathy medicines, Cell culture, Antiviral activity, Treatment.

Paper ID 15723

Prevalence of *Enterocytozoon Hepatopenaei* (EHP) and its co-infection with OIE listed diseases along the shrimp farming systems of Tamil Nadu

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Shrimp production in India has attained tremendous growth over the past two decades due to the intensification of culture practices which has led to the occurrence of various infectious diseases. *Enterocytozoon hepatopenaei* (EHP), a spore-forming intracellular microsporidian parasite is a common shrimp pathogen leading to drastic growth retardation and huge economic loss to the shrimp industry. EHP cause Hepatopancreatic Microsporidiosis (HPM) and may occur along with other infectious shrimp diseases caused by both bacterial and viral infections. In the present study, shrimp samples were collected from the shrimp farming regions of Tamil Nadu, including Thoothukudi, Ramanathapuram, Nagapattinam, Nagercoil and Pudukottai from September 2021 to March 2022. The collected shrimp samples were screened for the presence of EHP. Totally 100 shrimp samples were collected and screened in this study, of which 38 samples were positive for EHP by PCR. All the 38 EHP positive samples were further analyzed for the presence of OIE listed shrimp diseases using PCR for analyzing the co-infection along with EHP, including White spot syndrome virus (WSSV), Shrimp hemocyte iridescent virus (SHIV) or Decapod iridescent virus (DIV1), Infectious hypodermal and hematopoietic necrosis virus (IHHNV), Taura syndrome virus (TSV), Necrotising Hepatopancreatitis (NHP), AHPND bacteria, Yellow head virus (YHV) and Infectious myonecrosis virus (IMNV). The results had shown only one sample to be positive for WSSV amongst the 38 EHP positive samples screened. All other OIE-listed shrimp diseases were negative by PCR. The prevalence of EHP was 38% and the prevalence of co-infection of EHP with OIE listed shrimp diseases was 1%. From this study, it could be inferred, EHP to be the common pathogen affecting shrimps compared to other bacterial and viral pathogens and co-infection of EHP could occur along with other shrimp pathogens.

Key words: Disease, EHP, OIE, Prevalence, Shrimp farming

Paper ID 15765

Pathology of *Enterocytozoon hepatopenaei* and White Spot Syndrome Virus co-infection in *Penaeus vannamei* shrimp

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Shrimp aquaculture is a fast-growing sector offering livelihood for millions of people globally. The growth of this industry was phenomenal during the last decade because of the intensification of the culture system which has led to occurrence of many diseases. One important disease currently pestering shrimp farmers is hepatic microsporidiosis (HPM) caused by a microsporidian parasite *Enterocytozoon hepatopenaei* (EHP) causing stunted growth in shrimp. EHP often reported as a coinfection with other shrimp diseases, one such disease is the white spot syndrome virus (WSSV). In order to know the pathology of co-infection of EHP with WSSV, an experimental study was conducted in in *Penaeus vannamei* shrimp of 8-10g, 11-13cm. To elicit the pathology of EHP and WSSSV coinfection, the experimental shrimp were infected initially by feeding EHP infected tissues, followed by WSSV infected tissue orally. The sampling was done at periodical intervals and various parameters like haemolymph, histology, molecular pathology were studied. It was observed that the animals were found positive for WSSV by 4hrs without any mortality. However, the animals started dying at later stages. Total haemocyte count found to be increasing as the infection progresses. The differential haemocyte count revealed an increase in small granular cells, while large granular cells the count was found to decreased with disease progression. Histological changes were seen in gills as well as hepatopancreatic tissues with hemocytic infiltration in both the organs. The immune genes like superoxide dismutase (SOD), prophenoloxidase (PrPO) were expressed more in hepatopancreas than the haemolymph. From this study it can be concluded that WSSV infection occurs early in EHP infected shrimp which was evident from the parameters studied.

Keywords: White spot syndrome virus*,* *Enterocytozoon hsepatopenaei*, Histology

Paper ID 15783

Adaptation of Virus Nervous Necrosis Virus in E-11 Cells for the development of inactivated vaccine

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Viral nervous necrosis (VNN) also called as Viral Encephalopathy and Retinopathy (VER) is economically significant viral disease causing loss to fish culture to a major extent, the virus is distributed world over infecting freshwater, Brackish water and marine fishes belonging to 120 species from 30 families of fishes. VNN virus is a non-enveloped virus belonging to genus *Betanodavirus* and family *Nodaviridae*. VNN virus is one of the destructive pathogen of broodstocks in finfish hatcheries causing heavy loss to seed production and farming worldwide. To develop an inactivated VNN viral vaccine, VNN virus of finfish was adapted and propagated in E-11 cell line, by culturing in Leibovitz's Medium (L- 15) supplemented with 10 % fetal bovine serum. The VNN viral mass propagation in E-11 cell line produced characteristic cytopathic effect (CPE) in 48h post infection and viral purification was optimized. The infective dose of the vaccine virus was calculated using Reed and Muench method. VNN virus particles were purified using caesium chloride density gradient centrifugation. The purified virus was confirmed by RT- PCR and VNN viral protein coat using SDS-PAGE. Formalin inactivation of VNN virus using different concentration and duration was standardized and safety tested in cell culture and biological assay was done. Formalin inactivated (0.1%) sterility tested vaccine was administered in *L. calcarifer* juveniles for laboratory scale vaccine trial.

Keywords: VNN, Inactivated vaccine virus, Fish virus

Paper ID 15789

Judicious use of farm inputs for sustainable brackish water shrimp aquaculture

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Global aquaculture production has been increasing at an annual growth of 5.3% over the last two decades, reaching 114 million tonnes in the year 2018 contributing 46% to total fish production. Adoption of scientific culture practices including, genetic selection, better management practices and application of health care products, has led to the economic sustainability of the sector through improved production and productivity. The quantity of chemicals and veterinary medical products used determines the safety of the host and the environment. A survey (n=867) was conducted in three major shrimp producing states (Andhra Pradesh, Gujarat and Tamil Nadu) to determine the usage pattern of farm inputs under the category of disinfectants, nutritional supplements, probiotics, environmental modifiers, antimicrobials and antiparasitic in Indian aquaculture. Andhra Pradesh farmers (89.06 kg/tonne shrimp production) were using the highest inputs closely followed by Tamil Nadu (87.07 kg/ tonne shrimp production) and least by Gujarat (53.42 kg/tonne shrimp production). The survey revealed the frequent use of environmental modifiers (50.62%) followed by probiotics (20.94%), disinfectants (6.99%) and nutritional supplements (3.41%). No record of use of antimicrobials recorded in the survey. The number of products being marketed in the shrimp farming sector has increased from about 1200 to 3574, over the decade, pertaining to 52 different types of chemicals, biologicals and antimicrobials. Higher usage of environmental modifiers, probiotics and disinfectants suggest the safety of Indian shrimp products. A national policy on product approval and regulatory guidelines in line with USFDA, EMA and Health Canada is required to ensure quality of fish and fishery products to domestic and international consumers.

Keywords: Drug usage, Consumer safety, Antimicrobials, Regulation

Paper ID 15794

Possibilities for structure-based drug discovery against White Spot Syndrome Virus

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White spot syndrome virus (WSSV) causes severe disease in shrimps and other crustaceans, resulting in major economic losses to the farming industry. Currently, there are no effective treatment methods against the disease caused by WSSV. Taking the help of three-dimensional structural information available for the proteins coded by a pathogenic virus is a time-tested approach to come up with suitable anti-viral strategies. Towards this end, we have analyzed all the WSSV protein structures for which coordinates have been deposited into the protein data bank. Most of the past structural studies have looked at WSSV envelope proteins, primarily to target the viral entry process. More recently, the structure of WSSV-encoded enzymes such as dUTPase and thymidylate synthase have also been reported. These enzymes are essential for efficient viral replication, presenting themselves as potential drug targets. The presentation will address the structural attributes of WSSV proteins and discuss the possibilities towards the development of structure-based strategies against the virus.

Keywords: White spot syndrome virus, Structural biology, Anti-viral agents

Paper ID 15797

Emergence of *Argulus siamensis* (Wilson 1926) in endangered Golden Mahseer, *Tor putitora* (Hamilton) brooders

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The crustacean ectoparasite, *Argulus* (fish louse) causes one of the major parasitic infestations in freshwater systems throughout the world. This study investigated the occurrence of *Argulus sp.*on endangered golden mahseer, *T. putitora* (Hamilton) broodstock. Identification of *Argulus sp*. was performed by the conventional methods of morphological descriptions and further confirmation was done by 18srRNA molecular characterization. The phylogenetic tree was constructed using the unweighted pair group method with arithmetic mean (UPGMA) through Mega version X. Based on morphological, molecular and phylogenetic analysis, the species *Argulus* isolated from *T. putitora* was identified as *A. siamensis*. The phototactic nature of *A.siamensis* towards hues of blue and green and away from white illuminations gave a cue for the behavioural adaptation of negative heliotropism. The parasitic frequency of *A. siamensis* was higher in blue and green lightround tanks compared to the white lightsquare tanks. *A.siamensis* is the first known confirmed species of crustacean parasite from the host, *T.putitora* in the mid-Himalayan regions of India and the study also focused on control measures adaptable for under gravel filter tanks.

Keywords: *Argulus Siamensis*, Under-gravel filter tank, *Tor Putitora*, Light illumination, Parasitic frequency index, Control measure

Paper ID 15806

A cohabitation study revealing the resistance of Goldfish against Koi Sleepy Disease (KSD)

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Koi sleepy disease (KSD) of common carp and its ornamental variety, koi carp, is caused by the poxvirus, carp edema virus (CEV). CEV outbreaks are accompanied by high mortality rates in farmed populations of common carp and koi carp. KSD is usually associated with lower water temperatures (below 25°C). Few studies have addressed the susceptibility of goldfish (usually co-cultured with koi) at lower temperatures (below 25°C). In the present study, 20 healthy koi carps and 20 goldfish were cohabited in a tank along with CEV-infected koi carps. The experiment was conducted in glass tanks with continuous aeration. Water temperature was maintained at 22-24°C. Control tanks with healthy (CEV-negative) koi carps and goldfish were maintained under the same conditions. The experiment continued for 7 days. Ten moribund fishes from the experiment tanks were euthanized and their gills were tested for the presence of CEV by PCR using specific primers. Cohabited healthy koi carps started showing sleepy behaviour from the second day onwards. Their gills appeared pale and swollen. Goldfish showed no symptoms of KSD. The PCR results showed the presence of CEV in all the fishes with symptoms. Goldfish in both the control and the experiment tanks were negative for CEV. This confirms the resistance of goldfish towards CEV at water temperatures below 25°C. Sequencing of the PCR product and the subsequent similarity search in the NCBI database showed 100% similarity to other CEV sequences from India. In this study, we noticed that not all the symptomatic fishes became moribund; some of them, after exhibiting prominent symptoms (like lying on the bottom of the tank), recovered and became normal. Further studies are required to understand the immune susceptibility of koi carp against CEV.

Keywords: Goldfish, Koi carp, Koi sleepy disease, Carp edema virus

Paper ID 15822

Effects of dietary *Moringa oleifera* leaf extract on growth performance, enzyme activity, and non-specific immune parameters in Rohu, *Labeo rohita* (Hamilton, 1822)

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The present study was aimed to investigate the dietary supplementation of *Moringa olifera* leaf extract (MLE) on growth performance, digestive, anti-oxidative enzyme activities and non-specific immune responses of rohu, *Labeo rohita* fingerlings. All total of 180 rohu (avg. weight 12.24 g ± 0.5 g) were randomly divided into four experimental treatments in triplicates (15 fish in each tank), designated as control (C); basal diet without MLE; 0.25% MLE, 0.5% MLE, and 1.0% MLE containing 0.25% 0.5%, and 1% of MLE respectively, and fish were fed 3% of body weight daily for a period of 60 days. Results indicated that significant increment in growth parameters as evidenced by higher final weight and lower FCR in all treatments than control. Additionally, significantly enhanced digestive enzyme (amylase and total protease) activities as well as serum antioxidative enzyme (SOD and catalase) activities were observed in all MLE fed treatments with maximum was reported in 1% MLE. Inclusion of ≥ 0.5% MLE significantly ($p<0.05$) enhanced serum lysozyme, myeloperoxidase (MPO), blood respiratory burst activities (RBA), total serum protein; and albumin in all three treatments compared to control. Furthermore, dietary inclusion of 0.25% 0.5%, and 1% of MLE in fish feeds has resulted in significantly increased serum bactericidal activity (SBA) and alternative complement activity (ACH50) than basal fed fish. Thus MLE is advantageous to include in feed which attributes augmentation of immunity, hence can serve as potential immunomodulator and growth enhancer in aquaculture.

Keywords: Moringa leaf extract; Immune responses; Antioxidative enzyme; *Labeo rohita*

Paper ID 15834

Identification of aquatic pathogens free Marine polychaete, *Onuphis eremita*, composed as the first specimen from Kovalam seashore, Chennai suitable for grow-out practices

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The marine polychaete worm *Onuphis eremita* collected from Kovalam seashore to screen the presence of shrimp pathogens such as White spot syndrome virus (WSSV), *Enterocytozoon hepatopenaei* (EHP), Infectious hypodermal and hematopoietic necrosis virus (IHHNV), Acute hepatopancreatic necrosis disease (AHPND). The wild *O. eremita* (n-5, 1.5g, 16 cm size.) samples were collected during the low tide from three different locations of Kovalam seashore and pooled. DNA was extracted from anterior, middle and posterior parts of the polychaete worm using lysis buffer and Cetyltrimethylammonium bromide (CTAB) method for PCR analysis. Of these two methods, lysis buffer method fetched a good quantity of DNA. The middle portion of the polychaetes gave adequate quantity and quality of DNA for PCR analysis. The samples were screened by using OIE protocols for WSSV, IHHNV and AHPND, and EHP by SSU rRNA. It was observed that all the samples were negative for four shrimp pathogens viz., of WSSV, EHP, AHPND and IHHNV respectively. Furthermore, from previous studies it was evident that *O. eremita* contained a higher level of fat and fibre contents 15.86% and 16.52% (DWB) respectively as compared to mud worm *Marphysa madrasi.* Hence it was concluded that the *O. eremita* can used as a potential live feed for broodstock shrimps/fishes. The present study also shows that the polychaete worm of *O. eremita* is free from important shrimp pathogens and can be a promising live feed in hatcheries which are struggling to get live feed since many polychaete species are endangered. However, disease status in this species has to be confirmed in larger sample size.

Keywords: Screening; Polychaeta, Shrimp pathogens; Bio-chemical composition

Paper ID 15841

Laboratory evaluation of Antibiotic Florfenicol on growth, non-specific immune response and biochemical profiles in Indian Major Carps: A preliminary study

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Commercial aquaculture with intensive culture operations has increased the episodes of infectious diseases leading to severe economic losses all over the globe. Among the diseases, control of bacterial infections demands the use of various antibiotics. Florfenicol (FFC) is a USFDA approved antibiotic permitted for use in aquaculture. The present study was carried out to study its effect on immune status and serum biochemical profile in rohu, *Labeo rohita* after administration through the feed in graded doses. Rohu advanced fingerlings (avg. size 15 ± 2 g) in triplicates administered with the antibiotic in feed at graded doses viz., 0 (control), 10 (1X), 30 (3X), 50 (5X), 100 (10X) mg kg^{-1} of fish biomass per day @ 3% for 30 days followed by feeding with the control diet (without FFC) for another ten days (up to the 40th day) for post FFC dosing observation. Water quality parameters were in the optimal range in all the tanks and no mortality was recorded during the study period. Experimental fishes (n=5) were randomly sampled every 10 days interval up to 40th day. There was no significant effect of drug on growth within the experimental group compared to the control. Slight or no variations in respiratory burst activity (NBT) in blood, and serum myeloperoxidase activity were noticed during 20th to 30th day which was retained to normal range on 40th day. Serum glucose concentration was significantly increased especially in 50 (5X), 100 (10X) and its level reduced and reached to normal level after 10 day of post FFC dosing. Serum total protein and globulin levels did not show any differences among treatment groups while serum albumin increased significantly in 1X treatment group, but decreased at higher doses on 20th, 30th and 40th day. Serum alkaline phosphatase activities showed reduced activities in FFC treated groups than control. So the aquaculturist need to be careful while applying higher doses of antibiotics in aquaculture which will have adverse effect on the fish as well as environement.

Keywords: Florfenicol, Antibiotics, Rohu, Immune response, Biosafety

Paper ID 15860

Prevalence of Columnaris disease (*Flavobacterium columnare*) in ornamental fishes traded in Tiruvallur District, Tamil Nadu, India

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Ornamental fishes are known as living jewels owing to their attractive coloration and shape. Ornamental fish keeping has emerged as an important hobby worldwide. Tamil Nadu state of India is one of the major ornamental fish trading centre with Tiruvallur district of the state being an important hub in which ornamental fish breeding and rearing centres are concentrated. Disease is the major factor that affects the ornamental fish farming operations as they affect the appearance and health of the fishes which significantly results in reduced sale value, customer preference and associated production and economic losses. Columnaris is a common disease of freshwater ornamental fish caused by the bacterial pathogen, *Flavobacterium columnare* which has ubiquitous distribution in freshwater environment and infect many wild and cultured freshwater food fish and ornamental fishes. In our study on the prevalence of columnaris in the ornamental fishes of Tiruvallur district, Tamil Nadu, a total of 100 ornamental fish samples were collected from ornamental fish outlets and rearing units. The fishes with clinical signs of columnaris disease such as appearance of small round patch like lesion in the dorsal fin and saddle back appearance were collected, anaesthetized and the wet swab were taken from the lesion and inoculated in HP6 media with Tobramycin, Polymyxin and Neomycin. After incubation for 48 h at 20°c, the growth of *Flavobacterium sp* was observed as yellow rhizoid colonies. PCR amplification of the DNA from the isolates using Flavobacterium-specific 16sr DNA gene resulted in the amplicons of ~1188 bp size. Sequencing and comparison using NCBI BLAST showed that the isolate was *Flavobacterium sp*. with a homology of 99% with the DNA sequences in the NCBI records. The results of the study showed that the prevalence of columnaris was 20% in the ornamental fishes of Tiruvallur district, Tamil Nadu and there is a need to prevent control the spread of columnaris by adopting good management practices and to maintain water quality to prevent the disease spread in ornamental fish culture systems.

Keywords: Columnaris, *Flavobacterium columnare*, Ornamental fish, Tiruvallur

Paper ID 15862

Report on occurrence of infectious diseases in farmed Mud Crab in India

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The mud crab genus Scylla is an economically important aquaculture species. The genus is classified into four distinctive species viz., *Scylla tranquebarica, S.serrata, S.olivacea, and S.paramamosain*. In the year 2015, the global mud crab culture production was estimated to be 2, 26,390 metric tons with a farm-gate value of US$1.06 billion. *Scylla spp.,* are generally habitat in mangroves and estuaries of tropical countries. They are lucrative seafood products, especially in Southeast Asian countries. Mud crabs have a great demand due to their high commercial value. In India, the impetus is being given to mud crab farming. It has huge potential for future expansion in the aqua-farming sector due to increasing demand from the global market. However, large-scale farming of mud crabs is currently limited due to limited seed availability and crab farming extensively bank on wild-caught crabs for stocking of seed, fattening, and soft-shelled crab production. Mud crabs are generally considered hardy animals. But recently new diseases have been reported across the world with substantial mortalities with a pronounced impact on mud crabs production. At present pathogen profile of mud crab both either in the hatchery or grow-out culture, their transmission modes, and potential for transmission to other commercially important cultured species is limited. Disease investigation studies in mud crab farming carried out by ICAR-CIBA for more than a decade have documented disease outbreaks due to infectious agents, mass mortalities which led to consequent immense economic losses. The primary disease inflicting pathogens identified in the study comprised viral infections due to white spot syndrome virus (WSSV), mud crab reovirus (MCRV), bacterial infection due to vibrio spp. and heavy parasitic infestation especially due to barnacles such as *Octolasmis sp.* The present study provides insight into the occurrence of economically important diseases in farmed mud crab and envisages biosecurity measures to be in place for mud crab farming practices for sustainable production.

Keywords: Mud crab, *Scylla*, White spot syndrome virus, Mud crab reovirus

Paper ID 15875

Expression profile of immune-related genes in Asian Seabass (*Lates calcarifer*) and Milkfish (*Chanos chanos*) infected by Nervous Necrosis Virus (NNV)

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Nervous necrosis virus (NNV) produces significant mortalities in larvae and juveniles of many brackish water fish species. Asian Seabass (*Lates calcarifer*), a major candidate species in Brackish water aquaculture, is more vulnerable to diseases, whereas milkfish (*Chanos chanos*) is known to be resistant. However, the immune responses of both species to NNV are poorly understood. The present study aimed to evaluate the effects of NNV infection in Asian Seabass and milkfish by analyzing differential immune gene expression. Juveniles of both species were infected by injecting 0.1cc of NNV @ 10^4 $TCID_{50}$/ml per fish, and non-infected juvenile fishes were used as control. Brain, liver, spleen, and kidney tissues were collected at 1, 3, and 5 days post-infection (dpi) from infected fish and control. Quantitative polymerase chain reaction (q PCR) was performed to assess the expression profile of immune genes such as Tol3, IL1, IL13, MHC, and CXC in infected fish and control. The expression profile of all the genes exhibited higher expression in the kidney compared to other organs of Asian Seabass. Similarly, a higher expression pattern was observed in IL1, IL13, and MHC in the kidney of milkfish, while Tol3 and CXC were highly expressed in the brain. However, the expression of different genes was higher in Asian Seabass than milkfish, which could be related to the higher susceptibility of Seabass to NNV. Variations in the expression of genes between the days post-infection (1, 3, and 5 dpi) were also observed in both species. Based on previous studies, the primary target organ for NNV infection was considered as the brain; however, in the present study, the kidney of infected fishes displayed higher fold expression than other organs, and the liver had the most negligible expression. These results provide more insights into the interaction of NNV with Asian Seabass and milkfish.

Keywords: Immune genes, Asian seabass, Milkfish, NNV

Paper ID 15889

Digging deep on an old acquaintance: molecular phylogenetics of Dinoflagellate parasite *Piscinoodinium Sp.* isolated from an acute disease outbreak in Arulius Barb (*Dawkinsia arulius*)

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Freshwater velvet disease is caused by the dinoflagellate parasite *Piscinoodinium sp.* This parasite has been reported from tropical and subtropical fishes, and it can cause devastating losses. Moreover, *Piscinoodinium sp*. is identified as one of the least studied finfish parasites and the available molecular information about this parasite is meager. Recently, *Piscinoodinium sp.* was responsible for the 100% cumulative mortality of the captive-bred F1 generation of arulius barb (*Dawkinsia arulius*) an endangered freshwater fish native to India. The trophont stages of the parasite were observed in the skin and gills of the affected fish. Total DNA was extracted from the trophonts collected from the affected arulius barb and the nucleotide sequence of the nuclear ribosomal DNA (~2334 bp) of *Piscinoodinium sp.* was amplified using PCR. The amplified PCR product had exhibited a high sequence identity with *Piscinoodinium sp*. In the phylogenetic analysis, *Piscinoodinium sp.* emerged as a separate clade from other dinoflagellate species and suggests convergent evolution with another dinoflagellate parasite *Amyloodinium* sp that infects saltwater fishes. This is the first report of *Piscinoodinium sp*. from arulius barb and the impact of this parasite on the wild fish stock is not known. Furthermore, the parasite needs further research focus to generate baseline molecular information and to understand the host-pathogen interaction.

Keywords: *Piscinoodinium sp*., parasitic dinoflagellate, Indigenous ornamental fish, Endangered fish, Phylogenetic analysis.

Paper ID 15892

Bacterial load estimation of *Aeromonas hydrophila* in experimentally infected Indian Catfish, *Clarias magur* and its correlation with disease progression

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Motile *Aeromonas septicaemia* (MAS), caused by *Aeromonas hydrophila* is one of the significant bacterial pathogens severely impeding the production of *Clarias magur*. An *A. hydrophila* species specific SYBR Green I-based real-time quantitative PCR (qPCR) assay using primers from AscU gene of type-III secretion system (T3SS) was developed and optimized. The efficiency of qPCR was 97.01%. The sensitivity of qPCR was 10 copies/µL which was 10^3-fold higher than the conventional PCR. The qPCR primers specifically amplified *A. hydrophila* strains. The inter- and intra-qPCR assay coefficients of variation were low indicating its repeatability. To understand the pathogenesis, magur were intra-peritonealy injected with *A. hydrophila* at LD_{50} dose of 1×10^5 cfu/fish. Disease progression was tracked by quantification of bacterial load in kidney, liver, spleen, intestine and gill tissues at 3, 8, 24, 72- and 144-hour post infection (hpi). At 3 hpi, *A. hydrophila* load increased by 10-fold in all the tested internal tissue indicating rapid colonization, replication and dissemination leading to systemic infection. High bacterial load was in intestine followed by kidney and spleen. The bacterial load in tissues correlated with disease progression showed that pathogenesis of *A. hydrophila* is mediated in different stages i.e. incubation between 0 – 3 hpi, prodromal between 3 – 8 hpi, illness between 8 – 72 hpi, decline between 72 -144 hpi and convalescence period after 144 hpi. The established method should be a useful tool for quantification, diagnosis, and epidemiological monitoring of *A. hydrophila* infection in clinical samples.

Keywords: *Clarias magur, Aeromonas hydrophila*, Quantitative PCR, AscU Gene, Type-iii Secretory system, Bacterial load, Disease progression

Paper ID 15899

Evaluation of protective effects of Heat-inactivated Cyprinid Herpesvirus-2 (CYHV-2) Vaccine against Herpes Viral Hematopoietic Necrosis Disease (HVHND) in Goldfish (*Carassius auratus*)

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Cyprinid herpesvirus-2 (CyHV-2) is an important virus that causes herpes viral hematopoietic necrosis disease (HVHND) leading to huge economic losses in goldfish (*Carassius auratus*). However, until now no proper prophylactic measure or treatment is available for CyHV-2 infection in goldfish. Hence, in this experiment, we developed a heat-inactivated CyHV-2 vaccine and evaluated its performance in goldfish. Initially, CyHV-2 was propagated in the fantail goldfish fin (FtGF) cell line and the titer of the viral inoculum was $10^{7.8}$ $TCID_{50}$/ml. Subsequently, various temperatures (40 °C, 50 °C, 60 °C, 70 °C, and 80 °C) were evaluated to achieve the complete inactivation of CyHV-2. Only the viral inoculum inactivated at 80 °C for 1 hr did not show any cytopathic effect in the FtGF cell line after five blind passages. Hence the heat-inactivated CyHV-2 vaccine developed at 80 °C was further used for immunization trials in goldfish. The experimental goldfish were intraperitoneally immunized with 300 µL of the heat-inactivated CyHV-2 vaccine. Subsequently, the kidney and spleen tissues were sampled at various time points post-vaccination (6^{th} hr, 2^{nd} day, 4^{th} day, 6^{th} day, 10^{th} day, 16^{th} day, and 30^{th} day) to evaluate the expression of immune genes (IL-12, IL-10, IFN-γ, CD8, and CD4). A significant upregulation of immune genes was observed at various time points in the kidney and spleen tissue of the vaccinated goldfish. Furthermore, in order to study the efficacy of the vaccine, the experimental fish were challenged with CyHV-2 ($10^{7.8}$ $TCID_{50}$/ml) after the 30^{th} day post-vaccination. The survival of the fish in the vaccine group (86.7 %) was significantly higher compared to the non-vaccinated group (20 %). Moreover, the relative percentage survival of the vaccinated group was 83.34 %. In spite of the single dose, the heat-killed vaccine developed in the present study elicited the immune response and offered better protection in goldfish against CyHV-2. However, further large-scale field performance evaluation studies are necessary to develop this vaccine on a commercial scale.

Keywords: Aquaculture, Prophylaxis, Inactivated vaccine, Virus, Immune response

Paper ID 15908

Evaluation of potential prophylactic / therapeutic agents for the control of *Enterocytozoon hepatopenaei* (EHP) in shrimp culture.

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Enterocytozoon hepatopenaei (EHP), an emerging microsporidian parasite, the causative agent of hepatopancreatic microsporidiosis (HPM), has become a serious threat to the shrimp aquaculture industry. EHP did not cause mass mortality but was reported to be associated with size variation/ growth retardation and resulted in significant economic losses. However, the prophylactic and therapeutic protocols for the treatment and control of EHP are very limited. In this study, the potential prophylactic/ therapeutic agents were identified by checking the antimicrosporidian activity. EHP spore germination is an important event through which the microsporidian can pierce the host cell and spread infection. In this study, the artificial germination was induced and optimized with 1% KOH at pH 11 for 15 min incubation. Only viable spores can germinate and discharge the infective sporoplasm. Different chemical disinfectants, drugs, and nutraceuticals were evaluated for the antimicrosporidian activity by checking the spore extrusion inhibition activity. Among disinfectants, $KMnO_4$ at 10ppm, formalin at 100ppm, calcium hypochlorite at 30 ppm, sodium hydroxide at 3%, hydrogen peroxide at 2%, and ethanol at 30% were found to be effective in the complete inhibition of spore extrusion activity. Among different drugs, antihelminthic albendazole at 0.025% and among neutraceuticals, thymol at 1mg/ml and naringenin at 1mg/ml were found to completely inhibit the spore extrusion activity. Consequently, in in-vivo experiments, KMnO4 at 15ppm and calcium hypochlorite at 30 ppm were found to be effective in treating the EHP-infected soil. Also, the experimental diets with nutraceuticals such as thymol at 1mg/ml and naringenin at 1mg/ml were found to improve the growth and survival of *P.vannamei* in lab experiments. This study will be helpful in the development and standardization of holistic prophylactic/therapeutics for the control and management of EHP in shrimp culture.

Keywords: *Enterocytozoon hepatopenaei* (EHP), Albendazole, Naringenin, Thymol, Neutraceutical

Paper ID 15910

Screening of phyto-constituents and antibacterial activity of Nutgrass (*Cyperus rotundus L.)* rhizome extract against fish pathogenic bacteria *Edwardsiella tarda*: In vitro study

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Cyperus rotundus L. (family: Cyperaceae) is an indigenous perennial weed having pharmacological and medicinal applications and widely used in Indian traditional medicine. The present study aims to analyze the phytochemical constituent's antibacterial activities of organic and aqueous extract of *Cyperus rotundus* rhizome under *in vitro* conditions. The preliminary phytochemical screening test revealed the presence of alkaloids, flavonoids, phenols, terpenoids, tannins, cardiac glycosides, saponins, and steroids in the methanolic extract. Similarly higher concentration of the total phenolic TPC-(55.28 mg/GAE/g dry weight) and total flavonoids TFC (43.8mg/QCE/g dry weight) was found in methanolic extract. Further, the antibacterial activity of each extract was tested against potential zoonotic pathogenic bacteria, *Edwardsiella tard*a using the agar well diffusion method. The concentration of 1.25 to 5 mg/ml of both methanolic and ethanolic extract of *Cyperus rotundus* rhizome inhibited the growth of *E. tarda with* the highest inhibition zone (10 to 30 mm). The agar diffusion method for antibacterial sensitivity against *E. tarda* was found to be sensitive to commonly used antibiotics such as Gentamicin, Cefotaxime, Amoxicillin, Ciprofloxacin, Trimethoprim, Tetracycline, Chloramphenicol, Oxytetracycline, Sulphamethizole, Cefopernzone, Norfloxacin and Ampicillin/Sulbactam of antibiotics discs. The bacteria *E. tarda* showed resistance to Erythromycin, Penicillin, and Linezolid with intermediate activity to Azithromycin, Neomycin, and Furazolidone. The findings of the study provide baseline information about the organic-based extract of *Cyperus rotundus* rhizome that can inhibit *E. tarda* growth, allowing for future applications in herbal medicine and pharmacology.

Keywords: Phytochemical, *Cyperus rotundus*, *Edwardsiella tarda*, Therapeutic application

Paper ID 15914

Field evaluation of Recombinant Viral Nervous Necrosis vaccine in Asian seabass

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Viral nervous necrosis (VNN) is a serious disease of marine and brackish water fishes affecting more than 177 species. The disease is caused by Nervous necrosis virus (NNV) belonging to the genus Betanodavirus and family Nodaviridae. It is a relatively small virus measuring 25 nm in diameter and the genome consist of two single stranded RNA, RNA1 and RNA2 of size 3.1 and 1.4 kb respectively. There are four genotypes reported viz., Striped jack NNV, Barfin flounder NNV, tiger puffer NNV and red spotted grouper NNV. RGNNV is the only genotype reported in India. The disease causes up to 100% mortality in larvae and early juveniles.In this study, RGNNV was isolated from adult Asian Seabass and characterized. The capsid protein gene of RGNNV was PCR amplified, cloned and expressed in *Escherichia coli*. The recombinant protein was purified using nickel affinity chromatography. The recombinant capsid protein was emulsified with Montanide ISA 763A adjuvant and administered to Asian Seabass fingerlings intraperitoneally to study the efficacy of the vaccine. The efficacy of the vaccine was evaluated under field conditions at two different places. Two hundred fish (average body weight 40 gms) were vaccinated with recombinant VNN vaccine at a dose rate of 100 µg $fish^{-1}$ and were stocked along with two hundred unvaccinated fish separately in cages in backwaters at each place. The pre and post-vaccination serum was collected to assess the immune response. Earlier the vaccine was shown to produce significant immune response and provide protection to fish upon challenge with virulent NNV. Under field conditions also, the vaccinated fish had significantly higher ELISA OD_{405} compared to unvaccinated fish two months post-vaccination. There was no difference in the survival and growth between the vaccinated and unvaccinated fish. Hence, the recombinant VNN vaccine can be used to prevent VNN outbreak in Asian Seabass.

Keywords: Viral Nervous Necrosis; Nervous Necrosis Virus; Asian seabass; Recombinant vaccine

Paper ID 15917

Amyloodinum ocellatum: A Parasitic threat to fish culture systems and the remedial measures

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Amyloodinium ocellatum is an obligate parasite of marine and brackish water fishes, causing extensive mortalities in fishes reared in enclosures. A recent outbreak of *parasitic* infection in rabbit fishes was observed with sudden mortalities in a brackish water aquarium. The causative agent was identified and characterized through microscopy, histology, scanning electron microscopy, and molecular sequencing. The 18SSU ribosomal RNA of the parasite isolated showed 100% similarity to the *Amyloodinium ocellatum* and clustered along with the isolates from Italy, China, and the USA in a phylogenetic tree. This parasitic disease is sudden onset and spreads rapidly through asexual reproductions of tomonts. To eliminate and break the parasite's life cycle, the viability of dividing tomonts under different salinities was examined. Further, we examined the foraging of tomonts using zooplankton predators such as rotifers, *Artemia* nauplii, and adult copepods. The in-vitro experiment revealed the foraging of tomonts invariably by all the zooplankton. However, comparatively adult copepods were actively grazed on tomonts and survived long. The study helped us find the different salinity regimes for the survival, reproduction, and control of the parasitic stages of *Amyloodinium ocellatum*. The study also suggests that the zooplankton predators such as copepods and low salinities could effectively reduce and contain the *Amyloodinium ocellatum* infestation in fishes in closed brackish water and marine aquaculture systems.

Keywords: *Amyloodinium Ocellatum*, Control, Zooplankton predators

Paper ID 15921

Characterization of Inhibitor of Apoptosis (IAP) gene in *Penaeus monodon* by 2-d gel electrophoresis analysis

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Apoptosis is an important distinctive mode of "programmed" cell death. As a vital component of various cellular processes, it acts as a homeostatic mechanism to maintain cell populations in tissues. It also plays role in defense mechanisms such as immune reactions involving damage due to disease. Inhibitor of Apoptosis (IAP) gene plays an important role in regulating apoptosis in shrimp. This is an essential gene in the tiger shrimp, *Penaeus monodon*. Knockdown of IAP by specific ds RNA brings mass mortality within 48 hours post injection. Here proteomics analysis was undertaken to characterize this protein. After IAP knockdown by dsRNA and when shrimps were in moribund stage, pleopod samples were collected and protein was extracted. 2-D gel electrophoresis was carried out at 4-7 pH range. Gels were stained with Coomassie brilliant blue. Differentially expressed proteins were identified based on PD Quest software analysis. A total of 45 protein spots were identified which were found to be differentially expressed. Out of these, 37 differentially spots were expressed in IAP knockdown sample and 8 in the control sample. Some of the important differentially expressed proteins in IAP knockdown samples were Catechol O-methyltransferase domain-containing protein 1 which is involved in signal transduction pathways, metabolism, defense proteins, DNA repair and synthesis, apoptosis, cell cycle regulation along with unknown and hypothetical proteins. Similarly, another protein identified was Triosephosphate isomerase which is a glycolytic enzyme. Differentially expressed proteins in control were ubiquitin carboxyl-terminal hydrolase thiol protease that recognizes and hydrolyzes a peptide bond at the C-terminal glycine of ubiquitin and enolase which is a phosphopyruvate hydratase, a metalloenzyme. In order to predict the outcome of this differential expression, we tried to establish the network of IAP protein interaction. However, shrimp IAP protein interaction network is not available and therefore we compared with the *Drosophila* IAP protein. From this complex interaction, it is predicted that the entire system will be disturbed by the knockdown of IAP protein. Accordingly new proteins may get expressed by the breakup of the network or proteins which are under the control of IAP may erroneously miss the control signal and therefore gets expressed differentially.

Keywords: IAP, Apoptosis, Shrimp, 2d Gel analysis, Mortality, Gene network

Paper ID 15934

Pharmacological efficacy of seaweed, *Sargassum* species in *Labeo rohita* fingerlings

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The objective of the study was to investigate the antibacterial activities of three seaweed species namely *Sargassum cristaefolium, S. polycystum*, and *S. wightii* from the Mandapam coast of Tamil Nadu in *Labeo rohita* fingerlings. Extracts of powdered seaweeds were prepared following the cold extraction method in ethanol, methanol, n-hexane, dichloromethane, ethyl acetate, chloroform, benzene, and aqueous solvents and tested for antimicrobial activity on pathogenic bacterial strains using disc diffusion assay. *S. polycystum* ethanolic extract exhibited strong antimicrobial activity (20.5±0.11 mm) against both gram-positive and gram-negative bacteria. During the challenge study, *A. hydrophilla* was injected into *L. rohita* fingerlings and the fingerlings were fed with a diet incorporating extract for 30 days. At 1500 mg/gm of ethanolic extract of *S. polycystum in* the diet, significant improvement in survival (92.00%), hematological (protein 1.86 g/dl, albumin 1.00 g/dl, globulin 0.40 g/dl, hematocrit 36.94%, blood clotting time 32.8 seconds) and Histopathological parameters including intestinal layers, kidneys, and liver in the treated group were found normal, glomerular spaces and appropriate distribution of cellular components, respectively. In conclusion, raw *Sargassum spp.* the powder can be recommended as a feed ingredient, whereas ethanolic extracts could be used as feed additives in aquafeed formulation.

Keywords: *Sargassum polycystum, Aeromonas hydrophila*

Paper ID 15941

Impact of application of commercial probiotics on survival and growth of cage reared Red Snapper, *Lutjanus argentimaculatus*

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A study was undertaken on the effect of commercially available probiotic bacteria belonging to genera *Bacillus and streptococci* on survival and growth of wild collected red snapper, *Lutjanus argentimaculatus* in 3m dia. cages for a period of 90 days. Hundred numbers of wild collected juvenile fish, with initial average weights of 50 g, were stocked in 3m dia. cages in marine farm of Karwar RS of ICAR- CMFRI. Control fish were fed with pellet feed @ 8 % fish biomass. In experimental treatments (T1, T2 & T3), the fishes were fed with pellet feed supplemented with three different commercial probiotic combinations. Growth, Survival of fish and microbiological parameters were monitored at fortnightly intervals. After 90 days of culture, the Final mean weight (g), Average Daily Growth Rate (ADGR g day^{-}) and Specific Growth Rate (SGR % day^{-}) of fish, were recorded as 250g; 2.23g day^{-}; 0.79 % day^{-}respectively in T1. Significant difference ($p<0.05$) among the different treatments was recorded and T1 showed higher growth rate. Highest survival rate was recorded in T1 and T2 but no significant variation in survival rates among the treatments ($p<0.05$) was found. Microbiological analysis of fish gut revealed presence of *Bacillus* species as dominant group in T1 followed by T2. A significant variation ($p<0.05$) was recorded in total bacterial and *Bacillus* loads among all the treatments. The results of the study indicated that the application of *Bacillus* spp. as feed probiotic enhances the growth and production of cage cultured marine finfish.

Keywords: Cage culture, Commercial probiotics, Growth and survival, *Lutjanus argentimaculatus*

Paper ID 15954

Efficacy of laboratory-developed marine probiotic consortium on survival and growth of Indian pompano, *Trachinotus mookalee*

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Experiment on efficacy of laboratory developed probiotic bacteria belonging to genera *Bacillus, Shewanella and Paenibacillus* on survival and growth of Indian pompano, *Trachinotus mookalee* was carried out for a period of 90 days. Hundred numbers of fingerlings with initial average weights of 30 g were kept in one tonne tanks. Control fish were fed with pellet feed @ 6 % fish biomass. In experimental treatments (T1 & T2: Laboratory developed probiotics; T3: Commercial feed), the fishes were fed with commercial pellet feed (6%) supplemented with probiotics. Growth, Survival of fish and water quality parameters were monitored at fortnightly intervals. The study revealed a significant variation in average weight (g) and Average Daily Growth Rate (ADGR g day^{-}) among the treatments ($p<0.05$). Specific Growth Rate (SGR) and ADGR of fish are found to be highly significant in T2 ($p<0.05$). But no significant variation ($p>0.05$) was recorded in percentage survival of fish among the treatments. Fishes supplemented with T2 probiotic consortia exhibited maximum ADGR (g day^{-}) and SGR (% day^{-}), followed by T1. A significant variation ($p<0.05$) was recorded in total bacterial and total vibrio loads of water among the treatments. The study indicated that the laboratory developed marine probiotics are found to be suitable for better management of growth and health of cultured marine finfish.

Keywords: Marine probiotic consortium (laboratory developed), Survival and growth, *Trachinotus mookalee*

Paper ID 15965

Comparative effect of different sanitizers on shrimp White Spot Syndrome Virus (WSSV) inactivation in experimental and simulated field conditions

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Effective concentrations of different sanitizers were evaluated for total prevention of WSSV in culture environment. It was demonstrated how the concentrations can vary based on different laboratory or field conditions and also based on the way the pathogen is available in the environment. In this way, the right concentrations can be used to eradicate the pathogen and at the same time without putting much pressure on the aquatic environment (soil or water). This was done by various methods, (1) *In vitro* method wherein sanitizer at desired concentration added with equal volume of WSSV filtered particle (1:1) and incubated for 1h at RT, then it was injected to live virus free animals and mortality was observed. (2) Viral particles in sea water, in which WSSV filtered particles, were added to filtered sea water (~10^7/ml) and sanitizers were added. Kept for 48h and then animals were released to the treated water. Mortality was observed thereafter. (3) WSSV infected cut shrimp pieces in sea water, this was done similar to the above where in infected animal remnants were directly used. (4) WSSV particle in soil based, thereafter virus particle and sanitizers were added and left for 48h in a tub containing soil base and sea water. Then healthy shrimp were added to it and mortality was observed. (5). WSSV infected shrimp cut pieces in soil based, similar to the above, direct infected animal remnants were used for the study. Different sanitizers were effective at different concentrations. Among all the sanitizer studied BKC found to be more effective at the lowest concentration against WSSV infection compared to all other sanitizers. Further, these concentrations can prolong the survival rate of the shrimp.

Keywords: *P. vannamei*, WSSV, Sanitizer, PCR, DNA

Paper ID 15992

Halo-tolerant antimicrobial metabolites from *Streptomyces sp.*, against aquatic pathogens

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Bacterial infections constitute the most important source of disease problems in the aquaculture industry. In particular, Gram-negative and Gram-positive bacteria cause epizootics in cultured fish/shrimp species. These strains also actively play a pivotal role in biofilm formation in aquaculture tanks and cause grievous health issues both in shellfish and finfish communities. Viewing the disease's prevalence and biofilm formation, the present study was undertaken to isolate, screen, and identify a novel biogenic compound from a newly isolated halotolerant *Streptomyces* sp. [MH221097]. The results of antibacterial activity inferred that the crude ethyl acetate extract of *Streptomyces* sp. displayed a wide spectral inhibitory zone in the range from 12 ± 0.43 to 20 ± 0.91 mm with MIC (100-600 µg/ml) and MBC (200 to 800 µg/ml) values against aquaculture bacterial pathogens. The ethyl acetate extracts had also showed notable cytotoxicity properties against nauplii of *Artemia parthenogenetica* with an appreciable LC_{50} value. Partial purification of ethyl acetate extract of *Streptomyces* sp. by normal phase silica column chromatography depicted that the 14th fraction had promising antibacterial properties against chosen aquatic pathogens. Further, chemical characterization of bioassay-guided column fraction by FT-IR and GC-MS analysis evidenced the existence of 2-Propenamide, 3-Phenyl, and Bis (2-ethyhexyl) phthalate as the major biogenic compound.

Keywords: *Streptomyces sp.,* Antimicrobial and antibiofilm activities, Cytotoxicity

Paper ID 15993

Analysis of catalase protein of *Edwardsiella tarda* and *Edwardsiella piscicida* - An In-silico approach

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Edwardsiellosis caused by *Edwardsiella tarda* and *E. piscicida* from the *Enterobacteriaceae* family is one of the most common catfish diseases. The negative impacts of antibiotics on animal and human health diverted the research focus on modern strategies like target drugs, vaccination, and the development of disease-resistant stocks as an alternative to antibiotic usage. Bioinformatics paved an alternative approach to identifying, analyzing, and comparing the virulence proteins and their interaction with drugs and herbal compounds, and hence this study. The protein catalase which catalyzes the reduction of hydrogen peroxide into oxygen and water is considered one of the virulence factors of *E. tarda* and *E. piscicida.* These virulent protein sequences were retrieved from the UniProt database and analyzed the protein structures and functions using several servers. The homology model of the virulent proteins was built using SWISS-MODEL and validated using different servers as well as of good quality. The predicted 3D structures were used as receptors in docking studies with 175 antibacterial herbal compounds taken as ligands individually against both virulence gene proteins. Characterization of virulent protein catalase of *E. tarda* and *E. piscicida* revealed that these proteins are soluble, stable, hydrophobic, and partially thermostable. The Z- scores of the predicted models were almost within the range of scores typically found for native proteins of similar size, which indicated that the models generated by SWISS-MODEL are acceptable. The top three antibacterial herbal compounds that gave the least binding free energy **(**ΔG_{bind}) or E-value were lutein (*Amaranthus viridis*) > isoginkgetin (*Cyperus rotundus*) > sciadopitysin (*Cyperus rotundus*) for catalase protein of *E. tarda* and lutein (*Amaranthus viridis*) > ginkgetin (*Cyperus rotundus*) > isoginkgetin (*Cyperus rotundus*) > for catalase protein of *E. piscicida.* The docking results suggested that these antibacterial herbal compounds with the least E-value have the potential to compact Edwardsiellosis in aquaculture.

Keywords: Fish disease, *Edwardsiellosis*, Virulent protein catalase, Homology modelling, Molecular docking

Paper ID 16015

Effective antimicrobial therapy for *Aeromoniasis* in carps

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Aeromoniasis was considered to be the most predominant bacterial disease occurring in the fish farms of Southern Odisha varying from 6.7 to 29.4% as observed under a surveillance programme during April 2014 to March 2020. Use of antimicrobial drugs is one of the approaches of tackling *Aeromoniasis* in aquaculture. In the present study, three antibiotics namely Ciprofloxacin, Ofloxacin and Norfloxacin were tried. Doses were finalized according to 2.0g/ml as MIC value and 3.0 µg/ml as MBC value for Ciprofloxacin; 5.0 µg/ml as MIC value and 25.0 µg/ml as MBC value for Ofloxacin and 5.0 µg/ml as MIC value for Norfloxacin. MBC/MIC ratio was determined for Ciprofloxacin as 1.5 and for Ofloxacin as 5. Since the value of MBC/MIC ratio was below 4 for Ciprofloxacin, this was considered to be bactericidal. Whereas, Ofloxacin was considered to be bacteriostatic as the value of MBC/MIC ratio was above 4. Based on this ratio, Ciprofloxacin and Ofloxacin were found suitable for *in vivo* application. The LD_{50} value of *A. hydrophila* (*Ah*2) was calculated to be 2.19 x 10^7 cfu/fish. The causative agent was re-isolated from kidney and liver of the moribund fishes and subjected to 16S rRNA gene sequencing and deduced gene sequence of 1484 bp. The pair wise sequence alignment was performed with the reference strain, *Ah*2 (Gene Bank Accession No MT974689.1) showing 100% identity, confirming the causative agent to be the same strain *A. hydrophila*. Experimentally infected fishes were treated with two selected antibiotics, *viz.*, Ciprofloxacin and Ofloxacin at three different doses (2.5µg, 3.0 µg, 3.5 µg and 5.0 µg, 25 µg, 50 µg respectively) per gram of body weight respectively for ten consecutive days. Doses were selected on the basis of MIC and MBC values determined. Percentage recovery was found better for Ciprofloxacin than Ofloxacin. Farm trial was also conducted with same antibiotics with same doses. ANOVA with LSD analysis was carried out and the effect of doses of 3.0µg/ml and 3.5µg/ml was found significantly superior to 2.5 µg/ml of Ciprofloxacin. Finally, Ciprofloxacin at 3.5µg/ml incorporated in feed found suitable for application at farmer's pond.

Keywords: *A.hydrophila, Aeromoniasis*, Antibiotics

Paper ID 16019

Bacterial pathogens *Vibrio harveyi* and *Vibrio campbellii* in Indian shrimp hatcheries: Green and yellow colony dogma

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Vibrio harveyi has been widely reported from shrimp and finfish hatcheries and farms from several countries including India. It is also considered as a significant pathogen responsible for luminescent vibriosis in shrimp hatcheries resulting in up to 100% mortality in the early larval stages. Phenotypically it shares close relatedness from other pathogens such as *V. campbellii* and *V. owensii* leading to frequent misidentification. To understand the true identity, we investigated the genetic identity of 29 luminescent *Vibrio* isolates from Indian shrimp hatcheries and farms which were earlier identified as *Vibrio harveyi*. Phenotypic characteristics and 16S rRNA gene failed to differentiate these isolates up to species level. However, further analysis by haemolysin gene-specific PCR and phylogenetic analysis of house-keeping genes *rpoD* and *toxR* identified all the isolates as *V. campbellii*. Whole genome sequencing of one of these strains, LB102 further confirmed it as *V. campbellii*. A myth or dogma among hatchery operators and aquaculturist prevails that green colored colony on TCBS agar are harmful and keeping their number under control is vital for hatchery operation and also good farm outcome. To find the truth behind this dogma, we re-evaluated confirmed strains of *V. harveyi* and *V. campbellii* for their growth characteristics on TCBS agar. Our analysis suggested that contrary to belief, all the strains of *V. campbellii* (n=30) form green colonies while *V. harveyi* (n=5) produced yellow colonies on TCBS agar. This was supported by genomic analysis of strains of *V. harveyi* and *V. campbellii* available at the NCBI database (n=105). It was observed that above 90% strains of *V. harveyi* have operon for sucrose fermentation (responsible for yellow colored colony formation on TCBS agar) and more than 95% strains of *V. campbellii* lacked these genes (thus forming green colonies on TCBS agar). Our results strongly suggest that *V. campbellii* is a major pathogen in Indian shrimp hatcheries and saga of green vs yellow colony is untenable.

Keywords: *Vibrio harveyi, Vibrio campbellii*, Shrimp hatcheries, Diagnosis, Luminescence

Paper ID 16022

Genomic characterization of Indian Tilapia Lake Virus strain with implications for virus origin to aid in molecular epizootiological investigations

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Genomic characterization of viruses is essential for the epizootiological investigations and the implementation of proper control measures against the disease. *Tilapia lake virus* (TiLV) is an emerging virus in tilapia aquaculture industry resulting in heavy economic losses. Despite the enormous economic impact, the knowledge on the origin, evolution, and epidemiology of TiLV strains of India is still largely uncharacterized. Even though TiLV is first reported from India during 2018, no information of Indian TiLV genome is available. In accordingly, the study was targeted to generate the complete coding sequence information of certain genomic segments (segments numbered, 1, 3, 4, 6-10) of Indian strain of TiLV for the first time. The genomic analysis showed that four segments viz., segment 1, 6, 7 and 10 will be more informative for the classification of TiLV below species level. Further, the phylogeny of TiLV isolates was found to be dependent on the segment sequenced, suggesting that TiLV has undergone genomic re-assortment, reinforcing the necessity to consider all the genomic segments while phylogenetic analysis to infer geographic origin and track the movement. More interestingly, phylogenetic analysis demonstrated that the Indian strain has maximum similarity with Bangladesh TiLV strains. Our results warrant further studies on genetic types of TiLV circulating in the country through extensive active and passive surveillance programme in both healthy and diseased fish, to have specific stringent control measures against this emerging viral pathogen in aquaculture industry. In short, the study generates novel insights on the molecular epizootiology and genetic diversity of an important viral pathogen that threatens the tilapia aquaculture industry worldwide.

Keywords: Viral diseases, Phylogram, India, Aquaculture, Tilapia, Diseases

Paper ID 16026

Evaluation of florfenicol oral administration for the control of *Vibrio harveyi* infection in snub nose pompano, *Trachinotus blochii*

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Knowledge of the efficacy at the recommended dose in each host is an essential prerequisite for the responsible use of antimicrobial drugs in sustainable aquaculture practices. *V. harveyi* is one of the most predominant pathogenic *Vibrio* sp. in diverse marine finfishes however, there are no data on the pharmacological efficacy of different antimicrobials against *V. harveyi*. The present study forms the first report on the *in vivo* efficacy of florfenicol, a non-human antimicrobial drug recommended for aquaculture, against *Vibrio harveyi* in a high-value marine fish, *Trachinotus blochii*. Oral administration of the recommended dose (15 mg/kg/day for 10 days) was found to be effective against *V. harveyi* induced mortality. Therapeutic efficacy was further confirmed through histological and microbiological studies. The treatment completely removed *V. harveyi* from the infected fish, while non-treated fish remained as carriers. This is the first report on the efficacy of an antimicrobial drug in *T. blochii*. Another interesting observation was the loss of drug (10%) during medicated fish feed preparation, which needs due attention during the intended use. In short, the paper generates useful insights for the responsible use of florfenicol in sustainable aquaculture practices of *T. blochii*.

Keywords: Silver pompano, Antibiotic, Challenge studies, Recommended dose, Histopathology

Paper ID 16034

In silico characterization and promoter analysis of Perforin and Mucin genes in Indian Major Carp, *Labeo rohita*

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Perforin, a key molecule involved in T-cell and natural killer-cell-mediated cytolysis, and mucin, a high molecular weight glycoprotein polymer that forms a highly viscous gel in the epithelium play important roles in providing disease resistance to microbial infections in general and *Aeromonas hydrophila* infection in rohu, *Labeo rohita* particularly. The 574 aa perforin 1-like protein in rohu contains a MAC/Perforin domain at position 154-355 aa. The membrane-attack complex (MAC) of the complement system forms transmembrane channels. These channels disrupt the phospholipid bilayer of target cells, leading to cell lysis and death. Perforin polymerizes into transmembrane tubules in the presence of calcium and lyses non-specifically a variety of target cells. The conserved domain analysis identified the C2 domain of Perforin at position 376-502 aa which plays a role in lymphocyte-mediated cytotoxicity. A putative 689 aa sequence of mucin 2 contains von Willebrand factor (vWF) type D domain, trypsin inhibitor-like (TIL) cysteine rich domain and C8 domain. VWF is a large multimeric glycoprotein and D domains in the protein are necessary for multimerisation. TIL and C8 domains are found in disease-related proteins and some large modular glycoproteins. Promoter sequence analysis of perforin gene using Transfac, Tfsitescan, PROMO, etc detected the presence of transcription factors like Sp1, Ets family and myeloid elf-1 like factor (MEF) and the absence of a TATA box. Mucin promoter sequence contains both TATA box and CACCC box. Homeobox domains (Cdx), CCCTC-binding factor (CTCF), GATA family, HATH1 and Sp1 family immune cell specific transcription factors like Oct-1, HNF-1, FOXD3, Pax-6 were found in mucin promoter sequence. Altering the expression of these two candidate genes will allow us to test the function of these genes on microbial disease resistance. Gene editing of the promoter of these genes using techniques like CRISPR enables their up and down-regulation. Knowledge about these genes will help to validate their potential role in *Aeromonas hydrophila* resistance in rohu.

Keywords: Perforin, Mucin

Paper ID 16040

Identification and characterization of few isolates of *Klebsiella pneumoniae* associated with freshwater fish mortality events

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Fish under stressful conditions are mostly susceptible to infectious diseases caused by a phylogenetically diverse collection of bacterial pathogens. In the present study, samples were collected from four different fish species i.e. *Labeo rohita, Catla catla, Cirrhinus mrigala* and *Channa striata* from different freshwater aquaculture fish ponds of Odisha during mortality events showing common clinical signs of red patches over operculum and body surface; ulcers over body surfaces, and fin rot and tail rot. *Klebsiella pneumoniae*, an opportunistic Gram-negative bacterium was isolated from the above infected cases and confirmed using biochemical characterization, 16S rDNA PCR and sequencing, and PCR amplification of *K. pneumoniae* specific ITS region. Koch's postulate was experimentally established through intraperitoneal challenge tests conducted in *L. rohita* for all four isolates. The isolates were found resistant to nine classes of the antibiotics out of eleven classes studied here. In addition, three antibiotics resistance genes were also detected using semi-quantitative PCR. The class I integron was also detected in two of the isolates. The isolates were tolerant to copper and mercury, and less tolerant to chromium. Virulent siderophore genes namely entB (enterobactin) was found in all four bacterial isolates while fimH-1 and mrkD genes, encoding type 1 and type 3 fimbrial adhesins, respectively, were found in two isolates. Further, cyclophosphamide-induced immunosuppression in *L. rohita* juveniles increased the susceptibility of fish to *K. pneumoniae* infection as compared to control fish. This investigation generated information on the prevalence of potential pathogenic *K. pneumoniae* in aquaculture system and their pathogenicity under immunosuppressive condition.

Keywords: Cyclophosphamide, Immunosuppression, *Klebsiella pneumoniae*, Pathogenicity

Paper ID 16053

Assessment of infectivity and replication efficiency of Red Sea Bream Iridovirus (RSIV) in different fish cell lines

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Red sea bream iridovirus (RSIV) is the etiological agent responsible for Red sea bream iridovirus disease (RSIVD) in fish. In 2018, RSIV was first time reported in Asian sea bass from Indian waters. The present study was aimed to investigate the RSIV infection in different fish cell lines. Further, infectivity and replication efficiency of this virus was studied in eleven fish cell lines. All the tested cell lines were susceptible to infection with RSIV and exhibited positive cytopathic effect (CPE). Morphologically, CPEs of the RSIV infection was characterized by cell shrinkage, rounding, enlargement and cell lysis. The CPE with rounding and enlargement was prominent in the infected cells of SISS, SISK, AFF, OnIL, DRG and IGK cells. Whereas, rounding of cells were not prominent in the EM2GExa, EM4SpEx, HC2SPEx, IEK and CSK cells. A progressive CPE was observed in SISS, SISK, AFF, OnIL and IGK cells after 3 to 5 days of post infection (dpi). Complete degeneration of the monolayer of cells was observed from 9 dpi. RSIV infection in virus infected cell lines were further confirmed by RSIV-specific PCR using the genomic DNA. The replication efficiency of RSIV in the different fish cell lines was determined by TCID50 assay. All the cell lines supported the propagation of RSIV with virus titers ranging from $10^{2.6}$ to $10^{6.3}$ TCID50/ml. In this study it was observed that among eleven cell lines studied, RSIV replication was found to be high in SISS with a titer value of $10^{6.3}$ TCID50/ml followed by SISK with $10^{5.3}$ TCID50/ml. These results show that the SISS and SISK cell lines are conducive for RSIV replication. Thus SISS and SISK cell lines can be used for further research towards the development of diagnostics tools and vaccines against RSIV.

Keywords: Asian sea bass, Fish cell line, Tcid50, Infectivity, RSIV.

Paper ID 16056

First report of Infectious Spleen and Kidney Necrosis Virus (ISKNV) in Orange Chromide (*Etroplus maculatus*) Karnataka, India

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Mortality of orange chromide (*Etroplus maculatus*) was reported from Dakshina Kannada, Karnataka, India. There are three species comes under genus *Etroplus*, i.e., *E. canarensis* confined mainly to Karnataka whereas *E. suratensis* and *E. maculatus* were found in the Kerala region. These endemic fishes were found in locations of biodiversity hotspots of Western Ghats. The present study was conducted to identify the aetiological agent associated with mortality of E. maculatus. The *E. maculatus* exhibited external clinical signs such as body discolouration along with petechial haemorrhages whereas internally with enlarged spleen and kidney. PCR amplification of the major capsid protein (MCP) gene with a product size of 563 bp was sequenced and phylogenetic analysis confirmed that the aetiological agent was infectious spleen and kidney necrosis virus (ISKNV) of the genus Megalocytivirus. The phylogenetic analysis revealed that the isolated ISKNV sequence was closely related to the ISKNV isolated from Angel fish (*Pterophyllum scalare*) from Australia. The sequence was then submitted to NCBI GenBank data base (SUB2567868). Virus propagation was carried out by using SISS cell line. Infected SISS cells showed cell rounding, enlargement, and following detachment of cells which clearly indicate the cytopathic effects (CPEs). The viral load was high about 1.24×10^{12} copies found in spleen of E. maculatus. The present study confirmed the susceptibility of an endemic species (*E. maculatus*) to ISKNV infection indicating expansion of its host range.

Keywords: Infectious Spleen and Kidney Necrosis Virus, Western ghats, *Etroplus maculatus*, Viral load, Host range

Paper ID 16059

Profiles of antibiotic resistance and virulence genes in Vibrionaceae associated with *Scylla olivacea* (Herbst, 1896): A surveillance perspective

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Increased incidences of vibrio infections in humans and aquatic animals due to ocean warming, demanded detailed studies of Vibrios in potential harboring animals, with focus on virulence and antibiotic resistance. Scylla olivacea is a coastal fisheries candidate with known potential to harbour microflora and little data is available on microbiology of these crabs, focusing public health significance. The analysis was done in the study with respect to overall bacterial distribution in different tissues, and profiling of antibiotic resistant (AR) genes associated with this microflora. It was found that apparently healthy *S. olivacea* harbours vibrios with greatest concentrations in gut (1.74 X 10^6 CFU/g), followed by gill (1.60 X 10^6 CFU/g), and lowest mean in hemolymph (1.77 X 10^2 CFU/ml). A total of 23 morphologically different vibrio isolates identified, belonging to 3 distinct species (prevalence order: *V. parahaemolyticus* (56%) > *V.alginolyticus*> *V. diazotrophicus*) with gut having the maximum diversity. Phylogenetic analysis indicated 2 clades (Harveyi and Diazotrophicus), with dominant Harveyi clade. Prevalence order of virulent genes was chiA (V. harveyi)> collagenase (*V. parahaemolyticus*)> toxR (*V. parahaemolyticus*) > toxR (*V. alginolyticus*). AR pattern (against 21 antibiotics/6 classes) showed that imipenem, nalidixic acid and chloramphenicol as most efficient antibiotics against vibrios. Among 18 AR genes screened, only tetS, tetH, tetB and aphA3 were present in vibrios with an overall prevalence of AR genes as 2.89%. About 87.80 % isolates were multidrug resistant (MDR), they were neither extensively drug resistant (XDR) nor pan-drug resistant (PDR). About 92.68% isolates showed multiple antibiotic resistance index (MAR index) value > 0.2, indicated antibiotic resistance risk. The study forms first report on occurrence of tetH and tetS among vibrios. Apart from aquaculture angle, the generated ABST pattern, profiles of virulent and AMR genes of vibrio isolates through the study will have applications in public health perspectives too.

Keywords: *Scylla olivacea*, Multiple antibiotic resistance index, Antibiotic resistance genes, Virulence genes, Vibrionaceae

Paper ID 16063

Artificial designing of antimicrobial peptide

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Artificial short antimicrobial peptide (sAMP) has emerged as a new class of AMP to overcome the shortcomings of the natural AMPs. In the present study, we have designed a short antimicrobial peptide using four types of amino acids. The designed peptide is amphipathic with a net charge of +6. The peptide was synthesized by FMOC chemistry and characterized by various in-silico tools. The peptides showed promising antimicrobial activities against various bacterial and fungus-like pathogens, including antibiotic resistant bacteria. Molecular docking studies showed that the peptide interacts strongly with two important target proteins of Aeromonas spp; outer membrane protein (OMP) and aerolysin. The antimicrobial activity of the peptide was checked under various environmental conditions, such as high temperatures, presence of serum and physiological salts. The peptide is less hemolytic even at higher concentration. The peptide also exhibited its ability to interact with bacterial genetic material as determined by DNA binding assay and hence may inhibit replication. The peptide also interferes with bacterial membrane integrity. In in-vivo experiment, the peptide completely inhibited the growth of fungus like pathogen, Saprolegnia parasitica, at ≥ 30 µM peptide concentrations in embryonated fish eggs. To conclude, the results suggest that the artificially designed peptide may have therapeutic importance in aquaculture.

Keywords: Artificial antimicrobial peptide, Bacteria, Fungus like pathogen, Antimicrobial activity, Molecular docking

Paper ID 16064

Molecular confirmation of naturally co-infected *Lernaea* and *Argulus* in cultured and ornamental fishes

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As the world population increases, the demand for the fish has been also increased. This increasing demand has to be met by the aquaculture due to decline in capture fisheries because of over-exploitation. Disease is one of the limiting factors in aquaculture and is responsible for huge economic loss. Aquaculture is prone to various diseases from infectious agents like virus, bacteria and parasitic and also from non-infectious agents. It effects the fish by inducing various diseases and directly affect the market value of fish in trade. Many parasites also have the zoonotic potential, as a consequence it is the major cause of concern in aquaculture and also results in financial loss. There is a wide group in parasites (Protozoans, Myxozoans, Microsporidians, Nematodes, Cestodes, Trematodes and Crustaceans) which may cause diseases, some of them can cause coinfections in fishes. The information available on the coinfection of parasites is scant, therefore research into the parasites is important and therefore, this study was undertaken by aiming such parasites which may cause infection in cultured and also in ornamental fishes. Total 120 samples were screened, Rohu (n=3) and Gold Fish (n=2) were found to be coinfected with *Lernaea* and *Argulus*. These were detected at phenotypical level by using the bright field microscope and at the genotypic level by following standard molecular diagnostic techniques. The amplified 28S rRNA gene showed a bright band at 744 bp. Among them three were sequenced which belonged to *L. cyprinaceae* and submitted to NCBI-GenBank with accession number OM835790, OM827070 and OM827069, and closely related to Russian isolates. One of three *Argulus* sample was amplified for COI gene yielded a product size of 709 bp. Sequencing and phylogenetic analysis revealed it belonged to *A. japonicus* with close relatedness to strains from Japan and submitted to NCBI-GenBank with accession number OM836429.

Keywords: Coinfection, Parasites, Molecular, Rohu, Goldfish, *Lernaea cyprinaceae*, *Argulus japonicus*, NCBI-Genebank

Paper ID 16067

Molecular detection of pathogens from cultured White leg shrimp farms in Karnataka, India

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Whiteleg shrimp, *Litopenaeus vannamei* is one of the most cultivable species in India. The present study aimed at screening of major shrimp pathogens from cultured shrimp in Karnataka by polymerase chain reaction (PCR) assay. A total of 278 samples were collected from shrimp farms of Karnataka during January 2020 to March 2022. Samples were subjected to polymerase chain reaction based detection of DNA viruses such as white spot syndrome virus, hepatopancreatic parvovirus, monodon baculovirus, infectious hypodermal and hematopoietic necrosis virus, decapod iridescent virus-1 and RNA viruses like taura syndrome virus, infectious myonecrosis virus, yellow head virus, microsporidian parasite like *Enterocytozoon hepatopenaei* and acute hepatopancreatic necrosis disease causing *Vibrio parahaemolyticus* strain. PCR analysis confirmed the presence of *Enterocytozoon hepatopenaei* (EHP) and White spot syndrome virus (WSSV) from the collected samples and no other pathogens could be found in the analyzed samples. Out of 278 samples, 63 (22.6%) samples were found to be positive for EHP and 14 (5%) samples were found to have infected by WSSV. Among these, three samples were infected by both WSSV and EHP. Shrimp samples infected with WSSV exhibited typical white spot on the carapace and EHP infected shrimps showed its distinctive symptoms of size variation and white gut. Further, histology of gill tissue infected with WSSV shows basophilic intra-nuclear inclusion bodies and hepatopancreas tissue infected with EHP showed basophilic plasmodium. Our findings demonstrate the prevalence of EHP was higher in shrimp farms of Karnataka. The present study strongly recommends strict biosecurity measures and good management practices at shrimp culture areas for the continuity of *L. vannamei* culture in India.

Keywords: *Litopenaeus vannamei*, WSSV, EHP, Good Management Practices.

Paper ID 16068

DNA decorated gold nanoparticles for rapid identification of *Saprolegnia Parasitica*

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The genus, Saprolegnia comprises of many species which are responsible for devastating diseases in freshwater fish. Saprolegnia are considered as secondary pathogens but some are highly virulent, particularly *S. parasitica* and has infected various fish species worldwide resulting in huge economic loss. Therefore, early identification of causative species will enable to initiate proper control measure before the disease spread. At present, the most commonly practiced method for identification of Saprolegnia species is sequencing of rDNA-ITS region. However, sequencing is not possible in less equipped laboratories and takes time in outsourcing. Here, we developed a rapid and sequencing free method for identification *S. parasitica* using gold nanoparticles (AuNPs) decorated with species specific DNA probe. The underlying principle of this methodology is that in positive samples (*S. parasitica* DNA), hybridization of the DNA probe with complementary sequences prevents aggregation of AuNPs under the influence of hydrochloric acid (HCl) and the solution remains red. Whereas in the case of negative samples (other species), the AuNPs aggregate upon addition of HCl and the solution turns purple. Thus, based on colour of the reaction mixture, *S. parasitica* can be identified visually without sequencing within few minutes. This methodology requires no sophisticated instruments, hence will be suitable for field laboratories with limited facilities.

Keywords: *Saprolegnia parasitica*, Gold nanoparticles, DNA probe, Visual detection

Paper ID 16078

Disease occurrence and physico-chemical parameters in some fish farms of Ganjam and Kalahandi Districts of Odisha, India

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A study has been conducted from November 2015 to March 2020 in 22 fish farms of Ganjam district and 21 fish farms of Kalahandi district of Odisha, India to assess the disease occurrence in fin fishes and physico-chemical parameters of water under ongoing National Surveillance Programme on Aquatic Animal Disease (NSPAAD) at College of Fisheries (OUAT), Odisha. During survey, 86 water samples were collected and evaluated, 50 of which were from Ganjam district and 36 from Kalahandi district. The water quality parameters selected for assessment were pH, Temperature, Dissolved oxygen, ammonia, nitrite, phosphate, alkalinity and hardness. Except for ammonia level in some farms of Kalahandi district, the values were found to be within desirable ranges. In fin fishes, Argulosis and Aeromoniasis were found to be predominant parasitic and bacterial infection. In order to investigate the association and influence of physico-chemical parameters on disease occurrence in two districts, appropriate statistical tools were used to establish the correlation. It was observed that water quality parameters except ammonia have minimal effect on the occurrence of disease. Occurrence of Argulosis and Aeromoniasis in some fish ponds of both districts might be due to excess organic load at the bottom at poor pond environment.

Keywords: Physico- Chemical water parameter; Disease Incidence; Argulosis; Aeromoniasis

Paper ID 16085

The use of seaweed as an organic antibiotic in the health management of aquaculture

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Aquaculture is often regarded as the fastest-growing food-producing sector on the planet. Pathogens that live in water come into touch with fish regularly. Disease outbreaks are a major issue in aquaculture. Infection sensitivity is exacerbated as a result of high population density, poor hydrodynamic conditions, and poor nutrition. Various drugs are used to treat and prevent illnesses to avoid substantial economic losses caused by diseases. Chemical use has negative consequences for the environment and human health. Antibiotic resistance develops as a result of long-term antibiotic use. In aquaculture, the occurrence of antibiotic-resistant microorganisms linked to fish diseases is a global issue. Over the last few years, alternatives to antibiotics have been sought, and seaweeds are one of the available solutions. Seaweed extracts are high in important bioactive compounds, which have a wide range of biological actions including anti-inflammatory, antiviral, and antibacterial properties. The principal active antibacterial chemicals are the discovery of fatty acids, lipophilic and phenolic compounds, lectins, acetogenins, terpenes, alkaloids, polyphenolics, isoprenoid metabolites, and hydrogen peroxide in seaweeds. Although all seaweeds have antimicrobial effects against a variety of pathogenic agents found in fish and shrimp, *Asparagopsis* spp. (red seaweed) and *Sargassum* spp. (seaweed) appear to have a greater range of antibacterial capabilities (brown seaweed).

Keywords: Seaweed, Antibiotic, Aquaculture, Anti-bacterial, Anti-microbial

Paper ID 16096

Isolation and characterization of *Photobacterium damselae* from cultivable and wild fishes of Tamil Nadu

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Photobacterium damselae is an emerging pathogen affecting marine fish of importance in aquaculture. *Photobacterium damselae* is a pathogenic member of the vibrionaceae family with two subspecies *Photobacterium damselae* subsp. *damselae (Pdd)* and *Photobacterium damselae* subsp. *piscicida (Phdp).* This is an opportunistic pathogen common in marine ecosystems and has the potential to cause mortality in seabass, cobia, pompano, seabream, catfish, shrimp, and crabs. In this study, isolation and characterization of *Photobacterium damselae* was attempted from cage cultured and wild fishes. Samples were collected from marine cages, farms, and markets in Nagapattinam, Thoothukudi, and Ramanathapuram districts. Samples were processed for the identification of *Photobacterium damselae* from kidney, spleen, liver, eye, and brain. Fifty-five presumptive isolates were taken for the biochemical and molecular confirmation of the bacteria by Multiplex PCR using *ureC* gene and *16SrRNA* gene. A total of 23 isolates were confirmed as *Pdd* and 2 as *Phdp*. These 25 isolates were analyzed for the presence of virulence gene (*hly A* gene) by PCR. Among the 23 confirmed isolates of *Pdd,* 82.5 % (19/23) of isolates showed an amplicon product of 417 bp for the *hly A* gene and 50% (1 / 2) isolates of *Phdp* showed an amplicon product of 417 bp for the *hly A* gene.

Keywords: *Photobacterium damselae*, Virulence genes

Paper ID 16119

Probiotic efficiency of a novel bacterium *Chryseobacterium gleum* isolated from the gut of fresh water fish *Oreochromis niloticus* (Nile Tilapia)

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Nowadays, the use of probiotics in nutrition, disease control, and immune response has significantly elevated global aquaculture production, reduced the emergence of antibiotics resistance adjuvant in vaccine production. In the current study a novel probiotic strain SKC-BT02, was isolated from the gut of a freshwater fish, *O. niloticus* and screened for its antagonistic efficiency against *Vibrio alginolyticus* (18 mm), *Vibrio parahaemolyticus* (15 mm), *Vibrio vulnificus* (17 mm), and *Vibrio harveyi* (20 mm). This bacterium showed promising lipase, protease, and amylase enzyme activities, Biochemical and molecular characterization of SKC-BT02 authenticated the candidate bacterium as *Chryseobacterium gleumin* (MF508917). Further, the probiotics supplemented diets (3% diets) showed higher growth in *Labeo rohita* fingerlings. Moreover, the experimental diet fed fish showed better survival rate, specific growth rate, feed intake ration and thereby proclaim that candidate bacterium *C. gleumin* to be a promising probiotic bacterium.

Keywords: Nile Tilapia, Probiotic, Growth enhancer, Aquaculture pathogens, *Labeo rohita*

Paper ID 16152

Antioomycete and immunostimulatory potential of the artificially designed peptide against *Saprolegnia Spp*.

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The present investigation estimated the antioomycetes potential of the artificially designed peptide against *Saprolegnia* spp. The peptide was designed based on the literature survey considering critical physicochemical properties of AMPs such as net cationic charge, hydrophobicity and amphipathicity. Molecular docking of the peptide was carried out with effectors proteins of *Saprolegnia parasitica* to investigate the target binding sites. The effectiveness of peptides on two species of *Saprolegnia*, *Saprolegnia parasitica* and *Saprolegnia australis,* were tested for the minimum inhibitory concentration (MIC) on zoospores mycelium growth inhibition and spore germination inhibition and colonization. Nitric oxide production and myeloperoxidase activity of the compounds were tested in head kidney leukocytes of rainbow trout, *Oncorhynchus mykiss,* to assess the immune-stimulatory potential. The peptide could completely inhibit zoospore at MIC level of 15.62 µM of both *Saprolegnia* spp. and significantly inhibit hyphal growth against *S. parasitica* and *S. australis* at 125 µM and 62.5 µM, respectively. Although, the zoospore germination and colonization of *S. parasitica* and *S. australis* was reduced at 3.9 µM. The molecular docking results were consistent with *in vitro* studies, possibly due to the binding with the vital proteins of *S. parasitica* and ultimately inhibiting their activity. The nitric oxide and total peroxidase activity of rainbow trout leukocytes in peptide treated showed no significant difference against the control. The peptide exhibited low cytotoxicity and high stability in different physiological environments. The peptide may have potential as an antioomycete agent in aquaculture applications, especially for the control of saprolegniasis.

Keywords: Designed peptide, Antioomycetes potential, Molecular docking

Paper ID 16159

Phenotypic and molecular characterization of *Stenotrophomonas maltophilia* associated with diseased *Labeo rohita*

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The present communication reports the isolation and phenotypic and molecular characterization of *Stenotrophomonas maltophilia* associated with a mixed bacterial infection in *Labeo rohita*. The diseased *L. rohita* had fin rot, skin lesions, scale loss, body discolouration, gill discolouration, reddening of the eye, haemorrhages on the body surface, and fluid accumulation in the peritoneal cavity as well as degeneration of internal organs. On Hsu-Shotts agar, inocula from the fin rot of *L. rohita* yielded yellow-pigmented colonies. From the diseased fish, *S. maltophilia* R1F3, *Brevundimonas dimunuta* R1F1 and *Chryseobacterium* sp. R1F2 were isolated and characterized. *Stenotrophomonas maltophilia* was a Gram-negative, rod-shaped and proteolytic bacterium that hydrolyzed casein protein. The Vitek-2 Compact system identified the R1F3 strain as *Chryseobacterium* sp. However, the molecular characterization confirmed that the R1F3 strain was *S. maltophilia*, which formed a monophyletic group with other strains of *S. maltophilia* based on evolutionary phylogenetic analyses. No mortality was noted in *L. rohita* challenged intramuscularly with *S. maltophilia* R1F3 at 1.82x109 CFU/fish, except for the inflammation at the injection site and fluid accumulation in the body cavity. Most likely, this is a new record on the isolation and association of *S. maltophilia* in diseased *L. rohita* in West Bengal, India. Further investigations on *S. maltophilia* as an emerging opportunistic pathogen in cultured carps are necessary, which would help manage the disease.

Keywords: *Stenotrophomonas maltophilia*, *Labeo rohita*, Phenotypic characterization, Molecular characterization, Opportunistic pathogen

Paper ID 16165

The effects of Chlorpyrifos an organophosphate pesticide in fresh water ornamental fish (*Trichopodus trichopterus*)

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Contamination by pesticides in aquatic ecosystem is a serious problem and fishes are more frequently exposed to these pollutants Fish are widely used to evaluate the health of aquatic ecosystems because pollutants build up in the food chain and are responsible for adverse effects and death of aquatic organisms. Chlorpyrifos is a widely used organophosphate pesticide, second largest selling in India and used for more than a decade to control pests in field crops like cotton, paddy, sugarcane, pasture and vegetable crops like tomato, brinjal, chillies, bhendi and pulses. Fresh water ornamental fish like three spotted gourami (Trichopodus trichopterus) were selected for the pesticide toxicity study. The toxicity study to assess the toxic effects of chlorpyriphos in a fish model was conducted in three spotted gourami (Trichopodus trichopterus). The effect of chlorpyriphos was studied with different concentration of pesticides viz, 1.00 ppm, 2.00 ppm, 3.00 ppm, 4.00 ppm and 5.00 ppm. The lethal dose (LD 50) of the compound was 2.00 ppm. Chlorpyriphos pesticide toxicity exposed animals' the morphological parameter like pattern of movement, surface visit, body discoloration, mucous secretion, haemorrhage on the body and mortality were recorded. Histological changes in tissue of fishes and residue in the tissue of fishes were carried out, in addition to the molecular analysis of expression of genes were carried out.

Keywords: Pesticide toxicity, Chlorpyriphos, Residue, Molecular characterization

Paper ID 16167

Innate immune gene expression following Poly I C induction in Sea Bass *Lates calcarifer* Bloch 1790 Cell Line

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Asian sea bass has been promoted as an alternative species for marine aquaculture and cell lines have been already established from this species for virus isolation and gene expression studies. In the present study, we have investigated the presence and the modulation of some immune genes in the SBCP-2 (Sea bass caudal peduncle) cells from Asian sea bass (Lates calcarifer). The basal expression of the selected genes (Type I interferon (IFN), ISGs such as Mx, ISG-15 and IRF-3) have been investigated and successively, their modulation have been studied both after stimulation with different inducing agents such as LCNNV and Poly I:C stimulation. Among the different genes investigated (Type I Interferon (IFN), ISGs (Interferon stimulated genes) such as Mx, ISG-15, IRF-3), interferon stimulation was more or less uniform in all the treatments, while virus infection and poly I:C transfection had higher immune gene expression. Thus, the selected genes are expressed in the SBCP-2 cell line, after infection with NNV and treatments with Poly I:C, led to an high up-regulation of IFN and ISGs. Pre-treatment of the sea bass cells with PRR ligands like Poly I:C also led to a high up-regulation of IFN and ISGs. The results showed that on nodaviral infection in SBCP2 cells, all the targeted genes were up-regulated showing the highest expression for ISG-15 gene. The study indicated that poly I:C could induce increased innate immune response in clownfish against betanodavirus. The increased expression of immune genes would help enhance the antiviral defence in live fish and could act as potential immunostimulatory compounds and also as adjuvants in vaccination trials.

Keywords: Poly I:C, Cell Line, Sea Bass, Virus

Paper ID 16174

Application of Gut Metagenomics research in aquaculture: Current trends and future perspective

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With the advancement of high throughput sequencing technology, the field of metagenomics has tremendously proliferated in last few decades. Metagenomics refers to the study of genetic material present in any environmental samples and also referred as environmental genomics, economics or community genomics. Metagenomics intends to provide insightful information on the structure and functions of microbial communities which are more often grounded on the diversity of 16s rRNA gene. The invention of 16s rRNA analysis techniques for determining community phylogenetics has been a game-changer in the field of microbiology. The gut microbiome of vertebrates harbors rich diversity of microbiota that plays a crucial role in promoting host health by outperforming opportunistic pathogens and thereby boosting the immune system in a non-inflammatory way. An optimal gut microflora creates an effective barrier against invading pathogenic bacteria through colonizing in the gut, thus generates a variety of metabolic substrates (e.g. vitamins and short chain fatty acids), for the host and activates the immune system. The unravelling of intricate host-microbe symbioses and identification of core microbiome functions is essential to use the benefits of a healthy microbiome to our advantage. However, among non-mammalian vertebrates, fishes are the only class where gut microbiota and its determinants have been widely investigated, mainly because of its prospective applications to improve aquaculture. With the growing demand of fish as a cheap source of animal protein, aquaculture research remains on its toes to investigate novel approaches for maximizing the sustainable yield using metagenomics approaches.

Keywords: Microbiome, Gut, Immunology, 16s rRNA, Sequencing

Paper ID 16182

Phenol alters aromatase activity, steroid production, and antioxidant metabolism in cultured Freshwater Iridescent Shark Catfish, *Pangasianodon hypophthalmus* (Sauvage 1878)

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Phenol, an industrial waste product, is being introduced into rivers for a long time and has a negative impact on the river Ganga biota, including fish, benthic fauna, algae, plankton, and others. In addition to explicit toxicity, phenol, designated as a potent endocrine disruptor (EDC), has been shown to have a number of subtle effects on the biota, including decreased fertility, reduction in young survival, and growth suppression. In the present study, iridescent shark catfish (*Pangasianodon hypophthalmus*) were cultured in glass aquariums and subsequently treated with sublethal doses of phenol every 24 alternative hours from 0 to 96 hours. Aromatase activity was observed to be increased significantly ($p<0.05$) after treatment, with the highest level recorded after 96 hours. Serum T and E_2 levels in fish were significantly reduced ($p<0.05$) after 96 hpe. Total superoxide dismutase (SOD) and catalase activities in serum decreased gradually and significantly from day 0 to 96 hpe. The activity of SOD in the liver seems to be strongly influenced by phenol. SOD activity in the liver of phenol-exposed fish increased gradually from 0 to 96 hpe. Catalase activity was significantly inhibited up to 96 hpe to phenol when compared to their 0-hour control. Glutathione (GSH) and glutathione peroxidase (Gpx) has been shown to increase significantly ($p<0.05$) after 96 hpe phenol treatment. Stress biomarkers, HSP 70 and 90-expression were also changed with the highest found at 96 hpe. Our findings, for the first time, report that phenol acts as a potent EDC, by increasing aromatase activity, reducing steroid hormone production, and altering antioxidant metabolism and stress markers in iridescent shark catfish, *Pangasianodon hypophthalmus*.

Keywords: Endocrine-disrupting chemical, Phenol, Aromatase activity, Steroid, Stress marker

Paper ID 16189

Polyphasic identification, virulence characterization and antibiotic susceptibility of *Aeromonas salmonicida* subspecies Salmonicida isolated from aquaculture environment in India: A first report

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This is the first report of *Aeromonas salmonicida* subspecies *salmonicida* COFCAU_AS, isolated from a tropical aquaculture environment in India. The physiological, biochemical, 16s rRNA gene sequencing, and PAAS PCR test identified the strain as *Aeromonas salmonicida* (MK907596.1). The MIY PCR tests established the subspecies as '*salmonicida*'. The *in vitro* pathogenicity tests showed the test bacterium as haemolytic and positive for casein, lipid, starch, and gelatine hydrolysis activity, indicating its pathogenic properties. The strain also showed the ability to produce slime and biofilm, and addionally, it possessed A-layer surface protein. The LD_{50} dose of the bacterium was evaluated to be $10^{6.9}$ cells $fish^{-1}$ in *Labeo rohita* fingerlings. The bacteia-challenged fingerlings showed skin lesion, erythema at the base of the fins, dropsy, and ulcer. Almost identical clinical signs and mortalities were observed when the same LD_{50} dose was injected into other Indian major carp species, *L. catla* and *Cirrhinus mrigala.* Among the twelve virulent genes screened, the presence of nine genes viz., *aerA*, *act*, *ast*, *alt*, *hlyA*, *vapA, exsA*, *fstA*, and *lip* were detected*,* whereas *ascV, ascC*, and *ela* genes were absent. The *A. salmonicida* subsp. *salmonicida* was resistant to antibiotics such as penicillin G, rifampicin, ampicillin, and vancomycin while highly sensitive to amoxyclav, nalidixic acid, chloramphenicol, ciprofloxacin, and tetracycline. The findings collectively revealed that the *A. salmonicida* subsp. *salmonicida* was a virulent pathogen and could cause significant mortality and morbidity in Indian major carps. The presence of virulent *A. salmonicida* subsp. *salmonicida* in a tropical aquaculture environment is alarming and thus has great economic significance.

Keywords: In Vitro and In Vivo pathogenicity, Virulence genes, Antibiotics susceptibility, Indian Major Carps, *A. salmonicida Subsp. Salmonicida*

Paper ID 16192

Outbreak of mortality associated with multiple etiologies in cage cultured Asian seabass (*Lates calcarifer*, Bloch): A case study

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Asian seabass, *Lates calcarifer* can be cultured in various aquaculture systems in low saline and marine environment. These ecosystems have unique disease challenges. In the present study, an outbreak of disease associated with multiple etiologies in *L. calcarifer* was observed in 60 % fishes reared in cages installed off Karwar, India in the month of March, 2022. External examination revealed dark colored body with fin and tail rot along with scale loss and pealed skin. Severe disease condition lead to wounds and pus formation and these were found in the anterior part of dorsal fin. Internally, liver, kidney, spleen were enlarged and brain was hemorrhagic. The gastrointestinal tract was empty except for a small amount of liquid. Moribund fish showed necrotic areas, hemorrhages and hyperemia in kidney and liver. Hyperplasia in the gill filaments was observed histopathologically. Fishes were infested by *Dactylogyrous* spp. and other bacterial pathogens such as *Vibrio* spp. (from Gill), *Staphylococcus haemolyticus* (from liver), *Staphylococcus arlettae* (from kidney) were detected by molecular and conventional methods. It was observed that multiple etiological agents were associated with the mortality in cage cultured Asian seabass. It was also observed that there was a direct relation between mortality among fishes and environmental factors. In present study water temperature (29.5±1.5°C) with low oxygen levels (4.15±0.28ppm) lead to reduced metabolic activities of Asian seabass, making the fish more susceptible towards parasitic infection followed by secondary bacterial infection.

Keywords: Case Study, Mortality, Pathogens, Asian seabass, Histopathology.

Paper ID 16194

Development of a Novel Glycovaccine against *Aeromonas hydrophila* for Tilapia aquaculture in India

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Oreochromis niloticus (Nile tilapia) dominates the global tilapia production for serving important source of animal protein and thus the main escalator of global economy through tilapia aquaculture Aeromonas disease in tilapia has emerged as one of the most important bacterial diseases for farmed tilapia, for which there is no commercial vaccine. Vaccination strategies have been proved to be successive tools for effective and economical to protect aquaculture from infectious diseases. Advanced technologies like the development of nanovaccines extends the credibility towards sustainable aquaculture. Our study will investigate a novel immersion and injection delivery vaccine for Aeromonas disease in tilapia based on an innovative nanotechnology platform, with the potential to offer effective mucosal immunostimulation using characterised lectin NP antigens. Lectins is known for their antibacterial property as well as in neutralizing pathogens and thereby eliciting protective innate immune response. The biophysical characterization of the synthesized Lectin-nanoconjugate will be performed using TEM and then mixed with formalin killed *A.hydrophila* vaccine. The vaccine will be administered to the fishes via injection and immersion delivery systems and the efficacy of delivery in each method will be analyzed by determining the expression of the immune genes keeping an adjuvanted vaccine as control. The mucoadhesive property of the nanovaccine will also be measured using DAPI staining. ELISA is used to measure the antibody titres. The relative percentage survival after vaccinated fishes get injected with virulent strain of *A.hydrophila* will be assessed. The study emphasize a plausible approach for effective vaccination strategies through injection and immersion method of administration to protect the fishes from bacterial diseases which can be further commercialized for mass vaccinations for the sustainable tilapia aquaculture**.**

Keywords: *Aeromonas hydrophila*, Lectin, Glycovaccine, Nile Tilapia, Injection, Immersion.

Paper ID 16195

Oral delivery of a Novel Glycovaccine in Nile Tilapia, (*Oreochromis niloticus*) for protection against *Aeromonas hydrophila* infection

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Nile tilapia (*Oreochromis niloticus*) carries an important role in the global aquaculture, However, intensification of aquaculture resulting in infectious diseases is causing ramparts in the sustainability as well as huge economic loss in the aquaculture industry. Vaccination has gained attention for disease control in aquaculture enabling strong and long-lasting immunity. Lectins are one of the glycoproteins which are involved in innate immune response by the recognition of pathogen associated molecular patterns and assisting in the neutralization of pathogens. Lectins when conjugated with nanoparticles will enhance its antibacterial activity, and help to treat bacterial infections even at low nanoparticle concentrations. We hypothesis, the lectin-nanoparticles conjugate when mixed with formalin killed *Aeromonas hydrophila,* will provide antibacterial activity as well as specific immune response to *A. hydrophila* infection in host system. The aim of the present study is to validate the effectiveness of a glycovaccine in Nile tilapia (*Oreochromis niloticus*) against *A. hydrophila* through oral route platform and to confer protection in fish against infection. Oral vaccination is one of the successful routes of administrating vaccine in aquaculture and avoid stress in fish. The vaccine is either mixed with the feed, coated with feed or given through bio-encapsulated delivery to the fish. *A. hydrophila*-lectin nanoparticles conjugated vaccine will be delivered into Nile tilapia through oral feed for 7 days followed by a booster dose. Immune response elicited and antibody titres will be determined. A virulent strain of bacteria will be injected to determine the relative percentage survival. The study provides a putative approach for vaccination strategies employing novel glycovaccines providing protection to fishes from infectious bacterial diseases This can be further effectively commercialized highlighting the possibilities towards mass vaccination especially in low to middle income countries.

Keywords: *Aeromonas hydrophila*, Lectin, Nile Tilapia, Formalin-killed vaccine, Glycovaccine, Oral vaccine

Paper ID 16196

Development of a nanoparticle vaccine against *Aeromonas hydrophila* infection for Tilapia aquaculture in India

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Tilapia (*Oreochromis* sp.) is the second largest farmed fish species after carp globally and is a major trade commodity for many low to middle-income countries (LMIC). Infectious diseases of Tilapia aquaculture is viewed seriously for posing global threat to tilapia industry, food security and livelihood for billions of people. Aeromonas has emerged as one of most important bacterial diseases for farmed tilapia, for which there is no commercial vaccine, and farmers resort to using antibiotics to control this disease. Our study addresses to investigate a novel and innovative nanoparticle vaccine against *A.hydrophila* infection. The vaccine will be administered through injection, immersion and oral delivery systems and ist efficacy will be compared in each mode of delivery.The immune response it elicits will be evaluated by RT-PCR and compared to an adjuvanted vaccine. Fish will be challenged with a virulent strain of *A.hydrophila* to test the level of protection elicited by the vaccines. Relative percentage survival and antibody titres will be determined for vaccinated fish. The antigenic diversity between Indian bacterial isolates to ensure the vaccine is able to cross-protect between isolates will be also examined using western blotting followed by contemperory proteomic analysis. The demonstration of the effectiveness of nanoparticle fish vaccine that can be delivered orally or by immersion would represent a significant opportunity for many different aquaculture industries, and this technology could be applied to several diseases in different aquaculture settings, including LMIC countries and even domestic aquaria, where price of vaccination or handling of fish for vaccination is problematic. We hypothesize this as a plausible approach that helps to pursue the commercialisation of the *A.hydrophila* vaccine, provide an easy and acceptable manner of vaccine delivery systems for tilapia fish farmers and to advance scientific knowledge on *A.hydrophila* infections of Tilapia.

Keywords: Aquaculture, *Aeromonas hydrophila*, Nanoparticle, Vaccination

Paper ID 16214

Incidence of Leech infestation in Striped Murrel, *Channa striata* broodstock

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Striped murrel, *Channa striata* is one of the popular and important aquaculture food fish species in South Asia and South-East Asia due to its nutritional properties and pharmacological properties. The demand for quality seed opens the gateway for hatchery establishment and seed production of *C. striata*. Broodstock management and its rearing form an integral part prior to hatchery operations. *C. striata* brooders are reared in enclosed concrete tanks, the confinement and high density can induce an outbreak of diseases and their spreading. During the month March-July, 2018 the case of leech infestation was found in striped murrel brooder tanks. Leech infested murrels showed periodic upside-down and erratic swimming behaviour. Clinical signs include excessive mucus secretion, petechial, haemorrhages and coagulated blood at the point of parasite attachment. The leeches were found attached all over the fish's body. The maximum attachment was found at the dorsal, pectoral and caudal fin base and opercular areas. There was no mortality recorded. Prevalence of 100% with a mean intensity of 21 leeches per fish was observed in the infected fishes. The leeches were also found on the aquatic vegetation (*Eichhornia crassipes*), tank surfaces, and the brooder tanks' bottom soil. Leeches were collected aseptically and stored in 70% ethanol for study. The parasitic leech has been identified as *Glossiphonia sp.* CS1 using 28s rDNA sequencing and morphologically. The sequence was deposited in the NCBI GenBank with accession No. OL412752.The infested fish were treated with a salt bath.

Keywords: Leech, Striped murrel, *Channa striata*, Glossiphonia, Parasite

Paper ID 16217

Climbing Perch, *Anabas testudineus*: A potential biocontrol for Leech infestation in Striped Murrel, *Channa striata*

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Parasite infestation is a menace in an aquaculture system. Leech (Hirudinea), a semi-aquatic annelid, is known to parasitize diverse groups of animals, including fish. *Channa striata*, striped murrel, a popular food fish in Southeast Asia, is susceptible to leech attacks. Leech, *Glossiphonia sp.* CS1 was reported to infest *C. striata* (*Striped murrel*). An alternative to chemical treatments is using bio-control as a natural predator is an effective environmental strategy. *Anabas testudineus*, climbing perch, an air-breathing fish, a known insectivorous and larvivorous fish, is used as biocontrol. The present study evaluates climbing perch as a potential natural predator and bio-control agent to check leech infestation in *C. striata* broodstock rearing tank. In an in-vitro experiment, for 24 hours, climbing perch having avg.4.48 g was stocked with leeches in a glass aquarium, with water hyacinth *Eichhornia crassipes* as a natural hideout and without *Eichhornia crassipes*. The experiment showed early predation in a group without water hyacinth and took a comparatively long time for predation in an aquarium with hideouts. In an in-vitro experiment, climbing perch stocked with leech-infested striped murrel; after two weeks the leech population substantially reduced. The experimental result suggests further research to evaluate climbing perch as a potential bio-control agent in leech-infested ponds and compatibility in murrel culture, paving the way for extra income.

Keywords: Climbing perch, *Anabas testudineus*, Striped murrel, Biocontrol, Leech,

Paper ID 16225

Regulating usage of chemicals and veterinary medical products in Indian aquaculture

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Use of chemicals and veterinary medical products (VMP) is essential for effective management of quality culture environment and health of farmed aquatic animals. Regulating the usage of these substances is required to address the safety of aquatic foods and the surrounding environment. Chemicals are used for optimal environmental quality, disinfectants for biosecurity, nutritional supplements for improved growth and production, probiotics for enhanced health, antibiotics and antiparasitic agents for therapeutic control of bacterial and parasitic diseases in aquaculture. Factors like, awareness among farmers, species cultured, farming intensity, region and the burden of diseases determine the quantity and type of chemical and VMPs use. Agencies like, US Food and Drug Administration (FDA), European Medical Agency (EMA), Health Canada regulate the use of chemicals and VMPs in their respective countries. In India, Coastal Aquaculture Authority (CAA), Marine Product Export Development Agency (MPEDA) and Export Inspection Council (EIC) issue guidelines and monitor the usage of antimicrobials and other pharmacologically active substances in aquaculture. Research organizations needs to generate data on biosafety, efficacy, pharmacokinetics, tissue depletion and environmental impact for each of the substances in identified host species under prevailing ecological conditions. Based on this information an aquaculture formulary may be prepared and manufacturing and application needs to be monitored. Emphasizing the prophylactic measures including, application of vaccines, immune stimulating agents and probiotics and implementation of national regulatory guidelines in harmony with the international standards is essential for safe and economical and sustainable aquaculture.

Keywords: Aquaculture medicine, Regulation, Veterinary medical products, India

Paper ID 16238

Recombinant antioxidant proteins based on homologous sequences and protection against bacterial infection in Rohu, *Labeo rohita*

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In freshwater aquaculture the continuous exposure to biotic and abiotic stress leads to activate antioxidant defense system, which renders a significant protection against environmental stress and maintains the correct redox balance in cells, thereby supporting proper immune function. Here in our study, four major antioxidant recombinant proteins i.e., GST- mu (24.31 kDa), GPX-1 (16.6 kDa), CuZnSOD (18 kDa), catalase (58.9 kDa) were produced in bacterial expression system based on rohu (*Labeo rohita*) sequence information. All four recombinant proteins mentioned above showed antioxidant activities at 25 µg/ml concentrations by protecting supercoiled DNA from H_2O_2 and UV damage. The antimicrobial activities of recombinant proteins were tested against Gram-positive *Staphylococcus aureus* and Gram-negative *Aeromonas hydrophila* bacteria. The minimum inhibitory concentration (MIC) of these recombinant proteins were found to be 12 µM, 8 µM, 11.5 µM and 20 µM concentrations using r*Lr*GPX-1, r*Lr*GST-mu, r*Lr*CuZnSOD and r*Lr*CAT respectively at 24 h post-incubation. The relative percentage of fish (*L. rohita*) survival against bacterial infection (*A. hydrophila*) with r*Lr*GPX-1, r*Lr*GST-mu and r*Lr*CAT was studied and found to be 48%, 50% and 40%, respectively. However, r*Lr*CuZnSOD was found to be toxic to fish. The level of protection induced by these proteins were correlated by examining the expression profile of different immune-related genes i.e., apolipoprotein-1, lysozyme G, CuZnSOD, GPX-1, GST-mu, HSP-70 and nuclear factor-2 in both liver and kidney tissues of infected rohu at different time periods. An indirect ELISA using purified recombinant proteins of all the above mentioned antioxidants of rohu was developed and the sensitivities were found to be 3 ng (CuZnSOD), 1.5 ng (GPX-1), 1.5 ng (GST-mu) and 0.78 ng (catalase), respectively, in detecting the levels in rohu serum samples. The concentration of CuZnSOD, GPX-1, GST-mu and catalase were determined in rohu serum infected with *A. hydrophila* at different hours of post infection and found to be correlated with survival from infection. Hence, it was concluded that rohu antioxidants plays an important role in innate immunity by providing protection from oxidative damage and bacterial infections.

Keywords: Rohu, Antioxidant, Recombinant protein, Innate immunity

Paper ID 16260

The invasive brackish water Mussel, *Mytella strigata* - A potential carrier of Perkinsus.

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The invasive brackish water mussel *Mytella strigata,* a native of central and South America has already invaded many of the Southeast Asian countries. In India, the species was first observed in the brackish water habitats in Kerala in 2019. Euryhaline nature, high growth rate and fecundity, round the year larval recruitment, short lifespan and high dispersal ability make *M. strigata* a very successful invasive species. Within a short span of three years, the species has made inroads into almost all brackish water habitats in Kerala. Numerous diseases have been reported from bivalve molluscs. World over, protozoans of the genus *Perkinsus* are known to cause serious mortalities in bivalve populations and two species, *P. olseni* and *P. marinus* are notifiable to OIE. *P.olseni* has been responsible for serious mortalities in cultured green mussels in northern Kerala. Higher temperatures and salinities further aggravate the pathological effects of *Perkinsus.* The southwest coast of India harbours high bivalve biodiversity with many commercially exploited bivalves including mussels, clams and oysters. Co-existence of diverse species of bivalves and pathogens in these habitats may facilitate cross transmission of pathogens. As a part of the National Surveillance Programme for Aquatic Animal Diseases, a study was carried out to assess the prevalence of *Perkinsus* sp. in *M. strigata* populations in Kerala. During 2019-2022 a total of 866 samples were collected and screened following standard procedures. Ray's Fluid Thioglycollate Medium culture revealed the presence of spherical, blue-black hypnospores indicating the presence of *Perkinsus* spp. The intensity of infection varied from light to very heavy. Molecular diagnosis using species-specific primers confirmed the presence of two species, *P. olseni* and *P. beihaiensis* with a prevalence of 3.23% and 26.09 % respectively, while mixed infections stood at 1.61%. The present study forms the first report of a *Perkinsus* infection in *M. strigata*. The highly invasive nature of *M. strigata* and its potential to harbour and transmit two species of *Perkinsus* coupled with the imminent climatic changes pose a serious threat to bivalve aquaculture in the country.

Keywords: *Mytella strigata*, *Perkinsus Spp*, Bivalve, Diseases, Invasive

Paper ID 16289

Assessment of occurrence of White Spot Syndrome Virus (WSSV) and Enterocytozoon Hepatopenaei (EHP) infection in *Penaeus vannamei* farming along the coastal districts of Tamil Nadu

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Prevalence of white spot syndrome virus (WSSV) and *Enterocytozoon hepatopenaei* (EHP) was investigated in the shrimp farming systems of the coastal districts of Tamil Nadu for the period spanning 6 years from 2014-15 to 2019-20. Samples of *Penaeus vannamei* were collected from shrimp farms of Thoothukudi, Ramanathapuram, Pudukottai, Thanjavur and Nagapattinam districts under the National Surveillance Programme. A total of 844 shrimp samples were collected from 266 shrimp farms and were screened for the presence of EHP, WSSV and combined infection of both EHP and WSSV by either single step or nested PCR. Out of 844 shrimp samples screened by PCR, 37 (4.3%), 327 (38.7%) and 30 (3.55%) samples were positive for WSSV, EHP and dual infection with EHP and WSSV respectively.

Keywords: EHP, WSSV, Occurrence, Shrimp farming, Surveillance.

Paper ID 16290

Assessment of hematological responses in cultivable fish, Pearlspot (*Etroplus suratensis*) (Bloch, 1790) after exposure to Oxytetracycline through intraperitoneal and oral route

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Hematological parameters are recognized as a bioindicator of the health and physiological status of fish. Oxytetracycline is an approved antibiotic used in aquaculture as a prophylactic and therapeutic measure. The present study was carried out to examine the hematological profile in response to oxytetracycline administration through intraperitoneal and oral route of pearlspot one of the most important cultivable fish in Kerala. The study was conducted in a total number of 84 (n=84) (for i.p control-3, treatment-42; for oral dosing control-3, treatment-36) healthy (mean body weight, 100 ± 20 g) and disease-free pearlspot For the intraperitoneal injection, the fishes were randomly divided into two groups: for control (normal saline i/p) and treatment was administered intraperitoneal at a single dose of 80 mg/kg body weight and blood was collected at time intervals of 0.25h, 0.5h,0.75h,1h, 1.5h, 2h, 4h, 6h, 8h, 12h, 18h, 24h, 36h and 48h. For oral administration, the fishes were divided into two groups, the control group was given a non-medicated feed and the treatment group was given orally with medicated feed at a dosage of 80 mg/kg/day for 5 consecutive days followed by a non-medicated feed was given up to 21 days. Blood was collected at a time intervals of 12h, 24h, 48h, 72h, 96h, 120h, 144h, 168h, 10th day, 13th day, 18th day and 21st day. The collected blood was analyzed immediately using an automated hematology analyzer. The results revealed that the hematological parameters such as RBC, WBC, and hemoglobin and hematocrit value showed no significant difference between the control and treatment groups of both studies. It could be concluded, that the oxytetracycline at a dose rate of 80 mg/kg bodyweight does not pose any serious health risk to pearlspot fish. These hematological values form baseline data for the assessment of the health status of fish after oxytetracycline administration.

Keywords: Oxytetracycline, Hematology, Pearl spot, Intraperitoneal and Oral dosing

Paper ID 16302

Evaluation of growth and immunomodulatory potential of *Terminalia arjuna* in Stinging Catfish, *Heteropneustes fossilis* larvae

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Enhanced immunity especially the non-specific immunity in larvae has shown to improve the survival and growth. Methanolic bark extract of *Terminalia arjuna* (Arjuna) was evaluated for its growth and immune-boosting potential in stinging catfish, *Heteropneustes fossilis* larvae through dietary intervention for a period of 40 days. A total of 180 numbers of larvae (15 dph; 22±2.6 mm, 43±3.5 mg) were randomly distributed in three treatment groups and one control in triplicates (15 larvae in each tank). Experimental diets were prepared with 3 levels of the extract, i.e. 0.1%, 0.25% and 0.5%, whereas, diet without extract served as control. Feeding was done thrice a day until satiation level for all the experimental groups. After 40 days of rearing, larval group fed diet with 0.25% extract showed significant (p<0.05) improvement in final body weight (641.13±8.65), and specific growth rate (6.48±0.03% day^{-1}). The respiratory burst, lysozyme and myloperoxidase activity as well as the albumin and alkaline phosphatase activity were also significantly increased in the larvae fed with 0.25% arjuna extract which clearly indicates immune-boosting action of arjuna extract in fish larvae. However, larvae fed with 0.1% extract supplementation showed only marginal increase in the immune parameters while the 0.5% extract supplementation showed reduced growth and immunity in larvae. This study suggests that an increasing level of innate immunity in *Heteropneustes fossilis* larvae were observed up to 0.25% extract supplementation, while further increase in the extract level (0.5%) in diet leads to stress in the larvae as observed through their compromised immunity level and growth.

Keywords: *Heteropneustes fossilis*, *Terminalia arjuna* (arjuna), Immunity, Growth

Paper ID 16313

Influence of sub-lethal dose of Emamectin Benzoate on Hemato-immuno and Biochemical responses in Rohu fish (*Labeo rohita*)

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The present study describes the hemato-immuno and biochemical alterations in blood, serum, and different organs exposed to emamectin benzoate in *L. rohita*. The LC_{50} of emamectin benzoate was 163 μgL^{-1}, 112 μgL^{-1}, 99 μgL^{-1} and 91 μgL^{-1} at 24 h, 48 h, 72 h, and 96 h respectively. Based on 96h LC_{50}, fish were exposed to two concentration of emamectin benzoate (1.82 μgL^{-1} and 9.1 μgL^{-1}) for a period of 30 days. In emamectin benzoate treated fish, white blood cells, red blood cells, hematocrit and hemoglobin counts were increased significantly. Superoxide dismutase and catalase activity in the liver, gill, muscle and kidney increased significantly in comparison to control fish. Glutathione-s-transferase (GST) activity in the gill, liver and kidney increased significantly. Glutamate pyruvate transaminase and Glutamic-oxaloacetic acid transaminase activity were increased in liver, kidney, and muscle tissue. The level of immunological responses like complement 3 and immunoglobulin-M activity decreased while heat shock protein 70 (HSP70), HSP90, and cortisol activity increased significantly in fish exposed to emamectin benzoate after 30 day of exposure. Thus, emamectin benzoate exposure at two sub-lethal concentrations in *L. rohita* induces several hemato-immuno and biochemical alterations.

Keywords: Emamectin Benzoate, *Labeo rohita*, Hemato-immuno and Biochemical alterations

Paper ID 16315

Thematic evolution of Betanodavirus infection in aquaculture: A scientometric analysis (1998-2021)

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Diseases of viral origin with a long history of causing substantial economic losses and mass mortality in fish and shellfish aquaculture. The infections caused by betanodavirus is of utmost concern among many fish viral diseases reported worldwide (Jung et al., 2000; Oh et al., 2002). A scientometric analysis was performed to understand the impact of betanodavirus infections in aquaculture and to examine the evolution of global scientific research carried out in this scientific arena. A total of 771 publications were obtained from the Web of Science (WoS) database to plot the scientific research output of "Betanodavirus infections in aquaculture" from 1998 to 2021. Bibliometric analyses, i.e., thematic map, trend topics, three fields plot, factorial analysis, Lotka's law and Bradford's law were carried out using R version 4.0.4 and R studio (1.4.1106 version) to evaluate the research productivity. Trend topics analysis could indicate the progress as well as the pattern change in the target areas of research investigations from 1998 to 2021 on this topic. Thematic map displayed the motor, niche, emerging or declining and basic themes of the research concepts carried out in the selected research for clear understanding. The results of the systematic scientometric mapping of the research areas and themes aids in the identification of research interests and their evolution across time. It also provides insight into various novel research directions that need to be focussed on the future.

Keywords: Betanodavirus, Fish culture, Viral disease, Scientometrics, Trend topics and Thematic evolution

Paper ID 16353

Insights into aquatic animal disease surveillance in Andaman and Nicobar Islands, India

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Andaman and Nicobar Islands (ANI) is one of the biodiversity hotspots of India located in the Bay of Bengal in close proximity with South East Asian countries. Fisheries sector of ANI is supported by the presence of marine, brackish water and freshwater ecosystems. At present, freshwater aquaculture is widely practiced in ANI whereas brackish water aquaculture and mariculture are the potentially identified sectors for development. The aquatic environment of ANI is also infested with the aquatic animal diseases. Various infectious (viral, bacterial, fungal, parasitic) and non-infectious diseases were reported from the aquatic animals of ANI through continuous monitoring and disease surveillance. Abdominal dropsy, *Aphanomyces* sp., *Achlya* sp., *Gyrodactylus* sp., *Dactylogyrus* sp., *Piscinoodinium* sp., *Ichthyophthirius* sp., *Argulus* sp., *Myxobolus* sp., *Lernaea* sp., nematode and cestode infestations were reported from the freshwater fishes. Likewise, pop-eye disease, monogeneans, isopods, trematode and cestode infestations from the marine fishes, White Spot Syndrome Virus (WSSV), Infectious Hypodermal and Hematopoietic Necrosis Virus (IHHNV), Laem Singh Virus (LSNV), luminescent vibriosis and isopods from the marine crustaceans have been reported from the Bay Islands. Besides, baseline data has been collected from a total of 1100 freshwater fish farms located at ANI and necessary advices were provided on better management practices in order to improve the existing aquaculture practices. Various capacity building programmes were conducted on aquatic animal health management in order to create awareness among the stakeholders. Detailed information on the aquatic animal diseases would lead to the development of policies and plans to check the introduction and spread of diseases into this relatively virgin ecosystem. Ultimately, disease free aquaculture practices and healthy aquatic ecosystem leads to improved production for the famers and also sustain its resources for the future generation.

Keywords: Disease surveillance, Aquatic animals, Fish pathogens, Health management, Andaman and Nicobar Islands

Paper ID 16356

Development of four cell lines from different organs of Oscar (*Astronotus ocellatus*) to evaluate the replication of Infectious Spleen and Kidney Necrosis Virus (ISKNV)

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Infectious spleen and kidney necrosis disease (ISKND) is a major viral disease in both freshwater and marine fish species. In this study, four new cell lines were developed and characterized from gill, spleen, kidney, and brain of Oscar (*Astronotus ocellatus*) in addition to another cell line from fin for the efficiency of ISKNV replication. Cell lines were cultured in Leibovitz-15 (L-15) medium supplemented with 10% fetal bovine serum (FBS) at 28 ºC. All four cell lines were successfully cryopreserved and revived at different passage levels. The cells of the gill, spleen, kidney, and brain were sub-cultured continuously at an interval of 2–3 days and attained the passage level of 90, 60, 52, and 58. Chromosomal analysis of the cells revealed that *A. ocellatus* cells have a normal diploid number with 2n = 48. Polymerase chain reaction (PCR) products obtained from the cells and tissues of *A. ocellatus* with primers specific to the conserved region of 16S ribosomal RNA and cytochrome oxidase I genes of *A. ocellatus* revealed the origin of cell lines from *A. ocellatus*. The cell lines did not show Mycoplasma contamination. The cells showed good transfection efficiency when transfected with 2µg of pAcGFP1-N1expression vector. Multiple vacuolation and a typical cytopathic effect for virus infection were observed in infected gill, spleen, kidney, and brain cells. Infection of the different cell lines was confirmed by PCR. The virus concentration in culture supernatant collected from the infected *A. ocellatus* cell lines increased gradually from 10^3 on day 1 post-infection to 10^7 $TCID_{50}$ ml^{-1} on day 9. The amount of virus in different cell lines was also quantified by RT-PCR. These results indicate the susceptibility of the gill, spleen, kidney, and brain cell lines for ISKNV propagation for developing viral diagnostics and vaccines. The developed cell lines will be deposited at the National Repository of Fish Cell Line (NRFC), ICAR-National Bureau of Fish Genetic Resources, India for further dissemination among the researchers in India.

Keywords: ISKNV, *Astronotus ocellatus*, Cell lines, Cytopathic effect, PCR, RT-PCR

Paper ID 16359

New reports of bacterial diseases from the freshwater fishes of Andaman and Nicobar Islands, India

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Andaman and Nicobar Islands (ANI) is one of the union territory of India located in the Bay of Bengal close to South East Asian Island group. Fisheries sector is one of the important, revenue generating activity chiefly contributed by marine capture fisheries. However, freshwater fish farming is also a promising avenue for development, as there is a good demand for carps, catfishes and other candidate species among the island inhabitants. The reports of bacterial diseases prevalent in the freshwater fishes of ANI are very scanty and restricted only to one outbreak of *Aeromonas hydrophila* in *Catla catla*. Recently, screening for bacterial diseases were done in various freshwater farms, ornamental retail shops, and natural water bodies of South Andaman Islands. A total of 10 bacterial pathogens were isolated from diseased edible and ornamental fishes. The isolates *viz. Citrobacter werkmanii* and *Citrobacter* sp. associated with ulcers in *Channa striata; Staphylococcus pasteuri* and *S. warneri* associated with haemorrhagic ulcers in *Carassius auratus; Aeromonas veronii* and *Pseudomonas alcaligenes* causing abdominal dropsy in *Cyprinus carpio* var. Koi and *Barbonymus gonionotus; Corynebacterium jeikeium* causing fin rot in *Catla catla, Aeromonas caviae; Pseudomonas otitidis* causing fin rot in *Cirrihinus mrigala; Vogesella perlucida* causing emaciation in *Barbonymus gonionotus.* The isolates were confirmed by molecular characterization of the 16Sr DNA and the disease causing capabilities were also proved by Koch's postulate. The present study alerts the fisheries stakeholders to undertake management practices for curtailing economic loss, incase intensive fish farming methods are undertaken in the near future.

Keywords: Bacteria, Pathogens, Gram positive, Gram negative, Sequencing

Paper ID 16360

Large-scale mortality of Gift Tilapia reared in Biofloc System caused due to *Aeromonas hydrophila* - A case study

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Tilapia is a widely adopted species for aquaculture particularly in the biofloc system. Many times, the commercial tilapia culture operations are hampered due to devastating disease problems. Recently, large-scale mortality of GIFT tilapia was reported from a commercial biofloc rearing unit from the Malappuram district of Kerala, India. The affected fishes exhibited anorexia, reduced growth and severe ulcers in the caudal peduncle. The moribund fish were live transported to the laboratory and subjected to parasitological, virological and bacteriological examination. The examined animals were free of parasites and any known viruses. However, we could isolate four bacterial species from the necrotic tissue near the caudal peduncle of moribund fish ie. *Aeromonas hydrophila, Pseudomonas putida, Staphylococcus epidermidis* and *Aeromonas dhakensis*. The isolated bacteria were identified based on their biochemical test and 16s rDNA sequence analysis. Furthermore, in order to test the Koch's postulate, a challenge experiment was done under controlled laboratory conditions in disease free tilapia (n=100). The experiment was done in duplicate, the fish were divided into five groups (*A. hydrophila, P. putida, S.* epidermidis, *A. dhakensis* and control groups) and distributed in 10 tanks, each tank containing 10 fish. The bacterial fish group were intraperitonially injected with the corresponding bacteria. Control fishes were injected with normal saline. Complete mortality was observed in fish group injected with *Aeromonas hydrophila* within 24 hours. However, no mortality was observed in other bacterial and control group. From this experiment we could claim that *Aeromonas hydrophila* is one among the virulent pathogen in warm water fishes and especially lethal to Tilapia. Therefore, proper preventive measure should be taken for the sustainable production in intensive aquaculture system.

Keywords: GIFT, Biofloc, Tilapia. Aeromonas, Bacteria

Paper ID 16367

Sequence analysis of DNA Methyltransferase and DNA Polymerase Gene from Koi Ranavirus (KIRV)

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Ranavirus belonging to the family Iridoviridae is one of the most important emerging pathogens that affect farmed and wild fishes of both economic and ecological importance in aquaculture worldwide. Recently we isolated a ranavirus from infected koi (Koi ranavirus, KIRV) which was closely related to the Santee Cooper group of viruses of the genus *Ranavirus*. Sequence analysis of DNA methyltransferase and DNA polymerase genes was investigated in KIRV. Primers for the two viral genes were designed overlapping different sequence locations of KIRV based on mandarin fish ranavirus by primer BLAST software. PCR analysis of the KIRV infected cells with overlapping primers for both DNA methyltransferase and DNA polymerase gene produced amplicons of 1043, 1003, 949, 875, 1865, 1798 bp, and 983, 1570 bp respectively, and these were analyzed by sequencing. Phylogenetic analysis of the DNA methyltransferase gene (663 bp) indicated that KIRV was closely related to Largemouth Bass Virus (LMBV) (99.85%), Doctor fish virus (DFV) (98.68%), and Mandarin fish ranavirus (97.59%). The amino acid sequences of the KIRV gene product of DNA methyltransferase (220 aa) showed more than 99 % identity with LMBV. The open reading frame (ORF) of the DNA methyltransferase gene was 663 bp encoding 220 amino acids (GenBank accession No. MW228398). Moreover, phylogenetic analysis of the DNA polymerase gene (795 bp) indicated that KIRV was closely related to Mandarin fish ranavirus (98.99%), Doctor fish virus (97.85%), and LMBV (97.74%). The amino acid sequences of the KIRV gene product of DNA polymerase (265 aa) showed 99.45% and 99.25% identity with LMBV and Mandarin fish ranavirus respectively. The open reading frame (ORF) of the DNA polymerase gene was 795 bp encoding 265 amino acids (GenBank accession No. MW228399). The result of the present study that phylogenetic analysis of DNA polymerase and DNA methyltransferase gene indicated that KIRV is closely related to LMBV, DFV, and Mandarin fish ranavirus. The determination of the genome of KIRV will help to better understand the molecular mechanism underlying the pathogenesis of the KIRV and provide useful information for rapid detection of this virus for controlling the infection caused by ranavirus.

Keywords: KIRV, DNA Methyltransferase, DNA Polymerase, Largemouth bass virus, Mandarin fish ranavirus, Doctor fish virus

Paper ID 16379

Preliminary investigation on immunization of marine finfish for prevention of *Photobacterium damselae Subsp. damselae* infections

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Photobacterium damselae subsp. *damsela*e (Pdd), a marine bacterium causes widespread infection and mortality in cultured marine finfishes. In the present study, Pdd isolated from diseased cobia was used for vaccination and strain variation analysis. Pathogenicity study was carried out in experimental damselfish (*Chromis* sp.) using the bacterial isolate. The isolate was found to be virulent with LD_{50} value of 1.45 x $10^{3.5}$ CFU/fish. To control the outbreaks caused by *Photobacterium damselae* subsp. *damselae,* vaccination is considered as a better choice in protecting cultured finfishes. Formalin killed whole cell vaccine was prepared from the isolate and injected to experimental damselfish (*Chromis* sp.) to test its efficiency. Vaccine was administered intraperitoneally on the 1st day and with Booster dose on 21st day. On the 45th day of vaccination study, both vaccinated and non vaccinated group were injected with virulent Pdd. The relative percentage survival was found to be 67% and provides a promising way to protect Pdd in the marine finfishes. Whole cell protein analysis of the isolate grown under different salinity condition were found to possess similar protein pattern.

Keywords: *Photobacterium damselae Subsp. damselae*, Vaccination, Formalin killed whole Cell vaccine, Damselfish (*Chromis sp.*).

Paper ID 16384

Isolation, identification and characterization of pathogenic *Aeromonas hydrophila* from fresh water farming system in South India

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Aeromonas hydrophila is a Gram-negative bacterium which infects a wide range of hosts including amphibians, reptiles, avian and mammals. It causes motile aeromonad septicemia (MAS), which results in great economic losses in freshwater fish farming worldwide. Pathogenesis of *A. hydrophila* is multifactorial. The present study was involved in isolation and characterization of *A. hydrophila* from water and soil samples of different freshwater farming system located in Tamil Nadu, Kerala and Pondicherry by biochemical, molecular and immunoblotting techniques. *A. hydrophila* was isolated by using *A. hydrophila* selective agar by spread plate method. The typical colonies were isolated and further characterized by biochemical, molecular and immunological methods. One hundred and fourteen isolates of *Aeromonas* were obtained by using selective media from carp culture pond, murrel culture, diseased botla and common carp. Among these, 34 isolates were screened by polymerase chain reaction using specific primer of β haemolysin and serine protease. An expected base pair length of 683 (β-haemolysin) and 350 (serine protease) were obtained by PCR. Out of 114 environmental strains, 26 isolates were shown positive amplification for β-haemolysin and 27 serine protease genes. All 34 isolates were gram negative, oxidase and catalase positive. Ten isolates (AHPU31, AHPU34, AHPU42, AHPU44, AHPU62, AHPU67, AHPU80, AHPU92, AHPU93 and AHPU107) were resistant to aztreonam, amikacin, cefazolin, cefpodoxime, cefuroxime, imipenem, ofloxacin and nalidixic acid. The higher haemolytic activity (14 mm) was found in the strain of AHPU13, followed by AHPU03, AHPU107 (13 mm). Other isolates showed medium and low activity. Isolate of PUA16 showed higher (16 mm) proteolytic activity compare to other isolates followed by AHPU13 (15 mm). Isolate AHPU13 has high haemolytic and proteolytic activity. Twenty six isolates which were expressed positive amplification for β-haemolysin gene in PCR were also showed as positive reaction in western blotting methods. In conclusion, virulence gene of hemolysin and serine protease expressed isolates showed antibiotics resistance against commercially used antibiotics.

Keywords: *Aeromonas hydrophila*, Hemolysin, Serine protease, PCR and Antibiotics

Paper ID 16396

Screening of Oxytetracycline residue in cooked fish samples by chromatographic method

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Aquaculture is a rapidly growing and important source of animal protein nutrition, particularly in low- and middle-income countries (LMICs). Increasing use of antimicrobials in food producing animals is driving antimicrobial which is amongst this era's defining global health challenges. Rising incidence of antimicrobial resistant pathogens of animal production increase treatment failure rates, undermining sustainable food animal production and animal welfare. Antibiotic residues in meat and fish can cause a serious health issue to human. These residues may damage the intestinal flora, lead to the development of resistant strains in humans. Development of resistant strains cause the omission of antibiotic treatment in humans and can create allergenicity when present in high accumulation. It is important to investigate the progressions in and dependability of these anti-microbial residua during cooking for aversion and identification of the nearness of anti-infection agents in meat and fish. This study aims in the effect of cooking methods on antibiotic residues in catla. Catla samples were spiked with 1 ml of 500 µg Kg^{-1} of standard oxytetracycline concentration and further subjected to four varieties of cooking such as fish curry, fish 65, and fish deep fry and pan fry. The samples were extracted and subjected to HPTLC for further detection and quantification. The results revealed that only fish curry was positive for oxytetracycline residues with the overall range (145-498 µg Kg^{-1}), which was less than the spiked concentration. No samples were found to be positive for fish 65, fish deep fry and fish pan fry.

Keywords: Oxytetracycline residues, Cooked fish, HPTLC, Antibiotic resistance

Paper ID 16407

In vitro assessment of antibacterial activity and time-kill kinetics of Zinc oxide nanoparticle- A potential environmental-friendly therapeutic strategy for the replacement of antibiotics used in aquaculture

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The incidence and spread of aquatic animal diseases caused by intensified culture systems, increased global trade, and climate change are considered as major limiting factors impeding the expansion and development of aquaculture food production systems. As a result, chemotherapeutic agents and antibiotics are widely used in aquaculture. Imprudent use of antibiotics in aquaculture is a contributing factor in the spread of anti-microbial resistance, occurrence of antibiotic residues and also results in serious human health and food safety concerns, and devastating effects on the aquatic ecological sustainability. Nevertheless, in order to treat increasing diseases in a milieu of global emergence of antimicrobial resistance and strengthening regulations on antimicrobial use, sustainable alternatives are urgently needed. Thus, the potential prophylactic and therapeutic feasibility and employability of environmental- friendly compounds to combat bacterial infections is being progressively explored in aquaculture as an alternative to traditional antibiotics and chemotherapeutant usage in aquaculture food production system. The study focused on assessing the in-vitro antibacterial efficacy of Zinc oxide nanoparticle against aquatic environment isolate (antibiotic resistant) *Aeromonas hydrophila. A hydrophila* is a potent opportunistic aquatic pathogen and also an emergent human pathogen. The antibacterial activity was determined by microbroth dilution method by determining the Minimum Inhibitory Concentration (MIC) and time kill kinetics assay was performed to know the rate at which the bactericidal/bacteriostatic effect has occurred. The viable count was determined at different time intervals (0, 6,12,18,24 hrs) and time-kill curves were constructed by plotting $\log_{10}$CFU/ml vs time and the change in bacterial concentration was determined. The results of the study revealed that, ZnO nanoparticle inhibited bacterial growth at 4096µg/ml via bactericidal effect. The findings of the present study ascertain the potential therapeutic efficacy of ZnO nanoparticles as a viable alternative to antibiotics in aquaculture to treat the resistant bacterial community.

Keywords: Antibiotic resistant *Aeromonas hydrophila*, Zinc oxide nanoparticle, Minimum inhibitory concentration, Microbroth dilution, Time kill kinetics assay.

Paper ID 16412

Light intensity and photoperiod manipulation improves growth, haematology, hormonal profile and biochemistry of Butter Catfish, *Ompok bimaculatus*

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The butter catfish *Ompok bimaculatus* (known as Pabda in India and Bangladesh) is getting importance as a promising aquaculture candidate species due to its favoured taste, superior nutritional profile, smooth bony structure, rich lipoprotein content, and consumer preference. The experiment was conducted to study the effect of photoperiod and light intensity on growth, haematology, hormonal profile and biochemistry of *O. bimaculatus* in captivity. The fish(31.90 ± 0.18 g) were subjected to six photoperiod treatments: 24:0 light:dark(L:D), 12L:12D(8:00-20:00 light), 15L:9D(6:00-21:00 light), 9L:15D(10:00-19:00 light), 24D:0L and natural conditions for 60 days. Except for full dark and natural conditions, the rest of the photoperiod treatments were conducted with 3 different light intensities (500 lux, 1000 lux, and 1500 lux). The highest final body weight gain, average daily gain, specific growth rate (SGR), and feed conversion ratio (FCR) were observed in 15L:9D photoperiod at 1000 lux intensity on 60 d. The haematology revealed that a long photoperiod condition up to 15L: 9D for 30 days raises the haemoglobin content, red blood cell (RBC), white blood cell (WBC) count and improves the overall health of pabda.The highest level of testosterone and 11-keto testosterone was observed at 1000 lux in 12L:12Dand 15L:9D photoperiod, respectively, in females and males. The serum biochemistry study showed significant($P<0.05$) upregulation of glucose and cortisol level indicating stress response in *O. bimaculatus* in high light intensity (1500 lux) and long photoperiod(24L:0D) condition. A similar trend was also observed in lactate dehydrogenase (LDH) and C- reactive protein (CRP) level, but alanine aminotransferase (ALT) and aspartate aminotransferase (AST) showed a reverse trend with the increasing days of exposure. Better ionic balance (sodium-potassium equilibrium) was also observed in 15L:9D photoperiod in 1000 lux. The present study showed that photoperiod manipulation with fixed light intensity stimulate the growth, haematology, histology, hormonal profile and biochemistry of butter catfish, *Ompok bimaculatus*, which can help better production of this indigenous high valued catfish.

Keywords: Environmental manipulation, Photoperiod, Growth, Hormonal profile, Ionic balance, Serum

Paper ID 16416

A two-decade bibliometric analysis of Betanodavirus infection and its impacts in aquaculture

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The present study plots the research output of betanodavirus infection in aquaculture during 1998–2021 by means of the Web of Science (WoS) database. A total of 771 publications were used for this study to assess the research productivity. Bibliometric indicators of publications viz., total citation counts, average citation per paper (ACPP), and h-Index were extracted from the WoS database and used to assess the productivity of research institutions and authors. VOS viewer (Leiden University, Leiden, Netherlands) was used for analysing and visualizing relationships between countries, authors and terms (keywords). China ranked first in terms of total publications and total citations among the most productive countries and accounted for 17.49% of the total publications. The network visualization map revealed that the lead collaborating country was China followed by Taiwan and Japan. Fish and Shellfish Immunology and Journal of Fish Diseases are the most relevant journals found through this study. However, the journal local impact was higher for Diseases of Aquatic Organisms, when assessed by h-index. Co-occurrence of keywords, most productive authors and institutes and their collaboration, most cited papers and funding organizations were also analysed in the current study. The findings of the study indicate that there is a need to increase the research efforts on this viral pathogen since it has the potential to implicate huge economic loss for the fish farming sector of the world.

Keywords: Betanodavirus infection, Fish culture, Diseases, Web of science, Scientometrics, H-index

Paper ID 16464

Prevalence of Tetracycline resistant *Klebsiella pneumoniae* in freshwater fish farms in Kolleru region of Andhra Pradesh, India

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Antibiotic resistance (AMR) is one of the biggest threats to global public health, food security and development. As a result of increasing resistance, clinically efficacious antibiotics available for the treatment of infections caused by Multi-drug resistant (MDR) bacteria have been dwindling at an alarming rate over the last few decades. *Klebsiella pneumoniae* is a major pathogen implicated in nosocomial infections. High prevalence of tetracycline resistant *K. pneumoniae* was observed in freshwater fish farms in Kolleru region of Andhra Pradesh, India, a region known for its carp and lately, pangasius culture. The tetracycline mediated resistance mechanism in *K. pneumoniae* isolates was characterized. Soil and fish samples were collected from 44 fish farms in this region. Identification and characterization of resistant isolates was done by the standard methods. Antimicrobial susceptibility testing by disk-diffusion and biofilm formation assay by tissue culture plate method. Genes encoding for tetracycline resistance *tet A, tet B, tet C, tet D, tet M*, *tet O* and *tet X* were assayed by PCR. Among the 84 isolates, Thirty-two resistant *K. pneumoniae* to oxytetracycline, doxycycline, minocycline, chlorotetracycline, tigocycline were included in the study. Antimicrobial susceptibility test revealed that 88%, 75%, 64%, 81%, 45% of isolates were completely resistant to oxytetracycline, doxycycline, minocycline, chlorotetracycline, and tigocycline, respectively. All the isolates had the ability to form biofilm and 16 (51%), 10 (32%) and 6 (19%) were strong, moderate and weak biofilm formers respectively. Spearman rank correlation reveals that there is strong relationship between biofilm formation and antibiotic resistance to tetracyclines. All (100%) tetracycline resistant isolates harbored *tet A* and *tet M* genes, were detected in 50 % of the strong biofilm formers. Whereas *tet B, tet C, tet O* and *tet X* were not detected in any of the isolate. Findings of this study reveal that multiple factors play in mediating high level of antibiotic resistance in *K. pneumoniae*. Hence, a multifaceted approach is advocated for the prudent use of antibiotics in aquaculture, veterinary medicine and meticulous hygiene practices to prevent the transmission and infections caused by *K. pneumoniae* in the food chain.

Keywords: Antimicrobial resistance, Mutli-drug resistant, Tetracycline, Biofilm

Paper ID 16468

Development Recombinant Protein of Segment 4 of Tilapia Lake Virus (TILV) and studies on its immunogenicity for virus detection

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Tilapia lake virus (TiLV) is a novel single-stranded RNA virus which causes large-scale mortalities in tilapia farm worldwide and is considered to be a threat to tilapia industry. Recombinant technology which does not require the handling of live viruses is proved to apply to different viruses. Currently, the diagnostic test available for TiLV is based on molecular detection or cell culture-based isolation of the virus. The present study is aimed to develop a recombinant protein of TiLV which may work as a positive control for developing a diagnostic test for the virus in the future. For this purpose, the complete coding sequence of segment 4 of the virus was optimized, amplified, and cloned in pET-28a (+), a prokaryotic expression vector. The recombinant protein was expressed in BL21 competent *Escherichia coli* by Isopropyl-β-D-thiogalactopyranoside (IPTG) induction. The expression of the recombinant protein was successfully confirmed by SDS-PAGE. The recombinant protein was further used to raise hyperimmune sera in rabbit. Subsequently, an Indirect ELISA (iELISA) test was developed using immune sera as primary antibody and recombinant protein as positive control. ELISA test showed its immune reactivity with clinically isolated TiLV from tissue homogenate and mucous of field samples. Clinically symptomatic and asymptomatic samples that were positive by RT PCR were also detected positive by iELISA. The recombinant protein-based ELISA could be an effective tool for detection of TiLV from mucous as well as from tissue homogenates of infected fish.

Keywords: TiLV, Recombinant protein, Virus, Detection Elisa

Paper ID 16469

Acetone bark extract of *Terminalia arjuna* reports potential antioxidants

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The *Terminalia arjuna,* is an important ethnomedicinal plant that has been used in treating geriatric and chronic diseases in human being. A study was executed to explore the prospective bioactive principles methanol leaf extract of *T. arjuna*. The purified samples were subjected to high resonance liquid chromatography and mass spectroscopy (HRLCMS) coupled with Orbitrap. The raw data then analyzed in Compound Discover Software using Chem Spider for the confirmation and accuracy of the prominent compounds of interests. The analyses showed the highest concentration of Ellagic acid (*m/z* 302.0064g/mol) which is found to possess anti-oxidant, anti-cancer, anti-inflammatory, and antibacterial effects. The study also revealed the presence of potential antioxidants and terpenoids compounds such as (-)-Epigallocatechin, 3,5-Dihydroxybenzoic acid, Azelaic acid, 4-Methoxycinnamic acid, Caffeic acid, Catechin, Catechin gallate, Gallic acid, Quercetin, Epicatechin, Epigallocatechin gallate, Myricetin, Naringenin, Quinine, Quercetin-3β-D-glucoside, 18-β-Glycyrrhetinic acid, Syringic acid, and Ursolic acid. The noticeably, *Terminalia arjuna* acetone bark extract firstly reports the presence of D- (-)-Quinic acid which has been proved to be used as a potent drug candidate to combat prostate cancer. This is an indication that methanol leaf extract of *Terminalia arjuna*, is an ample source of important bioactive compounds that could be further studied for their possible utilization in aquaculture and human welfare applications.

Keywords: Antioxidants, Flavonoids, *Terminalia arjuna*, Chem spider, D- (-)-quinic Acid

Paper ID 16471

Antibacterial efficacy of extracts from *Ulva Sp*. against bacterial pathogen

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In the present study, the antibacterial activity of extracts from green seaweeds *viz*. *Ulva lactuca*, *Ulva reticulata* and *Ulva intestinalis* was tested using in *in vitro* techniques. Seaweed extracts were prepared in methanol, ethanol, chloroform, dichloromethane, benzene and aqueous solvents. Many phytoconstituents were reported in extracts. Gas Chromatography Mass Spectroscopy (GC-MS) was done for quantitative study of extracts. Antibacterial study of seaweed extract and Antibiotics was done *in vitro*, using antibacterial sensitivity test and Minimum Inhibitory Concentration (MIC) methods. MIC was also carried out using combination of extracts with standard antibiotics enrofloxacin and oxytetracycline. In the case of antibacterial activity of seaweed extract, a varying zone of inhibition was found against *Aeromonas hydrophila, Vibrio cholerae, Staphylococcus aureus and Bacillus subtilis.* Lowest values of minimum inhibitory concentration were recorded from methanol, ethanol and aqueous extracts. The combination of the extracts with Enrofloxacin and Oxytetracycline showed the possibility of synergistic effects of extracts against *A. hydrophila*,*V. cholera*, *E. coli* and *S. aureus*. From the above study, we can conclude that the seaweed *Ulva lactuca* possesses antibacterial effect and could act synergistically with antibiotics. The results encourage further investigation of extracts of Ulva sp. extract for a potential antibacterial formulation.

Keywords: Ulva, Sea weed, Pathogen, GIFT, *In vitro*

Paper ID 16477

Stress related changes on the skin mucosal immunity of Rohu (*Labeo rohita*)

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The fish immune system is comprised of numerous distinct and interdependent immune components which helps in defending themselves against invading pathogens. Fish skin mucus is a key element of the innate immune system and acts as a first line of defense against pathogens. Mucus serves as an important component of innate immune mechanism in fish. The study was conducted to observe stress related changes on skin mucus immune parameters of rohu (*Labeo rohita*) with two experiments, acute crowding for 0, 2, 24 and 48 hrs; and hypoxia exposure for 0, 1 and 3 min. The IgM levels exhibited significant difference ($p<0.05$) between acute crowding and hypoxia exposure groups. SDS-PAGE, under denaturing condition, expressed 6, 7, 9 and 7 protein bands with the range of MW 100 to 25kDa, 135 to 11kDa, 135 to 11kDa and 245 to 11kDa for 0, 2, 24 and 48h acute crowding exposure respectively; whereas 6, 5 and 7 protein bands with the range of MW 100 to 25kDa, 180 to 35kDa and 100 to 11kDa were expressed for 0, 1 and 3min hypoxia exposure respectively. The skin mucosal lysozyme activity evidenced high significant difference ($p<0.05$) between the fishes undergone acute crowding and hypoxia exposure. These results provide preliminary information for a better understanding of the role of epidermal mucus and its components in the fish innate immune system.

Keywords: Mucus, Stress, Acute-crowding, Hypoxia, Innate immunity

Paper ID 16478

Immunostimulatory effects of dietary Chitin, Chitosan and Levamisole on Tilapia *mossambicus*

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Overcrowding tends to adversely affect the health of cultured fish. Warm water aquaculture in Asia has problems with bacterial diseases such as motile aeromonads septicaemia, furunculosis, columnaris, and edwardsiellosis. Among these, disease caused by Aeromonas hydrophila is most widespread in freshwater fish. *A. hydrophila* is associated with disease in carp, eels, milkfish, channel cat fish, tilapia and ayu and produces stress related diseases in salmonids with the common symptoms of ulcerations, exophthalmia, abdominal distension etc. Immunostimulants have long played a major role in disease control in aquaculture practices globally. The effects of dietary chitin (poly [1→ 4] –β-N-acetyl-D-glucosamine), chitosan (de-N-acetylated chitin) and levamisole hydrochloride on the immune response and disease resistance to *Aeromonas hydrophila* were investigated in tilapia (*Tilapia mossambicus*). The aim of the present study was to evaluate the effects of chitin, chitosan, and levamisole on immune response and disease protection in *Tilapia mossambicus* against *A. hydrophila* an opportunistic pathogen in fresh water fish culture systems. Fish were fed with diets contains chitin (10 g), chitosan (10 g) and levamisole (250 mg) per Kg^{-1} of diet and non-supplemented diet for 60 days. The dietary supplements significantly enhanced the WBC count to a maximum on 45th day in fishes fed with levamisole supplemented diet, followed by chitosan and chitin. Chitosan supplemented diet enhanced the adherent leukocyte activity maximally on day 30. The maximum serum lysozyme activity was found on day 30 in all the groups fed with chitin, chitosan and levamisole supplemented diets. The results of disease resistance revealed that the fish fed with chitosan, levamisole and chitin attained relative percentage survival (RPS) value of 77%, 66% and 55% respectively.

Keywords: Immunostimulants, Chitin, Chitosan, *Aeromonas hydrophila*, Tilapia

Paper ID 16496

Aquatic animal disease surveillance in India

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The fish production in India has been growing at a rate of over 7% during the last decade. The country is second largest fish producing country and one of the largest exporter of shrimps. However, a recent study indicates huge economic losses worth Rupees 7624.64 crores due to shrimp diseases in the year 2018-19. This highlights the significant threat of diseases to the growth of aquaculture. Early detection is considered crucial for controlling the spread of diseases and the same is outlined in 'The Prevention and Control of Infectious and Contagious Diseases in Animals Act, 2009'. To fulfil the spirit of the act, Government of India (GoI) initiated a National Surveillance Programme for Aquatic Animal Diseases (NSPAAD) in 2013 with objectives of improving the collection of information on aquatic animal diseases; rapidly detect new and exotic diseases and meeting international disease reporting obligations. Currently, the program is being implemented through 30 institutes and coordinated byICAR-NBFGR. The major emphasis of NSPAAD has been to strengthen the passive surveillance system and undertake need-based active surveillance. The strengthening of passive disease surveillance is evident by first time report of seven new diseases from the country, namely Goldfish herpesviral haematopoietic necrosis disease; Koi sleepy disease; Hepatopancreatic microsporidiosis; Infectious myonecrosis, Epitheliocystis; Tilapia lake virus disease and infection with Red sea bream iridovirus, Mud crab reovirus. The active surveillance carried out under programme allows to state that three major pathogens of finfish i.e. Spring viremia of carp virus, Infectious pancreatic necrosis virus and Viral haemorrhagic septicemia virus and two of shrimp pathogens, namely Yellow head virus genotype 1 and Taura syndrome virus in shrimp have not been detected in India and provides transparent scientific evidence for this. NSPAAD has made significant impact in terms of developing a network of aquatic animal health laboratories; diagnostic capability for pathogens; issuing alerts to stakeholders following detection of new diseases; providing scientific advice to farmers and meeting international disease reporting obligations. The Government of India is contemplating to strengthen the disease surveillance programme under Pradhan Mantri Matsya Sampada Yojana, which would assist in sustainable growth of aquaculture sector in the country.

Keywords: Fish disease, Surveillance

Paper ID 16497

Experimental study of the pathogenicity of cell culture grown Tilapia Lake Virus (TiLV) in Nile Tilapia.

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Tilapia lake virus (TiLV) has recently been emerged as a transboundary disease posing great threat to tilapia aquaculture industry. This study describes an experimental challenge of Nile tilapia using tilapia lake virus with emphasis on the post-challenge survival proportions (PCSPs) and histopathological examination. Healthy Oreochromis niloticus (Nile tilapia) fingerlings were injected intra-peritoneally with 50µl of 1×10^5 $TCID^{50}$/ml of TiLV prepared by growing the virus in EPC cells. Infection was followed with daily monitoring of fishes for clinical signs and histopathology analysis in the main target organs viz. brain and liver. The cell culture grown virus produced clinical signs typical of TiLV such as bilateral exophthalmia and abdominal swelling. Microscopic examination revealed localized cuffing of lymphocytes and blood clotting in the brain cortex, syncytial cell formation and presence of intracytoplasmic inclusion bodies in the liver tissue. Overall, the Tilapia lake virus isolated and grown in cell culture produced infection in Nile tilapia fingerlings with clinical signs and histopathology similar to TiLV infection reported earlier.

Keywords: Tilapia Lake Virus, Pathogenicity, Histopathology

Paper ID 16499

Parasitic study and treatment of Indian Major Carps (IMC) in extensive culture systems of Srikakulam District, Andhra Pradesh, India

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The work was conducted to isolate and identify different parasites, to find out the severity of infestation and Parasitic Frequency Index (PFI, %) from IMC in extensive culture systems i. e. community and panchayat tanks. Our investigation was carried out during the July to December months of the year 2014-2018 in four different sites in the Srikakulam district of Andhra Pradesh, India. Approximately 80-100 infected fish were examined from each location for parasites and gross clinical signs were recorded. In the present study, isolated parasites were *Dactylogyrus* spp., *Gyrodactylus* spp., *Myxobolus* spp. and *Thelohanellus* spp. found on carps. The infested fishes suffered mainly from respiratory problems, blackness of the skin and mortalities. The results of the study revealed that parasitic infestations were found to be the major problem in cultivable fish ponds. Among IMCs, *Catla catla* and *Labeo rohita* were found to be more susceptible to *Dactylogyrus* spp. and myxozoans (*Myxobolus* spp. and *Thelohanellus* spp.) parasites respectively. Isolated parasites were obtained from gill and skin tissues of fishes. Furthermore, this paper provides the knowledge for management and prophylactic treatment of the diseases CAUsed by Myxozoans and monogenean parasites in culture system using common salt (25 kg Ha^{-1}) and formalin (1L Ha^{-1}) as per the standard recommendations.

Keywords: Andhra Pradesh, IMC culture, Parasites, Flukes, Myxozoans, Prevalence, Treatment

Paper ID 15748

A novel infection of *Achlya* sp. associated with dermal ulceration and mortality in an endemic snakehead fish *Channa aurantimaculata* from India

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A case of novel infection by *Achlya sp.* causing severe dermal ulceration and mortality is reported in *Channa aurantimaculata* an endemic snakehead fish, for the first time from India. The Achlya sp. associated with the infection was isolated in potato dextrose agar and confirmed by light microscopy following lactophenol blue staining. The *Achlya sp.* was further confirmed by molecular characterisation following PCR amplification internal transcribed spacer (ITS) gene and the gene sequence was submitted in the NCBI GenBank under the accession number MH571985. Bacterial isolates associated with the ulcers such as Vibrio cholera, *Chryseobacterium sp., Lysinibacillus fusiformis* and *Myroides pelagicus* were also isolated and characterized by the sequencing of the 16SrDNA gene. The histology of the infected muscle tissue revealed mycotic granulomas and fungal hyphae penetrating the dermis and musculature of the host. An infectivity study conducted in *Oreochromis niloticus* revealed 100 percent mortality and demonstrated similar disease conditions as that of the host *C. aurantimaculata.*

Keywords:

Fungi, pathogenic, Parasitic, Spores, Molds.

5. AQUATIC ENVIRONMENT MANAGEMENT

Paper ID 15526

Environmental Impact Assessment of open sea cage fish farms: A GIS based modelling approach

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Open sea cage farming is an emerging sub-sector of aquaculture in India, gaining its momentum in recent years. The Union Government is keen on boosting marine fish production through its flagship scheme under "*Pradhan Mantri Matsya Sampada Yojana"* (PMMSY). Manifestly, the expansion of cage farms in territorial waters are intensified. Hence, in order to ensure sustainability, it is essential to identify, quantify and monitor the metabolic waste release from sea cage farming activities. Modern developments in technologies such as GIS and remote sensing allows analysis of waste released and its movements in coastal waters. The current study has undertaken to access the environmental impact at sea cage farming sites in Gujarat, along Northwest coast of India by developing GIS based particle tracking model. Data on key environmental parameters such as pH, salinity, GPP, Chlorophyll, NPP, Ammonia, Dissolved Oxygen, Total Suspended Solid (TSS), Nitrate and Phosphate; Phytoplankton diversity were assessed. Significant difference was observed ($P<0.05$) in TSS and DO between culture site and reference site. The model could identify the factors which are influential in degerming the particles and tracking its direction and movement during the culture period. The current modelling exercise to track the movement of metabolic wastes disposed in coastal waters, its residential time and rate of nutrient flushing in given locality. The results of the study could lead to develop sustainable managemental strategies for ecosystem-based expansion of sea cage farms in territorial waters of the country.

Keywords: GIS, Cage Culture, Modelling, Environmental Impact Assessment, Particle Tracking Model

Paper ID 15544

Assessment of microplastic abundance and its characterization in commercially important edible bivalves and gastropods from the Southwest coast of India

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At present, microplastic pollution has emerged as one of the most significant global threats to the environment. Researchers are getting more concerned about microplastics due to their ubiquitous and persistent nature, negative impacts on the natural environment and biota, and potential to cause human health risks. Therefore, the present study was carried out to assess and quantify the occurrence of microplastics in commercially important edible bivalves and gastropods species inhabiting along the southwest coast of India. For the study, four different bivalve species such as *Perna perna* (Linnaeus, 1758) (brown mussel), *Villorita cyprinoides* Gray, 1825 (black clam), *Crassostrea madrasensis* Preston, 1916 (Indian backwater oyster), *Paphia malabarica* Dillwyn, 1817 (short neck clam) and one gastropod species *Babylonia spirata* (Linnaeus, 1758) (Spiral Babylon), were selected as sentinel species as they are used for human consumption and contribute significantly to the molluscan fishery of southwest coast of India. The mean abundance of microplastics, particles/g of soft tissue in the studied species, *Perna perna* (3.02 MPs/g) from Enayam, Tamil Nadu coast and *Villorita cyprinoides* (36.87 MPs/g), *Crassostrea madrasensis* (14.03 MPs/g), *Paphia malabarica* (18.31 MPs/g), *Babylonia spirata* (5.17 MPs/g) from Kollam and *Villorita cyprinoides* (14.12 MPs/g) from Cochin, Kerala coast were significantly different from one another. Microplastics of >1000 µm, fibres, and transparent were dominant in all studied species. The mean abundance of microplastics in water varied between 95 and 180 particles/L. The polymers like Polypropylene, Polyethylene, and Polyamide have been majorly identified in water and molluscan samples. Interestingly, a strong correlation was observed with microplastic abundance, total length, and meat weight. Bivalves showed a negative correlation with size as the number of MPs per g of soft tissue decreased with the increasing size of bivalves. In contrast, the gastropod species showed a positive correlation as MPs uptake per gram of soft tissue increased with size. Furthermore, studies are needed to clarify the impact of microplastic in biota, human microplastic exposure via bivalve and gastropod consumption and its health effects.

Keywords: Microplastics, Bivalves, Gastropods

Paper ID 15560

Growth and biochemical characteristics of microalgae *Chlorella vulgaris* grown on various combinations of fish waste hydrolysate and seaweed hydrolysate

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Chlorella vulgaris was cultivated in fish waste hydrolysate and seaweed hydrolysate to study the effects of different concentrations on the growth and biochemical characteristics. *C. vulgaris* was cultivated in various combination of fish waste hydrolysate and seaweed hydrolysate (3%:3%, 3%:6%, 3%:9%, 6%:3%, 6% :6%, 6%:9%, 9%:3%, 9%:6%, 9%:9%). A combination of 3% : 6% fish waste hydrolysate and seaweed hydrolysate has been found to be most effective for growth and biomass production of *Chlorella vulgaris*. The microalgae reached maximum cell density(4.26×106 cells/mL), chlorophyll-a concentration (2.6 mg/mL), specific growth rate (0.85/d) and biomass (3.14 g/L) on this media composition. The proximate composition of the algae raised in this combo had protein (123.87 mg/g), carbohydrate (44.904 mg/g) and lipid (84.21 mg/g) on dry weight basis of algae. The algae effectively striped up to 86% of nitrate, nitrate, ammonia and phosphorus in the final fish waste and seaweed medium proved the efficient utilization of nutrients by *Chlorella vulgaris*. The production of *Chlorella vulgaris* in the medium indicated that effective bioremediation of fish waste is possible through mass production of algae in fish silage. The study also proved that microalgae grown in fish silage have great potential as a source of feed and biofuel at industrial scale.

Keywords: Fish Waste, Seaweed, *Chlorella vulgaris*, Hydrolysate

Paper ID 15561

Containment of contaminants in *Chlorella* culture through Ammonium chloride and Copper sulphate infusion

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Microalgae have been construed to be a panacea of future demands of energy, edible oil, food, feed, fuel, fertilizer, functional foods, cosmetics, and planetary health. They take less and render more in all terms of resources. This benevolence merits its production, especially, *Chlorella* sp. because of its versatility in culture and benevolence in commercial content. Concurrent problems primarily felt of predation by grazers. To contain this ammonium chloride and copper sulphate have been tried at varied concentrations observed over a period of 12 hr duration. The ammonium hydroxide aside elevated inimical ammonia to rotifers increased the pH levels antagonistic to rotifers. Diluted ammonium hydroxide (1ml/1000 ml v/v) pushed forward pH from 7.3 to 8.9 at an addition of 8 ml/l. while this concentration caused 100% mortality in Vorticella, Rotifer, and Paramecium, the algal population also suffered 11% loss. A reverse phenomenon was observed in $CUSO_4$, with respect to pH. At a concentration of 10 mg/l copper sulphate could reduce 90 % Vorticella, 82% Rotifer, and 85% Paramecium in 12 hrs. This also caused 7.2% of algal biomass reduction. This study has more empirical application because of lesser cost and residual impact.

Keywords: *Chlorella Sp*., Zooplankton Grazers, Copper Sulphate, Ammonium Hydroxide

Paper ID 15562

Human urine as an alternative source of nutrient for biomass production of *Scenedesmus dimorphus*

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Microalgae are known to produce an array of value-added components like pigments. The nutrient medium used for the cultivation of microalgae is generally deemed to be more expensive. The emphasis of this work is on the practicality of human urine as a low-cost source of nutrients for microalgae culture, as it includes major nutrients, minor minerals and is cost-effective. Of course, it is a digressive approach from an aesthetic point of view. But the ultimate products are can be purified obviating pathogenicity. Human urine was collected, sterilized and different dilutions were prepared (5,10,15,25,50,75,100%). Cultures of *Scenedesmus dimorphus* was inoculated into a diluted human urine medium, incubated for 15 days at room temperature (around 29ºC) under window spread sunlight. The concentrations 5 %, 10%, and 15% have supported the production of microalgae. The maximum biomass was observed in a 5 % human urine concentration having cell density of 1.74×10^6 cells/ml with 3.2 g/l biomass production. The biomass productivity was 0.167g/l/day. Growth cessation could be perceived at more than 25 % of human urine concentration. This study offers scope for the consideration of human urine for algal production targeting value-added products, aside obnoxious liquid waste utilization.

Keywords : *Scenedesmus dimorphus*, Human Urine, Biomass Production, Low-cost Nutrient Medium.

Paper ID 15563

A comprehensive analysis on biochemical composition of red seaweed *Gelidium* from Indian coast

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The biochemical composition was assessed in five *Gelidium* species *(*Rhodophyta*) namely G.pusillum, G. crinale, G.micropterum, G.corneum* and *Gelidium sp.* The specimen for the current study was collected from Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu coast. The protein content varied from 14.25±1.36 % to 23.81±2.73 % of dry weight. The species *G. pusillum* revealed higher protein and total dietary fibre (24.91±0.0% dry wt) content whereas the total carbohydrate content is higher in *G. micropterum* (56.60±2.72% dry wt*).* Among the collected specimen, *G. crinale* was the only species collected from both West (Aksha beach- Mumbai, MH*)* and East coast (Vizhag, AP*)* and *s*patial variation was observed in its biochemical composition. Higher protein content (22.35±0.67% dry wt) and total dietry fibre (22.27±0.0 % dry wt) were found in the samples collected from East coast and carbohydrate (49.75±2.65% dry wt) was higher in samples of West coast. Additionally, chlorophyll and carotenoid content were also analyzed. Highest carotenoid content (59.87±0.19 mg g^{-1} Fresh wt) was recorded from *G. corneum* while total chlorophyll content was maximum in *G. crinale* (0.37±0.23 mg g^{-1} Fresh wt).The maximum yield of agar was found in case of *G. pusillum* (19%). The protein content of *Gelidium* species was higher as compared to other edible seaweeds therefore, it is recommended for human consumption.

Keywords: *Gelidium*, Biochemical Composition, Agar, Carotenoid.

Paper ID 15586

Assessment of polychlorinated biphenyls in freshwater and brackish water fishes of Thamirabharani river – a perennial river in South East coast of India

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PCBs were used in hundreds of industrial and commercial applications. Polychlorinated biphenyls (PCB) are the group of synthetic chlorinated aromatic hydrocarbons and its residues have been identified throughout the global ecosystem with widespread contamination. Polychlorinated biphenyls such as PCB 28, PCB 52, PCB 101, PCB 138 and PCB 153, PCB 180 and PCB 209 were studied in selected fishes of Thamirabharani River. Fish samples were collected from the respective sites and brought to the laboratory in iced condition and held in deep-freezer at -20o C until analysis. Three freshwater fish viz Catla (*Catla catla*), Rohu (*Labeo rohita*) and Tilapia (*Oreochromis mossambicus)* were collected from the first four sampling sites. Four marine and estuarine fishes such as Indian mackerel (*Rastrelliger kanagurta*), Milk fish (*Chanos chanos*), Indian oil sardine (*Sardinella longiceps*) and Mullet (*Mugil cephalus*) were collected from the station 5, which is an estuary region receiving influx of marine and freshwater. In the present study, the concentration of PCB 28 in fish samples of all stations ranges between 0 and 31.5 ng/g. In the present study, the accumulation of PCB 52 and PCB 101 in fish samples varies between 1.7 and 25.96 ng/g at all stations. The accumulation of hexa PCB compounds in fish samples at all stations ranges between 0.01 and 23.21 ng/g. The accumulation of PCB 209 shows decreasing trend in the order of Catla> Rohu> Tilapia during monsoon-17 season at Station II. However, the concentration of PCB 209 shows an increasing trend in the order of Catla< Rohu< Tilapia during premonsoon-19 season at Station II. Therefore, fish and animals at the top of the food chain are more contaminated than those feeding at lower trophic levels. From this study, it is concluded that increase in the release of chlorinated biphenyl from the nearby industries in to the aquatic ecosystem has severe effect in the selected fishes of Thamirabharani River.

Keywords: PCB, Thamirabharani River, Estuarine Fishes, Hepta PCB

Paper ID 15623

Acute and chronic toxicity effect of Triclosan on biomarker enzymes and protein content of *Labeo rohita* (Hamilton, 1822)

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Triclosan is a broad-spectrum anti-bacteriostatic compound being commonly used in Pharmaceutical and Personal Care Products (PPCP) as an active ingredient. In the present study, the toxic effect of triclosan on the biomarker enzymes such as acetylcholinesterase (AChE) and glutathione S transferase (GST) and protein content in the muscle tissue of *Labeo rohita* was examined during 96 h acute and 28 days chronic exposure to the toxicant. The toxicity result of the investigation shows that it has the potential to affect the rohu at the median lethal concentration of 1.795 ppm. The activity of AChE in the brain during acute and chronic exposure got gradually decreased with an increase in the concentration of triclosan. The mean AChE activity of brain tissue of rohu exposed to the control medium was 0.478 ± 0.02 $\mu M.min^{-1}.mg.protein^{-1}$. The percentage reduction of AChE activity of the brain during 96 h acute exposure from control to a higher concentration of TCS (2.014 ppm) was 44.94% and during the 14th and 28th days of chronic exposure were 47.28% and 40.17% respectively. While the GST activity of liver tissue significantly increased from 6.171 ± 0.50 to 9.940 ± 0.61 nmol. min^{-1} mg. $protein^{-1}$ at 0.504 and 2.014 ppm respectively during 96 h acute exposure to TCS. The percentage increase in GST activity in liver tissue of rohu from control to higher concentration of TCS (0.719 ppm) on the 14th and 28th day was 51.33% and 51.94% respectively which proved that the enzyme was actively involved in the process of removing the toxic metabolites from the fish body. The mean protein content of the control group of rohu during 96 h acute toxicity was 15.673 ± 0.21 $mg.g^{-1}$ which significantly reduced to 11.604 ± 0.14, 9.214 ± 0.40, and 6.224 ± 0.33 $mg.g^{-1}$ at the triclosan concentrations of 0.504, 1.007, and 2.014 ppm respectively during 96 h acute toxicity test. During the chronic toxicity test, the percentage reduction of protein content was 75.82 and 98.8% during the 14th and 28th days of exposure to TCS. This preliminary study of toxic effects of TCS in fishes would gain more interest to regularly monitor the contamination profile of emerging pollutants of personal care products.

Keywords: Triclosan, Toxicity, Emerging Pollutant, Acetylcholinesterase, Glutathione S Transferase

Paper ID 15641

Microplastics accumulation in pelagic and benthic fishes along the Thoothukudi coast, South Tamil Nadu, India

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Microplastics contamination in the marine environment of size < 5 mm poses a serious threat to marine biota, so the current study was carried out to assess the incidence of microplastics in the gastrointestinal tracts of pelagic and benthic fish collected from the six landing centres along the Thoothukudi region from January 2021 to December 2021. In the present study, demersal fishes showed a higher abundance of microplastics than pelagic species, with 0.53 ± 0.11 and 0.67 ± 0.14 microplastics/individual, respectively. The dominance of microplastic shapes, size and colour found were comparable among both pelagic and benthic fishes, this being fibre (27.56% and 48.33%), 0.5 -1mm (39.78% and 42.94%), and blue (50% and 40.85%), respectively. There was an insignificant difference in microplastics between pelagic and benthic species in terms of their abundance, shape, size, and colour ($p > 0.05$). This indicates that the microplastics are evenly distributed throughout the entire column, resulting in similar microplastic accumulation in both groups. Attenuated Total Reflectance-Fourier Transform Infrared Spectroscopy (ATR-FTIR) analysis revealed the high prevalence of polyethene (PE) in pelagic and benthic species, which accounted for about 46.24% and 48.18%, respectively. PE is a low-density polymer that is easily ingested by pelagic species, and these microplastics sink to the bottom due to biofouling. This may cause an accumulation of PE in the benthic feeders. The present study showed that microplastics are ubiquitous in both habitats, which raises serious concerns for public health. Hence, measures focusing on reducing local emissions and plastic waste disposal should be implemented to control microplastic pollution in the marine environment.

Keywords: Microplastics, Pelagic, Benthic, Polyethylene, Marine, ATR -FTIR, Thoothukudi

Paper ID 15643

Efficiency assessment of fish scales as biosorbent in the treatment of aquaculture wastewater

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The development of efficient and low cost adsorbent has been a recent focus on wastewater treatment. Currently, wastewater released from aquaculture farms poses great danger to the quality of coastal water and its resources. The organic and inorganic pollutants in livestock wastewater deteriorates the quality of draining area. Advanced technologies employed for wastewater treatment are costly and non-eco-friendly in nature. So in the present work, low cost biowaste like fish scales are employed as Fish Scale Biosorbent (FSB) in order to assess its potential in the treatment of organic pollutants present in shrimp farm wastewater. The experiment was conducted as batch work under varying FSB dosage levels and contact time. The FSB treatment produced significant results ($p<0.05$) with 89.95 ± 0.07 % removal of biological oxygen demand (BOD), 91.87% removal of chemical oxygen demand (COD) and 98.69 % removal of ammonia in shrimp farm wastewater. The other parameters such as nitrite and nitrate were also positively reduced after treatment. Langmuir and Freundlich models fitted well with the experimental data (R^2 values ranging between 0.67 and 0.97). From this study, the FSB dosage of 1 g /100 mL at 90 minutes contact time was found to be best for the treatment of wastewater. However, 180 minutes contact time with FSB dosage of 1 g/100 mL was found to be suitable for the removal of nutrients from wastewater. The pore structure and surface morphology of FSB were observed using FESEM analysis before and after treatment. The elements and functional groups present in raw and treated FSB were also observed using analytical techniques like EDS and FT-IR analysis. The results showed that fish scales exhibit good adsorption ability and thus can be used as biosorbent in the treatment of wastewater.

Keywords: Adsorption, Aquaculture, Biosorbent, Pollutants, Scales, Treatment

Paper ID 15646

Pyrolysis of fruit peels: Assessing its efficiency in bioremediation of shrimp farm effluent

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Shrimp farm effluent contains huge amount of organic matter and other pollutants which should be treated before discharging into the environment. Fruit wastes like pomegranate peels are potential bio-remediators which can be applied in treating effluent. In this study, pyrolysis of fruit peels were carried out at 300^{o}C to prepare pomegranate peel biochar (PPB). The turbidity parameters such as Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) removal efficiency were higher after treatment with pomegranate peel biochar. PPB showed <30% removal efficiency in the treatment of nutrients (nitrite and nitrate) and ammonia. The best dosage and contact time for the treatment of pollutants in shrimp farm effluent with PPB were found to be 1.25g and 90 minutes respectively. The surface pore availability and elemental composition of PPB were observed by FESEM and EDS analysis. Surface functional groups in PPB were identified through FTIR analysis. The results indicated that pyrolysis technique is found to be the promising technique in removing excess nutrients, TDS and TSS.

Keywords: Adsorption, Biochar, Effluent, Pollutants, Removal

Paper ID 15651

Assessing the status of microplastics pollution in waste waters draining into the Nagapattinam coastal region

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The usage of plastics especially, use and throw plastics continue to increase. As a result, the thrown plastics in the environment became meso and microplastics due to various physico-chemical processes. Thus, these microplastics enters into the aquatic ecosystems through various means. The disintegrated plastics which are lower than 5mm in diameter is known as "microplastics". The study of MPs in various environment and its effects on aquatic organisms are still in nascent stage. In the present study, the MPs in Nagapattinam coastal region was carried out by sampling the waste water which is entering into the coastal region. Nagapattinam and Nagore waste water were taken for analysis with an interval of once in seven days for six weeks. After initial filtration with 38µm sieve the samples were brought to lab for analysis wherein digestion of organic matter, density separation and filtration was carried out. After that the filtrate was send to the FT-IR analysis, with wave number range of 4000-400 cm^{-1}. From the result it was found that the presence of i) Nylon, ii) Polyvinyl chloride (PVC), iii) Polypropylene (PP), iv) Polyethylene terephthalate (PETE/PET), v) High-density polyethylene (HDPE), vi) Low-density polyethylene (LDPE) or linear low-density polyethylene (LLDPE), vii) Latex, viii) Nitrile, ix) Ethylene vinyl acetate (EVA), x) Poly (methyl methacrylate) (PMMA), xi) Acrylonitrile butadiene styrene (ABS), xii) Polycarbonate (PC), xiii) Polytetra-fluoro ethylene (PTFE) MPs in the samples. Predominant occurrence of PE 14% in Nagapattinam and 21% in Nagore sampling site. Further studies needed to find out the effects of MPs enter into coastal region in aquatic organisms.

Keywords: Microplastics, Wastewater, Polyethylene, FT-IR Analysis, Coastal Waters

Paper ID 15665

Genotoxic effect (DNA damage) of Lambda cyhalothrin pesticide on Tilapia (*Oreochromis niloticus*)

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Environmental pollution caused by pesticides is one of the most important problems in developing countries. The discharge of agricultural wastes into the aquatic environment leads to bioaccumulation of the pesticides in the aquatic organisms. It damages the DNA of the aquatic organisms which is responsible for the growth and survival of the aquatic organisms. Comet assay is used as an important tool for environmental monitoring and assessing health of aquatic animals by detecting DNA damage in fish, clams, shellfish, and mussels. Lambda-cyhalothrin is an insecticide belongs to a group of pyrethroids which is used to kill insects in the agricultural field. The aim of the current study was to determine the acute toxicity of Lambda cyhalothrin on Tilapia (*Oreochromis niloticus*), of about 100 ± 2g size and the genotoxic effect (DNA Damage) of Lambda cyhalothrin on gill and liver of Tilapia fishes using comet assay. Different concentrations (0.75, 1.5, 3, 6 & 12ppb) of Lambda cyhalothrin pesticide was used to investigate 96 hours Lethal Concentration 50 (96 hrs LC_{50}). Behavioral changes and mortality of fishes at different concentrations were also observed. Total mortality of fishes was observed at 6 and 12 ppb of cyhalothrin. The results revealed that the 96 hours LC_{50} value for the cyhalothrin pesticide on Tilapia was 2.26ppb or 0.00226ppm. After 96 hours, the comet assay was used to find out the DNA damage of the gill and liver of Tilapia in the first three lower concentrations. The DNA Damage Index of gill and liver exposed to 3.0 µg/l of cyhalothrin were 226.16 ±15.24 and 185.43 ± 5.32 and also significantly higher than in control group (0.00 ± 0.00). Based on this index, it could be concluded that DNA Damage Index was increased with the increase in concentration of pesticide and the gills of Tilapia was highly affected than liver.

Keywords: DNA Damage, Cyhalothrin, Tilapia

Paper ID 15680

Development of pocket-size device for on-site aquaculture water quality testing

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A pocket-size device is described in this study for determination of water quality of aquaculture water. A simple and inexpensive colorimeter is fabricated by combining light sources of various wavelengths with an electrical circuit and a light dependent resistor. For ease handling, the entire device was designed to fit into a pocket or palm. The performance of the newly created portable colorimeters was also compared to that of a commercially available device. These portable devices allow on-site measurement of water quality parameters in aquaculture due to their precision, portability, economy, and ease of use.

Keywords : Pocket-size Device, Water Quality, Aquaculture, On-site Determination

Paper ID 15696

The minimal optimal concentration of minerals required in low saline *Penaeus vannamei* culture system

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Macro and micro minerals are essential for the growth of shrimp, and it requires water with a specific concentration range of major minerals like calcium, magnesium, potassium and sodium. The farmers in India are facing a problem of mineral deficiency in low saline waters and it is essential to determine the minimal optimum concentration of minerals required for the optimal growth of *P. vannamei*. A set of four different experiments were conducted to determine the minimum optimum concentration of magnesium (Mg), calcium (Ca), sodium (Na) and potassium (K), by adding respective minerals in 2 ppt along with controls at 2 ppt and 25 ppt each. The concentration of Mg was maintained at 160, 260 and 360 ppm, Ca at 100, 150 and 200 ppm, Na at 1200, 2400 and 3600 ppm, and K at 60, 120 and 240 ppm using $MgCl_2$, $CaCl_2$, NaCl and KCl, respectively. The addition of Mg at 260 ppm, Ca at 150 ppm, K at 120 ppm and Na at 1200 ppm increased the shrimp weight gain by 4.99, 3.93, 3.44 and 5.46 units, respectively compared to other concentrations of each mineral. The specific growth rate was also observed to follow the same trend with 0.86, 0.77, 0.75 and 0.92 units at 260 ppm Mg, 150 ppm Ca, 120 ppm K and 1200 ppm Na respectively. The serum osmolality increased with increase in concentration of each mineral viz; 785 mOsm/kg in 260 ppm Mg, 803 mOsm/kg in 150 ppm Ca, 669 mOsm/kg in 120 ppm K and 769 mOsm/kg in 1200 ppm Na. The study suggested that a minimum concentration of 260 ppm Mg, 150 ppm Ca, 1200 ppm Na and 120 ppm K are to be maintained in low saline waters for optimum growth of shrimp.

Keywords: Minimal Optima Mineral Concentration, *P. Vannamei*, Low Saline, Specific Growth Rate

Paper ID 15707

Histological and Enzymatic effect of Cypermethrin in Common carp, *Cyprinus carpio*

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Cypermethrin is a type of synthetic pyrethroid used in fields and as pest control agent which enters into the aquatic environment and can cause potential health hazards to aquatic organisms and humans. The present study was designed to evaluate the effect of cypermethrin in the freshwater fish, *Cyprinus carpio*. *C. carpio* were exposed to five different concentrations viz. 0.5, 1.0, 2.0, 4.0 and 8.0 ppb of cypermethrin for 96 h acute toxicity test. Gill, liver and muscle tissues were collected, fixed and histological changes were investigated. Muscle protein content, glutathione S-transferase activity in liver tissue and brain acetylcholinesterase activity were evaluated after 96 h of exposure to Cypermethrin. In the present study, the 96 h LC50 value of cypermethrin in *C. carpio* was found to be 2.20 ppb. Histological alterations were noted in the tissues of gill, liver and muscle after the acute exposure to cypermethrin. Time and dose dependent reduction in muscle protein content and brain AChE activity was observed. However, significant increase in liver GST activity was observed on acute exposure to cypermethrin.

Keywords: Acetylcholinesterase, Cypermethrin, *Cyprinus carpio*, Histology, Protein

Paper ID 15708

Spatiotemporal occurrence, distribution, and characterization of microplastics in Pazhayakayal estuary of the coastal region of the Gulf of Mannar, Southeast coast of India

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Estuaries are the most important natural environment which supports all aquatic plants and animals in the coastal ecosystem. Estuaries work like a "sink" because it filters all the pollutants (pesticides, run-off, metals, etc.,) from the surrounding environment like the river, swamp, marsh, and agriculture runoff. Among the pollutants, microplastics (MPs) is considered the major pollutant because they will accumulate and affect the water, sediment, and organism of the estuary. Therefore, studies are essential to evaluate the presence of MPs in the water and sediment of the estuary. The present study was undertaken to investigate the spatiotemporal variations in the occurrence, distribution, and characterization of MPs in water and sediment from the Pazhayakayal estuary for a period of one year from Oct 2020-Sep 2021. Samples were collected from the estuary for the analysis of the MPs throughout the year as they vary with the season by Nile red staining method. The maximum occurrence of MPs in the sediment was recorded as 97 MPs/kg during the post southwest monsoon season, in water, it was 48 MPs/liter during post southwest monsoon season. The dominant size of MPs for the water and sediment samples was<0.5 mm and white color with irregular shaped MPs was found to be dominant throughout the study. The predominant component of the extracted MPs was characterized by Fourier transform infrared spectroscopy and identified as polyethylene (PE) and polypropylene (PP) in water and sediment samples. The study provides information that is intended to raise awareness among identified sectors and to act towards the prevention of MPs inputs in the region.

Keywords: Estuary, Microplastics, Pollutant, Sediment, Water

Paper ID 15758

Variations in ocean-atmospheric parameters and marine fish resources along the Kerala coast

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El Nino Southern Oscillation (ENSO) which is a coupled ocean-atmospheric phenomenon is known to change the environmental characteristics of coastal waters which are the major habitats of marine fish resources. The impact of ENSO events during 2007-2018 on environmental parameters and marine fish resources along the Kerala coast were studied. The monthly catch data of major pelagic and demersal fishes like oil sardine, Indian mackerel, anchovy, penaeid prawns, and threadfin breams during 2007-2018 were also used in this study. ENSO indices like EMI, MEI, SOI, TNI, Nino4, Nino 1+2 and DMI and ocean-atmospheric parameters such as rainfall, SST, chlorophyll a concentration, local temperature anomaly (LTA), salinity (SALT), sea surface height anomaly (SSHA), and ocean current velocity (OCV) were also analyzed. The relationship of ENSO and ocean-atmospheric parameters to variations in abundance of oil sardine, Indian mackerel, anchovy, penaeid prawns and threadfin breams were evaluated using Generalized Additive Model (GAM). GAM results indicated that ENSO could explain 62.2% of the deviance in LTA, 59.9% of the deviance in monthly rainfall, 57.9% of the deviance in SSHA, 52.9% of the deviance in chlorophyll a concentration, and 36.9% of the deviance in SST. The ENSO episodes could also explain 31.4% deviance in abundance of oil sardine, 31.7% deviance in abundance of Indian mackerel, 49% deviance in abundance of anchovy and 43.6% deviance in total fish resources. The study also indicated that a combination of ENSO indices and ocean-atmospheric parameters could explain better the deviance in the abundance of fish resources. The combined model explained 40.1% deviance of oil sardine, 84% deviance of Indian mackerel, 71.1% deviance of anchovy, 58.7% deviance of penaeid prawns, 81.2% deviance of threadfin breams and 71.7% of the deviance in total fish resources.

Keywords: ENSO, GAM, Kerala Coast, Marine Fish Resources, Ocean-atmospheric Parameters

Paper ID 15768

Finding the critical temperature regime and thermal preference of Silver Pompano, *Trachinotus blochii* (lacepède, 1801) for evaluating the species mariculture potential

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Due to the prevalence of diverse climatic zones and seasons along the Indian subcontinent, it is important to study the temperature influence on the performance of candidate mariculture species namely silver pompano *Trachinotus blochii,* which is one of the most promising among cultivable marine finfish species having a potential to catalyze both marine and brackish water mariculture sector. In this context, we have attempted to study the thermal tolerance limits of the species through Critical Thermal Minimum (CT_{Min}) and Critical Thermal Maximum (CT_{Max}). By using these dynamic methods, the relative effect of acclimation temperature on temperature tolerance was estimated to assess the distinct acclimation temperature zone for this species. The biological and behavioral response at six different temperatures (18°C, 22°C, 26°C, 30°C, 34°C, 36°C) based on the prevailing agro-climatic conditions prevailing along the Indian subcontinent were evaluated. The CT_{Max} of this species ranged from 37.26°C to 43.38°C and the CT_{Min} ranged from 12.52°C to 19.80°C. The thermal polygon revealed a total area of 434.50°C showing the species wide tolerance of temperature, with varying acclimation temperatures, thereby signifying their resilience of climatic variations. The response of marine species to changes in environmental temperature is of prime concern, in deciding the appropriate choice of species for mariculture even in non-conventional farming areas. The acclimation response ratio (ARR) of pompano juveniles exposed to various combinations of temperature, showed a range of 0.29 - 0.51. Silver pompano was found to be one of the ideal candidate species for mariculture promotion in both tropical and sub-tropical regions, wherein the average water temperature does not fall below 17.10°C during winter and does not exceed 38.52°C during summer.

Keywords: Silver Pompano, *Trachinotus blochii*, Thermal Tolerance, Critical Temperature, Acclimation Response Ratio (ARR), CTmax, CTmin, Thermal Polygon

Paper ID 15780

An Inventory on native micro algal strains from various temples and quarries in Chennai region

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Study was carried out in four temples and two quarries in Chennai region. The sample sites were Vadapalani Murugan Temple, Mylapore Kapaleeswarar temple, Kandhakottam Kandaswami temple, Ponneri Agatheeswarar temple, Sikkarayapuram (Sivanthangal) Stone quarry and Pallavaram Stone quarry (Canyon of Pallavaram). 21 water quality parameters calculated for all the 6 samples including Appearance, Odour, Turbidity, Temperature, pH, Salinity, Dissolved Oxygen, TDS, TSS, Total solids, Electrical Conductivity, BOD, COD, Hardness, Alkalinity, NH_3, NO_2, NO_3, Calcium, Magnesium, Phosporous. The maximum Calcium concentration was found in Pallavarm stone quarry water followed by the Sikkarayapuram stone quarry with concentration of 120 mg/L and 88 mg/L respectively. The maximum ammonia concentration (0.513 mg/L) was found in Ponneri Agatheeswarar temple. Water from Mylapore Kapaleeswarar temple was analysed to be the soft water with the hardness of 50 ppm. A total of 151 algal species were identified from all the samples including 41 species from Pallavaram stone quarry, 30 species from Sikkarayapuram stone quarry, 24 species from Vadapalani Murugan temple, 16 species from Mylapore Kapaleeswarar temple, 19 species from Ponneri Agatheeswarar temple and 21 species from Kandhakottam Kandhaswami temple. Common classes of algae encountered in this study were *Chlorophyceae, Bacillariophyceae* and *Cyanophyceae*. The most commonly occurring class from all 6 samples was *Chlorophyceae*. The most common Genus identified in this study was *Scenedesmus*.

Keywords: Micro Algae, Temple Tank, Quarry Water, *Chlorophyceae, Bacillariophyceae, Cyanophyceae*

Paper ID 15796

Bioremediation of Cadmium by using Water hyacinth *Eichhornia crassipes*

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Bioremediation is a tool used to convert concentrated solution into less toxic by using bacteria, plants, fungi etc. In phytoremediation method, the contaminated water will be treated by aquatic plants like *Eichhornia crassipes,* microalgae, seaweeds etc to reduce the contaminant concentration. The plants species were chosen based on its growth, nativity, adverse impact on environment, Efficiency of plant and cost effective. The waste water from cephalopod processing plant contains high level of cadmium which is present in the ink gland, gonads, liver. A study was carried out to experiment different concentration of cadmium ie. control, 1, 3, 6, 9 mg L^{-1} and remediated by water hyacinth (*Eichhornia crassipes)* and it was conducted with scheduled intervals of 7 and 14 days. After remediation, the plant samples (leaves & roots) were collected, homogenised and microwave digested with nitric acid. The Cd in the samples were measured by Inductively-Coupled Plasma Atomic Emission Spectroscopy (ICP-AES). From this study it was observed that *Eichhornia crassipes* is very effective in remediating higher level cadmium of 9 mg L^{-1} and the plant absorbed the cadmium at the level of 164.2±3.735 µg g^{-1} Cd and 175.4±0.68 µg g^{-1} Cd in 7 and 14 days interval respectively.

Keywords: Bioremediation, Water Hyacinth, Cadmium, ICP-AES

Paper ID 15798

Geo-spatial modelling of riverine habitat quality for ecosystem management: A case study from the Godavari river basin, India

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The habitat quality of a riverine ecosystem determines its biodiversity richness, that in turn linked with the production of multiple ecosystem benefits along with its flow. However, the dynamic riverine ecosystem is threatened by multiple anthropogenic stressors including catchment area land use land cover (LULC) change, inflow of sediment and nutrient runoff, damming, abstraction of water flow, river bed degradation, illegal fishing and spread of invasive fish species. The mapping of habitat quality considering the relative impact of these stressors, sensitivity of riverine habitat, distance between the stressors and habitat is essential for the conservation and restoration planning of the riverine ecosystem. A study was carried out in river Pranhita, a tributary in Godavari River Basin, for its habitat quality assessment using the Habitat Quality Model of InVEST v3.10.1 (Integrated Valuation of Ecosystem Services and Tradeoffs) Tool. The river with 103 km length, flows through the Deccan Plateau and harbours rich diversity of endemic and threatened fish species. The riparian LULC map of river Pranhita was prepared using the Sentinel -2 satellite imagery of 10 m resolution in ERDAS Imagine-2016 platform and spatial input data on anthropogenic threats to riverine habitats were generated in ArcGIS v10.8.1 platform using the information collected through field explorations (2019-2021). The study results showed relatively high habitat quality in riverine areas located along the natural land cover *i.e.,* forests with minimal anthropogenic interference. Further, the model results; validated using the field data collected on physical habitat setting, water quality and fish diversity assessment from sampling sites located along the river course; revealed its close association with the model output. The demonstrated utility of InVEST model for mapping the habitat quality of Pranhita riverine ecosystem can be taken up at the basin level for prioritising river stretches for biodiversity conservation and habitat restoration.

Keywords: Riverine Ecosystem, Habitat Quality, Spatial Modelling, Godavari Basin, LULC

Paper ID 15803

Development of an effective microalgae diet (*Picochlorum maculatum*) using Twin Layer Recirculation System (TLRS) for the culture of *Oithona dissimilis* (order: Cyclopoida): An integrated approach for biomass production and nutrient remediation

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Excessive nitrogen and phosphorus loading from aquaculture wastewater treatment plants is a continuous risk to water quality, resulting in more stringent environmental regulations in various regions. The microalgal mediated twin-layer recirculation system (TLRS) is an interesting nitrogen and phosphorus removal approach since it provides a treatment that efficiently removes both nutrients while also producing potentially important biomass. The TLRS successfully separates microalgae from the bulk of their growing media, yet allows diffusion of nutrients. The substrate and source layer for TLRS were chosen as PRNM (Proton Reinforced Nitrocellulose Membrane) and Metal grid wire mesh, respectively. *Picochlorum maculatum* was used to investigate the removal of nitrogen and phosphorus from aquaculture wastewater. Within a short retention time (15 days) the TLRS system supports the growth of *P.maculatum* (7.52 ±1.12 g dry weight m-2) in aquaculture effluent. The effects of wastewater (WW)-cultured *P. maculatum* as a feed for *Oithona dissimilis* as well as their survival and population density were also examined, and the results were compared to those of synthetic media (SM)-cultured *P. maculatum*. The results showed that of the two microalgal diets examined, the WW grown *P.maculatum* fed *O.dissimilis* had the best survival rate of 80%, compared to the SM grown *P.maculatum* fed *O.dissimilis.* WW grown *P.maculatum* fed copepods produced the highest population density with 584 ind./l containing 346 Nauplii, 184 Copepodite, and 54 adult copepods. The lowest population density was obtained in SM grown *P.maculatum* fed copepods (563 ind./l) which includes 336 Nauplii, 176 Copepodite and 51 adults. Protein, lipid, carbohydrate moisture, and ash of *O.dissimilis* were found to be greater in WW grown *P.maculatum f*ed copepods with mean values of 66.23 ± 0.51%, %, 4.54 ± 0.5%, %, 10.97 ± 0.7%). %, 84.35 ± 0.4% and 2.01 ± 0.12 respectively. This research suggests that utilizing the microalgae *P.maculatum* to improve the nutritional composition of the *O.dissimili*s as supplementary live feed for shrimp/fish larvae has the potential to be beneficial.

Keywords: Bioremediator; Microalgae Feeds, Immobilized Cell Culture, Copepods and Proximate Composition

Paper ID 15805

An Assessment of non-targeted catch of marine macrophytes caught in mini-trawl (Thallu madi) in Palk Bay, Tamil Nadu

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Seagrasses are flowering plants with long and narrow leaves, which grow by root-rhizome extension and often spread across large "*meadows*". Seagrass beds occur extensively in shallow waters. and they form "*seagrass meadows*" in tropical and temperate waters. The Palk Bay ecosystem covers from Point Calimere to Arichalmunai, have seagrass meadows which support the fishery of green tiger prawn. The mini trawl is targeted to catch green tiger shrimp and the quantum of non-targeted seagrasses were caught along with this and discarded in the sea. A study was conducted to assess the quantity of marine macrophytes caught as non-target catches in mini trawl in Devipatinam periodically. The non-target catches of macrophytes contains seagrass and seaweeds and they were segregated. The species wise wet weight was recorded in each haul. The mean value of non-target catch of macrophytes comprised of seagrass dominated by Karumbu passi *Cymodocea serrulata* (4.965 kg/haul) followed by Noodle seagrass *Syringodium isoetifolium* (3.445 kg/haul), Ribbon seagrass *C. rodundata (*1.297 kg/haul), Tape seagrass *Enhalus acoroides* (0.117 kg/haul) and others (seagrass/seaweed) 0.012 kg/haul. The fishing area of mini-trawl along Devipattinam waters were limited with seaweeds than seagrasses. This study provides the baseline information on non-targeted catch of marine macrophytes caught in mini trawl for better management of fishery.

Keywords: Palk Bay, Non-targeted Catch, Marine Macrophytes, Seagrass, Mini-trawl

Paper ID 15807

Persistent organochlorine residues in water and sediment samples collected from Thamirabarani River, South East Coast of India

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The study was undertaken to investigate the accumulation of organochlorine (OCPs) in surface water and sediments of the Thamirabarani river system. Samples were collected from given sampling sites viz. Papanasam (S1), Cheranmadevi (S2), Vannarapettai (S3), Srivaikundam (S4) and Punnakayal (S5) and analyzed for organochlorine pesticides by Gas Chromatography Electron Capture Detector (ECD) following QuEChERs method of extraction. A total of 200 surface water and sediment samples at 5 sampling stations were collected along the river in four seasons during 2017to 2019. The ∑ OCP concentration in water and sediment samples was in the range of 0.001 to 26.66 µg/l and 0.001 to 16.474. the dominant OCPs in water samples are Aldrin, BHC Compounds, Endosulfan which show different contamination patterns among the sampling seasons. The distribution pattern of DDTs, Heptachlor and other OCPs in the present study shows the heterogenic nature of non-point sources of pollution. Notable contamination of water, sediment samples were observed in upstream (S1) 28.66 µg l−1 and downstream (S4) 16.474 µg/kg dw explaining agricultural and municipal outfalls, whereas frequent damming effect reduces the concentration level in the midstream

Keywords: Organochlorine Pesticides, Endosulfan, Heptachlor, Pops, South East Coast of India

Paper ID 15810

Status of marine litter in selected beaches and fish landing centres of Palk Bay and Gulf of Mannar

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Marine litter are man-made objects discarded directly or indirectly into beaches, sea shores, fish landing centres etc. There are variety of litters ranging from plastic lid, spoon to large fishing net have emerged as important threat to coastal and marine ecosystem, endangering the flora, fauna and also affect the livelihood of fishers. A study was carried out on the non-biodegradable litters in selected beaches and Fish landing centres along the Palk Bay and Gulf of Mannar during August 2020 to March 2021. A quadrate with dimension of 2mx2m was selected at each location. The non-biodegradable wastes include Plastic covers/ bottles, nylon nets/pieces, glass bottles, Thermacols/polyurethane and e-wastes. Data were collected periodically along the fish landing centre of Rameswaram, Pamban, Devipatinam and selected beaches of Thonithurai & Ariyaman. The marine litter were recorded maximum in Rameswaram FLC about 155.42g/sq.m followed by Devipatinam FLC (66.53g/sq.m.) and Pamban FLC (52.18g/sq.m.) during Jan 2021. The Arichalmunai beach maximum debris/litter were recorded during Dec 2020 (47.32g/sq.m) whereas in Thonithurai beach during Jan 2021(63.75g/sq.m). During the study period, the mean value of non-biodegradable litters were recorded in the Rameswaram FLC as 136.95g/sq.m, Devipatinam FLC as 48.36g/sq.m, Pamban FLC as 39.1g/sq.m, Thonithurai beach as 50.75g/sq.m and Ariyaman beach as 39.92g/sq.m. At Rameswaram FLC, the maximum marine litter was comprised by fish net pieces/HDPE ropes with the mean value of 107.25g/sq.m followed by plastic items/ covers of 10.125g/sq.m. The Thonithurai beach, Pamban FLC, Ariyaman beach, Devipatinam FLC were recorded the maximum quantity of fish net pieces/ HDPE rope with the value of 22.5g/sq.m, 13.626g/sq.m, 13.187g/sq.m and 7.75g/sq.m, respectively. This study gives overall picture of non-biodegradable litter status along the beaches and Fish landing centres of Palk Bay and Gulf of Mannar region.

Keywords: Marine Litter, Fish Landing Centre, Non-biodegradable, HDPE Rope, Palk Bay, Gulf of Mannar

Paper ID 15816

Assessment of phosphorus solubilizing capacity of *Rhodococcus* sp and *Arthrobacter* sp isolated from mangrove rhizospheric sediment and its potential application in aquaculture

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Phosphorus is present abundantly in the earth's crust, but it acts as limiting nutrient in aquatic environment due to its non-availability as it forms insoluble precipitate with Ca, Mg, Fe, and Al. Phosphorus solubilising bacteria (PSB) solubilizes the inorganic precipitate into soluble P forms. In the present study, thirteen nos. of PSB isolates were screened from the rhizospheric sediment samples of *Avicennia marina* collected from Ennore region and identified as *Rhodococcus*, *Arthrobacter*, *Bacillus*, *Enterococcus, Staphylococcus* and *Pseudomonas*. The P-solubilizing activity of PSB isolates were found to be in the range of 7.62±0.51- 16.33±0.84 mg/l. Acid phosphatase (ACPase) activity of these isolates ranged from 4.40±0.28 - 22.77±0.32 $\mu molml^{-1}h^{-1}$. The maximum ACPase activity was exhibited by *Arthrobacte*r sp. (22.77± 0.32 $\mu molml^{-1}h^{-1}$) followed by *Rhodococcus* sp. (18.08±0.78 $\mu molml^{-1}h^{-1}$). *Arthrobacte*r sp. and *Rhodococcus* sp. were selected to assess their P - transformation potential at various temperature, salinity and carbon source. The highest ACPase activity was recorded at the temperature of 40°C in *Rhodococcus* sp (20.4 $\mu molml^{-1}h^{-1}$), *Arthrobacter* sp (23.6 $\mu molml^{-1}h^{-1}$). The highest P-solubilising activity was recorded at 30°C in *Rhodococcus* sp (14.78 mg/l); at 40^0C in *Arthrobacter* sp (14.51 mg/l). The highest ACPase activity and P-solubilising activity were recorded at 25ppt in *Rhodococcus* sp; 35ppt in *Arthrobacter* sp. The highest ACPase and P-solubilising activity were observed with glucose as carbon source in both the isolates. The P-mobilizing potential of the isolates obtained in this study were compared with the commercial product following a microcosm study for a period of 21 days. *Rhodococcus* sp. showed higher ACPase activity in sediment (12.00 $\mu molg^{-1}h^{-1}$) than that of the commercial product (11.23 $\mu molg^{-1}h^{-1}$). In terms of available phosphorus, commercial product showed significantly ($p<0.05$) higher efficiency. The phosphate level in water was the highest in both *Rhodococcus* sp and commercial product (0.49mgl^{-1}).

Keywords: Phosphorus Solubilising Bacteria, Mangroves, Rhodococcus , Arthrobacter

Paper ID 15818

Characterization of *Pseudomonas aeruginosa* Ws-l9 bacterium a novel isolate having heterotrophic nitrification and aerobic denitrification capability

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Pseudomonas aeruginosa WS-L9 a novel isolate showed remarkable characteristics of heterotrophic nitrification and aerobic denitrification ability. Isolation of this isolate was completed from environmental samples in enrichment media containing ammonium chloride as nitrogen source and glucose as carbon sources keeping Carbon:Nitrogen ratio of 10 under shaking condition with 120 rpm in the shaker incubator. Identification of this isolate by biochemical and molecular methods showed presence of gram negative, rod shaped, smooth, colony by morphological and microscopic methods. Sequence analysis of 16S rRNA sequencing after amplification with universal primer (27F and 1492 R) revealed 99% similarity with *Pseudomonas aeruginosa*. The neighbor joining phylogenetic tree analysis showed phylogenetic relationship with *Pseudomonas aeruginosa* and formed closed group with it, so it was named as *Pseudomonas aeruginosa* WS-L9. Subsequently the sequence was submitted to NCBI and it is available with accession number MT598011 in the genbank database. The characteristic features of *Pseudomonas aeruginosa* WSL-9 was studied under different cultural conditions such as at different pH, temperature, Carbon: Nitrogen ratio and by using different carbon sources in nitrification media. The results of above experiments revealed that the isolate could efficiently remove nitrogen at pH 7.2, 30 C, C: N of 10 and by utilizing glucose as carbon source. The nitrogen removal ability of this isolate was more than 85% in nitrification median and more than 77% in denitrification media. This isolate could also able to amplify the Nap-A and Nir-K genes which proved the presence of heterotrophic nitrification and aerobic denitrification ability.

Keywords : Heterotrophic Nitrification; Aerobic Denitrification; *Pseudomonas aeruginosa*; Nitrogen Removal

Paper ID 15820

Distribution of polychlorinated biphenyls in water samples of Thamirabharani river

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Polychlorinated Biphenyls (PCBs), persistent synthetic group of chemicals have been linked with serious health and environmental effects. The PCBs used in various activities end up in rivers, lakes and finally end up in oceans. Samples were collected from five sampling sites viz. Papanasam (S1), Cheranmadevi (S2), Vannarapettai (S3), Srivaikundam (S4) and Punnakayal (S5) and analyzed for Polychlorinated Biphenyls (PCBs) by Gas Chromatography Electron Capture Detector (ECD). The present study recorded the presence of PCB congeners in the surface water of the Thamirabarani river system which also found to be vary according to the seasons. The accumulation of PCB52 and PCB101 in the water samples varies between 1.05 and 3.52 mg/l at all stations. The accumulation of PCB52 and PCB101 in the sediment samples varied between 1.17 and 35.48 ng/g. The accumulation of PCB52 and PCB101 in fish samples varied between 1.7 and 25.96 µg/kg at all stations. The accumulation of Hexa PCB compounds in fish samples at all stations ranged between 0.01 and 23.21 µg/kg. The accumulation of PCB180 in the water samples of all stations varied between 1.23 and 2.95 mg/l. The maximum concentration of PCB 28 (11.3 µg/l), PCB 101 (3.52 µg/l), PCB 52 (2.86 µg/l), total tetra CB's (6.38 µg/l), PCB 180 (2.95 µg/l) , PCB 209 (0.05 µg/l) were observed in station V which is the estuarine area receiving more amount of runoff from agricultural fields and industrial complexes before meeting the Gulf of Mannar. Since the organochlorine pesticide and polychlorinated biphenyls occurrence was observed to be high during the monsoon season than in other seasons, the wastewaters should be properly treated before letting into the river.

Keywords: PCB, Thamirabharani River, Water sample, Hepta PCB

Paper ID 15823

Assessing the economic impact of marine debris on fishing in Andhra Pradesh, Southern India

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Oceans around the world are being impacted by increasing levels of marine debris. It has become ubiquitous and an insidious global threat both to human and marine life. This man-made menace ends up in ocean through many ways of improper waste management both intentionally as well as unintentionally. Most of the literature examines the prevalence and types of marine debris and its impacts on marine organisms. However, marine debris also causes an economic loss to fishing by the way of cost associated with it *viz*. fuel consumption, value of fish catch and labour cost. This work is an attempt to assess the economic impact of marine debris on fishing. To understand the presence and effects of this persistent marine debris around Visakhapatnam in Andhra Pradesh coastal waters, experimental trawling was carried out from 2017 to 2019 at depths ranging from 30-40 m on a biweekly basis. Fish catch and debris were segregated and weighed separately for each fish species and type of debris. Swept area method was used to estimate the debris collected per square km. Fish catch were valued based on the market rate prevalent at the local fish landing centre. Fuel cost and labour cost involved per fishing trip / fishing effort were calculated. With this mean data, economic loss in fishing due to marine debris was estimated with the data on total time of trawling during that period. An effort was also made to note the perceptions of fishermen on marine debris. Fishermen expressed positive feedback for an incentive program to collect and bring back debris encountered during fishing. However, to wholly tackle the issue the ingress of shore-based debris should be prevented.

Keywords : Cost of Fishing, Financial loss, Collect Debris, Incentive

Paper ID 15833

An investigation on the survival threshold of Spiny lobster *Panulirus homarus*, on altered salinity exposures

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The spiny lobster *Panulirus homarus* is an economically, ecologically, and recreationally valuable decapod crustacean that inhabits the shallow coastal and rocky areas along the Indian coast. In lobster coastal aquaculture, the selection of suitable environment settings is crucial due to the variable salinity regime of coastal waters, which can be either gradual or sudden fluctuations. This makes the determination of salinity tolerance/threshold one of the prerequisites for the testing culture potentialities of *P. homarus*. We therefore investigated the range of salinities for which survival was possible for *P. homarus* under slowly adjusted as well as abruptly exposed changes of salinity, in the present research. In the study, we tested the survival of lobsters in salinities ranging from freshwater to hypersaline conditions (8-55 ppt) under in-vivo laboratory conditions and determined whether the mode (abrupt and gradual) of exposure affected experimental results. Both modes of experiment examined survivorship and behavior of lobsters by increasing or decreasing salinity from the natural environment under laboratory conditions. Mortality in each tank was recorded daily for 7 days for the gradual adjustment trials and abrupt trials. Overall, there was significant difference in survival % between different salinities both after gradual increase (log-rank; $\chi2 = 44.28$, $p<0.05$) and after gradual decrease (log- rank; $\chi2 =116.07$, $p<0.05$) from the control condition. Similarly, sudden lowering and increasing of salinity regimes also showed a significant influence on survival (log ranks $\chi2=82.97$, log ranks $\chi2=81.64$, $p<0.05$, respectively). There was 100% survival between 17‰ to 44‰ for gradual exposure and 26 to 41‰ salinity, in abrupt exposures. The higher and lower limits of LD50 that caused 50% mortality in *P. homarus* for gradual exposures were 51.81‰ and 10.66‰ respectively. Similarly, the higher and lower limits of LD50 following abrupt exposures were recorded as 44.57‰ and 22.39‰, respectively. Binary logistic regression model on the likelihood of lethality during gradual shifts and abrupt shifts in salinity were statistically significant ($\chi2= 53.72$ and $\chi2= 126.95$, respectively at $p < 0.0005$) when compared with control conditions. The model explained 65.3% of the total variance for gradual exposures of altered salinity and correctly classified 92.8% of cases for abrupt exposures. It was found that the mortality did not occur between 17‰ to 44‰, and between 26 to 41‰ following gradual and abrupt exposure to salinity shifts. Thus, the study indicated a better capacity of *P. homarus* to tolerate wider salinity and provide data for future coastal aquaculture practices of the species, prone to significant freshwater or saltwater input.

Keywords: Lobster, Survival, Climate Change, Salinity Shift

Paper ID 15865

A comparative study on plankton dynamics in *Vannamei* culture ponds and adjacent coastal waters along Thoothukudi coast, India

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The present study was carried out to assess the biomass and diversity of plankton in *Litopenaeus vannamei* culture pond (station 1 & Lat 09º01 N; Long 78º16 E) and effluent treatment pond, receiving the shrimp pond effluent (station 2 & Lat 06º30 N; Long 76º07 E) in comparison to a reference (station 3 & Lat 10º23 N; Long 78º06 E) of apparently an unpolluted coastal waters relatively free from any pollution, nor influenced by the effluents from the shrimp ponds. The density of phytoplankton was counted using Sedgewick rafter counting chamber and found to be dominant in station 1 (73400 to 164600 cells/l) during November 2013 and April 2014 compared to station 2 (39200 to 84000 cells/l) and station 3 (38400 to 75200 cells/l) whereas the species diversity index (H') of phytoplankton was comparatively lower in station 1 (0.99 to 2.03) followed by station 2 (1.62 to 2.94) and station 3 (2.37 to 2.96). The maximum and minimum density was recorded during summer and monsoon season, respectively. With regard to zooplankton composition, station 1 recorded high density (182500 to 397500 numbers/m^3) compared to station 2 (12500 to 352500 numbers/m^3) and station 3 (97500 to 272500 numbers/m^3). The species diversity index (H') for zooplankton in station 1, 2 and 3 varied from 1.01 to 33, 2.39 to 2.95 and 2.37 to 2.96, respectively. The present investigation showed that the shrimp culture pond (station 1) had high densities of plankton with less species diversity than unpolluted coastal waters of station 3. This indicates that the presence of *Vannamei* farm near coastal area of Kalaignanapuram seemed to have no influence on plankton dynamics of coastal waters. The effluent treatment ponds receiving shrimp pond effluent (station 2) had only slight variation in the plankton diversity compared to the unpolluted station.

Keywords : Diversity, Phytoplankton, Zooplankton, Shrimp Pond Effluents

Paper ID 15873

Phytoremediation for environment management in estuarine ecosystems

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Estuarine management in Mangaluru City needs to take into consideration multiple factors especially with increasing population and diverse anthropogenic needs for the utilization of biotic and abiotic resources of the region. The challenge to minimize the climate impacts of storm surges and flood risk is on the increase and added to that is the need for effective management of effluent discharges. Hence, appropriate environment friendly technologies using locally available resources are needed. Water quality management in estuarine ecosystems emphasizes site specific salinity regimes through the mixing of fresh and tidal waters as well as a control over the sources of pollution. Phytoremediation is a term applied to a group of technologies that use plants to reduce, remove, degrade, transform or immobilize environmental pollutants, primarily those of anthropogenic origin, with the aim of restoring the area to better conditions. The screening of plant species for their ability to grow and establish in contaminated soils and water is one of the first steps in selection of species for phytoremediation. Seven different plants were selected from different sites in the estuarine area near the bar mouth of Mangaluru to understand the movement of contaminants in the ecosystem. Mangrove ecosystem in the estuarine waters of Netravati and Gurupura River acts as a shield to absorb the heavy metals before it reaches the Arabian Sea. Heavy metal Cu absorbed by *Acanthus ilicifolius* was 9.24±2.87 ppm, while Cd, Cr and Hg absorbed in the sedge plant *Cyperus malaccensis was* 0.40±0.47 ppm, 1.09±0.32 ppm, 0.21 ±0.05 ppm respectively. Out of the 7 different plants selected from the estuarine area *Acanthus ilicifolius* and *Cyperus malaccensis* was observed to have greater potential to adsorb heavy metal. The factors that influence phytoremediation include type and amount of contaminant, soil characteristics, water content, nutrient availability, species and plant growth.

Keywords: Phytoremediation, Mangrove, Estuarine, Management, Soil, Water

Paper ID 15881

Study on spawning and the complete larval cycle of invasive Charru mussel *Mytella strigata* (Hanley, 1843) (bivalvia: Mytilidae) under captive condition.

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The American brackish water mussel *Mytella strigata* (Hanley, 1843) has invaded all most all the backwaters of South Kerala (unpublished reports), and the species is threatening the local mussel species, especially *Perna viridis* in the backwaters of Kerala and also affecting cage farming operations adversely by clogging the nets. A native of Central and South America (notably Panama, Argentina, Brazil and Venezuela), it had invaded the southern United States (mainly Florida and Georgia). Later, they got transferred to the Philippines, Singapore, Thailand, and India. To study the larval cycle of the species, adult animals collected from Kayamkulam backwaters spawned in the hatchery at 35 ppt salinity. They were reared through all the larval stages like D-veliger, umbo, pediveliger and plantigrade to spat and juvenile of 70 days old to get a clear idea about its early stagebiology, which can be used in controlling their spread. Eggs were lemon yellow and measured 35 to 53-micron. Newly hatched (1dph) larvae measured 77.82 µ in length, and dinoflagellate *Isochrysis galbana* was given as feed till 15 dph and afterwards mixed algae was given. Settlement of larvae started after 13 dph, and by 15 dph, all larvae completed metamorphosis and settled. Compared to native species; Asian green mussel *Perna viridis*, this alien mussel has a shorter life cycle, early settlement of larvae and adaptability to any kind of feed, makes this species a aggressive invasive animal in the natural waters

Keywords: Invasive Mussel, *Mytella strigata*, Spawning, Larval stages

Paper ID 15886

Role of marine sediments and associated benthic fauna in the productivity of artificial reefs in the coastal waters of Tamil Nadu – energy engineers of reef ecosystem

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Studies were conducted to assess the impact of artificial reefs deployed in the coastal waters of Tamil Nadu in habitat and benthic biodiversity enhancement. Nearly fifty sites were surveyed for sediment texture, macro- and meiobenthic fauna before deployment of artificial reefs and at regular intervals post-deployment. This paper highlights the observed impact of artificial reefs on the sediment texture, benthic faunal assembly and diversity, and resultant increase in productivity in the reef areas at selected sites. Changes in soil characteristics and diversity and abundance of benthic biota were assessed at 12 sites where artificial reefs were deployed 1-2 years ago. The sites with firm substratum and sandy texture are preferred for installing the artificial reef modules. Upwelling and downwelling and currents/waves deposit and erode the soil materials around and within the reef site in a dynamic manner. Calcareous shells and remains of crustaceans, molluscs and echinoderms contribute to the particulate solids. As the reef modules act as an obstruction to bottom currents, larger sediment particles tend to accumulate within the reef area. The organic content of the reef soil also tends to increase over time due to increased metabolic exercise in the surrounding waters. The sediments in the reef areas hold 25-30% more macrobenthos than non-reef areas after an incubation period of 6 months and a 3 to 4-fold increase is observed in about a year after reef deployment. This is found to stabilize at 45-75% increase over 3 years at the site. The number of individuals of macrobenthos observed in a reef site can be as high as 6300 n/sq. m., stabilizing after 2-3 years in the reef associated sediments. The Relative Benthic Status (RBS) of the artificial reef-associated sediments improves substantially resulting in higher productivity in the surrounding waters.

Keywords: Biodiversity, Relative Benthic Status, Carbon Sinks, Sediment Texture, Meiobenthos

Paper ID 15890

Mass production of *Oithona brevicornis* using monospecific and mixed feed diets

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The study was conducted to find the best combination of microalgae as diet in order to produce the maximum number of copepod nauplius for *Oithona brevicornis* with a minimum period of time. The microalgae fed at the rate of 40000-50000 nos per ml. Newly hatched copepod nauplii getting matured within 9-18 days depending up on the combination of microalgae given as feed on daily basis. The species getting matured within 9 days fed with a combination of *Chaetoceros* sp and *Isochrysis* sp @ 40000 nos/ml in an indoor culture condition followed by combination of *Thalassiosira* sp and *Isochrysis* sp (10 days), *Thalassiosira* sp (12 days), *Chaetoceros* sp and *Tetraselmis* sp (14 days). Salinity tolerance was observed between 5-30 ppt and size of the nauplius (Nauplius I- VI) is in the range of 73.5- 240 µm. Size of copepodite (Copepodite I-V) is observed in the range of 243- 690 µm. Copepodite VI (Adult) is observed in the range of 700- 1150 µm. Average fecundity was 20 nos (Range 12-35 nos). Mass culture of copepod was done in 500 litre tanks fed with combination of microalgae, baker's yeast and rice bran. Highest density was observed within 14 days using combination of *Chaetoceros* sp and *Isochrysis* sp (5500± 350 nos/L) followed by *Thalassiosira* sp (4750± 242 nos/L and finally rice bran powder and baker's yeast (3250± 125 nos/L). The study shows potential of *Oithona brevicornis* to use as live feed in finfish hatcheries during early larval stages.

Keywords: Microalgae, Mass Production, Copepod, Nauplius, Live Feed

Paper ID 15896

Microplastics in edible clam, *Meretrix casta* (chemnitz, 1782) in Udyavara estuary of Karnataka

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Anthropogenic activity has resulted in the accumulation of piles of plastic waste in coastal areas and has affected all marine life. As filter feeders, bivalves tend to accumulate various contaminants including microplastics. Microplastics are one of the major pollutants of the aquatic environment and there are no reliable reports available along Karnataka Coast which assess the microplastic accumulation in bivalves. *Meretrix casta* (Chemnitz, 1782) form a subsistence fishery in Udyavara Estuary in the Udupi district of Karnataka. Malpe, one of the largest mechanized fish landing centers with activities ancillary to marine fisheries, is located in the bar mouth of the estuary. To assess the extent of microplastic contamination in the locally consumed clam species, samples were collected from the clam beds in Udyavara Estuary. Microplastic were extracted using the method suggested by Van Cauwenberghe et al. (2015). The present study aimed to investigate the presence and composition of microplastic in clams of Udyavara Estuary and evaluate the effects of depuration, cooking & decanting on microplastic content in clams.

Keywords: Microplastics, Bivalves, Udyavara, Karnataka

Paper ID 15897

Macroplastics in the coral reefs of Agatti island: Management suggestions

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The Union Territory of Lakshadweep is an archipelago situated in the Arabian Sea at a distance of 220 - 440 km from the west coast of India. In Lakshadweep Archipelago, Agatti Island is one of the major tourist destinations due to the presence of an airport and better infrastructure. The island is 7.6 km long with a 17.5sqkm lagoon on its west side. In order to understand the extent and cause of macroplastic pollution in the coral reef area of Agatti Island, a rapid underwater survey was conducted. The quadrat sampling method was used and plastic particles greater than 5 cm were segregated into various groups based on the sector of their origin. The objective of the study was to understand major activities which contribute to the macroplastic pollution in the lagoon area of the Island. The construction-based activities (7 nos/ 10sqm) are causing significant pollution in the reef area when compared to other activities. For all the construction and infrastructure development on the island, the materials are transported from the mainland, which are usually supplied in plastic bags, and these are not disposed of properly on the island. The paper discusses the promising management options for checking macroplastic pollution in sensitive reef areas.

Keywords: Macroplastics, Pollution, Agatti, Coral Reef, Lagoon

Paper ID 15940

Effect of chemical treatments for *Enterocytozoon hepatopenaei* (EHP) management on soil quality

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Intensive shrimp farming results in disease outbreak due to soil and water quality deterioration manifested by high stocking densities and inputs. Shrimp farms in Asia are infected with the microsporidian parasite, *Enterocytozoon hepatopenaei* (EHP) affect the growth of the animals and impact the farm production severely. To suppress and kill the growth of microsporidian parasite spores and prevent the disease, pond treatment with caustic chemicals to raise the pH above 10 is commonly advocated and practiced by the farmers. Altering the pH to high levels changes the biological activity and affects the soil quality. To assess the impact of chemical treatment for EHP management on soil quality, yard experiment was conducted by applying CaO and NaOH, and estimated the activity of soil enzymes. Application of CaO at 6000 kg/ha, raised the soil pH to 9.78 within 1 hour and stabilised at 9.48 after 24 h. Similarly NaOH application raised the pH to 10.13 within one hour. Fluorescein diacetate hydrolysis activity (FDA) reduced to 53.9, 35.1 from 135 ug/g soil/h within a week of application of CaO and NaOH, respectively. Similarly, the dehydrogenase activity reduced to 18.4, 6.85 from 34.6 ug TPF /g soil/h, within a week of application of CaO and NaOH, respectively. The microbial activity recovered to the initial level by 16th week. The results revealed that application of chemicals significantly affected the soil quality by decreasing the microbial activity and needs amendments for resilience.

Keywords: *Enterocytozoon hepatopenaei* (EHP), Chemical Treatments, Soil Enzymes, Soil pH

Paper ID 15952

Degradation kinetics of Sulphadimethoxine under varying environmental condition

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Aquaculture is one of the fastest food growing sectors and farmed shrimp production is the major contributor of seafood export of India. Due to intensive shrimp farming, animals are prone to diseases due to high stocking density and high input leads to deterioration of soil and water quality. Antibiotics are commonly applied for prevention of disease spread. Sulphonamides are the commonly used antibiotics after tetracyclines due to their broad spectrum activity and low cost. Efficiency of the antibiotics depends on their degradability, solubility and bioavailability to the animals. Sulphadimethoxine is fairly water soluble and its ionisation depends on the matrix pH. To study the persistence of sulphadimethoxine, degradation study was carried out by varying pH and salinity. Sulphadimethoxine degradation was faster under acidic condition and with increase in pH there was reduction in photolysis. After 15 days of incubation degradation percent was 62, 48 and 43 at pH 4, 6 and 8 respectively. With increase in salinity there was reduction in photodegradation of sulphadimethoxine. Percent degradation was 75, 70, 62 and 56 at 0, 15, 30 and 45 ppt, respectively after 40 days of incubation. Persistence of sulphadimethoxine was high under brackishwater system (high pH and salinity) than freshwater system.

Keywords: Sulphadimethoxine, Degradation, pH, Salinity

Paper ID 15961

Synergistic effect of environmental stress conditions on the growth rate and lipid accumulation of marine microalgal species *Nannochloropsis salina* isolated from the coastal waters of Gulf of Mannar

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The present study was conducted to evaluate the combined effect of environmental stress conditions such as salinity, pH and light intensity on the growth performance and potential of lipid accumulation of the marine chlorophyte *Nannochloropsis salina* using photobioreactor. The growth performance of the microalgae grown under different salinity ranges of 10 to 60 ppt suggests that the optimum salinity to obtain maximum cell density of $36.37*10^6$ cells/mL was observed as 30 ppt followed by 32.78 and $28.71*10^6$ cells/mL in 40 and 20 ppt respectively. The maximum biomass concentration and productivity obtained in 30 ppt salinity was 0.51 g/L and 0.036 g/L/d respectively whereas the highest lipid accumulation of 0.21 mg/mL was obtained at 40 ppt. pH experiment conducted in the range of 5 to 10 with 40 ppt salinity as standard, concludes that the optimum pH for achieving maximum biomass production was 9 with the cell density of $32.1*10^6$ cells/mL followed by $31.87*10^6$ cells/mL in pH 8. The biomass concentration and productivity obtained under pH 9 were 0.45 g/L and 0.033 g/L/d respectively. Similarly, the lipid accumulation was also found to be high in pH 9 with the lipid production of 0.19 mg/mL. In light intensity experiment with salinity (40 ppt) and pH (9) as standard, the maximum cell density was obtained in 6000 lux followed by 8000 lux which was 34.1 and $28.8*10^6$ cells/mL respectively. The maximum biomass concentration and productivity achieved in 6000 lux was 0.48 g/L and 0.034 g/L/d respectively whereas the highest lipid production was achieved under 10000 lux with the value of 0.25 mg/mL. Overall research findings suggest that the lipid accumulation in microalgae was greatly influenced by salinity and light intensity. These two factors can be further applied in industrial sectors such as biodiesel production which focuses on the lipid yield of microalgae.

Keywords: *Nannochloropsis salina,* Gulf of Mannar, Environmental Factors, Lipid Accumulation

Paper ID 15980

A note on the morphometric study of *Halophila beccarii* in Kadalundi estuary, Calicut, Southwest coast of India

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The present study was carried out in Kadalundi estuary, Calicut, southwest coast of India during June 2019 to November 2021. The area is bestowed with mangrove vegetation, mudflats, nursery grounds for finfish and shellfish, foraging sites for seasonal birds, seagrass ecosystem and as well as human inhabitation. *Halophila beccarii* also known as Beccari's sea grass / Ocean turf grass is one of the smallest seagrass, seen in the upper intertidal stretches of estuary. This monospecific species belongs to the family Hydrocharitaceae and is listed as Vulnerable in the IUCN Red List Status of Threatened Species (2011). In Kadalundi estuary, the Beccari's seagrass is spread in an area of 2 hectares, associated with the mangrove ecosystem in the upper intertidal region. It is fast-growing in nature by means of sexual and asexual reproductive strategy. In Kadalundi, seasonal flowering and fruiting was observed during late October-November and continued till early December. The monoecious nature and the morphometric characters (40 characters) of species were recorded during the present study. The female flower has an ovoid ovary and style profused at the base, bifurcating in the mid region into two numbers. The unopened male flower is slightly curved initially, becomes erect later and opens with three anthers. The fruit is somewhat oval-shaped and apex with curved nature and the seeds inside varies from 1 to 4 in number. The shoot density (no/m2) was in the range of 17-1,254. The canopy height was 4-7cm. The estimated above and below-ground biomass was 20.3-40.22 g dry wt/m2 (av. 30.1 ± 0.01 g dry wt/m2) and 19.78-31.2 g dry wt/m2 (av.25.49 ± 0.06 g dry wt/m2) respectively. The present study was carried out to reduce the existing knowledge gap on morphometrics of the highly vulnerable seagrass *Halophila beccarii* with a sparse distribution in the Kadalundi estuarine wetland.

Keywords: *Halophila beccarii*, Kadalundi, Morhometric Traits, Seagrass

Paper ID 15982

Diversity and seasonal distribution of seaweeds at Thikkodi, Calicut, Southwest coast of India

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The present study was carried out in intertidal region of Thikkodi coast (N II^{0}28'466''; E 075^{0}37'212'') of Northern Kerala with varied biodiversity. There is not much information available about the seaweeds of Thikkodi compared to other coasts. Hence, the present study depicts seasonality of seaweeds and information generated would be useful in the light of emerging seaweed cultivation in Indian waters. The laterite hard substratum at Thikkodi helps in sustenance of macroalgae and also provide habitat for other biota. The study was conducted during June 2019 to Nov 2021. A total of 32 taxa were recorded in Thikkodi. Of these 14 belonged to Chlorophyceae (44%), 11 to Rhodophyceae (34%) and seven to Phaeophyceae (22%). The seaweeds were abundant during post-monsoon followed by pre-monsoon period and least in monsoon season. The dominant genus of green algae was *Caulerpa* (15.6%) represented by six species, the genera *Gracilaria* and *Acanthophora* (3.12% each) were dominant in red algae while *Padina* (3.12%) was the dominant genus in brown algae. *Gracilaria corticata* and *Acanthophora spicifera* were common in all sampling months though less abundant in monsoon period. The diversity and distribution of seaweeds were different with respect to seasons and was affected by several physicochemical parameters. During monsoon season, the macroalgal diversity was very less due to decreased salinity, high wave action and high turbidity. Most of the seaweeds inhabited the intertidal zone and often epilithic in nature, although some were epiphytic also (*Acanthophora* sp). The horizontal zonation shows that green algae present near to shore in sandy areas while the red and brown towards the intertidal-subtidal region. As the distributions of seaweeds in Thikkodi is very patchy, large scale harvesting of the wild stock of seaweeds may not be feasible; however, this area would be highly conducive for seaweed farming to meet the growing demand.

Keywords: Diversity, Distribution, Seaweeds, Thikkodi

Paper ID 15987

Assessing the impact of tropical cyclone induced extremely heavy rainfall on water quality for aquaculture

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Aquaculture is the most important activity in coastal regions of the country besides its contribution to the national economy. Aquaculture like agriculture is vulnerable to climate change induced changes, particularly alterations in the environmental parameters of source waters (SWs) and shrimp culture ponds (CPs). The extreme rainfall after the cyclones and flood affects the water quality and productivity of aquaculture. In the present study, we examined the effect of heavy rainfall received after the cyclone 'Shaheen' formed on 26th September 2021 in the Kannur, Alappuzha and Kottayam districts of Kerala. The study area received a good amount of rainfall during September 2021 before the cyclone due to the southwest monsoon followed by extremely heavy rainfall during October after Cyclone Shaheen. Kottayam District received a very high rainfall of about 200 mm within 24 Hours. The water samples were collected from the fixed sampling stations on SWs (Kannur-2, Alappuzha-1, Kottayam-1) and three culture ponds from each district during pre-cyclone (September), cyclone (October) and post-cyclone (November), and analysed for physicochemical parameters and mineral profile. The decrease in pH and salinity was more in CPs compared to SWs conversely, the decrease in alkalinity was more in SWs. Though a decrease in metabolites (total ammonia-N and nitrite-N) and nutrients (nitrate and phosphate) concentration was observed, the values of the former were high in CPs, and the latter in SWs. A drastic decrease in the minerals profile (Ca, Mg, K, Na) was observed during the cyclone. The values of all the parameters reached normal within 28 days after the cyclone. The changes in the water parameters during extreme weather events indicated the need for the implementation of better management practices to bring back the optimum water quality in culture ponds at the earliest, to avoid stress to animals.

Keywords: Aquaculture, Cyclone, Heavy Rainfall, Water Quality

Paper ID 16003

Effect of stocking density on dynamics of carbon fractions in *Vannamei* culture

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The contribution of excessive usage of carbon as inputs in intensive and semi-intensive aquaculture systems to the global carbon cycle is poorly understood. To comprehend this concept, initially, the effect of stocking density (SD) on carbon fractions was determined. *P. vannamei* were reared for 60 days in 500 L tanks at three different SDs, 20/m^2 (Low), 40/m^2 (Medium), and 60/m^2 (High) in an outdoor experiment. Maximum shrimp growth and survival were registered in high and medium SD treatments, respectively. A decrease in salinity, alkalinity, and chlorophyll (no defined trend) was observed with days of culture (DOC) in all the treatments due to heavy rainfall during the experiment. The inorganic carbon (ppm) fraction forms a major component of the total carbon (ppm), which showed a decrease with DOC in all the treatments and an increase with SD (Low-29.5; Medium-30.7; High-32.6). The organic carbon (ppm) content showed a significant increase with DOC and was maximum with high SD (11.39) compared to medium (9.73) and low (6.64). The database on carbon fractions of different input and output processes of shrimp culture is essential for the estimation of carbon budgeting and in turn its contribution to global warming.

Keywords: Carbon Fractions, *P. Vannamei*, Stocking Density

Paper ID 16005

Contribution of shrimp aquaculture to global warming potential: life cycle assessment approach

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Life cycle assessment (LCA) is an important tool for estimating cradle-to gate environmental impacts and to identify the sources and hot spots responsible for the impacts around the world. We are interested in examining global warming potential (GWP) associated with shrimp production. The present study employs LCA to quantify and compare environmental impacts associated with Pacific white leg shrimp (*Penaeus vannamei*) farming in India. The system boundaries included hatchery, feed mill and farming separately and all together. The primary data was collected from the feed mill, hatcheries and farms for data inputs. These foreground data supplemented by secondary data were used to determine the carbon footprints of each process and to evaluate the environmental performance for shrimp farming. The environmental impact categories assessed in this study are the standard LCA categories based on the Life Cycle Impact Assessment (LCIA) of the functional unit and is carried out with the SimaPro software. In particular, the impact assessment was performed by means of one of the most recent and up-to-date LCA methods, the ReCiPe 2016 Midpoint (H) V.1.02. The results showed that farming is the key stage significantly contributing to GHG emissions followed by the feed mill and hatcheries. The global warming potential (GWP) of shrimp farming was 3230 $kgCO_2eq$. The electricity use was the largest contributor to these emissions, accounting for 38.6% of the total, followed by the feed (32.7%) and diesel (24.4%). To conclude, the management implications of this study indicate that the carbon footprint of the shrimp supply chain from hatchery to production can be reduced by employing energy-conserving technology. Such approaches can help to achieve its goals with regard to more sustainable operations and can help to enhance cleaner production initiatives in the Indian aquaculture sector.

Keywords: Shrimp Aquaculture, Carbon Footprint, Life Cycle Assessment, Global Warming Potential

Paper ID 16016

Marine finfish and shellfish eggs and larval abundance and distribution off Visakhapatnam, North Andhra Pradesh

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A good prediction of fishery of any resource would depend on a good understanding of species biology, more so of its reproductive biology and survival of the young till they are recruited to the fishery. With this aspect in focus an attempt had been made in the present study to understand the abundance of marine finfish and shellfish eggs and larvae in the waters off Visakhapatnam. Both qualitative and quantitative analysis was done of the plankton sample collected during the experimental trawling trips made from April 2019 to February 2021. The collected sample was filtered with 300µ mesh sieve and fixed in 10% formalin. The average plankton concentration was 0.588 ml/m^3 and the range was 0.006-3.3 ml/m^3. The highest and lowest plankton concentration was seen during January and February of the year 2020, respectively. CCA (Canonical Correlation Analysis), indicates close relationship of fish eggs, megalopa, fish larvae with Sachhi disc reading, i.e, transparency of water, while nauplius with CHL a, pH and BOD and prawn zoea with water temperature and Depth. Most of the early life stages of finfish and shellfish were primarily influenced by water parameters such as water temperature, DO, turbidity and water depth.

Keywords: Marine, Plankton, Eggs and Larvae, Abundance, Distribution

Paper ID 16023

Are coastal waters of Gujarat are deoxygenated? A satellite remote sensing approach

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Current research investigation we attempted to understand the DO in the coastal waters of Gujarat (50 m depth contour shapefile) using satellite-derived DO (Data sourced from Marine Coopernicus and data was processed using SeaDAS 7.5.1). The annual dissolved oxygen data retrieved from the satellite has shown significant decrease in the coastal waters of Gujarat from 1993 to 2020 (R^2=0.378). The month-wise variations in satellite DO were observed, the highest DO values were recorded during the February (6.91±0.07 mg L^{-1}) and the lowest was in June (6.24±0.04 mg L^{-1}). The higher DO concentrations were recorded during the winter months (December to March), but the lowest values were observed in the summer months (May to July). The satellite derived DO were validated with in-situ DO concentrations at monthly temporal scale in the region. Dissolved oxygen, DO is the crucial water quality variable in any aquatic ecosystem, which supports living biota and plays pivotal role in the biogeochemistry. Current research investigation we attempted to understand the DO in the coastal waters of Gujarat (50 m depth contour shapefile) using satellite-derived DO (Data sourced from Marine Coopernicus and data was processed using SeaDAS 7.5.1). The annual dissolved oxygen data retrieved from the satellite has shown significant decrease in the coastal waters of Gujarat from 1993 to 2020 (R^2=0.378). The month-wise variations in satellite DO were observed, the highest DO values were recorded during the February (6.91±0.07 mg L^{-1}) and the lowest was in June (6.24±0.04 mg L^{-1}). The higher DO concentrations were recorded during the winter months (December to March), but the lowest values were observed in the summer months (May to July). The satellite derived DO were validated with in-situ DO concentrations at monthly temporal scale in the region. Coastal waters are critical habitats for the many fishery resources in terms of feeding and breeding grounds in addition to supply nutrients to offshore waters, recreation, supports biodiversity. The DO concentrations over the past years have shown significant declining trend, which proclaim important implications for our understanding of climate change, anthropogenic activities and industrialization in the coastal waters.

Keywords: Dissolved Oxygen, Coastal Waters, Deoxygenation, Gujarat

Paper ID 16024

Comparative analysis between different meteorological drought indices in Southeast Tamil Nadu, India

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Drought is an inevitable condition with negative impacts on the major natural hazard / disaster, affecting climate and agriculture severely worldwide. Careful drought events assessment is crucial to reduce their adverse impacts on water resources, agriculture and ecosystems. Agricultural land is severely affected by many types of drought, especially meteorological and agricultural drought. The present study evaluates meteorological drought using 30 years monthly precipitation data of Indian Meteorological Department (IMD) stations wise from 1985 to 2015 in Ramanathapuram District, Tamil Nadu. Drought Indices Calculator (DrinC) software was used to calculated different drought indices such as Precipitation Deciles (PD), Standardised Precipitation Index (SPI) and Reconnaissance Drought Index (RDI). Time series drought of 3, 6, 9 and 12 months can also be estimated using DrinC software. Result from PD shows among 30 years of study period 6 years (1985 to 1990) as the lowest 20% much below normal, the most affected years. SPI shows 3 years as meteorological drought years (1988, 1995, 1999) with extremely and severely dry condition. RDI result shows 3 years (1985 to 1987) as severely drought and 3 years (1988 to 1990) as moderately drought condition. Both RDI and PD results shows 1985, 1986 and 1987 as severely affected drought years whereas in SPI and PD 1988,1989 and 1990 shows as most affected drought years. Entire analysis shows RDI is the best drought indices as compared to other two indices as predicted drought years were matching with actual drought years. The outcome demonstrated that these approaches could be useful for developing preparedness plan to combat the consequences of drought. Findings from such research are useful tools for devising strategic preparedness plans to combat droughts and mitigate their effects on the activities in the various sectors of the economy.

Keywords: Rainfall, DrinC, Precipitation Deciles, Standardised Precipitation Index, Reconnaissance Drought Index, Meteorological Drought.

Paper ID 16028

Incidence of Trichodesmium bloom in the coastal waters of Gujarat, Northeastern Arabian Sea: biogeochemistry insights

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Trichidesmium blooms were encountered with varied intensity in a span of three years of present study predominantly during the winter and post-winter months in the coastal waters of Gujarat, which is in the northeastern Arabian Sea. The variables like euphotic depth (ED), dissolved oxygen (DO), D-ortho phosphate (PO_4), nitrates (NO_3), and chlorophyll-a (Chl-*a*) were significant different between bloom and non-bloom sites. The DO concentrations were significantly lower in the bloom stations (3.89±0.44 mg L^{-1}) than the non-bloom stations (5.50±0.70 mg L^{-1}), due to biological degradation of organic matter in addition to anaerobic microbial respiration. Nutrients (PO_4 and NO_3) and Chl-*a* concentrations were recorded higher in the bloom locations at 0.83±0.21 µmol L^{-1}, 4.47±0.69 µmol L^{-1}, 4.14±1.49 mg m^{-3}, respectively. PO_4 and NO_3 has shown significant higher positive correlation of r=0.73 and r=0.69 with Chl-*a* for bloom data than the non-bloom data. The variable PO_4 explains highest of 24.19% variability in the PC1, followed by Chl-*a* (19.89%), N-P ratio (17.36%), DO (10.88%), etc. The study depicts that the PO_4 triggers the bloom formation and also proclaims higher concentrations of Chl-*a* in the bloom locations. The bloom concentration was ranges from 9553 to 12235 trichomes L^{-1} (mean of 10612 trichomes L^{-1}) during the current study. The bloom intensity has shown a significant positive correlation with Chl-*a* (r=0.77), NO_3 (r=0.56), PO_4 (r=0.30), but negative correlation was noticed with variables DO (r=-0.63) and pH (r=-0.49). The study also initiates a way forward research investigations to study on algal blooms using the advanced ocean color sensor remote sensing technologies to identify and monitor blooms, negative influence on trophic equilibrium, impact of toxins evolved from the HAB species, and association of blooms with climate change driven factors, etc.

Keywords: *Trichodesmium*, NEAS, Multivariate Analysis, Nutrients, Chl-a

Paper ID 16043

Automated extraction of Salt affected lands using remote sensing techniques

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Assessment of salt-affected land (SAL) is still a major challenging task worldwide, especially in developing nations due to limited facilities and data availability. Traditional methods of soil salinity measurement are not only time-consuming but do not provide time-series data. The advancement and availability of remotely sensed digital satellite images of different spectral bands and combinations of their spectral indices have made way to assess the soil salinity based on the reflection of the various bands at different wavelengths and spectral indices. Sentinel-2 satellite images of the year 2020, and Shuttle Radar Topographical Mission data from Google Earth Engine (GEE) data catalog were used for the calculation of various vegetation indices. Vegetation indices (Normalized Difference Vegetation Indices, Enhanced Vegetation Indices, Soil Adjusted Vegetation Indices, Generalized Difference Vegetation Index), soil salinity indices (Normalized Difference Salinity Index, Canopy Response Salinity Index, Salinity Index (SI), SI1, SI2, SI3, Salinity index I (SI-I), SI-II, SI-III, SI-IV, SI-V, SI-VI), topographical characteristics (Elevation, Slope, Aspect and Hillshade) and spectral bands of Sentinel-2 (B2 to B8, B8A, B11, and B12) were used in the study. The electrical conductivity values of samples collected in the field was used for training and testing SAL using the Random Forest model. The prediction shows 1.7% of the total study area as SAL with 92% validation accuracy. Out of the total SAL, 54% land was found as moderately saline, 28% land as highly saline, and 18% land as extremely high saline SAL. The present study demonstrated the strength of remote sensing techniques to assess the SAL, which will be helpful to quantify the unproductive lands at a state or national level for reclamation or other productive use.

Keywords: Random Forest Model, Google Earth Engine, vegetation Indices, Salinity Indices, Salt-affected Land

Paper ID 16058

Plastic litter act as a substrate for biofouling and influence on community dispersal in Kanjiracode Kayal of Ashtamudi estuary

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Plastic litter increase in the aquatic environment is one of the most rapidly magnifying pollution problems, causes disturbances to its structure, functions and values. The present study aims to investigate the plastic litter from the strandline litter survey conducted during January to December 2021 on the inner reaches of Ashtamudi Estuary along the southwest coast of Kerala. It focused on the type of plastic litter, quantity, source of origin and seasonal variations along with the macrobenthic communities attached to them in this region. A total of 885 plastic items in terms of number with an overall mean litter density of 0.90 items/ m^2 and a total weight of 18640g with a density of 19.05g/ m^2 were estimated from the study area. The major items of plastic debris comprising of single-use carry bags (54%), PET bottles (30%), containers, sheets, fragments and miscellaneous items. Household wastes represented the largest source (70.64%) of plastic litter and fishing sector was the second most source followed by other items through land-run off. It is noticed that litter accumulation shows seasonal changes with rainfall mainly attributed to river discharge and more than 70% of the total debris collected during monsoon season, mostly from September to November (>57.5%). The fouling communities on plastic debris were also analysed and found that 22 species belonging to five different phyla were observed from plastic litters. *Pirenella cingulata, Clithon oualaniensis, Nassarius jacksonianus, and Crassostrea madrasensis* were the most abundant species with an invasive species *Mytella strigata*. The results showed plastic litter act as a substrate for fouling and it facilitates the alien species introduction into new ecosystem thereby causing a shift in species composition or even extinction of other species.

Keywords: Aquatic Pollution, Plastic Litter, Biofouling, Ashtamudi Estuary.

Paper ID 16060

Study on the effects of fertilizers and manures on plankton production in fish ponds

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The objective of the present review is to showcase, how organic and inorganic fertilizers affect plankton production in fish ponds. An experiment carried out for three months, in nine man-made earthen ponds of 100 m2 to test three types of fertilisers namely 'poultry manure', 'cow manure', and 'urea with triple-super phosphate' at the rate of 3.300 kg/ha, 9.200kg/ha, and 100 kg urea plus 100 kg TSP/ha, respectively in treatments T1, T2, and T3 revealed that, despite its high iso-phosphorus content, poultry manure had much better nutrient status than cow manure or inorganic fertilisers when applied alone. Similarly, an eight-week experiment in earthen ponds to investigate the effects of iso-nutrient fertilisation on fertiliser combinations having an equal quantity of nitrogen (N) and phosphorus (P) proved that, poultry manure had a better nutrient profile than cow manure. And another experiment was conducted to evaluate the effect of using different types of organic manure on the plankton abundance in three replicate ponds per treatment (chicken manure, cattle manure, pig manure, and no-manure as a control). After 84 days the *T. rendalli* in the chicken manure treatment were significantly larger and had higher net annual yields than those in the cattle manure, pig manure and no-manure treatments. The effect of various types of organic animal manure on plankton abundance was investigated and the researchers determined that poultry manure is the best type of organic manure because it includes more N and P, which are important for plankton production. The aquaculture sector will benefit from this review, which will help to increase productivity.

Keywords: Plankton Production, Manures, Fertilizers

Paper ID 16061

A study on effective use of sewage in sewage-fed aquaculture systems, East Kolkata wetlands, India

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Aquaculture has effective contribution to address protein and micronutrient deficiencies in people in developing and under-developed countries. However, cost of feed and water quality management are the major challenges in aquaculture. These challenges are uniquely addressed by the technique of using domestic sewage for fish culture in East Kolkata Wetlands since decades. This technology not only reduces stress on fresh water resources and potential land but also ensures food security demands. This is the largest operational system in the world to convert waste into consumable biomass. As sewage effluents are complex mixture of organic and inorganic substances, the present study has been designed to obtain a better understanding about the suitability of water quality in sewage- fed aquaculture system when compared to rain fed aquaculture system. Water samples were collected from Nalban sewage-fed aquaculture system, Kolkata and few nearby rain-fed managed aquaculture ponds for analysis. Parameters like pH, DO, TS, TDS, BOD, COD, NH3-N and PO4-P were assessed by following APHA, 2012 for one year with monthly interval. Results showed that, DO, BOD and COD levels were significantly high in sewage fed system, and the other parameters were similar with the culture pond. But, all the parameters were within the acceptable range for fish culture. These findings indicate that organic nutrients available in sewage-fed systems were utilized as feed substitute in these unique ecosystems. The study concludes that the sewage fed aquaculture is a highly productive system and is not only lucrative to the farmers but also it is one of the unique ways to recycle the organic waste to meet food and nutritional security for people. However, precaution must be taken for periodic monitoring of the fish as well as aquatic ecosystem as the quantity and quality of sewage vary from time to time.

Keywords: East Kolkata Wetlands, Water Quality, Sewage Fed Aquaculture Systems

Paper ID 16075

The economic value of ecosystem services of Kadalundi-Vallikunnu community reserve of Kerala, India

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The Kadalundi estuary (11º7'28" - 11º8'1" N and 75º49'36" - 75º50'20" E) located at the mouth of the river Kadalundi, drains into the Arabian Sea on the west coast of India. The oyster picking season is very narrow extending for a period of three months, from April to June. There are about 20 oyster pickers in the entire KVCR who regularly pick oysters (mainly the Indian backwater oyster *Magallana bilineata* (=*Crassostrea madrasensis*) from the wetland and the estimated total harvest of oysters is 5,600 kg annually. The average annual net revenue from other fishing and aquaculture practices (cast net, gill net, hook & line, oyster picking and mussel farming) is estimated to be Rs. 3 crores. The annual revenue of the tour operators ranged from Rs.28,000/- to Rs. 16,48,000/- and the total annual revenue from tourism was estimated to be Rs. 20.83 lakhs. The mangrove ecosystem of the Kadalundi wetland is estimated to have a value of Rs. 2.55 million while the total economic value of different ecosystems, including the adjacent open sea is estimated to be Rs. 56.11 million. The increase or decrease in the economic value of biodiversity and ecosystem services will have a direct effect on the livelihood and income generation of the people of KVCR. Continuous research, monitoring and management of KVCR coupled with stakeholder participation in all decision-making processes is vital for the sustainability of the Community Reserve.

Keywords: Economic Valuation, Ecosystem Services, Estuaries, Mangrove Wetlands

Paper ID 16077

An assessment on the abundance, distribution and sources of plastic litter in the Vembanad lake ecosystem, Kerala, India

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A study was conducted to assess the various impact of plastic pollution on the biota and ecosystem functioning of Vembanad Lake, the largest lake in Kerala and the longest in India, with International significance designated under the Ramsar Convention. The abundance, distribution, sources and impact of plastic litter pollution were assessed through 123 sampling locations spread across the three zones of the Lake and a series of locations in the interlinking canals. The data thus collected through planned field surveys by following standard sampling protocols and globally accepted analytical methods brings out the intricacies of the plastic pollution in the coastal waters. Litter hotspots identified through the application of the GIS platform throw light on the intensity of anthropogenic influences in litter pollution which can be attributed to improper waste management. Among the non-degradable litter, plastic was predominant forming 71.57% of the benthic and 81% of the floating litter. High and low-density Polyethylene (HDPE/LDPE) formed the dominant, followed by Polypropylene (PP), Polyethylene terephthalate (PETE) and rare pieces of PVC. The order of dominance of various items was: Plastic carry bags > Food packaging cover > Thermocol > Nylon thread > Foam sponge > Hard plastic > Pieces of thick plastic sheets and flex pieces. An analysis to understand the origin of litter indicated that more than half (62%) of the total items originated from Domestic sources >Tourism > Industrial > Fishery > Medical > e-waste. Targeted studies were conducted to assess the impact of litter on the traditional artisanal fishers operating in Vemabanad Lake especially on stake net fishers as they were most affected. A record of microplastic ingestion was also noted in five out of 20 species studied.

Keywords: Plastic Litter, Abundance, Sources, Distribution

Paper ID 16087

Index of biotic integrity: A tool for conservation of wetlands in India

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Index of Biological Integrity (IBI) is a scientific tool that is used to identify and classify water contamination concerns predominately in the delicate ecosystems of wetlands in India. An IBI is a metric that connects anthropogenic influences on a water body with biological activity in that body, and it's derived from bio survey data. Biotic integrity is based on the notion that human activities or changes are the primary sources of a reduction in the value of an ecosystem's services. It has been used in fisheries to monitor catchment and water quality in the system. It exhibits human influence on the natural environmental structure, forcing biological integrity to be impaired. Generally, in wetlands, metrics used are a total number of taxa, pollution tolerant taxa, pollution intolerant taxa, composition of species, Total species biomass, % abundance of pollution –indicator taxa, % abundance of carnivores and omnivores taxa, % abundance of deep-deposit feeders,etc. In the light of study in wetland ecosystems, the possibility of species changing their feeding habits, alterations in the tropic levels, the dominance of pollution tolerant species, and its indirect effects on native fish abundance are also often seen. If implicated properly, IBI studies in wetlands indeed connect model outcome and aquatic life and are a boon for the beautiful wetlands in the country under inordinate anthropogenic stress.

Keywords: Index of Biological Integrity, Wetland, Anthropogenic, Bio Survey, Biological Metrics

Paper ID 16088

Evaluation of the influence of pesticides upon nitrate and phosphate distribution in the central sector of Vembanad lake, Kerala.

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The purpose of this study is to conduct an exhaustive evaluation of water quality based on major nutrients and pesticides, in India's second largest Ramsar site, the Vembanad Lake, which is also the longest as well as the largest lake and wetland system. As a consequence of massive anthropogenic activities, the widespread use of dangerous chemicals and pesticides has been increasing, which in turn will eventually find their way into the aquatic environment, resulting in total pollution and mortality of aquatic organisms. In the context of this, sixteen stations were randomly selected from the central sector of Vembanad Lake and analysed for nitrate and phosphate, as well as pesticide distribution. The maximum nutrient levels observed were 13.142 µmol/L and 9.383 µmol/L for nitrate and phosphate, respectively. Diuron, at 15.2321 ng/ml, was the pesticide found to have the highest range in the selected stations, followed by parathion, at 4.5689 ng/ml. Besides this, HCB, heptachlor, and different DDT metabolites such as p,p'-DDE, p,p'-DDD were detected. According to the findings, nutrients and pesticides are intertwined in such a way that long-term usage of pesticides loaded with high phosphate and nitrate can irreversibly deteriorate water quality by raising nutrient levels in water, resulting in eutrophication. Furthermore, organochlorine pesticides are extremely persistent and can bioaccumulate in aquatic creatures, impacting the entire food chain. The next highly dominant organophosphates, due to their high phosphate content, can also cause phosphate contamination and acute hazardous consequences. Hence, this study will serve as an indicator to assess the quality of the aquatic environment and to monitor the pollutant loads, which will aid in the management and conservation of the water body.

Keywords: Vembanad Lake, Ramsar Site, Nitrate, Phosphate, Pesticide, Water Quality

Paper ID 16090

Studies on the effects of fertilizers and manures on plankton production in fish ponds

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The objective of the present review is to showcase, how organic and inorganic fertilisers affect plankton production in fish ponds. An experiment carried out for three months, in nine man-made earthen ponds of 100 m2 to test three types of fertilisers namely 'poultry manure', 'cow manure', and 'urea with triple-super phosphate' at the rate of 3.300 kg/ha, 9.200kg/ha, and 100 kg urea plus 100 kg TSP/ha, respectively in treatments T1, T2, and T3 revealed that, despite its high iso-phosphorus content, poultry manure had much better nutrient status than cow manure or inorganic fertilisers when applied alone. Similarly, an eight-week experiment in earthen ponds to investigate the effects of iso-nutrient fertilisation on fertiliser combinations having an equal quantity of nitrogen (N) and phosphorus (P) proved that, poultry manure had a better nutrient profile than cow manure. And another experiment was conducted to evaluate the effect of using different types of organic manure on the plankton abundance in three replicate ponds per treatment (chicken manure, cattle manure, pig manure, and no-manure as a control). After 84 days the T. rendalli in the chicken manure treatment were significantly larger and had higher net annual yields than those in the cattle manure, pig manure and no-manure treatments. The effect of various types of organic animal manure on plankton abundance was investigated and the researchers determined that poultry manure is the best type of organic manure because it includes more N and P, which are important for plankton production. The aquaculture sector will benefit from this review, which will help to increase productivity.

Keywords: Plankton Production , Manures, Fertilizers

Paper ID 16123

A holistic approach for climate smart aquaculture

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Aquaculture like other agricultural activities appropriates a wide range of environmental goods and services and is vulnerable to impacts of climate change as the cultured animals are sensitive to various kinds of biotic and abiotic stresses. Climate change affect the aquaculture directly by influencing fish stocks or indirectly alter the primary and secondary productivity, structure and composition of the ecosystems, or by influencing the availability and cost of fish meal, fish oil and other goods and services required for aquaculture farmers. The perceptions of farmers on impacts of climate change on brackishwater aquaculture and vulnerability of aquaculture to climate change were assessed in different states of the country. Environmental, biological and economic impacts of climate change drivers on aquaculture indicated 20 to 30 % loss due to seasonal variations (temperature and rainfall) and 50 to 100% loss due to extremely heavy rainfall, flood and cyclones. Aquaculture practices constitute a largely undefined source of greenhouse gases emissions. Direct measurement of emission of GHGs from aquaculture systems and through Life Cycle Analysis (LCA) emissions in aquaculture supply chain indicated the contribution of aquaculture to global warming potential. There is no universally applicable list of mitigation practices and need to be evaluated for individual aquaculture systems. Adaptation options in aquaculture are best addressed when they are incorporated in integrated coastal management and sustainable development plans by taking into consideration of ecosystem approach to aquaculture, ecological foot print, implementation of better management practices and carbon labeling and carbon foot print measurement. Autonomous and planned adaptation measures are to be implemented by farmers, researchers and policy makers for climate resilient aquaculture.

Keywords: Adaptations, Aquaculture, Climate Change, Global Warming Potential, Greenhouse Gases, Mitigations

Paper ID 16130

Seasonal dynamics of physico chemical parameters and phytoplankton diversity along the coastal waters of Dakshina Kannada and its influence on fish larval abundance

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Capture fisheries is dependent on biotic as well as abiotic factors of the estuarine and coastal waters. The relative abundance of fish larvae determine the intensity of recruitment into that stock which is commercially exploitable. Studies of fish larvae can also indicate relative size classes and abundance of spawning fish stocks and aid management decisions pertaining to fisheries and conservation. The knowledge on the larval stages of fishes and their seasons of occurrence could aid managers to protect the resources, and enhance the prediction of the recruitment of the species as a commercially viable stock. The present study attempts to correlate the physico chemical parameters that influence the fish larval distribution along the coastal waters of Dakshina Kannada. A total of six stations covering two estuaries viz. Netravati-Gurupura and Mulki-Pavanje in addition to the sites along the coastal waters were studied for 36 months. Pronounced monthly variations in the primary production, phytoplankton standing stock (chlorophyll a), physio chemical parameters such as water temperature, pH, salinity, dissolved oxygen and nutrients were observed at the selected stations especially estuarine and coastal waters. To test the differences in physico chemical parameters between stations each parameters were tested using a one-way ANOVA, and a post-hoc Fisher Least Significant Difference (LSD) analysis was also performed. Significant difference was observed in dissolved oxygen and chlorophyll and highly significant variations ($p<0.001$) in pH, salinity, dissolved carbon dioxide, Chlorophyll a, nitrate, ammonia and silicate concentrations. Multivariate comparisons (Tukey HSD) revealed variations in the physico chemical parameters within the stations. Fish larvae collected from these stations were identified up to the family level by referring to literature and fish larvae identification guides.

Keywords: Physico Chemical Parameters, Phytoplankton, Fish Larvae, Fisheries

Paper ID 16131

Impact of the invasive mussel, *Mytella strigata* (hanley, 1843) on fisheries and farming

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Rapid surveys were conducted during periods from May to August 2020 in estuaries along Central Kerala (Chettuva, Vembanad, Ashtamudi estuaries),South Kerala(Kayamkulam Lake, Poovar lake, Anchuthengu Lake, Kadinamkulam Lake) and North Kerala(Kavai backwaters, Kallai estuary, Puthiappa fishing harbour, Kadalundi estuary) to assess the extent of invasion of the species, the influence of physico-chemical parameters on its abundance, the impact of bioinvasion of this species on economically important native fauna and aquaculture activities. Settlement density of *M. strigata* in Chettuva Estuary, Vembanad Lake and Ashtamudi Lake was estimated as 32-12,400 nos/sq.m. Physical and chemical parameters of water and sediment characteristics were also analysed. *M. strigata* was found to be highly euryhaline and adaptive to anoxic conditions. In all three estuaries of Central Kerala, there was spat settlement of the species on bottom, cage ropes, cages nets etc. In Chettuva estuary, *P. viridis* and *M. strigata* population in the fishing ground necessitated additional 3 h/fishing day/boat/person for segregating *P. viridis* from *M. strigata.* As per the fishermen's perception, the fouling on cages increased the frequency of net exchange, interferes with harvesting activities and mortality of fish in cages . In Vembanad Lake, there was heavy infestation of the species on oyster rens suspended in oyster farms. There was a reduction in edible oyster spat settlement by 38% in oyster farms. More than 60% of the *M. strigata* settlement was observed on shells near the surface of the oyster rens. The potential threat of the species to bivalve farming, bivalve fisheries and finfish cage farming demands the formulation of management strategies for preventing the establishment of this non-native species that may cause ecological and economic havoc.

Keywords: *Mytella strigata*, Invasive Mussel

Paper ID 16147

Evaluation of artificial reefs and performances – biological productivity and reef efficiency assessment indices

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Information on the shelf life, performance in terms of fishing potential, yield, sustainability and extent of influence of artificial reefs are relevant for better management of the reef habitats and the resources therein. The performance, stability and efficiency of artificial reefs primarily depends on the design, number of modules and area covered, and sediment characteristics of the site. In addition to estimates of biomass and standing stock at the reef sites, biological productivity indices such as Area of Influence (AI), Primary Effective Boundary (PEB), Secondary Effective Boundary (SEB) and Biological Influence Range (BIR) were worked out. Equations were also derived to assess the Efficient life of Artificial Reef (AREL), Sinking Rate of Artificial Modules (ARSR) and Performance Efficiency of Artificial Reefs (ARPE). These equations were applied to assess and compare the performance of deployed reef across the selected sites. Values of the Coefficient of Current velocity (CC) and swell (CS) were incorporated to accommodate site-specific variability. The results of the study indicates that the average lifespan of a good quality concrete module assembled on sufficiently firm sea beds is 10-12 years, while AREL is anticipated to be 6-8 years. The performance indices derived for the reef sites will serve as a management tool for reef-associated fisheries and sustainability measures, as well as to estimate requirements in future deployment programmes.

Keywords: Area of Influence, Effective Boundary, Biological Influence Range, Efficient Life, Sinking Rate, Performance Efficiency

Paper ID 16148

Plankton biodiversity and productivity in artificial reef associated ecosystem in Tamil Nadu – a coastal highway to blue economy

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Plankton and benthic biodiversity were studied at 12 artificial reef sites in the coastal waters of Tamil Nadu and species richness, evenness and diversity indices of reef versus non-reef areas assessed. Total productivity levels in all the reef sites were higher than the immediate non-reef waters. The reef sites showed an exceptional increase in zooplankton species richness, evenness and diversity indices. Higher productivity indicators in most of the sites translated into increase in populations of foraging fishes, including those of commercial value. Post-deployment of reefs, meiobenthos was found to increase considerably in numbers, biomass and diversity. Underwater observations indicated that the reef areas can accumulate organic and mineral deposits and shell grits. Burrowing worms, filter feeders and detritivores act as sediment engineers and recycle metabolic discharge in the immediate sediments back to the waters, thus fertilising and making the reef bubble nutrient-rich. The waters surrounding the reefs show an increase in organic content in the sediment interstices, and increased levels of phosphates and nitrates. These carbon and nitrogen sinks support a multitude of microbial flora, nannoplankters, diatoms and larval forms. Increased surface area and reduced water currents inside the reefs allow settlement of spores, fragments and larval forms to settle, colonize and build a reef community. With increasing global demand for seafood and fast dwindling fishery resources, restoration of coastal ecosystems, which are vulnerable to destructive fishing methods including bottom trawling, and enhancing productivity and fish stocks will play a big role in moving towards Blue Economy.

Keywords: Species Richness, Biodiversity, Zooplankton, Carbon-Nitrogen Sinks

Paper ID 16160

(floliz) Floating littoral zone: A solution to sustain macro-invertebrate communities in regulated lakes.

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Artificial water-level fluctuations (WLF) seriously threaten the functioning of littoral zones in lake ecosystems and biodiversity. Artificial floating islands (AFI) are usually designed as simple vegetated floating mats. Here a design of artificial Floating Littoral Zone (FLOLIZ), which mimics a natural littoral zone composed of a terrestrial section vegetated with helophytes and several underwater levels containing soil and hydrophytes are aimed to assess the effectiveness of FLOLIZ in supporting macro-invertebrate communities. The cumulated abundance, taxonomic richness, diversity and Functional profiles of macro-invertebrate communities were significantly higher in the FLOLIZs than in the control littoral stations, particularly when water level rose abruptly (i.e., in spring) and during the post-drawdown season (i.e., in summer) over four seasons of one year. More specifically, communities in littoral control stations were dominated by highly mobile and resistant taxa (e.g., Beetles, Bugs, Chironomids), while communities in the FLOLIZs were dominated by less mobile species with longer life cycles (e.g., *Hydra sp*., Oligochaeta). These findings show that FLOLIZs were more successfully colonized by original, diversified, and abundant macro-invertebrate communities with respect to littoral control stations. The AFIs resulted into a development of a floating habitat for diversity of a macro-invertebrates community. In Riverine study, the AFIs improved the water quality: reducing the pollution load by 46% of total suspended solids (TSS), 51% of turbidity, 37% of total Kjeldahl nitrogen (TKN) and 39% of BOD in a period of year. By observing, these FLOLIZs and AFIs could provide suitable, biogenic habitats for macro-invertebrates in reservoirs exhibiting high WLF and also serves as water cleansing green landscape. Longer term monitoring, including of other compartments than macro-invertebrates (e.g., fish), could provide additional evidence that FLOLIZs mitigate the deleterious effects of high WLF on aquatic biodiversity.

Keywords: Floating Littoral Zone, Artificial Floating Island, Macro-invertebrate Communities , Water-level Fluctuations

Paper ID 16166

Spatio-temporal studies of Inland water bodies for Telangana state of India

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The inland water body extraction of Telangana state was done using Remotely sensed Satellite images. Landsat 8 OLI image was selected for water body delineation, for this analysis from March to April 2016 (pre monsoon season) and October to November 2016 (Post Monsoon season). Images were downloaded from USGS Earth Explorer. After image processing, more than 0.5 hectare of water bodies are extracted through Image classification and manual digitization process in GIS platform using Arc GIS. After extraction of water bodies, they are categorized into five classes. Classes range from 0.5 to <10 ha, 10.0 ha to < < 50.0 ha, 50.0 to < 500.0 ha, 500- 1000 ha and more than 1000 ha. A total 5574 number of water bodies are delineated and the average area is 110527.09 hectares. Among the total water bodies extracted only 893 water bodies are perennial and 4681 water bodies are seasonal. This study would provide baseline information for planners, researchers and stakeholders for achieving the sustainable utilization of water resources for fisheries development.

Keywords: GIS, Arc GIS, Landsat 8 OLI, Inland Water Bodies, USGS, Telangana

Paper ID 16184

Hemato-biochemical variation in the bronze Featherback *Notopterus notopterus* (Pallas, 1769) as a bio-monitoring tool to assess riverine ecology: A case study from the middle and lower stretch of river Ganga

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Fishes being the poikilothermic animal are the rapid responder to any sort of ecological alteration. The responses in the fish can be easily assessed from their hematological and biochemical responses. To study the variation in the haemato-biochemical parameters in retort to ecological alteration and ecological regime. A study was conducted at seven different sampling stations of the middle and lower stretch of river Ganga i.e., at Buxar, Patna, Bhagalpur, Farakka, Berhampore, and Balagarh, in which various hematological and biochemical responses of fishes are monitored in response to ecological changes. For the assessment of ecological alteration Water Pollution Index (WPI), Water Quality Index (NSF-WQI), and Nemerow's pollution index (NPI) were calculated based on various water quality parameters such as pH, Dissolved Oxygen (DO), Total Dissolved Solids (TDS), Total Hardness (TH), Total Alkalinity (TA), Electrical Conductivity (EC), Chlorinity (CL), Biochemical Oxygen Demand (BOD), Total Nitrogen (TN), Total Phosphorus (TP), etc. Among the hematological parameters WBC, RBC, Platelet, Hemoglobin, and Hematocrit were monitored. The various serum biochemical parameters SGPT, SGOT, ALP, Amylase, Bilirubin, Glucose, Triglyceride, Albumin, Globulin, Total Protein, and cholesterol were investigated. In the study, it has been observed that an NSF-WQI varied from 45.08 at Buxar110.63 at Berhampore and showed a significantly positive correlation with SGPT, SGOT, ALP, TRIG, CHOL, and WBC. Whereas, a significantly negative correlation was observed between TRIG and RBC. WPI varied from 19 to 23 and showed a significant positive correlation with SGOT and negative relation with Total nitrogen. The PCA analysis illustrated the significance of both natural as well as anthropogenic factors on the riverine ecology. Strong positive loading was observed with SGPT, SGOT, ALP, and Platelet. The study signified the need for monitoring hemato-biochemical responses in response to alterations in the ecological regime.

Keywords: River Ganga, Hematology, Serum Biochemical Response, Water Pollution Index, NSF-WQI, NPI

Paper ID 16186

Eco-toxicological effect of a commercial dye Rhodamine B on freshwater microalgae *Chlorella vulgaris*

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Microalgae are an ecologically important biotic component of aquatic ecosystems due to their role as primary producers. Organisms in the aquatic environment are exposed to a variety of chemical substances including toxic dyes discharged from the industries. In this study, the toxicity effects of a fluorescent xanthene dye, Rhodamine B (RhB), widely used in textile, paper, and leather industries was investigated on freshwater microalga *Chlorella vulgaris*. The acute toxicity of RhB on *C. vulgaris* was determined by examining growth, cell morphology, pigment production, protein content, and the activities of oxidative stress enzymes. In the toxicity study of 24h to 96h, the median inhibitory concentration (IC_{50}) values ranged from 69.98 to 31.29 mg L^{-1}. The growth of *C. vulgaris* was conspicuously inhibited by Rhodamine B exposure, and the cell surfaces appeared to be shrunk. The growth of *C. vulgaris* was hindered after an exposure to graded concentrations (10-50 mg L^{-1}) RhB. A significant reduction in growth rate, pigment synthesis (chlorophyll *a*, chlorophyll *b* and carotenoid), and protein content was recorded in a dose-dependent manner when the mid-exponential phase algal populations were exposed to various concentrations of RhB. After 96h exposure of *C. vulgaris* to 50mg L^{-1} RhB, chlorophyll *a*, chlorophyll *b*, total chlorophyll, and carotenoids contents were reduced by 71.59, 74.90%, 72.63%, and 65.84%, respectively. After 96h exposure, the protein content was 74.20% lower than the control. The activities of the antioxidant enzymes peroxidase (POD), and catalase (CAT) also increased markedly in the presence of RhB. A pronounced effect was noticed on oxidative enzymes catalase and peroxidase, indicating that oxidative stress may be the primary factor in the inhibition of growth and pigment synthesis. The study provides a convincing evidence for the metabolic disruption in the ubiquitous microalga *C. vulgaris* due to the RhB dye toxicity.

Keywords: Textile Dye, Microalgae, *Chlorella vulgaris*, Rhodamine B, Toxicity.

Paper ID 16201

Degradation of Emamectin benzoate in pond water under tropical condition.

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Seafood is one of the most important and valuable commodities in the world to meet the requirement of protein rich nutritious food. Aquaculture bridges the supply–demand gap, but often parasitic infections cause stunted growth and leads to economic loss for the farmer. To control and prevent parasitic infection, Emamectin Benzoate (EMB), an anti-parasitic drug is used in aquaculture. When feed-based drug is added to the pond, a significant portion of it reaches the water through the leaching of uneaten feed and feces. To understand the influence of abiotic factors on the degradation of EMB under tropical conditions, a known quantity of EMB was added to water under varying pH (6, 8 and 9) and salinities (2, 15 and 30 ppt) and was maintained under dark and sunlight conditions throughout the study. During the experiment, the temperature and light intensity varied from 30.2 - 37.2 ˚C and 2454 - 1,17,500 lux respectively. Sampling was done at periodical intervals and EMB was analyzed using LC-MS/MS. EMB degradation followed the first-order kinetics with a half-life period of 5.6 days under sunlight and was 10 times higher under dark condition. Among the pH and salinities, degradation was higher under pH 9 and the salinity of 2 ppt. It shows that EMB degradation is faster in low saline with alkaline pH when exposed to sunlight. In India, EMB degradation in aquaculture pond water is rapid due to the prevalent sunlight exposure throughout the year.

Keywords: Emamectin Benzoate, Degradation, pH, Salinity, Sunlight

Paper ID 16202

Relationship between macrobenthic community, water quality and sediment quality off Padubidri coast, Udupi, Karnataka

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Macrobenthos always play a significant role in the food web in the costal environment. It also used as a good aquatic ecosystem health module indicator. The abundance and distributions of macrobenthos in off Padubidri coast, Udupi were studied in relation to hydrological parameters. The present study was conducted to know the diversity and seasonal variations of macro-benthic infauna and associated environmental factors influencing the macrobenthic community in the coastal waters of southern Indian coast during the period from October 2020 to May 2021 at monthly intervals. Four stations were selected along off Padubidri coast at 4 different depth. Altogether, 64 infaunal samples (Van-veen grab 0.1 m²) were collected which revealed the occurrence of 38 species representing five diverse groups. Polychaetes were the dominant group, followed by Bivalves, Gastropods, Echinoderms and Miscellaneous. Among polychaetes, *Capitella capitata. Paraprionospio pinnata, Glycera alba*, *Nepthys spp., Nereis spp*. and *Cossura coasta* were dominant in the coastal waters have been recorded almost at all the depths of the sampling stations. Among bivalve species *Arca* spp., *Tellina* spp., *Cardium* spp. and Bivalve spat were found to be dominant. From this, it can be concluded that these species acts as indicator or opportunistic species for monitoring of pollution in coastal environment. It was observed that the macrobenthic population increased with increased depth. Seasonally higher species density was recorded during pre-monsoon season compared to post-monsoon months.

Keywords: Macrobenthos, Bivalves, Gastropods, Padubidri

Paper ID 16205

Impact of physico- chemical parameters on diversity and abundance of plankton along Chitrapura coast, Mangaluru, Dakshina Kannada, Karnataka

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Plankton plays an important role as a bio-indicator of water quality. Its abundance is also considered as a primary source of feed for the aquatic organisms. This study aims to measure the water quality and plankton abundance and to know their relationship in Chitrapura coastal areas, Mangaluru, Dakshina Kannada. This study was carried out from January 2019 to March 2020in the 5 selected stations for sample collection. The water quality parameters viz., temperature, salinity, dissolved oxygen (DO), pH, phosphate (PO_4), Ammonia (NH_4), Silicate (SiO_3) and nitrate (NO_3) values were measured.Phytoplankton study showed the presence of 34 different genera with the abundance of *Biddulphia regia*, *Chaetoceros decipiens, Coscinodiscus lineatus*, *Ditylum. brightwelli*, *Nitzschia longissima, Rhizosolenia shrubsolei*, *Thalassiothrix longissima*, and *Chaetoceros compressus*. The qualitative analyses of zooplankton revealed the presence of 18 different groups, among them *Tintinids* were the most dominant group, followed by *Rabdonella sp., Tintinopsis sp., Sagitta enflata, Calanus finoctobericus, Oikopleura sp.,* and *Polychaete larvae.* The highest plankton abundance and diversity found in station 3. The correlation analysis results showed a significant correlation between the planktonsand water quality. It can be concluded that Station 3 has the good water quality and plankton abundance compared to the other stations based on the results of monitoring conducted.

Keywords: Chitrapura, Phytoplankton, Zooplankton, Benthos

Paper ID 16206

Variation in sediment quality and hydrology – Is it a reason for short-neck clam biomass depletion in Ashtamudi Lake?

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The internationally renowned short neck clam Paphia malabarica is India's first MSC certified resource. Its fishery is well established in Ashtamudi Lake (Lat.8°45'-9°28'N and Long.76°28'-77°17E) one of the Ramsar site in India and the second largest wetland in Kerala. As a locally marketed clam till 1981, its demand increased as export market began in 1981. The clam was overexploited and the stock was depleted in the year 1990, but the resource was revived through the implementation of self imposed ban suggested by CMFRI. In the present scenario, this resource is showing a declining trend in the fishery. The decadal trend in the landings, 2014 showed a peak 10810.98 and 3056 t (2020) followed by 706t in 2021.This decline is aggravated by the flood in 2018. The studies conducted by CMFRI, the textural analysis of sediment in Ashtamudi Lake showed distinct changes in the sediment quality. The preferred bottom texture for the short neck clam is sandy clay. The consecutive surveys (biomass, sediment and hydrography)and monthly sampling results revealed the prominent changes in sediment texture. High values for silt was observed after the flood in 2018. In the year 2010 the average silt percentage was 3 to 5% and 10 to 22% in 2020. Hydrographic parameters analysed for the survey samples also showed drastic changes in temperature (28.6 to 31° C),nitrite (0.002 to 0.009 mg-L), dissolved oxygen (5 to 3.49 mg-L), and chlorophyll (4.2 to 1.8 mg-L-day) values.The possible role of various environmental parameters determining the water and sediment quality on the decline of short neck clam biomass in Ashtamudi Lake is analysed in detail in this paper.

Keywords: Ashtamudi Lake, Hydrology, Short Neck Clam, Sediment Quality

Paper ID 16209

Climate-resilient adaptation strategies for sustainable management of floodplain wetland fisheries in India

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The warming of earth due to climate change adversely impacts wetlands along with anthropogenic stressors, including environmental pollution, habitat degradation and loss of biodiversity. Floodplain wetlands (0.5 million ha area) play an imperative role in fish production and recruitment as they provide breeding and nursery grounds for many fish species. Recent studies indicated considerable impact of climate change on ecology and fisheries of floodplain wetlands and associated livelihood. Therefore, focus has been given globally to develop climate resilient strategies for sustainable fish production. In the present study, we assessed large number of wetlands from lower Ganga basin. Ecological approaches and stakeholder perception based studies were employed for vulnerability assessment and to document location specific adaptation strategies. The results indicated degradation and shrinkage (37-57%), depth reduction (2-81%), loss of fish diversity (22.85 to 54%) and decline in production of natural fish fauna in wetlands. Analysis of climatic data has revealed a climate anomaly of increasing temperature (0.07-0.22°C) and decreasing rainfall (61.41-146.63mm) in study area over the last three decades. The adaptation strategies used for climate smart fisheries management in floodplain wetlands include deep pool based fish culture, refuge/weed based culture system, submerged branch pile, climate resilient pen culture, cage culture and climate resilient culture based fisheries. The study identified climate resilient fish species based on feeding guilds, stress tolerance, reproductive plasticity, doubling time etc. The paper discusses conservation and restoration of the wetlands through adoption of climate smart fisheries management. Holistic efforts of the stakeholders may provide suitable management to reduce the risk of climate change in floodplain wetlands.

Keywords: Climate Change, Wetlands, Adaptation Strategies, Stakeholders, Management

Paper ID 16219

Assessment of habitats and fish diversity in Chharaganga beel, an open wetland of river Ganga

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The Ganga River basin endows a diverse regime of open or floodplain wetlands, which are considered as the key habitat of aquatic organisms including small indigenous fishes, and act as the breeding and nursery ground for the inhabitants. The present study was conducted from December 2020 to November 2021 at Chharaganga beel, an open wetland connected to the Ganga located in Purba Bardhaman and Nadia district of West Bengal, India, to better understand the diversity pattern of the fish community in relation to various environmental factors. A total of 45 fish species belonging to 11 orders and 23 families were recorded, of which three species belong to the "Near Threatened" and one to the "Endangered" under the IUCN Red List category during the study. Eight major fish groups were found namely Cyprinids (30%), Ambassids (28%), Catfishes (10%), Danionids (7%), Clupeids (4%), Gobiid (2%), Loach (1%), and Miscellaneous fish group (17%). The diversity indices were analyzed as Shannon diversity (2.98), Simpson diversity index (0.93), Margalef species richness index (5.27), and Equitability index (0.78) which indicates moderate to high diversity in Chharaganga beel. One-way ANOVA showed a significant station-wise difference for water turbidity ($p<0.05$). Fish fauna shows a positive correlation with turbidity whereas, plankton has a positive correlation with Nitrate-N, Phosphate, Silicate, and Mg^{2+}. The current study underlines the importance of river connectivity in sustaining the ecological integrity of open wetland ecosystems and thereby restoring fish species through hydrological flushing by river water.

Keywords: Open Beel, Fish Habitat, Ecological Parameters, River Ganga, Diversity Indices

Paper ID 16221

Isolation, identification and optimization of growth conditions for the marine microalga *Skeletonema Subsalsum* isolated from the Gulf of Mannar, South-east coast of India

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Marine microalga *Skeletonema subsalsum* was collected and isolated from the keelakarai (9°13'24"N; 78°47'12"E) coastal waters of the Gulf of Mannar. Isolation of the diatom was carried out by serial dilution in test tubes, 96 well plates followed by streaking. The purified alga was identified by a light microscope initially and the confirmation based on the ultrastructure of the cells was done using SEM-EDAX. Optimization of culture conditions for the identified microalga was studied with different culture media (Diatom Artificial Medium (DAM), F/2 medium, and Walne's medium) by various salinities to assess their best growth for industrial application. The pure isolate was cultivated in F/2 medium at the optimum environmental parameters such as salinity;35ppt, temperature; 25℃., pH;8.5, light intensity; 3000 lux, airflow rate;5l/min which was standardized to obtain high biomass using photobioreactor. The maximum cell density of $6.7x10^7$cells/mL was obtained within 12 days of the culture period. Under optimized growth conditions, in the mass production of algae in the outdoor tanks, high wet biomass of 1.4g/L was obtained. As the microalga strain was isolated at the succession stage, it can tolerate a wide range of environmental conditions and could be mass-produced in outdoor conditions for industrial applications

Keywords: Indigenous Marine Microalga, Morphological Confirmation, Suitable Growth Conditions, Outdoor Mass Production

Paper ID 16232

A study on the efficiency assessment of orange peel biochar in the treatment of COD in shrimp farm wastewater

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The release of untreated effluent into the environment can have several negative effects. The raising demand for seafood leads to the establishment of numerous small scale and large scale shrimp farms in coastal areas. Intensive culture practices produces enormous quantity of wastewater loaded with high amount of organic matter and other pollutants. Traditional methods such as coagulation and flocculation are being used by effluent treatment plants but there is a need for exploring the use of natural adsorbents since it is eco-friendly and cost effective. So, the present study aims to assess the Chemical Oxygen Demand (COD) removal ability of biochar prepared from waste orange peels. Commercially available powdered activated carbon is used as control. The experiments were conducted in batch mode with manipulating dosage levels of biochar and activated carbon in varying contact periods. The initial concentration of COD in shrimp farm wastewater was found to be 121.76 ± 1.49 mg/l. After treatment with biochar, the COD concentration was reduced to 1.61 ± 0.12 mg/l at 90 minutes contact period with the dosage level of 1.25g/100 ml. The results showed that both orange peel biochar and activated carbon treatment showed better COD reduction performance (>95%) during treatment. The surface characteristics and elemental composition of untreated and effluent treated orange peel biochar was observed using Field Emission Scanning Electron Microscopy (FESEM) coupled with Energy Dispersive X-ray Spectroscopy (EDS). The interaction of functional groups present in biochar was also observed before and after treatment using Fourier Transform Infrared spectroscopy (FT-IR) analysis. The present work assessed the pollutant adsorption potential of biochar prepared from waste orange peels in the treatment of wastewater.

Keywords: Adsorption, Biochar, COD, Treatment, Pollution

Paper ID 16233

Utilization of acid washed fish scale adsorbent in the removal of TSS and TDS in sewage water

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Globally, pollution caused by discharge of sewage water is a rising environmental issue. Sewage water consists of numerous organic and inorganic pollutants released from domestic households and industries. It contaminates the draining environment and cause serious impacts on natural habitats and associated living organisms. Sewage alters the quality of local water resources and cause water pollution problems. Usually, treatment of sewage water is being done by large scale treatment plants with the help of activated sludge. Now-a-days, development of low cost methods for sewage treatment receives much attention. Natural and synthetic adsorbents are being explored by scientists for their pollutant adsorption nature. Therefore, the present study aims to reuse the waste fish scales as eco-friendly adsorbent in the treatment of Total Suspended solids (TSS) and Total Dissolved Solids (TDS) in sewage water. Fish scales were modified with acid treatment and used in batch experimental study with different dosage levels and treatment times. Acid washed fish scale adsorbent showed greater potential in the removal of TSS and TDS in sewage water during treatment. The adsorbent showed maximum reduction of TSS (78.79%) at 0.27 g/300 ml whereas 85.24% reduction of TDS was observed at 0.09 g/300 ml. The optimum treatment time was found to be 60 minutes during the experiment. The porous nature and elemental composition of adsorbent was observed using FESEM (Field Emission Scanning Electron Microscopy) and EDS (Energy Dispersive X-ray Spectroscopy) analysis. The influence of functional groups of adsorbent during sewage water treatment was also analysed using FTIR (Fourier Transform Infrared spectroscopy) analysis. The results of present work showed good TSS and TDS removal ability of adsorbent prepared from waste scales and thus provides an eco-friendly alternative for wastewater treatment.

Keywords: Adsorbent, Scales, Sewage, Pollution, Treatment

Paper ID 16235

Effects of different physico-chemical and environmental parameters on nitrogen fixation rates in freshwater systems

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The effects of different physico-chemical parameters including light, temperature, aeration, pH, dissolved organic matter, phosphorus, iron, ammonia, and molybdenum, through enrichment were analyzed on nitrogen fixation rates in freshwater aquatic systems in simulated microcosms. In comparison with the control the different treatments included light exposure at 2:1 and 3:1 (light/dark), water temperatures at 25^0C, 30^0C and 35^0 C, aeration in water for 8 hours and 16 hours, pH at 6.3, 7.0 and 9.2, organic matter at 1ppm and 2 ppm, phosphate-phosphorus at 1 ppm and 2 ppm, iron at 1ppm and 2 ppm, ammonia at 1 ppm and 2 ppm and molybdenum at 1 ppm and 2 ppm respectively. The nitrogen fixation rates were measured by ARA (Acetylene Reduction Assay) in both water and sediment media. Exposure to light intensity, temperature and enriching the system with iron, molybdenum and dissolved organic matter showed an increase in the nitrogen fixation rates whereas prolonged light exposure, aeration and ammonia reduced the activity. The results indicate tremendous scope to enhance the biological nitrogen fixation in pond ecosystems through environmental manipulations for sustainable aquaculture.

Keywords: Physico-chemical Parameters, Nutrient Enrichment, Nitrogen Fixation

Paper ID 16248

Substrate specific alteration in the periphyton as an eco-pollution indicator in the Ganga river system

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Periphytons are the photosynthetic organisms having a complex assemblage of autotrophs and heterotrophs (algae, bacteria, protozoa, rotifer, etc.) found attached to the submerged substrates. Evaluation of attached algae that is periphyton, provides an accurate, reliable indicator of water quality. The reliability and accuracy of periphyton measurements are affected by physical conditions such as substrate type and condition. However, there is some evidence that they play a key role in primary productivity, nutrient cycling, and food web interactions. A study was carried out to know the effect of different substrates on periphyton composition in terms of abundance and density at Bihar (Bhagalpur) stretch of river Ganga. For this purpose, periphyton samples were collected from the different substrates i.e. wood, thermocol, and plastic substratum. In the analysis, it was observed that the highest Shanon and Simpson index was observed in the wooden subsurface (1.742 and 0.74), while the higher dominance index was observed in the thermocol subsurface (0.260). The occurrence of toxic cyanobacteria such as *Crococcous* sp., *Phormidium* sp., *Oscillotoria* sp. were found higher in plastics (837 x 105 unit/cm^2), followed by thermocol (7267 x 103 unit/cm^2) and found least on wooden subsurface (10 x 104 unit/cm^2). The diatom shared the maximum density (548 x 103 unit/cm^2) on the wooden surface which may be describing the good environmental conditions. It can be concluded that the periphytic algal composition has been changed according to the different substratum. The plastic substratum was more suitable for cyanobacteria growth than the wooden substrate for the diatoms.

Keywords: Periphyton, River Ganga, Algae, Thermocol, Plastic, Wooden Surface

Paper ID 16256

Physico chemical depiction of sea near Pulicat lake in a steno spatial temporal scale

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Pulicat Lake region served as an abode of a spectrum of flora and fauna nurturing wide range of diversity and its history dates back to 13th century. It is the second largest brackish water ecosystem which is characterised by recurrent bar formations in the mouth region. A lot of apprehensions prevail over the loss of its unique resources, at the backdrop of current developments. This warrants a constant monitoring of biotic and abiotic factors and phenomenon relevant to this region. This has prompted this study of monitoring, the physico-chemical parameters for a period of one year from Jan 2021 to Jan 2022. Further, to ensure restitution of this region with more of biotic potential an artificial reef installation program has been envisaged. With this backdrop five study locations were fixed along the sea area of Pulicat Region. Water and sediment samples were collected and analysed. Physico-chemical parameters like temperature, pH, salinity hardness, alkalinity, ammonia, Nitrate, nitrite, TS, TDS, TSS, DO, COD, BOD, phosphate and EC were assessed. Soil parameters pH, organic carbon, organic matter, moisture content, calcium, magnesium and available phosphorous were assessed. Remarkable season wise fluctuation in the physico-chemical parameters could be recorded during the study especially during monsoon season. The fluctuations were of considerable magnitude in Nitrate (0.361 to 0.526 µg/l), TS (3.2 to 9.2 g/l), Dissolved oxygen (4.5-8mg/l), BOD (4.2 to 12mg/l) and COD (8.2-18mg/l). Major play of riverine input could tangibly be seen in this investigation.

Keywords: Pulicat, Sea Water, Physico-chemical Parameters

Paper ID 16301

Insights on the self-healing and regeneration of upside-down Jellyfish *Cassiopea* (scyphozoa: Rhizostomeae) under controlled conditions

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Self-healing and regeneration are common in metazoans, like planarians and cnidarian polyps, due to their higher regeneration capacity. The present study attempts to give an insight into the self-healing and regeneration capacity of the injured umbrella (3.5±0.2 cm - 4 nos), radially amputated (3.8±0.4 cm - 12 nos), and cut tissue (0.5 cm - 1 no) of the upside-down jellyfish, *Cassiopea* during January 2021 to April 2021 (3 months) in the Cnidarian laboratory. The animals were maintained individually in an aquarium tank of 5 to 20-litre capacity with optimum seawater parameters (Salinity 33±2 ppt; water temperature 30±2ºC, light intensity 60±20 PAR, and photoperiod 18L/6D) with adequate water exchange. The animals were fed freshly hatched *Artemia* nauplii, and the mucus/uneaten nauplii were siphoned daily. Morphological changes and regeneration were observed under a stereomicroscope. The results revealed that the injured medusae umbrella could regain its umbrella structure in 18±2 days. The cut tissue regenerated all body structures, including canal structures, mouth, oral arms, and oral vesicles in 90 days. The radially amputated medusa initially self-healed its umbrella symmetry and then recovered bell tissue, including zooxanthellae and the rhopalia, in 15±5 days. Upon complete development of the oral region, gastrovascular cavities, canals structures, lappet systems; the other oral arms have started developing from the mouth, and further formation of oral vesicles in the arms and centre of the mouth; thus, a complete structure has evolved in 82±12 days. Our observation indicated that *Cassiopea* has a self-healing and regenerative capacity and offers broader scope for developing this organism as a cnidarian model for regeneration studies. The present finding on the self-healing and regenerative capacity of *Cassiopea* medusa is the first of its kind from India.

Keywords: Body Structures; Development; Rhizostomeae; Self-repair; Umbrella Tissue

Paper ID 16305

Plastic debris from beach sediment at the Veraval and Adri, Saurashtra coast, Gujarat

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The present study was conducted to investigate the occurrence, distribution and comparative assessment of plastic debris from sediment on the selected beaches of Veraval and Adri of Gujarat, India for 6 months. Beach sediments samples were collected, extracted and quantified along with their physical characteristics for microplastic (<5 mm). The quantification, and abundance along with the physical characteristics of the macro-plastics (> 2.5 cm) and meso-plastics (> 5 mm - < 2.5 cm) were done by the visual method. The average abundance of macro-plastic at stations 1, 2 and 3 of about 6.041 ± 2.169, 2.399 ± 1 and 4.028 ± 1.773 items/m^2 respectively. Fibre type macro-plastics were dominant at station 2 followed by stations 1 and 3. The dominant sizes ranged between > 2.5 – 5 cm at station 3 followed by station 1 and station 2. The white-coloured particles were dominant at stations 2 and 1. The average abundance of meso-plastic at station 1, 2 and 3 of about 2.555 ± 0.893, 0.666 ± 0.675 and 1.470 ± 0.825 items/m^2 respectively. Irregular type meso-plastics were dominant at station 2 while thermocol and fragment were dominant at station 1 and station 3. The dominant sizes ranged between 1.5 - 2 cm at station 1 followed by station 3. White coloured particles were dominant at station 2 followed by stations 1 and 3. The average abundance of microplastic at stations 1, 2 and 3 of about 7.331 ± 2.678, 3.166 ± 0.742 and 4.361 ± 0.817 no/100 g respectively. Foam type microplastics were dominant at stations 1 and 3 while, fibre type microplastic was dominant at station 2. The dominant sizes were 2-4 mm at stations 1, 2 and 3. White coloured particles were dominant at stations 1 and 3 while the blue-coloured particle was dominant at station 2.

Keywords: Plastic Debris, Macro-plastic, Meso-plastic, Microplastic, Beach Sediment, Veraval

Paper ID 16308

Ingestion of microplastics in commercially important fishes along Thoothukudi coast, South east India

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Microplastics (MPs) pollute the marine environment and pose a greater risk to marine organisms. Here, the present study investigated the occurrence and characteristics of MPs in seawater and commercially important fishes (11 species) and crustaceans (2 species) from four different feeding habitats sampled from six sampling sites along the Thoothukudi coastal waters from January 2021 to December 2021. The mean concentration of MPs in seawater varied from 32.49 ± 3.67 to 395.33 ± 47.65 particles/l. Twelve out of 13 species contained MPs with an occurrence and average prevalence of about 30.06% and 0.64 ± 0.11 MPs/individual, respectively. The herbivores (1.23 ± 0.61 MPs/individual) and carnivores (0.77 ± 0.14 MPs/individual) had significantly higher levels of MPs contamination than the omnivores (0.23 ± 0.06 MPs/individual). Most of the MPs were fibre-like, 0.5–1 mm in size, and blue-coloured MPs were found in fish with different feeding habitats. Polyethylene (40.73–54.80%) was the most common polymer, followed by polypropylene and polystyrene. Field Emission Scanning Electron Microscopy and energy dispersive X-ray spectroscopy (FESEM -EDAX) images revealed that the MPs surfaces had undergone varying degrees of degradation, as well as the presence of natural elements and metal contaminants adhered to the MPs surfaces. These elements might be derived from the additives present in the MPs polymer or from the adsorption of contaminants from the surrounding environment. The present study suggests that the occurrence of MPs in the surrounding environment and the feeding type of the fish could be the possible factors that influence the uptake of MPs in fish and crustaceans. Further, ingestion of these particles probably causes harm to marine organisms.

Keywords: Microplastics, Coastal Waters, Fish, Polymers, Feeding, Herbivore, Polyethylene, Fesem-edax

Paper ID 16309

Abundance and characterisation of microplastics in beach sand and seawater along Thoothukudi coast of Gulf of Mannar region

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Microplastics (<5 mm) in beach sand and seawater were studied in two stations along the Thoothukudi coast for abundance, characterization (shape, size, and color), and chemical composition. The microplastics abundance in beach sand varied from 62 ± 1.0 to 302.33 ± 82.85 particles/kg (mean concentration: 144.93 ± 91.53 particles/kg), whereas in seawater, it varied between 31.67 ± 7.23 and 83.67 ± 7.77 particles/l (mean concentration: 57.70 ± 19.12 particles/l). Threspuram significantly registered higher microplastics in beach sand (219 ± 69.83 particles/kg) and seawater (72.73 ± 10.29 particles/l) than Spic Nagar. This was probably due to the direct discharge of municipal and domestic effluents into the sea via the Buckle canal, waste discharge from fishing activities, and a high coastal population. The most abundant shapes and colours in beach sand and seawater were fragments (48.99%, 62.45%) and transparent (38.73%, 48.14%). In beach sand and seawater, 2–4mm and 1–2mm sized microplastics were dominant, accounting for 44.44% and 37.65%, respectively. Attenuated Total Reflectance-Fourier Transform Infrared Spectroscopy (ATR – FTIR) revealed the high dominance of polyethylene in beach sand (56.41%) and seawater (62.5%). The current study provided baseline data on the presence of microplastics along the Thoothukudi coast. Furthermore, it is recommended that research is needed on the risk of microplastics in the marine environment and aquatic health.

Keywords: Microplastics, Seawater, Beach sand, Abundance, Threspuram, ATR -FTIR, Polyethylene

Paper ID 16509

Assessing the potential of biochar prepared from pomegranate peel and coconut husk in the treatment of COD in shrimp farm effluent

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The deliberate discharge of wastewater from industrial and livestock farms are creating serious environmental problems. Due to increased popularization, food demand gets enlarged. Numerous shrimp farms have been constructed along coastlines which pose threat to coastal habitats and ecology. The effluent released from shrimp farms are loaded with toxic chemicals, sediments, organic and inorganic pollutants. The concentration of Chemical Oxygen Demand (COD) in untreated effluent is usually higher than optimum limit which affects the water quality in draining area and thus create negative impacts on aquatic organisms. Treatment of COD in wastewater is generally carried out by various conventional technologies in treatment plants. But, new studies using natural and synthetic adsorbents have been reported in reducing the concentration of pollutant parameters with the help of adsorption phenomenon. Among various adsorbents, the present study focused on the usage of biochar as adsorbent prepared from pomegranate peel and coconut husk in equal ratio (P+C) in the treatment of COD in shrimp farm effluent. Biochar was produced by slow pyrolysis at 300˚C at 10-15 ˚C /min heating rate in a muffle furnace. The treatment study was conducted in batch mode at different biochar dosage levels and contact times. The initial concentration of COD in effluent was 120.6 ± 0.88 mg/l. After treatment with biochar, there was a significant reduction ($P<0.05$) of COD (>95%) at 90 minutes contact time with dosage of 1.25g/100 ml. The adsorption behavior of biochar was assessed by FESEM (Field Emission Scanning Electron Microscopy) analysis before and after treatment. The presence of biochar functional groups were identified using FTIR (Fourier Transform Infrared spectroscopy) analysis. The present work showed the COD reduction potential of pomegranate peel and coconut husk biochar in effluent treatment and thus provides an alternative way to reduce water pollution.

Keywords: Biochar, COD, Shrimp Farm Effluent

Paper ID 16321

Clam population characteristics with respect to physicochemical parameters at Tuticorin Bay and Pazhayakayal Estuary

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A study was carried out to elucidate the clam population changes with respect to physicochemical parameters of two ecosystems in Tuticorin district viz., Tuticorin Bay and Pazhakayal Estuary from January 2021 to December 2021. The study was based on the monthly sampling for both clam population and physicochemical parameters at three stations each. The standard procedures were followed for analysis. At Tuticorin Bay, the total clam biomass was ranged from 0.52 kg/m^2 (at station III during December) to 2.5 kg/m^2 (at station II during July) with an average biomass of 1.23 kg/m^2. Among the species *M. casta* was dominant (41 %) followed by *G. pectinatum* (34 %), *M. opima* (33 %) and *P. malabarica*, (26 %). In Pazhayakayal Estuary, the clam population was supported by single species, *Meretrix casta* and the total clam biomass ranged from 3.75 kg/m^2 (at station I during April) to 17.9 kg/m^2 (at station III during March) with an average biomass of 8.26 kg/m^2. Both biomass and density of the clams were significantly different between stations at both places ($p < 0.01$). The clam populations were not significantly influenced by the water quality parameters. Comparatively lower salinity was noticed at Pazhayakayal Station and varied between 9.92 to 32.11ppt. The studies indicated that the fine sand bottom (35.01 to 81.62%) with high organic carbon content (0.110 to 0.751%) supports the high diversity and less density population at Tuticorin Bay. Whereas the coarse sand (13.29 – 77.65%) with hyposaline water support the high-density of *M. casta* at Pazhayakayal Estuary. Statistically significant variations were also noticed in the sediment constituents and organic carbon content of the soil between the stations of both locations ($p < 0.01$).

Keywords: Clam, Density, Population, Tuticorin Bay, Pazhayakayal Estuary

Paper ID 16334

Assessment of the potential threat of Nickel nanoparticles to fish Pearl Spot *(Etroplus suratensis*) associated with the changes in accumulation and histological parameters

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Aquatic ecosystem acts as a sink for many toxic substances and contamination of toxic substances. Pollution of the aquatic environment by heavy metals pose a great threat because of their persistence and tendency to accumulate in aquatic organisms. The study was to assess the bioaccumulation and histopathological changes of Nickel nanoparticles (Ni NPs) exposure in *Etroplus suratensis*. Ni NPs were synthesized by sonication and characterized by Scanned Electron Microscope (SEM). The crystallite sizes were calculated using Scherrer's formula applied to the major intense peaks and found to be the size of 46 nm. Fishes selected for the study were exposed to two sub lethal concentrations of LC_{50} of Ni NPs for 28 days. After exposure, a significant accumulation of Ni NPs in experimental group was observed in the gill, liver and kidney tissues, with the highest levels found in the liver. Ni NPs exposed fish showed nuclear degeneration (ND), necrosis (NC) and irregular-shaped nuclei were observed in liver tissue. The hyperplasia of the gill epithelium (GE), lamellar fusion of secondary lamellae (LF), dilated marginal channel (MC), epithelial lifting (EL) and epithelial rupture were observed in gill tissue. Degeneration and occlusion of tubules, increased in bowmen`s space, glamulular degradation and increase in renal tubules were observed in kidney.

Keywords: Nickel Nanoparticles, Histology, Bioaccumulation

Paper ID 16336

Effect of Zinc fertilization on survival and growth of Jayanti Rohu (*Labeo rohita*) fry

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Zinc, one of the micronutrients is an integral part of a number of enzymes and acts as catalyst for regulating the activity of several metalloenzymes. The imbalance in the nutritional status of pond waters can change not only plankton quantity and taxonomic composition but also the physiological features of the cells. To assess the optimum level of Zn fertilization, an experiment was conducted to observe its effect on survival, growth, and development of Jayanti Rohu (*Labeo rohita*) fry. Under this experiment, different levels of Zn were applied: control, 0.10, 0.20, 0.30 and 0.50 mg/l Zn supplied through zinc sulphate. The fry (255.0±5.6 mg; 2.50±0.08 cm) were reared for 3 months in 100 litre FRP tanks under controlled conditions. At the end, the fish fingerlings were harvested and survival, length, weight were recorded. There was no mortality across the treatments irrespective of Zn dose. There was significant increase in length and weight under the treatment 0.10 mg/l Zn (7.57±0.05 cm; 3.27±0.15 g) compared to control (6.02±0.11 cm; 2.53±0.04 g). However, further increase in Zn concentration failed to induce increment in length and weight rather it decreased with increase in Zn concentration from 0.20 to 0.50 mg/l. Such results suggested Zn application up to 0.10 mg Zn/ L is beneficial for rearing fry to fingerling and further increase in Zn beyond 0.10 mg /l Zn is detrimental for fish growth.

Keywords: Zinc, Micronutrient, Fertilization, Jayanti Rohu

Paper ID 16357

Qualitative analysis of cyanotoxins in Powai lake, Maharashtra, India

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Powai Lake (19°7'10.84"N, 72°54'18.29"E) is situated in the metropolitan city of Mumbai. It is an artificial lake built in 1891 known as 'Anglers Paradise' predominantly influenced by anthropogenic activities. The Qualitative analysis of cyanotoxin concentration was carried out for Powai Lake from October 2018 to May 2019. The algal bloom was observed in Powai Lake in February 2019, and the bloom sample has been tested for the presence of cyanotoxins. The dense cyanobacterial scums or natural bloom samples were collected using a plankton net of mesh size 10 micron. About 100 litres of surface water containing the bloom was filtered to get the desired quantity of dried powder for the analysis. Methanol has been used to extract cyanotoxins. Rotary evaporation equipment was used to obtain an extract from the solvent, allowing it to evaporate Methanol. In the data-dependent acquisition mode of LCMS/MS total of 57 analogues of cyanotoxins were targeted. Among these, 11 toxin compounds were detected belonging to three different groups. In that microcystin, cylindrospermopsin were hepatotoxin, whereas anatoxin-a was a Neurotoxin. The qualitative abund value data from LCMS/MS showed MC-LA (Microcystin-leucine- alanine), MC-VA (Microcystin-valine-alanine) and Anatoxin-a were dominated. The Cylindrospermopsin showed a low abund value of 183 with an m/z ratio of 415.

Keywords: Toxin, Cyanotoxin, Microcystin, Algal Bloom, Lcms/ms

Paper ID 16372

Toxicity bioassay of organophosphorus pesticide, Dichlorvos (DDVP) in fingerlings of *Cyprinus carpio* (Linnaeus, 1758)

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Toxicological effects of pesticides on aquatic organisms are very important, especially when these animals are serving as functional foods with respect to human consumption. Dichlorvos, one of the extensively used insecticides was investigated in the present study for acute and sub-lethal toxicity. Fingerling common carp (*Cyprinus carpio*) was selected for the bioassay experiments. Acute toxicity test through static bioassay was conducted by exposing fingerlings to dichlorvos in the laboratory. The 96hour LC_{50} value was found to be 21.11 ppm. Impact of test conditions i.e., water hardness on LC_{50} value was evidenced through decreased toxic potential of test substance in the present research. The animals were experimented at pH: 7.1±0.2; salinity: 1 ppt; temperature: 32±2˚C; alkalinity: 220±18 ppm; hardness: 380±26 ppm; dissolved oxygen: 8.0±0.6 ppm. Sub-lethal toxicity studies were carried out by selecting 1/5 th & 1/10 th concentrations, following static renewal bioassay method for 28 days to observe pesticide induced changes in physiological activities (feed consumption rate, ammonia excretion rate) and proximate composition (crude protein, crude fat, ash and moisture contents) of fingerling commoncarp.

In sub-lethal toxicity studies, fishes seemed to be under stress with reduced metabolic performance, but were not fatal. Exposure to sub-lethal concentrations resulted in dose (concentration) and duration dependant decrease in case of crude protein, crude fat, food consumption rate and increase in ash, moisture contents and ammonia excretion rate by the end of test period. Food consumption and ammonia excretion rates showed 1.17fold decrease and 1.1fold increase respectively in 1/5 th LC_{50} compared to 1/10 th LC_{50} concentration. The sub-lethal toxicity impact (either negative or positive) of dichlorvos on biochemical (proximate) composition of was in the order of fat>ash>moisture>crude protein. The findings of present study would be helpful in framing guidelines to protect aquatic animals against both physiological and ecological deaths in species and ecosystem specific ways.

Keywords: Bioassay, Dichlorvos, Lc 50, Common Carp

Paper ID 16375

Observation on occurrence of *Noctiluca scintillans* bloom along the coast of Ratnagiri, Maharashtra

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The *Noctiluca scintillans* (Macartney) Kofoid & Swezy 1921, popularly known as sea sparkles was observed in the month of May 2019 along the coast of Ratnagiri, Maharashtra. It is ubiquitously distributed marine planktonic dinoflagellate responsible for coloured red and green tide in marine and coastal environments. Sampling station in the bloom area consisted of two creek [Shrigaon Creek (ShC), Sakhartar Creek (SC)] and four nearshore stations [Rajiwada (RW) Mirya Bander (MB), Pandhara Samudra (PS), Neware Sea (NS)]. Out of six stations, four stations reported presence of *N. scintillans*. Highest cell density per litter was recorded at Mirya Bander station (110000 nos l^{-1}) followed by Pandhara Samudra (36000 nos l^{-1}), Neware Sea (25000 nos l^{-1}) and creek station Sakhartar (1000 nos l^{-1}). Sea based stations recorded highest cell density ranging from 25 - 110 $\times 10^3$ cells l^{-1} compared with creek stations 0-1 $\times 10^3$ cells l^{-1} indicating the spread of bloom was largely restricted in the coastal waters. Changes in SST in the month of April might have promoted convective mixing, thereby renewal of upper mixed layer with nutrient rich water that in turn, resulted in proliferation of *N. scintillans*. Further, convictive mixing could be the probable reason for higher values of nutrient in surface water. In the present investigation, conducive environmental parameters especially nutrients and changes in sea surface temperature was ideal for growth of *N. scintillans* in all open sea-based stations.

Keywords: Bloom, *Noctiluca scintillans*, SST, Ratnagiri

Paper ID 16376

Heavy metals concentration in biotic and abiotic components

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Heavy metal contamination is hazardous and a severe problem in the marine environment. The inshore waters off Mangaluru receive a substantial amount of discharges from oil refineries, fertilisers, pesticides and other contaminants. Decapods have been extensively researched as bioindicators of metal concentrations. Commercially important crab populations are found in coastal areas with high levels of heavy metals. Considering the polluted state of marine ecosystem, efforts were made to know the heavy metals concentration in water, sediment and different organs of *Portunus pelagicus* and *P. sanguinolentus*. The order of average heavy metal concentration in different organs of *P. pelagicus* was Cu (163.04 mg/kg) > Zn (58.06 mg/kg) > Ni (8.93 mg/kg) > Pb (1.97 mg/kg) > Cd (1.00 mg/kg) in gills; Zn (133.69 mg/kg) > Cu (29.34 mg/kg) > Ni (4.15 mg/kg) >Pb (1.34 mg/kg) > Cd (0.47 mg/kg) in muscles and Zn (151.41 mg/kg) > Cu (126.46 mg/kg) > Cd (21.51 mg/kg) > Ni (7.55 mg/kg) >Pb (1.66 mg/kg) in hepatopancreas. However, in *P. sanguinolentus*, the heavy metal concentration was Cu (153.88 mg/kg) > Zn (128.61 mg/kg) > Ni (6.62 mg/kg) > Cd (1.54 mg/kg) > Pb (1.54 mg/kg) in gills; Zn (131.88 mg/kg) > Cu (28.93 mg/kg) > Ni (6.13 mg/kg) >Pb (1.93 mg/kg) > Cd (0.77 mg/kg) in muscles and Zn (128.61 mg/kg)> Cu (104.17 mg/kg) > Cd (25.21 mg/kg) > Ni (4.71 mg/kg) >Pb (1.91 mg/kg) in hepatopancreas. Cadmium (Cd) in hepatopancreas and Cu and Zn in all organs of both species were found to be greater than the maximum allowable concentration specified by food safety regulations (FAO 1983 and WHO, 1989). Abundance of heavy metal concentrations in the waters was Ni>Zn>Pb>Cu>Cd while, abundance of heavy metal concentrations in the sediment was in the sequence of Zn>Cu>Ni>Pb>Cd. However, in order to keep heavy metal accumulation within control in the future, proper monitoring should be undertaken.

Keywords: Heavy Metal, Crabs, Water and Sediment Contamination

Paper ID 16387

On carbon and nitrogen ratio in shrimp aquaculture systems

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The ratio of carbon to nitrogen (C/N ratio) has been used to assess the status of soil organic matter and the usefulness of livestock manures and other organic matter sources as soil amendments and fertilizers in traditional agriculture for many decades. The C/N ratio is also an indicator of pond bottom soil fertility and organic fertilizer quality in aquaculture. The C/N ratio has provided a basis for improving development of Bioflocs in aquaculture systems. Marine shrimp, *Litopeneaus vannamei* has been the candidate species in the present study used to understand the importance of carbon and nitrogen ratio in aquaculture systems. The water quality parameters *viz,* temperature, pH, alkalinity, salinity, DO, BOD, TSS, TDS, NH_3, $N0_2$, $N0_3$, $P0_4$ and SiO_3 were found to vary from 27-34°C, 6.5-8.5, 20-115 ppm, 0-35 ppt, 4.00-10.83 mg/l, 0.51-15.22 mg/l, 0.006-0.21 g/l, 0.15-67.04 g/l, 0.13-60.01 µg.at/l, 0.08-80.09 µg.at/l, 0.07-77.15 µg.at/1, 0.81-20.14 µg.at/l and 0.94-245.23 µg.at/l respectively. Organic carbon recorded between 0.458 and 1.265%, optimum available nitrogen was found to be 1.75 mg/100g; available phosphorus fluctuated between 0.31 and 2.15 mg/100g while, C/N ratio was in the range from 3.015 to 9.154 during the study period. The water quality parameters results indicated quite rich in nutrient level in shrimp ponds whereas, organic carbon showed higher values throughout the study period in all the ponds that impacted on water quality and influenced the C/N ratio and biomass of ponds. Maintenance of water and soil quality has a great potential for enhancing production in culture system.

Keywords: Shrimp Farming, C/N Ratio, *Litopeneaus vannamei*

Paper ID 16397

Geospatial database for shrimp farm in coastal watershed of Thiruvallur district

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Brackishwater shrimp farming has developed rapidly and now it plays a vital role in feeding the rising global demand for protein food. The dynamic nature of the coastal system presents many challenges to the officials for managing aquaculture in a sustainable manner. Hence this study was undertaken with an aim to map the spatial distribution of shrimp farms and develop a geospatial database for farmers benefit in the coastal watershed of Thiruvallur district. Landsat 8 and sentinel 2 satellite image was used for shrimp farm demarcation. Shrimp farm survey number was collected from CAA and mapped along with cadastral map in ArcGIS 10.4. Shrimp farms were further verified using onsite verification. Socio economic survey has been conducted using a structured questionnaire, and detailed information has been collected from the shrimp farmers and was inputted in individual farm attributes. Surface and subsurface water quality data has been collected from September 2019 - Jan 2021 and seasonal water quality has been integrated into the geodatabase. Using this database shrimp farm information can be analysed and managed for querying, decision making and resource management. This digital information will also be handy for the policymakers for licensing the farm, monitoring growth and to enforce environmental guidelines.

Keywords: Coastal Watershed, Geospatial Database, Landsat, Sentinel-2, Shrimp Farming

Paper ID 16405

Ethological approach in aquatic toxicological studies

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Toxicology research has advanced far beyond relying on mortality metrics to include sophisticated behavioral preparations that can assess the effects of sublethal toxicant exposure. Advances in undersea exploration, in situ monitoring of fish populations, and the development of cutting-edge technology bring new insights into fish behavior and strategy, which have long been overlooked and neglected. Ethology is concerned with the ability to adjust social behavior expression in response to prior experiences and social settings. The use of ethological tools for measuring the harmful consequences of environmental contaminants is gaining popularity. Methods for recording data in an ethological experimental setting, such as ad-libitum sampling (unusual, infrequent events are simply recorded in a field notebook), serial recording (recording all kinds of behaviors in the order during a given period), time-based sampling (obtaining a snapshot of behavior after a regularly spaced interval) are available. An organism's behavior is the response to its interaction with the surroundings. In aquatic toxicity, fish ethological investigations are quick, sensitive, and effective. Alterations in certain fish behavior such as opercular movement and avoidance reflexes are particularly sensitive markers of sublethal exposure to numerous aquatic contaminants. Other experiments including predator avoidance, feeding behavior, learning, social interactions, and diversity of locomotor activities have shown promise, but their sensitivity and efficiency have yet to be determined. Wastewater-exposed test fish displayed abnormalities in behavioral responses such as hyperactivity, convulsion, somersaulting activity, eye and fin movement, and equilibrium status. In recent times the trends of ethological research are based on the neurotoxic and cytotoxic effects of pollutants on fish behavior. Ethological study can play a crucial role in aquatic pollution and toxicological studies. Fish being a major component of the aquatic ecosystem can be effectively used as a model for ethological studies.

Keywords: Ethology, Fish, Behavior, Toxicity

Paper ID 16414

Trophic state index of Mongra reservoir in Central India

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The climatic, morphometric, and hydro edaphic factors have the greatest impact on reservoir productivity. High nutrient loadings in the reservoir due to agricultural runoff and anthropogenic activities frequently provide optimal conditions for algal blooms, resulting in eutrophication. The present study was carried out to assess the trophic state index (TSI) of Mongra, one of the India's tropical small reservoir during March 2021 to February 2022. Nine sampling sites encompassing riverine, transitional, and lacustrine zones of the reservoir were monitored seasonally (pre-monsoon, monsoon, and post-monsoon) for 12 water quality indicators. The TSI (total phosphate) and TSI (Secchi disc depth) were at their maximum levels during the monsoon season, although TSI (Chlorophyll-a) was relatively higher in the pre-monsoon season. TSI (Secchi disc depth) revealed significant variance ($P<0.05$) among the zones. The transitional and lacustrine zones exhibited a significant difference ($P<0.05$) in the total trophic status index (TSI). The total TSI had a high value in all the zones throughout the monsoon season. The Mongra reservoir has a trophic status that ranges from mildly eutrophic to eutrophic. However, with precaution, this aquatic body seems to be suitable for aquatic life and fish growth.

Keywords: Mongra Reservoir, TSI, Water Quality

Paper ID 16418

Spatio-temporal fluctuation in the concentration of microplastic distribution in the marine ecosystem off Kochi, Southeastern Arabian Sea, India, during the years 2019 and 2021

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The marine ecosystem and its biota are challenged by microplastic pollution worldwide. The present study was conducted to evaluate the variation in the spatio-temporal distribution of microplastics in the surface waters and sediments, off Kochi, southeastern Arabian sea, India. The sampling was conducted at the S1 station (5 m depth - 9° 58′ 15.937″ N -76° 14′ 49.685″ E), S2 station (10 m depth - 9° 58′ 6.521″ N-76° 9′ 46.879″ E), and S3 station (20 m depth - 9° 58′ 18.140″ N-76° 6′ 37.016″ E) during the pre-monsoon, monsoon, and post-monsoon seasons of the years 2019 and 2021. For estimating microplastics, a Working Party Net (WPN) of 200 µm mesh was hauled in surface water and Van Veen grab (0.0756 m^2) was used for sediment sampling. The study revealed a notable increase in the spatio-temporal distribution of microplastics in the year 2021 compared to 2019. In the year 2021, spatial variation was maximum at nearshore (S1 station) in both surface water (0.30 ± 0.22 particles m^{-3}) and sediment (203.0 ± 108.0 particles m^{-2}) with a significant variation in distribution ($p < 0.05$). While the temporal variation was maximum during the monsoon season in both surface water (0.40 ± 0.18 particles m^{-3}) and sediment (160 ± 132.0 particles m^{-2}). The distribution of microplastics in surface waters showed a significant positive correlation ($p < 0.05$) with the rainfall. The major microplastics were polyethylene fragments of size between 1-5 mm of blue colour and white colour during the years 2019 and 2021 respectively. Furthermore, the SEM-EDS analysis revealed the fragmentation and the incidence of potentially toxic elements in microplastics that can cause harm to marine biota. Thus, the study reveals that microplastic pollution poses a major threat to the sustainability of one of the important fishing grounds off Kochi.

Keywords: Microplastic, Concentration, Off Kochi

Paper ID 16419

Ecophysiology and heavy metal pollution status of invasive and native gastropods found in the lower Ganga

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Two species of freshwater molluscs, *Filopaludina bengalensis* and *Tarebia granifera* are dominantly distributed in the River Ganga. The current study validates the impact of diverse physicochemical parameters among the species and focuses on heavy metal accumulation among different sampling sites of the lower stretch of River Ganga. The maximum abundance of *T. granifera* was observed at Berhampur, Balagarh, and, Tribeni which is inversely proportional to the availability of *F. bengalensis*. The correlation between the species with ecological parameters showed that water temperature and available phosphate (P_2O_5) from different sources inversely affect the abundance of *F. bengalensis*, while *T. granifera* is found to be more tolerant to the variations in water temperature and P_2O_5 content of riverine water and soil from Buxar to Fraserganj. The higher range of total N_2 and soil organic carbon led to a decrease in the number of *T. granifera,* but the number rose in the case of *F. bengalensis*. The concentration of heavy metals from the molluscan samples collected from Buxar, Patna, Bhagalpur, Farakka and Balagarh are: Cd (3.466 ± 1.403 µg/g), Cr (4.77 ± 4.79 µg/g), Fe (3471.715 ± 516.95 µg/g), Pb (5.115 ± 2.135 µg/g) and Zn (226.20 ± 40.25 µg/g) as detected in *F. bengalensis*, and Cd (0.984 ± 0.239 µg/g), Cr (3.464 ± 4.543 µg/g), Fe (1876.15 ± 236.10 µg/g), Pb (1.047 ± 1.4 µg/g) and Zn (90.05 ± 13.45 µg/g) recorded from *T. granifera*. The trend of metal concentration showed a gradient like Fe >Zn >Pb >Cr >Cd. Therefore, from the present study, we conclude that the invasive species, *T. granifera*, is far more adaptive and tolerant than *F. bengalensis* when exposed to extreme riverine conditions.

Keywords: Ganga, Heavy Metal, Eco-physiological Parameters, *Tarebia granifera, Filopaludina bengalensis*

Paper ID 16420

Sensitive method for the detection of Triclosan using reversed-phase high performance liquid chromatography in environmental samples

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Triclosan (TCS) [5-chloro-2-(2, 4-dichloro phenoxy) phenol] is a broad-spectrum antibacterial biocide used widely in pharmaceutical and personal care products and regarded as an emerging pollutant. Presence of this compound in nanogram to microgram levels at different sediment-water matrices have a severe impact on almost all aquatic organisms. Therefore, it is important to develop a sensitive and specific detection method for quantification and continuous monitoring of TCS in the natural system which facilitates for development of management strategies. The present study describes the development of simple rapid, sensitive, selective and reproducible method of using the RP-HPLC for the estimation of Triclosan in natural samples including sediment, water and living tissues. In present work a simple, sensitive and specific method has been developed by using an oyster BDS premium C18 column having 5 µm particle size and 200 mm x 4.6 mm in length and gradient mode, with a mobile phase containing acetonitrile and HPLC grade water in the ratio of 80:20 (pH 2.5, adjusted with orthophosphoric acid). The flow rate was 1.5mL/min with injection volume of 20µL and eluate were monitored by a UV-VIS detector at 280 nm. The method is linear (0.1-16 ppm) and the regression equation obtained was y = 12.176x+0.6497 (R^2 =0.9994). Estimation of triclosan was done in 4 different samples (water, sediment, algal cells and living tissue) and the method was validated for linearity, precision, accuracy, ruggedness and the recoveries from samples were between 98% and 101%. The limit of detection and limit of quantification was 0.013644 and 0.041344ppm respectively. The present method for the detection of triclosan is confirmative with earlier developed sensitive and specific methods.

Keywords: Triclosan, C18 Column, Method Validation, RP-HPLC

Paper ID 16426

Inter annual variability in the phytoplankton abundance and community structure of Chettuva, a temporarily closed estuary, South-west coast of India

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The present study assess the inter annual and seasonal variability in the phytoplankton abundance and community structure corresponding to environmental drivers during monsoon and post monsoon season of the year 2019 and 2021 in Chettuva estuary. A total of 88 species belonging to four classes, Bacillariophyceae (52), Dinophyceae (20), Cyanophyceae (3), Chlorophyceae (13) were recorded. Bacillariophyceae (72-76%) dominated the total phytoplankton population followed by Dinophyceae (7-15%), Cyanophyceae (0-0.8%) and Chlorophyceae (5-11%) during monsoon of both years. For shannon diversity and evenness, seasonal variability was observed and highest values were attained in monsoon 2021 followed by post monsoon 2021. Analyses of similarity percentage showed overall average dissimilarity 83.19% during post monsoon season of both the years and the dissimilarity contributed species are *Nitzschia longisima, Pleurosigma elongatum, Nitschia seriata, Melosira sulcata, Skeletonema costaum, Biddulphia sinensis, Ceratium furca, Biddulphia mobilensisare*. The present study assess the inter annual and seasonal variability in the phytoplankton abundance and community structure corresponding to environmental drivers during monsoon and post monsoon season of the year 2019 and 2021 in Chettuva estuary. A total of 88 species belonging to four classes, Bacillariophyceae (52), Dinophyceae (20), Cyanophyceae (3), Chlorophyceae (13) were recorded. Bacillariophyceae (72-76%) dominated the total phytoplankton population followed by Dinophyceae (7-15%), Cyanophyceae (0-0.8%) and Chlorophyceae (5-11%) during monsoon of both years. For shannon diversity and evenness, seasonal variability was observed and highest values were attained in monsoon 2021 followed by post monsoon 2021. Analyses of similarity percentage showed overall average dissimilarity 83.19% during post monsoon season of both the years and the dissimilarity contributed species are *Nitzschia longisima, Pleurosigma elongatum, Nitschia seriata, Melosira sulcata, Skeletonema costaum, Biddulphia sinensis, Ceratium furca, Biddulphia mobilensisare*.

Keywords: Abundance, Environmental Parameters, Estuary, Phytoplankton, Season

Paper ID 16436

Bioconversion of toxic arsenic into less toxic arsenic using microalgae biofilm grown on agri-wastes

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Arsenic is a class I carcinogen present in groundwater affecting the health of millions of people worldwide. The toxicity of arsenic mainly depends on its speciation and the inorganic forms of arsenic viz., arsenite (As (III)) and arsenate (As (V)) are more toxic when compared to organic forms of arsenic (dimethylarsinic acid (DMA), monomethylarsonic acid and arsenobetaine). Globally, groundwater used for drinking purposes contains more amount of inorganic arsenic (i.e. 5000 ppb) which is far higher than the WHO limit for arsenic in drinking water (<10 ppb). In addition, around 80 million tonnes of banana pseudostem wastes have been generated every year which remains unutilized. Banana pseudostem was found as a good adsorbent for heavy metals, but for arsenic there requires biotransformation of arsenic species. Microalgae biofilm was found effective for biotransforming toxic arsenic into less toxic forms. Hence the present study utilized banana pseudostem waste as a substrate for growing microalgae biofilm and the same was exposed to 5ppm As (III) for 5 days. Arsenic speciation in microalgae biofilm, banana pseudostem, and water was analyzed after As (III) exposure using LC-ICP-MS. The result revealed that 9% of added As (III) remains in water in the form of As(V) (94.8%) and DMA (5.2%). Banana stem accumulated 70% of added As (III) and the microalgae biofilm grown in them converted the toxic As (III) into less toxic As (V) and DMA, released back into the water. The present study could pave way for the effective utilization of agri-wastes for treating arsenic-contaminated water in a more sustainable way.

Keywords: Banana Pseudostem, Microalgae Biofilm, Arsenite, Arsenate, Arsenic, Wastes

Paper ID 16461

Sub-lethal effect of Malathion (ec 50%) induced impairments in the gill, liver and kidney of Mozambique tilapia, *Oreochromis mossambicus* (Peters, 1852)

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The present study was carried out to find out the histopathological alterations in gill, liver and kidney of freshwater fish, *Oreochromis mossambicus* under sub-lethal concentrations of Malathion. Fishes were exposed to sub-lethal concentrations of 0.0148, 0.0295, 0.059, 0.118 and 0.236 ppb for 28 days which are 1/10th of their 96 h LC_{50} (0.5925±0.0625 ppb). At the end of the experiment (14th and 28th day), live fish samples were collected from the middle (0.059 ppb) and last (0.236 ppb) concentrations, sacrificed and their gill, liver and kidney were excised out and fixed in Bouins fixative for 24 h and stained by haematoxylin and eosin, observed under trinocular microscope. Excessive mucus secretion, blood congestion, collapsed secondary lamellae, fusion of secondary lamellae, lamellar aneurysm, hemorrhage at primary lamellae, shortening of the secondary lamellae, detachment of the secondary lamellae, disorganization of the secondary lamellae, oedema, swelling of the secondary lamellae, curling of secondary lamellae, deformation of the cartilage core, hyperamia, hypertrophy of epithelial cell, epithelial lining in the tips, erosion of secondary lamellae and hyperplasia were observed in gill. Anomalies like degeneration of hepatocytes, cellular hypertrophy, fat deposition, blood sinusoids, blood congestion, nuclear degeneration, rupture of nucleus, cellular necrosis, hyperplasia, hypertrophied hepatocytes, hemosiderosis and melanomacrophage aggregation were observed in liver of Malathion treated fish. Further, histological changes like appearance of melanomacrophage aggregation, degenerated glomerulus, increased periglomerular space, dilated lumen, increased peritubular space, severe hemorrhage, hypertrophied epithelial cells, shrunken glomerulus, degenerated tubule, distended tubular and blood sinusoids were seen in the kidney. Thus the present investigation has proved that Malathion is a potential organophosphate pesticide toxicant affecting the fishes at tissue level even at low concentrations, which might in turn affect the physiological processes in the long run.

Keywords: *Oreochromis mossambicus*, Malathion, Sub-lethal, Histology, Gill, Liver, Kidney

Paper ID 16507

Validation and inter-sensor comparison of satellite-derived environmental variables using in-situ data

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The quality assessment of three satellite-derived parameters i.e. Chlorophyll-a, Sea surface temperature and Salinity with the *in-situ* observations (n=190) was statistically evaluated by applying strict match-up in view of complexity and variability of coastal water. The r^2 values observed for the three chlorophyll-a regression equations were not so strong, but showed a significant relationship for MODIS ($r^2 = 0.36$; $p<0.001$), OCM2 ($r^2 = 0.32$; $p<0.001$) and VIIRS ($r^2 = 0.19$; $p<0.001$) with evident overestimation (MODIS and VIIRS) and in tune (OCM2) with the satellite-derived datasets. Comparison of retrieved chlorophyll-a with *in-situ* products showed lowest root-mean-square error (RMSE) of 0.32 for OCM2. In case of Sea surface temperature, r^2 values for both the regression equations in comparison with *in-situ* observation showed strong association and significant variability (0.75 for MODIS and 0.76 for SNPP VIIRS at $p<0.001$). The significant RMSE observed for the MODIS (1.05) and SNPP-VIIRS (1.0) showed that satellite-derived SST agreed well with *in- situ* observations. Comparison of SMAP satellite-retrieved salinity products with in-situ data showed r^2 value of 0.4; $p<0.001$ and a root-mean-square error (RMSE) of 2.04. The comparative study highlighted the need for further development of algorithm for Chlorophyll-*a* and Salinity measurement from satellite observations.

Keywords: Chlorophyll-a, Sea Surface Temperature,

6. AQUATIC BIODIVERISTY, STOCK ASSESSMENT AND CONSERVATION

Paper ID 15472

Taxonomic Description, DNA Barcoding and Habitat Mapping of *Naziritor chelynoides* (McClelland, 1839) from Uttarakhand, India

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Naziritor chelynoides (McClelland, 1839) is distinguished from all other mahseer by its mouth pattern and unique body characteristics. Mouth is arched, inferior, and upper jaw is overhanging lower jaw. Fine black dots on scale are present throughout the body, including head, but concentrated more along the lateral line, giving the appearance of dark band. Lower lip is without fleshy median lobe, and continuous at the angle of mouth. There is a conspicuous black blotch on caudal fin base, and the end of operculum in smaller specimens (weight ≤ 5.8 g). Uncorrected pair-wise COIX genetic distance between *N. chelynoides* and other *Tor spp*. and *Puntius spp*. ranged in between 8.6 to 10.5%. *N. chelynoides* is a distinct mahseer species, found in shallow, fast flowing, oxygen rich, gravel bed streams of central Himalayan region of Uttarakhand, India.

Keywords : *Naziritor*, Dark Mahseer, Central Himalaya, India, DNA Barcoding

Paper ID 15528

Estimation of Maximum Sustainable Yield using Production Modelling: a stock appraisal of Giant Catfish *Netuma thalassina* (rüppell, 1837) fishery from Tamil Nadu, India Waters.

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Due to the dramatic rise in marine fish production in Tamil Nadu, it is critical to assess the fishery status of major commercially important fish species in order to determine their long-term viability. This study aims to analyse the maximum sustainable yield of the giant catfish *Netuma thalassina* (Rüppell, 1837) fishery and estimate its current status in Tamil Nadu marine waters when data is limited. Time series data of catch and effort of the giant catfish in marine water of Tamil Nadu for the last two decades from 2001 to 2020 were reconstructed and used to fit surplus production models. The analysis was carried out using the stock assessment tools Catch and Effort Data Analysis (CEDA), Catch-Maximum Sustainable Yield (C-MSY) and the Bayesian state-space implementation of the Schaefer surplus production model (BSM). Observed biological reference points of MSY, B/B_{MSY} and F/F_{MSY} from the best fitted Schaefer -Normal model using CEDA model was 1,890 tonnes (R^2=0.27), 1.38 and 0.47 respectively. The C-MSY and BSM model results of the MSY, B/B_{MSY} and F/F_{MSY} were 1320-1350 tonnes, 0.735 and 1.23 respectively. By comparing computed MSY values to catch data in both cases and taking B/B_{MSY} and F/F_{MSY} into an account, it is clear that this fishery resource of giant catfish has reached the stage of overexploitation in Tamil Nadu waters during recent decade and hence more conservative methodologies need to be considered essential for better management and sustainable exploitation in future. Effect of changes in total allowable catch (TAC) and different levels of effort on stock biomass was projected by CEDA and found that TAC of 765 tonnes and effort of 621.25 million horse power days will lead stock biomass to a level that exceed total biomass during next decade.

Keywords : Tamil Nadu Fisheries, Sustainable Fishery, Fish Stock Assessment, Catfish Fishery, Surplus Production Models, Fisheries Management.

Paper ID 15529

The Cranial Osteology of *Daysciaena albida*, a monotypic Sciaenid species.

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The present study provides first line information on osteology of neurocranium, jaw bones of *Daysciaena albida*, found in esturaine waters of India. In the cranial osteology, details on different bones were discussed and provided with its importance to taxonomy of this monotypic sciaenid species. While studying jaw bones details on infraorbital bones, gill and hyoid arches were also discussed in detail. With this study we acknowledge a knowledge gap in morphological studies using osteology among the scienid fishes. Right identification of a species and its characters can make way to right conservation measures.

Keywords : Osteology, Neurocranium, Jaw bones, Hyoid bones, Otolith

Paper ID 15551

National Repository of Fish Cell Lines (NRFC): Facilitating access of Authenticated Cell Line Resources for R&D

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The Use of fish cell lines have been increased numerously in several biological Research & Development (R&D) areas, like cytotoxicity, chromosome studies, disease diagnosis, gene expression, immunology, virus isolation etc. India has also witnessed considerable growth in fish cell lines research and applications in the last two decades. There is similar global trend as reflected by the increased interest in the development of fish cell lines, wherein over 800 fish cell lines have been reported worldwide; but only a fraction of them are available and accessible for R&D. Access of these cell lines will help not only to accelerate research in aquaculture, environmental research, fish health etc., but also will prevent work duplication. Additionally, a researcher need not to exercise and invest time and money in developing new cell lines and can immediately work on the application part, thereby saving both time and resources. This is what a cell line repository could play an important role in the public good by supporting R&D, particularly in fisheries sector. Same time, only a few fish cell lines are available in major repositories of the world and their access is not economical. The collections are varied with 26 freshwater species (like *Catla catla, Clarias magur, Danio rerio*, *Cyprinus carpio*, *Orochromis niloticus* etc.), 7 marine species (like *Amphiprion sebae*, *Dascyllus trimaculatus*, *Pomacentrus caeruleus* etc.) and 2 brackishwater species (*Lates calcarifer* and *Etroplus suratenssis*). Tissue wise collection includes fin tissues (25), gill tissues (10), heart (6), eye (6), spleen (5), caudal peduncle (4), kidney (4), muscle (4), brain (4), thymus (4), liver (2), testes (1), peritoneal (1), blood lymphocytes (1) and barbel (1). In the last five years, the repository has dispatched over 120 requests of authenticated, mycoplasma free, well-characterized fish cell lines and fulfilled the requirements of researchers along with technical support and hands on trainings so that more and more researchers can use fish cell line resource effectively.

Keywords : Biological resource, Cell line, Fish, NRFC, Repository

Paper ID 15599

Population Dynamics and Stock Assessment of Shark Ray, *Rhina ancylostoma* (Elasmobranchii: Rhinidae) in the Northern Indian Ocean.

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Growth and mortality of the shark ray, *Rhina ancylostoma* in Karnataka waters were assessed from data of 450 specimens sampled from trawlnets, gillnets and artisanal gears during 2016-2020. The length-weight relationship indicated that *R. ancylostoma* exhibited negative allometric growth. The von Bertalanffy growth parameters derived were TL_∞= 305 cm TL, K = 0.15 year^{-1}, and t_0 = -1. 06 year with growth performance index of ϕ' = 4.14. The species was found to be a continuous breeder and showed a first peak in recruitment in March and a second peak in July. The total mortality rate, Z was estimated as 0.52 year^{-1}, with fishing mortality, F being 0.28 year^{-1}. The current exploitation ratio (E_{cur}) was 0.54, which was lower than E_{max} (0.61) estimated for the species using Beverton and Holt yield per recruit analysis. For a large elasmobranch like *R. ancylostoma* that has very low litter size of 2-6 pups and a prolonged gestation period of about 1.06 years, the spawning stock biomass (SSB_0) must be maintained at 50% or higher as the critically minimum threshold to ensure sustainable rebuilding of stock. Thompson and Bell prediction model showed that current exploitation gives an equilibrium yield of 23.3 t while reducing the virgin stock biomass (B_0) and SSB_0 to 59.4% and 55.1%, respectively. The shark ray does not support a targeted fishery and is usually an incidental catch or bycatch in gears operated for other fishery resources. Even so, the results of the present study indicate that even without targeted fishing the shark ray is exploited considerably in the region. This fish has been listed as "Critically Endangered" in the IUCN Red List of Threatened Species with a decreasing population trend globally. Hence, concerted efforts are needed for evolving management plans to sustain the population of the shark ray in Indian waters.

Keywords : Elasmobranchs, Exploitation, Growth Parameters, Length-weight Relationship, Spawning Stock Biomass

Paper ID 15633

Diversity and Distribution of Jellyfishes along Palk Bay coast

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A routine survey for assessing the diversity and distribution of Jellyfishes along the Palk Bay coast was carried out during 2017-2020 at two Sampling stations viz., Dhanushkodi (Lat 9°12'10.9"N, Long 79°23'45.5"E) and Ariyaman (Lat 9°18'05.5"N, Long 79°03'43.2"E) in Ramanathapuram district of Tamil Nadu, Southeast coast of India. Shore seine landings were monitored at these two stations for three years and the occurrence of jellyfish in different seasons were recorded. There were nearly eight different species of scyphozoan and one species of Cubozoan were recorded during this period namely; *Rhopilema hispidum*, *Cyanea cf. nozakii*, *Cyanea lamarckii*, *Crambionella annandeli*, *Lobonemoides robustus*, *Chrysaora sp*. (three colour morph), Cassiopea *sp*., *Mastigias papua* and *Chiropsoides sp*. Among the four prevailing seasons along the Palk Bay; Post monsoon (Jan-Mar), Summer (Apr-June), Pre-monsoon (July-September) and Monsoon (October-December), Jellyfish abundance in shore seine was recorded during the post monsoon and summer seasons only. It was observed that only five scyphozoan species have the tendency to form bloom in Palk Bay waters (*Rhopilema hispidum*, *Cyanea cf. nozakii*, *Cyanea lamarckii*, Lobonemoides *robustus*, *Chrysaora sp.)*. At Ariyaman sampling site the SST range was recorded during jellyfish abundance during summer was 32 to 33.5^{o}C, where as the salinity regime was 33-35 ppt. In Dhanushkodi waters the SST range was recorded during jellyfish abundance during summer was 32 to 33^{o}C, where as the salinity regime was 33-35 ppt. These results clearly revealed that the increase in salinity and sea surface temperature (SST) play a pivotal role in the bloom formation of jellyfish in the Palk Bay. Among the eight scyphozoan species occurring in Palk Bay *Cyanea sp*, *Lobonemoides robustus*, and *Rhopilema hispidum* were recorded to grow in the weight range of 4-10 kg per individual.

Keywords : Jellyfish, Scyphozoan, Bloom, Cubozoan, Palk Bay

Paper ID 15634

Occurrence of Immortal Jellyfish *Turritopsis cf. dohrnii* from The Gulf of Mannar

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Jelly plankton survey along the Mandapam coastal waters in Gulf of Mannar, during February 2022, a swarm of hydrozoans was collected and were identified as immortal jellyfish species called *Turritopsis cf. dohrnii* belongs to class Hydrozoa under the phylum Cnidaria. The term aging refers to "a persistent decline in the age-specific fitness components of an organism due to internal physiological deterioration" and *T. dohrnii* is successful in reversing that process. When *T. dohrnii* is physically damaged or weak, it shrinks its body and settles on the bottom and further develop into a new polyp. This life cycle reversal can be repeated many times. This is the classic example of reversing the ageing process. This kind of transformation is called trans differentiation and a very rare occurrence in animals. Trans differentiation is the dedifferentiation of a differentiated cell into some sort of stem cell, and then differentiation of that into another cell type. In simple terms, when the medusa of the immortal jellyfish (*Turritopsis dohrnii*) dies, it sinks to the ocean floor and begins to decay. However, its cells then reaggregate into polyps, and from these polyps emerge new jellyfish. Though *T. dohrnii* was described in 1883, their immorality was discovered only in 1980s. The immortal jellyfish is known to have originated from Caribbean and Mediterranean but now have spread world over possibly through ship's ballast water discharge. In jellyfish's sexes are separate; in sexual reproduction, eggs and sperms are released and fertilised, the free-swimming larva settle at the bottom on suitable substratum. The hydrozoans *T. dohrnii* collected in the present study were in the size range of 2-3mm.

Keywords : Gulf of Mannar, Turritopsis, Immortal Jellyfish

Paper ID 15642

Observations on a Record-sized Endangered Ornate Eagle Ray *Aetomylaeus vespertilio* (bleeker, 1852) caught in the Gulf of Mannar, India

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A single record-sized specimen of the ornate eagle ray Aetomylaeus vespertilio (Bleeker, 1852) was caught by single-day fish trawler off Pamban Island in the Gulf of Mannar, Tamil Nadu, India on 19th July 2021. The ray measured 384 cm in disc width (DW), the largest size ever reported for the species globally, and weighed 530 kg. The maximum size of the species reported previously was 240 cm DW globally and from India it was190 cm DW. The morphometrics, stomach contents and reproductive state were studied. The specimen was a pregnant female with 3 full-term pups in the uterus. The major food item found in the stomach was the big-eye scad, *Selar crumenophthalmus*. The fish was sold for Rs. 60/kg and the net price was Rs. 25,200/- as its head which weighed nearly 21% of the total weight, did not have any market demand and was hence discarded. The remaining body was cut it into pieces, brined at a local elasmobranch processing unit in Rameswaram and transported to Kerala. The ornate eagle ray is listed as "Endangered" in the IUCN Red List of Threatened Species and its population trend has been assessed as decreasing, globally. *A. vespertilio* is the largest and most rare species among eagle rays (family Myliobatidae) with a patchy known range from the Indo-West Pacific including Mozambique, the Red Sea, India, the Maldives, Indonesia, Philippines, China, Malaysia, Taiwan, and northern Australia. It is highly susceptible to demersal fishing gears operated in inshore areas, including trawls and bottom-set gill nets. Except few reports from the south-west coast, especially from Kochi, the catch of this species by traditional and commercial gears operating in Indian waters has been seldom reported.

Keywords : Disc width, Pamban island, Morphometrics, Pregnant female, Stomach content and pups

Paper ID 15645

DNA Barcoading of fish species belonging to family Balistidae prevalent along the coastal waters of Karnataka

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DNA barcoding is a method with promising fast and accurate identification of animal species based on the sequencing of the 16S rRNA and mitochondrial c oxidase subunit (COI) gene.Fish belonging to this family are commonly referred as "Triggerfish". The Balistidae family comprises of 42 species and 12 genera spread throughout the world. In this study, we explored the prospects for DNA barcoding in fish belonging to the Balistidae family, prevalent along the coast of Karnataka. Morphometric and meristic analysis of 270 individual fish in this study revealed the fishes to be grouped as *Abalistes stellaris, Sufflamen fraentum,* and *Odonus niger* species. However, a Principal Component Analysis performed on statistically normalized morphometrics data showed inter and intra-morphological variations within the species. For molecular identification using DNA barcoding, we sequenced the 16S rRNA as well as the mitochondrial COI gene from the 3 currently recognized balistidae fish species, and combined these data with a further sequence from available sequences in NCBI database. The species were readily distinguishable by COI barcodes as *Abalistes stellaris, Sufflamen fraentum,* and *Odonus niger.* We discuss the taxonomic status of these species groups in light of molecular and morphological data.

Keywords : Balistidae, COI Barcodes, DNA Barcoding, Karnataka, Principal component analysis

Paper ID 15647

Studies on Batoids Diversity off Rameswaram Island, Tamil Nadu

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Gulf of Mannar (GoM) and Palk Bay (PB) are two biodiversity rich ecosystems in the east coast of India as it occupies vast coral reefs, seagrass meadows, sandy and muddy bottoms. Rameswaram Island covers both GoM and PB in its south and north vicinities respectively. Month and season wise species diversity of batoids off the Rameswaram Island analysed. Based on the cyclic phenomena of meteorological events, three seasons are broadly indicated as month wise and they are (1) Pre –Monsoon (PRM) (June to September) (2) Monsoon (M) (October to January) (3) Post-Monsoon (POM) (February-May). The diversity indices calculated using the PRIMER package. In the Rameswaram Island waters, the number of batoid species recorded in various seasons was in the range of 11–40. While the maximum number of species was found in PRM (35), the minimum was found in POM (11). Totally, 40 species of batoids were recorded in the area. These included 21 species belonging to family Dasyatidae, 5 to family Rhinobatidae, 6 to family Mobulidae, 2 each to Rhinopteridae, and Aetobatidae 1 species to families Glaucostegidae, Rhinidae, Gymnuridae and Myliobatidae. *Neotrygon indica*, was the most dominant species followed by *Aetobatus ocellatus*., *R. javanica, Gymnura poecilura, Brevitrygon imbricata, Himantura uarnak, H. tutul, H. leopard, Maculabatis gerrardi, Taeniurops meyeni, Pateobatis bleekeri* and *Pastinachus ater* were observed in all seasons. The Shannon diversity was more in July (4.60) followed by August (4.45) and June (4.40). The Margalef species richness showed remarkable differences between July (6.12) and April (1.11). The evenness was comparatively more in February (0.97) than July (0.95). Highest Shannon diversity (4.75) and species richness (6.82) was observed in PRM. Species evenness was more in POM (0.94) and least during PRM (0.92). The variation in taxonomic distinctness index was more between PRM and POM (0.962 - 0.912). All three diversity indices in M were intermediate between PRM and POM. PRM and M formed a group with highest similarity percentage of 64.31 to which POM got linked at 32.86.

Keywords : Dasyatidae, Evenness, Margalef Species Richness, Season, Neotrygon Indica And Shannon Diversity

Paper ID 15657

Assessment of Riverine Ecosystems and Mapping of Potential Zones for Brackishwater Aquaculture in Kannur District, Kerala, India

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Aquaculture has emerged as one of the fastest growing food producing industries in developing countries for both domestic and export consumption. Especially, brackishwater aquaculture not only generates revenue but also provides employment opportunities to the skilled and unskilled rural population. In India, there are huge unassessed potential areas in the estuaries / rivers for brackishwater aquaculture. The present study was carried out for the identification of the potential areas in major riverine ecosystems of Kannur District, Kerala for their suitability to brackishwater aquaculture. The water and soil samples were collected at different points from the bar mouth to upper stretch of the river (till 0 ppt salinity) every month from five major rivers viz., Perumba, Kuppam, Valapattanam, Anjrakandy and Kuyyali for a period of one year. The samples were analyzed for Physio - chemical parameters, phytoplankton, zooplankton and benthos. All the parameters were mapped in ArcGIS, results were generated using Analytic Hierarchy Process (AHP) and Multiple-Criteria Decision-Making (MCDM) methods. The river systems of Kannur were fresh (0 ppt) to saline water (31 ppt) due to South West monsoon and various ecological factors. The estuarine river systems were classified into highly potential, potential, marginally potential and non-potential zones. A total of 4700 ha of brackishwater area is available in the major riverine ecosystems of Kannur District, out of which 75% is either highly potential or potential to carryout various brackishwater aquaculture activities. Based on the parameters analysed the identified areas can be used for cage and pen culture of shrimp, crab and finfishes to enhance the aquaculture production in the district.

Keywords : Brackishwater Resource Mapping, Potential Zone, Remote Sensing and GIS

Paper ID 15663

Ichthyofaunal Diversity and Habitat Ecology of Tel River, a Tributary of Mahanadi, India

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Ichthyofaunal survey was conducted in Tel River, an important tributary of Mahanadi, to evaluate the diversity and distribution of freshwater fishes along with documentation of the habitat characteristics along the river during July, 2016 to September, 2018. A total of 71 species belonging to 48 genera, 22 families and 8 orders were recorded from the study area. Cypriniformes was found to be the most dominant order (53.5%), followed by, Siluriformes (19.7%) and Perciformes (14.1%). Maximum value of species richness and diversity was observed at Belgaon and Kisinga, midstream sites. Shannon–Weiner diversity index ranged between 2.33 to 3.705 indicating well-being of the river. Habitat and water quality parameters were documented and correlation analysis between the parameters was carried out. Seasonal variations in the fish abundance and habitat features were also studied. Cyprinids, the most dominant and abundant group, was found to have a positive relationship with limnological characters wetted area and channel width. Baseline dataset on fish biodiversity has been generated in this study which can now be periodically monitored and form basis for future conservation plans. The study would also assist in formulating strategies for management of this riverine ecosystem and thus support the livelihood of communities.

Keywords : Biodiversity, Ecosystem, Habitat, Conservation

Paper ID 15673

Unravelling the Hidden Diversity of Congrid Eel, *Ariosoma* (Teleostei: Anguilliformes: Congridae) from Indian Waters

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Conger eels (Congridae Kaup, 1856) are known as small to large body animals, dwell throughout the temperate and tropical waters, particularly in sandy and muddy bottoms of the continental shelf or slope of the deep sea. Due to their diversity and abundance, it is believed that congrids play a significant role in ecological niche and documentation about the diversity of these resources for conservation and management purposes is needed. The taxonomy of the congrid fishes is complicated due to the presence of lacustrine populations, minute variations within the wide range of species and also differential growth patterns. Very few research is being carried out on the taxonomic investigation of the order Anguilliformes, especially, the family Congridae and resulted in documentation of 23 species from the Indian waters. In the present study, sampling was conducted along the major landing centers of Indian waters to attain the precise species diversity of the genus *Ariosoma*. In out-turn, six species including two new species and one new distributional record to the Indian water were documented, viz. *Ariosoma anago* (Temminck and Schlegel, 1846), *A. dolichopterum* Karmovskaya, 2015, *A. gnanadossi* Talwar & Mukherjee, 1977, *A. majus* (Asano, 1958), *A. maurostigma* Kodeeswaran et al., 2022 and *A. melanospilos* Kodeeswaran et al., 2021. To strengthen the classical taxonomy, phylogenetic analysis has been done and the results revealed that the Indian water species forms a well separate clade, which would descend from a common ancestor that originated in the Pacific Ocean and also promises the possibilities of presence of few more undescribed species. As these fishes do not possess much commercial importance, mostly landed as trawl bycatch, which conceals the true diversity of this group. Hence, more intensive sampling would reveal the factual diversity of these species and also would pave the way for building up the conservation strategies.

Keywords : Taxonomy, Diversity, New species, Ariosoma, Molecular Analysis

Paper ID 15705

Stock structure analysis of *Siganus canaliculatus* (park, 1797) along Indian coast using Truss Network Analysis

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Modern fisheries management is moving towards a precautionary approach to ensure sustainable utilization of marine resources. A fundamental requirement of this approach is to consider the full impact of management actions, including identifying the stock complexity of fish species. Determination of the population structure of exploited species is an essential component in the successful management of fisheries. In the present study, an attempt was made to investigate the stock structure of *Siganus canaliculatus* across four locations along the Indian coast using Truss analysis. The study was based on 13 landmarks and 28 truss distances covering the morphology of the entire fish. A few truss distances loaded heavily on PC1 alone explained more than 37% of the variance. PC 2 explained more than 14% of the total variation, with four distant variables loaded heavily into this component. PC 1 and PC 2 comprise the posterior abdomen and the caudal peduncle region of the fish, which were all found to be positive, thus signifying a positive correlation. The discriminant analysis showed 15 out of 28 variables to be effectively discriminating among the different populations. The predicted group membership showed 8.3% of the Visakhapatnam population mixing with Tamilnadu. About 1.7% of Karnataka**'s** population mixes with Tamilnadu and 0.7, 4.9, 3.3% of Kerala populations mix with Tamilnadu, Karnataka, and Kerala respectively. The results of scatter plot and cluster analysis confirm different stocks of *Siganus canaliculatus* found across the Indian coast. Further study on mitochondrial markers can confirm the genetic difference between these existing stocks.

Keywords : Exploitation, Landmarks, Morphology, Stock structure, Management, Truss net work

Paper ID 15714

Observations on the Fishery of Silverbellies along Tamil Nadu coast of India

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The fishery of silverbellies (Family: Leiognathidae) along south-east coast was studied for the period 2010-2019. The all-india landing of silverbellies increased from 73,817 tonnes (t) to 1.4 lakh tonnes while the landings in Tamil Nadu increased from 49,950 tonnes to 1.16 lakh tonnes during 2010 to 2019. Tamil Nadu accounts for more than 75% of the silverbellies landed along the Indian coast, followed by Kerala (8.14%) and Andhra Pradesh (6.23%). The average contribution of silverbellies to the total marine fish landing in Tamil Nadu during this decade was 10.87%. More than 98% of silverbellies in Tamil Nadu were caught by mechanised trawlers, out of which 81.63% was from single day trawlers. The catch per unit effort of mechanised multiday trawlers was 177.13 kg, single day trawlers was 194.74 kg and outboard trawlers was 1.87 kg. Based on oceanographic features and associated fishery, the maritime state of Tamil Nadu is broadly categorised into Gulf of Mannar (GoM), Palk Bay (PB) and Coromandel coast (CC). Mechanised multiday trawlers and gillnetters operating for 5-15 days at sea are more in the CC, while PB and GoM ecosystem are suited for operation of small, less powered single day trawlers. The species composition of silverbellies in GoM was predominantly *Karalla dussumieri* (43%), *K. daura* (8.3%), *Gazza minuta* (38.4%), *G. rhombea* (0.55%), *Equulites lineolatus* (2.3%), *E. leuciscus* (0.3%), *Deveximentum insidiator*/*D. indicium* (2.1%) and *D. ruconius* (3.35%). In PB the most dominant species was *Eubleekeria jonesi*, which contributed 58.34% followed by *Nuchequula gerreoides* (30.08%), *D. insidiator* (3.65%) and *D. ruconius* (4.51%). *The species composition in CC is different from other two ecosystems, where Eubleekeria splendens* (25.54%)*, Photopectoralis bindus* (21.97%) and *K. dussumieri* (21.66%) *dominate,* followed by *D. insidiator* (10.44%) and *G. minuta* (8.44%).

Keywords : Coromandel Coast, Gulf of Mannar, Leiognathidae, Multiday Trawls, Palk Bay, Single-day Trawls

Paper ID 15716

Status of Goatfish Fishery in Tamil Nadu-a Decadal Analysis

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Goatfishes (Family: Mullidae) form a chief demersal finfish resource along the south-east coast of India. Data on the average fishing depth, catch, craft, gears, catch per unit effort (CPUE) in terms of units and hours and species composition over 10 years (2010-2018) were analysed. The estimated landing of goatfish in India in the year 2019 was 22,705 tonnes (t). In comparison to 34,575 t in 2010, the striking decline was about 11,870 tonnes (34.3%). The average annual production was 26547.68 t in India and 11067.54 t in Tamil Nadu, which forms >43% of the national average. Based on bathymetry and fishing types, the maritime state of Tamil Nadu is broadly divided into Gulf of Mannar (GoM), Palk Bay (PB) and Coromandel Coast (CC). The depth of operation of trawlnet, gillnet and shore seine is in the range of 25-90 m, 20-25 m and 2-3 m respectively in GoM, and 4-20 m, 5-16 m and 1-1.5 m respectively in PB. Operational depth in CC ranges between 40-200 m for multi day trawlers, 10-35 m for single day trawlers, 60-300 m for mechanised gillnetters, 4-20 m for motorised gillnets and 3-4 m for shore seine. The maximum distance from land to fishing ground in the GoM, PB and CC is 100 km, 30 km and 90 km, respectively. Nearly 84.5% of the goatfish in Tamil Nadu were caught by mechanised trawlers, followed by motorised gillnets (12.03%), and non-motorised trawlers (1%). The goatfish composition in GoM consist of *Upeneus tragula, U.heemstra* (57%), *Parupeneus indicus* (20%), *P. heptacanthus* (9.5%), *U. sulphureus* (7%) and remaining catch from *U. supravittatus, U. molluscensis, U. guttatus, U. margarethae* and *U. vittatus*. In PB, *U. sundaicus* dominated in the landings with 61% catch followed by *U. tragula* (16%), and 10% each by *U.sulphureus* and *P.indicus*. The species composition in CC was *U. sulphureus* (35.1%), *U. guttatus* (24.2%), *U. moluccensis* (19.8%), *U. supravittats* (1 6.5%), *U. tragula* (2.7%), *U. sundaicus* (0.5%) with occasional landing of *P. indicus.*

Keywords : Coromandel coast, Gulf of Mannar, Palk bay, Mullidae, Upeneus and Parupeneus

Paper ID 15726

Studies on Reproductive Biology of Ridged Swimming crab *Charybdis natator* (decapoda: Brachyura) along the Gulf of Mannar, South East coast of India

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The abundance, Sex ratio, Growth, Morphology, and reproductive biology of *Charybdis natator* have been studied in the Gulf of Mannar, Southeast coast of India between June 2015 to June 2016. Among, 1227 individuals were recorded of which males constituted 61.77% (n=758), non-ovigerous females (n=324) and ovigerous females (n=145) constituted 26.40% and 11.81% respectively. The carapace length ranged from 1.9 cm to 9.5 cm, carapace width 2.4 cm to 12.8 and the weight ranged from 20 to 659 g. The females size ranged from 77.01- 100.31mm Carapace width (CW) was highly variable and body weight ranged from 115-233 g. Age and Growth of males attained CW of 7.65cm, 8.9cm, 10.4cm and 12.41cm at 0.6, 0.8, 1.1 and 1.7 years respectively and females recorded a size of 7.2cm, 8.8cm, 10.52cm and 11.05cm in 0.6, 0.7, 1.5 and 1.6 years. The average sex ratio was (Male: Female) 1:0.62.The relationship between carapace width –weight – fecundity was F=1526 CW - 99827 (R^2 = 0.919) and F = 8770 (Body-weight) BW - 60489 (R^2 = 0.748). The estimated fecundity ranged from 72,234- 2,98,675 eggs per female. Also, reproductive output was size dependent with increased CW and BW. Berried females were recorded throughout the year however peak season was during December to February.

Keywords : *Charybdis natator*, Abundance, Fecundity, Sex Ratio, Age and Growth, Gulf of Mannar

Paper ID 15730

Reproductive Characteristics of Magnificent Shrimp, *Ancylomenes magnificus* (bruce, 1979) from The Gulf of Mannar, India

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The magnificent shrimp *Ancylomenes magnificus* (Bruce, 1979) is an anemone associated marine ornamental species, exploited from Indo-Pacific waters for aquarium keeping, as of its attractive colouration. However, there is no information available on its biology and reproductive parameters (length-weight relationships, fecundity, sex ratio, and maturity stages). A total of 126 individuals were collected from the intertidal regions of the Gulf of Mannar, Tamil Nadu, India during the period of October 2021 to January 2022, out of which 38.01% of males (48) and 61.9% (78) females. The overall sex ratio was unbalanced towards the female animals (0.61 male: 1 female). The mean carapace length (CL) is 3.3 mm for males and 5.0 mm for females, which showed significant differences between the sexes ($p<0.05$). The estimated fecundity of *A. magnificus* is ranged from 93-272 eggs (161) and egg size ranged from 0.45-0.61 mm. The relationship between carapace length, weight and fecundity showed the positive allometric with a significant coefficient of determination ($r2=0.9$, 0.69) respectively. The present study provides first information on the reproductive and population characteristics of *A. magnificus,* which will help for the sustainable management of this resource and standardization of its captive breeding protocols.

Keywords : Sea Anemone associated shrimp, Fecundity, Sex Ratio, India

Paper ID 15738

Comparative Study of Phenotypic Variation in *Chitala chitala* (hamilton, 1822) From Indian Rivers Using Truss Network and Cartesian Coordinate System for Geometric shape analysis

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Chitala chitala (Hamilton, 1822) is an economically important food fish species occurring throughout Indian rivers, which also has ornamental value. This study focuses on morphological variations in *C. chitala* (n=149) from seven river basins across India namely; Son, Tons, Ken, Brahmaputra, Ganga, Gomti and Gandak. Nine landmarks were identified from the digital images and used for generating respective procrustes cartesian coordinate data matrix (149x18) and 36 truss morphometric measurement data matrix (149x35), after applying appropriate transformations. Both data matrices were subjected to geometric shape analysis by applying method Principal Component Analysis (relative warps) that provide 6 relative warps (RW) controlling 96.19% and 95.97% of variation respectively. The loadings of truss variables over RW1, RW2 were in range of (-)0.29 - 0.52, (-)0.14 - 0.34 while that of Procrustes coordinates varied from (-)0.57 - 0.45, (-)0.53 - 0.65. The shape variations over locations indicated warp density score in range of (-) 45-159, (-)192-103 and (-)137-83, (-)130-182 for coordinate and truss morphometric data matrices respectively. The shape variation through ROC curve over (1-specificity) vs. sensitivity of discriminant function, analysed for all seven rivers, showed that the value of area under curve (AUC) in each ROC ranged from 0.8973 to 0.9921 for coordinate data while it ranged from 0.9389 to 0.9971 for truss morphometric data indicating "outstanding performance" in distinction between the rivers. The results showcase the ability of both data matrices as effective discriminator in geometric morphometric analysis. The results showcased in the present study shall help in better understanding of intra-specific diversity which is significant for management and conservation of species.

Keywords : Conservation, Intra-specific, Management, Plasticity, Population, Variation

Paper ID 15741

Detailed study on the Food and Feeding Habits of the Deep-Sea shrimp *Heterocarpus woodmasoni*, Alcock 1901 (Crustacea: Decapoda: Pandalidae) off Quilon Bank, Southwest coast of India

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Deep sea caridean shrimp *Heterocarpus woodmasoni* Alcock, 1901 is a commercially important species landed along the southwest coast of India at a depth of 250-400m. The present study aimed to assess the diet composition and feeding habits of *H. woodmasoni*. A total of two thousand four hundred and thirty three (2433) specimens were analyzed including 1349 males and 1084 females which were collected from the commercial bottom trawl catches at Sakthikulangara fishing harbour (8°56'60.78"N/76°32'34.27"E), of Kollam, Kerala from September 2019 to March 2021. All the analysis were carried out in relation with variations in season, sex and size. The diet components of *H. woodmasoni* consist of crustaceans, foraminifera, mollusk, fish remains, detritus and sand particles. Index of preponderance indicates that the diet in males and females was similar, but preference towards each component varied with sex, season and size. Preference to crustaceans was seemed to be higher than that of others in the case of females and males showed higher preference towards foraminifera. Considering the feeding intensity, females belong to the medium size group were found to be more active than males and comparatively higher feeding intensity was observed during post monsoon season. Stomach fullness index was higher in females than males and showed vice versa in case of vacuity index. High occurrence of empty stomach was observed in *H. woodmasoni* throughout the study period. Gastro somatic index (GSI) was calculated for the species and showed variation in males and females. Season wise observation indicated greater GSI value in post monsoon season than premonsoon. Based on these observations, it is thus concluded that food and feeding pattern of the deep sea shrimp *H. woodmasoni* varies with season, gender and size. The relevance of this study is to give additional information concerning the feeding pattern of *H. woodmasoni* which can provide greater insight regarding the better management of the existing stock.

Keywords : Caridean shrimp, Sakthikulangara fishing harbor, Food and feeding habits, Index of Preponderance, Gastro Somatic Index

Paper ID 15742

Assemblage of Shellfishes in the Rocky intertidal Zone of Veraval Beach, Gujarat.

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Shellfish are the most abundant intertidal residents, having a diverse range of occurrence in the intertidal zones biota. From 2017 to 2019, a three-year study on shellfish assemblage on Gujarat's Veraval Beach assessed the variety and evenness of the near shore species. Taxonomic classification revealed 5 classes, 11 orders, 29 species, and 15 families. Using analysis of variance, the total yearly density of gastropod assemblages does not differ substantially at p 0.05. (ANOVA). The Shannon- Wiener species diversity index (H′) found a high number of species in the Patellidae family, with a computed H′ value of 3.32 in Patella (Cellana) radiating species. When the value of J' is 1.22, evenness is complete (J' = 1). Turbo intercostalis, Chiton granoradiatus, and Chicoreus ramosus were the species with the most diversity, with H′ values of 2.60 and J' values of 0.85. The Monodonta australi species come next. The overall assemblage of shellfish is unaffected by changes in yearly mean temperature (r = -0.4709). Patella (Cellana) radiate (2017 = 87, 2018 = 134, and 2019 = 187, total = 408) Turbo intercostalis (2017 = 78, 2018 = 125, and 2019 = 165, total = 368), and Chiton granoradiatus (2017 = 60; 2018 = 113; and 2019 = 127; total = 301) are among the top tolerant species. From 2017 to 2019, a three-year study on shellfish assemblage on Gujarat's Veraval Beach assessed the variety and evenness of the near shore species. (ANOVA). The Shannon- Wiener species diversity index (H′) found a high number of species in the Patellidae family, with a computed H′ value of 3.32 in Patella (Cellana) radiating species. When the value of J' is 1.22, evenness is complete (J' = 1). Turbo intercostalis, Chiton granoradiatus, and Chicoreus ramosus were the species with the most diversity, with H′ values of 2.60 and J' values of 0.85. The Monodonta australi species come next. The overall assemblage of shellfish is unaffected by changes in yearly mean temperature (r = -0.4709). Patella (Cellana) radiate (2017 = 87, 2018 = 134, and 2019 = 187, total = 408) Turbo intercostalis (2017 = 78, 2018 = 125, and 2019 = 165, total = 368), and Chiton granoradiatus (2017 = 60; 2018 = 113; and 2019 = 127; total = 301) are among the top tolerant species. The intertidal zones pool is usually diversified, despite being subjected to a variety of environmental conditions. The findings suggest that certain species are more resistant to temperature changes.

Keywords : Shellfish Assemblage, Rocky intertidal, Tolerant Species, Shannon-wiener Index, Pielou's Evenness Index

Paper ID 15744

Habitat Ecology and Shellfish Diversity of River Burhi Gandak, North Bihar, India

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The present study was conducted to investigate the distribution and abundance of shellfish fauna from the river Burhi Gadak in North Bihar, India. The hydro-morphology of the river were studied and revealed that river width varied from 87.34±10.17 to 102.77±11.58 m and maximum river width was recorded in August 2020. The maximum depth was observed between 8.62±0.99 to 13.55±1.21 m and maximum depth was observed in August 2020 and minimum depth ranged from 6.44±0.80 to 9.92±1.06 m and minimum depth was found in June 2021. The maximum water flows varied between 0.55±0.11 to 0.74±0.11m/s and the minimum flow rate was recorded in August 2020 and minimum water flow ranged from 0.40±0.07 to 0.47±0.06 m/s and low water flow was recorded in June 2021. The investigation recorded a total of 12 shellfish species under 4 orders, 9 families and 10 genera. Identified shellfishes comprised of 5 species of crustaceans (3 species of freshwater prawns and 2 species of crab under 2 orders, 2 families and 3 genera) and 7 species of molluscs (5 species of snails and 2 species of mussels under 2 orders, 7 families and 6 genera). The highest species abundance was observed at Muzaffarpur sampling site having Palaemonidaeas the predominant family with 3 species. The Shanon-Wiener diversity index, Pielou's evenness index and Margalef's species richness index ranged from 2.30 to 2.50, 0.90 to 1.0, 2.0 to 2.30, respectively.

Keywords : River width, Depth, Water flow, Species composition, Crustaceans, Molluscs

Paper ID 15756

Evaluating the Influence of Previous Experience on Shell selection by *Diogenes alias* (Paguroidea: Diogenidae)

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Experimental trails were carried out using hermit crab *Diogenes alias*, to examine the influence of previous experience on shell size and species preference. Individuals of *D. alias* were kept for 30 days in lab under two conditions 1) excess availability of shells and 2) absence of shells. The crabs were then permitted to choose from broad range of empty gastropod shells of the two most occupied species in natural field: *Indothais lacera* and *Tibia curta.* Hermit crab variables (size) and preferred shell variables (Shell aperture length, Shell aperture width and shell species) were correlated to find out the best relationship. *D. alias* shown a strong affinity towards *I. lacera* shells, which clearly indicates that previous experience did not have any influence in both shell size and species preference.

Keywords : Anomura, Hermit Crab, *Diogenes alias*, Previous experience, Shell selection.

Paper ID 15767

An annotated Checklist of Sharks and Its fishery along the Coromandel coast of Tamil Nadu, Eastern Indian Ocean

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The present study was carried out to ascertain the shark resources along the Coromandel region of Tamil Nadu, Southeast coast of India by fortnightly sampling during June 2019 to March 2020. For the investigation study, different marine fish landing centers (FLCs') were selected from three coastal districts along Tamil Nadu *viz.,* Kasimedu-Royapuram fishing harbor (Chennai), fishing harbor (Cuddalore) and Akarapettai fishing harbor (Nagapattinam). From FLCs' shark species were identified and occurrence data were generated. The study recorded 35 species of sharks which are distributed under 4 orders, 9 families and 16 genera. The order-wise representation revealed Carcharhiniformes (27) are dominant, followed by Orectolobiformes (4), Lamniformes (3) and Squaliformes (1). The family-wise representation revealed the least number of species were documented from Sphyrnidae (3) and Hemiscyllidae (3) and the dominant one belonged to Carcharhinidae (21). In addition, gear-wise catch composition for the shark resources is documented; the shark catches are found to be in the ascending order of hook & line (39%) <trawl net (33%) < gillnet (28%). The technical specification of the fishing gears and crafts are documented such as hook size (No. 0-4), trawl net (mesh size. 20-30 mm), gill net (mesh size. 120-180 mm) & 8-30 m over all length of the fishing craft which includes mechanized multi-day boats, motorized multi-day boats and motorized single-day boats. Henceforth, the annotated checklist of shark species would be first detailed report from this region and documented the fishing pattern will pave a way for futuristic studies on taxonomy, biodiversity and conservation aspect along the Coromandel coast of Tamil Nadu.

Keywords : Shark Resources, Fishing Pattern, Conservation, Coromandel Coast.

Paper ID 15770

Fishery and Biology of Green Tiger Prawn *Penaeus semisulcatus* (De Haan, 1844) In Palk Bay, Southeast coast of India

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The green tiger prawn is one of the commercially important species landed year around along the Palk Bay coast and forms good fishery. Green tiger prawn is caught by trawl net, Thallu valai (Mini trawl) and Gill net (trammel net) in Palk Bay. The single day trawlers operate in 5-12 m depth using cod end mesh size of 20 mm and Mini trawl that operate at 1-3 m depth use cod end mesh size of 18-20 mm. The outer and inner mesh size of the trammel net is 120 and 34 mm respectively. Major fishery of this species is from seven mechanised and 95 motorized landing centres along the Palk Bay coast. Two peak fishing seasons for this fishery was observed viz.; December to February and June to August. The landings of green tiger prawn in Palk Bay have been estimated at 6346 t (2020) which was contributed by Mechanized trawlers (92%), Mini trawl (7.2%) and Gill net (Trammel net) (0.8%). The average Catch per unit effort (CPUE) for single day trawl is 2.9, Mini trawl 1.29 and Gill net 0.02 kg/hr. 70% of the females were in mature condition, 10% in spent 5% in immature 15% in early mature and maturing condition. The gut content analysis showed detritus, crustacean and molluscan shell remains as major constituent in the diet and 75% of the stomach were empty. Fecundity ranged from 86400 to 1198840 in prawns of 121 mm-176 mm size range. The annual sex ratio between male and female was 1:1.3. The length-weight relationship for male is $W = 0.003799TL^{3.28128}$ (n=560) and female is $W = 0.00447TL^{3.23767.}$ (n=669). Analysis of covariance showed that the variation of length-weight relationship between males and females was significant at 0.05 level.

Keywords : Fishery, Green Tiger Prawn, Palk Bay, Length-weight Relationship, Trawl

Paper ID 15772

Trends in Penaeid prawn Fishery in Palk Bay, Southeast coast of India

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The Palk Bay ecosystem is unique with shallow depth extending from Point Calimere to Arichalmunai. This ecosystem is rich with seagrass meadows which support the fishery of green tiger Prawn *Penaeus semisulcatus.* The trend of penaeid prawn landings of Palk Bay was analysed from 2010 to 2021. The maximum landings were recorded in 2012 (13494 t) and lowest in 2018 (6139 t). The landings in 2021 (10509 t) increased by 0.52% than 2020 (10454 t). In Palk Bay 80-90 % of the catch was landed by the mechanized trawlers followed by the outboard trawl net (8-11%). The prawn landings in Palk Bay is comprised of eighteen species viz; *Penaeus semisulcatus, P. latisulcatus, P. indicus, P. merguiensis, P. japonicus, P. canaliculatus, P. monodon, Kishinouyepenaeopsis maxillipedo, P.stylifera, Ganjampenaeopsis uncta, Metapenaeus moyebi, M. dobsoni, M.monoceros, M. lyssinassa, Metapenaeopsis stridulans,M.andamanensis, M. tolensis* and *Trachypenaeus granulosus*. Prawns are landed round the year along this coast with two peak landing *viz.* December to February and June to August. However, *Penaeus semisulcatus* is dominant in the catch which contribute 60-70% in the total prawn landings. Among the five southern coastal districts Ramanathapuram District stood first in the prawn landings in Palk Bay followed by Pudukottai District.

Keywords : Palk Bay, Penaeid prawn, Green Tiger prawn, Ramanathapuram, Trawler

Paper ID 15779

Reproductive Biology of the *Barilius vagra*, with Histomorphometric Analysis of Gonadal Tissue

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The reproduction of *Barilius vagra* from the Ladhia river, Kumaon Himalya, India was studied by elucidation of sex ratio, size distribution, frequency of occurrence, fecundity, condition factor, sexual maturity, gonadosomatic index, ova diameter, and histological techniques. A total of 37 males and 67 females, *B. vagra* were captured bimonthly between September 2019-July 2020. The sex ratio of *the B.vagra* was slightly skewed towards females with male is to female ratio of 1:1.2. Total length at which 50% of individuals attained maturity was estimated as 6.6cm for males and 7.6 cm for females. The condition factor during all seasons did not show marked variation and was less than 1 during all seasons which therefore attributed the alarming threat to the existence of *B. vagra* in Ladhia river. The elucidation of the microscopic staging and oocyte frequency distribution in females indicated that *B. vagra* exhibits asynchronous oocyte development and spawning commence between late August (monsoon) to early autumn (Nov) season.

Keywords : Small Indigenous Fish Species, Reproductive Biology, Histology, Barilius,kumaon Himalaya

Paper ID 15793

Length-weight Relationship and Stock Assessment of selected Freshwater prawn (*Macrobrachium* Genus) from Burhi Gandak River, North Bihar, India

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The study was conducted from July, 2020 to June, 2021 to investigate the length-weight relationship and Stock assessment of selected *Macrobrachium* species from the Burhi Gandak river, North Bihar, India. *Macrobrachium lamarrei, M. dayanum* and *M. malcolmsonii* were recorded during study period. *Macrobrachium lamarrei was dominant species in the catch composition and peak landing was observed during the months from June to August 2021.* The maximum length was recorded for *M. malcolmsonii* (16.8 cm) followed by *M. dayanum* (8.0 cm) and *M. lamarrei* (6.1 cm). The length weight relationship analysis of *M. lamarrei*, *M. dayanum*, and *M. malcolmsonii* indicated negative allometric growth with the slope (b) values of 2.7692, 2.6027 and 2.7513, respectively. The Von Bertalanffy growth parameters which includes, asymptotic length ($L\infty$), growth co-efficient (K) and age at zero length (t_o) for *M. lamarrei* were 5.67 cm, 2.3 yr^{-1} and -0.5913 yr^{-1}; for *M. dayanum* were 10.08 cm, 0.990 per yr^{-1} and -0.6684 yr^{-1} and for *M. malcolmsonii* were 16.59 cm, 0.730 per yr^{-1} and -0.7289 yr^{-1}, respectively. Fishing mortality was lower than natural mortality and it was estimated as 1.71 for *M. lamarrei,* 0.15 for *M. dayanum* and 0.18 for *M. malcolmsonii*. The present study revealed that, the smaller length groups showed higher natural mortality, whereas larger length groups showed higher fishing mortality. The present exploitation rate was 0.26 for *M. lamarrei*, 0.06 for *M. dayanum* and 0.09 for *M. malcolmsonii*. The calculated exploitation rate indicated that studied three species were underexploited.

Keywords : *Macrobrachium*, Growth and Mortality Parameters, MSY

Paper ID 15804

Alopias pelagicus Nakamura, 1935, a new host for *Gangliopus pyriformis* Gerstaecker, 1854 (pandaridae) from Andaman and Nicobar waters, India

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The thresher sharks of the family Alopiidae are widely distributed worldwide in tropical and temperate seas *whi*ch is most common by catch from long line fishing from Andaman Wate*rs*. Copepod parasites of the family Pandaridae are exclusively parasitic on elasmobranchs, attaching to their body surface, fins, gills, nasal passages and cloacal aperture and comprises of 23 genera and 64 species. Of the 23 genera, 13 were monotypic including *Gangliopus.* Most of the pandarid parasites are host specific with rigid dorsal plates and extreme chitinisation, which in turn makes them incapable of moving. *G. pyriformis* is reported to infect the gills of *Alopias vulpinus*. *The present study gives the first report of Gangliopus pyriformis* Gerstaecker, 1854 a pandarid copepod infested on a new host *Alopias pelagicus Nakamura, 1935 from Indian Exclusive Economic Zone of Andaman Sea. Two adult females of G. pyriformis of length range* 8.6 to 9.1 mm have been recovered from the gill lamellae of the host with a prevalence of 25%.

Keywords : Copepod Parasite, Sharks, Pandaridae, Alopiidae

Paper ID 15809

Key Information Needs to Move from Knowledge to Action for Biodiversity Conservation in India

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In particular, some marine and freshwater environments are currently experiencing an alarming decline in the biodiversity of aquatic animals. Biodiversity conservation has become the stated objective of national governments, state agencies, local communities, and scientific organizations. To address the ongoing global biodiversity crisis, conservation approaches must be underpinned by robust information. India is uniquely positioned to contribute to meeting global biodiversity targets, with some of the world's largest remaining intact ecosystems, and a commitment to co-application of Indigenous ways of knowing alongside scientific, socioeconomic, and other approaches. We elicited input from experts across a range of disciplines to identify the key information needed to advance policy and management actions to conserve biodiversity in India. Experts concluded that, in many cases, a lack of information is not the major barrier to biodiversity conservation; instead, mechanisms to translate information into action are most urgently needed. Collaboration among natural, social and data scientists can facilitate social change and biodiversity information management. Experts identified major priority information needs which emphasize the importance of (i) reviewing policies and actions and disseminating lessons learned from successes and failures; (ii) better understanding mechanisms to build public support; (iii) improving, in specific instances, understanding of the status and trends of habitats, species, ecosystems, and threats for planning and management; and (iv) mobilizing biodiversity information. Through the Convention on Biological Diversity, the global community has resolved to “live in harmony with nature”; we conclude that the most pressing need to address this resolution is an improved understanding of how to move from conservation knowledge to conservation action.

Keywords : Keywords: Aquatic Biodiversity, Policies, Conservation Action

Paper ID 15814

Patterns of Genetic Structuring in Spadenose shark, *Scoliodon laticaudus* (carcharhinidae) along Indian Coast

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Globally, many of the elasmobranch species are facing the threat of extinction due to their vulnerable life histories, over-exploitation, habitat alterations, and climate change. Spadenose shark, *Scoliodon laticaudus* Müller & Henle, 1838 (Carcharhinidae) is a small-bodied coastal shark occurring in the northern Indian Ocean. The recent Global International Union for Conservation for Nature (IUCN) Red List Assessment has classified *S. laticaudus* as Near Threatened (NT) indicating its vulnerability to intense fishing pressure in the known distribution range. We investigated the genetic stock structure of *S. laticaudus* along the Indian coast using mitochondrial COI, control region, and NADH2 markers. Significant genetic differentiation was detected between the east and west coasts of India indicating restricted gene flow. Natal philopatry, selection on mitochondrial genes due to differential habitat characteristics, and environmental differences between the east and west coasts of India can be considered as the reasons for restricted gene flow and genetic differentiation. Based on the results of the present study, *S. laticaudus* can be managed as two stocks along its range of distribution and suggest the need for detailed genetic stock structure studies for widely distributed and highly exploited vulnerable species.

Keywords : *Scoliodon laticaudus*, Shark, Genetic Stock Structure, Indian Ocean, Threatened, Marine Fish

Paper ID 15825

Composition and abundance of Fish eggs in the waters of Gulf of Mannar, Tamil Nadu

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The present research investigation deals with the composition and abundance of fish eggs in the waters of Gulf of Mannar, Tamil Nadu. Monthly samplings were conducted at Mandapam, Thoothukudi and Punnakayal stations in the Gulf of Mannar for two years from 2017 to 2019. Horizontal surface towing (0-5 m) was carried out for 15 minutes with a bongo net sampler of 45 cm in diameter & 150 µm mesh size. In the present study, fish eggs belong to 11 families were recorded from Mandapam and Thoothukudi, 16 families from Punnakayal. The eggs of the Clupeidae family were found as the major component with the maximum of 50.99% and the minimum component identified was Synodontidae (0.04%) at Mandapam. Similarly, eggs of family Cynoglossidae (38.24%) was observed as the maximum and the minimum was Synodontidae (0.06%) at Thoothukudi whereas eggs of Cynoglossidae contributed the maximum (53.22%) and Teraponidae was found as the minimum component (0.07%) at Punnakayal. The present study exhibited the diversity of fish eggs in the waters of the Gulf of Mannar.

Keywords : Fish, Eggs, Composition, Abundance, Gulf of Mannar.

Paper ID 15831

Ichthyofaunal diversity in the upper reaches of River Yamuna, Uttarakhand: Strategies for Conservation of Mahseer and Snow Trout

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The river Yamuna is a snow-fed river, originating from the Yamunotri glacier located in the lower Himalaya of Uttarakhand. The study elucidates the ichthyofaunal diversity, DNA barcoding of selected native fish species, biotic and abiotic parameters in the upper reaches of river Yamuna near Vyasi hydroelectric project site. The upper reaches of Yamuna river harbors a total no. of 14 species belonging to 10 genera namely *Tor putitora, Tor tor, Naziritor chelynoides, Schizothorax richardsonii, Schizothorax plagiostomus, Barilius bendelisis, Barilius vagra, Gara gotyla, Glyptothorax pectinopterus, Glyptothorax indicus, Schistura savona, Puntius sophore, Amblyceps* spp. and *Bhavania australis*. The physico-chemical parameters recorded during winter and summer were ranging viz. water temperature (14.2-18.4°C), transparency (40.3-41.8 cm), dissolved oxygen (10-9.2 mg/L), pH (7.1-8.2), nitrate (0.4-0.7 mg/L), alkalinity (120-140 mg/L), total dissolved solids (166-199 mg/L), phosphate (0.02-0.06 mg/L), conductivity (186-198 µS/cm), water velocity (1.32-3.1 m/sec). Bacillariophyceae, Chlorophyceae and Cyanophyceae were the dominant plankton and periphyton group in the river. The upper reaches of Yamuna harbors the world famous game and sports fishes, *Tor putitora* (Golden mahseer), *Tor tor* (Tor mahseer) and *Naziritor chelynoides (*Kali mahseer) which needs both in-situ and ex-situ conservation. The river is also home to two to three species of snow trout and people participation for their conservation will be a critical approach for safeguard of this group of fishes in the river.

Keywords : Yamuna River, Mahseer, Snow Trout, Conservation

Paper ID 15842

Fishery, Biology and Stock status of Hilsa Shad *Tenualosa Ilisha* (hamilton, 1822) along West Bengal coast, Northwestern Bay of Bengal: A Scientific basis towards sustainable management

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Hilsa shad *Tenualosa ilisha* (Hamilton, 1822) is a commercially important anadromous fish species, widely distributed in the northern Indian Ocean mainly in the Bay of Bengal region, most popular and relish table fish of Indian subcontinent. Hilsa stocks have been in declining trend in most of its distributional ranges during the recent decades due to several factors, such as overexploitation, habitat degradation, climate change etc. Hilsa is the state fish of West Bengal (WB), India which provides food, nutritional security and livelihood for millions of fishermen. The fishery and biology of Hilsa shad from WB coast, (India) was investigated during April 2021 to March 2022. The specimens were collected from gillnets and trawls, ranged between 128-604 mm Total Length (TL) and 28-2246 g Total Weight (TW). The Hilsa landings along WB coast fluctuated between 752 t in 1988 and 89109 t in 2016 with an average of 22329 t, contributing nearly 17% of the total marine landings of the state during the period 1981-2021. In the recent years the catch has been in declining trend with estimated landings of 5372 t in 2021, registering a decrease of about 24% compared to the previous year. The major gears contributed to the Hilsa fishery along the coast were gillnets (77%) followed by trawls (23%) during 2021. The Hilsa fishery attained its peak during July-September contributing about 3711 t (69%) followed by October to December (1277 t, 24%), lowest during January-March (194 t, 3.6%) and April-June (190 t, 3.5%) coinciding with monsoon fishing ban period. The stock status of Hilsa shad along the WB coast was estimated from commercial catches by using two independent and most recent methods such as length-based Bayesian biomass (LBB) method and catch-based Monte Carlo method (CMSY). The detailed biology of the species is also presented in this study. The result can be used to provide a scientific basis for sustainable management of Hilsa shad in this region.

Keywords : Tenualosa Ilisha, Declining Trend, Stock Status, LBB, CMSY, Bay Of Bengal

Paper ID 15844

Population Dynamics of Blackfin sea catfish (*Arius jella* Day, 1877) in West Bengal coast of India

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The present study investigated the length-weight relationship, population parameters of blackfin sea catfish, *Arius jella* based on the length-frequency data collected on monthly intervals from the Digha coast of West Bengal using the FAO-ICLARM Stock Assessment Tools (FiSAT II) software package. A total of 782 specimens were collected between February 2021 and January 2022. The data were grouped into 10 mm class intervals with an average length ranging from 148.14±38.45 mm and an average weight was 42.32±28.75 g, respectively. The length-weight relationships were established as $W = 0.006022L^{3.150054}$. The estimated value of the exponent "b" was (3.150054), indicating a positive allometric growth pattern of the species with a high correlation coefficient (0.912). The Von Bertalanffy growth parameters were estimated as: $L\infty$ =281.80 mm, K = 0.78year^{-1}, t_0 = -0.0763 years and Ø = 3.677. The total mortality (Z), natural mortality (M) and fishing mortality (F) coefficients were obtained as 3.68 yr^{-1}, 1.21 yr^{-1} and 2.47 yr^{-1}, respectively. The mean length at first capture (Lc) was observed at 54.20 mm. The exploitation rate (E = 0.68) estimated using the length-converted catch curve method was found to be higher than the optimum value (E=0.50) and the M/K value (1.551) indicated overexploitation of the fish on the West Bengal coast. The recruitment of Blackfin sea catfish was found throughout the year with two peaks, one from March to April and another from October to November. The estimated virtual population analysis (VPA) indicated that the fishing mortality (F) of 2.472 was observed at above 135 mm length class. The exploitation level needs to be reduced from the present fishing pressure for the replenishment of the stock and measures are needed to regulate it for promoting its sustainability.

Keywords : *Arius jella*, Length-weight, Population Dynamics, FiSAT-II, West Bengal

Paper ID 15847

Stock status of the Longtail Butterfly Ray, *Gymnura poecilura* (shaw, 1804) along North-west Bay of Bengal: Implications of Conserving a high-risk species in a multispecies fishery

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The longtail butterfly ray *Gymnura poecilura* is regularly caught as bycatch in trawlers along western Bay of Bengal. The species has been classified as "Vulnerable" by the International union for conservation of nature (IUCN). However, so far no stock assessment of the species has been carried out across its distribution range. We carried out a size-based stock assessment of the species based on 336 male and 547 female samples collected during 2013-2015 at Visakhapatnam, off western Bay of Bengal. The Maximum Sustainable Yield (MSY) for male *Gymnura poecilura* was 621 t; however, the spawning stock biomass (at current fishing levels) was only 11.8% of the virgin biomass indicating recruitment overfishing. The MSY for females was 1015 t and the spawning stock biomass was 20.8% of the virgin biomass; once again indicating a stock with recruitment overfishing. Hence the species needs to be conserved urgently and a stock assessment over its entire distribution range is critically needed. However, trying to conserve a single overfished species in a multispecies fishery is challenging. Measures like implementation of Minimum Legal Size for high risk species and provision of incentives to fishermen for returning under-sized live animals back to the sea could help. India should urgently create a marine species list based on extinction probabilities to highlight marine species that require urgent conservation within Indian waters. Moreover, a stock assessment network across the Bay of Bengal working towards a regional assessment of extinction probabilities of high-risk marine resources in the region which will highlight regional conservation actions needed for such species, is also called for.

Keywords : Trawl fisheries, Recruitment overfishing, Conservation, Coastal Rays, Elasmobranchs

Paper ID 15848

Stock Assessment of the Japanese Threadfin Bream, *Nemipterus japonicus* (bloch, 1791) along the Malabar coast, Kerala, India

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Population characteristics of *Nemipterus japonicus* were carried out based on the length-frequency data collected from the commercial trawl boat landings which fished off the Malabar coast (northern Kerala) during 2017-2021. The asymptotic length (L∞) and growth coefficient (K) were estimated as 379 mm and 0.8/year. Total mortality rate (Z), fishing mortality rate (F) and natural mortality rate (M) were estimated at 3.50/yr, 2.06/yr and 1.44/yr respectively. Recruitment of *N. japonicus* was unimodal with a peak in March-April. Length at capture was estimated at 139.6 mm. The exploitation rate (U) and exploitation ratio (E) were found to be 0.57 and 0.59 respectively. The Emax also exhibited at 0.59 indicated that the species is fully exploited in the region with no further scope for increasing the effort.

Keywords : *Nemipterus japonicus*; Growth; Mortality; Exploitation; Stock Assessment

Paper ID 15849

The fishery of Rays (batoidea) along the South-East coast of India: Need for Precautionary Management Interventions

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This study describes the fishery of rays (Superorder: Batoidea) (excluding Family Pristidae) along the south-east coast of India bordering the western Bay of Bengal from 1985-2019. The ray landings along this coast ranged from a low of 9032 t in 1995 to a high of 22159 t in 2012. The south-east coast of India contributed on average 6.7% (range: 5.2% in 2007 to 10.4% in 2012) of the global reported batoid landings annually. The annual average contribution of the south-east coast was 60.2% (range: 43.25% in 1990 to 73.7% in 2012) to total ray landings of India. Within the south-east coast, Tamil Nadu (along with Puducherry) contributed on average 76.2% of batoid landings and Andhra Pradesh the rest. A CUSUM analysis indicated alternating periods when the landings were "out of control" going far beyond the reference mean. For Tamil Nadu and Puducherry, though variable, the landing trends never went "out of control" during the study period. On the other hand, since 2003, the positive deviations of Andhra Pradesh ray landings have increased consistently and were "out of control". The major fishing gears which landed rays along the south-east coast of India were the trawl nets (59.6%), gillnets (23.5%) and hooks and lines (3.0%). The average catch rate in trawls was 1.39 kg/h; average catch per unit effort in gillnets was 1.99 kg/unit and in hooks and lines it was 1.84 kg/unit. The commercial ray fishery of the south-east coast of India was supported by nearly 20 species of rays and five species of guitarfishes. Eleven of the ray species are Vulnerable, 5 are either Data Deficient or Not Evaluated, 2 are Near Threatened and 1 is Endangered as per the Internation union for conservation of nature (IUCN) Red List. Of the guitarfishes, 3 are Vulnerable and 2 are Data Deficient as per the IUCN Red List. Species composition of the major rays showed geographical differences from north to south within the study region.

Keywords : Bay of Bengal, Batoid fishery, CUSUM, India, Iucn, Trawls, Gillnets

Paper ID 15852

Fishery and Stock status of False Trevally *Lactarius lactarius* in South Eastern Arabian Sea

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For better management of fishery, it is important to develop an accurate understanding of the stock status of the fishery resources. Among various stock assessment tools used, the length-based Bayesian model becomes a potent tool. *Lactarius lactarius* is an important fishery resource exploited along Karnataka coast. Present study assessed the fishery and stock status of *Lactarius lactarius*, using length frequency from 2007- 2020 The false trevally is mainly exploited by the trawls. Landings fluctuated during the study period and registered average landings of 2719 t, forming 7% of the total marine fish landings of the coast. The stock of the species along south eastern Arabian Sea was found to be overfished (B/Bmsy=0.25, F/M=3.3). Current level of relative biomass indicated that the resource to be in grossly overfished category. However, since 2017, noticeable improvement in the level of biomass was observed, due to diversion of trawl effort to exploit the pelagic resources which lead to an effective reduction of fishing pressure on *Lactarius lactarius* which is considered as an important demersal resource. Estimates of B/Bo=0.092 indicates extremely low biomass of the species. Lc/Lc_opt and Lmean/Lopt were found to be below unity (0.66 and 0.75) suggesting truncated length structure and fishing of very small individuals. The ratio of the 95th percentile length to asymptotic length L95th/Linf was close to unity (>0.94) suggesting that at least some large fishes were still present in the population. The Length-based Bayesian Biomass **(**LBB) method provided comparison of Lc relative to Lc_opt that would maximize catch and biomass for the given fishing pressure. Based on this information, changes in length at capture and fishing pressure could be suggested until the relative biomass exceeds the approximate MSY level. This paper provides the important fishery reference points and stock status that can inform managers and form the basis for various management strategies

Keywords : LBB Model, Length At Capture, Biomass, Optimum Length, Karnataka

Paper ID 15854

Stock status evaluation of Low-valued Crustaceans landed along Gujarat Coast of India

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Crustaceans are one of the major marine fishery resources landed along Gujarat coast. During 2019, crustacean accounted for 24% of the total marine fish landings of the state. Penaeid prawns, lobster and portunid crabs forms the major commercial crustacean resources of the state. Crustacean also plays a key role in the ecosystem for its greater role in trophic structure as key prey items for several fish species. The healthy stock status of crustacean resources is key to ensure sustainability of commercially important fish species in the region. Information on stock status of commercially important crustaceans like penaeid prawn, edible crabs and spiny lobster is available from different parts of Indian coast. On the contrary, similar evaluation was lacking for species of paste shrimps, stomatopods and non-edible portunid crabs which are landed in significant quantity. Recently, the stock status of *Acetes* from Gujarat waters has been carried out, leaving later two groups unassessed. Stomatopods accounted for around 8000 t of the total marine fish landings of the country in 2019. More than 30% (2780 t) of stomatopods were landed along Gujarat coast alone. The crab landings of the state in 2019 were around 7500 t and a significant proportion of it is comprised of non-edible crabs, *Charybdis hoplites. C. hoplites* is known to be most ubiquitously distributed crabs in the coastal waters of the west coast of India. The greater role in trophic structure of these resources and its significant landings along Gujarat coast warrants their stockassessment. The present study evaluates the stock status of two most common stomatopods and a non-edible portunid crab. The species specific length frequency data collected from commercial trawlers during the period 2018-2019 were used as the input data for the present evaluation. The Length based Bayesian Biomass (LBB) estimation approach was used to arrive at key indicators of stock status like B/B_{MSY}, B/B_0, F/M, L_{mean}/L_{opt}, Lc/Lc_opt and L_{95th}/L_{inf}. These parameters were used to group the stock into different categories of exploitation.

Keywords : LBB, Stomatopods, B/Bmsy, *Charybdis hoplites*

Paper ID 15855

Length-weight Relationship and Reproductive Biology of the Japanese Threadfin Bream, *Nemipterus japonicus* (bloch, 1791) from Northern Kerala Coast, India

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Studies on the maturation and breeding seasonality of fish are an essential precursor for rational exploitation and sustainable management of fisheries. Length-weight relationship and reproductive biology of *Nemipterus japonicus* was studied by examining samples collected from the commercial trawl landings of northern Kerala (Malabar region) coast during 2017-2021. The sampled individuals exhibited total length and weights varying between 55-352 mm and 2.5-498 g, respectively. The exponent value (b = 2.991) in the present study was very close to 3 indicating that the growth followed an isometric pattern. The overall sex ratio was 1:1.34 showed the dominance of females in the population. The length at first sexual maturity (Lm50) was estimated to be 150 mm and 155 mm total length for males and females respectively. Monthly proportions of macroscopic gonadal maturity stages and monthly variations in the Gonado-somatic index indicated that *N. japonicus* spawned from September to December with the peak in October month.

Keywords : *Nemipterus Japonicus*; Length-weight; Sex Ratio; Maturity; Spawning

Paper ID 15858

Length-weight Relationship and Breeding Seasonality of the False Trevally, *Lactarius lactarius* (bloch & Schneider, 1801) off Malabar Coast, Kerala, India

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Studies on breeding seasonality with reproductive biology of fish are an essential precursor for eco-friendly rational exploitation and sustainable management of fisheries. Length-weight relationship and reproductive biology of *Lactarius lactarius* was studied by examining individuals collected during 2017-2021 from the Malabar region of the Kerala coast. The sampled individuals exhibited total length and weights varying between 70-256 mm and 3-160 g, respectively. Length-weight relationship indicated a positive allometric (b = 3.107) growth. The size at first maturity of *Lactarius lactarius* was estimated at 127.5 mm and 130 mm total length for males and females respectively. The overall sex ratio of 1:1.3 was skewed towards females. *L. lactarius* spawned from September to March, with a peak in December, based on the monthly proportions of macroscopic gonadal maturity stages and monthly variations in the Gonado-somatic index.

Keywords : *Lactarius lactarius*; Length-weight; Sex Ratio; Maturity; Spawning

Paper ID 15864

Elasmobranch Fishery of India – an Overview

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Elasmobranchs, (sharks, rays, skates, sawfishes and guitarfishes) have been the focus of global concern over their sustainability. India is one of the top elasmobranch fishing countries in the world, contributing ~8-9% of the annual global landings. Within the mechanized sector, trawl nets accounted for 61.7%, gillnets 21.4%, line gear 2.2% and combination gears (trawl and line/gill net and line gears) 6.5%. Gujarat (with Daman & Diu) on the west coast and Tamil Nadu (with Puducherry) on the east coast together accounted for >50% of the elasmobranch landings in the country. Sharks, rays and guitarfishes formed 45%, 49% and 6% respectively of the total elasmobranch landings. Eleven families contributed significantly to the shark landings – Carcharhinidae, Sphyrnidae, Triakidae, Hemiscyllidae, Alopiidae, Lamnidae, Echinorhinidae, Centrophoridae, Squalidae, Pseudocarcharhiidae and Stegostomatidae; of this, Carcharhinidae contributed to >80% of the landings. Ray fishery was dominated by five families - Dasyatidae, Mobulidae, Myliobatidae, Gymnuridae and Rhinopteridae while guitarfishes were represented by two families - Rhinidae and Rhinobatidae. Protected species such as whale shark (Family: Rhincodontidae) and sawfishes (Familiy: Pristidae) were also landed occasionally due to accidental entangling.

Keywords : Carcharhinidae, Fishing, Guitarfishes, Landings, Rays, Sawfishes, Sharks

Paper ID 15866

Reproductive and Feeding Biology of *Sardinella longiceps* Valenciennes, 1847 Caught along Veraval Coast of Gujarat, India

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This study denotes the reproductive and feeding biology of *Sardinella longiceps* caught on Veraval coast off Gujarat during the study period of September 2019 to March 2020. The observed length of the species was in the range of 145 to 236 millimeter and weighing from 37.54 to 122.35 grams. The highest mean length of 206 ± 9 mm was observed. The overall sex ratio was 1 Male : 1.45 Female. There was no significant difference between the slopes of males and females at 1% or 5% level, a combined length-weight relationship of 0.00007407 x (TL) $^{2.622}$ was obtained. Fifty percent of the individual of the species in the population attained sexual maturity as their body measured a total length of 155 mm. They spawned throughout the year with the peak in October. The combined Gonadosomatic Index was highest during September. The combined Gastrosomatic Index was highest during December. Copepods and Diatoms were the most preferable food item of this species. In diatoms, the most dominant food item was *Coscinodiscus* sp., *Rhizosolenia* sp., *Pleurosigma* sp. and *Nitzschia* sp. It was observed that the highest (83.8%) similarity in diet of this species was observed between December and January months. The variation in reproductive and feeding biology may be due to the ecological and geographical differences which lead to variation in water quality parameters and availability of food thereby affecting the fish growth.

Keywords : Biology, *Sardinella longiceps*, Length Weight Relationship, Fecundity, Similarity

Paper ID 15870

Optimization of Rearing Protocol and Reproductive Characteristics of Brackishwater Polychaete *Nemalycastis abiuma*

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Fishery and aquaculture of polychaete, marine or brackishwater annelid worms, has been expanding for the last one decade, owing to its indispensable role in shrimp hatcheries as a maturation diet, across the world. *Nemalycastis abiuma* is a brackishwater polychaete found in organic sediments. In order to develop a mass-rearing protocol, experimental studies were carried out at indoor facilities. Wild *N. abiuma* juveniles (weight and length: 0.16 g and 6.6 cm) were cultured in plastic tanks of 35 litres filled with pretreated estuarine sediment topped with filtered seawater. The stocking density was 25 worms/tank. The worms were grown under three different experimental conditions: 1. Different water salinities from 10 to 35 ‰; 2. Feeding with powdered leaves of *Spinacia oleracea, Avicennia marina, Salicornia sp.,* and powdered shrimp feed; 3. Different substrates such as pond soil, coir pith, and biofloc sludge. The percentage survival obtained was 92, 84, 40 and 24%, respectively, at salinities of 10, 20, 30 and 35‰. The percentage of survival was 72, 36, 20 and 16% respectively for shrimp feed, *Salicornia sp., A. marina* and *S. oleracea*. The highest growth was observed for worms fed with shrimp feed (length and weight: 8.81 cm and 0.25 g). Survival obtained was 61, 89 and 5% respectively for pond soil, coir pith, and biofloc sludge. The biomass produced for pond soil, coir pith, and biofloc sludge was 5.32, 7.055 and 0.365 g, respectively. Histology of *N. abiuma* revealed the major sexual feature of the animal. In the coelomic cavity, gametogenesis was observed in each posterior segment. Oocytes of various developmental stages and mature oocytes of 127.5 µm diameter were noticed. The sperm plates were found in the coelomic cavity, with elements that appear as mulberry-like spermatogonia clusters. The results suggest that the feed type, substrate and salinity are the major factors that determine the survival and growth of *N. abiuma.* The study provided first-hand information on gametogenesis in *N. abiuma* to the best of our knowledge.

Keywords : Polychaete Culture, *Nemalycastis Abiuma*, Reproductive Biology, Maturation And Salinity

Paper ID 15872

The Coastal Trawl Fishery in South-west Bay of Bengal along the Coromandel Coast by Trawl boats Operating from Chennai, Tamil Nadu.

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The Coromandel coast runs along the south-eastern coast of the Indian subcontinent, between the Eastern Ghats and the Bay of Bengal. Chennai is one of the major trawl landing centres on this coast, with trawl boats operating from the Madras Fisheries Harbour. The trawl ground for the Coromandel coast extends from Machlipatnam (16.1700◦N; 81.1300◦E) in Andhra Pradesh to Vedaranyam (10.3753◦N; 79.8503◦E) in Tamil Nadu, extending over a stretch of 19164 km^2. We present an account of Chennai's trawl fishery during 2008-2019. Catch and effort data were obtained from the National Marine Fisheries Data Centre (NMFDC) of ICAR-CMFRI, Kochi. Species composition of the major groups was assessed from weekly observations of the trawl landings during 2008-2019. The annual average trawl landing at Chennai during 2008-to 2019 was ~30,010 t. Multiday trawlers contributed 81.9% and single-day trawlers, 18.1%. Trawl landings at Chennai increased by more than 2.7 times from 2008 to 2019. The number of effort units fluctuated during the period, with an overall increasing trend for multiday trawlers and a declining trend for single-day trawlers; effort hours also showed similar trend. The overall catch-per-unit-effort (CPUE) increased from 732.68 kg in 2008 to 2751.1 kg in 2019 and catch-per-hour (CPH) increased from 36.04 kg in 2008 to 57.31 kg in 2019. Pelagic finfishes formed ~39% of the trawl landings, demersal finfishes formed ~38%, crustaceans formed ~14% and cephalopods, ~8%. Other marine resources accounted for about ~1% of the landings. Penaeid prawns, clupeids, carangids, silverbellies, threadfin breams and ribbonfishes contributed to >50% of the average annual trawl landings at Chennai. The biological characteristics of major species contributing to the fishery is also presented.

Keywords : CPH, CPUE, Economics, Effort, Multiday Trawlers, Single-day Trawlers

Paper ID 15874

Spatial Distribution of Selected Marine Fish and Shellfish species from Commercial Multi-day Trawl Fishery along the coast of West Bengal, India through GIS Mapping

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The present study was carried out to study the spatial distribution of *Coilia dussumieri*, *Harpadon nehereus*, *Pampus argenteus*, *Johnius macrorhynus* and *Parapenaeopsis stylifera* from a total of 132 hauls of commercial multi-day trawl catch through geographic information system (GIS) mapping along the West Bengal coast of India between July, 2019 and March, 2020 at a depth ranging between 9.5 m and 54.5 m. The predictive maps of spatial distribution of the above mentioned species were prepared using inverse distance weighted (IDW) approach in Geo-statistical Analysis Arc GIS10.1. The thematic maps results indicated that maximum availability of *C. dussumieri* at 10-40 m, *H. nehereus* at 10-20 and 35-55 m, *P. argenteus* at 15-35 m, *J. macrorhynus* at 25-40 m and *P. stylifera* at the 20-50 m depth zones. *P. stylifera* was recorded up to 55 m depth. Juveniles of *J. macrorhynus* were abundant in shallow waters whereas adults were recorded beyond 25 m depth. The distribution pattern is attributed to availability of nutrients, food items, migratory pattern and other favourable conditions. The geo-database generated by the present study would help the stakeholders to gather exact geospatial information on fish and shellfish species and fishing activities of trawlers along the West Bengal coast.

Keywords : Trawl Fishery, Spatial Distribution, GIS Mapping, West Bengal

Paper ID 15879

Stock Assessment of Selected Sciaenids Species Landed along Gujarat Coast

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Sciaenids, commonly known as croakers, are one of the major demersal fishery resources landed along the Indian coast. In 2019, the total sciaenid landings of India were 135750 t. A major share, nearly 1/3rd (32%) was landed along Gujarat coast alone. The coastal waters of Gujarat are known to be one of the richest grounds of croakers along the entire coastline. Sciaenid fishery of the state is of typical tropical type, comprising several species having overlapping fishing grounds. Sciaenids are a diverse group and can be broadly classified in to two broad categories, namely larger sciaenids (slow growth and long-lived) and lesser sciaenids (fast growth and short-lived). Larger sciaenids, being more popular and easily distinguishable in the field, have relatively reliable information on time series catch. But the same in lacking for smaller sciaenids where catches are at most segregated up to genus level. There are some studies on the population dynamics and stock assessment of few lesser sciaenids species in the past which also need reassessment in changing fisheries scenario where bulk of trawl effort has been diverted towards pelagic trawling in the region. The present study evaluates the stock status of 10 lesser sciaenids species using length frequency (LF) data as an input. The Bayesian biomass estimation approach with LF data as input has been opted for estimation of key stock indicators like B/B_{MSY}, B/B_0. F/M, L_{95th}/L_{inf} and Lc/Lopt. The stocks were grouped in to different categories of exploitation based on the values of estimated B/B_{MSY}namely under-exploited ($B/B_{MSY} > 1.2$), fully exploited ($0.8 \leq B/B_{MSY} \geq 1.2$) and over-exploited ($B/B_{MSY} < 0.8$). L_{95th}/L_{inf} and Lc/Lopt are the indicators of the length structure of the catches and give insight in to truncated length structure.

Keywords : Croakers, Johnius, Otolithes, LBB, Paranibea

Paper ID 15883

Biological aspects of the Indian Halibut *Psettodes erumei* (bloch and Schneider, 1801) from Western Bay of Bengal along the East Coast of India

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The Indian halibut *Psettodes erumei* (Bloch & Schneider, 1801) (Order: Pleurinectiformes Family: Psettodidae) is a typical tropical bottom dwelling, piscivorous marine flat fish distributed in Indo-Pacific waters in depth ranges of 1 to 100 meters (m), but more common in coastal waters of 20-50 m depth. It is commonly fished from depths of 10-90 m in Indian waters. A possible candidate for aquaculture, it commands good table value. There are not many recent studies on this species, and published information on its biology from Indian waters is limited. We studied the reproductive biology of this fish from the east coast of India, based on the commercial fish landings at selected centres on the Andhra Pradesh and Tamil Nadu coasts during 2013-2021. The monthly distribution of female spawners indicated a year-round spawning pattern, with peaks in March and October-November. Sex ratio, both monthly and across size-classes, showed a pre-dominance of females and a total absence of males in size classes above 40 cm total length (TL). Fecundity ranged from 19,740 numbers in a female of 22.5 cm TL weighing 112 grams (g) to 2,72,826 numbers in a fish of 54.5 cm TL weighing 2378.2 g. The overall average fecundity per g ovary weight was 2365, 2838 and 3416 in late maturing, ripe and oozing fishes respectively. Length at first maturity (Lm50) of male and female *P. erumei* was estimated at 29.7 and 32.6 cm TL, respectively. Diet analysis revealed that this fish is a predator, feeding mostly on fishes, particularly those inhabiting demersal and mesopelagic waters, and also on cephalopods and shrimp. The information presented from this study will be useful in understanding its stock dynamics in the wild and also in developing husbandry and feeding protocols for captive rearing.

Keywords : Psettodidae, Length at First Maturity, Fecundity, Diet, Sex Ratio

Paper ID 15895

Fishery, Length-weight Relationship and Relative Condition Factor of Barracudas Exploited from Pamban Island Waters, Tamil Nadu

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Barracudas, otherwise called spikes, belong to the family Sphyraenidae. They are important food as well as sport fishes and one of the notable pelagic groups that constitute a fishery in Tamil Nadu waters. Barracudas are exploited by mechanized trawls and motorized gill nets and hooks & lines. Though the Indian barracuda fishery is constituted of 11 species, only 5 species are dominant in the commercial landings viz. *Sphyraena obtusata*, *S. putnamae, S. barracuda, S. forsteri* and *S. jello*. The estimated catch, catch per effort (C/E) and catch per hour (C/H) of barracudas during 2020 were 10447.43 tonnes, 1591.59 Kg and 90.10 kg respectively. Mechanized trawls contributed more than 96% to the total barracuda landings followed by motorized gill nets (3%); non-motorized sector contributed <1%. *Sphyraena obtusata* (39.0%), *S. putnamae* (38.4%), S. barracuda (8.7%), *S. forsteri* (7.6%) and *S. jello* (6.3%) contributed to the fishery. The coefficients 'a' and 'b' of the LWR derived for different barracuda species are *Sphyraena obtusata* (Male a=0.0075; b=2.886; r2=0.957 & Female a=0.0217; b=2.573; r2=0.955), *S. putnamae* (Male a=0.0063; b=2.911; r2=0.913 & Female a=0.0098; b=2.799; r2=0.969), *S. forsteri* (Male a=0.0056; b=2.976; r2=0.915 & Female a=0.0081; b=2.88; r2=0.980) and *S. jello* (unsexed a=0.0206; b=2.649; r2=0.900). The calculated Kn for different barracuda species are *Sphyraena obtusata* (Male=1.06 & Female=1.05), *S. putnamae* (Male=1.05 & Female=1.04), *S. forsteri* (Male=1.09 & Female=1.13) and *S. jello* (unsexed=1.09). For the first time, the LWR and Kn of *S. forsteri* and *S. jello* from the Gulf of Mannar are reported. The findings of this study will serve as a foundation for future research into population, feeding, and reproductive biology, all of which are critical for developing long-term management strategies for barracudas in this region.

Keywords : Gulf of Mannar, Barracudas, Catch and Effort, Negative Allometric Growth, Management

Paper ID 15898

Occurrence of Eel larvae in Palk Bay and Palk Strait, Tamil Nadu, Southeast Coast of India

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Uroconger lepturus (Richardson, 1848) is the only eel species known from Indian waters included under the family Congridae and subfamily Congrinae. The metamorphic larval stage of the eel (Leptocephali) collected from the Palk Bay ecosystem (294 km stretch from Point Calimere to Dhanushkodi) was studied in detail. This study reports on the occurrence of larval stages of eel observed during experimental fishing conducted in March 2021 in this area. Samples were collected during experimental fishing made at Mallipattinam (10°12'10.9"N 79°23'21.3"E), Kottaipattinam (9°56'24.6"N 79°17'59.1"E) and Thondi (9°34'08.1"N 79°00'34.2"E) in Palk Bay and Palk Strait. The collected samples consisted of several species of fishes, crustaceans and molluscs including fish larvae dominated by the larval stages of eel. The laterally compressed transparent eel larvae with a length ranging from 10 to 13 cm and height from 0.8 to 1.0 cm were identified as the glass eel stage. Further molecular studies confirmed the specimen collected was the leptocephali of the Uroconger species (COI-OM992253). Leptocephali accounted for 50% of the total fish larvae of the collections made. The eels are known to have complex migratory behaviour that alternates between freshwater and marine habitats. The Muthupet Lagoon is a large brackish water ecosystem where five rivers namely Pamani, Agniyar, Ambuli, Vellar and Pambar discharge their freshwater. The presence of the leptocephali in the sampling areas indicated the possibility of spawning in the continental shelf area and affirming that catadromous migration a feature of the eel life cycle occurs in the Palk Bay ecosystem and that the region offers a suitable habitat for eels.

Keywords : Leptocephali,Larval Stage, Migration,Spawning, Habitat

Paper ID 15901

Ecological and Biological Significance of Netrani Island, Karnataka

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Netrani Island (14º59'N, 74º19'E) also called Pigeon Island is one of the unique offshore islands in the Uttar Kannada district of Karnataka. It is located about 19.6 km from the Murudeshwar coast, covering an area of about 4.2 km^2 and an altitude of 77 m above MSL. The Netrani island and underwater reef area around the island are quite unique and previous studies have recorded the diversity and anthropogenic impacts on this site. A study was taken up to understand the ecological and biological significance of this island ecosystem based on eight criteria set for understanding the ecological or biological significance of an area. The criteria include uniqueness and rarity; special importance for life-history stages of species; importance for threatened, endangered, or declining species and/ or habitats; Vulnerability, fragility, sensitivity, and slow recovery; biological productivity; biological diversity; Naturalness; and ecosystem functions. The input information for various criteria was collected from published literature and by conducting site surveys from May 2019 to January 2022. Nearly 264 species of flora and fauna are recorded from the Netrani reef of which 24 species come under the list of Schedule organisms protected under the WPA, 1972. The forest area and the caves on the island harbor 40 species of avian fauna, of which 16 are winter migrants, and the remaining 24, are residents. The region is found to be the breeding ground or feeding ground or nursery ground of nudibranch, cuttlefish, sharks, turtles, and many teleost fishes. The island was found to be the breeding site of Indian Swiftlets, *Aerodramus (Collocalia) unicolor,* White-bellied Sea-eagles, Brahminy Kites, and various species of terns. The reef area around the island is found to be the fishing ground of hook and line fishing mainly targeting cuttlefish during the post-monsoon season. It is also an important tourist destination for scuba diving. The study clearly indicates that the islands present a fragile, ecologically delicate, and bio-geographically significant ecosystem and hence recommended to be conserved as an ecologically or biologically significant area along the Karnataka Coast.

Keywords : Netrani Island, Coral Reef, Sensitive Ecosystem, Karnataka

Paper ID 15902

Crambionella annandalei as a Human Food and Their Fisheries: Andhra Pradesh Perspective

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The catostylid jellyfish, *Crambionella annandalei* is confined to the Eastern Indian Ocean, in the Bay of Bengal and the Andaman Sea. The species is considered as an important fisheries commodity and the processed oral arms is exported to South East Asian countries. A study was carried out to document the contribution of the species to jellyfish fisheries and to evaluate the economic performance of harvesting the species by coastal fishers along the coast of Andhra Pradesh during 2017-20. The study revealed that only single species *C. annandalei* supports the active jellyfish fishery. The fishing season was found to be during March to July. The total quantities of this edible jellyfish caught by motorized crafts were estimated to 55,181 tonnes. The highest catch was in 2018, wherein 33,273 tonnes were landed. The estimated value of oral arms of jellyfish at landing center level was highest at Rs. 4,013 lakhs in 2018 whereas, the lowest estimated value was Rs. 20 lakhs in 2019. The average operating cost per trip of the single day motorized crafts engaged in fishing jellyfishes worked out to be Rs. 3,527, and with a catch rate estimated at 191 kg/trip, the gross revenue earned from each fishing trip was Rs. 6,271. Net operating income was Rs. 2,744 per trip with a capital productivity of 0.62. The study indicated the jellyfish fisheries of the species have resulted in substantial economic benefits to fishermen, the processors and thus the local economy. In order to improve the jellyfish business in the country, creating awareness among consumers on positive health aspects of consuming edible jellyfish and establishing safe and quick processing amenities, both for ensuring stable and good quality of the final product and for exporting edible jellyfish to foreign markets. Therefore, prospects for escalating jellyfish food uses in India will depend on the development of new processing technologies and on market demand, which in turn will depend on the increased knowledge of jellyfish as food and from its public awareness, respectively.

Keywords : Jelly Fish, Economics, Fishery, Processing

Paper ID 15903

Length-weight Relationship, Length at Maturity and Feeding Behaviour of Thyrsitoides Marleyi, (fowler,1929) from South West Coast of India

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Thyrsitoides marleyi (Fowler, 1929) belongs to the Family Gempylidae, which has a distribution across the tropical and subtropical waters. This is a monotypic species which inhibits the deep sea waters more than 400 meters, caught as the by catch of deep sea shrimp trawlers. The information on this fish other than taxonomy is limited. The present study gives information on the biology, length weight relationship and length at maturity of *T.marleyi* from the south west coast of India. The analysis on length weight relationship and length at maturity were done using R software. The average size at maturity for male is 65 cm and for female is 67.5cm. The pooled value of a, b, and r^2 are .000211, 3.45 and 0.96 respectively and shows isometric growth pattern. The diet pattern of *T.marleyi* includes fishes, shrimps and cephalopods etc.

Keywords : Key Words: *T.marleyi*, South West Coast, Bycatch, Biology

Paper ID 15904

The Diet Composition of Brushtooth Lizard Fish *Saurida undosquamis* in Mumbai Waters, Northestern Arabian Sea.

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The feeding habits of brushtooth lizardfish from Mumbai waters, north eastern Arabian Sea was investigated. The large number of prey items foraged by brushtoothed lizard fish was grouped into four distinct groups i.e Teleost, crustaceans, mollusc and tunicates. Teleost (FPI=65.73% and %IRI=53.82) were found to be preferred prey group in the diet of *S. undosquamis* followed by crustacean (FPI=21.55 & %IRI = 41.73) as secondary accessory food item group. Cephalopods and tunicates form accidental accessory food item foraged by brushtooth lizard fish. The frequent occurrence of poorly fed stomachs and empty stomachs in *S. undosquamis* was high in most of the months. An ontogenic shift in prey species consumed as *S. undosquamis* increased in size was observed. The occurrence of bottom dwelling fishes as well as pelagic fishes in the prey items evidenced that S. undosquamis is an active predator, probably making vertical movement to pursue its prey. Also, this species showed a sort of preference towards carangids, Apogon, Nemipteridae, *Decapterus sp*., *Acetes sp*., *Uroteuthis sp.* The present study provides needful baseline information on the trophic dynamics of *S. undosquamis* which will be helpful in developing models in support of ecosystem-based management.

Keywords : *S. undosquamis*, Ontogenic Shift, Active Predator, Ecosystem Based Management

Paper ID 15906

Length-weight Relationship and Reproductive Biology of *Ariomma indica* (day 1871) From Visakhapatnam, Andhra Pradesh.

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Ariomma indica or commonly known as 'Indian drift fish' forms by-catch in bottom trawl gear and has a good demand in local market at Visakhapatnam, Andhra Pradesh. However, information on the species is lacking hence this study was conducted based on 900 specimens collected during January 2018 to December 2019 from Vishakhapatnam fishing harbor. Length weight relationship of the species is $W = 0.0306*L^{2.75}$ for males, $W = 0.0162*L^{2.97}$ for females and $W = 0.0129*L^{3.04}$ for pooled samples. The sex ratio (F:M) for the entire sample was 1.5 with significant differences ($X^2 = 73.24$, d.f. = 1, $P < 0.05$) from the expected 1:1. Numerical dominance of females was highest in the month of October (3.4) and July (3.2) and lowest in April (0.5) and January (0.6). In the months of March and April 100% mature females were encountered and 97 % and 100 % for males. Significant numbers of mature females were seen throughout the year, with September showing lowest mature individuals. From the mature individuals observed in different months it can be interpreted that the species has prolonged spawning season from November to June, with peak breeding season in the months of February to March. Size at first maturity (L_m) for females was estimated at total length of 17.6 cm. Gonado Somatic Index (GSI) was highest in the months of April, March and February, indicating peak spawning season. The findings give detailed information on reproductive biology of *A. indica* landed at Visakhapatnam, Andhra Pradesh.

Keywords : Bycatch, Trawl Fishery, Spawning, Coastal Fish

Paper ID 15907

Portunid Crab Species Morphometric Delineation Using Truss Software Packages along Gulf of Mannar Coast, Tamil Nadu

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The present study was conducted on commercially important portunid crabs from the Gulf of Mannar coast. By employing a truss network to differentiate them based on body morphometry and morphology, four closely related portunid species such as *Portunus pelagicus* (Linnaeus, 1758), *P. sanguinolentus* (Herbst, 1783), *P. gladiator* (Fabricius, 1798), and *Charybdis natator* (Herbst, 1794) were studied. With regard to conventional morphometry in portunid species, only few characters are seemed to be diagnostic and many characters are found to be overlapping. Hence, Truss morphometry was attempted. Fourteen truss distances landmarks on the cephalothorax dorsal surface were fixed using tpsUtil an digitized using tpsDig computer software package. All the four species showed significant differences by the student's t-test ($p<0.05$). Multivariate analysis revealed that there is significant variation in morphometrics of the portunid species with a high magnitude of differences based on Hotelling's (Sequential Bonferroni significance) p-values ($p<0.01$) on the dorsal surface. The findings support the use of truss networks for diagnostic identification for various species of portunid crabs apart from conventional morphometry. The study will be of immense use particularly in providing intriguing insights for stock identification and characterization, besides, it also clearly reveals any ambiguity in taxonomical clarification.

Keywords : Portunid Crab, Truss, Landmarks, Morphology, Morphometric Measurements

Paper ID 15911

Trophodynamics and Spawning Cycle of Sepia Brevimana Steenstrup, 1875 from South East Coast of India

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Cephalopods are one of the significant components of marine capture fisheries with uneven distributed fisheries and landings in the world's oceans. Cephalopod landings now constitute almost 5% of the world's total fisheries production. Molluscs contributed about 6% of the total marine landings of India during 2020 and cuttlefish contributed about 39% of the total cephalopod landings during the same period. During 2018-19, of the top six states in India contributing to the cephalopod landings, Andhra Pradesh ranked sixth contributing 2% of the mean annual marine landings. The main species of cuttlefish exploited in Andhra coast are *Sepia pharaonis, S. aculeata, S. brevimana, S. vecchioni* and *Sepiella inermis*. About 14% of the total cuttlefish landings were contributed by *S. brevimana* during the period 2018-20. It is commonly called as 'Shortclub cuttlefish' due to its small sized tentacular club with minute suckers. This species is found to be distributed mainly along the Bay of Bengal and Andaman Sea, mainly in shallow coastal waters down to depths of 30 m. They were no reports on its distribution along the west coast of India. In A.P. the annual landings of the species was about 302.7 t in 2020 with peak landings during the winter season (Nov-Jan). Owing to scarcity of information available on the biology of *Sepia brevimana* globally, the present study was conducted using 652 individuals captured during 2018–20, to decipher trophic ecology and spawning cycle of the species along the Andhra coast. The sex ratio was 1:1.3 indicating a numerical dominance of females in the fishery. The mean size of the species in the fishery was about 71.35 mm. Even though they have a morphometric differences in sexes, there was no sex based size difference in the fishery data. Most of the specimens analysed had empty stomachs especially the males (49%). The species is a batch spawner which spawns throughout the year with an absolute fecundity of 57-388 eggs.

Keywords : Feeding, Reproduction, Short Club, Cuttlefish, Andhra

Paper ID 15916

First Report on the Occurrence of *Umbonium vestiarium* (linnaeus, 1758) in Gosthani Estuary of Andhra Pradesh

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Umbonium species commonly called as 'button shells' are the smallest gastropod shells under the family Trochidae and subfamily Umboninae. Even in single species various colour and patterns can be seen. They are distributed in the Indo-West Pacific regions in the shallow, soft and sandy bottoms. They usually occur in high densities in shallow subtidal water. They are non-edible ornamental gastropods that have high demand in the ornamental shell craft industry. *Umbonium vestiarium* (Vesta's button top shell) is the commonly landed species in India. *Umbonium sp.* landed in large quantities at Chollangi, Yetimoga, Dumulapeta, Pedavalasa villages of West Godavari district of Andhra Pradesh and Yanam area which is the part of Puducherry near to Kakinada. First time it is reported from the Gosthani estuary of Bheemunipatnam, towards the north of Kakinada, during 2019 survey across the bed sample of estuary which were conducted from 2017 onwards. The other gastropod species of this estuarine habitat is *Telescopium telescopium*, *Crethedia* sp., *Natica* sp. etc. The salinity of the estuary drops to even 18 parts per trillions (ppt) or less during monsoon due to high fresh water inflow. The density of *Umbonium* sp. occurred mostly in the bar mouth area of estuary which is about 156 nos/m^2 were the average salinity is about 33 ppt. The biomass of the species in the estuary ranges between 0.875 to 35 g/m^2 with an average value of 18.5 g/m^2. During summer it occurred almost in all zones with a biomass of 19.25 g/m^2. There is a scope for future fishery due to its ornamental value even though there was no fishery for the species in this estuary till now.

Keywords : Button Shell, Andhra, Bheemli, Estuary, Gastropod

Paper ID 15926

Does Weighted Nonlinear Modeling Approach Provide Better Solution Compared to Weighted Model Averaging Approach in Explaining the Power Law in Fishery Biology?

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Power law (regression) is often used in fishery biology to predict the bodyweight of fish from commonly available length data. However, the variance (error) distribution structure of the data is often ignored while establishing the relationships between length and weight data which could lead to inaccurate estimation of parameters and their confidence intervals. The difference between Akaike information criterion values (delta AICc) for two models (NLM AICc=3259.81 and LM AICc=3259.63) were used to statistically determine the probability distribution of the data. As the delta AICc was found between -2 ≥delta AICc≤ 2, equal support for both the error distribution structures (normal as well as lognormal) was assumed and therefore, an AICc weighted model averaging approach (wMA with AIC=3260.14 and BIC=3271.66) was followed that gave the estimates for model coefficients and their confidence intervals as a=0.0062, 95% CI=0.0048-0.0078 and b=3.08, 95% CI= 3.004-3.163. However, none of the above models could homogenize the variance structure of the data and hence, a weighted NLM (wNLM) approach was used to address the heteroskedasticity in the data. Out of four different variance weighing structures i.e., (varFixed, varPower, varConstPower and varExp), the 'varPower' was found to be appropriate as it produced the lowest AIC (3224.65) and Bayesian information criterion (BIC=3241.34). Further comparison of AIC and BIC scores revealed that the wNLM is better compared to the wMA as well as LM and NLM. The model coefficients and their confidence intervals obtained from the superior approach (i.e., wNLM) were a=0.0064, 95% CI=0.0049-0.0078 and b=3.07, 95% CI= 2.995-3.144. The findings of the study indicate that wNLM is the best approach to deal with the power regression analysis.

Keywords : Log-normal Distribution, Model Averaging, Weighted Least Squared, Variance Structure

Paper ID 15929

Population Genetic Investigations on the Invasive Tropical American Brackish Water Mussel, *Mytella strigata* along the Indian Coast

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The invasive tropical American brackish water mussel, *Mytella strigata* (Hanley, 1843) has been recorded from the Indian coast recently. They outcompete native species and thus affect native farming practices. *M. strigata* has been reported to affect farming of *Perna viridis* due to faster growth and short larval cycle. We investigated the population structuring in *M. strigata* from the east and west coasts of India using mitochondrial Cytochrome C Oxidase 1 (COI) gene. Samples of *M. strigata* were collected from mussel beds of eastern (Orissa (Chilka lake), Andhra Pradesh (Bapatla), Tamil Nadu (Karapad Bay, Tuticorin and Cuddalore), and western (Kerala (Vizhinjam, Padanna and Kochi)) coasts of India. DNA was extracted from adductor muscle and the COI sequence information was generated. The sequences were aligned using MEGAX and a phylogenetic tree constructed. Three highly divergent clades were present in the dataset. Samples from the west coast of India, Tuticorin and few samples from Cuddalore, recorded 100% identity with *Mytella strigata* samples reported from Singapore retrieved from NCBI, GenBank. The second highly divergent lineage was found in the samples from Cuddalore (82% identity with *M. charruana*). The third highly divergent lineage was recorded from Andhra Pradesh (Bapatla) and Orissa (Chilka lake) (81% identity with *M. charruana*). K2P distance values between these highly divergent clades varied from 14-17%. These highly divergent samples indicate the presence of two other species of this genus along the Indian coast mainly along eastern coast of India. This may be the reason for the high levels of divergence between samples collected from different localities. This need to be further investigated using morphological comparisons and advanced molecular markers.

Keywords : Mytella Strigata, Genetic Divergence, Adaptive Evolution

Paper ID 15931

Seasonal Diversity of Deep-sea Fishes in the Trawler Fishery of The Quilon Terrace Region, South West Coast of India

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Deep-sea fishing season for trawlers operating from Sakthikulangara Fisheries Harbour, Kollam, Kerala commences from October and lasts till May each year, fishing from a depth of 250-500 m. The Quilon Terrace is the smallest terrace region extending from ~200m to 800m and lies between (8.5 ºN to 9.0ºN). Deep-sea finfishes are bycatch of deep-sea shrimp fishery. The finfish bycatch is sold for fishmeal and oil extraction. Studies conducted from October 2019 to February 2022 on the diversity of finfishes in the fishery of the Quilon Terrace yielded a total of 124 species belonging to 107 genera from 71 families and 37 orders. In the spring intermonsoon (SIM) seasonal diversity, a total of 54 species, 48 genera, 49 families and 19 orders were observed among which Order Perciformes dominated the diversity (10 spp.) followed by Anguilliformes (8 spp.). The most numerically abundant species was *Epigonus robustus* (21.83%) in the total diversity, followed by *Chlorophthalmus bicornis* (17.30%). During the fall intermonsoon (FIM), a total of 56 species, 50 genera, 49 families and 20 orders were observed. The order Ophidiiformes dominated the diversity (4 spp.) followed by Scombriformes (3 spp.). The most abundant species was *Bathyclupea hoskynii* (19.35%) followed by *Neoepinnula orientalis* (11.80%). In the North east monsoon (NEM) seasonal diversity, a total of 90 species, 81 genera, 53 families and 28 orders were observed. The order Ophidiiformes dominated the diversity (9 spp.) followed by Acropomatiformes (6 spp.). *Neoscopelus microchir* (20.63%) and *Chlorophthalmus bicornis* (18.10%) were observed as the most abundant NEM species. Species richness (d) and Peilou's indices (J) which indicates species evenness was highest in NEM (d=47±8.5, J=0.75±0.03) followed by FIM (d=40±4.9, J= 0.72±0.01) and least for SIM (d=38±2.82, J=0.73±0.01). Shannon-Weiner biodiversity index (H') between years was 2.83±0.17 in SIM, 2.98±0.06 during FIM and 3.04±0.10 in the NEM months. The study addresses furthering our knowledge on deep-sea fishery and by-catch.

Keywords : Deep-sea Fish, Indices, Biodiversity, Seasonal Variations

Paper ID 15932

On A Method to Summarize the Stock Health of Resources of Indian Marine Fisheries at Various Levels of Exploitation

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Marine fisheries of tropical countries are wrought with many challenges, least of which happen to be the real-time appraisal of exploitation status and stock health. Many indicators of fish stock status (FSS) have been propounded in the last couple of decades, which aim at objective assessment of stock levels and combining them with the trend indicators before rolling out ready to use indicators for management strategy development and overall governance. With such exercises being more in demand under various national and international stipulations, Environmental Performance Index (EPI) to cite one, India is in the cusp of developing its own set of stock health indicators of exploited marine fishery resources, which are easy to compute, rational to comprehend and robust in reflecting the realities thrown up by the dynamics in the EEZ.Aiming a simple, yet conceptually annealed and comprehensive, quantification of fish stock status of the common resource and region-based fisheries of India, a four-point based index has been developed. This has been derived as a simple worksheet-based solution for most of the commonly landed resources for any year in the recent past and coming years. As per the categorization weighted with their relative contribution to Indian fisheries based on 2020 landing figures, 13.8% of the resources that were being caught were falling in the over-fished phase with the rest 86.2% falling in various categories of relative safety and comfort from the stock health point of view. This stock status index coupled with other indices involving selectivity and the weighted mean trophic levels of landed resources would give a mutually complementing comprehensive view of the status of Indian marine capture fisheries at any given point in time.

Keywords : Fish Stop Status, Indian Eel, Marine Capture Fisheries, Sustainable Harvest, Mean Trophic Level

Paper ID 15938

Virgin Information on Biology and Stock for Grey Bambooshark, *Chiloscyllium Cf griseum* müller & henle, 1838 Landed from Eastern Bay of Bengal

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The grey bambooshark, *Chiloscyllium griseum* is a moderate sized marine, demersal and one of the most common sharks caught in the coastal fisheries of West Bengal in India, along Eastern Bay of Bengal. Due to its small size and low economic value, the shark has not attracted attention for conservation and management, although it has been assessed as Vulnerable (VU) in the International Union for Conservation of Nature (IUCN) Red List. There is very little information available on its biology, globally and from Indian waters and the present study is aimed at providing some basic knowledge on the biology of the shark. A total of 471 (222 females and 249 males) grey bamboosharks were collected during 2018-2020 from Digha Mohana fish landing centre of West Bengal. The shark is mostly caught by trawlers along the West Bengal coast with an average annual landing of 205.72 tonnes during 2018-2020. The size of the sharks ranged from 30.5-65 cm (53.36±0.49) Total Length(TL) for females and 45-78 cm (50.43±0.46) TL for males respectively. The length-weight relationship was established as $W= 0.001L^{3.13}$ for females and $W= 0.001L^{3.12}$ for males. Sex ratio (Female: Male) in the fishery was 0.89:1. Length at maturity (LM_{50}) was estimated at 51.2 cm and 47.5 cm TL for females and males respectively. The Gonado-somatic Index (GSI) was found to be maximum (3.7%) in February. Condition factor (Kn) in females was highest in January (0.429). Ovarian fecundity ranged from 12-150 with egg diameter of 0.2-2.4 cm. The number of egg cases varied from 2 to 5. Bony fishes were identified as the most preferred food, with Index of Relative Importance 93.21%. The LC_{50} was found to be 46.5 cm. Growth parameters L_∞ and K were estimated as 84 cm and $0.55y^{-1}$ respectively. The exploitation ratio was found to be 0.47 indicating that the shark is exploited near its optimum exploitation level and can be continued to be harvested sustainably along the West Bengal coast following suitable management strategies as listed in the paper.

Keywords : Maturity, Bambooshark, Vulnerable, sustainability

Paper ID 15942

Characterization of Juveniles and Discards from Trawl Fisheries along the Mumbai Coast, India

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Indiscriminate exploitation of juvenile fishes in any fishery leads to biological and economic unsustainability. Due to its non-selective nature, trawl fishing results in significant discards including juveniles. In this context, experimental fishing was carried out fortnightly from November 2017 to May 2018 using shrimp trawl net (30 mm mesh size) to estimate the percentage and major juvenile species from trawl catch along the Mumbai coast. The proportion of juveniles in the commercial catch and discards was evaluated. Of the total 223.10 kg juveniles, juveniles of commercial catch comprised 56.10% and the remaining 43.90% was discards. Juveniles of major commercially important species harvested included *Coilia dussumieri* (18.24%), *Otolithoides biauritus* (8.83%), *Johnius glaucus* (6.14%), *Johnius belangerii* (5.85%), *Parapenaeopsis stylifera* (3.74%) and *Uroteuthis duvaucelli* (3.69%). The study represents the length at first maturity/length at minimum maturity of 62 species and their percentage-wise juvenile exploitation along the Mumbai coast. It has emerged from this study that trawl fishery exploited huge quantities of juveniles of conventional and non-conventional fish resources. The findings of the study highlight the need for regulating trawl fishery along the Mumbai coast.

Keywords : Juveniles, Shrimp Trawl, Experimental Fishing, Mumbai Coast

Paper ID 15945

Assessment of Ichthyofaunal Diversity of Chandragiri Estuary, Kasaragod, Kerala, India

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Ichthyofaunal diversity of Chandragiri estuary was studied from 2020 to 2021. A systematic and updated checklist of estuarine fishes was prepared which comprised 158 species distributed under 114 genera, 73 families and 32 orders. The order with the largest species diversity observed was Perciformes (39 species), followed by Decapoda (23 species). Most of the recorded species belong to the families Carangidae and Penaeidae. The investigation of ecological guilds revealed that brackish cum marine species were the predominated fishes, with the majority of the species preferring demersal and reef-associated habitats. The conservation status of all taxonomic groups revealed that a greater number of species belonged to Least Concern (74) in finfish and 37 species belonged to a Not Evaluated category in shellfish in IUCN Red list criteria. The proportion of top-level carnivores is higher, whereas the proportion of planktivores/herbivores is lower. A large number of commercial and gamefish have been found in the estuary. The biodiversity indices including Shannon-Wiener species diversity, Pielou's evenness, and Margalef's species richness were estimated based on fish abundance to assess the estuary's ecological health. The information generated from the present study will help formulate conservation and management policies.

Keywords : Ichthyofauna; Estuary; Diversity; Species Richness; Kerala

Paper ID 15949

Observations on the Feeding Indices and Diet Composition of Some Cutlass Fishes Occurring in Indian Waters

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This study is an insight into the feeding indices and diet composition of 5 ribbonfishes occurring in Indian waters such as *Trichiurus auriga*, *T. gangeticus*, *Lepturacanthus pantului, Eupleurogrammus glossodon,* and *Benthodesmus oligoradiatus.* Samples were collected from the landing centers of Sakthikulangara, Tuticorin, and Shankarpur from December 2020 to May 2021. Mainly the ribbon fishes were reported to feed on acetes larvae, sepia, shrimp, squilla, zoea larvae and mysids. In the analysis, the gastrosomatic index ranges from 1.25-3.59, gonadosomatic index ranges from 0.2-2.64, the hepatosomatic index ranges from, 0.23-0.77 and the vacuity index ranges from 11.1-79.29. There are no such details available on the feeding indices and diet composition of these species in Indian waters. Therefore, this study is an attempt to provide some vital aspects of the reproductive biology of these species.

Keywords : Cutlassfishes, Trichiuridae, Reproductive Biology, Diet Composition

Paper ID 15962

Length Weight Relationship and Biology of The Deep-Sea Shrimp *Penaeopsis Jerryi* Perez Farfante, 1979 Landed by The Trawlers Off Kollam Along the South-west Coast of India

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Length-weight relationships (LWR), food and feeding, and relative condition factor were studied for the deep sea peneaid shrimp species, *Penaeopsis jerryi from the southwest coast of India. Samples were* obtained from the trawl nets operated at 200-350 m depth off Kollam (8°56'60.78"N /76°32'34.27"E), Southeastern Arabian Sea during 2019-2020. Females outnumbered males in the catch (1:0.73) and peak fishery was observed from October to February. Total length varied between 60-105 mm in males and 62-127 mm in females. Length at recruitment (Lr) was 58 mm. The parameters of the length-weight relationship were estimated as: a = 0.011, b = 2.62, r^2 = 0.74 for males and a = 0.016, b = 2.66, r^2 = 0.83 for females which was not significantly different ($p>0.05$) between the sexes. The relative condition factor (K) in *P. jerryi* males ranged from 0.65-1.97 and in females 0.35-2.32 indicating better feeding efficiency in females. The food and feeding analysis in both the sexes, revealed the major dietary content as foramniferans (10%), crustaceans (20%) and digested matter. Feeding intensity showed full stomach (31.6%), three-forth (11.3%), half (26.7%), one forth (0.40%), trace (17.5%), empty (12.5%). *P. jerryi exhibits a distinct sexual dimorphism, male having petasma and thelycum in female. Maturity in females indicated immature (44.8%), early mature (22.6%), mature (2.1%) and spent (30.5%). This data reveals the information on the species and also contributes to the stock assessment of fishery resource.*

Keywords : *Penaeopsis Jerryi*, Length-weight Relationships, Food And Feeding, Condition Factor

Paper ID 15964

Reproductive Biology of Large Head Cutlassfish, Trichiurus Lepturus Linnaeus 1758 Along Eastern Arabian Sea And Western Bay of Bengal

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The reproductive biology of cutlassfish, *Trichiurus lepturus* was studied from 2014 to 2018 from 6167 specimens collected weekly along the Eastern Arabian Sea (EAS) and 3346 specimens from the Western Bay of Bengal (WBB). The sex ratio varied significantly ($P < 0.05$) all through the year with a dominance of females during all months except in September and October in EAS while it did not differ significantly ($P < 0.05$) except during June and July in WBB. The estimated length at first maturity (L_m50) for females was 58.0 cm TL in EAS and 55.5 cm in WBB. The Gonadosomatic Index (GSI) values recorded were higher in the months of February and May along EAS, while it was during February and October along WBB. The proportion of ripe and partially spawned fishes was high to moderate from January to May in EAS while it was high from October to March in WBB indicating peak spawning periods for *Trichiurus lepturus*. However, the presence of ripe, partially spawned, spent, and spent recovered fishes throughout the year in varied proportions implied protracted spawning in varying magnitudes and the microscopic and histological examination of the ovaries further confirmed *Trichiurus lepturus* to be an asynchronous batch spawner. The estimated absolute fecundity ranged from 21,930 - 1,85,941 with an average of 28,245 ± 3306 (SE) and 17,294 - 1,86,667 with an average of 75,000 ± 10,436 (SE) per female fish along EAS and WBB respectively. The relative fecundity varied from 12-841 with an average of 105 ± 12.2 (SE) and 64 - 241 with a mean of 64 ± 15.1 (SE) in EAS and WBB respectively.

Keywords : Arabian Sea, Bay Of Bengal, Cutlassfish, Spawning Periodicity, Sexual Maturity

Paper ID 15967

Comparative Study of Diversity, Distribution and Fishery of Beloniformes Fishes Along Kerala and Tamil Nadu Coast

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India has a rich biodiversity of marine fishes of about 2443 species belonging to 927 genera, 230 families and 40 orders, i.e., around 75.6 %. The order beloniformes are represented by 56 species under 19 genera and 5 families in India. They are mainly marine fishes along with few brackish water species. They constitute a minor fishery in the Indian coasts mostly at depth of 0 to 5 meters, hence a mesopelagic resource. They are mainly caught as bycatch in gillnets, purse seines, ring seines and trawls. Studies recorded the biodiversity of beloniform fishes in the southern coast are very few. In this regard, a comparative study of beloniformes occurring in the coasts of Kerala and Tamil Nadu were studied from January 2019 to January 2022. The present study describes 12 species of beloniforms belonging to 8 genera under 3 families from the Kerala coast; 15 species under 10 genera under 3 families from Tamil Nadu coast. The morphometric measurements and meristic counts were used together with the existing FAO keys for identification. Beloniformes are classic example of under exploited resource rich in protein and fatty acids, it can be developed as alternate fishery resource to reduce fishing pressure of other majorly over exploited stocks.

Keywords : Beloniformes, Belonidae, Hemiramphidae, Exocoetidae,tamil Nadu and Kerala

Paper ID 15971

Spatial Prediction Of Flower Tail Shrimp Abundance using Geostatistical Methods in the Vembanad Lake

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Geostatistics as a method provides an effective tool in resolving and evaluating multiscale geographic patterns as it capitalizes on an intrinsic property of nature: spatial and temporal autocorrelation. The optimal semivariogram model and kriging tool together make the best use of available information to obtain the most precise estimation. This is accomplished by minimizing estimation variance and avoiding systematic error while visualizing the error extent. *Metapenaeus dobsoni* (Miers,1878), commonly known as the flower tail shrimp contributes principally to the crustacean resources of Vembanad lake. However, the accurate mapping and distribution study of the species is lacking for the lacustrine water body. In the present study, survey was conducted during late winter season for the Vembanad lake covering 64 Chinese lift nets. Catch composition data and spatial coordinates for the lift nets positioned along the lake were collected. The nature and magnitude of spatial autocorrelation was assessed using a range of semivariogram models while correlating the abundance data with environmental variables. The model with the least possible value of Root Mean Squared Error (RMSE) and Nugget to Sill (N/S) ratio was chosen as the best fit. The kriging tool was performed using the selected semivariogram to produce the spatial distribution and standard error prediction maps. According to spatial mapping, *M. dobsoni* is more abundant in the southern parts of the lake, especially near Panangadu. A local fisher feedback-based survey found a significant reduction and deteriorating trend in species availability over time as a result of flooding, pollution, climate change, and urbanisation. The study's geospatial analysis enhances efforts in location-specific management and can effectively provide precautionary recommendations for management authorities.

Keywords : Geostatistics, Flowertail Shrimp, Kriging, Vembanad Lake

Paper ID 15972

Groupers- Assessment, Perceptions and Evaluation of India's Prized Fishery

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Abstract

Groupers are important marine fishes in reef ecosystems globally, important for food and for livelihoods in many coastal fisheries. The species are particularly susceptible to unmanaged fishing pressure due to their biological characteristics, especially longevity and aggregation spawning behaviour. Recent global reassessments of all grouper species, permits an evaluation of any changes and provides a profile of the current conservation condition of the taxon, identifies the challenges of assessing conservation status, and evaluates current and emerging threats. The assessments enable identification of measures needed to reduce threats, and lessons learned from conservation efforts. The present status of India's grouper biodiversity after the reassessment and the present status of their fisheries are presented. Global capture fisheries production in 2018 reached 96.4 million tonnes, an increase of 5.4 percent from the average of the previous three years. The increase was mostly driven by marine capture fisheries where production increased from 81.2 million tonnes in 2017 to 84.4 million tonnes in 2018, (FAO, 2019). Across India, landings of grouper species as per CMFRI figures have increased over 27 years from 3,251 tonnes in 1985 to 44,684 tonnes in 2013, with highest landings recorded from the southwest followed by southeast and northwest (does not include data from the Andaman and Nicobar Is.). The increases were especially due to landings in Gujarat, Karnataka and Kerala on the west coast and Tamilnadu and Andhra Pradesh on the southeast coast. Natural grouper abundance in India is highest in the southwest, especially off Mangalore mainly due to the presence of the Wadge Bank and the Angrea Bank. Of the 52 species recorded from Indian waters, 39 were reassessed. Of these, 79 percent were assessed as Least Concern (LC), 7.7 percent in Data Deficient (DD) and 7.69 percent as Vulnerable (VU), while 5 percent were Near Threatened (NT). *Epinephelus lanceolatus* which is protected by the WLPA (1971) falls in the DD category. Regional conservation measures must be strengthened to sustain some resources which have been moved from Vulnerable status to LC. Major threats faced are juvenile fishing, fishing on spawning aggregations located in outer reef areas leading to recruitment overfishing. Data collection of DD species to be taken up.

Keywords : Groupers, Conservation, IUCN Status, India

Paper ID 15978

Goatfish Diversity along the Indian Coast - A Rapid Assessment Study

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Goatfishes belonging to family Mullidae consists of 85 species in 6 genera (Nelson, 2016). Of the 6 genera in the family Mullidae, *Mulloidichthys* is the only genus represented in all tropical and subtropical seas (Uiblein, 2011), while *Parupeneus* is found only in Indo-Pacific region (Ben-Tuvia & Kissil, 1988) *Upeneus* is found worldwide except in eastern Pacific region (Randall & King, 2009). They are an important constituent of the marine food fishes of the world. Though many species of goatfish are brightly coloured (Vivekanandan *et al*., 2003), they are not very popular as aquarium fish trade. Goatfishes are ecological indicators and they are widely spread across different tropical and temperate coastal habitats. The present study was conducted across the east and west coasts of India including the Islands for a period of two years. The Mullidae diversity has been made from original collections from different sampling locations from both the west and east coast of India including Lakshadweep. A survey of goatfishes was done during the period 2019-2021. The species are identified based on the morphometric and meristic characters. A total of 11 species under 3 genera were recorded. The species identified: *Mulloidichthys ayliffe* (Uiblein, 2011); *Mulloidichthys flavolineatus* (Lacepède 1801); *Mulloidichthys vanicolensis* (Valenciennes, 1831); *Parupeneus barberinus* (Lacepède, 1801); *Parupeneus cyclostomus* (Lacepède 1801); *Parupeneus heptacanthus* (Lacepède,1802); *Parupeneus indicus* (Shaw, 1803); *Parupeneus macronemus* (Lacepède 1801); *Upeneus guttatus* (Day, 1868); *Upeneus margarethae* (Uiblein & Heemstra, 2010); *Upeneus moluccensis* (Bleeker, 1855); *Upeneus sulphureus* Cuvier, 1829; *Upeneus sundaicus* (Bleeker, 1855); *Upeneus tragula* Richardson, 1846; *Upeneus vittatus* (Forsskal, 1775). Huge knowledge gap exists in goatfish taxonomy, ecology and its diversity in the Indian waters. This study with limited period of time shows there were further study needed in the taxonomy of family Mullidae.

Keywords : Diversity, Mullidae, Goatfishes, Ecological Indicator.

Paper ID 15979

Diversity Studies of Croakers (family: Sciaenidae) from Indian Waters

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Sciaenidae are marine, brackish and freshwater fishes belongs to the order Perciforms. A total of 584 nominal species belonging to 289 valid species and 69 genera is included (Parenti, 2020). Information on taxonomy of sciaenids is confusing and has not been done in India since Lal Mohan (1981) described 30 species from 14 genera. The common name croakers derive from their ability to produce drumming or croaking sounds through specialized body muscles connected to the swim bladder. A rapid survey during 2020-2021 revealed the presence of 19 species in 9 genera from the Indian coasts. The species were identified based on the morphometric and meristic characters. The species identified: *Otolithes ruber, Otolithes cuvieri, Johnius amblycephalus, Johnius glaucus, Johnius carutta, Johnius carouna, Johnius belangerii, Johnius dussumieri, Johnius borneensis, Johnius macrorhynus, Johnius macropterus, Daysciaena albida, Kathala axillaris, Nibea maculata, Nibea soldado, Pennahia anea, Otolithoides biauritus, Protonibea diacanthus and Dendrophysa russelii*. Trewavas (1962) revised the West African species of sciaenids and Trewavas (1977) also revised the Indo-West Pacific species, while Chao (1978) reviewed the western Atlantic species. The FAO species identification guides cover the sciaenid species in the Western Central Pacific (Sasaki, 2001), Western Indian Ocean (Lal Mohan, 1983), Eastern Central Atlantic (Chao, 2016) and Western Central Atlantic (Chao, 2002). About 265 species distributed in 10 subfamilies are reported in the revision of the family prepared by Sasaki (1989) while 67 genera with 283 species are recorded by Nelson et al. (2016). It is concluded that more taxonomic studies should be done for identifying the fish diversity in family Sciaenidae.

Keywords : Checklist, Sciaenids, Arabian Sea, Bay Of Bengal

Paper ID 15984

Record of New Stranding of Rough-toothed Dolphin in Kanyakumari District, South East Coast of India

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A rare specimen of female rough toothed dolphin, *Steno bredanensis* (G. Cuvier in Lesson, 1828) measuring 244 cm TL and weigh about 92 kgs was stranded on 24th March 2022 at kovalam beach (Latitude 8° 4' 55.21" N and Longitude 77° 32' 5.3" E). This present study reports the first stranding record of *S. bredanensis* in Bay of Bengal, Gulf of Mannar, Indian Ocean, South east coast of India. It is evident that the previous record details were reported in south-west coast of India after more than 100 years in 2008. Further, the previous report revealed that three species between the years 1800 and 1900 were recorded in India. Recently, the Marine Mammals Research (MMR) team of the Department of Environment and Forest in Lakshadweep has also reported the first ever sighting of rough-toothed dolphins in Indian waters (The Hindu, Special correspondent, 24th March 2022, Kochi). In this present study, that 31 morphometric characters is presented. It was witnessed by the local fisher that around 100 numbers of rough toothed dolphins were sighted at a distance of 50 meters approximately from the shore. The detailed necropsy (*or post-mortem*) was carried out and found no any significant abnormalities. Based on the condition and external injuries it may be concluded that the cause of death might be due to eco location collapsed and hit by the rock. In addition, the bacteriology result was found that no pathogenic association was detected and virology result showed a negative result for Dolphin Morbillivirus genome. Furthermore, it is also protected under the Marine Mammal Protection Act. It is categorized as Data deficient (DD) as per CMFRI. The *IUCN Red List also* categorized it as least concern (LC).

Keywords : Rough-toothed Dolphin, South East Coast Of India, Stranded, Morphometric Characters

Paper ID 15986

An Annotated Checklist of The Family Portunidae in Gulf of Mannar Coast, Tamil Nadu

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The Gulf of Mannar is home to a diverse range of plants and animals. Crustaceans constitute a major fishery in this region, mostly comprising the dominant group of penaeid prawn, crab and lobster contributing 309.8 tonnes, 404.9 tonnes and 338.29 tonnes in Ramanathapuram district respectively. In Thoothukudi district, the contribution of penaeid prawns and crabs were to the tune of 7180.50 tonnes and 3201.70 tonnes respectively. In the present study, an annotated checklist of portunid crab species so far not been attempted has been made. To study the diversity and species abundance of portunid crabs, specimens were collected in four major fish landing centres namely Mandapam and Keelakarai in the north of the Gulf of Mannar and Thoothukudi and Tiruchendur in the south. Occurrence and abundance data have been generated to study the species composition and for the preparation of a checklist. A total of 31 species belonging to five genera of the family Portunidae have been identified. The highest abundance was observed in the genus *Portunus* with nine species. 14 species were identified in the genus *Charybdis* and four species in the genus *Thalamita*. Three species were recorded in the genus *Scylla* and one species in the genus *Podopthalmus*. The identified species were described in detail in terms of taxonomic classification, habitat and distribution. Comparing the four studied fish landing centres, Thoothukudi had a rich diversity, followed by Mandapam and Tiruchendur while Keelakarai showed the least abundance of portunid species. Of the 31 species identified, *Portunus pelagicus* and *Portunus sanguinolentus* were recorded in large numbers contributing to a substantial fishery of portunids, occurring throughout the year. The annotated checklist will be the first of its kind in this threatened marine biosphere.

Keywords : Portunid Crab, Taxonomy, Distribution, Gulf of Mannar, Sustainable Fishery

Paper ID 15996

Some Aspects of Lobster Fishery in Visakhapatnam, North Andhra Pradesh

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The average annual marine landing of Andhra Pradesh was 195772 t during the period 2016 - 2017 and the average annual trawl catch was 85644 t during that period. The crustaceans formed approximately 21% of the total trawl landings and the lobsters formed 0.3% of the total crustacean trawl landings. The lobster fishery of Andhra Pradesh is supported by species of the genus *Panulirus* and *Thenus*. The species mostly observed in the marine landings are *Panulirus homarus*, *P. polyphagus*, *P. versicolor*, *P. ornatus* among the spiny lobsters and *Thenus unimaculatus* among the sand lobsters. *Panulirus pencilatus* and *P. longipes* are observed occasionally. The fishery is observed from September to March. The highest and the lowest average lobster landings were observed in December and June respectively. The other gears used for lobster fishery are gillnet, bottom set gill net and artisanal gears. Bottom set gillnets are operated for catching lobster at Appikonda, Mutalammapalem, Gangavaram, Pudimadaka and Tandadi. Live lobsters are transported to the harbour in moistened bamboo baskets in auto. The live lobsters are kept in hold for up to 3 to 5 hours before the transport. In the present study an economic analysis of the lobster trade was also carried out.

Keywords : Lobster, Fishery, North Andhra Pradesh

Paper ID 16004

Observations on the Fishery and Biology of Moontail Bullseye *Priacanthus hamrur* (forsskal, 1775) caught Off Cochin Coast of Southwest India

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Bullseye fishes contribute 58,345 tonnes (6.59%) to the total demersal landings in India (central marine fisheries reasearch institute, 2019). The major species that landed in Kerala were *Priacanthus hamrur* (81.8%) followed by *Cookeolus japonicaus* and *Priacanthus sagittarius*. Multiday trawl net contributed to 89.65% of total landings and peak landing was observed during October (23.3%) and November (14.06%). *Priacanthus hamrur* is a circumtropical marine percoid fish that belongs to the family Priacanthidae, and which is one of the major demersal resources exploited along the coast of Kerala. Some biological characteristics of this species were studied based on specimens sampled from trawl landings at Cochin from 2017- to 2019. The total length of the sampled fishes ranged between 165 and 391 mm with the size varying from 165-350 mm and 170-391 mm for males and females respectively. Females were dominant in the fishery, the sex ratio being 1:1.86 (Male: Females). The Length weight relationships (LWRs) of *P. hamrur* were as follows: Male: $W=0.012\ L^{2.995}$, Female: $W= 0.025\ L^{2.779}$ and sexes combined: $W=0.017L^{2.90}$. The relative condition factor (Kn) estimated separately for males and females showed 1.026 and 1.021 respectively, indicating good growth condition. Concerning different size groups, the highest Kn value was observed in the size range of 200-250 mm for both male and female fishes. The highest number of mature gonads (87.5 %) was observed in December. The catch per unit effort (C/E) was estimated as 2.10 Kg/hr. The Von Bertalanffy growth parameters Lα and K were estimated as 401.90 mm and $0.46y^{-1}$ respectively. Analysis of gut content revealed that a dietary preference observed was for crustaceans, fishes and molluscs.

Keywords : Priacanthus Hamrur, Biological Characteristics, LWRs, Relative Condition Factor (Kn), Von Bertalanffy Growth Parameters

Paper ID 16008

Study of Length-weight Relationship of *Epinephalus diacanthus* (valenciennes,1828) Spinycheek Grouper from Kerala Waters

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Groupers are top predators thought to play significant roles in ecosystem function. Most of the spiny cheek grouper fishes caught are either juveniles or sub adults. In the present study, length weight relationship of *Epinephalus diacanthus* (spinycheek grouper) were assessed from Kerala waters, South west coast of India. Altogether 120 fishes were documented from commercial landing center of Kerala, India and used for the assessment of a, b and k values. Length- weight relationship was calculated by means of the least squares' regression on long transformation of the equation $w= al^b$ where w is the total weight (in g) and l is the total length (in mm). All linear regression were statistically significant ($P< 0.05$). Henceforth the length and weight relationship assessment of this species from the study area is supportive in firming up of base line data generation for upcoming outlook of the fisheries. The study also recommends that without rigorous management measures are not executed to limit overexploitation of this species, it is possible that they would soon be overexploited. Being an apex predator in the demersal food web, depletion of stock of *E. diacanthus*, would change the ecological health. Groupers are top predators thought to play significant roles in ecosystem function. Most of the spiny cheek grouper fishes caught are either juveniles or sub adults. In the present study, length weight relationship of *Epinephalus diacanthus* (spinycheek grouper) were assessed from Kerala waters, South west coast of India. Altogether 120 fishes were documented from commercial landing center of Kerala, India and used for the assessment of a, b and k values. Length- weight relationship was calculated by means of the least squares' regression on long transformation of the equation $w= al^b$ where w is the total weight (in g) and l is the total length (in mm). All linear regression were statistically significant ($P< 0.05$). Henceforth the length and weight relationship assessment of this species from the study area is supportive in firming up of base line data generation for upcoming outlook of the fisheries. The study also recommends that without rigorous management measures are not executed to limit overexploitation of this species, it is possible that they would soon be overexploited. Being an apex predator in the demersal food web, depletion of stock of *E. diacanthus*, would change the ecological health.

Keywords : *Epinephalus diacanthus* , Allometry , Conservation , Kerala Waters

Paper ID 16027

Flatheads: Urgent Need for A Taxonomic Revision

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Flatheads are demersal fishes of the Platycephalidae family mainly distributed along the Indo-Pacific region, lives primarily on muddy, sandy, and rocky substrates and found up to 300m depth. They have an elongate, sub-cylindrical body with ridges and spines on the dorsoventrally depressed head. Globally, there are 81 species and 18 genera, in which 14 species have been reported from Indian waters. They are landed in significant quantities along different landing centres, even though they do not make up a large part of the commercial catch. Flathead landing in India was estimated to be 11,425 tonnes in 2020, with landing of around 416 t along the Kerala coast. Misidentification of specimen is a common feature occurring in the family Platycephalidae, indicating that taxonomy remains a challenge for these group of fishes. Many species are still unknown, and little research has been conducted from India's southwest coast. No extensive taxonomic study on flatheads from the Indian coast is done after the study by Murty and Manikyan (2007). To address this issue, we collected specimens from the trawl landing centres of Kerala, primarily Munambam and Kalamukku. We measured and counted a total of 30 morphometric and 16 meristic characters and provided a comparison with other related Platycephalidae species found along the Indian coast. Observations were made on the important characters like ridges and spines on the head by examining adequate number of specimens. As a stepping stone for our future research, this work aims to shed more light on the taxonomic characteristics, correct nomenclature, and descriptions of widely occurring species as well as preparation of distribution maps.

Keywords : Platycephalidae, Misidentification, Southwest Coast, Taxonomic Characteristics

Paper ID 16029

Cephalopod Resources Off Chennai Coast: Fishery, Diversity, Status and Biology

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In Chennai, cephalopods are exploited by multiday trawl net and single day trawlers operating from Madras Fisheries Harbour in Kasimedu, Chennai. It is one of the largest fisheries harbours along the east coast of India. The cephalopod landings at Chennai during the period (2010 to 2020) was studied. The annual landing of cephalopods varied from year to year. The maximum cephalopods landing was observed in 2019 (10073.38 t) and minimum in 2012 (1560.81t). More than 90% of cephalopod landings was by multiday and single day mechanised trawl. Among cephalopods the resources that regularly contribute to the landing are *Sepia pharaonis Uroteuthis* (*Photololigo) duvaucelii, S. aculeata,* S. *Brevimana, Sepiella inermis. Octopus dollfusi* and *O. membranaceus.* This paper presents the status of cephalopod fishery and its species composition. A study on reproductive biology was also carried out. It indicated as a male dominated fishery and also the protracted spawning behaviour of cephalopods. Majority of the resources are exported to the foreign countries because of its high export value. Only squids are sold in local market for consumption in cephalopods.

Keywords : Cephalopods, Fishery, Species Composition, Reproductive Biology

Paper ID 16032

Inter-regional Migration of Indian Oil Sardine, *Sardinella longiceps* along the Southern Coast of India

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The seasonal fishing pattern of Indian oil sardine along the southern coast of India was monitored to trace the cause of seasonal fluctuation in their abundance along the region. Their landing pattern indicates possibility of periodic movement of the species between southwest and southeast coast. The spatial and temporal landing pattern indicates gradual disappearance of the stock along southwest coast by the close of 4th quarter of the year and subsequent building up their fishery along southeast coast. With the weaning of fishery along southeast coast, matured fishes appear along southern regions of southwest coast. This suggested regular seasonal movement between southwest and southeast coast. Timing of the movements, dynamics of coastal ecology, including coastal currents suggested ecological changes as the probable drivers for these movements. Earlier reports also suggested the possibilities of such regular movement and mixing of IOS stocks between both coasts as there is no barriers to prevent their movement between adjacent waters. Continuous distribution of oil sardine along both coasts, with recent finding that oil sardine of both southwest southeast coasts belong to same genetic stock adds weightage to the present finding on their movement between coasts. These findings are very important on deciding the fishery management protocols for the species.

Keywords : Inter-annual Fluctuation, Ecology, Coastal Currents, Genetic Stock

Paper ID 16036

Confirmation of Nemipterids based on Radiography Study Along Gulf of Mannar and Wadge Bank Tamil Nadu Coast

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The fishes belong to the family Nemipteridae generally dwells in muddy and sand bottom in offshore and continental shelf waters up to a depth of 300 m; few of the found in very shallow waters. The studies on taxonomy diversity of nemipterids and radiography identification along southern coast of Tamil Nadu were scanty. The present study aims to document the diversity and taxonomy variation in terms of morphology and radiography from the selected landing centers along Gulf of Mannar (GOM) and Wadge bank (WB), Tamil Nadu between September 2020 and September 2021. The specimens were collected randomly from trawlers operating bottom trawl nets have an overall length of 40 meters and a cod-end mesh size of 35 mm. The morphometric measurements and meristic counts of the specimen were recorded following standard keys. The study revealed a total of 16 species (GOM -15 species dominance of Scolopsis bimaculata, *Nemipterus furcosus*, *N. delagoae*, and *S. vosmeri*; WB-14 species dominance of *N. delagoae*, *N. randalli*, and *Scolopsis bimaculata*) the deeper water species *Parascolopsis bosemani* was recorded along WB whereas *Nemipterus marginatus* and *S. xenochroa* found in GOM due to its differential habitat preference. Based on radiography, the study reveals that anatomical different in the identification of Nemipteridae species viz., the genus Nemipterus have 24 vertebrae, whereas Parascolopsis represent 23 vertebrae and Scolopsis has 22 vertebrae. The detailed morphometric and radiography description has been given in the paper.

Keywords : Key Words – Threadfin Breams, Nemipteridae, X-ray, Vertebrae, Gulf of Mannar And Wadge Bank.

Paper ID 16044

Wedgefish And Guitarfish Fisheries of India: Addressing Sustainability, Livelihoods and Conservation.

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Wedgefishes and guitarfishes (W&GF) are one of the most vulnerable groups being fished globally but are one of the least studied groups as well. In India, W&GF landings increased marginally from an annual average of 2,364 t (1985–1994) to 2,874 t (2011–2020). Trawls landed ~73% of W&GF, followed by gillnets (~17%), artisanal gears (~5%) and hook & lines (~3%). Though W&GF formed only 0.1% of total marine landings in India, these species are ecologically important in coastal waters. Twelve species belonging to the families Rhinidae, Rhinobatidae and Glaucostegidae are landed in India, with *Rhynchobatus laevis* & *Rhinobatus annandalei* being dominant along the west coast and *Rhinobatos lionotus* & *Glaucostegus granulatus*, along the east coast. Seasonality in the landings of W&GF was observed and the west coast contributed significantly to W&GF landings (64%). Evidence of population decline of W&GF species has been voiced by stakeholder communities. Varying abundance in by-catch landings and minimal numbers in commercial landings makes the conservation of this group highly challenging. This study capsules historic trends and current status of W&GF landings in India and identifies research gaps in understanding the biology, ecology and diversity of W&GF in Indian waters, vital to sustain their fisheries and population in the region.

Keywords : Trawl, *Rhynchobatus Laevis, Rhinobatos Lionotus*, Data Deficient, Elasmobranch Fisheries, India

Paper ID 16046

Integrative Taxonomy of the Genus *Atropus* Oken, 1817 (Carangiformes: Carangidae) Reveals Misidentification of Species

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The genus *Atropus* (family Carangidae) is characterized by the combination of characters having a compressed, deep, disk-like or rhomboidal body; a roundly convex upper lip's dorsal contour around symphysis; chevron-shaped or triangular vomerine tooth patch; a poorly developed adipose eyelid; and naked area on breast extending beyond the base of the pelvic-fin. Recently, *Atropus atropos* (Bloch and Schneider 1801), two species of genus *Ulua* and two species previously known in genus *Carangoides* i.e., *Carangoides armatus* (Forsskål in Niebuhr 1775) and *Carangoides hedlandensis* (Whitley 1934) are included in the newly redefined *Atropus* by Kimura et al. (2021). Thus, the genus has five valid species namely: *Atropus aurochs* (Ogilby 1915), *Atropus armatus* (Forsskål in Niebuhr 1775), *Atropus atropos* (Bloch and Schneider 1801), *Atropus hedlandensis* (Whitley 1934) and *Atropus mentalis* (Cuvier in Cuvier and Valenciennes 1833), distributed in the Indo-Pacific region. Altogether, 80 specimens were collected from five geographical locations (Tuticorin, Vizag, Puri, Paradeep, and Digha) along the east coast of India during 2020-2022. In this study, an Integrative taxonomy, combining both molecular (COI sequence) and traditional taxonomic methods, was employed to validate the species of the genus *Atropus* along the Indian waters. Four species: *A. armatus, A. atropos*, *A. hedlandensis* and *A. mentalis* are confirmed along the Indian coasts in this study. After thorough examination of morphometric and molecular data, we found that *A. armatus* and *A. hedlandensis* are more closely related than two other congeners. We have also detailed the sexual dimorphism in three of the above species. The study revealed a number of misidentifications of species or inconsistently reported in global context including the NCBI database and recent publications. A simple key for field identification of the species of the genus *Atropus* is also provided. Our study will help in monitoring and management of harvested stocks of these species.

Keywords : Atropus, Carangidae, Integrative Taxonomy, Misidentification, India

Paper ID 16052

Spatio-temporal Variations in Physico-chemical Parameters of Water and Phytoplankton Diversity in A Tropical Reservoir in India

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The scientific management of reservoirs for fisheries development requires knowledge on trophic structure, population characteristics and the nutrient levels. The present investigation was carried out from July 2014 to Feb 2016 to analyse the Spatio-temporal variations in water quality and plankton diversity at Tunga reservoir, Karnataka. This is a medium reservoir created due to dam constructed across Tunga River, which is a major tributary of Tungabhadra River in Shivamogga district of Karnataka. This reservoir is situated at 75°40'20"E longitude and 14°00'24"N latitudes with water spread area of the 1600 ha. Water and plankton samples were collected from three zones viz., lentic, intermediate and lotic of Tunga reservoir. The water quality parameters values were recorded as pH ranged between 6.30 and 7.80, transparency varied from 25.0 cm to 180.0 cm, dissolved oxygen ranged from 4.59 mg/l to 8.54 mg/l and electrical conductivity varied between 126 µS/cm and 243 µS/cm during the study period. A total of 40 species of phytoplankton (cells/L) were recorded which belongs to 4 groups namely, Cyanophyta (6 species), Chlorophyta (19 species), Bacillariophyta (14 species) and Pyrrophyta (1 species) and the abundance ranged from 320 cells/L to 16285 cells/L. The Diversity indices values for phytoplankton were recorded as Margalef's Richness index (0.71 to 3.28), Evenness (Pielou's) index (0.49 to 0.96), and Diversity (Shannon's) index (0.56 to 3.10). In the present investigation, higher value of electrical conductivity was observed during pre-monsoon could be attributed to the concentration effect as a result of reduced water volume. The abundance of phytoplankton was found to be maximum during pre-monsoon, minimum in monsoon and moderate in post-monsoon season. The correlation analysis shows that total pH and dissolved oxygen are the main factors affecting phytoplankton community structure in Tunga Reservoir.

Keywords : Reservoir, Phytoplankton, Spatio-temporal, Richness, Water Quality

Paper ID 16054

Weight - Length Relationships of Nine Species of Nemipteridae Family Along the Gulf of Mannar, Southeast Coast of India

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The aim of the present study is to assess the weight–length relationships (WLRs) of nine fish species belonging to the family Nemipteridae. Samples of the species caught by using bottom trawl nets were collected from Thoothukudi fishing harbour between from September 2020 and June 2021. Among the nine species, eight species (i.e., *Parascolopsis eriomma*, *Scolopsis bimaculata*, *S. xenochrous*, *Nemipterus furcosus*, *N. zysron, N. furcosus, N. japonicus* and *N. bipunctatus*) showed negative allometric growth whereas (*S. vosmeri*) indicate positive allometric growth. The weight (W) and total length (L) are measured to the nearest 0.01 g and 0.1 cm, respectively, and then regression analysis is performed. Exponent (b) values for LWRs ranged from 2.61 (*Nemipterus japonicus*) to 3.12 (*Scolopsis vosmeri*). The intercept value (a) ranges from 0.0113 (*N. zysron*) to 0.058 (*S. vosmeri*). This detailed report on the WLRs was given in the paper and the study also records new TL max four species viz., *N. zysron*, *N. furcosus*, *N. bipunctatus,* and *P. eriomma.*

Keywords : Bay Of Bengal, Threadfin Bream, WLRs, Thoothukudi Fishing Harbour, Eastern Indian Ocean

Paper ID 16057

Enhancing Production and Sustaining the Black Clam (*Villorita cyprinoides*) Fishery of Vembanad Lake Through Scientific Stocking/ Re-laying in Suitable Sites

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Kerala is the leading producer of black clam, *Villorita cyprinoides* (Gray,1825). The Vembanad Lake, the largest estuary on the west coast of India contributes more that 90% to the total black clam landings with a mean annual production of 40,000 tonnes (2011-2020). This fishery provides livelihood to over 5000 clam fishers. Aimed at enhancing production and sustaining the clam fishery, baby clams were re-laid after identifying suitable areas on the northern side of the Thanneermukkom barrage of Vembanad Lake. Suitable sites for relaying were selected based on the water quality parameters and sediment characteristics. Approximately 140 tonnes of baby black clams with a mean length and weight of 15.1mm and 1.7 g were re-laid by the clam fishers in Keecheri area (lat-long 9º 49' 765" N, 76º 23' 675" E to 9º 50' 951" N, 76º 23' 406" E) of about 15.38 hectares at a rate of 9.52 tonnes/ha under the technical guidance of CMFRI. Approximately 60 tonnes of baby black clams with mean length and weight of 14.7mm and 1.7 g were also re-laid in Chakkathukadu area (lat-long 9º 52' 208" N, 76º 22' 096" E to 9º 52' 289" N, 76º 21' 948" E) of about 4.8 hectares at a rate of 12.5 tonnes/ha. The growth of the re-laid clams was monitored periodically. The fishermen started harvesting around 10 tonnes of clams per day from two areas of the Lake from December 2021 onwards. Fishermen under the Keecheri Ulnadan Matsya Thozhilali Sahakarana Sangham collect the clams using canoes from different locations and sold meat @150 per kg in the nearest market. Each fisher collected 450 kg of clams per day. An estimated production of nearly 1500 tonnes is expected from Keecheri area of Vembanad Lake, which is a 10-fold increase in the production of black clam from this part of the Lake. This relaying efforts helped to enhance new stock of *V. cyprinoides* in virgin areas of Vembanad Lake and facilitated the rejuvenation of black clam fishery.

Keywords : Re-laying, Black Clam, *Villorita cyprinoides* and Vembanad Lake

Paper ID 16079

Evaluation of Length-weight Relationship (LWR) *Aluterus Monoceros* (linnaeus, 1758) along the Indian Coast

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The study on Length-Weight relationship (LWR) and condition factors has a great potential for effective management of a fish species. So, the present study was aimed to explore the length-weight relationship and condition factors of *Aluterus monoceros* (Linnaeus, 1758) along the Indian cost. Over all, the Indian coast was classifieds into North-East coast, South- East coast, North-West coast and South-West coast. The parabolic Length-Weight relationship equation, $W=a\ L^b$ was found to be $W=0.32\ L^{2.59}$, $W=0.34\ L^{2.55}$, $W=0.2301\ L^{2.8219}$, $W=0.29\ L^{2.66}$, $W=0.2301\ L^{2.8219}$, $W=0.45\ L^{2.41}$ for over-all Indian coast, North-East coast, South- East coast, North-West coast and South-West coast respectively. The Le-Cren condition factor (K) was estimated as 2.25(0.74-4.33), 2.44(1.50-4.38), 0.98 (0.47 - 1.50), 3.06(1.88-5.40) and 3.62(2.41-6.37) for over-all Indian coast, North-East coast, South- East coast, North-West coast and South-West coast respectively and Fulton's condition factor (Kn) was 1.95(0.57-3.61),1.94(0.86-3.61), 1.254 (0.573 - 0.935), 2.00(1.02-3.61) and 1.91(0.74-3.51) for over-all Indian coast, North-East coast, South- East coast, North-West coast and South-West coast respectively. The values of a, b, K and Kn varied with age and sex of the fish, wet and dry seasons and environmental conditions. It is observed that this species thrives well in South-East coast of India, as it is caught throughout the year as compare to other coast which is abundantly found during the winter season from October-February.

Keywords : Length-weight Relationship, Condition Factor, Fulton Condition Factor, *Aluterus monoceros* (linnaeus, 1758), Indian Coast

Paper ID 16080

Anti-proliferative Activity of Acromitus Flagellates Crude Extract: A Pilot Study

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Jellyfish are aquatic, migratory invertebrates containing venomous collagen walled capsules known as nematocysts in their tentacles. The long tentacles of these coelenterates aid in their transport as well as in injecting proteinaceous toxins, an envenomation process carried out by means of microscopic barbed stingers, as a defense mechanism. Cutaneous deposition of these potent bio-active toxin molecules and the foreign stinging cell tubules may activate innate and adaptive cellular and humoral immune responses. Their stings are widely reported causing toxic manifestation on the skin, causing pain, lesions and necrosis. Once the toxin reached general circulation, the toxin has gastrointestinal, cardiac, neurological, muscular and immunogenic effects. Conversely, Jellyfish are an untapped resource of easily harvested collagen and other bioactive, which exhibits many bioactivities, including antioxidant activity, mineral binding capacity, antihypertensive activity, lipid-lowering effect, immune-modulatory activity, anti-proliferative, anti-microbial etc. Only a few species of jellyfish have been studied by characterizing and sequencing their venom proteins and in Indian context the study on jellyfish is limited. The molecular contents of the nematocysts from several jellyfish species have now been analysed using proteomic and this provides an insight of its therapeutic uses. The present work aimed to isolate the nematocysts of the jellyfish, found on the Indian west coast and implement these nematocyst extract as a source of candidate drug in the field of cancer by studying their anti-proliferative activity of on cancer cell lines.

Keywords : Jelly Fish, Nematocyst, Antioxidant

Paper ID 16084

Alizarin Red Stain Technique for Fish Skeletal Study

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Alizarin Red stain technique is a kind of preservation technique of intact skeletal system without removing muscles in any animal for long term. It is commonly used to study ossification of bones and skeletal system. This method is being used by different medical disciplinaries to study the rate of ossification in different bones of body and also used for detecting any kind of skeletal deformities. This method can also be applied in fisheries science for taxonomical studies, ossification and modification of bones structures. This technique involves two stains; first is alcian blue stain, which stains cartilage because it binds with the sulphates and glucosaminoglycans (GAGs) therefore, this stain can be used to stain cartilaginous fishes or developmental ossification in fishes. Second is Alizarin red stain, which is an anionic dye and is taken by the calcium presents in the bones to see the stained skeletal structure and rate of ossification without removing the muscles by help of maceration. In fish, scales and skin should be removed before staining. In this method concentration of stains used for staining was standardised. Different bony structure and joints like vertebral column, ribs, hypural, fins, skull of fish can be seen and identified clearly. This technique is easy and uses lesser quantity of chemicals and also with minimum equipments. Stained fish skeleton can be stored in glycerine for longer duration without any deformation or damage compared to other traditional methods of fish preservation for taxonomical studies.

Keywords : Alizarin Red Stain, Fish Skeletal, Taxonomy, Glycoproteins, Glucosaminoglycans, Alcian Blue Stain

Paper ID 16091

Biology Of Indo-pacific Sergeant Abudefduf Vaigiensis (quoy & Gaimard, 1825) From Gulf of Mannar, Tamilnadu, India

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Food and feeding habits of commercially important marine ornamental fish *Abudefduf vaigiensis* from Gulf of Mannar was evaluated with respect to its reproductive development. Analysis of gut contents in the present study indicated that *A. vaigiensis* is an omnivorous fish, feeds on any available food item in its environment such as seaweeds, cladocerans, copepods and insects. The feeding intensity studies of *A. vaigiensis* samples collected from study area revealed that most of the fishes were having either ¼ full or ½ full or ¾ full stomachs. Gastro-somatic index (GaSI) for male shown a regular pattern with an increasing trend after February and reached the highest value in July (1.20) and lowest value (0.36) in November and that of females shown an increasing trend followed by a decrease, with highest value in July (0.95) and lowest value (0.47) in January**.** Hepato-somatic index (HSI) of male increased from November (0.85) to January (1.25) and decreased from February to September with a peak found in December and that of females increased from August (0.85) to December (1.25) and then decreased in July. Gonado-somatic index (GSI) in male sustained a maximum from September to March with a peak during February and was observed to be lower during April to July. GSI in female sustained a maximum GSI from December to March with a peak during February and was observed to be lower during April to October**.** These results reveals that the feeding is correlated with reproductive development of the selected fish species inversely.

Keywords : Keywords: Gastro-somatic Index, Hepato-somatic Index, Gonado-somatic Index, Abudefduf Vaigiensis

Paper ID 16105

Diversity And Distribution of The Fishes of The Family Trichiuridae and Gempylidae in India.

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Trichiuroids are benthopelagic fishes, typically live close to the bottom on the continental shelf and the upper slope, reaching the depths of 50–1500 m. Trichiuroid fishes, includes 26 species of snake mackerels, snoeks, gemfishes, sackfishes, escolars, the oilfish and the domine (Gempylidae) and 45 species of cutlass fishes, hairtails, scabbardfishes and frostfishes (Trichiuridae). Out of 26 species belongs to the family Gempylidae, only ten species were reported from the Indian coast. Similarly, number of Trichiurids species reported from Indian coast is eleven only. In these two families, the fishes included in the family Trichiuridae contributes more to the commercial fishery. In India, except two coastal species Viz, *Trichiurus lepturus* and *Lepturacanthus savala,* other species were rarely exploited. And among these landing centres *Trichiurus lepturus and Lepturacanthus savala* have been found in all the landing centres. *Eupleurogrammus glossodon* is limited to East coast of India and *Eupleurogrammus muticus* is limited to North West coast of India. *Trichiurs auriga, Benthodesmus oligoradiatus, Lepidocybium flavobrunneum, Rexea bengalensis, Ruvettus pretiosus, Thyrsitoides marleyi, Neoepinnula orientichiurus gangeticus* and *Lepturacanthus pantului are limited to West Bengal. In the present study, diversity and distribution of Trichuridae and Gempylidae family fishes was reported.*

Keywords : Trichiuroids, India, Diversity, Distribution

Paper ID 16118

Length-weight Relationship and Fulton's Condition Factor of Four Commercial Fish Species at Nagapattinam Fish Landing Centre, Tamil Nadu, India

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This study assessed the Length-weight relationships (LWR) and Fulton's condition factor for four commercially available fish species, *Nemipterus bipunctatus, Sillago sihama, Rastrelliger Kanagurta,* and *Cynoglossus semifasciatus* of Nagapattinam Fish Landing Centre, Tamil Nadu, India. A total of 343 specimens ranging from 10.8 to 28cm in total length and from 11 to 252g in total weight were collected. The *Rastrelliger Kanagurta* fish species recorded higher mean total length (TL) and mean weight (WT) among the four fish species examined. The length-weight relationship was observed to be significantly strong ($P<0.01$) in all the four fish species evaluated with the Coefficient of determination (R2) ranging from 0.9709 to 0.9885 and the Root Mean Square Error (RMSE) ranging from 1.1938 to 5.815. The mean condition factor (KF) was higher in Nemipterus bipunctatus, followed by *Rastrelliger Kanagurta, Sillago sihama*, and *Cynoglossus Semifasciatus*. Based on the results, the growth pattern of *Sillago sihama* was Positive Allometric while the growth pattern of *Nemipterus bipunctatus, Rastrelliger Kanagurta*, and *Cynoglossus semifasciatus* was Negative Allometric. These parameters could be useful for assessing the relative condition of fish and species management as well as their fisheries and stock assessment in Nagapattinam Fish Landing Centre, Tamil Nadu, India.

Keywords : Allometric Growth, Fulton's Condition Factor, Length-weight Relationships, Relative Weight, Fish Landing Centre, Nagapattinam.

Paper ID 16121

Assessment of Sustainability Status of Marine Fisheries of Tamil Nadu Using Fish Stock Sustainability Index.

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Tamil Nadu is a prominent state in India in terms of fish production and resource utilization. In order to ensure sustainable production, fishery management must develop a viable approach for predicting the biological reference points and stock status. As a result, a stock assessment study was carried out to explore the condition of the stock status. The Catch and Effort Data Analysis (CEDA) tool and the Fish Stock Sustainability Index (FSSI) were used in this study to analyse the sustainability status of Tamil Nadu marine fisheries from 1998 to 2018 using reconstructed catch and effort data. The present study estimated 154 commercially important species. From this, 10 representative species were chosen and subjected to detailed analysis with CEDA and FSSI. The CEDA software revealed that 7 of the 10 species were optimally exploited, 1 species was overfished from 2012 to 2018, and one species each was under overfishing status during 1998-2004, 2005- 2011 and 2012- 2018. The scores of FSSI were 937.5, 962.5 and 912.5 for the years 1998 - 2004, 2005- 2011 and 2012- 2018 respectively. Historical assessment of the FSSI revealed that index values improved from 2005 to 2011, then plummeted from 2012 to 2018. The results of the CEDA software and the FSSI score suggested that the fishery in Tamil Nadu is being exploited optimally. However, the reduction in the FSS index during the last decades could be attributed to the overcapitalization in the fishing industries. The present study recommended a review of existing fleet strength and maintenance of fleet strength to an appropriate level in order to build sustainable exploitation of marine fisheries resources of Tamil Nadu.

Keywords : Biological Reference Points, Catch And Effort, Marine Fisheries, Stock Assessment, Surplus Production Model.

Paper ID 16124

Molecular Taxonomy and Phylogenetics of Species Under the Genus *Osteobrama* Heckel,1842 In India

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Genus *Osteobrama* Heckel (family: Cyprinidae) include small to medium sized fishes distributed in India, Pakistan, Bangladesh, Myanmar and China. In India, it is found in North-eastern and Peninsular region only. The present study involves taxonomic validation and elucidation of phylogenetic relationships of 7 *Osteobrama* species distributed within India. The results of meristic analyses showed significant level variation between *O. cunma*, *O. cotio*, *O. belangeri*, *O. cotio peninsularis*, *O. neilli*, *O. bakeri* and *O. vigorsii*, mainly for counts of anal fin rays, lateral line scales and in the presence/absence of barbells. The Principal Component Analysis (PCA) conducted on twenty- six morphometric ratios showed a varied pattern of clusterning between the species. The results of molecular studies showed that out of 647 positions analyzed in the COI dataset for various species, 181 positions were variable (27.9%). The genetic distance between different *Osteobrama* species studied ranged from 0.5% (between *O. cotio* and *O. cotio peninsularis*) to 16.8% (between *O. bakeri* and *O. belangeri*) for COI sequences. The highest genetic distance between *O. bakeri* and *O. belangeri* could be explained by their highest geographical separation. The results of morphological and molecular taxonomy showed that while *O. cotio* and *O. cotio peninsularis* could be differentiated based on morphology, genetically they are closely similar. *Osteobrama belangeri* showed high interspecies K2P distance from all other *Osteobrama* species, indicating that it is diverged quite early from other *Osteobrama* species. The maximum- likelihood (ML) phylogenetic tree constructed using COI sequences showed that *O. belangeri* is genetically distinct from other *Osteobrama* species corroborating with the pattern of evolution and dispersion of other Cyprinid fish species in India.

Keywords : Osteobrama, PCA, COI, Genetic Distance, Phylogenetic Tree

Paper ID 16127

Seaweed Mapping and Its Seasonal Distribution in Pulicat Lake

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Seaweed is a macroalgae which could be cultivated as aquaculture species for enhancing the livelihood of coastal fisher folks as seaweed-based industries are on rise. Cultivation of seaweed is being promoted in the recent years for which the knowledge on local availability, distribution and its habitat is of paramount. Hence the present study was undertaken to map the seaweed resources and document its seasonal distribution along with its habitat water quality parameters in Pulicat lake, a brackishwater ecosystem, straddling the borders of the states of Tamil Nadu and Andhra Pradesh, India. Seaweed mapping is done using satellite data, Landsat 8 OLI image. To increase the accuracy, pan sharpening has been applied using ArcGIS pro-2.6. NDVI (Normalized difference vegetation index) technique ((NIR-RED) / (NIR+RED)) was applied to map the seaweed patches. Field survey and ground truthing has been done covering 400 km2 stretch of the Pulicat Lake from the mouth to upstream portion of the lake by collecting water samples from twenty-five station points from January 2016 to January 2021. Seaweed samples were collected along the path using a sampling frame designed for this purpose. From the study it was observed that five species viz., *Gracilaria caudate*, *Hypnea muciformes*, *Entermorpha* sp, *Halophlia* sp and *Cymodocea* sp. *Entermorpha* sp, *Halophlia* sp and *Cymodocea* were found in all seasons, *Gracilaria caudate* and *Hydropuntia edulis* is observed in the late summer. Species distribution is in the order of *Cymodocea* sp > *Halophlia* sp > *Entermorpha* sp > *Hypnea muciformes* > *Gracilaria caudate.*

Keywords : Brackishwater, Coast, Pulicat Lake, Salinity, Seaweed Mapping , GIS and RS

Paper ID 16136

Can Artificial Reefs Help Sustain Vulnerable Marine Resources: Insights from Case Studies In Tamil Nadu

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Since 2005, ICAR-CMFRI, through its Madras Regional Station, has carried out siting and deployment of artificial reefs in nearly 150 sites in the coastal waters of Tamil Nadu. Post-deployment, Regular fishery and underwater observations conducted for different sites periodically has revealed distinct succession in faunal assemblage and improvement in biomass and productivity in the reef and adjoining areas. Several successful resource revival and restoration cases have been observed and reported by fishers too. Colonies of camel shrimps, juvenile spiny lobsters, sea lilies, galatheid, lobsters, urchins, marbled shrimps, gobiids etc tend to be resident populations and thrive in these substrates. Increased landings of several commercial species have been observed in the fishery from artificial reefs and adjacent areas. On an average 9 species (4-14) of commercial importance was observed in experimental fishing trials using hooks & lines and gill nets, while the scuba diver's perception analysis identifies nearly 16 species (11-22) on an average from the studied sites. VCT-based on underwater video footages shows an abundance of nearly 14 species (7-24) in the reef community settlements as residents. Populations of pearl oyster *Pinctada margaritifera*, Giant clam *Tridacna* sp., rays and skates, *Amphioxus* spp., sea potatoes, wrasses, cleaner wrasses, banner fishes, cardinal fishes, angels, rock cods, snappers, pigface breams, soft and hard corals, gorgonids, damsels, sergeants and surgeon fishes have been observed in good numbers in some specific sites and the stocks observed were healthy and growing.

Keywords : Faunistic Succession, Reef Restoration, Visual Census, Resident Population, Habitat

Paper ID 16154

Morphological Identification of selected Hermit Crabs Found along Tamil Nadu and Maharashtra Coast

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A total of 19 species of hermit crab belonging to 8 genera and 3 families, collected from 20 different sites from Tamil Nadu and Maharashtra coast, were studied for taxonomic evaluation. Descriptive statistics of morphometric variables of these species *viz*. *Clibanarius arethusa, C. infraspinatus, C. longitarsus, C. padavensis, C. zebra, Diogenes alias, D. dubius, D. miles, Dardanus imbricatus, D. pedunculatus, D. hessi, D. setifer, Ciliopagurus tricolor, C. krempfi, C. liui, Aniculus erythraneus, Pagurus kulkarni, Coenobita rugosus* and *Areopaguristes perspicax* revealed significant differences between the species. The Stepwise Discriminant Function Analysis (SDFA) was performed for 12 transformed morphometric variables of 14 species of hermit crabs. SDFA gave correct classification of 91.57% with few instances of misclassification. The major characters, contributing for species discrimination, were propodus length, carpus length, merus length, dactylus length, ischium length, antennular peduncle length, cheliped length, finger length, cheliped width and shield length. A field identification key for identifying hermit crabs available along Maharashtra and Tamil Nadu coast has also been proposed based on the study.

Keywords : Anomura, Hermit Crab, Taxonomy, Discriminant Analysis, Field Identification Key

Paper ID 16162

Characterization and Seasonal Variation of Multiday Trawl Bycatch along West Bengal Coast, India

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Trawl bycatch is one of the major concerns in the global marine fisheries owing to capture of wide range of non-target species. The present study was carried out, from July 2018 to March 2019 with a commercial multiday shrimp trawl having mesh size of 20 mm off Digha coast, West Bengal at a depth ranging between 9.05 m and 30.18 m, to characterize and study seasonal variation of bycatch. A total 145 species of finfishes and shellfishes were recorded out of which 130 species were characterized as bycatch. Overall bycatch formed 90.6% of the total catch. The major catch consisted of sciaenids, crabs, shrimps, clupeids, Bombay duck, molluscs and elasmobranchs. Discarded ones included gobies, angler fish, puffer fish, tripod fish, some species of crabs, stomatopods, octopus, gastropods and bivalves which have low or no economic value along this coast and juveniles of commercially important fishes. The percentage of pony fish, crabs and molluscs were more in pre-monsoon period while shrimps, elasmobranchs and Bombay duck were more in post-monsoon period. Coilia dussumieri was the only species recorded throughout the study period. It was also revealed that the percentage of retained bycatch was higher in post-monsoon while that of discards was in pre-monsoon period. Use of trawl net with reduced mesh size is the main reason for increased bycatch along this coast. Improvement of trawl net selectivity and use of bycatch reduction devices have been suggested for sustainable management of bycatch resources along the coast.

Keywords : Bycatch, Multiday Trawl, West Bengal

Paper ID 16163

The Complexity of The Feeding Ecology in A Multi Fisheries Based Tropical Ecosystem

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Tropical ecosystems are very complex due to the numerous interlinking between the organisms in terms of trophic interaction. Fundamental principles of Ecology are also based on the trophic interaction or prey and predator relationship. This trophic ecology-related study is essential to understand the overview of feeding strategies, food items, food habits of inhabitants, and the ecological roles of the organisms in a particular ecosystem. The ecological concepts like "Keystone species", "Niche Overlap" and "Electivity or selection of diet" are part of these studies. In our study, we have studied the feeding ecology of the Chilika lagoon ecosystem. Chilika lagoon is a well-known tropical ecosystem having a complex food network system of various flora and fauna including more than 200 species of finfish and shellfish. We have identified the "Keystone species of the Chilika lagoon ecosystem", "Niche Overlap pattern" and the "Electivity" through. the mass balanced ecopath model of Chilika Lagoon. In the keystone analysis, three keystone indices (KS_1, KS_2 and KS_3) were applied and groups like Elopiformes, belonids, eels, threadfin, snakehead, featherback, croakers, perches and crabs were identified as keystone species by more than two keystone indices. A total of 112 pairs were identified based on the niche overlap study. Groups like prawns and crabs were found as the most niche overlapping group among all the organisms and contributed about 14 and 13 number pairs among the 112 niche sharing pairs. Groups like prawns and crabs were found as the most niche overlapping group among all the organisms and contributed about 14 and 13 number pairs among the 112 niche sharing pairs. Similarly, the electivity of the ecological groups was analyzed and interestingly, almost all groups were showing negative index values for detritus and macrophytes. This study is very much helpful to understand the insights into the trophic pattern of the Chilika Lagoon ecosystem.

Keywords : Chilika, Ecopath, Niche Overlap, Key Stone Group, Electivity

Paper ID 16172

Conservation Status of Croakers (sciaenidae) Of India with Comments on The Fishery and Stock Status of Bronze Croaker Otolithoides Biauritus (cantor, 1849) From the North-Eastern Arabian Sea, India

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Croakers (Family: Sciaenidae) are important demersal fishes exploited and widely used for domestic consumption in India. Although 42 species from 18 genera are known from Indian waters, the actual diversity is yet to be understood. Medium to large-sized croakers (>50 cm TL) like *Otolithes ruber, Otolithoides biauritus, Protonibea dicacanthus*, *Nibea soldado,* Macrospinosa *cuja, Daysciaena albida, Argyrosomus japonicus* have a high demand for meat as well as for their swimbladder. Croakers contributed ~3.8 to 8.4% of the estimated marine fish landings of mainland India during 1985 to 2019, with the highest landing of 2,20,120 t recorded in 2011; thereafter the landings have shown a declining trend. Northern Arabian Sea coastal states of India, Gujarat and Maharashtra together contributed a major share (44-57%) of the country's croaker landings during 2015-2019. Forty species of croakers are reported from Indian waters have been assessed in IUCN Red List of Threatened Species; 62% assessed as Least Concern (LC), 29% Data Deficient (DD), 2% Endangered (EN) and 2% Near Threatened (NT). The giant croakers such as; Japanese meagre *Argyrosomus japonicus* is assessed as Endangered (EN) and Blackspotted croaker *Protonibea diacanthus* as Near Threatened (NT). Trawl was the major gear contributing to the fishery landings. The growth and exploitation of the species was assessed. Length frequency-based stock assessment *O. biauritus* in the north-eastern Arabian Sea indicated the need for continuous fishery and trade monitoring along with practical management interventions.

Keywords : : Croakers, Sciaenidae, Trawl Fishery, Bycatch, Swimbladder, Mixed Species Fishery, Arabian Sea, Indian Ocean

Paper ID 16180

Feeding Biology of Otolithes Cuvieri (family Sciaenidae) From Kerala Coast with Emphasis on Ontogenic Diet Changes

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Family Sciaenidae commonly called jew fishes are one among the fish families with high species richness. Out of the 283 species of Sciaenids found in the world, 30 are reported from India. Sciaenids are highly prized group of demersal fishes contributing around 15.3 % of the total demersal fish landings in India and 1.01 % of the annual marine fish landings of Kerala in 2019. Sciaenids are landed mainly by trawl nets (75%), drift gill nets and shore seines contributing the rest. Although studies on Sciaenids in other states are well documented, studies from Kerala are very few. Hence the present study was carried out during January 2020-December 2021 to assess the feeding biology of *Otolithes cuvieri* which is one of the dominant species in the fishery using samples collected regularly from Kozhikode, Kochi and Kollam (350). During the study, along with length, weight and sexual state of the sample, observations were made on the stomach condition, number of prey items, size and weight of prey were noted and the patterns in seasonality and diet shifts were determined. *Otolithes cuvieri* is a carnivore with specialization in shrimp diet (IRI =54.73), along with fish (IRI= 8.19) and other invertebrates. It is an active predator in the bentho-pelagic waters. The index of relative importance (IRI) was used to further elaborate the shift in diet among the size classes. Immature fishes feed mainly on *Acetes* and a clear shift to larger shrimps and fishes is noticed when they grow to larger size, as well as a decrease in feeding intensity. Feeding intensity was more during the post monsoon months.

Keywords : Sciaenidae, Otolithes Cuvieri, Biology, Feeding, Diet, Seasonality

Paper ID 16187

Landing Of Major Fish Group from River Ganga: A Case Study from Patna, India

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River Ganga harbours several fishery resources comprising of a variety of economically important fish groups like Indian Major Carps, catfishes, small indigenous fishes (SIF's) etc. In this present article, an endeavor was made to compare the decadal landing design of the major group of fishes from the river Ganga in and around Patna city. Data on previous records (1958- 1991) were collected through annual reports and bulletins published by ICAR- Central inland Fisheries Research Institute. The results revealed that annual landing from River Ganga at Patna declined from 54.6 t (1958) to 9.63 t (2021) at the display which is roughly 82.4%. Likewise, the share of Indian Major Carps also showed a gradual turn down from 21.53 t to 0.65 t during the period of 1958 to 2021 respectively. Similarly, the declining tendency was also observed in the case of catfishes during the period (1958-2021) where the value came down from 17.52 t to 2.71 t. The shift in landing patterns has been a major concern and can be ascribed due to different anthropogenic, hydrological, and climatic variables. Therefore, restoring natural fish stock from River Ganga requires significant consideration and administration interventions before further impairment.

Keywords : Ganga, Fish Landing, Patna

Paper ID 16188

A Provisionary Adjudgement on The Fishery Status of Pulicat Region Based on Landings

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Fishing is the prime bread provider of the fisher folks inhabiting Pulicat lake region. Pulicat lagoon is the second largest lagoon in India with its one third of area lies in Tamil Nadu rest of the portion in Andhra Pradesh. In the present study, the number of fish landed in the Pulicat region was monitored for the period of 1 year from March 2021 to Mar 2022. In addition, information about type of fishing practices, gears used, fishing days, etc. were also analysed. The mean monthly landings were averaged and variation in the fish landings was identified using correlation analysis. Around 25 fishing villages are distributed around the lake; among them 10 villagers are primarily concentrating in the marine fishing. 'Padu' system of fishing is the widely prevalent strategy in this region. Other than these trawling, hook and line, gill nets were also used for fishing. Maximum landing was recorded during March 2022 (25 tonnes/day) and minimum was recorded during the August 2021(3 tonnes/day). Fish like mackerel, lizard fish, Spanish mackerel, goat fish, crab and prawns were the common fishes caught during the study period. Vermilion coral cod, Queen Fish, milk fish, Gaint ray fishes were rarely caught in the fishing nets. Mostly pelagic fishing is being practised and by catch was very minimal.

Keywords : Pulicat, Fishing, Landing

Paper ID 16193

Mating In the Indian Squid *Uroteuthis duvaucelii* (cephalopoda: Loliginidae) From the Tropical Arabian Sea

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The Indian squid *Uroteuthis duvaucelii* (D'Orbigny, 1835) is the most important commercial species of squid caught from the Indian Seas. Sperm transfer is a complex process in cephalopods, with males transferring intricate spermatophores to females during mating. However, nothing is known about the mating and sperm transfer behaviour of *U. duvaucelii* from the tropical Indian waters. Spermatangia implantations were tracked over the buccal membrane of 14 females and one male Indian squid *Uroteuthis duvaucelii* from the Arabian Sea during February and March 2021. The size of mated female individuals ranged from 110 to 160 mm dorsal mantle length (DML). The numbers of spermatangia in the buccal region range from 64 to 385 (mean=178). The length of the spermatangia ranged from 0.66 to 1.35 mm (average=0.89 mm) and the maximum width ranged from 0.14 to 0.23 mm (average=0.19 mm). Based on the statolith based age estimation, the age of the mated squid ranged from 98 to 148 days. Normally spermatophores are transferred to the buccal region of females by males during copulation, but strangely, a male buccal membrane was observed with spermatangium (n=254), which is evidence of same-sex (homosexual) mating behaviour in the Indian squid. Back-calculated hatching dates for the squids were from September 28th 2020 to 28th November 2020. The present observations give evidence for pre-monsoon mating for the species in the tropical Arabian Sea. Furthermore, we recommend a detailed study on reproductive biology for a complete understanding of the mating behaviour of loliginids in the Arabian Sea.

Keywords : Indian Squid, Statolth, Age And Growth, Homosexual

Paper ID 16203

Long Term Impact Study of Ecological Parameters and Ichthyofaunal Diversity of Ganga River

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The Ganga is believed to be a holy and mighty river by Indians, has been experiencing habitat degradation and loss of indigenous flora and fauna including fish species, aquatic mammals, etc., due to anthropogenic interferences and intrinsic factors in last few decades. The present study was carried out from January 2016 to March 2022 to understand the present status of the environmental health of river Ganga and approaches were initiated through river ranching of native fish species for sustainable fisheries. A total of 190 fish species (182 native and 8 exotics) belong to 133 genera, 62 families and 23 orders were recorded during the entire study period from Harshil to Fraserganj. Cyprinidae was found to be the most species-rich (28 spp., 14.28%) family, followed by Danionidae (19 spp., 9.69%), Sisoridae (10 spp., 5.10%) and Bagridae (9 spp., 4.59%) respectively. The distribution of two brackish water fish species *Otolithoides pama* and *Leiognathus ruconius*, commonly found in the lower estuary of Ganges, the first time recorded in freshwater zone as *O. pama* at Farakka and Patna and *L. ruconius* at Nabadwip of the middle stretch of Ganga. In upper and middle stretch, significant improvement of dissolved oxygen was observed as7.6 to 33%. The decreasing trend of specific conductivity was observed at 2.7-38.2% indicating the improvement in the environmental health status of the river. The highest average B.O.D value of 3.83 ppm was recorded at Kanpur followed by Varanasi at 3.6 ppm and Prayagraj 3.36 ppm due to industrial area, indicating moderated pollution in Kanpur to Prayagraj stretch of river Ganga. For conservation and restoration of riverine resources on a sustainable basis, 68 river ranching programmes were conducted at depleted stretches of the Ganga River covering states like Uttarakhand, Uttar Pradesh, Bihar, Jharkhand & West Bengal summed to ranch 42 lakhs fingerlings of Indian major carps (IMC) and Mahseer. In addition, in lower stretch, from Farakka to Frasergunj, the emphasis was also given towards the stock enhancement and conservational measures for a priced and flagship species, Hilsa, *Tenualosa ilisha*. For the same, massive ranching programmes were arranged in upstream of Farakka barrage at Murshidabad, West Bengal and could able to release 53,222 hilsa juveniles and brooders. A total of 1896 adult hilsa were tagged to study their migratory behaviors in upstream of river Ganga. The present study signifies the improvement status of the environmental health of river Ganga and the importance of conservation and propagation of the native fish species for developing sustainable fisheries.

Keywords : The Ganga, Ecological Health, Sustainable Fisheries, River Ranching

Paper ID 16216

Molecular Taxonomic Approach for Identification of Squid Resources from Indian Waters

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Squids are one of the commercially important fishery resources from India with very high demand in the international market. Squid contributes 4% of total marine fish landings in India. Landing statistic over the last 10 years from 2010 to 2020 shows that the squid fishery increased over the years. An average of 94,687 tons of squid was caught every year and most of the landing was contributed by multiday trawlers. There are a lot of taxonomic ambiguities within the squid species and the accurate identification of species is of prior importance in managing and conserving this species. Integrated taxonomy using molecular markers and morphomeristic characters gives a clear picture of the species. With a view to identify and genetically catalogue the squid species, specimens were collected from different landing centres Initial identification was done based on morpho meristic characters. Molecular characterization was done with partial sequence information of mitochondrial gene Cytochrome C oxidase-I (COI) gene. A total of 85 specimens, belonging to 5 genera and 9 species were collected from 12 locations and COI sequences were generated (650 bp). Morphological and molecular analysis confirmed the species, *Urotethis edulis, U. singhalensis, U. duvauceli*, *Loliolus hardwickei, L. uyii, Sepioteuthis lessoniana, Thysanoteuthis rhombus, Sthenoteuthis oualaniensis* and *Euprymna hyllebergi* in the collections.

Keywords : Squid, Integrative Taxonomy, Cytochrome Oxidase, Phylogeny

Paper ID 16224

Ichthyofaunal Diversity of the River Banas Originating from the Aravalli Ranges of Rajasthan, India

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The rivers of India have vivid and diverse fish diversity and provide abode to numerous endemic and threatened species. The river Banas approximately 512 km in length originates from Khamnor hills of the Aravalli range in Rajasthan and lies entirely within this state. River Banas has left and right bank tributaries. This river is itself a tributary of the river Chambal in Ganga Basin that offers diverse habitat along its flow course and provides abode to numerous fish species of the Ganges basin. Nevertheless, this river has been studied poorly for ichthyofaunal diversity from origin to confluence with Chambal River, a tributary of the Yamuna, which merges into the Ganga. Experimental fishing and habitat assessments were performed during 2020-21 to explore the fish diversity and investigate the role of environmental determinants in shaping the fish community structure. This study revealed the distribution of 44 species belonging to 33 genera of 17 families and 10 orders along the river Banas. Cyprinidae followed by Bagridae was the richest family in terms of species richness. The dominance of exotic African catfish, *Clarias gariepinus* was reported from the river Kothari, a tributary of Banas River. The assessment of physical habitat and water quality variables revealed low dissolved oxygen (<5 mg/l) and high ammonia concentration (>1.2 mg/l) implying poor water quality with less fish diversity at a few sites. The information generated in the present study is vital for sustainable management of riverine fish diversity and ecosystem services to contribute meaningfully and achieve the Sustainable Development Goals (SDGs) especially, SDG 2 - Zero Hunger, SDG 6 - Clean Water and Sanitation, SDG 2 - Responsible Consumption and Production and SDG 15 - Life on Land.

Keywords : Banas River, Ganga Basin, Habitat, Ichthyofaunal Diversity, Rajasthan

Paper ID 16240

Trace Elements Patterns in Otolith Reveals the Stock Structure of *Nemipterus randalli* Russell, 1986 along the Indian Coast

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In India, threadfin breams form the major landings of demersal marine capture fisheries and contribute 4.29% to the total marine catch. Randall's threadfin bream, *Nemipterus randalli* is an economically important demersal fishery resource along the Indian coast. Despite this, information regarding the stock structure of the species is not available. Otoliths (n=5/sites) of *N. randalli* were collected from six important fishery regions of the Indian coast namely Mumbai, Mormugao, Kochi, Tuticorin and Visakhapatnam. Trace elements of whole sagittal otoliths (Ca, Sr, Li, Mn) were determined by inductively coupled plasma mass spectrometry. The ration of Sr:Ca did not showed a significant difference among the sites. Thoothukudi and Visakhapatnam samples showed significantly higher mean values of Li:Ca from the samples along the west coast and there was a significant difference in the Mn:Ca concentration of Visakhapatnam otoliths. In conclusion, Li:Ca and Mn:Ca were able to distinguish between the Indian stocks of *Nemiperus randalli* from different locations and suggests occurrence of different stocks in the Indian coast.

Keywords : Nemipteridae, Sagittae, Trace Elements, Fish Stocks

Paper ID 16241

"Reproductive Biology of Whitefish, *Lactarius lactarius* (bloch And Schneider, 1801) Off Mangaluru Coast, Karnataka"

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Abstract

The study aims to investigate the reproductive biology of the whitefish, *Lactarius lactarius* (Bloch and Schneider, 1801) to take the management measures to conserve the fish species because of its low landings along the Indian coast. Random samples of *L. lactarius* were collected fort-nightly from Mangaluru fish landing centre during April 2021 to January 2022. Based on the observations of 502 samples, it was reported that 303 were males and 199 were females ranging in size from 11.2 to 24.2 cm TL and 13 to 170.3 g TW. The estimated size at first maturity for male and female was observed at 14.7 cm and 15 cm (TL) respectively. The overall sex-ratio was recorded as 1:0.65 which showed a dominance of males. The chi-square ($\chi 2$) test showed a significant difference only during October. The Gonado-Somatic Index (GSI) value ranged from 0.5546 to 1.2106 in male and in females it ranged from 2.6168 to 3.7855. The highest GSI recorded during August for males and January for females. The fecundity ranged from 16,307 to 2,29,787 eggs with an average of 47,846 eggs. The ova-diameter ranged from 0.048 to 0.976 mm. The maturity stages of *L. lactarius* indicated that this species is a prolonged spawner, spawn throughout the year with a peak in January. Random samples of *L. lactarius* were collected fort-nightly from Mangaluru fish landing centre during April 2021 to January 2022. Based on the observations of 502 samples, it was reported that 303 were males and 199 were females ranging in size from 11.2 to 24.2 cm TL and 13 to 170.3 g TW. The estimated size at first maturity for male and female was observed at 14.7 cm and 15 cm (TL) respectively. The overall sex-ratio was recorded as 1:0.65 which showed a dominance of males. The chi-square ($\chi 2$) test showed a significant difference only during October. The Gonado-Somatic Index (GSI) value ranged from 0.5546 to 1.2106 in male and in females it ranged from 2.6168 to 3.7855. The highest GSI recorded during August for males and January for females. The fecundity ranged from 16,307 to 2,29,787 eggs with an average of 47,846 eggs. The ova-diameter ranged from 0.048 to 0.976 mm. The maturity stages of *L. lactarius* indicated that this species is a prolonged spawner, spawn throughout the year with a peak in January.

Keywords : Reproductive Biology, Lactarius lactarius, Gonado-somatic Index, Mangaluru Coast

Paper ID 16243

Studies On Biology of Razorbelly Scad, Alepes Kleinii (bloch, 1793) Along the Mangaluru Coast.

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The Razorbelly scad, *Alepes kleinii* (Bloch, 1793) is a reef associated, tropical marine fish species that belongs to the family Carangidae and the genus *Alepes*. The body is oblong and laterally compressed. The ventral profile is more convex than dorsal profile. The key characteristics to identifying this species are presence of a large black spot on the upper operculum and presence of dark vertical stripes above the lateral line. The lateral line posess broad and prominent scutes. It is also known as banded scad, golden scad and goggle-eye scad. They are locally called as 'Otubaare' in Mangaluru. In the present study a total of 411 fishes comprising 186 males and 225 females ranging from 11.5 to 25.9 cm size in total length (TL) were collected from the Mangaluru fish landing centre and brought to the laboratory for further observations. The length weight relationship for male and female was $W=0.0177L^{2.9603}$ and $W=0.0075\ L^{3.2306}$ respectively. The average relative condition factor (Kn) values obtained for male and female was 1.0107 to 1.0162 respectively. Gut content analysis confirmed that the fish is carnivore. The diet composed of more percentage of crustaceans (38.71%), followed by digested food matter (32.38%), teleosts (21.9%) and fish scales (5.86%). The size at first maturity for male and female was observed at a length of 15.2cm and 15.9cm (TL) respectively. The sex ratio of male:female was found to be 1:1.32 in the commercial catches, indicating the dominance of female fishes over the males in the population. The Gonado-Somatic Index (GSI) values ranged from 0.97 to 3.49 in males and in females it ranged from 0.94 to 4.44. The fecundity ranged between 35,359 to 3,14,530 eggs with an average of 1,08,166 eggs per individual. The ova diameter ranged from 0.01 to 0.47mm. The maturity stages of *Alepes kleinii* showed that species is a prolonged spawner, spawning from August to November with a peak in October.

Keywords : Biology, Razorbelly Scad, Carangidae, Mangaluru Coast

Paper ID 16245

Preservation of Fishes Using Plastination Technology for Academic Use

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The fishes were collected from fish landing centers, dissected and were fixed using10% formal saline for 3 days. Dehydration was carried out in four changes of pure acetone for a period of 7 days depending on the size of the specimen. Impregnation was carried out by using combination of 15% disposable tea cups and thermocol solutions at room temperature for 15 days. The fishes showed varied shrinkage and also colour changes. *Clarias batrachus* showed 67.70 % shrinkage with a black coloration, *Gerres filamentosus* 65.18% with slightly whitish coloration, *Nemipterus japonicas* with 67.86% with slightly yellowish coloration against their normal color. While, some fishes like *Rastrelliger kanagurta (63.21%) Etroplus suratensis* (61.83%) and *Rhabdosargus sarba* (64.97%) showed over all shrinkage percentage at room temperature and little or no discoloration. But there was no change in any morphological details except hardening in plastination technology of fish preservation.

The Elnady technique or Glycerin dry mount method of fish preservation, the discoloration and shrinkage percentage are very less compared to traditional plastination technology. In this technique, *Rastrelliger kanagurta* and *Gerres filamentosus* were preserved by using pure glycerin in impregnation and cornstarch in curing step. The shrinkage percentage in *Rastrelliger kanagurta* ranged from 21.00 to 20.91% and 8.33 to 9.15 *in Gerres filamentosus* at room temperature. The color was normal and consistency became soft and flexible.

Keywords : Plastination Technology, Elnady Technique, Fish Preservation

Paper ID 16246

Length–weight Relationship and Fulton's Condition Factor of Penaeid Shrimp Species, Fenneropenaeus Indicus and Penaeus Monodon of Pulicat Lake, southeast Coast of India

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The present study aimed to provide basic reference information on Length-Weight relationships (LWR) of the two most common and abundant shrimp species of Pulicat Lake namely, *Fenneropenaeus indicus* and *Penaeus monodon* for use in fisheries studies on important biological parameters such as sex ratio, fecundity, growth rate and recruitment to assisting fisheries management and conservation. A total of 1127 specimens of *F. indicus* and 1414 specimens of *P. monodon* were collected from Pazhaverkadu and Arambakkam landing centres from September 2019 to July 2021. The total length ranged from 6.8 to 15.4 cm. and 6.4 to 20 cm. for *F. indicus* and P. *monodon,* respectively. Body weight ranged from 1.8 to 19.7 gm and 2.4 to 66.5 gm for *F. indicus* and *P. monodon,* respectively. The length-weight relationship was calculated using the exponential regression equation, $W = a. L^b$. The Fulton‟s condition factor (K) which shows the state of the overall well-being of shrimps was calculated using the formula $K = W/L^3$. The statistical analysis revealed that both males and females of *F. indicus* and *P. monodon* follow a negative allometric growth trend with b values ranging from 2.676 to 2.922 for *F. indicus* and 2.827 to 2.946 for *P. monodon*.The calculated Fulton‟s condition factor values were in the range of 0.391-0.959 for *F. indicus* and 0.235 - 1.449 for *P. monodon.* The L-W relationship and Fulton‟scondition factor are comparable to works done by earlier researchers indicating that the growth in length is in proportionate to the growth in weight of *Fenneropenaeus indicus* and *Penaeus monodon* of Pulicat Lake. Further, the overall health conditions of these two shrimp species are also found to be good.

Keywords : Length-weight Relationship, Fulton‟s Condition Factor, *Fenneropenaeus indicus, Penaeus monodon*, Pulicat Lake.

Paper ID 16253

Stock Dynamics of Lizardfishes along Indian Coast: An Approach Through Biomass Dynamics Modelling in Multigear Fishery

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Lizardfishes, belonging to the family Synodontidae, is one of the key demersal finfish fishery resources along the Indian coast. They are mostly found at sandy or muddy bottom in shallow coastal waters up to a depth of 100 m and are widely distributed in the tropical and subtropical regions. The annual average landings of lizardfishes in India during the last decade was 68560 tonnes, which constituted 1.84% of the annual marine fish landings of the country. This resource is mostly harvested by mechanised fishing units especially trawlers and motorized and non-mechanised gears in lesser quantities. Three genera contributed to the landings of lizardfishes in the country with the dominance of two species *Saurida tumbil* and *S. undosquamis.* Analysis of data on landings estimated by ICAR-CMFRI for the period 1985-2019 indicate that there was a steady increase in landings over the years from a catch of 13930 t in 1985 to 94817 t in 2016, declining thereafter to 91444 t in 2019. Among the four maritime regions of India, northwest coast dominated in the harvest of this resource with 51% share followed by southwest coast (27%) together making the west coast as the major contributor to lizardfish landings of the country. The lizardfish stock in the four maritime regions of the country were modelled using biomass dynamics models by incorporating gear standardization parameters and gear specific catchability coefficients for handling the multigear situation in the fishery. The models fitted separately to each region gave very good fit when examined using observed and model fitted catch series. The status of lizard fish stocks in the four regions were further examined using Kobe plots generated based on B/B_{MSY} and F/F_{MSY} calculated for different years. For the southwest and southeast regions, the Kobe plot indicated the status of lizardfish stocks as overfished throughout the period, as sustainable in the northwest region after the initial two years, and for the northeast region the stock is stainable in the recent years.

Keywords : Biomass Dynamics, Fish Stock, Lizardfishes, Multigear Fishery

Paper ID 16255

Length-based Population Parameters of the Crimson Snapper, *Pristipomoides filamentosus* (valenciennes, 1830) From Andaman Waters

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The Crimson Snapper *Pristipomoides filamentosus* (Valenciennes, 1830) is one of the commercial important demersal resources from Andaman Waters which are locally known as *Kala Mrigal*. The Crimson Snapper is one of the species caught in large quantities and reduction in size range at landing centres has led to growing concern that the species could be at risk of over-exploitation. The purpose of this study was to carry out a stock status of *Pristipomoides filamentosus*. A total of 750 specimens in the length range of 21.5 cm and 66.6 cm total length (TL) collected during January 2016 to December 2017 from Junglighat Fish Landing Centre, Port Blair, South Andaman were analysed with the help of electronic package FiSAT. The parameters L∞ was 69.83 cm and K was 0.54/year. The Von Bertalanffy (1938) growth equation for *Pristipomoides filamentosus* is Lt = 69.83[1- e-0.54(t-t0)]. The recruitment pattern is bimodal and the period were February and September with peak during February. The longevity of the species was calculated as 6 years. After 1st, 2nd, 3rd, 4th,5th and 6th year the length attained by the species is 29.13, 46.12, 56.01, 61.78, 65.14, and 67.1 cm respectively. The estimated total mortality, Z= 2.17, natural mortality, M=0.93 and fishing mortality, F= 1.25/year. The M/K and Z/K value were 1.72 and 4.01 respectively. The virtual population analysis (VPA) for P. filamentosus indicated that fishes were caught at very early age and length group between 36.5cm to 41.50 cm. larger length group had very low survival rate. The estimated value of exploitation rate (U) and exploitation ratio (E) were 0.51 and 0.57year. -1 The present study showed that the exploitation level has reached to the maximum. To reverse the current trend of exploitation, improved management of the stock is required.

Keywords : Stock, Exploitation, Growth, Mortality, Survival

Paper ID 16262

Length-weight Relationship and Relative Condition Factor of The Crab, *Portunus Sanguinolentus* (herbst, 1783) off Mangaluru Coast Karnataka, India.

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The length-weight relationship of *Portunus sanguinolentus* was estimated and corresponding equation was deduced as $W=0.0431\ L^{3.1096}$ for male and $W=0.0486\ L^{3.0582}$ for female. Analysis of the covariance found that there is no significant difference in the length-weight relationship between male and female. Hence, the combined equation for both sexes was calculated as $W = 0.0451\ L^{3.0894}$and $W= 0.8397L^{2.7888}$. The relationship of carapace width - weight and carapace length - weight of *P. sanguinolentus* showed that the weight of the crab, increased by 3.0894 powers of carapace width. The carapace length – weight relationship showed that the weight of crab, increased as 2.7888powers of the carapace length. The fluctuation in the relative condition factor (Kn) value with respect to size indicated that condition of *P. sanguinolentus* more or less showed an increasing trend an increase in size of the crab. The seasonal fluctuations in the relative condition factor of both the sexes could be attributed to the sexual cycle, food intake and environmental factors.

Keywords : Length-weight Relationship, Relative Condition Factor (kn), *Portunus sanguinolentus*, Carapace Width, Carapace Length, Mangaluru Coast.

Paper ID 16267

Morphometric Characterization of Giant River Catfish, *Sperata seenghala* from River Sutlej, Punjab (india)

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The present study was conducted to characterize the stock of giant river catfish *Sperata seenghala* using morphometric and meristic approach and further their relationships were calculated to assess the present fishery status and well-being of *S. seenghala* population from river Sutlej in Punjab (India). The specimen of varied size of *S. seenghala* was collected from different stretches (upper, middle and lower) of river Sutlej through its course in the state of Punjab and analysed for 33 morphometric and 6 meristic characteristics. The total weight of fish ranged from 140-6730 g, while total length from 33-106 cm. The meristic characters were represented by count of fin rays (fin formula as D.1/7 0 P. 1/9, V. 0/8, A.0 /10) and four pair of barbles. The Sutlej stock of *S. seenghala*, revealed a linear pattern of length weight relationship with strong correlation (r =0.94). The regression coefficient 'b' (2.56) indicated the negative allometric growth of the fish, tended to be thinner with increasing length. The length-length relationships between total length, standard length and fork length (LLR) indicated strong correlation (r = 0.90-0.99). The Relative condition factor (Kn = 1.04) represented the suitability of habitat and conducive environmental conditions for the growth of S. *seenghala*. The data base generated in present study may be pertinent in drafting of suitable management action plan for sustainable production of S. *seenghala* in river Sutlej.

Keywords : *Sperata seenghala*, Morphometry, Length-weight Relationship, condition Factor, Sutlej

Paper ID 16268

Ichthyofaunal Biodiversity of Swarna Estuary of Udupi District in Karnataka, India

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The ichthyofaunal biodiversity assessment of the Swarna estuary was conducted in Kodi-Bengre region. Monthly sampling was carried out to study the abundance and seasonality of fish diversity at 3 stations of the estuary: Bar-mouth region of Sita River (S1), Sita River stretch (S2), and near Suvarna river stretch (S3). A total of 65 fish species belonging to 50 genera, 37 families and 11 orders were encountered. *Nematalosa nasus* was found to be the most dominant of all the species. Order Perciformes comprising of 22 families representing 36 species ranked first, and the order Clupiformes with 2 families representing 6 species ranked second. The seasonal abundance of ichthyofaunal diversity recorded during post-monsoon (October-January) is found to be more compared to pre-monsoon (February-March) and monsoon (August-September) seasons. The diversity indices including Margalef's richness index (d), Shannon-wiener index (H') (at log 10), Simpson index (A) and Pielou's evenness (J) were calculated. The K-dominance curve plot indicated that the species diversity and species richness was high near the bar mouth region. Bray-Curti's similarity index revealed that the maximum similarity was found between pre-monsoon and monsoon seasons at S2 and S1. Same pattern was evident from the MDS plot, and the stress values (0.13, 0.1 and 0.09) which were overlaid on the MDS plot showed good ordination. During the study period, among the 65 species recorded, 25 were Not Evaluated, 35 were Least Concern, 3 were Data Deficient, 1 was vulnerable, and 1 was Critically Endangered.

Keywords : Ichthyofaunal Biodiversity, Swarna Estuary, Biodiversity Indices, Karnataka.

Paper ID 16269

Length Weight Relationship (lwr) and Condition Factor (k) of *Cirrhinus mrigala* Collected from Domesticated and Riverine Habitats

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The length weigh relationship and condition factor of *C. mrigala* individuals collected from two different habitats and four sites i.e S-1 (River Sutlej at Ropar Headworks), S-2 (Harike Pattan at the meeting point of Sutlej and Beas), S-3 (Fish ponds of College of Fisheries, GADVASU, Ludhiana), S-4 (Fish Ponds from nearby farms of district Ludhiana) was estimated. A total 119 individuals of *C. mrigala* comprising males and females of varying sizes were collected and the length weigh parameters were recorded. The mean average length recorded from the S1- S4 was 57.95, 59.90, 37.95 and 35.86 cm, respectively with corresponding weight of 2552.08, 2679.70, 580.85 and 447.37 g, respectively. The length and weight parameters of *C. mrigala* collected from all the sites showed a linear relationship as is evident from the correlation coefficient values of 0.85, 0.81, 0.84 and 0.83 from S1-S4, respectively. The species showed negative allometric growth at all the four sites as depicted by exponent (b) values 2.88, 2.79, 2.64 and 2.52 at S-1, S-2, S-3 & S-4, respectively. The condition factor values of 1.31, 1.24, 1.06 and 0.97 from S-1 to S-4, respectively suggested that the environment at all the habitats was conducive for the well-being of the fish but comparatively it was more conducive at the domesticated habitats when compared to riverine environment.

Keywords : Mrigal, Allometric Growth, Condition Factor, B-values

Paper ID 16270

Ascertaining the Identification of Cryptic members of Filamentosus Group Fishes Inhabiting the Rivers of Dakshina Kannada and Udupi Districts Using Molecular Tools

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Evolution is a continuous process with the 'unfit' perishing, 'fit' fighting, and the 'fittest' surviving and evolving. In the era where humanity receives value only when humans are affected, human race has embraced technology to such an extent that the latter should have been granted the status of a basic need. With the Western Ghats being plagued by so many endemic & cryptic taxa which deserve the eminence of valid species, and the diversity being lost, in such a quick pace, in the name of development, ignorance towards digitalization will only promote faster disappearance of life. The efficiency of mitochondrial genes in clear resolution of closely related species, and the availability of robust primers for easier amplification of those genes have made 'DNA barcoding' a promising tool, and the COI & 16S rRNA genes indispensable for deducing molecular phylogenies. In the present study, efforts are made to clear the ambiguity existing with respect to the identity of the members of the genus: *Dawkinsia* by authenticating the true identity of the members involved in the ornamental trade. The COI & 16S rRNA sequence data clearly indicated the specimens as *D. assimilis* (specimens of rivers Yennehole and Payaswini) and *D. filamentosa* (specimens of rivers Yennehole, Payaswini, and Kumaradhara), and confirmed the existence of high intra-specific (COI: 0-2.76%; 16S rRNA: 0.83-3.62%) and inter-specific genetic diversity (COI: 14.29-14.94%; 16S rRNA: 10.78-12.66%) within the populations. The study recommends further studies on other genetic markers, distribution, stock structure, and divergent pattern analysis of the entire group.

Keywords : Cryptic Species, *D. Assimilis, D. Filamentosa*, Molecular Tool, COI, 16s rRNA

Paper ID 16273

Population Dynamics and Stock Assessment of Stripped Murrel *Channa Striata* from River Sutlej, Punjab

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Present study is conducted to assess population dynamics and stock assessment of *C. striata* first time from Sutlej River stretches in Punjab to evaluate its present status and outlining the future policies. River Sutlej is one of most important and longest tributaries of Indus River system with total length of 1450 km**,** out of which 740 km lie in India. In state of Punjab the total length of river Sutlej is approximately 440 km. striped snakehead *Channa striata* commonly known as 'Shol' is an important member of Channidae family. It has high demand in markets because of its taste, lack of intramuscular spine, flavour and medicinal values. Length frequency data of *C. striata* around 500 fish samples was collected at weekly intervals from three selected sites from November 2020 to October 2021 and analyzed using the FiSAT II (FAO-ICLARM). Asymptotic length (L_∞), growth coefficient (K) and age at zero length (t_o) to be calculated as 63 cm, 0.77 yr^{-1} and 0.02 yr, respectively. The growth performance indices (Ø) and longevity (t_{max}) value were calculated to be 3.488 and 3.92 yr. The higher recruitment peaks were detected during June (15.14 %) and July (16.66%), respectively. Total mortality (Z), fishing mortality (F) and natural mortality (M) rate were calculated to be 2.51, 1.27 and 1.24 yr^{-1}, respectively. The exploitation ratio was found to be 0.51 and the exploitation rate (U) to be 0.39 yr^{-1} indicating overexploited condition. The estimated E_{max}, $E_{0.1}$ and $E_{0.5}$ value of *C. striata* was 0.647, 0.557 and 0.343, respectively. The $E_{cur} < E_{0.1}$ denotes there is little scope to increase further fishing efforts for this species to reach the target reference point (TRP) and existing fishing pressure should be reduced substantially for sustainable development of *C. striata* species in River Sutlej.

Keywords : River Sutlej, Channa Striata, Population Dynamic, Fishing Mortality, Exploitation Ratio, Overexploitation

Paper ID 16274

Reproductive Biology of *Portunus Sanguinolentus* (herbst, 1783) Off the Mangaluru Coast of Karnataka.

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The maturation studies were carried out on *Portunus sanguinolentus* samples collected from commercial landings. Maturity stages were classified based on the macroscopic appearance of the ovary. The overall sex ratio of 1:1.1043 (M: F) was skewed towards female in *P. sanguinolentus.* Sex ratio differed in different months and size classes. The Gonado Somatic Index values ranged between 0.705 to 1.287 and 1.004 to 1.666 male and female respectively. The size at first maturity of *P. sanguinolentus was* estimated at 12.1cm and 11.6cm for male and female respectively. Fecundity of *P. sanguinolentus* ranged between 1,67,499 to 9,23,560 eggs respectively, with an average of 4,59,082 eggs.

Keywords : *Portunus sanguinolentus*, Maturation, Spawning, Mangaluru Region

Paper ID 16275

Stock Assessment of Three Fish Species of Cyprinidae family along the Potamon Zone of Thamirabarani River Basin, Eastern Slope of Western Ghats, South India

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The length frequency data for three fish species, *viz*., *Cirrhinus mrigala* (Hamilton, 1822), *Dawkinsia filamentosa* (Valenciennes, 1844) and *Labeo rohita* (Hamilton, 1822) were collected by using gears namely, cast net, drag net with 1.0 – 1.5 mm mesh size, gill net with various mesh sizes *viz* 70, 90, 120 & 180 mm and pole and line along the potamon zone of Thamirabarani River basin between November 2020 and October 2021. The estimated length-weight relationships (LWRs) were $W = 0.02699 * TL^{2.8850}$ ($r^2 = 0.9035$), $W=0.01137*TL^{2.5756}$ ($r^2 = 0.9646$) and $W = 0.00795 * TL^{3.1494}$ ($r^2 = 0.94276$) respectively. The stock status of the three cyprinid fishes were assessed by using FiSAT II software package wherein, growth parameters (L_∞ & K), mortality parameters (Z, M & F), fishing pattern were documented in this paper. The growth parameters of *C. mrigala* (89.25 cm, 0.87), *D. filamentosa* (22.05 cm, 0.68) and *L. rohita (*57.25 cm, 0.9) were estimated. Similarly, the mortality parameters of *C.mrigala* (2.14, 1.22 & 0.92), *D. filamentosa* (2.42, 1.54 & 0.88) and *L. rohita* (2.87, 1.42 & 1.46) were estimated. The estimated exploitation ratios (E) for the three species were 0.43, 0.36 and 0.51, respectively. The present mean catch per unit effort (CPUE) was found to be 0.9136 kg/hr/craft. In this purview, the present paper insights on LWRs, stock status and CPUE of three cyprinid fish species along the potamon zone of Thamirabarani river basin, South India to avail the suitable measures to conserve these fish stocks.

Keywords : Conservation, Cyprinid Fishes, Length Frequency, Stock Status, Thamirabarani River Basin

Paper ID 16276

Food and Feeding Habits of Crab, *Portunus sanguinolentus* (herbst, 1783) Off Mangaluru Coast Karnataka.

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The study deals with the composition and nature of food items, feeding habits and intensity of feeding habits of crab, *Portunus sanguinolentus* from Mangaluru region. The gut content analysis showed that approximately consisted of crustaceans (20.22%), molluscs (16.93%), fishes (16.51%) and large quantities of sand & debris (23.36%) and miscellaneous items (22.96%). represent the monthly diet composition of *P. sanguinolentus*.

Keywords : Food and Feeding Habits, *Portunus sanguinolentus*, Mangaluru Region.

Paper ID 16278

Stock Structure analysis of Moon Fish, Mene Maculata (bloach & Scheneider, 1801) By Using Truss Analysis

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Mene maculata is a unique species of the Menidae family which comes under order Perciformes. Present study focused on stock structure and management aspect of moonfish stock by using truss analysis. A total of 198 samples were collected from the three different landing centres on the west coast of Indian subcontinent as Veraval, Mumbai and Mangaluru during April, May and September 2021 respectively. A truss network constructed by using 12 landmarks to form a 28 number of truss distances across a body and nine meristic characters were analysed from various location. The principal component analysis conducted shows highest variation on PC1 i.e., 96% and 2.1% on PC2 which was further loaded to rotated sum of square loading it formed the two factor which revealed highest loading. Discriminant function analysis showed an overall 79.5% of original grouped cases correctly classified while, 77.8% of cross-validated grouped cases correctly classified, PCA and DFA illustrate ten truss variables with potential for explaining morphometric differentiation. Which was 6 truss distances (1-2,1-9,1-10,2-3,2-11,2-12,) from Factor 1 and (1-12,2-9,4- 5,5-6) from Factor 2 of 28 truss network measurements were significantly different. Two meristic characters Dorsal fin rays and lower gill rakers out of 9 found to be different. The most relevant morphometric characters were the head region, body depth, caudal peduncle area. This indicates that DFA and PCA is an effective and convenient method for separating the stocks of *M. maculata* from Indian water.

Keywords : Moon Fish, *Mene maculata*, Stock Structure, Tress Analysis.

Paper ID 16280

Length-weight Relationship and Morphometric Analyses of Unexploited Freshwater Mollusc, *Pila globosa* (swainson, 1822) From Cauvery Delta of Nagapattinam Region

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Length-weight relationship and relative condition factor are important in fisheries biological studies which provide information on the growth, general wellbeing, and fitness of fishes. The present study was carried out to examine the morphometry, length-weight relationship and relative condition factor of the Indian apple snail, *Pila globosa* collected from the Cauvery Delta of Nagapattinam region. The relationship between shell length and shell weight was found to be $Y=0.3492x^{2.8801}$. The estimated 'b' value (2.8801) indicated the negative allometric growth pattern of *P. globosa*. The relative condition factor (Kn) fluctuated between 0.70 and 1.53, indicating a state of well beingness of *P.globosa*. Morphometric measures were taken from 201 specimens and the shell length (SL) (3.80 ± 1.07cm), shell width (SW) (3.41±0.99 cm), spire length (SPL) (0.88 ±0.33 cm), base length (BL) (2.99±0.88 cm), aperture length (AL) (2.90 ±0.79 cm), aperture width (AW) (2.22 ±0.61cm) and shell weight (WT) (19.25±11.72g) were observed for *P.globosa* from Cauvery deltas of Nagapattinam region.

Keywords : *Pila globosa*, Apple Snail, Length-weight Relationship, Morphometrics, Nagapattinam

Paper ID 16298

Pigments Profile of Different Seaweeds from the Okha Coast, Gujarat

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Seaweeds are an abundantly available macroalgal group capable of producing various natural pigments through photosynthesis. These pigments are getting considerable attention in the medicinal sector due to their potential biological activities. Seven different types of seaweeds were collected, including red algae (*Halymenia venusta, Solieria robusta, Halymenia porphyraeformis*), brown algae (*Colpomenia sinuosa, Iyengaria stellata*) and green algae (*Caulerpa racemosa, Ulva lobata*) from Okha coast, Gujarat. Chlorophyll-a, Chlorophyll-b, total chlorophyll and carotenoid contents were estimated by two different methods using 80% acetone and DMSO. In the acetone method, Chlorophyll-a and Chlorophyll-b content were found to be maximum in *C. racemosa* (21.487 µg/ml and 16.192 µg/ml, respectively). Total chlorophyll content was more in green algae (6.811-37.669 µg/ml), followed by red algae (3.332-4.027 µg/ml) and brown algae (2.328-4.643 µg/ml). Carotenoid content was reported maximum in *C. racemosa* (0.784 µg/g), followed by *C. sinuosa* (0.239 µg/g). In the DMSO method, Chlorophyll-a was more in *C. sinuosa* (23.714 µg/ml) followed by *H. venusta* (20.405 µg/ml). The maximum chlorophyll-b was observed in *H. venusta* (20.436 µg/ml). Red algae (2.914-40.829 µg/ml) were reported with high total chlorophyll, followed by brown (7.091-31.032 µg/ml) and green algae (2.019-8.769 µg/ml). Carotenoid content was observed high in *H. venusta* (1.482 µg/g) and *C. sinuosa* (1.251 µg/g). It was revealed that extraction depends on the chemical nature of pigments with different solvents. The DMSO method delivered noticeable results for brown and red algae, whereas the acetone method was best for green seaweeds.

Keywords : Seaweeds, Pigments, Chlorophyll, Carotenoid

Paper ID 16303

Assessment of Mangrove Above-ground Biomass and Blue Carbon Stock along Tamil Nadu's Southern Coast Using Multispectral Satellite Images

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Mangroves have the potential to store carbon in their biomass and the bottom sediment; hence, these ecosystems serve as carbon sinks, thereby playing a significant role in climate change mitigation. Large scale mangrove mapping and its changes can be studied using remote sensing where the survey access is difficult and limited. In this view, the present study attempts to document the above-ground biomass of mangroves, and blue carbon stock along three locations in Thoothukudi (Punnakayal, Pazhayakayal, and Tuticorin) and two locations in Kanyakumari (Manakudy and Pantry-Rajakkamangalam), Tamil Nadu's southern coast. Multispectral Landsat 8 Operational Land Imager (OLI) satellite images between 2013 and 2021 were used for the study. Composite images of Landsat 8 bands of 5 (middle-infrared), 4 (near-infrared), and 3(red) were classified using Normalised Different Vegetative Index (NDVI) in open-source GIS platforms. The estimated above-ground biomass (AGB) from 2013 to 2021 showed a fluctuating trend with an overall increase of 36.54 % (i.e., 305. 77 ha to 416.25 ha). Mangrove's average growth rate per year was 5.18 %, with a higher growth rate in Manakudy (8.71 %) and lower in Tuticorin (1.56 %). The mangrove cover in the Thoothukudi (2021) contributes 87.7 % viz., Pazhayakayal (33.9%), Punnakayal (30.3 %), and Tuticorin (23.4%), whereas 12.3 % by Kanyakumari region (Manakudy and Pantry-Rajakkamangalam). The estimated carbon sink was 724 kiloton C year-1 (2021), and the notable mangroves species contributing to the blue carbon potential from the studies regions are Avicennia and Rhizophora. The results explored the significance of mangroves in climate change mitigation and their carbon sink capacity compared to other studies. The study provides baseline satellite information on the changes in mangrove areas, and the results will aid in enhancing the management planning of mangrove forests along the region.

Keywords : Carbon Sequestration, Gulf of Mannar, Kanyakumari, Landsat 8, Mangrove Biomass, NDVI, Thoothukudi

Paper ID 16316

Spatial analysis of Jellyfish Blooms in the Commercial Fishing Grounds of Maharashtra

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The diversity of jellyfish blooms and their occurrence in Maharashtra's commercial fishing grounds from 2017 to 2021 was collected. *Chrysaora sp., Rhopilemma hispidium, Chiropsoides buitendijki* and *Cephea cephea* are known to form blooms. The box jellyfish, *C. buitendijki* bloom was found to occur from October to December and April to May in the dolnet fishing grounds at the depth contour of 20-30m. *R. hispidium* bloom occurs from September to December at the depth contour of 20-30m in the Dolnet fishing grounds. *C.cephea* species interferes in trawl fishing at the depth contour of 40-50m from January to March off the Ratnagiri coast. *Chrysaora* spp., forms blooms round the year and peaks from October to December and April to May at the depth contour of 10-50m along the coast of Maharashtra. The *Chrysaora* spp., blooms found to interfere in the commercial fishing operation of trawlnet, dolnet and gillnet. Trawl and dol net operation was most affected by these jellyfish blooms among the gears. This study provides baseline information on the interference of jellyfish blooms in the commercial fishing operation in the Maharashtra waters.

Keywords : Jellyfish Blooms, *Rhopilemma hispidium, Chiropsoides buitendijki, Cephea cephea*

Paper ID 16317

Elasmobranch Bycatch in the Fishery along the North-eastern Arabian Sea Coast of India: Species Diversity, Biology and Implications on Fisheries Management

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Elasmobranchs are a regular constituent in the bycatch of the mixed species, multi-gear fishery from the north-eastern Arabian Sea along Maharashtra coast, forming ~1-2% of the retained and utilized bycatch in the state. The elasmobranch fishery, catch, diversity, species composition and biology of major species were studied during 2012-2019. During the period 2012-2019, the average shark catch was 80.7% of elasmobranch fishery, rays 17.1%, and guitarfishes 2.2 %. In Maharashtra, the highest catch was recorded in 2002 with ~14400 tonnes and the lowest in 2019 with ~1800 tonnes. Nearly 80 species are reported from Maharashtra; 59 species belonging to 24 families were observed in the course of our study. The most dominant elasmobranch families in the landings were Carcharhinidae and Dasyatidae in volume and number. The landings were dominated by small-bodied elasmobranchs, such as, *Scoliodon laticaudus* and *Brevitrygon walga* or juveniles. Trawlers contributed a major share of the total landings of elasmobranchs during the period, followed by gillnets and bagnets. Recurring seasonal incidental landings of juvenile sharks were observed at highly localized regions. The size and sex compositions of 42 species of sharks and rays are described and the size at maturity of males and females were determined for 18 of these species. The length–weight relationship was computed from linear regression analysis for 24 species. The study provides updated information on fishery and diversity of elasmobranchs in the north-eastern Arabian Sea and reiterates the need for continuous monitoring of bycatch, fishery and trade of vulnerable fauna.

Keywords : Conservation, Management, Shark, Bycatch, Carcharhinidae, Dasyitidae, Indian Ocean

Paper ID 16318

Ichthyofaunal Diversity of Gorai Creek, Mumbai

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A study conducted to assess the faunal diversity in Gorai creek of Mumbai, India during August 2019 to July 2020, revealed 75 species of fauna under 58 genera, 39 families, 20 orders, 5 classes and 3 phyla. The order-wise representation of identified fauna was found to be 7 ichthyofauna, 4 pelecypods, 6 gastropods, 2 cephalopods, 1 shrimp and 1 stomatopod. The data collected month wise were pooled together and transformed into three seasons [Monsoon (June to September), Winter (October to February), and Summer (March to May)] and this seasonal data were used for the study of biodiversity pattern. Using the average seasonal species occurrence data as input the following biodiversity indices, S, N, d, J', H'(loge), 1-Lambda, Delta, Delta*, Delta+, sDelta+, Lambda+, Phi+ &sPhi+ were calculated by using PRIMER *Vers. 7.0*. The results of the present study indicates that Gorai creek ecosystem is endowed with moderate biodiversity that needs to be conserved.

Keywords : Biodiversity Indices, Fauna, Gorai Creek, Mumbai

Paper ID 16322

Fecundity and Oocyte Size Frequency of *Sepioteuthis lessoniana* from Southeast Coast of India

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The fecundity and oocyte size frequency of bigfin reef squid (*Sepioteuthis lessoniana*) was studied from Thoothukudi, south east coast of India. Squid samples were collected from trawl and jigs, operated for cephalopod exploitation in this region. The oocytes were grouped into four categories viz., immature (I-milky white without striation; Size range – 0.1-2.0 mm) with maturing (II-less striation; size range- 2.0-3.5 mm) pre mature (III- more striations size range- 3.5-5.5 mm) and mature (IV- smooth transparent size range- 5.5-8.0 mm). Fecundity was estimated by counting the maturing, pre mature and matured oocytes of spawning female (stage IV). Fecundity of *S. lessoniana* ranged from 308 in 18.0 cm DML female with 11.8 g ovary weight to 2563 in 34.9 cm DML female with 70.4 g ovary weight. The total fecundity was ranged from 404 to 2777 ova. The estimated average fecundity of *S. lessoniana* was 1043 (mean). There was a clear increase in fecundity with increasing ovary weight (R^2=0.89). The larger females were more fecund than the smaller ones and shows moderate relationship (R^2=0.73). Size frequency of oocyte diameter was estimated for females with stage I to IV maturity stages. The stage I has ova size from 0.1 to 2.0 mm and stage II has ova size range between 0.1 and 3.5 mm. In stage III, ova size ranged from 0.1 to 5.5 mm. After stage III, there was a sharp increase in ovary weight and the development of ova for maturity was rapid in stage IV. All the four types of oocytes present in this stage and ova measuring 4.5 to 5.0 formed a prominent mode. The presence of different oocyte sizes in the mature ovary indicates the multiple spawning strategy in S. *lessoniana*.

Keywords : *Sepioteuthis lessoniana*, Thoothukudi, Fecundity, Oocyte, Ovary

Paper ID 16323

A Scientometric Assessment of Research on Artemia in India Vis-a-vis the World (1949-2021) - A Meta-analysis

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Brine shrimps are little planktonic crustaceans found all over the world in hypersaline habitats. Brine shrimp populations are found in numerous inland salt lakes and coastal salterns across the world. Scientometrics is a branch of statistics concerned with measuring and analyzing scholarly publications. The current study used a web of science (WoS) database to thoroughly analyze and document the *Artemia* research output over the last seven decades. A total of 9738 papers were examined for this study using R software to evaluate the scientific productivity in this specified topic area, with 21.822 % of the publications relating to fisheries and 21.308 % relating to marine, freshwater ecology. The global publishing share, rank, and evolution in terms of research and bibliometric indices such as total citations, h-index, and average citation per paper were analyzed. The United States of America ranks first among the most productive nations in terms of total publications, accounting for 18.895 % publications. India, on the other hand, came in sixth place, accounting for 5.812 % of the total publications. The findings of the current study revealed the trend of "*Artemia*" related research studies published between 1949 and 2021. Since the WoS database only includes WoS indexed journals, the actual number of publications is expected to be far greater than the current study. This study also highlighted the focal areas on this issue about which future topics of research can be chosen for conservation and sustainable utilization of these vital resources.

Keywords : Artemia, Scientometry, Meta-analysis, Research Need

Paper ID 16324

Fishery, Distribution and Utilization of Commercially Important Gastropods from South Coast of India

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Marine gastropod landings are mostly occurring in southeast coast of India viz., Tamil Nadu, Andhra Pradesh and Kerala. The species wise catch data was collected from major gastropod landing centres during 2012 January to 2021 December. The annual exploitation of gastropods in India was 5221 tonnes. Tamil Nadu was dominant (63 %; 5221 tonnes) followed by Kerala (22%; 1073 tonnes) and Andhra Pradesh (15%; 782 tonnes). In India nearly 60 gastropod species form commercial fishery and *Babylonia spp.,* (45 %) was the most dominant species followed by *Turbinella pyrum* (11%)*, Chicoreus ramosus* (10%) and *Lambis lambis* (4%). In Tamil Nadu, trawl net is the major gear followed by Skin diving and gill net. Among species, C. *ramosus* (30 %) *T. pyrum* (17%) and *Baylonia* spp., (12%) was dominat. In Kerala, maximum catch (99%) is from *B. spirata* and *B. zeylanica* by trawlers. In Andhra Pradesh, *Cerethidia sp.,* (40%), *Telescopium sp.,* (14%) and *Umbonium sp.,* (15%) are the dominant species from gillnets and trawl net. In 2021, gastropod landing of Tamil Nadu shows sharp increase with 7423 tonnes due to the emergence of Babylonia fishery which alone contributes 82 % of the total gastropod catch with an CPUE of 500 kg/ unit. However, the gastropod landing of Kerala reduced in recent years mainly due to the strict vigilance for landing of by catch to prevent juvenile fishery. The under sized and infested gastropod shell is used as an ingredient in poultry feed. There is a huge international market for operculum with the price ranging from US $ 10 to US $ 185/kg for ingredient in fragrance making.

Keywords : Gastropod, Fishery, Southeast Coast, Skin Diving, Operculum

Paper ID 16325

Length-weight Relationship of *Osteobrama Vigorsii* (sykes, 1839) (family: Cyprinidae) From Bhima River, Maharashtra, India

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Osteobrama vigorsii (Sykes, 1839) (Family: Cyprinidae), locally known as Phankut, is a minor carp widely distributed in the Krishna, Godavari and Mahanadi River systems of peninsular India. The species is endemic to the fast-flowing rivers and streams of Central India. The Length-Weight relationship is not presented to FishBase for this species and is given in this study for the first time. The relationship between length and weight was determined by the method of least squares using the equation logW = log a + b log L. The study was based on 174 specimens collected during November 2021 to January 2022 from the Bhima River, a part of the Krishna River system in Maharashtra. In the laboratory, total length (L) and total weight (W) were measured to the nearest 0.1 cm and 0.01 g respectively. The length of the specimens ranged between 89-270 mm and the weight ranged between 10-209 g. The equation for the length weight relationship is log W = -3.44797 + 2.325 log L. The value of the exponent b was observed to be 2.325 indicating that the species shows allometric growth. Correlation coefficient r^2 was calculated as 0.8491 and found to be significant for the species. The student's "t"-test was performed to test the significance of regression coefficient and the calculated t value was found to be significant for the species at 1% and 5% which further supported the allometric pattern of growth of the species. The length-weight information of the species is the basic parameter for monitoring the status of the population and it forms the fundamental data for conducting studies on reproductive biology and feeding biology.

Keywords : Length-weight Relationship, Minor Carp, *Osteobrama*, Allometric Growth

Paper ID 16337

Conservation Prioritization: Use of Microsatellite data towards Assessment of Stock Distinctiveness in Trout Stocks from India

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Rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta fario*) are popular salmonid species that are reared for sport and recreational activities worldwide. In India, they were introduced and successfully established in the late 19th and early 20th centuries by the European settlers. However, till now, no studies have analysed the genetic diversity of these stocks. The aim of this study is to analyse the genetic diversity of rainbow trout from North India and South India and brown trout from North India. Genetic diversity was studied using microsatellites and had revealed low genetic diversity in all the stocks with genetic bottlenecks in two stocks from South India and disruption of alleles in two other stocks from North India. This shows that the stocks can encounter regional extinction at any time in the near future and the South Indian stocks are in an endangered condition than the North Indian Stocks. In order to address these issues and preserve the South Indian stocks from extinction. Authorities should consider implementing conservative measures with immediate effect. Today, trout aquaculture is flourishing in North India and it contributes to the economy of the Himalayan states of India. Furthermore, conservative measurements implemented by the concerned authorities in the Himalayan states are yielding fruitful results. Therefore, South Indian authorities should also focus on implementing suitable conservative measures to improve trout farming in South India, which might contribute to the economy of the rural poor.

Keywords : Rainbow Trout, Brown Trout, Conservation, Microsatellites

Paper ID 16339

Length -weight Relationship of Streaked Spinefoot Fish *Siganus javus* (linnaeus, 1766) from Pazhaverkadu Coast, Tiruvallur District, Tamil Nadu

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This study describes the length-weight relationship of streaked spine foot fish *Siganus javus* from the Pazhaverkadu coast, Tiruvallur district, Tamil Nadu. Siganids are a commercially important fish group and attracted the attention of mariculturists of the Indo-Pacific regions because of their rapid growth, herbivorous diet and inhabitation of the shallow coastal waters, brackish lagoons and reef areas. Pazhaverkadu coast is rich in *S. javus* population because the Pulicat lagoon acts as a nursery and breeding grounds for many species of marine fauna. A total of 1040 specimens were monthly sampled during the period of one year (April 2021 to March 2022) from the commercial catches of fishermen. For each specimen, length (mm) and weights (g) were measured and the length-weight relationship was derived with the equation: $W = aL^b$. The ranges of length and weight observed were 3.36–44 cm and 0.65–2188 g respectively. Calculated values of the parameters of LWR are, intercept (a) =0.0137; Slope (b) =3.0556 and coefficient of determination (r^2) =0.995. The values of calculated a and B are much similar to the Bayesian model estimates in Fishbase. The r^2 value above 0.99 indicates the goodness of fit of the regression model and the reliability of the data.

Keywords : *Siganus Javus*, Length-weight Relationship, Growth Rate, Pazhaverkadu Coast

Paper ID 16341

Coral Reef Fish Diversity of Malvan Marine Sanctuary, Eastern Arabian Sea, Maharashtra Coast

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Fish diversity in the patchy coral reef of Malvan Marine Sanctuary (MMS) was recorded in 2021. Survey was conducted in the four sites 1. Sindhudurg fort, 2. Sargassum, 3. Fishes of Pomacentridae family dominated in the patchy coral reef of Malvan Marine Sanctuary (MMS) (42.8 %), followed by Chaetodontidae (21.4 %), Lutjanidae (8.9 %) and Siganidae (7.6 %), Pomacanthidae (5.4 %), Sparidae (5.2 %) and rest by other families. Species recorded in the survey as follows *Acanthopagrus berda, Abudefduf bengalensis, A. sordidus, A. vaigiensis, Acanthurus gahhm, Chiloscyllium griseum, Chrysiptera unimaculata, Cephalopholis formosa, Cynoglossus puncticeps, Chaetodon collare, C. decussatus, C. lunula, Diodon hystrix, D.holocanthus, Dascyllus trimaculatus, Epinephelus malabaricus, Halichoeres cf. Nigrescens, Heniochus acuminatus, H. monoceros, H. singularius, Hemiramphus archipelagicus, H. far, H. lutkei, Lutjanus argentimaculatus, L. rivulatus, L. russelli, L. quinquelineatus, Labroides dimidiatus, Lagocephalus inermis, Monodactylus argenteus, Neopomacentrus cyanomos, N. filamentosus, N. sindensis, Odonus niger, Paracanthurus hepatus, Pomacentrus caerulreus, Pomacanthus semicirculatus, Pseudorhombus javanicus, P. triocellatus, Pempheris vanicolensis, Pomadasys kaakan, P. maculatus, Pterois antennata, Pomacanthus annularis, Sphyraena jella, Siganus canaliculatus, S. javas, Scatophagus argus, Scarus ghobban, Terapon jaubua, T. theraps, Thalassorna lunare, Zancus cornutus and Zebrasoma flavescens.* Among the survey sites Classroom sites has represent more diverse group of fishes followed by Sindhudurg fort, Sargassum and Chivla. This study provides baseline information on fish diversity in the reef ecosystem of Malvan Marine Sanctuary.

Keywords : Coral Fish Diversity, Malvan Marine Sanctuary, Maharashtra, Malvan Scuba Diving Site

Paper ID 16344

Species Diversity, Distribution and Abundance of Molluscs in the Middle Stretch of Gangetic Riverine System (kanpur To Allahabad), Uttar Pradesh

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In the freshwater environment, molluscs are an important group where their abundance plays a pivotal role in ecosystem functioning such as nutrient balance by filter-feeding and algal-grazing. This preliminary survey was carried out in the middle stretch of River Ganga (Kanpur to Allahabad), Uttar Pradesh and comprising some parts of Yamuna River. In view of the scanty information on molluscan diversity of this river, an attempt was made to investigate its gastropod and bivalve diversity, distribution, population density (D) and relative abundance (RA). PRIMER (Plymouth Routines in Multivariate Ecological Research, version 6.1.9) for windows was used for the estimation of biodiversity indices. A total of 16 species, comprising seven gastropods and nine bivalves belonging to four orders, eight families and nine genera were recorded from the study area, based on which a checklist was prepared. Among these, 15 species of molluscs belonged to the Least Concern (LC) category of IUCN Red list whereas the species *Parreysia favidens* subsp. *viridula* belonged to the (Not Evaluated, NE) category. *Bellamya bengalensis* (Lamarck, 1822) and *Parreysia favidens* (Benson, 1862) were the most ubiquitous species in the river system. Numerical density of molluscs was the highest in Kade ghat station and the lowest at Triveni Sangam. In general, lower density and abundance of molluscs were noticed at stations where anthropogenic activities were intense. Shannon diversity index (3.79–3.83), Margalef richness index (4.90–4.98), Pielou's evenness index (0.24), Simpson dominance index (0.07) and Simpson diversity index (0.927–0.929) of molluscs in this region of the river were calculated. This new research provides a major contribution to the systematics of these organisms, with implications for future ecological and conservation research. Considering the lower diversity in comparison to the previous reports, we suggest comprehensive studies aiming at conservation of molluscs of this river system.

Keywords : River, Freshwater, Gastropods, Bivalves, Population, Indices, Conservation.

Paper ID 16346

Biology And Population Dynamics of *Scoliodon Laticaudus* Along Mangalore and Malpe Coasts of Karnataka

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The spadenose shark *Scoliodon laticaudus* is one of the smallest tropical sharks of family Carcharhinidae, locally known as "balyar/neer thate/chaate" in coastal Karnataka. A total of 506 individuals comprising 258 males and 248 females were used for the study. Fortnightly samples were collected from the Mangalore and Malpe landing centers during the period September 2015 to May 2017. The size and weight of fish ranged from 22.5 cm - 63.5 cm (TL) and 104 g – 998 g respectively. The relationship between body weight (BW) and total length (TL) was estimated as $W = 0.01406\ L^{2.7721}$ for male and $W = 0.01562\ L^{2.675}$ for female. *S. laticaudus* spawns throughout the year along Karnataka coast. The length at 50% maturity was found to be 36 cm (TL) and 35 cm (TL) for male and female respectively. In both sexes, it is observed that fish remains, and unidentified and semi-digested matter formed the major food items of the gut. Sardinella spp., *Saurida sp., Nemipturus sp., Priacanthus sp., Terapon sp.,* Sepia sp., *Loligo sp*., anchovies, croackers, shrimps, stomatopods, and molluscan remains were found in considerable quantities in the gut. von-Bertalanffy growth equation for this fish as $L_t = 65.10\ [1\text{-}e^{-0.46\ (t+0.7038)}]$. The total, natural and fishing mortality rates for *S. laticaudus* were recorded as 1.48, 0.85 and 0.63 respectively. The estimated exploitation ratio (E) and exploitation rate (U) were 0.43 and 0.33 respectively. The estimated probability of Length at capture (Lc) of fish yielded following values: length at which 25 percent of fish (L_{25}) will be vulnerable for capture by the gear was found to be 41.53 cm; and length at which 50 percent of fish (L_{50}) will be vulnerable to the gear was 46.29 cm. Similarly for L_{75}, the value obtained was 51.77 cm TL.

Keywords : *Scoliodon Laticadus*, Length-weight Relationship, Food And Feeding Habit, And Population Dynamics

Paper ID 16363

Biological Observation on Indian Squid *Uroteuthis* (*photololigo*) *Duvaucelii* Orbigny, 1835 from Northern Arabian Sea

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The present work aimed to understand the biological characteristic of the Indian squid along the Maharashtra coast. Based on 1462 specimens measurement (45-330 mm DML) revealed negative allometric growth for the Indian squid. The exponent (b) of length-weight relationships estimated for pooled, males and females were 2.29, 2.228 and 2.434 respectively. The overall male-dominant sex ratio (M:F, 1:0.59) of the Indian squid was found along the Maharashtra coast, which significantly differs from the 1:1 (M:F) ratio. The length of 50% maturity (L_{50}) for females was estimated at 92.1 mm DML. The spawning season of the species was protracted with peak GSI observed from October to December. The estimated fecundity was in the range of 1653 -13741 oocytes with a mean ± S.D. of 5965 ± 3947 oocytes per ovary. The diet analysis revealed species was carnivorous and cannibalistic with fishes as the preferential food item (%IRI; 64.2) followed by crustaceans (30.53) as secondary food item (5.25) and cephalopods (0.02) as accessory food. The mean vacuity index (70.5%) indicates the dominance of empty stomachs and slackness in feeding especially in larger individuals.

Keywords : Indian Squid, Length-weight Relationship, Reproductive Biology, Food And Feeding

Paper ID 16364

Trophic Interaction in Commercially Exploited Demersal Finfishes with Emphasis on Ontogenic Diet Shifts

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Trophic interactions were studied in seven commercially exploited marine demersal finfishes of Karnataka to understand the trophic organization with emphasis on ontogenic diet shifts and trophic overlap. In total, 4723 stomachs were examined, of which 73 prey items were identified. Crustaceans and finfishes formed the major prey item. Based on cluster analysis of predator feeding similarities and ontogenic diet shift within each predator, two major trophic guilds were identified. The first guild of 'crustacean feeders' included all size groups of *Nemipterus japonicus*, *N. randalli*, *Otolithes cuvieri* and *Priacanthus hamrur*. The second trophic guild, 'piscivores', was mainly made up of larger size groups of all predators and all size groups of *Saurida tumbil* and *S. undosquamis*. The mean diet breadth and mean trophic level showed a strong correlation with ontogenic diet shift. TROPH values (Trophic position) ranged from 3.4-4.6 for species indicating carnivorous diet pattern. All the species were carnivores and the extent of carnivory increased with ontogeny. It is clear from the present study that most of the species when they were young preferred crustaceans, other invertebrates and smaller fishes, but the preference changed for teleosts and other carnivores as they grew in size and age. A seasonal variation in the diet pattern observed was due to variations in prey abundance. Trophic network analysis showed maximum prey in Trophic level III, and any alterations due to ecological or anthropogenic activities affecting the prey would result in alterations in community dynamics of the predators.

Keywords : Ontogenic Diet Shift, Trophic Interaction, Demersal Finfishes, *Nemipterus japonicus, N. randalli, Saurida tumbil and S. undosquamis, Priacanthus hamrur and Otolithes cuvieri*

Paper ID 16366

Assessment Of Reduction in Catch Sorting Time with Separator Panel of Fish By-catch In Dol Net Fisheries

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The 'dol net' is one of the most important gears used in strong tidal currents along the coasts of Maharashtra and Gujarat. The very small mesh sizes (up to 8 mm) used in the codend is one of the reasons for the high juvenile capture rate and varied fish catch variety retained in the net. The present study aimed at designing a mesh panel to improve the retained catch composition of the dol net and save time in the sorting of catch. Two experiments were conducted along off Mumbai coastal area. Dol net (Set Bag net) fishery that compared catches and by-catches from conventional dol net with those from dol net containing mesh separator panels. The cod-ends of these nets are fabricated with very small mesh sizes ranging a few 8-12 millimeters. The square mesh separator panel has a mesh size of 35mm and is equipped with a regular dol net which has a length of 12-14 meters. The designed mesh panel divides the cod-end section of dolnet into two-part an upper section having a mesh size of 30-35mm and a lower section having a mesh size of 8-12 mm. The results showed the size variation of species in both upper and lower sections. The upper section's catch had a slightly greater mean size of finfish and shellfish than the lower section's catch. The separator panel allowed the passing of small size fish to the cod-end. The catch comprises of 12 species finfish 7 species of crustacean in the upper section whereas 9 species of finfish and 5 species of crustacean and 1 species of cephalopods in the lower section. Both the upper and lower cod-end comprises *Coilia dussumieri, Trichiurus lepturus, Stolephorous indicus, parastromateus niger, Megalaspsis cordyla, Legocephalus inermis, Acetes indicus, Parapeneopsis stylifera*, *Metapenaeus brevicornis*. The finding of this study will help the managers of dolnet fisheries to modify the existing dolnets in a sustainable manner.

Keywords : Bagnet, Dolnet, Net Modification, Separator Panel, Square Mesh

Paper ID 16371

Morphometrics And Meristic Characters of Three Fish Species of Uranoscopidae Family from Coastal Waters of Chennai, India

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The eighteen morphometrics and meristic characters of Uranoscopidae family were examined and described in detail based on two genera and three species. A total of 11 fish specimens were caught by using a gill net from Chennai coastal waters, east coast of India between June 2021 and December 2021. Body measurements, meristic, and colour were taken in fresh in fresh condition, which are then brought to the laboratory for further examination. Total length was measured from the tip of the snout to the caudal fin tip. Total length and weight were measured to the nearest 0.1 cm and 0.001 g using a standard ruler and analytical monoplane weighing balance. In this study, meristic and body measurements are measured as the percentage of total length (TL) or head length (HL). Taxonomical finfish identification was confirmed with standard books and FAO identification sheets. In addition, the specimens were preserved in 5% formalin for deposit in the museum. From this study, it was found to be three species viz., *Ichthyscopus lebeck* (Bloch & Schneider, 1801), *Uranoscopus scaber* Linnaeus, 1758 and *Uranoscopus oligolepis* Bleeker. In this present study, the maximum length of 29 cm and weight of 671 g were recorded for *I. lebeck*. As per Fishbase *U. scaber* was venomous and least concerned (LC) and the remaining two *U. oligolepis* and I. *lebeck* were harmless but not evaluated (NE) as per IUCN.

Keywords : Chennai Coast, Finfish Identification, Fishbase, Meristic, Morphometric, Iucn, Uranoscopidae

Paper ID 16382

Marine Fishery of West Bengal: An Overview

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West Bengal contributed about 9.5% to the total marine landings of India in 2020. The marine catch was highest in 2011 (about 365030 tonnes) after which it showed a drastic decrease of 79% in 2014. An initial revival was noticed till 2017 during which the landings made another high recouping about 99% of decline compared to 2014. The catch, however, is highly fluctuating a lot since the all time high of 2011. The marine fish landings of West Bengal in the year 2020 was about 2.6 lakh tones showing an increase of 4.6% compared to 2019. The resources were predominantly exploited by mechanized multiday trawlers (54%) followed by mechanized gill netters (12%), inboard bag netters (7%) and other gears (27%). Pelagic resources contributed maximum (49%) to the fishery followed by demersal resources (32%), crustacean resources (16%) and molluscan resources (3%). Among the pelagic resources maximum contribution comes from minor clupeids including hilsa (24%) followed by bomabay duck (16%), golden anchovy (10%) and ribbonfish (8%). Pelagic resources like tuna, half and full beaks have shown considerable increase in landings whereas resources like mullets, scads, hilsa have declined in 2020. Among the demersal resources maximum contribution comes from sciaenids (27%) followed by pomfrets (16%) and catfishes (14%), perches (12%), soles (10%), and elasmobranchs (9%). In 2020, big jawed jumper showed 99% decline whereas landings of skates, rays, threadfin breams, threadfins, pomfrets increased considerably. Penaeid and non-penaeid prawns contributed nearly 66% and 21% respectively to the crustacean landings followed by crabs (13%) and lobsters (0.3%). Except *Acetes* and lobsters, other crustacean resources have shown increase in landings in 2020. Cuttle fishes predominantly contributed (71%) to the molluscan landings of West Bengal followed by squids (28%) and Octopus (1%). There has been drastic decrease (71%) in octopus landings in 2020. *Uroteuthis* spp. landings have increased by 96%. Exploitation ratio was higher than the optimal level (E_{opt}=0.5) in only 6 out of 21 species investigated which are *Sardinella gibbosa* (0.82), *Parapenaeopsis sculptilis* (0.74), *Nemipterus japonicas* (0.68), *Coilia dussumieri* (0.66), *Parapenaeopsis stylifera* (0.64) and *Otolithes ruber* (0.63) that warrants exploitation management for sustainability.

Keywords : West Bengal, Marine Fishery, Stock Assessment, Exploitation Level

Paper ID 16388

A Holistic Approach Towards Restoration of Hilsa Shad, Tenualosa Ilisha, An Anadromous Migratory Fish in The River Ganga

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Hilsa, an anadromous migratory fish and iconic species to both India and Bangladesh. Since, 1975, due to construction of Farakka barrage, on the river Ganga the species has stopped migration to the India part of the river Ganga. Therefore, resulting in zero catch in the strech of more than 1000km from Allahabad to Farakka. In order to restore the fish, catch in the selected stretch, our study has developed a holistic approach towards the restoration of the species in river Ganga through 1) river ranching of adults and juveniles hilsa 2) artificial fecundation and ranching the reared juveniles into the river 3) massive awareness programme among the fishermen. During 2019, river ranching of the hilsa was initiated towards hilsa fish restoration in the river Ganga. Till 2022 March, a total of more than 55000 adult hilsa has been ranched in the upstream of the Farakka barrage. Tracking of the fish species through tagging has indicated that the fish could migrate more than 1300 km upstream of the ranching site underlining the return of hilsa to its native habitat. Therefore, our ongoing study highlighted to protect the migratory rout and facilitate the hilsa migration through the barrage could re-establish the lost hilsa in river Ganga.

Keywords : Hilsa, Restoration, Ganga, River, Fish Pass

Paper ID 16394

Population Biology of *Siganus* Stock in Gulf of Mannar Region.

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Siganids are commonly called as Rabbit fishes which occur in shallow waters. These fishes constitute 25-30% of the reef fish landings. As the Population studies on *Siganus* species are in initial stage,this study was conducted to assess their Population biology of *Siganus* stock available at Gulf of Mannar.The length frequency data were collected at fortnight intervals for studying the length-weight relationship, growth patterns and recruitment pattern. The landing pattern of *S. canaliculatus, S. javus, and S. lineatus* showed year-round occurrence along Gulf of Mannar. The estimated life span of *S. canaliculatus, S. javus* and *S. lineatus* was estimated as 3,4 and 3.5 years, respectively. The K value for S. canaliculatus was low (0.27) because of slow growth and for *S. javus* and *S. lineatus* it was high 0.57 and 0.52 respectively. The estimated total instantaneous mortality (Z) of *S. canaliculatus, S. javus* and *S. lineatus* were 0.59, 0.58 and 0.56 respectively. Recruitment of *S. canaliculatus, S. javus* and *S. lineatus* was recorded throughout the year with single peak. The Virtual Population Analysis revealed that fishing pressure was high in the length group of 18 to 25 cm for *S. canaliculatus*. For *S. javus* and *S. lineatus* natural mortality was low upto 16cm. Based on the relationship between exploitation ratio and yield per recruit of *S. canaliculatus*, *S. javus* and *S. lineatus* it could be inferred that these species are moderately exploited. The present study suggests management initiative taken to conserve ecologically important that *Siganus* groups off Gulf of Mannar region.

Keywords : Siganids, Rabbit Fishes, Virtual Population Analysis, Fish Stock Assessment, Length Weight Relationship

Paper ID 16400

Optical Classes and Fishery Resources Off the Coastal Regions of Arabian Sea

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Understanding the interactions between physical oceanographic events and fish abundance (spatial distribution) is a critical component in the accurate assessment of climate change impacts in context of fisheries. This remains elusive owing to the lack of synoptic-level datasets on the oceanographic variables. We have adopted the concept of optical classification proposed by Melin and Vantrepotte, 2015 and Monolisha et al., 2018 to delineate the boundaries of biogeographic provinces in relationship to the fishery resources of the study region across space and time. The current study uses satellite Remote Sensing Reflectance (RRS) datasets from 1998-2013 as an optical property to classify the Arabian Sea (AS). Monthly fish landing datasets from the years 1998-2016 of ten major fishery resources of the five coastal states situated along the Arabian Sea region were obtained to evaluate the dynamics of the fishery resources of the region. In total, eight optical classes were identified along the coastal waters of the Arabian Sea. Classes 1, 2, 3, 4 and 5 constitute the higher percentage of pixels in SEAS and these classes were meagre in the NEAS. However, classes 3, 4, 5 and 7 represent the higher percentage contribution of pixels from the SEAS region. The monthly climatologies of dominant optical classes, chlorophyll concentration and optical diversity of the Eastern Arabian Sea were plotted. To make comparisons on the abundance of fishery resources and optical classes of the region, the monthly and seasonal percentage contributions of memberships of each pixel for all optical classes was estimated. The normalised fish landing datasets and annual catch ratios were then used to describe the linkage with the resultant optical classes across the coastal regions bordering the Arabian Sea. Based on the habitat, distribution patterns and feeding habits, the resources were categorised into three: Pelagic Planktivores, Pelagic Carnivores and Demersal Carnivores. The annual catch ratios derived from fish-landing estimates hints at the invigorated presence of carnivorous fish population characterizing denser coastal waters of the NEAS, whereas the lighter coastal waters of SEAS communicate the dominance of planktivores species.

Keywords : Optical Classes, Diversity, Fishery, Geography, Arabian Sea

Paper ID 16401

Fish Faunal Inventory of Satpura Reservoir in Madhya Pradesh, India

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Results of the fish species inventory carried out in 'Sarni' or 'Satpura' reservoir, a medium scale reservoir in Betul district of Madhya Pradesh is presented. Monthly samplings were performed in 21 locations representing the fluvial (n=4), transitional (n=4), lacustrine (n=6) and spill (n=7) zones from November 2020 to April 2021 during COVID – 19 lockdown period. Fishing was carried out using diverse array of fishing methods by gill nets *(*Tangdi / Fasla Jal*),* big traps (Bada Piinja), small traps (Chhota Pinjra*),* cast nets (Fekua Jal*)*, longlines (Gal*),* hook and line (Chhadi), shore seines (Mahajal, Jholni Jal), boat seine (Peshi Jal), covering nets *(*Chaap Jal, Dhankni Jal), mosquito net (Macchhardani), wooden boats (Naav), tubes (Tube), rectangular and triangular framed tin boats (Dongi / Donga). For the collection of shell fishes diving and handpicking was employed. The inventory yielded a record of 54 finfishes *and* 11 shellfishes consisting of 2 species of crustaceans and 9 species of molluscs. Finfish species encountered were belonging to 34 genera in 13 families and 6 orders dominated by Cyprinformes (2 families, 20 genera and 33 species) followed by Siluriformes (4 families, 6 genera, 10 species); perciformes (4 families, 5 genera, 8 species); Osteoglossiformes; Beloniformes and Synbranchiformes (1 family, 1 genus and 1 species each). Out of the 54 finfishes recorded, 4 species are belonging to the threatened category as per IUCN redlist. Among molluscs, bivalve dominated with 6 species, 5 genera, 4 families, 3 orders. Molluscan fauna in the reservoirs is represented by 3 species, 3 genera, 3 families and 2 orders. Crustacean diversity in this manmade ecosystem was represented by 2 species of the genus *Macrobrachium* and *Barytelphusa*. The current study has recorded first report of 15 species of the finfish fauna and first hand information on the shellfish fauna of reservoir. This comprehensive account on the finfish and shellfish fauna of Sarni reservoir in Madhya Pradesh will act as the baseline information while formulating conservation and sustainable use actions.

Keywords : Ichthyofauna, Finfishes, Shellfishes, Satpura Reservoir, Biodiversity.

Paper ID 16402

Fishery, Trophodynamics, And Reproductive Biology of Sawtooth Barracuda, *Sphyraena Putnamae* (sphyraenidae) From the North-eastern Arabian Sea

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Fishes of the family Sphyraenidae known as barracudas forms an economically important part of the marine capture fisheries in the northern Arabian Sea, India. Nine species of barracudas are known from northern Arabian Sea. However, 4 species contribute to the barracuda fishery in the region namely, *S. putnamae*, S. *jello, S. obtusata*, and *S. barracuda*. The highest barracuda catch was in 2012 (1862 t) and the lowest catch was 433 t in 2020 along Maharashtra. Fishery and biological aspects of sawtooth barracuda, *Sphyraena putnamae* is studied from the north-eastern Arabian Sea. Sawtooth barracuda contributed to the major share (82%) of the total barracuda fishery in Maharashtra. The major gear contributing to the fishery was pure seines. Fish having a mean length of 45.5-49.5 cm FL contributed to the fishery. The length-weight relationship was $W=0.000028L^{2.75}$ ($r^2=0.963$) which shows that the fishes have negative allometric growth. The sex ratio (F: M) was 1:0.95, showing the dominance of females in the fishery. The gut content analysis shows that sawtooth barracuda is a generalist predator, mainly an opportunistic piscivorous pelagic predator that feeds mainly the teleosts. 68.3% of stomachs analysed were empty or trace, 27.4% of the stomach was partially full and 4.3% was full. The stomach content showed 15 species representing 3 major groups like teleost, crustaceans and molluscs. Based on the Index of Relative Importance (%IRI), carangids were the main prey groups (41.3 % IRI), followed by *Sardinella longiceps* (33.3% IRI) and *Uroteuthis duvaucelii* (22.8% IRI). The size of sexual maturity in females was estimated as 41.8 cm FL. Gonado somatic index (GSI) ranged from 0.63 to 3.69. Mature fishes were observed throughout the year. The peak spawning is observed from May to June having the highest GSI value. However, the incidence of spawning capable, regressing, and regenerating fishes all through the year in varied frequencies implies that spawning takes place throughout the year. The present study provides an updated biological understanding of the species which supports stock assessment aiding fishery management in the Northern Arabian Sea.

Keywords : Large Pelagics, Biology, Iri, Feeding Habit, Bycatch, Marine Fisheries, India.

Paper ID 16403

Fishery of Ribbonfish (trichiuridae) with Special Emphasis on the Trophodynamics, Reproductive Biology and Stock Assessment of Largehead Hairtail, Trichiurus Lepturus Linnaeus,1758 From the North-eastern Arabian Sea

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Fishes of the family Trichiuridae, known as ribbon fishes form an economically important part of the marine capture fisheries in the northern Arabian Sea, India. Five species are known from the region, Eupleurogrammus *glossodon* (Bleeker, 1860), *Eupleurogrammus muticus* (Gray, 1831), *Lepturacanthus savala* (Cuvier, 1829), *Tentoriceps cristatus* (Klunzinger, 1884), *Trichiurus lepturus* Linnaeus, 1758. Three species contribute to the Ribbonfish fishery in the North Eastern Arabian Sea. In Maharashtra, 62% of the total ribbonfish landing in Maharashtra was contributed by *Trichiurus lepturus.* The study is based on the *Trichiurus lepturus* samples collected from the major landing centres of Maharashtra, North Eastern Arabian Sea. Major gear contributing to the fishery was the trawl net followed by dol nets. Length-weight relationship shows that the fish shows negative allometric growth. Sex ratio in F:M was 1:0.95 shows the dominance of females in the fishery. Gut content shows that the fish is highly carnivorous and mainly feeds fishes (76%). Crustaceans and molluscs were also formed a minor part of the diet. Mature specimens were observed throughout the year. The von Bertalanffy's parameters are $Lt=129.4*(1-e^{0.61(t-(-0.0248))})$. The mortality parameters were estimated as 4.35,3.49 and 0.86 for Z, F, and M respectively. The optimum length estimated was 88 cm and the fishery is mainly contributed by the fishes having a length range of 57 to 75 cm. The exploitation ratio was 0.8 and the E_{max} is 0.72. The present study provides an updated biological *and stock status of Trichiurus lepturus* from the northern Arabian Sea.

Keywords : Ribbon Fish, Trawl, Biology, Stock, Length-weight, India

Paper ID 16404

Status of Sawfishes (pristidae: Rhinopristiformes) in Indian Waters

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Sawfishes (Pristidae) are one of the most threatened fishes in the world. All the five species in the family are assessed either as Critically Endangered (CR) or Endangered (EN) in the IUCN Red List of Threatened Species due to population declines and regional extinctions. Consequently, they are targets of intense global conservation efforts. Four species of sawfishes, i.e., Narrow sawfish *Anoxypristis cuspidata* (Latham 1794), Largetooth sawfish *Pristis pristis* (Linnaeus 1758), Green sawfish *Pristis zijsron* Bleeker 1851 and Dwarf sawfish *Pristis clavata* Garman 1906 are known to occur in Indian waters. Three species are listed and protected under Schedule I of the Indian Wildlife (Protection) Act 1972. The project involved dedicated monitoring surveys, stakeholder workshops and interviews with fishermen to assess the status of sawfishes in Indian waters and gather information on local (fisher) knowledge, cultural significance and perception on sawfishes in the country. The results indicated a significant decline in the sightings and catch of sawfishes along the coasts of India. The study identified key areas of sawfish distribution in Indian waters which is a proxy for areas where sawfishes have increased probabilities of interacting with fishing gear and subsequent incidental capture. In no part of the country were sawfishes targeted for either their fin, meat or rostrum; though, if any incidental mortality occurred after being caught as bycatch, the meat was mostly utilized Though fishermen were aware of the protected status of sawfishes, enhanced outreach programs and stakeholder participation will be needed further to effectively protect the last of the sawfishes in India.

Keywords : Extinction, Bycatch, Arabian Sea, Bay Of Bengal, India, Elasmobranchs, Sharks And Rays, Marine Conservation

Paper ID 16408

Assessment of Finfish Bycatch from the Commercial Trawlers of Nagapattinam Region

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The present study was carried out to quantity the finfishes and its juveniles bycatch from the trawlers of Nagapattinam region between January 2017 - August 2019. In the annual average landings, commercial catch shared 70.75 % (10,905.78 tonnes), and annual finfish bycatch formed 21.12% (3,256.14 tonnes). Furthermore, juveniles of finfish constituted 56.88 % (1851.94 tonnes) of the annual bycatch landing. During the study period, finfish juveniles catch were reported high in June (2017, 2018 and 2019), July (2017, 2018 and 2019), August (2017, 2018 and 2019) and September (2018). The peak fishing effort was observed in March 2017 (1975) followed by March 2019 (1694), March 2018 (1660) and low fishing effort was observed in February 2018 (140) followed by September 2018 (192), September 2017 (207) with the fishing effort ranging from 140 (February 2018) – 1975 (March 2017) boat-days during the study period. The total number of trawlers registered in this region was 430 with the OAL of 18-20 meters and mostly operated at the depth of 15 - 90 m with a distance between 40 - 80 Nautical Miles. In the annual average landings, commercial catch shared 70.75 % (10,905.78 tonnes), and annual finfish bycatch formed 21.12% (3,256.14 tonnes). During the study period, finfish juveniles catch were reported high in June (2017, 2018 and 2019), July (2017, 2018 and 2019), August (2017, 2018 and 2019) and September (2018). The peak fishing effort was observed in March 2017 (1975) followed by March 2019 (1694), March 2018 (1660) and low fishing effort was observed in February 2018 (140) followed by September 2018 (192), September 2017 (207) with the fishing effort ranging from 140 (February 2018) – 1975 (March 2017) boat-days during the study period. Based on the present study, it was observed that indiscriminate catch of juvenile finfishes as bycatch in Nagapattinam region, which could be avoided by enforcing proper mitigation measures through mesh size regulation, fleet regulation, fishing area restriction, use of bycatch reduction devices and partial modification of square mesh in the cod end to reduce the bycatch of juvenile fishes and sustain the fishery resources for future.

Keywords : Assessment, Trawler Bycatch, Finfish, Nagapattinam

Paper ID 16411

Developmental Traits of Indian Smiliogastrinae: Scope as a Potential Tool for Conservation

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Elucidating reproductive biology, especially with gametic and ontogenic development of teleosts has wide dimensions in resolving various puzzles in the field of systematics and conservation. The current work addresses identifying unique or peculiar developmental traits of one of the most speciose diverse subfamily Smiliogastrinae consisting of small to medium-sized barbs of the Order Cypriniformes in India. The possible available information on the reproductive, embryonic and larval ontogenies was compiled and endeavoured to link its current systematics at the generic level. The analysis revealed that all genera exhibit unique sexual dimorphic characters specifically with the development of colour patterns in males with exceptions like *Rohtee ogilbii* and *Osteobrama belangerii*. With the fecundity values ranging from two digits to six digits and based on the ova-diameter profile, the members were categorised into five types. The seasonality of spawning is reviewed and a categorisation based on the colour pattern of eggs is made for species identification. The pace of embryonic development did not keep a peculiar scale among species and genera. Retention of unique character in the form of a subdorsal band from the larval to juvenile phase has been recognised except for variants like *B. carnaticus* and *O.belangeri*. Based on the review of consistently available developmental traits, an attempt is made to define Indian Smiliogastinae. The results of the study also support the exclusion and inclusion of various taxon in the phylogenetic trees prepared based on molecular techniques.

Keywords : Conservation, Cyprinidae, Developmental Biology, Smiliogastrinae

Paper ID 16415

Species Differentiation of Shrimps of The Genus *Acetes* (family Sergestidae) Based on Petasma Morphology.

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The shrimps of the genus *Acetes*, family Sergestidae are small sized coastal shrimps of epipelagic in nature, often seen in brackishwater also. Reproductive organs in adult males are studied to understand the species diversity and to differentiate the species of Indian sub-continent. Six species were studied from different parts of India to understand the morphology of petasma of males. Petasma is the male copulatory organ in males which shows wide variations between and among species. Broadly two classes of shrimps of the genus *Acetes* are taken into account after the study. The parts of petasma like capitulum, pars astringens, pars externa, pars media and processus ventralis were the identical parts of petasma which can be studied to differentiate the species based on morphology.

Keywords : *Acetes*, Petasma

Paper ID 16423

A Study on Trawl Fishery and its Bycatch Along Udupi Coast of Karnataka

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The trawl is one of the major gear being operated along the Udupi coast. Trawl accounts for 21.98% of total gears being operated along the coast and the trawl fishery contributes for 76.68% and 72.77% of total landings during the study period 2019-20 and 2020-21 respectively. The study revealed that the Lowest Trawl contribution was during the month of September 2019 (23.05%), due to the COVID-19 situation the movement of the boats were less and the highest trawl catch contribution was during the month of November 2020 (93.64%) due to increased landings of bycatch. The highest bycatch recorded was 87.90% during February 2020. It indicates decrease in commercial landings and low value bycatch landings grew significantly. In the present study more than 55.84% by-catch were used for fishmeal/fish oil industry. Small size fish which are not normally consumed and also the juveniles of all commercial fish were used for the production of fish meal and oil. The study shows that special emphasis has to be given to manage juvenile catch and better utilization of the bycatch as the bycatch is inevitable.

Keywords : Trawl Fishery, Udupi, Bycatch

Paper ID 16424

Differential Pigmentation Pattern in Paired Fins of Many Spotted Flying Fish, *Cheilopogon Spilopterus* (valenciennes, 1847), an Epipelagic Species of Exocoetid from Indian Waters

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Differential pigmentation patterns in fins of epipelagic fish species are recorded poorly but much more common in demersal finfishes, which is by the activity of melanophore cells, the derivative of neural crest cells. Any change in the environment may result in a significant difference in the pigmentation pattern, an adaptive strategy for escaping predation from the large pelagics. Differentiation of *Cheilopogon spilopterus* (many spotted flying fish) normal specimens from the one with differential spot and pigmentation patterns. The present study deals with a comparative account of morphometric and molecular traits in individual specimens collected. The color variations, morphology, chances of phenotypic plasticity, and coastwise specificities were recorded in *Cheilopogon spilopterus* collected from all over the Indian coast. We could find three different spots and pigmentation patterns from the Thoothukudi, Tamil Nadu coast specimens. In contrast, the specimens from other locations of the Indian coastline were normal as described in the original literature.

Keywords : Pigmentation, *Cheilopogon Spilopterus*

Paper ID 16429

Identification of Ichthyoplankton from Manori Mangrove Area Using Morphological and Molecular methods for Conservation and Management of Mangrove Fish Diversity

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Fish eggs and larvae are often excluded from identification because of lacking distinctive morphological characteristics. Accurate identification of ichthyoplankton can provide vital information about species' preferential spawning grounds, migratory routes, reproductive period, and monitor the recruitment process. This study aimed to identify ichthyoplankton based on morphology and molecular methods collected from Manori creek to obtain information on richness and diversity. 419 eggs were collected and segregated to the lowest possible taxonomic level based on morphological characteristics such as size and shape, diameter, egg membrane, presence or absence of oil globule, yolk segmentation, and pigmentation pattern perivitelline space. 9 species (*Dendrophysa russelii*, *Moolgarda perusii*, *Rastrelliger kanagurta*, *Mugil cephalus*, *Nematalosa nasus, Thryssa hamiltonii, Acanthopagrus berda, Omobranchus ferox, Osteomugil sp*) belonging to 7 families and 3 orders were identified using morphological and molecular methods targeting the COI gene. Sciaenidae was the most dominant family among the collected eggs, followed by Mugilidae. The most abundant species were *Dendrophysa russelii* and *Mugil cephalus.* The present findings confirm the efficacy of DNA barcoding in identifying ichthyoplankton and strengthening the nucleotide databases in poorly studied areas along the Indian coast. This information will serve as baseline data for conserving and monitoring the breeding ground of mangrove ecosystems.

Keywords : Ichthyoplankton, DNA Barcoding, Mangrove Ecosystems, Conservation

Paper ID 16438

Fishery and Stock Assessment of Goldspotted Grenadier Anchovy *Coilia dussumieri* Valenciennes, 1848 from the North-eastern Arabian Sea

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Goldspotted grenadier anchovy, *Coilia dussumieri* (Clupeiformes: Engraulidae) is distributed mainly on the northern part of Indian coasts, Myanmar, Thailand, and Malaysia in the Indian Ocean and from Thailand to Java in the western central Pacific Ocean. It forms an important fishery resource in the northern Arabian Sea coastal states of India, Maharashtra, and Gujarat. Goldspotted anchovy is mostly caught as bycatch and also forms a targeted fishery, the species is dominantly caught in trawl nets (56%) and bag nets (39%) in Maharashtra. During the 2008-2018 period the average catch of *Coilia dussumieri* estimated was 9,318 tonnes and it contributed 2.38% to 4.08% of total marine fish landing in Maharashtra. In Maharashtra, the catch of Goldspotted anchovy showed minor fluctuations, where the average annual catch from 1981 to 2000 was 10,870 tonnes and from 2001 to 2019 it was around 11,009 tonnes. The historical maximum landings recorded was 19,591 tonnes in 1998. Recent studies on the stock assessment of Goldspotted anchovy supporting the management of the resource are limited. Stock assessment parameters were estimated using Electronic Length frequency Analysis (ELEFAN) as included in the R package TropfishR. The length-converted catch curve and the length-based yield per recruit model were employed. The exploitation rate (E) and current fishing mortality (F) were slightly below the optimum level of exploitation and reference level respectively, showing *C. dussumieri* is not overexploited in the Arabian Sea but management interventions are needed to keep the fishery at a sustainable level.

Keywords : Bycatch, Clupeids, Goldspotted Anchovy, Small Pelagics, Stock Assessment, Targeted Fishery

Paper ID 16439

Feeding Ecology of Commercially Important Fishes from North-eastern Arabian Sea

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Stomach content analysis of fishes provides insight into their trophic interaction, feeding guild, food-web connectivity in the ecosystem and helps in understanding the predator-prey relationships and preferences. We examined the stomach contents of thirteen commercially important marine fishes from the north-eastern Arabian Sea, these fishes contribute ~30 % of the estimated marine fish landings along the Maharashtra coast. The selected fishes showed wide variation in the prey preference and diet constitution. The diet matrix showed, crustaceans (42%) as the most common prey items, followed by teleosts (41%), unidentified semi-digested matter (13%), zooplanktons (3%), and mollusc (1%). Among the crustacean prey items, *Acetes* spp. (68%) was dominant followed by *Nematopalaemon* spp. (15%). Among the selected fishes, the diet content of *Trichiurus lepturus* showed a higher Shannon-Wiener Index diversity value (2.55) followed by *Pampus candidus* (7.78), *Scomberomorus guttatus* (1.63), *Chirocentrus nudus* (1.61), *Coilia dussumieri* (1.57), *Lepturacanthus savala* (1.55), *Scomberoides tol* (1.48) and *Johnius borneensis* (1.45). Low prey diversity was observed in *Euthynnus affinis* (1.15), *Cynoglossus arel* (1.01), *Harpadon nehereus* (1.01), *Sphyraena putnamae* (0.83), and *Ilisha filigera* (0.11). The nonlinear multi-dimensional scaling (NMDS) plot of the diet analysis showed 50% similarity among *C. nudus, S. tol*, *S. guttatus*, *L. savala*, *J. borneensis*, *C. arel* and *E. affinis*. Levin´s standardized index indicates that all species shows a specialized type of feeding behavior, as the value for all selected fishes varied between 0.02 to 0.39 depicting that only a few prey types dominate the diet. Pianka's measure of niche overlap was significantly high (>0.6) for all selected fishes except *H. nehereus* and *P. candidus.*

Keywords : Acetes Spp., Diet, Diversity Index, Prey, Ecology , Niche, Trophic Guild

Paper ID 16441

Length-Weight Profiles of Small Indigenous Fishes (SIFs) from Different Freshwater Bodies of Goa, India

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Small Indigenous Fishes (SIFs) are defined as the species, which can grow up to a maximum length of 25-30 cm. They inhabit rivers, tributaries, floodplains, ponds and tanks, lakes, beels, streams, lowland areas, wetlands, and paddy fields. In India, out of the total 765 native freshwater fish species recorded, 450 are categorized as SIFs, out of which 104 species classified as food fish and ornamental types. Many of these are also cultivable and can be introduced into freshwater aquaculture systems as candidate species, which can be bred in captivity. Length and weight are considered to be the basic biological information that could be useful in designing fishery management practices. This data help in estimating the growth, reproduction, and overall condition of fish. In the present study, length-weight relationship of four finfish species belonging to the Cyprinidae family is estimated from different freshwater bodies of Goa, India. Fish samples were collected by different gears like cast net, drag net, hand net from 2020 to 2022. The length and weight range for four species, *Systomus sarana, Rasbora dandia, Puntius vittatus*, and *Puntius mahecola* varied as follows- 3.0 to 24.3 cm and 2.0 to 126.0 g, 2.5 to 9.8 cm and 3.0 to 13.0 g, 1.0 to 5.1 cm and 1.0 to 3.0 g and 1.7 to 8 cm and 2.0 to 20.0 g. Juveniles formed 99.2%, 46.3%, 46.3% and 56.3% of the total samples of *Systomus sarana, Rasbora dandia, Puntius vittatus*, and *Puntius mahecola* respectively. The matured individuals shared 0.8%, 53.7%, 9.2% and 43.7% for the four former species respectively. The data gained in this study formed the baseline information for preparing the database for the management of wetlands and rivers along Goa coast and developing breeding programmes for the species.

Keywords : Small Indigenous Fishes, Length-weight, Conservation, Aquaculture

Paper ID 16444

Assessment of Sedimentation and its Impacts on Fisheries in Navegaonbandh Reservoir Using Remote Sensing

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Reservoir sedimentation generates several interconnected issues. Water storage capacity is reduced as sedimentation raises turbidity and limits primary production. Our knowledge of reservoir and ability to predict its impacts is inadequate. Due to the scarcity of such data, investigations were carried out by adopting combination of satellite-based observation and on field sampling was carried out from July 2020 to February 2021 to fulfil the following objectives: (1) To assess the sedimentation rate of Navegaonbandh Reservoir (2) To monitor the impacts of altered habitat on fish catch. It is observed that the original storage capacity of the reservoir was estimated to be 29.93 Mm3 while 26.65 Mm3 of derived reservoir capacity was estimated from the remote sensing data. This reveals the loss of 3.28 Mm3 (11%) from the live storage capacity due to sedimentation between 276.33 m and 277.45 m elevation of the reservoir from 1967 to 2019-20. Present study observed 41 fish species in the Navegaonbandh reservoir belonging to seven orders, 16 families, and 30 genera. Fish catch data for the years 1998 and 2021 are compared in this study to observed the change in fish catch composition. In 1998, 52.27% of the catch came from the Indigenous (Minor) group, 6.23% of the catch came from the Indigenous (Major) group, and 41.50% of the catch from the Non-Indigenous group. In 2021, the Catch from Indigenous (Minor) group is 1.76%, which is reduced drastically compared with the year 1998, Catch from Indigenous (Major) group is 3.55%, which is half of the year 1998, and Non-Indigenous group is contributing 94.68% in catch. Present study recommends that strategic planning be implemented to reduce the sedimentation rate. Additionally, the breeding grounds for Indigenous minor group fishes should be protected so that they can coexist peacefully with other fish groups.

Keywords : Reservoir , Sedimentation , Remote Sensing , Navegaonbandh ,Impacts on Fisheries , Conservation

Paper ID 16446

Ichthyofaunal Diversity of Godavari River at Dowleswaram, East Godavari District of Andhra Pradesh, India

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Ichthyofaunal diversity of Godavari River at Dowleswaram and surrounding fish landing centers were investigated from April 2021 to March 2022. The occurrence of Seventy-eight fish species belonging to 14 orders, 30 families and 49 genera were observed during the study period. In the present study, Cypriniformes dominance was observed (39.74%), followed by Siluriformes (23.08%), Perciformes (16.66%), Channiformes (5.13%) and Gobiiformes (3.85%). The orders like Osteoglossiformes, Clupeiformies, Beloiniformes and Mastacembeliformes shared each with 02.56% whereas the orders, Cyprinodontiformes, Elopiformes, Gonorynchiformes, Anguilliformes and Mugiliformes contributed each with 01.28%. Analysis of temporal variation of ichyofaunal diversity revealed that maximum number of species was recorded during July 2021 whereas minmum during May 2021. The IUCN conservation status of all these species is discussed in this paper. Based on our study, it is observed that the habitat protection and pollution reduction must be given due importance to conserve these precious inland resources.

Keywords : Ichthyofauna, Godavari River, IUCN Status, Conservation

Paper ID 16460

Diversity of Fish Bycatch in the Trawlers Off Kanyakumari Coast, Wadge Bank, Southeastern India

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Fish bycatch diversity was studied in trawlers off the Kanyakumari coast during the period of July 2015 to June 2016. During the study, 167 species belonging to 2 classes, 13 orders, 59 families, and 110 genera were recorded. The order Perciformes dominants with 80 species (48 %) followed by Tetraodontiformes with 25 species (14 %) and Scorpaeniformes 18 species (10 %) and Temporal diversity analysis revealed that the maximum species diversity was observed during the Monsoon (131 species) while the minimum was observed during the Summer (79 species) period. Numerically dominant bycatch species were found to be *Decapterus russelli* (10 %), *Sardinella gibbosa* (8 %), *Saurida tumbil* (5), *Leiognathus equulus* (4%) and *Odonus niger*, (3%). Biodiversity analysis revealed that the Shannon-Wiener species diversity index ranged from 3.73 (June) to 4.41 (September). The IUCN categories of bycatch species are mostly classified as Not Evaluated, Least Concern, Data Deficient and Vulnerable viz., 70%, 27%, 2% and 1% respectively. Cluster and MDS analysis clearly showed that species collected in various months of the respective region got grouped themselves. The present study also gives information on various diversity indices on finfish groups that are encountered in trawl bycatch along the Kanyakumari coast. The conclusion of the study gives clear information on the bycatch diversity which covers the way for the sustainable exploitation and management of exploited fisheries resources in this region.

Keywords : Bycatch Diversity, Temporal Diversity, Sustainable Exploitation, Management

Paper ID 16465

Conservation And Restoration of Wild Gangetic Carps: A Protocol of Practice

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Riverine ecology is being degraded by the multifarious interventions of man-made activities, which resulted in the depletion of riverine ecology. The degradation has resulted in the alteration of the ecological niche for the native aquatic fauna including fishes. In the river Ganga, the stock of native fish organisms is also being degraded by multiple constraints such as riverine pollution, climatic changes with the impact of global warming, non-regulation of fishing nets, etc. For the purpose of conservation and restoration of native fish stock of the river Ganga, an initiative was undertaken by ICAR-Central inland fisheries research institute under the flagship program of the "National Mission for Clean Ganga". For the purpose initially, a study was made at 31 different sampling sites where the spawn availability was monitored and the analyzed data was compared with the earlier available literature published by ICAR-CIFRI since 1960's. The Live fish of the four most priced native carp fish species of the river Ganga i.e., *Labeo rohita* (Rohu), *Labeo catla* (Catla), *Cirrhinus mrigala* (Mrigal), and *Labeo calbasu* (Calbasu) were collected using specialized technique and were reared up to their maturity. These brooders were bred using hypophysation and the spawns were reared up to fingerling size (>15 cm). At last, the fish fingerlings were ranched in the preidentified depleted stretches of the river Ganga. To date, there are 68 ranching programs have been organized in the 04 different states of the country i.e., Uttar Pradesh, Bihar, Jharkhand, and West Bengal, in which more than 42 Lakhs of the selected fish fingerlings have been released in the river Ganga.

Keywords : River Ganga, Fish Stock, Conservation, Ranching

Paper ID 16470

Changing Scenario of "trawl Bycatch" In India: Concerns Shifted from Ecosystem Health to Stock Health

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Bycatch in marine fisheries has been a source of great worry, and trawling was considered to be the major fishing activity, accounting for a large percentage of bycatch. A study on trawl bycatch conducted by ICAR-Central Marine Fisheries Research Institute as integral part for developing guidelines for "best trawling practices" in India, revealed that 30 to 60% trawl landing in India was constituted by "low value bycatch (LVB)", which were mainly used for fish meal preparation. Indian trawl fishery has undergone revolutionary changes in last 20 years and the installation of high-speed engines on trawlers facilitated successful semi-pelagic/pelagic trawling, which replaced the slower bottom trawling. These developments were induced by the high market demand for finfishes and cephalopods. As a result, trawlers have been carrying a variety of trawl nets suited for each target, depending on the species available. Disturbances and loss of benthic biota generated by sweeping the seabed continue to be a concern and the biggest negative impact of the trawling operation on a global scale, but contrary to that, the studies in India have indicated that after the introduction of semi-pelagic trawling in commercial fisheries, there appears to have been a significant reduction in the devastation of the benthic ecology caused by trawling operations. Which confirms that bycatch from Indian trawling is no longer comparable to the global issue but the problem is from high amount of juvenile fishery. Due to current operational modifications, the juvenile composition of commercial fishes, notably pelagic fishes, has increased in LVB. The high juvenile composition of commercial fishes caught in trawls, especially pelagic fishes, may pose a danger to long-term marine fish productivity. The introduction of a minimum legal size as well as mesh size restriction is thought to be a possible method for avoiding the problems.

Keywords : Trawl Bycatch, Low Value Bycach (lvb), , Pelagic And Semi-pelagic Trawling, Ecological Impacts, Juvenile Fishery

Paper ID 16476

First Record of Genus *Mugilogobius* Smitt, 1900 (gobiidae) From India

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The present study reports the first record of the Gobiid fish genus *Mugilogobius* Smitt, 1900 from Indian waters. Three *M. tigrinus* specimens were collected from Ennore creek on the Southeastern coast of India at a depth of about 1.5 feet in mangrove vegetation during low tide. The previously known distribution of this species is from Singapore, Thailand and Malaysia and later the range was extended towards the West with reports from Northwestern Sri Lanka and South Andaman Islands. This current observation is the new record for the mainland waters of India, thereby adding one more gobiid fish genus and species to the Indian Ichthyofaunal diversity.

Keywords : New Record, Indian Mainland, Ichthyofaunal Diversity, *Mugilogobius*, *M. Tigrinus*

Paper ID 16479

Assessment of the Stock Status of Indian Squid from the Northern Arabian Sea

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In India, cephalopods are found to be increasing importance in marine fishery and many species are targeted for commercial exploitation. Along the Maharashtra coast, three species of squids are exploited commercially but neritic squid having an Indo-Pacific distribution *Uroteuthis (Photololigo) duvaucelii* has commercial importance and contributes to more than 90% of squid landing along the Maharashtra coast. In recent past, fluctuation in Indian squid landing and targeted fishery stressed to find stock status of the resource along Maharashtra coast. In present study, growth, mortality parameters and fisheries reference points were estimated using TropFishR and Catch-MSY (CMSY). The estimated growth parameter based on pooled length-frequency data were $L\infty$ = 392.84 mm DML and K = 1.67 yr-1. The instantaneous natural mortality (M), total mortality (Z), fishing mortality (F) and exploitation ratio (E) of the Indian squid were estimated at 1.788 yr^{-1}, 10.4 yr^{-1}, 8.612 yr^{-1} and 0.83 respectively. The current exploitation ratio (E; 0.83) was higher than the reference exploitation ratio (E_{MSY}; 0.79) indicating overexploitation of species and precautionary approach should be followed in the near future by maintaining the exploitation ratio at 0.61 ($E_{0.5}$). The MSY was estimated at 13.2 thousand t using the Catch-MSY method.

Keywords : Indian Squid, Stock Assessment, Growth, Mortality, Stock Status, Msy

Paper ID 16485

On The Record of *Channa Kelaartii* (günther 1861) from India

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The present study reports the first record of the snakehead fish *Channa kelaartii* from the Indian freshwater ecosystem based on the integrative taxonomic approach based on a series of specimens collected over the entire Southeastern peninsular India. *Channa kelaartii,* a recently validated fish species of dwarf snakehead from Sri Lanka is found to have a distribution in the East flowing rivers, streams and other water sources including stagnant water bodies in Southeastern peninsular India. Multiple series of specimens were collected from the Southern Andhra Pradesh and Tamil Nadu which reveals its identity as *C. kelaartii* based on both morphological and genetic analysis. It is evident that most dwarf snakeheads so far reported as *C. gachua /C.orientalis* from Eastern peninsular India are *C. kelaartii.* Hamilton (1822) described *C. gachua* from the waters of the river Ganges in Bengal and reported to have a distribution from Iran to Taiwan. Günther (1861) described *C. kelaartii* from Sri Lanka. Day (1878) synonymized *C. kelaartii* with *C. gachua* but Deraniyagala (1945) identified *C. kelaartii* as a subspecies of *C. gachua.* Sudasinghe et al. (2020) revalidated *C. kelaartii*. The findings of this study document the confirmed distribution of *C. kelaartii* in Southeastern peninsular India thereby adding an additional species to Indian snakehead diversity.

Keywords : Dwarf Snakehead, Diversity, Sri Lanka, Southeastern Peninsular India, *C. Gachua*, *C. Kelaartii*

Paper ID 16487

Effect of Trawling and Its By-catch on Marine Fish Diversity Off South West Coast of India

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Bycatch is recognized as unavoidable in any kind of fishing but the quantity varies according to the gear operated. The changing perspective of bycatch itself offers the greatest challenge, as yesterday's by-catch becomes today's target catch. However, this study to ascertain the ichthyofaunal biodiversity loss due to trawling was conducted between August, 2010 to May, 2012 recorded a total 131 species of finfish and shellfish belonging to 62 families and 18 orders. Family Carangidae contributed 10.69 per cent of total number of species followed by Engraulidae (6.11%), Leiognathidae (6.11%), Synodontidae (3.82%), Tetraodontidae (3.82%), Nemipteridae (3.05%), Sciaenidae (3.05%) and Scombridae (3.05%) to the total number of fish species whereas, other families contributed less than 3 percent, and a total of 52 commercial species were reported in by-catch in the year 2010-11 whereas, it reduced to 41 species during the year 2011-12 with increased species number of low value fishes. This trend showed that significant increased of low value fish species with decrease in commercial fish species in by-catch. The average bycatch contribution was 33.54% (2010-11) and 45.68% (2011-12) during the study period. The results of Shannon-Weiner index (H') showed variability in different capacity engines. This study also indicated that the Mangalore coast is one of the major fishing harbours having rich biodiversity. Hence, it is recommended to reduce the fishing pressure especially by trawling to conserve the resources and biodiversity of the marine fauna.

Keywords : Trawling, Bycatch, Biodiversity, Mangalore

Paper ID 16488

Freshwater Fish Fauna of Aarani River, Southern Eastern Ghats, India

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River Aarani, a non-perennial river of 110 km length, originating from the Eastern Ghats in the Chittoor district of Andhra Pradesh and flows eastward through Tiruvallur district of Tamil Nadu and empties into the southern edge of the Pazhaverkaadu lagoon (Pulicat lagoon) adjoining the Bay of Bengal. Ichthyofaunal diversity studies were carried out for a period of four years from 2018 to 2021. A total of 70 fish species of 56 genera belonging to 30 families under 10 orders were recorded. Order Perciformes dominates the diversity with 25 (some freshwater migrants) species under 21 genera and 12 families followed by Cypriniformes with 24 (primary freshwater fish) species under 16 genera and 2 families and order Siluriformes with 9 species under 6 genera and 6 families. Of the total recorded fish species, 9 are exotic and the remaining 62 are native. As per the IUCN conservation status,3 fish species were near threatened and one fish species is endangered. Record of the endangered and endemic Chennai saw fin barb *Pethia sharmai* and the Sri Lankan snakehead *Channa kelaartii* shows their extended distributional range. The river holds a good population of all the native fish species but exotic fish invasion and several anthropogenic factors are threatening the fish diversity and population sustenance. This study documents the fishes of the river Aarani for the first time.

Keywords : Aarani, Eastern Ghats, Diversity, P. Sharmai, C. Kelaartii

Paper ID 16501

Thematic Evolution of Wetland Research in India Vis-à-vis the World: A Bibliometric Analysis (1998-2021)

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A scientometric analysis was performed to systematically analyse and document the global as well as national research output of wetland research carried out in this scientific arena during the past three decades. A total of 63671 publications were found from the Web of Science (WoS) database to plot the scientific research output of "wetland research" from 1988 to 2021. Bibliometric analyses, i.e., thematic map, trend topics, three fields plot, factorial analysis, Lotka's law and Bradford's law were carried out using R version 4.0.4 and R studio (1.4.1106 version) to evaluate the research productivity. Trend topics analysis could indicate the progress as well as the pattern change in the target areas of research investigations from 1988 to 2021 on this topic. Thematic map displayed the motor, niche, emerging or declining and basic themes of the research concepts carried out in the selected research for clear understanding. The results of the systematic scientometric mapping of the research areas and themes aids in the identification of research interests and their evolution across time. It also provides insight into various novel research directions that need to be focussed on the future.

Keywords: Wetland, Bibliometrics, Fisheries, R Analysis, Trend Topics and Thematic Evolution.

7. AQUATIC FOOD PROCESSING

Paper ID 15539

Effect of Duration of Chemical Treatment on Polymeric Characteristics, Crystalline Structure, Physicochemical and Thermal Properties of Colloidal Chitin

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Colloidal chitin is the short-chained, partially soluble dietary compound linked by glycosidic bonds formed due to the depolymerization of chitin in the presence of acids under controlled conditions. Chemical hydrolysis was performed at the chitin: acid ratios of 1:3 with different acid treatments (30, 60, 90, 120, and 150 min) and the recovery rate obtained was in the range of 57.50 to 71.65%. In addition, the study was focused on its crystalline structure and thermal properties by employing FTIR, CHNS analyzer, X-ray diffractometry, scanning electron microscopy, and differential scanning calorimetry. Results showed that colloidal chitin exhibited small, stable, and uniform microfibrils. The Degree of N-acetylation of colloidal chitin was 88 to 89 ± 0.4% indicating the negative impact on time interval. The d-spacings of colloidal chitin samples were 9.5 ± 0.2 Å and 4.6 ± 0.2 Å at (0 2 0) and (1 1 0) planes. The crystalline sizes were decreased from 6.58 nm to 5.8 nm, respectively. Further analysis on physicochemical properties revealed that they had a positive effect on the EC, WHC, FBC, and solubility. Thus, as the acid treatment increases, the recovery rate decreases with an increase in the soluble fraction, chitin nitrogen, mineral content, and functional properties, and pH was maintained between 5.0- 6.0. In addition, BD showed a negative correlation with TD, Solubility, WBC, EC, and FBC. The color analysis had an impact on the addition of colloidal chitin resulting in high lightness, low yellowness, and high whiteness due to a non-enzymatic reaction called the browning reaction. The thermal degradation of colloidal chitin samples showed a wide endothermic peak, that centered between 50 and 130 °C due to evaporation of water, and the chitin degraded at 320±4°C. Thus, renders high interest for research studies and brings forth implementation in nutraceutical and food industries.

Keywords: FTIR, Fourier Transform Infrared Spectroscopy; Hcl, Hydrochloric Acid; Mw, Molecular Weight; Sem, Scanning Electron Microscope; BD: Bulk Density; TD: Tapped Density; WBC: Water Binding Capacity; EC: Emulsion Capacity; FBC: Fat Binding Capacity.

Paper ID 15585

Development of an Excel-VBA tool for Calculating F_0 value of pasteurized crab meat

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This paper deals with the development of F_0 value calculator by excel spreadsheet using Visual Basic Application (VBA) programming language. F0 value is used to quantify the pasteurization/sterilization effect on the product achieved through the destruction of vegetative spores and microorganism. The F_0 value is calculated using patashnik improved general method. The calculator design was done in excel spreadsheet with programmed command buttons. This work intends to ease the F_0 calculation through user friendly interactive way. Besides, it is a useful tool to understand different ranges of F_0 value that varies with process time and temperature. The end users of this calculator are teaching professionals, researchers, students, and entrepreneurs.

Keywords : Visual Basic Application (VBA), F_0 Value, Pasteurization, Crab Meat, Calculator, Excel.

Paper ID 15588

Characterization of azolla for its application as functional ingredient in seafoods

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Azolla is regarded as an excellent source of nutrients and hence finds application possibilities in human diet. Present study was carried out to investigate the suitability of different drying techniques and extraction procedures of azolla for its application in seafoods as functional ingredient. Azolla from two species viz., *Azolla pinnata* and *Azolla caroliniana* was cultured under controlled aquatic conditions and powder was prepared by different drying techniques viz., sun drying, mechanical cabinet tray drying and hot air oven drying. Retention of nutrients and rehydration properties were observed superior for mechanical cabinet tray dried samples. Standardized protocol was developed for effective extraction of azolla for its active ingredients. The samples were also nutritionally characterized and assessed for its antioxidant property as well as compounds such as total phenols, flavonoids, tannins. Results indicated its exploration possibilities as an active ingredient in seafood products.

Keywords : *Azolla*, Drying, Rehydration, Functional Seafoods, Antioxidant Properties

Paper ID 15595

Microwave assisted enzymatic extraction of ACE-inhibitory peptides from rohu fish waste

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Hypertension kills millions of people silently every year globally and has to be controlled by ACE inhibitors. In this study, ACE-inhibitory peptides were extracted from rohu fish wastes using microwave assisted enzymatic extraction (MAEE). Rohu (*Labeo rohita*) fish waste comprised of 23.9% head, 5.18% trimmings, 4.19% scales and 0.65% swim bladder. The protein content ranged from 17.09% (head) to 34.08% (swim bladder). Homogenized fish waste treated with microwave (2450 MHz) before alcalase® hydrolysis at different power (180, 360, 540, 720 and 900W) and pre-treatment time (5, 10, 15, 20, and 25 min) to optimize the process using response surface methodology (RSM) with central composite design (CCD). The optimized conditions were 335W microwave power and 15min time, which gave 26.4% degree of hydrolysis (DH), 59.1% ACE-inhibition (ACE*i*) and 57.5% peptide yield (PY). *In vitro* stability of peptides was evaluated during hydrolysis at different heat treatment (25 to 100°C for 2h and 121°C for 15 min), pH (2 to 10) and gastrointestinal enzymes (pepsin-0.05%, trypsin-0.05%, chymotrypsin-0.05%, and trypsin-0.025% + chymotrypsin-0.025%), which exhibited good stability between 25°C to 100°C but not at 121°C, and higher ACE*i* between pH 6-8 but not at pH 10. Peptides retained ACE*i* against all gastrointestinal enzymes except pepsin. Therefore, MAEE can produce peptides from rohu fish wastes with enhanced ACE*i* and more stability.

Keywords : Peptides, Microwave, Extraction, Rohu, Waste

Paper ID 15596

First report on the nutritional profile of red-toothed triggerfish, *Odonus niger* (balistidae) from Indian waters

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The present investigation deals with the assessment of nutritional quality characteristics of *Odonus niger*, which is emerging as the top-most resource in the marine fish landings of India. The proximate composition analysis showed that the fish constituted high protein (15.15-20.05%) and moisture (77.78-83.02%) with a low fat (0.46-1.94%) and ash (0.55-1.48%) content. The average energy value calculated was slightly higher in females compared to males. Total amino acid profile was in the range of 143 to 189 and 146 to 191 mg g^{-1} fish samples for male and female fishes respectively. Leucine was found to be the most predominant essential amino acid (EAA) for both the sexes. Various protein quality indices (chemical score, EAA index, nutritional index, and biological value) represent high-quality protein. Fatty acid profile exhibited high proportions of ω3 polyunsaturated fatty acids (PUFA) (10.9-52.3%) together with notable quantities of oleic acid (10.0-19.2%) and palmitic acid (20.2-45.9%). Docosahexaenoic acid (DHA) accounted for 71% of the total PUFA and five times more prevalent than eicosapentaenoic acid (EPA). Among the minerals studied, potassium (K) was found to be the most dominant macronutrient followed by phosphorous, sodium (Na), magnesium, and calcium. The Na/K ratio was less than 1 throughout the trials, indicating that the species is a favourable meal for human health, particularly in the prevention of cardiovascular diseases. Overall, the nutritional profile of this under-utilized species determined for the first time is comparable with other commercially important fish species and could be exploited for various food applications.

Keywords : Energy Value, Leucine, Nutritional Profile, Potassium, Red-toothed Triggerfish

Paper ID 15654

Development of protein powder and noodles from squilla –a viable option for utilization of an untapped fishery resource

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Squilla, a major component of shrimp by-catch is an underutilized fishery resource. High moisture content of meat and difficulties in removing meat from the shell are the major constraints for its utilization as an edible food product. In the present study, protein powder (SPP) was prepared from squilla and effects of different foam stabilizers (maltodextrin (MD), *Gum arabica* (GA), and carboxy methyl cellulose (CMC)) on the foam and powder characteristics were evaluated. Yield of protein powder from fresh squilla was 13.4%. Protein content of fresh squilla meat and dried squilla powder was 13.46 and 66%, respectively. Maltodextrin gave good foam expansion (54%) among the three stabilizers while CMC imparted good foam stability (96%) and low foam density (0.59 g/cm^3). Water binding capacity of the dried protein powder was in the order MD-SPP (276.99%) >GA-SPP>CMC-SPP>control (186.95%). Suitability of squilla protein powder (2.5 and 5%) as a flavoring and/protein source in noodles was evaluated. Cooking time of noodles varied from 4.36 min for control noodle to 5.5 min in 5% SPP added noodles. Water absorption index of control, 2.5% SP noodle and 5% SP noodle was 184.305%, 197.725% and 236.56%, respectively. Cooking loss was more with 5% SP added noodles (4.54%). L* value of noodles decreased with increase in squilla protein powder. Cooked noodles with 2.5% SPP had higher sensory score in terms of flavor. In brief, the study demonstrated a promising approach towards the improved utilization of an untapped fishery resource.

Keywords: Squilla, Foam Mat Drying, Foam Stabilizers, Noodles, Physicochemical Qualities

Paper ID 15658

Green tea extract incorporation in sodium alginate film: effect on film characteristics and packaged fish steaks quality

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Green tea extract (GTE) is rich in antioxidants and functional compounds. The antioxidant, antimicrobial, functional, and structural properties of the GTE (0.25, 0.5, 1, and 2%, v/v) incorporated sodium alginate film were analyzed. At a concentration of 1mg/ml, GTE had 57.81 mg of galic acid/ g total phenolic content and DPPH radical scavenging activity was 75.19%. The highest DPPH scavenging activity and metal chelating activity were found in film incorporated 2% GTE. FTIR spectroscopy revealed the presence of bands at 3408-3400 cm^{-1} and 1608 cm^{-1} due to stretching vibrations of O–H groups inphenols and N–H stretching in amines, and C=O stretch in polyphenols, respectively. GTE-alginate film exhibited smaller micro-voids with a denser internal structure than pure alginate films, representing the formation of a cross-linking network structure between GTE and sodium alginate. Sodium alginate film incorporated with 1% GTE was selected to study the effect of GTE incorporation into sodium alginate film (GTF) on the quality of chill stored (2±1°C) tilapia steaks. Tilapia steaks were wrapped with sodium alginate film (AF) and GTE incorporated sodium alginate film (GTF) were then packed in polythene bag and stored under chilled conditions at 2±1°C. Tilapia steaks packed only in a polythene bag was used as a control (C). GTE incorporation showed better ability to inhibit the formation of volatile bases (TVB-N) and lipid oxidation products such as PV and TBARS. Aerobic plate counts of the steaks reached 5.5 log cfu/g, 5.45 log cfu/g and 4.76 log cfu/g in C, AF and GTF, respectively, on the 21st day of chilled storage. GTE packaged tilapia steaks scored better sensory attributes compared to AF packaged steaks. Considering the fact that green tea has high consumer acceptance, the packaging of fish and fish products in green tea incorporated films opens new possibilities to enhance the quality of fish through safe and active packaging materials.

Keywords: Green Tea Extract, Sodium Alginate Film, Functional Properties, Tilapia Steaks

Paper ID 15660

Characterization of edible packaging film from green seaweed (*Chaetomorpha sp*.)

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This study aims to develop edible packaging film from green seaweed (*Chaetomorpha sp*.) and evaluate their antioxidant and mechanical properties. Edible packaging film was prepared using 0.5% *Chaetomorpha sp*. along with sodium alginate and plasticizer. Antioxidant activities such as DPPH scavenging activity, ABTS radical scavenging activity, reducing power assay, phenolic content and physical and mechanical propertiesof green seaweed film was analyzed. Total phenolic content of the samples was 18.83µg Eqvt. of gallic acid/mg at 10mg/ml concentration. Seaweed film had exhibited good DPPH free radical scavenging activity (59.07%) and ABTS free radical scavenging activity (61.86%) at 10 mg/ml sample concentration. Fourier transform infrared spectroscopy (FTIR) were used to analyze functional groups in seaweed based film. Green seaweed packaging film developed from *Chaetomorpha sp*. can be easily sealed using hand operated sealing machine at lower temperature. Thickness and tensile strength of the film were 720 gauge and 140.4 kg/cm^2(MD), 125.5 kg/cm^2 (CD), respectively. Results indicate the film have low barrier properties. Results show that green seaweed is a promising sustainable, non toxic and ecofriendly material for preparing bioplastic for food application.

Keywords : Green Seaweed, *Chaetomorpha Sp*., Edible Packaging Film, Functional and Mechanical Properties

Paper ID 15675

Extraction of fish oil by cold process method and the effect of fruit peel extract as a natural preservative

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Fish is a highly nutritious food as it contains high amount of first class easily digestible animal protein. Fish is not only rich in protein but also with good quality fat. The lipid content of oily fishes consists of poly unsaturated fatty acids (PUFA) which have enormous health benefits for human. Generally fish body oil is extracted by heat process method which can cause the denaturation of these poly unsaturated fatty acids due to high temperature and can also induce the oxidation process quickly. Fish oil is easily prone to oxidation and to retard the oxidation process some preservatives like antioxidants can be added. Commercially, synthetic antioxidants like butylated hydroxyl toluene (BHT), butylated hydroxyl anisole (BHA) and tert butyl hydro quinone (TBHQ) are available in market and have been used as additives in seafood but health risks associated with these chemicals limits their application in seafood products. Alternative to this, natural plant extracts which contains various bioactive molecules can be used as preservatives. In this present study, the fish body oil is extracted by non-heat process which is otherwise called as cold process and the yield of both methods were analyzed. Cold process method yields higher amount of oil compared to heat process method. The extracted fish oil was incorporated with fruit peel extracts from pomegranate and orange. The impact of these fruit peel extracts on the oxidation of fish oil was analyzed by determining the peroxide value and thiobarbituric acid reactive substance (TBARS). Both fruit peel extracts had the potential to slow down the oxidation process. Comparatively pomegranate peel extract had high potential to retard the oxidation in fish body oil than orange peel extract.

Keywords : Cold Process, Extraction Of oil, Natural Preservative, Fruit Peel

Paper ID 15686

Biodegradability and physicochemical properties of clove essential oil incorporated biopolymer film prepared using agar, alginate and carrageenan

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Alternate packaging material to plastics has been our quest ever since humans have known the harmful effects of disposal of used packaging material to the environment. The 2.5% clove essential oil incorporated biopolymer film prepared using agar, alginate, and carrageenan (AAC-CEO) was studied for the physicochemical and mechanical properties as well as the environmental biodegradability under the soil and water. The mechanical properties of the experimental film remained 55.21 µm thickness, 22.66 MPa tensile strength, 23.42 % elongation at break, 63.12 N puncture resistance and 0.38 10-10 gmm-2Pa-1s-1 WVP. The film exhibited anti-microbial activity against *Staphylococcus aureus* (ATCC-25923) and *E. Coli* (ATCC-25922) at a level of 6 % incorporation of clove essential oil. A level of 2.5% incorporation of clove essential oil gave the maximum anti-oxidative activity of 85.7% DPPH radical inhibition. The biodegradability was quantified as % weight loss during decomposition in soil and in water. The thermal stability as determined by TGA revealed 41.9 % weight loss at the temperature range of 214.7 ° C to 348.7 ° C. The composite film exhibited a slight shift in XRD peaks than those of individual polymers. The bonding pattern of ATR-FTIR peaks did not exhibit any significant change in wavenumber shift. A nano level elevation in topography appeared in AFM image after the addition of CEO. The 2.5% clove essential oil incorporated biopolymer was degraded completely within 14 days in soil and 28 days in the water system. The properties of AAC-CEO film revealed a good potential to be used as a food packaging film.

Keywords : Clove Essential Oil (ceo), Biopolymer Film, Biodegradability, Vermicompost, Dpph

Paper ID 15687

Storage stability of pangasius cutlet under refrigerated conditions

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Abstract

In the present study, quality changes of the fish cutlets prepared from the mince of pangasius (Pangasianodon hypophthalmus) using sensory and biochemical methods during refrigerated storage were investigated. A storage study was conducted to find out the shelf-life of the product under refrigerated conditions for 12 days. The initial values of moisture, crude protein, fat and Ash content of the prepared cutlet were found as 54.20, 18.27, 15.40 and 4.35 percent respectively. At the end of the 12th day of storage moisture, crude protein, fat and Ash content were found 50.20, 19.90, 15.60 and 4.90 per cent respectively. NPN content decreased from 3.20 to 1.06 during the study. The total volatile base nitrogen contents (TVBN) increased from 5.0 to 18.60 (mg %) on the 12th day of study. Peroxide value also showed an increasing trend and was found as 7.80 (meq O2/kg) on the 12th day of the study. Similarly, the pH value increased from 6.58 to 7.20 during the study. Titratable acidity showed a decreasing trend and a final value of 0.26 (meq/100g) was recorded on the 12th day of the study. The product was rejected by the taste panel on the 12th day of the study.

Keywords : Keywords: Pangasius, Fish Cutlet, Sensory Evaluation, Storage Study

Paper ID 15689

Effect of water soluble chitosan in fortifying selected food products

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Food products such as health mix, vegetable soup and grape drinks are fortified with water soluble chitosan (WSC). FTIR results confirmed the presence of WSC in the fortified health mix, grape drink and vegetable soup. Proximate composition, pH, aminoacids and mineral content were analyzed for the fortified food each product. WSC fortified health mix and the vegetable soup had a higher protein content of 16.77± 0.02 and 12.72± 0.01 respectively. The pH of the WSC fortified health mix, vegetable soup and grape drink, were 6.5±0.05, 5.2±0.06 and 4±0.06 respectively. WSC fortified health mix and WSC fortified vegetable soup contained all the essential amino acids. Among these, isoleucine was found high in WSC fortified health mix (1.896±0.01 mg/100mg) and vegetable soup (1.477±0.01mg/100mg). Whereas, the WSC fortified health mix was found to be rich in glutamine (1.722±0.01mg/100mg). The minerals were found in considerable amounts with a high amount of magnesium in WSC fortified vegetable soup (1455.75 ± 39.72 mg/Kg). Storage studies for 200 days were performed for monitoring oxidation and microbial activity of the fortified food products and found stable during the storage period. This could be due to the preservative activity of water soluble chitosan. Sensory evaluation revealed the confirmed acceptance of all three products.

Keywords : Water Soluble Chitosan, Health Drink, Grape Drink, Vegetable Soup, Fortification

Paper ID 15697

Enrichment of Omega-3 Polyunsaturated Fatty Acids (PUFA) by hydrolysis of sardine body oil using microbial lipase

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Fish is not only rich in digestible animal protein but also with good quality lipid. Omega-3 polyunsaturated fatty acids (PUFA) are the essential fatty acids which the human body cannot synthesis and have a lot of health benefits in human nutrition. In this present study, the sardine fish body oil was extracted by non-heat process, where the pH of the fish muscle was adjusted to its isoelectric point (p*I*) by organic acid to separate the fish oil. The extracted oil was checked for its quality and subjected to hydrolysis using different microbial lipases. Three different commercially available microbial lipases, from *Candida rugosa* (CR), *Candida cylindracea* (CC) and *Aspergillus niger* (AN) had been used for the hydrolysis of sardine fish body oil in different concentrations with variation in hydrolysis timings. Degree of hydrolysis (DH), total fatty acid profile and lipid composition after hydrolysis were determined and found that the *Candida rugosa* lipase showed the highest degree of hydrolysis than other two lipases. The fatty acid profile of the sardine fish body oil was analyzed. All the lipases showed changes in fatty acid composition. The highest total omega-3 polyunsaturated fatty acids were resulted when the hydrolysis was done with *Candida rugosa* lipase for about 6 hours. Hydrolysis done with *Candida cylindracea* lipase at lower concentration showed high level of eicosa pentaenoic acid (EPA) and docosa hexaenoic acid (DHA). Only DHA content was increased significantly with the hydrolysis using *Aspergillus niger* lipase. Since many methods are used to concentrate omega-3 polyunsaturated fatty acids, lipase-catalyzed hydrolysis is one of the effective methods to concentrate omega-3 PUFAs from sardine fish body oil and have the potential for use in various nutraceuticals and pharmaceuticals.

Keywords : Lipase Hydrolysis, Non-heat Extraction, Fatty Acid Profile, Omega-3 Fatty Acid

Paper ID 15699

Seaweeds as nutritional additives: investigation of proximate composition, nutritional profile and bioactive properties of *Gracillaria edulis* and *Ulva lactuca*

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Seaweeds are less tapped renewable living resources which are abundant in nutrients and minerals that are playing role in plentiful biochemical reactions and non-nutrient constituents like polyphenols and dietary fibers. The aim of current study was to explicate the nutritional composition of the two marine macro algae *Gracillaria edulis* (red seaweed) and *Ulva lactuca* (Green seaweed) and the results revealed that the both seaweeds possess a fiber content of 10.05 ± 1.045% and 8.10 ± 0.98 %, a total ash content of 21.53 ± 1.04 and 19.40 ± 1.16, ether extract of 1.49 ± 0.59 and 1.40 ± 0.36, a protein content of 14.83 ± 0.98 and 14.83 ± 1.36 and gross energy of 3231 Kcal/kg and 3192 Kcal/kg respectively. Phenolic contents and carotenoids contents were also found to be good in both the seaweeds. Fatty acid profile verified the presence of major fatty acids with high nutritional value and amino acid composition showed that both seaweeds possess most of the essential amino acids. Phenolic content, antioxidant activity was found to be high in *G.edulis*, when compared with *U.lactuca* The result suggests that both the seaweeds have greater nutritional value with good bioactive properties and hence, can be used as outstanding nutritional additive.

Keywords : *Ulva, Gracillaria*, Nutritional Composition, Ftir, Bioactive Properties Etc

Paper ID 15729

Nutrient profiling and antioxidant capacity of *Kappaphycus sp*. collected from the farming sites of Gulf of Mannar

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Seaweeds are important marine resources extensively found around the world. The seaweeds are enriched with high nutritive composition, antioxidant and antimicrobial properties. *Kappaphycus sp.* is a red algae which contains high source of carrageenan and have many biotechnological applications in natural food products. The present study investigated the nutritive profile and bioactive properties of the *Kappaphycus sp.* Carbohydrate represents the major portion to the algae. The proximate composition in which *Kappaphycus* sp. contains moisture content of 12.803 ± 0.794 as in fresh it constitutes 90% of water content, protein of 6.21 ± 0.098, fat of 1.46 ± 0.101, fibre content of 6.72 ± 0.175, ash content of 19.65 ± 0.63, carbohydrate content of 49.06 ± 1.79. It also exhibits gross energy content of 3095 Kcal/g. FTIR spectrum observed in the study indicated the presence of seaweed polyphenols, sulphate ester, 3,6 anhydro - d - galactose content due to the presence of carrageenan. The minerals, fatty acids, amino acids, total phenolic content and DPPH radical-scavenging activity of *Kappaphycus sp.* were measured in the present study. In case of fatty acid composition, omega 6 fatty found to be higher when compared to saturated and monounsaturated fatty acids. It also contained rich source of aminoacids like lysine, leucine, arginine isoleucine, proline, tyrosine, phenylalanine. The extract from *Kappaphycus sp.* possessed with high total phenolic content and DPPH radical-scavenging activity. Based on the nutritive profile and the bioactive properties seaweed can be incorporated into food products as a nutrition supplement for human and animal health.

Keywords : *Kappaphycus sp*., Antioxidant, Phenolic Content, Bioactive Properties

Paper ID 15733

Development of bacterial cellulose based natural drip absorbent film for vacuum packaging application in fish

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Bacterial cellulose (BC), synthesised by microbial fermentation, is a versatile biopolymer with very high water-uptake capacity. In the current study, BC production by the bacteria, *Komagataeibacter xylinum* in Hestrin-Schramm medium by static fermentation was standardized. Further, BC based drip absorbent film was developed for fish packaging application and characterized. Average thickness of the film was 40±3 µm. The film had a whitish yellow colour and the L^*, a^* and b^* values of the films were 37.3±1.5, -1.49±0.34 and -0.55±0.12, respectively. Tensile strength of the film was 5.35±0.85 kgf while elongation at break (%) value was 21.0±2.6. DSC analysis revealed that the glass transition temperature (T_g) of BC film was 114 °C. FTIR spectra showed all characteristics peaks of BC. Oxygen transmission rate of the BC film was 30±5 $cm^3/(m^2.24$ h.0.1MPa). Moisture content (%) and % swelling degree of the BC film were 33.2±1 and 190±20. The developed BC film was used as a drip absorbent wrap in vacuum packed Indian Oil Sardine (*Sardinella longiceps*) stored at 2 °C. The results of the present work revealed that drip loss was greater in vacuum-packed fish while BC film acted as an excellent natural drip absorbent.

Keywords : Bacterial Cellulose, Vacuum Packaging, Drip Absorbent Film, Indian Oil Sardine

Paper ID 15736

Development of fish balls from needle scaled queenfish (*Scomberoides tol*)

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The Needlescaled Queenfish (*Scomberoides tol*) is a coastal fish which can be found in estuaries and inshore waters which is locally called as Thol paarai in Tamil Nadu. It is one of the low-cost fish which is suitable for converting into value-added product. Starch is commonly added at 3 to 12% (w/w) as a binder for many meat, fish, and vegetable products. The most frequently used starches include corn and tapioca as they are found to improve the water holding capacity and textural properties of products. The objective of this study was to develop fish balls from Needlescaled Queenfish (Scomberoides tol) and to evaluate the organoleptic properties of the developed product. Three different types of fish balls were prepared as pre-boiled and fried fish balls with 5% corn starch (SA), raw and fried fish balls with 5% corn starch (SB) and pre-boiled and fried fish balls with 5% corn starch and 5% tapioca flour (SC). Fish balls were evaluated for appearance, color, texture, taste, flavor and overall acceptability by sensory evaluation. Pre-boiled and fried fish balls with addition of both corn starch and tapioca flour (SC) was rated highest, whereas the SA made with only corn starch rated lowest in terms of overall acceptability.

Keywords : Fish Balls, *Scomberoides tol*, Corn Starch, Tapioca Flour, Sensory.

Paper ID 15754

Utilization of low-value fish powder and shrimp head exudate to develop ready to eat snack products

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The study was aimed to examine the changes in the proximate, biochemical, functional, microbial, and sensory parameters of the extruded product incorporated with low-value fish powder and shrimp head exudate. The fish powder was prepared from low-value fish and shrimp head exudate was prepared from shrimp head wastes. The nutritious Ready-to-eat (RTE) snack was developed using fish powder (0, 2.5%, 5% and 7.5%), shrimp headexudate (0.25%, 0.5%, 0.75% and 1%) and cereal flour such as cornflour and rice flour. A total of 8 extruded products were analyzed to optimize the incorporation rate for extruded products. Among the extruded products, extruded products incorporated with 2.5% fish protein and 0.75% shrimp head exudate had good physical characteristics and sensory scores individually. Hence, these concentrations individually can be used for the preparation of extruded snacks with increased protein content and flavor. Among the optimization of incorporation rates, these concentrations were used for the preparation of extruded snacks in combination as treatments for storage studies. (T1-FP0%, T2-FP2.5% T3-FP2.5%+0.75%SHE). To evaluate the shelf life of the extruded snack products T1, T2 and T3 were analyzed periodically up to 90 days of storage period. The resulting extruded products were assessed for the physical parameters such as ER, porosity, WSI, and WAI showed the declining trend in products and BD showed the increasing trend in the products during storage time. The biochemical parameters such as pH, PV, FFA, TBA, and Water activity were assessed and showed an increasing trend in the product during the storage period. The proximate parameters (moisture, protein, fat, and ash values increased and reduced carbohydrate and calorie composition in the product and microbial parameters (TPC, TFC, *E.coli*, *Staphylococcus aureus*) were assessed. A sensory acceptability study was conducted and sample T2 showed better acceptability in terms of quality and acceptability. The research demonstrated that the low-value fish and shrimp wastes should be utilized to reduce environmental pollution and to utilize the nutrients available from them. As a consequence, the product may be offered at a low cost to increase protein availability to the general people.

Keywords : Proximate, Functional, Biochemical, Microbial And Sensory , Fish Flour, Shrimp Head Exudate

Paper ID 15777

Storage stability of fish pickle prepared from *Cyprinus carpio communis*

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A study was undertaken to develop fish pickle from *Cyprinus carpio* and conduct a shelf-life study of the product at room temperature for a period of twelve months. The initial values of moisture, protein, fat and ash, and NPN content of the of the freshly prepared fish pickle were found as 47.50, 27.51,12.79 and 5.41% respectively. The initial values recorded for the, PV, TVBN, pH and titratable acidity were found as 2.5(meq O_2/kg), 3.40 (mg %), 5.15 and 0.61(meq/100g) respectively. The peroxide value showed an increased trend and a final value of 10.23 (meq/100g) was recorded in the twelfth month of the study. Similarly, TVBN value also increased during the study and was found as 15 (mg %) at the end of the study. pH value increased during the study and a final value of 6.21 was recorded at the end of the study. Final titratable acidity value was found as of 0.22 (meq/100g). The product was rejected by the taste panel on the basis of the organoleptic evaluation in the twelfth month of the study.

Keywords : Common Carp, Fish Pickle, Storage Study, Sensory Evaluation

Paper ID 15802

Innovative Approach in the Crude Protein Analysis with E-gadgets –an Overview.

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Protein analysis forms an integral part in the evaluation of any food stuffs. This is common for animal feeds. The samples to be tested vary in their state either as liquid or solid or semi solid. Therefore the method opted for the estimation of protein also varies. Conventionally there are two major methods of analysis are followed for protein estimation. They are titration and spectroscopic methods. They have been fine-tuned further with different methods of observation or recording the values. Although these methods are time-tested and widely practised for various types of products, they are either cumbersome or time consuming or developing wastes or sometimes pose health threats too. At this juncture, electronic gadgets with sensor based application and IOT enabled help in many ways. Sensor based estimation method is cheaper, user friendly, adoptable in all place and compatible with any data storage system. In addition to the above, this sensor based readable devices can surpass all the conventional methods like titration and spectroscopic methods in having no chemical handling and waste disposal. A Comparative Analysis has been made in bringing out the major advantages of IOT based E-Gadget working with sensors for estimation of protein in Aquafeeds, over the conventional methods. Evaluation study also yielded positive results encouraging the wide use of these e-gadgets for crude protein analysis in feed and feedstuffs.

Keywords: Crude Protein, Kjeldahl, Nirs, E-gadget, IoT

Paper ID 15828

Study on physicochemical properties of seaweed jam prepared from *Ulva lactuca*

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Edible seaweeds are commonly consumed in Asian countries because of their abundance and high nutritional value. *Ulva* is one of the edible seaweed found in the Gulf of Manner and Palk Bay region. The *Ulva* has the potential nutritional contents which can be used to prepare functional or healthy supplementary foods. This study aimed to fortify the seaweed pulp (*Ulva latuca*) with other fruits pulp – apple, guava, green banana, papaya, and pineapple to improve its physicochemical, nutritional, textural, and sensory properties. However, the physicochemical properties of jams did not differ much. Jam incorporated with seaweed pulp was found to contain a high amount of protein and minerals, which are highly beneficial for humans. The other characteristics such as pH, Energy (Kcal/100g), Carbohydrate (%), Vitamin C (Mg/100g), organoleptic properties, and shelf-life were determined. The effect of sugar concentration and storage time at ambient temperature on the quality of seaweed jam products were investigated to produce good quality products. The maximum sensory score is 6.70 out of 7. Sensory evaluation and microbiological changes of the jam were performed to assess consumers' likeness and safety for human consumption.

Keywords : Green Seaweed, Nutritional Profile, Shelf Life Analysis, Ulva Jam, *Ulva lactuca*

Paper ID 15868

In Vitro Bioaccessibility and antioxidant properties of unicorn leather jacket fish (*Aluterus monoceros)* skin collagen peptides prepared using crude collagenase enzyme isolated from fish fins

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In this study unicorn leatherjacket (*Aluterus monoceros*) fish skin collagen was hydrolyzed with the crude collagenase extracted from the fish fins discarded as by-product at three different temperature viz. 5^0C (CP-5), 25^0C (CP-25) and 50^0C (CP-50) to obtain collagen peptide of three molecular mass fraction *viz.*, <30kDa, <10kDa and <3kDa by ultra-filtration using TFF system. The collagenase extracted from fins had a MW of 29kDa and hydrolyzed skin collagen to molecular masses <24kDa efficiently with a DH ranging from 6.6-7.6%. CP-5 peptides with <3kDa showed the maximum antioxidant activity. DPPH and hydroxy radical scavenging activities were good with 70% and 68%, while metal chelating ability was 33% and reducing power was 0.3315. *In vitro* gastro-intestinal digestion study indicated that after pepsin digestion protein was more in CP-5 than CP-25 and CP-50. The rate of peptide absorption of the CP was significantly high in <3kDa CP-5 (32.56%), followed by CP-25 (32.43%) and CP-50 (32.35%) after gastric and pancreatin digestion. CP-5 of <3kDa having better antioxidative activities of collagen peptides in *in vitro* gastro-intestinal digests than CP-50 of <3kDa. The study thus indicated that CP with good antioxidant activity shall be produced by hydrolysis the skin at 5^0C, rather than at 50^0C.

Keywords : Unicorn Leather jacket, Collagenase Enzyme, Collagen Peptides, Hydrolysis Temperature, Simulated Gastro Intestinal Digestion, Bio Accessibility

Paper ID 15882

Microencapsulation of tuna bone collagen peptides and examination of their physico – chemical properties to determine their shelf stability

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Fish collagen peptides have attracted special attention due to their unique bioactive properties like anti-aging, anti-osteoporotic, and wound healing; but have certain limitations in their applicability, due to hygroscopicity and bitterness. Encapsulation is the most relevant technology in which bio-molecules within a thin film to generate microcapsules are enclosed, with enhanced bio-absorption properties. In this study, collagen peptides derived from bones of tuna (*Katsuwonus pelamis*) are encapsulated using different five carriers viz. soy protein isolate (protein), gum arabic (polysaccharide), sodium alginate (polysaccharide), mannitol (polyalcohol), and liposomes (lipid) following standard methodologies. The encapsulation efficiency ranged from 24.24% to 133.49% with soy protein isolate showing the maximum. Microcapsules viewed under SEM showed particle sizes ranging from 2.14 to 295.5µm. The zeta potential varied from -20.5mV to -50mV and the glass transition temperature from 72 to 114ºC. The storage life of microcapsules held at 5ºC was 35 days. *In vitro* digestion study showed that microcapsules are further hydrolyzed during pancreatic digestion to yield 36 to 45% additional α-free amino groups. The encapsulated peptides showed good bioabsorption properties ranging from 58 to 61%, and SPI – encapsulated peptides showed the maximum absorption. Thus, encapsulation of collagen peptides using a protein carrier (SPI) can provide microcapsules with better physicochemical properties, enhanced absorption, assimilation potential, and good shelf stability to serve as a suitable dietary supplement exhibiting various bioactive properties.

Keywords : Tuna Bones, Collagen Peptides, Encapsulation, Physico-chemical Properties, In Vitro Digestion

Paper ID 15930

Development and characterization of deep-sea fish gelatin and fucoidan based biopackaging film as a suitable protectant for frozen fishes

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Biocomposite films were prepared with deep sea fish gelatin extracted from scales of goat fish *Parupeneus heptacanthus* and fucoidan extracted from brown seaweed *Rosenvingea intricata* using glycerol as plasticizer. Fucoidan was incorporated at concentrations of 5, 10, 15 and 20% of protein concentration to prepare films GF-5, GF-10, GF-15 and GF-20 films, respectively. The prepared films were characterized by ATR-FTIR, SEM and XRD. Followed by physico-chemical characterization viz. average thickness, Tensile strength, elastic modulus, Water Vapour Transmission Rate, water solubility. The variable storage time showed an effect of fish quality under refrigerated condition. The study further showed that incorporation of fucoidan in fish gelatin films enhanced anti-oxidative properties besides improving mechanical and barrier properties, to serve as an active bio packaging film. Biocomposite films were prepared with deep sea fish gelatin extracted from scales of goat fish *Parupeneus heptacanthus* and fucoidan extracted from brown seaweed *Rosenvingea intricata* using glycerol as plasticizer. Fucoidan was incorporated at concentrations of 5, 10, 15 and 20% of protein concentration to prepare films GF-5, GF-10, GF-15 and GF-20 films, respectively. The prepared films were characterized by ATR-FTIR, SEM and XRD. Followed by physico-chemical characterization viz. average thickness, Tensile strength, elastic modulus, Water Vapour Transmission Rate, water solubility. The variable storage time showed an effect of fish quality under refrigerated condition. The study further showed that incorporation of fucoidan in fish gelatin films enhanced anti-oxidative properties besides improving mechanical and barrier properties, to serve as an active bio packaging film.

Keywords : *Rosenvingea intricata* Fucoidan, Goat Fish Gelatin, Biopackaging, Frozen Fish Preservation.

Paper ID 15947

Extraction and characterization of cellulose nanocrystals from brown seaweed Dictyota Bartayresiana Lamouroux, 1809

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Cellulose nanocrystals (CNCs) are bio nanomaterial derived from natural cellulose polymers, which are renewable and low-cost innovative packaging materials apart from their applications in drug delivery and biomedical engineering. In this study for the first time, the CNC was extracted from the brown seaweed *Dictyota bartayresiana* collected from the East coast of India. The brown seaweed samples were depolymerized, bleached, acid hydrolyzed, and mechanically dispersed to obtain about 10% of CNC. The spectral characterization of cellulose nanocrystals was carried out by ATR-FTIR, XRD, and SEM. CNCs exhibit an elongated rod-like shape, diameter within the nanoscale, and higher length. Physico-chemical and mechanical analysis showed that the prepared cellulose nanocrystals have greater film forming efficiency, which can be utilized for food packaging applications.

Keywords : Cellulose Nanocrystals, Brown Seaweeds, Dictyota Bartayresiana , Spectral Characterization, Film Forming Ability

Paper ID 15970

Extraction of shrimp hydrolysate from shrimp head waste and its functional properties

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Proteins form a major part of shrimp head waste. Extraction of these proteins in the form of shrimp hydrolysates powder and their incorporation in some food products will increase the availability of protein in the food. In the present study, an attempt was made to extract shrimp hydrolysates from shrimp head wastes using pepsin enzyme. The conditions for extraction like temperature, pH, time and enzyme/ substrate ratio were optimized and found that temperature of 50ºC, pH 6.5, E/S ratio of 1% and 60 min. of extraction time were the optimized conditions for extraction of shrimp hydrolysates. Shrimp hydrolysate was extracted in the optimized conditions and the functional properties of the hydrolysate were evaluated. The hydrolysate had a protein content of 80.34%, the DPPH, FRAP and metal chelating activity at 200 mg/L was 45.73%, 0.68% and 65.74% respectively, foaming capacity of 52.03%, foaming stability of 16.59% and has inhibited the growth of *Staphylococcus aureus, Bacillus subtilis and Escherichia coli* at a significant level. The Shrimp hydrolysate powder may be incorporated to an appropriate level to the snack foods for increased protein availability and shelf-life extension

Keywords : Shrimp Hydrolysate, Shrimp Waste, Extraction, Protein

Paper ID 15976

Enhancing the Shelf Life of *Shidal*, a Fermented Fish Product of North-East India by Environmental Manipulation

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North-East (NE) India is well-known for traditional food and food products. One such food product is *Shidal*. *Shidal* is a fermented product in which the shape of the fish (*Puntius* spp.) remains almost intact. It has several local names such as *Shidal*, *Sepaa* and *Hidal* in Assam, Tripura, Mizoram, Arunachal Pradesh and Nagaland, *Ngari* in Manipur. Though it is consumed across all NE states, but it is most popular in the tribal belts and Bengali communities. It is consumed after preparing *shidal* chutney (*Shidal Bhorta*) or *shidal* curry. Such preparations are believed to provide protection against Malaria. Earthen pot (locally called *Mutka*) is used for preparation and storage of *Shidal,* however, it is observed that if the product is taken out of that pot while retailing or kitchen use, it loses it shelf life and quality. In general, people store it by wrapping with newspaper, banana leaf or plastic packet which is not a hygienic practice. Therefore, in the present study, we have assessed how to improve the shelf life of *Shidal* by low-cost means. It was observed that if the product is stored at refrigerated condition (4^{o}C) with 2% common salt, its pH remains stable (4.3-4.6) and not much significant alteration happens in the level of non-protein Nitrogen (NPN), Free α-amino Nitrogen (AAN), Total volatile base nitrogen (TVB-N), Peroxide value (PV), Free fatty acid (FFA) and Thiobarbituric Acid (TBA) of the product. Refrigerated condition lingers the overall acceptability period of the product. Normally, the shelf life of *Shidal* after taking out of *mutka* is 60 days but in this study, it was observed that if it jarred with 2% salt and stored at ambient temperature its shelf life is enhanced to 90 days and if stored at refrigerated temperature, its shelf life is further enhanced to 105 days. From this experiment, it could be concluded that by simple environmental manipulation, the shelf life of *Shidal* could be extended by 30 to 45 days.

Keywords : Fermented Fish, Shelf Life, Storage Temperature, Biochemical Property

Paper ID 15988

Effect of pre-drying treatments on quality of traditional and artificial dried Bombay Duck (*Harpadon nehereus*, Hamilton 1822) stored at ambient temperature

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The present investigation was carried out to evaluate the effect of pre-drying treatments on drying capacity of Bombay duck (*Harpadon nehereus*) using sodium benzoate as a preservative. Bombay ducks are distributed in five different treatments including control. First treatment was used as a control, second treatment containing 18% brine solution, third treatment containing 2% Ascorbic acid, treatment fourth and fifth contained mixed solution of ascorbic acid and brine solution. After application first four treatments, Bombay ducks were dried using traditional sun drying method and the last treatment was dried using artificial method. At the end of the experiment Bombay duck under sun drying containing mixture of ascorbic acid and brine was efficient for improving shelf life.

Keywords : Bombay Duck, Pre-drying Treatments, Drying Methods

Paper ID 15998

Refrigerated storage studies of coated stretched shrimp developed from pacific white leg shrimp (*Litopenaeus vannamei*, Boone, 1931) treated with citrus fruit peel extracts

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Litopenaeus vannamei, **(**white leg shrimp) is the most widely cultured shrimp species contributing 90% of the shrimp production globally. Shrimps rank first among the seafood products exported from India. They are exported in the form of raw frozen, IQF, cooked frozen etc. This study aims at better utilization of this species inorder to explore its potential in the area of value addition. In this regard the present work was conducted by developing stretched shrimp followed by treatment with orange peel extract, battering and breading, packing and storage in refrigerated condition. Stretched shrimp was produced by employing the shrimp stretching mould designed by ICAR-CIFT. Quality assessment and shelf life studies were conducted for this product stored under refrigerated condition. The products were appraised for the physical, chemical, sensory and microbiological quality attributes. Sensory analysis was conducted throughout the study which exhibited a reduction in scores during the storage along with the increase in value for the quality parameters. When compared to the control group, treatment group exhibited an extended shelf life of 2 days under the storage condition. The treated products exhibited a storage life of 15 days under refrigerated condition.

Keywords : *Litopenaeus vannamei*, Refrigeration, Shrimp, Citrus, Fruit Peel

Paper ID 16012

Development of different molecular weight-based chitosan edible films: optimization of film forming parameters by Response Surface Methodology (RSM) and characterization

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In the present study, Response surface methodology (RSM) was used to optimize the film-forming properties for chitosan film development as influenced by the molecular weight of chitosan. Box-Behnken design (BBD) with 3 center points was employed for determining the effects of the input variables on film formation. Based on preliminary experiments, the input variables selected were Chitosan concentration (%, w/v) X_1, Glycerol concentration (%, w/v) X_2, drying temperature (° C) X_3, and Molecular weight grade X_4, which were chosen as independent variables and each variable was coded at three levels -1, 0, +1. Film thickness, Tensile strength, and elongation (%) were selected as the response for 27 different combinations of input variables. The quadratic model fitted for film formation revealed that the coefficient of determination (R^2) was 0.9177, explaining 91.77% of the variability in response. Based on the models derived by RSM, the optimized conditions for film formations are 2.30% of medium molecular weight chitosan, 1.5% of glycerol with a drying temperature of 45°C. In the case of low molecular chitosan, 2.35% of low molecular weight chitosan with 1.5% of glycerol and the drying temperature of 50° C were the optimal condition for the film formation. Based on the results, high molecular weight chitosan was found unsuitable for film development. At optimized conditions, the films were developed and properties such as residual moisture, water-solubility, opacity, thermal properties, morphology, chemical functional groups, and colour analysis were characterized. The study revealed that low and medium molecular weight chitosan films showed better mechanical properties and could be successfully developed as a film that in turn can be used in food packaging applications.

Keywords : Chitosan, Molecular Weight, Response Surface Methodology (RSM), Box-behnken Design, Mechanical Properties, Functional Properties

Paper ID 16039

Development of cassava starch cookies fortified with fish protein concentrate

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The food industry is growing worldwide with rapid introduction of new products, formulated with the intent of meeting specific health benefits or organoleptic needs of consumers. Cassava is a rich source of carbohydrate with around 25% starch, 1–2% fat, 1–2% fibre and 1–2% protein. Fish protein powder is an excellent source of highly digestible proteins and can be used for the enrichment of food products. The present study revealed that addition of 5 and 10% Fish Protein Concentrate powder into cookies, increased fat and protein contents, improved the texture as well as appearance of cookies. This formulation demonstrated that fish protein and cassava starch can be potentially applied as functional constituents and nutritional supplements in bakery products like cookies.

Keywords : Cassava, Starch, Fish Protein Concentrate, Cookies

Paper ID 16066

Biochemical, structural, functional and antioxidative properties of brown seaweed protein isolate (*Sargassum tenerrimum*) as influenced by drying techniques

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Globally the demand for vegan proteins is increasing over animal proteins owing to growing health concerns and sustainability. Seaweeds can form an excellent sustainable alternative source for vegan proteins. In India, seaweeds are under-exploited despite of their abundance along the Indian coast. Alkaline solubilisation and acid precipitation technique (Isoelectric point precipitation/pI method) have been proven to be a simple and scalable techniques of protein isolation from various food sources. Though there are reports on protein isolation from seaweed using pI, the effects of drying have not been studied in detail with reference to the quality of seaweed proteins. Hence, in the present study, we have investigated the effect of drying techniques like freeze drying, vacuum drying and spray drying on the structural, biochemical functional and antioxidant properties of proteins isolated from *Sargassum tenerrimum,* using pH shift-based technique. Based on the drying methods employed, the protein isolate samples were designated as SD-SPI (spray-dried *Sargassum* protein isolate, FD-SPI (freeze-dried *sargassum* protein isolate) and VD-SPI (vacuum dried *Sargassum* protein isolate). Dried raw seaweed (*Sargassum tenerrimum*) used for protein isolation contains 10.37 ± 0.21% moisture, 12.55 ± 0.74% protein, 2.02 ± 0.03% fat, 15.53 ± 0.50% ash, and 58.78± 0.79% total carbohydrate. The protein content of SD-SPI, FD-SPI and VD-SPI were 66.29 ± 2.28 %, 64.64 ± 4.62% and 49.16 ± 2.90%, respectively. Alcoholic extract from protein isolates were studied for antioxidant potential. The highest antioxidant activity was observed in SD-SPI (69.30 ± 5.23 %) followed by FD-SPI and VD-SPI. The maximum total phenol content was observed in the extract of FD-SPI (9.09± 0.76 mg GAE/g) than SD-SPI (7.43± 1.13 mg GAE/g) and VD-SPI (6.90± 0.31 mg GAE/g) respectively. The FRAP of all the samples increased significantly ($p < 0.05$) with the increase in protein concentration in alcoholic extract. FTIR analysis of seaweed and protein isolates was carried to understand the structural difference manifested due to drying methods. The properties like solubility and viscosity and functionalities including emulsion and foaming were also studied. Based on the overall results obtained, having the cost of operation and ease of handling in view spray drying of seaweed protein isolate can be a choice of commercial production. The present study has demonstrated the seaweed as a source of raw material for vegan protein development and also elaborated on the effect of different drying techniques on quality seaweed protein isolate.

Keywords: Seaweed, Protein, pH shift process, Biochemical composition, Drying methods, Structural analysis

Paper ID 16074

Comparison of biochemical composition and physicochemical properties of yellow clam (*Meretrix meretrix*) after oven drying and freeze drying

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Freeze dried and oven dried yellow clam (*Meretrix meretrix*) meat is compared for its biochemical composition and physicochemical properties. The steamed meat was subjected to oven drying and freeze drying along with raw meat. Biochemical composition analysis includes analysis of proximate composition, mineral profile, fatty acid composition and amino acid profile. Physicochemical properties such as pH, water activity, and DSC profile were also analysed. Proximate composition analysis of raw clam meat showed moisture of 78.47%, crude protein of 10.58%, crude fat of 0.975% and ash of 3.18%. Oven dried clam meat powder has a moisture content of 7.71%, crude protein of 43.42%, crude fat of 4.86% and ash content of 5.65%. Freeze dried clam meat powder has a moisture of 4.43%, crude protein of 46.97%, crude fat of 5.02% and ash of 5.26%. The mineral profile analysis showed a rich content of calcium, magnesium, sodium, phosphorous, iron and manganese. Amino acid profile showed a highest content of glutamic acid followed by aspartic acid, arginine and alanine. Higher T_{max} value was found in Steamed oven dried clam sample compared to steamed freeze dried sample indicate the ability to resist thermal denaturation. Freeze dried and oven dried yellow clam meat can be used as a protein additive to enrich various food products.

Keywords : Yellow Clam, Freeze Drying, Oven Drying, Nutient Composition

Paper ID 16081

Physico-chemical and functional characteristics of microwave/ sundried chitosan

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The effect of drying on physicochemical and functional properties of chitosan was investigated. Chitosan was prepared from industrial chitin (shrimp shell) by cold process. Yield of chitosan obtained from chitin was 60%. Chitosan was dried under microwave process at different range of power starting from 400watts to 1600watts. Chitosan dried under sun was kept as control. Drying time varied significantly $p< 0.05$) in microwave processed chitosan than sundried. Viscosity of chitosan ranged from 828.50 Cp to 2117 Cp. The highest viscosity (2117Cp) was observed for chitosan processed under 1600watts. Chitosan dried under sun had a viscosity of 828.50Cp. The degree of deacetylation ranged from 77.3% to 80.8%. The higher L* (74.70), the lower a* (2.02) and b* (16.42) values were obtained for sundried chitosan. Functional properties such as water and fat binding capacities were also determined. Water binding capacity ranged from 269.86% to 499.65%. Fat finding capacity. The highest fat binding capacity was obtained for chitosan processed under 400watts. DSC and FTIR analysis revealed that there is no significant change in the thermal and structural pattern of chitosan dried under different conditions.

Keywords : Chitosan, Microwave Dried, Sun Drying, Physical Properties, Functional Properties

Paper ID 16100

Physicochemical, functional, structural, sensory and cooking characteristics of seaweed (*caulerpa racemosa*) incorporated pasta

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Abstract

The aim of the study is to optimize the incorporation of seaweed powder (*Caulerpa racemosa*) at different percentages (0, 2.5%, 5%, 10%, and 15%) in pasta. The increase in seaweed level in pasta increases the nutritional composition compared to the control pasta. The moisture contents 6.21±0.035 to 5.52 ± 0.04, crude protein 4.61±0.03 to 5.18±0.06, crude fat 0.48±0.04 to 0.9 ± 0.06, ash 3.12 ± 0.07 to 5.08 ± 0.04 and crude fibre 6.25±0.03 to 5.86 ± 0.02. The FTIR analysis confirms the enrichment of seaweed polyphenols in the seaweed incorporated pasta due to the presence of functional group in the wavenumber 3761.81cm^{-1}. According to microstructure studies, seaweed incorporated pasta exhibited a better protein starch network. Sensorily, the 5 percent seaweed powder incorporated pasta was well accepted. Fortification with seaweed powder in pasta enhanced phenolic content compared to control pasta increased in the range from 0.52 ± 0.01to 1.03 ± 0.04 mg gallic acid equivalents (GAE/g) and among various samples the 2,2-Diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity of sensorily accepted 5 percent seaweed powder incorporated pasta showed 33.75±0.05% activity compared to that of control 28.21±0.03%. Additionally the 5 percent seaweed incorporated pasta accepted with a high amino acid content, fatty acid content, and its high antioxidant properties.

Keywords : Seaweed, Pasta, Polyphenols, Nutrition, Antioxidant Properties

Paper ID 16177

Production and properties of squid paste from seafood waste using endogenous enzymes

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Seafood processing produces huge quantity of waste which is nearly 20 - 80 % of the total weight of the produce and it depends mainly on the type, style of processing and fish species. The disposal of fish processing waste is the major issue due to the negative environmental impact. Fish waste also contains high amounts of protein as well as fats and minerals which are also recycled and are used in making different product. Squid is the most widely used food in cephalopods because of its high protein content and export value. Hence, the present study was undertaken to develop the product from squid waste as a feed ingredient and study its shelf stability at room temperature. The biochemical, microbial and sensory quality parameters were analysed during the storage period. The protein content was in the range of 20.30-25.47 % (wet wt basis) during the storage study. The sample had the fat content of 2.60 % (wet wt basis). The initial mesophilic count was high and it was reduced to 5.601 CFU/g due to the increasing the load of yeast and mould in the sample at the third month of rejection. The initial TMA-N content of the squid paste was 1.39 mg/100g. The acid value was reduced during the storage period. Fatty acid composition of squid paste studied using GC-MS. The saturated fatty acid contents were high than that of mono and poly unsaturated fatty acid contents. The product had the shelf life of 3 months at room temperature.

Keywords : Seafood Waste, Squid Paste, Shelf Life Stability

Paper ID 16197

In Vivo wound healing and cytotoxicity properties of skin collagen peptides derived from unicorn leather jacket fish (*Aluterus monoceros*)

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In this present study the collagen peptide was extracted from the skin of unicorn leatherjacket (*Aluterus monoceros*) and it was hydrolyzed using crude collagenase enzyme extracted from the fish fins which are discarded as waste. Based on the results of my earlier experimental studies the freeze-dried and spray dried collagen peptide of <3kDa was extracted using molecular mass fraction by ultra-filtration using tangential flow filtration (TFF) system at 5^0C (CP-5) was used to study the *in vivo* wound healing activity and also the cytotoxicity studies in the albino male mice, BALB/c. The wound healing properties were assessed by making a subcutaneous circular incision wound on albino male mice and it was monitored for its contraction over the period of treatment for 15 days by comparing with collagen peptide (test group), megaheal gel ointment (standard group) and control group as no treatment. The results showed that the percentage wound reduction was much faster in the collagen peptide treated groups (48.48±0.02%) than the standard (45.45±0.03%) and control (31.31±0.01%) groups. Similarly, the spray dried collagen peptide (CP-5 of <3kDa) was given orally for 15 consecutive days and its cytotoxic effect was studied in the small intestine of 6 BALB/c. The treatment was divided into two groups viz., control (1ml of saline) and test group (50mg/ml of collagen peptide) with 3 animals in each group weighing approximately 25 g each and it was provided with food and water and housed under standard environmental conditions of temperature with 12 h light and dark cycle. The result showed no cytotoxic effects in the epithelial cells of small intestine. the study thus indicated that the skin collagen peptides derived from unicorn leatherjacket had good wound healing properties and no cytotoxic effects.

Keywords : Unicorn Leather jacket, Albino Male Mice, Wound Healing, Collagen Peptides, Cytotoxic Effects

Paper ID 16198

Studies on the organoleptic acceptance of *Salicornia* incorporated fish cutlet

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Salicornia is a halophyte and its succulent leaves are cooked and eaten. Fish cutlet is a healthy and tasty snack food rather costly, for which an attempt shall be made to incorporate salicornia in fish cutlets so as to reduce the cost of the product. The present study was undertaken to prepare fish cutlets incorporating halophyte at different proportions and to evaluate organoleptic quality characteristics of the product. *Salicornia* plant samples were collected and the proximate composition was analyzed. Fish cutlets were prepared incorporating cooked *Salicornia* leaf at different levels viz.15, 25 and 35 percentage using standard protocol. Fish cutlets prepared without addition of halophyte leaf served as control. Sensory scores were obtained for various attributes like appearance, colour, flavour, odour, taste, texture and overall acceptability of the products through trained judges. Cutlets prepared with 15 % *Salicornia* obtained an organoleptic hedonic point (8.0) almost equal to control (8.6). The overall sensory scores of cutlets with 25 and 35 percent of halophyte leaf were 6.5 and 6.0 respectively. Among cutlets prepared with different levels of halophyte, cutlet with 15 % of halophyte was similar in attributes to that of the control. Hence, this study proves that the *Salicornia* can be incorporated in fish cutlets with 15 % level to prepare cost effective quality fish cutlets.

Keywords : *Salicornia*, Fish Cutlet, Halophyte, Organoleptic Evaluation

Paper ID 16208

Development and Evaluation of Calamari Protein-based Beverage Mix as Functional Food

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The high protein beverage powder supplement based on marine squid, *Loligo duvauceli* had been developed. The squids were eviscerated, cleaned and minced to form a paste. The squid paste was enzyme hydrolyzed using papain under alkaline conditions maintained using food grade sodium hydroxide at 50ºC. The squid protein hydrolysate (SPH) was extracted from the hydrolyzed mixture after filtration to remove extracted meat particles and dried to powder form at 63ºC overnight in a hot air oven. The SPH prepared was found to contain 79.1% protein, 10% fiber, 0.6% fat,10.8% moisture and 4.866 kilocalorie/g energy value. The yield of SPH was found to be 2.33%. The percentage inclusion of SPH in the beverage mix was standardized based on organoleptic qualities to evaluate the acceptance of the product. The high protein beverage supplement was formulated using ingredients viz., malt extract powder, SPH, cocoa and skim milk powders. The nutritional analysis found that the formulated beverage supplement had 30.12 % crude protein, 10 % fibre, 5% fat, 3.52% ash, 5.6% moisture and 4.502 kilocalorie/g energy. The amino acid analysis revealed that the supplement was significantly high in essential amino acids viz., arginine, lysine, leucine, methionine, isoleucine and valine, and conditional amino acids namely taurine and proline. The sensory analysis of the mix in milk showed that the product was significantly acceptable and good. Production and marketing of squid protein-based beverage mix is an excellent opportunity for a food business operator to utilize the technology to tap the existing demand in the market for functional food.

Keywords : Squid, Beverage Mix, Protein Hydrolysate, Functional Food, Aminoacids

Paper ID 16210

Development of Eco Packaging Material From Tilapia Skin Gelatin and Bioplastics

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Gelatin is a byproduct of fish and animal processing which could be widely utilised in the food and packaging industry. Furthermore, due to the high concentration of proline, glycine, and hydroxyproline, which equip gelatin with exceptional film-forming capacity and aid in the construction of a flexible film. Traditional packaging materials based on petrochemicals, on the other hand, these are non-biodegradable and generate major environmental issues. Therefore, biodegradable food packaging materials must be developed as an alternative to synthetic plastic packaging materials, particularly for use in short-term packaging and throw away applications. However, due to their environmentally friendly nature, good processibility and acceptable mechanical and barrier properties, the bioplastics such as poly(lactide) (PLA), poly(butylene adipate-co-terephthalate) (PBAT), poly(butylene succinate) (PBS) and other biodegradable polyesters have recently attracted attention for packaging and other value added applications. Thus, the aim of the work was to create novel biodegradable multi-layered films for food packaging as an alternative to synthetic plastics. Eco-packaging material was developed from tilapia skin gelatin, poly(lactic acid) (PLA) and poly(butylene adipate-co-terephthalate) (PBAT). The resulted three-layered films (PLA/Gelatin/PBAT) were subjected to analyse the properties, in comparison with the control counterparts. The thickness of multi-layered films was increased ($P<0.05$). Mechanical properties of developed films were improved by the addition of PLA and PBAT. The lowest water barrier property was observed for the control gelatin film ($P<0.05$). Colour of the resulting films was affected differently. The higher transparency value was obtained for multi-layered films. Solubility of gelatin films was impacted by the addition of bioplastics. Thus, the property enhancement of gelatin film can be done with the bioplastics and these eco-packaging materials could gradually replace the synthetic plastic films.

Keywords : Eco-packaging, Fish Gelatin, Bioplastics, Multi-layered, Mechanical Property, Water Vapor Permeability, Transparency

Paper ID 16212

Study on the development and evaluation of squid and millets-based extrudate under two different packaging conditions

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The squid seems to be low utilized seafood compared to other finfish and shellfish in the domestic market. The minor millets are also an underutilized agricultural crop. An attempt was made to produce a nutritive and healthier snack by combining squid, finger millet and pearl millet through extrusion technology. The squid powder (6.5%), finger millet flour (10%), pearl millet flour (10%) and cornflour (73.5%) were moistened with 6% water and extruded in a twin-screw extruder to produce optimized extrudate. The extrudate was packed in aluminum foil laminated pouches with and without nitrogen flushing. The packed products are stored at room temperature in paper board cartons and tested for various quality indicators to determine the shelf life. The squid and millets-based extrudate had 53.71% more protein content than the control extrudate. The developed product was found to be stable for 90 days. The nitrogen flush packaging of squid and millets-based extrudate was found to increase the shelf life of the product.

Keywords : Squid, Millets, Extrudate, Nitrogen Flushing, Shelf Life

Paper ID 16215

Study on the quality evaluation of ohmic heated green mussel meat in comparison with traditional heating method

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A comparison of ohmic heating and traditional heating methods on the nutritional characteristics and textural attributes of green mussel (*Perna viridis*) meat was investigated in this study. Green mussels farmed in Pullicat Lake were collected, depurated and shucked. The mussel meat weighing 13-15 g was selected for ohmic heating to ensure process uniformity. For ohmic heating 200g of mussel meat and 600 ml of water were placed in the processing chamber of the ohmic heater and heating was done at 120V for 5minutes. For conventional heating, mussel meat was immersed in boiling water for 8minutes. The potential of the ohmic and conventional heating process was assessed based on proximate composition, cook loss, pH, texture profile, changes in the protein-carbohydrate group, minerals, amino acid and fatty acid composition of mussel meat. The proximate composition of ohmic heated mussel meat was significantly ($P<0.05$) higher than conventional heated mussel meat. The nutrient composition of ohmic and conventional heated mussel meat was found to be 43.17 ± 1.23% and 34.48 ± 0.32% protein, 5.66 ± 0.37% and 5.51 ± 0.27% lipid and 2.44 ± 0.17% and 2.92 ± 0.09% ash respectively. The cooking loss was found low in ohmic heated mussel meat (6.37 ± 0.89%) than conventional heated mussel meat (13.64 ± 0.84%). There was no significant difference in pH of ohmic and conventional heated mussel meat. Ohmic heating did not affect the texture of mussel meat as compared to the conventional heated one. It was found that ohmic heating yielded superior quality products in terms of nutrient retention. The shelf life of ohmic heated mussel meat was found to be 40 days in refrigerated storage whereas the conventional heated one was stable only for 3 days.

Keywords : Ohmic Heating, Traditional Heating, Green Mussel Meat, Proximate Composition, Texture

Paper ID 16218

Study on the development of freeze-dried snack from *Penaeus vannamei*

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Penaeus vannamei is the most widely cultured shrimp variety being exported in the form of block frozen, IQF and battered and breaded products. There is an increasing demand for convenient, nutritious and safe foods all over the world. Standardization of the process of freeze-drying of *Penaeus vannamei* and subsequent development of ready-to-eat freeze-dried shrimp snacks was conceptualized. Freeze drying of shrimp was standardized to obtain the final moisture content of 3%. The freeze-dried shrimp was air-fried and oil-fried. Five flavours were tried on the product and among these peri-peri was selected based on the organoleptic evaluation. The storage studies were conducted on freeze-dried shrimp snacks in comparison with hot air-dried shrimp snacks packed in an air and nitrogen atmosphere for 120 days. Biochemical and microbial analyses were carried out during the storage period. The result of the analysis showed that the product was good and shelf-stable for a period of 120 days.

Keywords : Freeze-dried Shrimp, Freeze Dryer, Hot Air Dryer, Sensory Evaluation

Paper ID 16250

Impact of arginine on properties of low salt surimi gel from tilapia (*Oreochromis niloticus)*

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Low salt surimi was prepared from tilapia (*Oreochromis niloticus*) using arginine and their gel properties were investigated. The main aim of the present study is to optimize the salt (0.5, 1.0, and 1.5 %) and arginine (0.5, 0.75, and 1.0%) concentration for obtaining higher gel strength by response surface methodology using a central composite design. The optimum salt concentrations of 1.01 %, 1.02 %, 1.00 %, and arginine concentrations of 0.72 %, 0.72 %, and 0.70 % were established for obtaining maximum gel strength, hardness, and minimum expressible moisture content of surimi gel. The predicted maximum gel strength and hardness were 435 g.cm and 54.26 N respectively. The predicted minimum expressible moisture content was 2.50%. Additionally, whiteness, TCA soluble peptide content, and protein pattern of surimi gel were evaluated. The whiteness of surimi gel decreased with the addition of arginine. TCA soluble peptide content value was in agreement with the result of gel strength. Protein pattern revealed polymerization of MHC in surimi gel, which had the maximum gel strength and hardness. Therefore, the present study revealed that the addition of arginine could yield high quality gel from tilapia surimi in low salt condition.

Keywords : Low Salt Surimi, Arginine, Rsm, Gel Strength, Hardness

Paper ID 16251

Review on freeze dried fishery products

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This review examines the physical, functional and biochemical changes of lyophilized fishery products. Rehydration percentage, rehydration coefficient, rehydration ability, water activity, density, colour, volumetric shrinkage, apparent density, rheological data were analyzed. Advantages and disadvantages of the freeze drying and techniques associated with its use to reduce the cost were proposed. The effect of freeze drying on proximate composition of fishery products such as moisture, carbohydrates, fat, ash, fiber, nitrogen free extract, Nacl were analyzed. The functional properties such as water holding capacity, protein soluble, gel forming ability, emulsification capacity and stability foaming capacity and stability were also discussed. It is concluded that freeze drying increases the rehydration capacity of dried fishery product to a greater extent. The long processing time and energy costs are the major limiting factor. It is possible to reduce the long processing time by adopting combined technology.

Keywords : Freeze Drying, Fishery Products, Proximate Composition, Rehydration Co-efficient, Product Stability, Functional Properties.

Paper ID 16265

Characteristics of tilapia skin gelatin structurally modified with N-hydroxysuccinimidic ester of myristic acid at various levels

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Gelatin modified with *N*-hydroxysuccinimidic ester of myristic acid (C14:0) (NHSE-MA) at various levels (0, 0.25, 0.5, 1 and 2% w/v) was characterized and analyzed for functional properties. ATR-FTIR spectra of myristic acid (MA) and myristic acid ester (NHSE-MA) were significantly different. Myristic acid ester was attached to the gelatin molecules as indicated by the decrease in free amino group content, whilst increased degree of modification ($P<0.05$). Control gelatin (without modification) had the higher free amino group content ($P<0.05$). Gelatin modified with fatty acid ester had the increased surface hydrophobicity and solubility ($P<0.05$). ATR-FTIR spectra revealed the differences in the secondary structure and functional groups of modified and un-modified gelatins. Electrophoretic study revealed the decreased molecular weight of α_2-chains for modified gelatins, when NHSE-MA levels increased. Functional properties, including emulsifying and foaming properties of modified gelatins were generally improved. Thus, the properties and characteristics of modified gelatins were governed by the degree of modification.

Keywords : Gelatin, Myristic Acid, N-hydroxysuccinimide, Free Amino Group, Surface Hydrophobicity, FTIR, Functional Properties

Paper ID 16282

Production and characterization of medium viscosity chitosan from industrial chitin

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Isolation of chitin and conversion to chitosan is one of the most accepted and practical way of utilization of crustacean shell waste mainly shrimp shell waste. Chitosan, the most usable form has found applications in many industries like functional food, biopackaging material, cosmetics, pharmaceutical, medical, agricultural, water treatment, etc. As a result of extensive research on applications of chitosan, it has been understood that the properties of chitosan are governed by polymer quality parameters like molecular weight, degree of deacetylation and pattern of acetylation. Controlling and tailoring the aforementioned factors during the production process would result in chitosan with exciting properties so that the applications and in turn the value. Viscosity is often a direct indicator of polymer quality. In the present study, we produced medium viscosity chitosan in the range of 260-777 cP using commercial chitin sourced from industries through alkali assisted deacetylation process (37.5% NaOH; 120-135 min; 92-95℃; chitin to alkali ratio of 1:30). On the basis of solubility of samples in 1% acetic acid, the deacetylation was terminated). Seven different batches of chitosan from each batch of 500g chitin were produced and characterized for physico-chemical, structural and functional properties. The variations were observed among the batches in spite of production from single batch of chitin. The chitosan content and degree of deacetylation (determined by UV spectroscopy method) were 88-93% and 77-86%, respectively. Fourier-Transform infrared spectroscopic study of samples confirmed the conversion of chitin to chitosan and also the typical characteristics bands of chitosan. All the chitosan samples were comparable with the standard medium viscosity chitosan from commercial suppliers. The application studies are under progress and of future scope of investigations. The production of medium viscosity chitosan is a way for value addition and also opens new range of properties and applications.

Keywords : Chitin Value Addition, Chitosan, Viscosity, Medium Viscosity, Chitosan Process

Paper ID 16297

Qualitative evaluation of acid preserved silage prepared from fish waste

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The aim of this research was to use three distinct acids to convert fish market trash into protein-rich silage: formic acid (3.5%), lactic acid (2.5, 3.5, 4.5 and 5.5%) and acetic acid (2.5, 3.5, 4.5 and 5.5%). Raw papaya (Carica papaya) was used as a catalyst to accelerate the process of fermentation. Initially, the proximate composition of the raw material was moisture (79.34 ± 0.27%), crude protein (15.53 ± 0.09%), fat (2.72 ± 0.06%) and ash (2.40 ± 0.15%). The nutritional, biochemical and microbiological properties of different acid preserved fish silage were analyzed during a study period of 60 days at ambient temperature. *Treatments A1 (2.5% lactic acid), A2 (3.5% lactic acid) and B1 (2.5% acetic acid) were spoiled at the end of the 12th, 18th and 12th days, respectively. The pH, TMA and TVB-N values were increased with duration and then stable up to 60 days. The TPC count showed a decreasing trend and was not detected after six days. The protein content of acid silages after 60 days, treatment FA (3.5% formic acid), A4 (4.5% lactic acid), B2 (3.5% acetic acid) and B3 (4.5% acetic acid) had greater values of 13.81 ± 0.07, 13.10 ± 0.02, 13.56 ± 0.03 and 13.79 ± 0.07%, respectively. Formic acid silage was compared with lactic acid and acetic acid in relation to the proximate, biochemical and microbiological parameters. The treatments FA (3.5% formic acid), A4 (5.5% lactic acid) and B3 (4.5% acetic acid) gave almost similar results. The present study revealed that lactic acid and acetic acid could substitute formic acid. Acetic acid is less expensive and locally available than formic acid. Acetic acid can substitute formic acid and make it more economically feasible. Fish silage can be stored for up to 60 days without deterioration.*

Keywords : Fish Waste, Fish Silage, Qualitative Evaluation, Shelf Life

Paper ID 16300

Fabrication and characterization of marine eel collagen-sodium alginate based bio-composite film for potential wound dressing applications

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Marine derived collagen as a competitive biomaterial for biomedical and pharmaceutical applications has attracted much attention. Fish processing discards could be promising cost-effective collagen sources through recycling of those wastes. Thus, the present study was aimed for the extraction of pepsin soluble collagen (PSC) from the skin of an underutilized species, Muraenesox cinereus and the development of a novel bio composite film composed of collagen and sodium alginate by solvent casting method. The extracted collagen was characterized as Type 1 collagen with a yield of 27%. Fourier Transform Infrared Spectroscopy (FTIR) spectra confirmed the intact triple helical structure stabilized mostly by hydrogen bonds and scanning electron microscopy (SEM) investigations showed the morphology of isolated collagen as a multi-layered, tubular structure of complicated collagen fibrils. In addition, sodium alginate – pepsin solubilized collagen blend film was characterized by FTIR spectrum which showed the functional group interaction of the biocomposite film and the morphological changes and crystallinity were examined under SEM and X-ray diffractometer (XRD). The antibacterial activity of the films was investigated and it presents good inhibitory activities against the tested bacteria as compared to the control sample. The findings of the study indicates that the developed bio composite film is expected to have an excellent wound dressing application

Keywords : Marine Collagen, Sodium Alginate, Biocomposite Film, Antimicrobial Property

Paper ID 16312

Natural Spices and Herbs: potential bio ingredient for enhancement of seafood shelf life

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Consumer demand for minimally processed seafood that retains its sensory and nutritional properties after handling and storage is increasing. Food preservative additives are natural or manmade compounds that prevent microbial growth, enzyme activity, and oxidation from causing food degradation. Synthetic food additives were more commonly used in the past. Synthetic chemicals have not been universally accepted by consumers in recent years due to their alleged negative health effects. Therefore, customers' preference for natural ingredients (species and herbs) is growing by the day. Natural preservatives with strong antioxidant and antibacterial characteristics have been extensively researched and adopted as safe alternatives in the preparation of seafood with the preliminary objective of enhancing shelf life. There is a strong and growing interest among consumers and manufacturers in products that can be used to enhance health and wellness. Due to an increasing interest in the creation of safe and effective natural food preservation, spices and herbs have gained relevance as potential sources of natural food preservatives in recent years.

Keywords : Seafood, Natural Preservatives, Spices And Herbs, Shelf Life, Human Health

Paper ID 16319

Development and characterization of novel ulvan- sodium alginate composite film for effective packaging applications in food processing industry

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The application of green technology in developing different food packaging materials are gaining moment due to increasing concern on environmental sustainability and plastic pollution causes. Ulvan, a sulphated polysaccharide from the green seaweed *Ulva sp.* has important biological potentials such as an anticoagulant, antioxidant, anti-inflammatory, and antiviral activities. The present study utilized ulvan extracted from the green seaweed *Ulva reticulata*, for the development of bio-functional films in combination with sodium alginate, another natural polysaccharide from brown seaweeds. Further the physical, mechanical, thermal, antioxidative, and structural properties of ulvan- sodium alginate-based films were studied. The incorporation of ulvan polysaccharides had a positive effect on improving the thickness, color, and opacity, with lower moisture and solubility measurements. The films were free of bubbles and fractures in SEM micrographs and elemental distribution via EDX showed lower sulphate but silicon content in ulvan added films rather than pure sodium alginate film. Thermal behavior showed that high activation energy is required for the melting of biocomposite, which might be attributed to their high level of interaction within the polymeric system. The FTIR spectra evidenced the miscibility of both seaweed biopolymers with the plasticizer and increased hydrogen bonding owing to their hydrophilic nature. Also, the inclusion of ulvan had a significant effect on improving the free radical scavenging activity confirmed through DPPH analysis. Hence the results suggest the scope for extending their application for the preservation of different food products mainly perishable items like seafood, meat varieties etc.

Keywords : *Ulva reticulata*, Ulvan- Sodium Alginate Composite, Sem-edx, Ftir, Perishable Products

Paper ID 16333

Nutraceutical properties and anticancer activities of indian marine red alga, *Gracilaria verrucosa*

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Bioactive compounds from seaweeds are found to play an important therapeutic role in disease prevention in humans. Seaweed bioactive such as pigments, polyphenols, and peptides have been proven to possess various beneficial biological properties both in an in-vitro and in-vivo model system. Thus, there is a substantial opportunity that seaweeds could potentially contribute to functional food and nutraceutical development. With this background, the present study aimed to examine the nutritional composition, functional properties, and anticancer activities of the marine red alga, *Gracilaria verrucosa*. The moisture, ash, protein, fat, and fiber content of G. *verrucosa* was analyzed by standard AOAC methods. The amino acids composition was quantified by using HPLC connected with an RI detector. The carotenoids profile was analyzed by using HPLC connected with a PDA detector. The total phenols and flavonoids content was measured by the spectrophotometric method. The pigment extract of marine algae was analyzed for its growth inhibitory effect in breast cancer (MDA-MB-231) cells using WST-1 assay, migration assay, and live/dead staining. The results indicate that G. ve*r*rucosa had protein, fat, and fiber content of 13.13, 0.24, and 1.13% respectively. It had a considerable amount of essential, non-essential, and semi-essential amino acids. The carotenoids profile showed that G. *verrucosa* contains lutein and β-carotene as major carotenoids. The pigment extracts of red algae showed growth inhibitory potential in human breast cancer cells which were associated with suppressed migration and increased cell death. The results of this study highlight that those marine red algae could be utilized for functional food and nutraceutical development.

Keywords : Marine Algae, Pigments, Phycocyanin, Anticancer

Paper ID 16335

Optimization of methods for the extraction of phycocyanin from marine red alga, *Kappaphycus alvarezii*

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Kappaphycus alvarezii is one of the economically important red alga, mainly used for the production of commercially important hydrocolloids. India shares more than two percent of global *K. alvarezii* production. In Tamil Nadu, a considerable number of households engaged in seaweed farming as an alternative livelihood. However, marine red algae are found to possess several health-beneficial components. The present study aimed to examine the c-phycocyanin content of *K. alvarezii* collected from Mandapam, Tamil Nadu using various extraction methods. The extractions were carried out using five different methods, including organic and inorganic acid treatment, solvent treatment, freeze-thaw, and sonication methods. The nutritional composition of the red alga, *K. alvarezii* was also analyzed by standard AOAC protocols. In the inorganic acid treatment method, hydrochloric acid at 2.0 M had a higher phycocyanin concentration of 0.19 mg/ml with a yield of 0.098 mg/g. A higher concentration of 0.003 mg/ml of phycocyanin was observed in acetic acid treatment at 8.0 M with a yield of 0.014 mg/g. Extraction using phosphate buffer showed a phycocyanin yield of 0.03 mg/g. The extraction using sonication exhibited the highest concentration and yield of phycocyanin among all the methods treated. The freeze-thaw method had an extraction yield of 0.047 mg/g with a 0.009 mg/ml concentration. This study shows that *K. alvarezii* could be a renewable resource of phycobiliproteins that could be used in various industrial applications

Keywords : Marine Algae, Extraction, Pigments, Phycocyanin

Paper ID 16338

Discolouration with spreading pattern of black spot in white leg shrimp (*Litopenaeus vannamei*) during chilled storage

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The discolouration is a phenomenon occurring in crustaceans & triggered by a biochemical reaction mediated by the polyphenol oxidase (PPO) enzyme. A study was carried out regarding discolouration in *Litopenaeus vannamei* during chilled storage (at 2°C) for 14 days. Partial purification of polyphenol oxidase was done by 70% ammonium sulphate precipitation followed by dialysis and the PPO activity in different parts of *L. vannamei* was analysed to understand the contribution of different organs in the commencement of discolouration called melanosis using 3, 4-dihydroxy phenylalanine (L-DOPA) as substrate. The activity was the highest in carapace (98.99 U/mg of protein), followed by cephalothorax (45.98 U/mg of protein) during chilled storage. The melanosis score increased significantly ($P<0.05$). Metric chroma (C) had a negative relationship with PPO activity during storage. Correlation matrices showed a specific activity of PPO in different parts that had a negative correlation with lightness (L*) but a positive correlation with redness (a*) and yellowness (b*) except for cephalothorax. The organoleptic score indicated the acceptability of *L. vannamei* was up to 6 days. This study concluded that discolouration in shrimp was started from head and spread to different parts from the 6th day onwards under chilled condition.

Keywords : Discolouration; Melanosis; Litopenaeus Vannamei; Polyphenol Oxidase Activity; Metric Chroma; Organoleptic Score.

Paper ID 16340

Development of shrimp patties from inland saline water reared *L. vannamei* and its storage study

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White leg shrimp (*Litopenaeus vannamei*) has become one of India's most important seafood export commodities due to its great culture potential. This shrimp is usually raised in brackish water, which is the natural environment for shrimp growth and survival. In many parts of the world, this shrimp is now produced in inland saline waters, which is not a native environment. Since the shrimp are reared in compromised or stressed conditions, the meat quality and flavour of the shrimp may also get affected. Value addition increases the strength of the flavour while masking the disparities in quality and flavour. Therefore, in this study, an attempt was made to develop shrimp patties from inland saline water reared *vannamei* (ISRV) and compare their quality to that of brackish water reared *vannamei* (BWRV). The patties prepared from ISRV had high protein (25.69% w/w), high ash (1.68% w/w) and low fat (0.20% w/w) content as compared with BWRV patties, which had protein, ash and fat content as 21.45%, 1.52% and 0.43%, respectively. No significant difference was observed in the sensory scores of the patties prepared from ISRV and BWRV. The storage study of patties was conducted at refrigerated temperature based on biochemical, microbial and sensory analysis. From the results, it was observed that the shelf life for shrimp patties prepared from BWRV and ISRV during refrigerated storage was 8 days. As a result of the current analysis, it can be concluded that ISRV can be used to make value-added products because there were no major quality discrepancies between it and BWRV.

Keywords : Inland Saline Water; Shrimp Patties; Quality; Refrigerated Storage

Paper ID 16369

Quality analysis of seaweed-based pickle developed using Sea Lettuce, *Ulva lactuca*

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Seaweeds are known for their nutritional benefits and it is consumed by South East Asian countries such as Japan, Korea, and China. Recently, the consumption of seaweed as food is becoming popular all around the world due to its health beneficial role. Though seaweed is considered a vegetarian food, the aroma of the seaweed hinders the preference of the Indian population for regular edibles. Green seaweed, *Ulva lactuca* is a widely available seaweed with a mild flavor. Hence, this study aimed to standardize a seaweed recipe for spicy pickles with sensory acceptability, nutritional benefits, and shelf life. The pickle prepared with 10% and 20% of *U. lactuca* showed high acceptability in sensory evaluation. The nutritional composition of seaweed was evaluated using standard AOAC methods. The protein, fat, and fiber content of 10% seaweed pickle was found to be 12.5%, 5.5%, and 2.3% respectively. The pH of the product was 4.5. The product was observed with sensory, chemical, and microbiological acceptability after three months of storage at room temperature. The results of the present study indicate that *U. lactuca* could be utilized for the preparation of functional food products which will improve the economic value of seaweed.

Keywords : Marine Algae, Value Addition, Seaweed Pickle

Paper ID 16389

Evaluation of colour and sensory quality of analogue shrimp products from lizard fish in retortable pouches

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A ready-to-serve thermally processed analogue shrimp curry and masala have been developed using steam air and water immersion retort. The developed analogue shrimp products were subjected to various color and sensory properties of analogue shrimp products in retortable pouches processed by steam/ air and water immersion retort were determined. Based on colour and sensory properties of analogue shrimp curry processed by steam air retort was good for human consumption.

Keywords : Biochemical, Sterility, Texture, Colour, Sensory, Steam Air, Water, Immersion

Paper ID 16391

Functional properties of imitated shrimp gel products from lizard fish (*Saurida tumbil)*

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Twelve imitated shrimp gels were prepared using different additives such as microbial transglutaminase, egg white, sodium lactate, trehalose with different proportions and compared with the control imitated shrimp gels. The functional properties of imitated shrimp gel products such as texture profile analysis (hardness I, hardness II, cohesiveness, springiness, gumminess, chewiness, fracture force, stiffness), breaking force, deformation, gel strength, folding test, expressible moisture content and other parameters such as colour, SDS PAGE, microstructure and differential scanning calorimetry (DSC) were determined. Based on the functional properties, imitated shrimp gel with microbial transglutaminase (Batch II) was the best suited for the preparation of imitated shrimp products.

Keywords : Cohesiveness, Stiffness, DSC, SDS PAGE, Microstructure, Hardness

Paper ID 16428

Heat penetration characteristics of analogue shrimp products (ASP) from lizard fish (*Saurida tumbil*) in retort pouches

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Analogue shrimp products were prepared and thermally processed in retortable pouches. About 125g of shrimp analogue product and 100g of curry (masala) were filled in retort pouches of size, 150x200mm. Air inside the pouch was exhausted by steam injection followed by heat sealing and processing at 121.1ºC in a retort by steam/air overpressure retort and water immersion retort. The difference in the heat penetration characteristics of analogue shrimp products processed in retort by steam/air overpressure retort and water immersion retort were studied. Heat penetration values were recorded for each minute of processing with the Ellab data recorder. Obtained data were plotted on a semi-logarithmic paper with temperature deficit on the x-axis against time on the y-axis.

Keywords : Keywords: Steam Air, Come Up Time, Heat Penetration, Ellab Data Recorder, Water Immersion. Shrimp Analogue

Paper ID 16431

Optimization of formulations for 3D printed fish product enriched fish marine polyunsaturated fatty acids

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The present study aimed to standardize the formulations for developing novel 3D printed fish product fortified with marine lipid. Food bot 3D printer is used for extrusion and fresh fish mince, canned fish mince in combination with corn flour, egg white and marine oil from Indian oil sardine was used for optimizing the formulations. A total of 14 combinations with varying levels of ingredients were used for optimization. Moisture content, hardness, instrumental colour and flow rate of the formulations were monitored in the study. Moisture content of the formulations ranged between 47 to 58%. Mass flow of the formulations from the extruder was observed to be in the rate of 1.05 to 2.19g per minute. Shark fish design was plotted using open source software *Cura* and the design was converted into STL files which was used for 3D printing. Mass flow without interruption, printability, printing layer by layer without altering its pre-designed shape, printing without any air gap were considered as the selection criteria. For the formulations with fresh minced fish, exhibited varying moisture content in the range of 47 to 58% and the hardness of the sample was between 0.03 to 0.08kgf and uniform flow rate could not be achieved due to poor extrudability. The formulations with canned fish meat resulted in almost uniform moisture content (51 to 52%). The formulation with canned meat resulted in good printability and the material flow was continuous and layer by layer deposition without any air gap was observed. The final 3D printed product weighing 5.3 to 5.46g resembling pre-designed shape was obtained from formulations with canned fish mince indicating its suitability. No significant loss in the polyunsaturated fatty acids (both EPA and DHA) was noticed in 3D printed fish product, indicating its suitability for the development of fortified fish products.

Keywords : 3D Printed Fish Products, Fortified Food, Optimized Formulation

Paper ID 16445

Automatic Temperature Controlled Solar Drier for Effective Drying Of Fish.

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Present work aims to produce a low cost, easily affordable solar dryer which have an automated temperature controlling facility for both home and industrial scale applications. It provides a feature for continuous monitoring and eliminate the need for frequent temperature testing. Fish is a very high source of protein, iodine, vitamins and minerals and contains rich number of fatty acids (PUFA). Food and Agricultural organization suggest that 17% of global population intake of animal protein and 6.5 % of all the protein consumed is accounted from fish resources. It serves both as food and provides income. In order to overcome the surplus demand, food must be preserved for a long period of time and the best method for preservation of food is drying by traditional ways i.e., sun drying/solar drying. In spite of the availability of many advanced operations and equipment, the traditional methods of preservation and drying of fish is solar drying. The major limitation in traditional method of sun drying is there is no proper control over the temperature. Miniature model of solar drier with automated temperature controller based on LM35 temperature sensor and Arduino Programming was fabricated. In present work the fish (matthi) is dried in both sun drying and automated temperature controlled solar drier. Automated temperature controlled solar drier used to maintain colour, texture and water activity in the fish. The final dried product from the miniature model reduces more moisture than the fish dried in sun drying. It had been found that the fish sample dried in automated temperature controlled solar dryer reduce 6.09% more moisture content than the sample dried under the sun.

Keywords: Automated Temperature Controller, Solar Dryer, Arduino Programming, Lm35 Sensor, Fish Drying.

Paper ID 16483

Fishery and trade of lobsters in West Bengal: An overview

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Lobsters are not targeted in West Bengal mainly due to muted local demand and are usually caught as by-catch mainly by bottom trawls. With minor landings of about 124 t, they contributed a negligible 0.3% to the marine crustacean landings of the state in 2020. The catch was highest in 2011 at 789 t after which it declined by 90% in 2014 and is highly fluctuating since then. The lobsters landings in 2020 was about 84% lower compared to historic high in 2011 and about 60% lower compared to previous year. The fishery is mainly contributed by Panulirus homarus (78.5%) followed by Panulirus polyphagus (21.0%) and negligible quantity by Thenus unimaculatus (0.5%). Highest landings were usually observed during winter. The inferior quality lobsters with dark pigmentation and slacked carapace are traded in local market at 250-500 rupees per kg depending on the size. Superior quality lobsters commands a market price of 1000-1500 rupees per kg and are traded by processing units. These lobsters are circulated to various states (Kerala, Tamilnadu, Karnataka, Goa, Andhra Pradesh, Odisha, Maharashtra, Gujarat and Delhi) and also outside India. Due to meager landings, the market intermediaries pool the lobsters and transport to the processing plant where they are thoroughly washed, graded and are shifted to FRP boxes (100 kg capacity). The lobsters are bent in such a way that their uropods are kept below the abdominal segment and are fixed by rubber band to prevent slackness. The lobsters are placed in a dorsal down-ventral up orientation in the FRP boxes layer after layer covered with crushed ice. Sodium bisulfate is sprinkled over each lobster layer to prevent dark discoloration. After loading, the boxes are air sealed by thick poly sheet which preserve the quality of lobsters during long duration transportation. Lobsters are transported by road to Howrah, Sealda and Kharagpur railway stations from which they are distributed to different states in India. For export, the consignments are transported to holding facilities near Kolkata airport where they are redistributed into small lots of 20 kg each, packed in small polystyrene rectangular containers and transported by air. Popularization of lobster as a delicacy and proper marketing linkages could increase the fisheries focus on this esteemed marine resource.

Keywords : Lobster Fishery, Trade, Export, Processing

Paper ID 16484

Development of android-based mobile application for calculating F_0 value of crab meat pasteurization

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The vital part of the food supply is made up of processed foods,which arebecoming a lifestyle habitat. There are several parameters to address the freshness and quality of the food. F0 value is one of the parameters that help in defining the quality of thermally processed foods. F0 value is the number of minutes at a given temperature required to kill known population of organisms in a given food under specified conditions. Many methods are available for calculating F_0 value, here this android based application was developed using Patashnik improved general method. This research deals with developing a user-friendly and convenient mobile application on Android Mobile Operating System for calculating the F0value of thermally processed food, especially pasteurized crab meat. Optimum F_0 value of the process specific to the fishery products helps in retaining the nutritive value of the fish while ensuring microbial safety. The manual method of F_0 value calculation includes the calculation of thermal death time and lethality of the process. It is a time-consuming process and demands a well-trained technical person. The use of mobile app helps in calculating the F0 value in less than a minute and can be calculated by a lab technician with minimum proficiency in mathematical calculations.

Keywords : Android, Mobile Application, F_0 Value, Pasteurized Crab Meat, Processed Food, Shelf Life

Paper ID 16500

Effect of degree of hydrolysis and enzyme type on bioactive properties of protein hydrolysate from *Acetes spp*.

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Although there are several bioactive proteins and peptides have been reported from fish sources, other marine sources such as crustaceans and mollusks has still need to be studied extensively. *Acetes spp.* were commonly known as paste shrimp which is an unexploited tiny prawn resource available from Asian, African and pacific waters. Four commercial enzymes such as Alcalase, Papain, Trypsin and pepsin were used for the extraction of protein hydrolysate from Acetes spp. at varied Degree of Hydrolysis (DH). The bioactive properties such as Antioxidant, Antihypertensive and Metal chelating activities were determined for the protein hydrolysates produced at varied DH. Results indicated that the DPPH radical scavenging activities increased with the increase in DH and the highest activity of 60.41% was obtained at DH 30% in papain assisted hydrolysis. A progressive significant relationship of ACE inhibition with DH was obtained and the lowest activity of 41.30% was obtained in alcalase assisted hydrolysate at 5% DH and the highest activity of 81.82% in alcalase assisted hydrolysate at 30% DH. These findings implied that DH influenced bioactive properties of protein hydrolysate produced from Acetes spp. and also its potential to inhibit ACE activity and scavenge free radicals

Keywords : *Acetes spp*., Ace Inhibitiory Activities, Degree Of Hydrolysis And Enzymatic Hydrolysis

8. AQUATIC FOOD SAFETY AND QUALITY

Paper ID 15527

Physicochemical and Functional Characteristics of Microencapsulated Anti-Osteoporotic Fish Bone Collagen Peptides

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The main objective of this study to prepare microencapsulated fish bone collagen peptides having anti-osteoporotic properties, which can serve as a functional food. In the present study, fish bone wastes were used to obtain fish bone collagen peptides (FBCP) through hydrolysis using 1 % alcalase. To reduce the bitterness and hygroscopicity, FBCP were encapsulated using different carriers viz. soy protein isolate (protein), gum arabic and sodium alginate (polysaccharide), soy lecithin (lipid) and mannitol (sugar alcohol) by different ways such as thin film hydration, spray drying and dropping technique. Storage stability was examined for physical, sensory and microbiological qualities. The bio-accessibility of collagen pepties was studied by *in vitro* gastrointestinal digestion using pepsin and pepsin-pancreatin. FTIR spectra showed amide A peak at 3398cm^{-1}, amide B peak at 2925 cm^{-1}, amide I peak 1656cm^{-1} and amide II peak 1564cm^{-1}. Collagen peptides on encapsulation by different methods gave encapsulation efficiencies (EE) ranging from 24.24% to 133.49%, with SPI-ECP giving the highest EE. Cell proliferation, cell differentiation and bone mineralization studies conformed that cell proliferation was the maximum at 100□g/ml concentration, cell differentiation occurred on 7th day, bone mineralization and alkaline phosphatase (ALP) activities were maximum on 14th day. The SPI-ECP treated cells showed two folds higher ALP activity and bone mineralization. Encapsulation as viewed by SEM showed that the size of encapsulated collagen peptides (ECPs) ranged from 2.14 to 295.5 µm. The zeta potential varied from - 20.5 mV to - 50.3 mV and glass transition temperatures from 72 to 114℃. The FBCP and ECPs had good storage stability for 35 days. *In vitro* digestion study proven that pancreatic digestion further hydrolyzed collagen peptides yielding 36 to 43% additional □-free amino groups. The absorption of FBCP and ECPs in simulated study ranged from 58 to 61%, with SPI- ECP capsules showing the maximum. The study therefore concludes that SPI-ECP capsules that exhibited excellent anti-osteoporotic properties and better functional properties than other ECPs and FBCP is recommended as the best dietary supplement or functional food.

Keywords : Osteoporosis, Fish Bone Collagen Peptides, Mc3t3-e1 Bone Cells

Paper ID 15681

Halochromic Sensor for Real-time Monitoring Spoilage of Packed Seer Fish

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The objective of this study is to develop a cellulose-based halochromic sensor that can be used to monitor the degradation of fisheries products. The first step is to produce a cellulose-based thin film composite with mixed-halochromic indicator dyes. The thin film was characterised using UV-visible and FT-IR spectroscopy. The thin film characteristics were further investigated using lab and RGB measurements. To check spoilage, seer fish fillets were packaged with newly designed halochromic sensors. With the spoilage of the packed fish, the sensor produced identifiable colours. The present study revealed a potential material combination for sensor fabrication that might be used to monitor the degradation of packed fishery product in real time.

Keywords : Packed Fish Spoilage, Halochromic Sensor, Colorimetric Sensor, Seafood Spoilage

Paper ID 15694

Human Health Risk Assessment for Heavy Metals in Raw and Heat Processed Rock Crab, *Charybdis Natator*

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Human health risk assessment is a way of assessing the impact of heavy metals through consumption of seafood for a group of people or population. In this study, the thermally processed body and claw meat of rock crab, *Charybdis natator* caught along Thoothukudi coast was investigated for risk due to arsenic (As), cadmium (Cd), mercury(Hg) and lead (Pb). The average concentration of As, Cd, Hg and Pb in raw body meat and claw meat were 13.9 & 17.9 µg/g; 0.28 & 0.08 µg/g; 0.027 & 0.027 µg/g and 0.48 &0.23 µg/g respectively. In boiled, fried and microwave cooked crabs, there was an increase in the Hg and reduction in Pb concentration in all the crabs. In contrast, the concentration of As and Cd reduced in boiled crabs, while they increased in fried and microwave cooked crabs. The risk assessment analysis indicated that there was non- carcinogenic risk upon lifetime consumption of boiled and fried rock crab, *C. natator* as the Target Hazard Quotient was >1, on exposure to As, indicating a possible health risk to the exposed consumers.

Keywords : Rock Crab, Heavy metals, Risk Assessment, Thermal Processing

Paper ID 15721

Effect of Different Processing Interventions on the Retention of Residual Level of Formaldehyde in Fish

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Abstract

The fish and shellfish are an excellent source of high-quality protein, essential amino acids, fatty acids, vitamins and minerals and are also considered as the highly perishable food commodity. Formaldehyde, the simplest of the aldehydes used in chemical industry is top in the list of illegal, harmful food additives which is highly hazardous and carcinogenic in nature. Formaldehyde is used by some fishermen and fish vendors to preserve the freshness and quality of fish and seafood. An experiment was conducted to evaluate the efficiency of different processing methods such as washing, cooking and baking on removal of formaldehyde from Indian Mackerel fish. The fish samples were dip - treated initially with 1% formaldehyde solution. Washing is done at different interval time of 2.5, 5, 7.5, 10, 12.5 ,15 minutes. The reduction of formaldehyde was calculated in HPLC method as this method was found to be sensitive comparative to spectrophotometry method. The residual formaldehyde before washing in the fish ranged from 13.09 ± 0.099 to 12.86 ± 0.052 µg/g. After washing, the residual formaldehyde was decreased to 3.74 ± 0.047 µg/g as increase in the contact time, the percentage of removal of formaldehyde also increases. In washing, the percentage of absorption and removal of formaldehyde in fish meat after 15 minutes were found as 29.10% and 70.9%. Another experiment was done in order to compare the effect of washing, boiling and microwave cooking on formaldehyde content of fish. It was found that formaldehyde content was reduced by 70.66 % in washing, 74.98% in boiling and 50.196% in microwave cooking. Boiling of fish could significantly reduce the formaldehyde content in fish compared to washing and microwave cooking.

Keywords : Formaldehyde, HPLC method, Washing, Boiling, Microwave Cooking.

Paper ID 15732

Occurrence of *E. Coli* in Fresh fish marketed in Chennai, India and their Antibiotic Resistance and Resistance Genes

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The occurrence of *Escherichia coli*, their antimicrobial resistance and antimicrobial resistance genes in samples of finfish (*Nemipterus japonicus*) and shellfish (*Penaeus indicus*) was studied from three retail fish markets of Old Mahaballipuram Road (OMR), Chennai. Seventy-two fish and shrimp samples were collected from the Kovalam, Kelambakam and Navallur fish markets and analysed for the presence of total heterotrophic bacteria, total and faecal coliform bacteria and *E. coli*. Aerobic plate count ranged from 5.47 to 7.79 log cfu g-1 and was greater than the limits specified by ICMSF for fresh and frozen fish. Total coliform bacteria and faecal coliform bacteria were also high in all the seafood samples analysed and at the maximum detectable limit of over MPN 140 10g-1 in most cases. *E. coli* counts ranged from MPN 0.4 to > 140 10g-1 and the occurrence of *E. coli* was confirmed in all the samples. Three hundred and two presumptive *E. coli* showing metallic sheen on EMB agar were isolated and 126 isolates (42%) were confirmed as *E. coli* based on biochemical tests. Three biotypes of *E. coli* had been described with 77%, 8% and 15% under biotype I, II and faecal type respectively. From the 126 confirmed *E. coli*, 100 isolates were selected for further studies involving serotyping and antibiotic susceptibility. Serotyping of the 84 typeable isolates showed the occurrence of serogroups O2, O5, O7, O8, O9, O11, O20, O22, O25, O26, O35, O49, O52, O84, O118, O119, O120, O121, O134, O135, O145 and O157 based on the somatic antigen. Of the 18 antibiotics tested, resistance was observed towards 16 antibiotics. All the isolates were resistant to ampicillin and the resistance to other antibiotics was polymyxin B (80%) followed by gentamicin (65%), nalidixic acid (65%) and tetracycline (32%). Resistance towards β lactam antibiotics belonging to first, second and third-generation cephalosporins was in the range of 22 to 32%. The multiple antibiotic resistance (MAR) index of all the isolates was above 0.2 indicating a high-risk source of contamination. Presence of antibiotic-resistant genes namely *bla*TEM, *blaSHV*, *bla*CTX-M, *ampC, sul1, sul2* and class 1 integron was recorded in 70%, 14%, 29%, 74% 12%, 8% and 31% of isolates, respectively. The presence of pathogenic *E. coli* in seafood is a concern emphasizing the need for hygienic conditions in the landing centre and markets in addition to the hygienic handling of fish. The occurrence of multiple antibiotic resistance and resistance genes in *E. coli* in seafood may act as reservoirs for resistant bacteria and could facilitate the transmission of the resistance genes to other human pathogenic bacteria.

Keywords : *Escherichia Coli*, Serogroups, Antibiotic Resistance, Antibiotic Resistance Genes.

Paper ID 15749

Quality Prediction of Ready to Eat Fishery Products Packed in Tin Can Using Neural Network

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Food processing industry is growing in double digit, urging the scientific community to find quick and accurate solutions for ensuring the quality of the food products that are consumed by the consumer. Modeling and prediction study in food processing industry with the help of ANNs demonstrate certain ability to predict the end product quality based on quality characteristics of input material and standard processing conditions. The aim of the present study is to evaluate the suitability of a neural network model for predicting the post processing quality characteristics of ready to eat fishery products packed in Cans. The investigations were carried out based on the application of existing data sets obtained from previous studies. Some important process parameters and physicochemical characteristics of the ready to eat fishery products packed in cans were used as training factors to achieve the best applicability in a wide range of possible compositions. The developed neural network techniques demonstrated that pre-processing of input parameters and broadening of the training data range through large number of further experiments could be effective to achieve an appropriate prediction performance.

Keywords : Neural Network, Prediction, Ready to Eat, Fishery Products,tin Can, Levenberg-marquardt, Bayesian Regularization, Scaled Conjugate Gradient (SCG), Algorithms

Paper ID 15753

Development of Electronic Nose for Sardine Fish Freshness Detection

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Fish are highly perishable food items due to their biological composition. The evaluation of fish quality has become an important factor in the food industry. The objective of this study is to develop a simple, portable, and low-cost electronic nose system for determining the freshness of sardine fish. E-nose system developed consists of MQ-135 gas sensor, Arduino UNO, bridge rectifier, step down transformer, and LCD display. The electronic nose system was demonstrated for real-time classification of the freshness of sardine fish into three categories. Data were collected hourly from sardine fish during storage under ambient conditions. Results of conventional methods such as sensory evaluation, weight loss, microbiological method, and pH analysis were compared with the results of the developed electronic nose system. E-Nose system successfully classified all samples of sardine fish into fresh, mild, and spoiled with an accuracy of 84.45%. Results have shown that the developed e-nose system could be fast, easy and low-cost solution for determining the fish quality parameters.

Keywords : Electronic Nose, Low-cost, Portable, Mq-135 Gas Sensor, Physicochemical Analysis

Paper ID 15761

Authentication of Snapper Fish Species Using PCR-AFLP Technique

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Seafood adulteration is an important issue for food authorities, because species substitution and mislabeling in seafood market sector around the world. So, novel and safe techniques are essential to assess species identification and authenticity of the product to protect the consumers. Recent developments in species authentication are mainly based on the presence of polymorphism in DNA sequences that are specific to each species. Among the vast array of PCR based methods, Amplified Fragment Length Polymorphisms (AFLP) is gaining increasing attention in food authentication. This technique is based on the PCR amplification of restricted fragments ligated to synthetic adapters and then amplified using primers, which carry selective nucleotides at their 3′ ends. AFLP, a novel fingerprinting technique, is mainly used to study genetic linkage maps. It is also used to analyze the genetic differentiation of few aquatic species including catfish, trout, tuna and oysters. In this study, PCR-AFLP performed with single pre-selective primer, *EcoRI*, and selective primer, ACG were used to differentiate nine species of fresh, frozen, cooked and fried snappers. The selective primer ACG produced 16 to 24 bands of the genome that are unique to differentiate all the nine species of snapper. Band sharing index (BSI) is used to explain the evolutionary closeness between two species or individual. Greater BSI value indicates low genetic distance and lower values indicates higher genetic differences among the species. Two species *viz*., *L. fulvus* and *L. fulviflamma* had the highest BSI in patterns obtained with selective primer ACG - 0.8500. This revealed that these two species are very closely related species among the nine snapper species. This method can be efficiently used to authenticate snapper species by food regulatory authorities and seafood industries to avoid seafood species substitution.

Keywords : DNA Based Authentication, Seafood Adulteration, PCR-AFLP, Snapper Species

Paper ID 15764

Factors Influencing the Biofilm Formation of *Salmonella* Isolated From different Seafood Contact Surfaces of Fishing boats, Landing centres, Markets and Seafood Processing Plants.

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Salmonella, is a leading cause of food borne illness and a major reason for seafood rejection. *Salmonella* are capable of producing biofilms which are influenced by different factors temperature, pH, sucrose concentration & incubation time. Biofilms of *Salmonella* may cause cross contamination in seafood processing area. This study investigates the influence of various factors on biofilm formation of *Salmonella* isolated from different seafood contact surfaces such as fishing boat, landing centres, fish markets and seafood processing plants situated in Sothern India. Out of 344 swab samples collected from contact surfaces, 37.2% were presumptive positive, 18% were biochemically positive and 1.6% were molecularly confirmed using invA gene 275 bp as *Salmonella* spp. Biofilm forming ability of *Salmonella* was investigated using different assays. The biofilm forming ability of *Salmonella* was high at different temperature viz., 25 and 35°C and was strong on HDPE, stainless steel, wood and tiles surfaces at 25°C. In contrast, in glass surface biofilm formation was high at 35°C than 25°C. At pH 7 Salmonella, exhibited good biofilm formation on wood. Biofilm formation by Salmonella was two times higher at 20% sucrose than at 10 & 5 % sucrose and it was maximum in HDPE and stainless steel surfaces. This study indicated that biofilms are formed by Salmonella in 5 days on contact surfaces. The most favorable environmental factors enhancing biofilm formation by Salmonella 25°C, pH 7 and 20% sucrose. HDPE and Stainless steel are more prone for biofilm formation by Salmonella at the above environmental conditions, this findings shall help the seafood processors to mitigate the formation of biofilms on various contact surfaces.

Keywords : Salmonella, Seafood contact surfaces, Food Borne Illness, Cross Contamination

Paper ID 15782

Study on Heavy Metals Accumulation in *Pila globosa* Along Cauvery Delta

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Water pollution in natural ecosystems have led to an increase in the accumulation of heavy metals in fish body, which may create risks in human health due to consumption of fish. The present study investigates heavy metal accumulation in *Pila globosa* collected from four sites along Cauvery delta in South India such as Trichy, Thanjavur, Thiruvarur and Nagapattinam, to assess the human health risks through consumption of this species. The freshwater snail samples were collected for the analysis of the heavy metal concentrations from its edible part (flesh). The metals present in the current study followed the order: Ca>Mg>Na>P>K>Fe>Pb>Zn>Cd>Cu. Heavy metal concentrations in the snail tissue varied as follows: Ca: 71.35-98.01, Cd: 0.006-1.004, Cu: 0.03-0.14, Fe: 0.31-2.32, K: 5.31-5.32. Mg: 13.43-18.12, Na: 5.59-9.82, P: 2.49-7.95, Pb: 0-1.74, Zn: 0.34-1.02 mg/l. Metals accumulation in the snail samples collected at different locations were below the limits proposed by the World Health Organization; also, cancer causing Pb were found below deduction limit (BDL) and within an acceptable level. Therefore, this study suggests that the levels of heavy metals in *P. globosa* collected from this fragile aquatic bodies should be continuously observed to assess its fate and effect in humans after consumption.

Keywords : Cauvery Delta, Heavy metals, Human health, *Pila globosa*

Paper ID 15821

Prevalence of ESBL -producing *Escherichia coli* strains in Seafood Samples From Fish Landing Centers and Retail Fish Markets in Thoothukudi, South India.

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The heterotrophic bacterial load, coliform bacteria and *Escherichia coli* in fresh seafood samples landed and marketed at two major fish landing centres (Therespuram and Fishing harbour) and two retail fish markets (VOC market and Poobalrayarpuram) in Thoothukudi were studied from December 2020 to May 2021. The antibiotic resistance pattern of *E. coli* isolated from the seafood samples was also analyzed. A total of 63 seafood samples were taken for this study (19 shellfish and 44 finfish). Total coliform bacterial load ranged from MPN 0.4 to 140+ /g and MPN 15 to 140+ /g in samples from fish landing centres and retail fish markets, respectively. Faecal coliform bacteria ranged from MPN 0.7 to 140+ /g in fish markets and MPN 0 to 140+ in fish landing centres. *E. coli* ranged from MPN 0.4 to 140+ /g in fish markets and MPN 0 to 140+ in fish landing centres. 98.5 % of the samples were positive for faecal coliforms and *E. coli*. The APC ranged from 10^4 to 10^7 cfu/g in samples from the fish landing centres and retail markets. 339 of the 433 presumptive colonies isolated from all the samples were confirmed as *E. coli*, and classified as biotype I (93.8%), biotype II (6.1) and faecal type (2.9%). Based on the source of the sample and the biotype of the isolates, 136 isolates were selected for preliminary antibiotic screening against indicator cephalosporins antibiotics. Of the 136 isolates, 26.5% isolates identified as ESBL producing phenotype and exhibited a moderate level of resistance to indicator cephalosporins antibiotics ceftazidime (22%), cefpodoxime (19.11%) and cefotaxime (16%). A high level of susceptibility was recorded against ciprofloxacin (81.7%), aztreonam (86.8%), cefoxitin (97.8%) and ertapenem (98.6%). All the isolates were susceptible to amoxicillin/clavulanic acid, piperacillin/tazobactam and meropenem. The multiple antibiotic resistance (MAR) index ranged from 0.09 to 0.54 and 16.9% of *E. coli* showed MAR index greater than 0.2 suggesting that they might have originated from a high-risk source of contamination. Total coliform, faecal coliform and *E. coli* loads were high in all the samples revealing potential faecal contamination at all the sampling sites and more at the retail fish markets compared to the samples from landing centres. The presence of ESBL producing *E. coli* in samples of seafood is a potential threat as the resistance could be transferred to human pathogenic bacteria and cause health issues in consumers.

Keywords : PCR, ESBL, *Escherichia coli*, TPC, Coliform Bacteria

Paper ID 15877

Development of a HACCP Program for Soft-shell Blue Swimming Crabs (*Portunus pelagicus*) by Standardization of Pre-cooking and Pasteurization processes Based on Heat Penetration Studies.

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Blue swimming crab (*Portunus pelagicus*) forms a major fishery in India, having an annual landing of 8000-10000 metric tonnes. Pasteurized hard-shell crab meat has got good export potential in the US, fetching a revenue of US$28.66 million in 2019. The landings of soft-shell crabs constitute 20-40% of the total crab catch but are not preferred for pasteurization by crab processors due to high water content. In this study, pre-cooking and pasteurization processes for soft-shell crabs were standardized to develop a HACCP program for pasteurized soft-shell crabs. Pre-cooking time temperature was standardized as 100ºC for 5 min, with 82% pre-cooking yield and < 15% drip loss. Pasteurization time temperature was standardized for soft-shell crabs processed along with hard-shell crabs at three ratios viz 30:70, 40:50, and 50:50 in 227g plastic cans at seven time-temperature conditions (83-86ºC for 120-160 min). Pasteurized crabs processed at a 30:70 ratio at 83-84ºC for 150 min had a high sensory acceptance score (4.95), and the calculated F value from the lethality curve was constructed based on heat penetration data was 58.25 min. Texture analysis showed that stiffness increased with the addition of soft-shell crabs from 802.15 to 3282.1 N/m and puncture resistance from 4.12 to 11.12 N. The TVB-N values exceeded the limit of 30-35 mg% in crabs processed at >84 ºC and at 50:50 ratio, but not in crabs processed at 30:70 at 83-84ºC. A HACCP program for the pasteurized soft-shell crabs along with hard-shell crabs was developed by identifying the hazards, CCPs and setting up the critical limits of the pasteurization process, for adoption by crab processors.

Keywords : Blue swimming Crabs, Soft-shell Crabmeat, Pre-cooking, Pasteurization, HACCP

Paper ID 16006

Prevalence, Molecular characterization and Antimicrobial Resistance of *Listeria Monocytogenes* Associated with Fish and Fishery Environment in Veraval, Gujarat

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Listeria monocytogenes is an intracellular pathogen which has been implicated as a cause of several foodborne illnesses in humans. The present study aimed to determine the prevalence, virulence and antimicrobial susceptibility of *Listeria monocytogenes* isolated from fish and ice of Veraval, Gujarat. Around 120 samples including ice from ice plant, ice before crushing (after unloading from transportation vehicle), ice after crushing and ice from fish hold (after fishing) and fish from fishhold were collected. The incidence of *Listeria* spp. and *Listeria monocytogenes* in fish and ice was 3.3% and 2.5% respectively. The *Listeria* spp. was found in ice collected from fish hold, ribbon fish, threadfin bream and squid. *Listeria monocytogenes* was detected only in fish (Ribbon fish, threadfin bream and Squid) stored in fish hold. The *L. monocytogenes* isolates carried all virulent genes namely inlA, inlC, inlJ, hlyA, iap, plcA and prfA and all the isolates were belonged to 1/2a, 3a serogroups. The *L. monocytogenes* isolates were tested for antimicrobial susceptibility test and found the isolates were multidrug-resistant and showed resistance to ampicillin, penicillin, tetracycline, cefotaxime and cephalothin respectively.

Keywords : Antibiotic, *Listeria monocytogenes*, Fish, Serotype

Paper ID 16072

Assessment of Microplastics and Heavy Metals in Bombay Duck Samples Collected From Domestic Markets of Navi Mumbai, Maharashtra

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Microplastic pollution in foods especially from the aquatic region is a global food safety concern. The inclusion of microplastics and heavy metals in food web can result in significant adverse effects on human health. Thirty samples of Bombay duck (*Harpadon nehereus*) were collected from the domestic market of Navi Mumbai in fresh condition and assessed for the presence of microplastics in the edible and gastrointestinal tissues after digestion by using inverted microscope. Also, the edible tissues were subjected to evaluation of heavy metal content using ICP-OES. Out of the 64 particles observed in Bombay duck samples, 18.8% were present in the edible tissue and 81.2% in the gastrointestinal tissue. The particles were identified in 31.8% in edible tissues and 59.25% in gastrointestinal tissues. The particles are of different shapes ranging from fiber (31.25%), rod shaped (26.56%) curved rod (12.5%), coiled (3.13%), other shaped (20.31%) and circular (4.69%). Arsenic content was detected in 5.9% of samples in the range of 0.56 to 1.2 ppm. Cadmium content was present in 94.1% of samples in the range of 0.07 to 0.21 ppm. Lead content was detected in 5.9% of samples (Avg. 0.36 ppm). Mercuric content was detected in one sample at 0.19 ppm.

Keywords : Bombay Duck, Edible Tissue, Gastro Intestinal Tissue, Microplastics, Heavy Metals

Paper ID 16120

Antibiotic resistant *Salmonella* isolated from shrimp farms located in Nagapattinam region of Tamil Nadu

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Salmonella has been the major cause for the rejection of farmed shrimps at the International markets, due to their exposure to the contaminated environments. This study investigated the incidence of antibiotic resistant *Salmonella* in farmed shrimps collected from shrimp farms located in Nagapattinam region of Tamil Nadu. The samples were collected from shrimp and water (120), sediment (26) and biofloc, feed and probiotics (11) during one culture cycle was examined for the presence of *Salmonella* by conventional and molecular methods. *Salmonella* isolates were tested for their antimicrobial resistance by disk diffusion assay against the allegedly used antibiotics in shrimp farms. The antibiotic resistant strains were sequenced and identified by BLAST analysis. The incidence was high in water samples (40.8%) followed by shrimps (22.4%), probiotics (16.6%) and sediment (7.6%). The *Salmonella* isolates were sensitive to furazolidone (FZ), tetracycline (TC) and chloramphenicol (CAP), but resistant to sulfonamide (SF). The highly resistant *Salmonella* strain isolated from farmed shrimp sample was identified as *Salmonella enterica* subspecies Enterica, which is highly pathogenic to humans, based on the PCR amplification of mitochondrial 16S rRNA region.

Keywords : *Penaeus vannamei*, *Salmonella*, Inva, Antibiotic resistance, 16s rRNA

Paper ID 16161

Prevalence of *Vibrio vulnificus* risk in Fish and Shellfish landed in different Landing Centres of South East Coast of Tamil Nadu, India

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The current study was performed to assess the presence of *V. vulnificus* by targeting *gyrB* gene which is used as a species specific marker and virulence markers namely repeats in toxin (*rtxA*), hemolysin (*vvhA*) and clinical virulent genes in the fish and shellfish samples landed in different landing centres of Nagapattinam coast, Tamil Nadu. Totally, 415 numbers of seafood samples were collected for this study (308 finfish, 65 bivalves and 42 crustaceans). Of which, 134 isolates from finfish while 43 isolates from bivalves and 32 isolates from crustaceans were obtained. The percentage of species specific *gyrB* positive isolates confirmed from finfish, bivalves and crustaceans are 63.02%, 21.88%, and 15.10% respectively. Higher prevalence percentage of pathogenic *V. vulnificus* was detected at Nagore fish landing centre, followed by Samanthanpettai, Keechankuppam and Nambiyar Nagar respectively, and indicating it as a possible source of rising temperature and anthropogenic pollution. The results of antibiotic sensitivity tests conducted with the *gyrB* positive *V. vulnificus* isolates showed high resistance (>50%) to Ampicillin (88.02%), moderate resistance to Chloramphenicol (28.13%), Streptomycin (23.44%), Tetracycline (15.63%) and Gentamicin (11.46%). The results indicate that the Nagapttinam coast is contaminated with potential human bacterial pathogen which might pose a serious health risk to the public if not adopting stringent measures.

Keywords : *Vibrio Vulnificus*, Seafood, Virulence Genes, Pathogen, Nagapattinam, PCR.

Paper ID 16164

Prevalence of Antibiotic resistant Enterobacteriaceae in seafood samples collected from Nagapattinam coast of Tamil Nadu

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The current study was carried out to evaluate the incidence rates of Enterobacteriaceae among seafood samples due to its prime importance in the development of drug resistance collected from different areas, retail markets, and landing centers of significant importance for a duration of two months. We obtained 160 isolates from 20 raw seafood samples of which 60% isolates were *E.coli*, 20% isolates were *Klebsiella pneumoniae,* 10% isolates were *Salmonella* serovars, 3.75% isolates were *Proteus mirabilis*, 3.13% isolates were *Shigella sonnei, 1.565%* isolates were *Serratia marcescens*, *1.565%* isolates were *Enterobacter aerogenes.* ESBL positive phenotypes were detected in 77.50% isolates which were predominated by *E.coli* (45%), *Klebsiella pneumoniae* (22.5%), *Serratia marcescens*(5%), *Proteus mirabilis* (3%), *Shigella sonnei* (2%). 160 isolates were specifically challenged against Carbapenems, 3rd generation cephalosporins, and colistin antibiotics for analysis of resistance patterns. 62.5 % isolates were resistant to 3rd generation cephalosporins, 30.57% isolates were resistant to carbapenems and 6.5% isolates were resistant to colistin. Some isolates specifically *E.coli*, *Klebsiella pneumoniae,* and *Serratia marcescens* were screened for the presence of plasmid encoding mcr-1 gene conferring colistin resistance. The prevalence of these multi-drug resistant isolates symbolizes seafood as a major carrier of these deadly pathogens, which indirectly shows the level of secondary contamination in seafood.

Keywords : Enterobacteriaceae, Mcr-1 Gene, Klebsiella Pneumoniae, Serratia Marcescens , Drug Resistance.

Paper ID 16176

Survival of Enteric virus using MS2 Bacteriophage as Surrogate in chilled and frozen Shellfish

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Human enteric viruses such as norovirus, enterovirus, hepatitis A virus, etc, are important food-borne pathogens transmitted by the fecal-oral route, responsible for causing food- and water-borne gastrointestinal diseases worldwide. They primarily infect and replicate in the gastrointestinal tract of the host. Contaminated seafood is implicated as one of the significant sources of infection by these viruses, especially the noroviruses. Viral surrogates, ideally with similar structure and size, and able to mimic the survival and growth properties of the target virus are used for survival studies of non-culturable enteric viruses. Male specific MS2 bacteriophage is a single-stranded, non-enveloped RNA bacteriophage icosahedral in shape. MS2 is most frequently isolated from feces and sewage, and it can replicate readily in the mammalian gastrointestinal tract. Owing to the structural similarities, physiological characteristics, non-pathogenicity, and easy propagation ability, MS2 bacteriophage has been conventionally used as a surrogate for enteric viruses. In this study, Escherichia coli bacteriophage MS2 (ATCC® 15597-B1™) was used as a surrogate to evaluate the survival of enteric viruses such as norovirus and enterovirus under low temperature processing conditions in rock oyster (*Saccostrea cucullate)* meat. *Escherichia coli* strain C-3000 (ATCC® 15597™) was used as host for phage propagation. The bacteriophage was spiked at a concentration of 10^{10} PFU/ml into oyster meat and stored at 0°C and 20°C for the survival study. The estimation of phage titre was done using the double agar overlay method by counting individual plaques formed on plates. The results indicated that MS2 bacteriophage could survive for 10 days with 6 log reduction in the phage titre value under iced conditions. On freezing, the MS2 bacteriophage showed 4 log reduction in 35 days, which indicated that a requisite reduction of enteric virus load is not achieved in freezing. Hence frozen shellfish could serve as a potential source of infection by enteric viruses.

Keywords : Enteric Virus, Shell fish, MS2 Phage, Chilled, Frozen, Storage

Paper ID 16190

Contamination profile of organochlorine pesticides in Sea Lettuce (*ulva Lactuca*) of the gulf of mannar

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This study, the toxicity of organochlorine pesticide (OCP) on *Ulva lactuca*, a type of green seaweed available in the Gulf of Mannar was determined. At the end of the North-East Monsoon and the beginning of the post-monsoon, samples were taken from five places in the Gulf of Mannar: Hare Island (Site 1), Erwadi (Site 2), Seeniyappa Dhargah (Site 3), Mandapam (Site 4), and Rameswaram (Site 5). The OCP residues were extracted using the AOAC 2007.01 QuEChERS extraction technique and analysed using Gas Chromatography Mass Spectrometry (GC-MS). The total OCP concentrations was found to vary between 49.61 ng g^{-1} and 123.68 ng g^{-1} in sites 5 and 1, respectively. Hexachlorocyclohexane, endosulfan, endrin, and DDT have all been found to survive in the environment. The highest concentration was found in January, which was 8 to 12 times higher than in other months. This finding clearly shows that the concentration of OCP residues is higher during the seaweed fruiting season. According to this investigation, green seaweed was found to possess high OCP residues immediately after the rainy season. There are no established criteria for the MRLs of each OCP in seaweed to determine the safety of *U. lactuca* for food applications.

Keywords : OCPs Residues, *Ulva,* Safety, Edible Seaweed

Paper ID 16199

Safety assessment of imported canned fishes using microbiological and physiochemical and heavy metal analysis

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The present investigation was based on testing for the physiochemical, microbiologically, and heavy metals in the different imported canned fish products. These canned fish samples were purchased from the local markets to make sure that they achieved the concept of safe food. The results revealed that canned fish products contained a total protein that ranged from 3.8086 ± 0.1408 to 4.0210 ± 0.0907, moisture ranged from 65.7367 ± 0.0907 to 66.9457 ± 1.7243, total ash ranged from 3.2775 ± 0.0487 to 3.5879 ± 0.0498 and fat ranged from 24.0699 ± 1.4205 to 25.4315 ± 0.8662. The level of heavy metals analyzed in different kinds of tested products ranked as Co> Pb> Cd> Hg in canned fish. The microbiological analysis indicated that the canned mackerel and canned tuna samples had a low bacterial count, but the canned sardine had a high bacterial count from 1.8×10^2 to 3.0×10^3 CFU/g (i.e) *E.coli, Staphylococcus aureus, Salmonella spp., Shigella spp., Vibrio spp., Listeria* spp., and anaerobic bacteria were detected in all samples. The results showed that all examined canned fish samples were compatible with the Indian and Gulf specifications for human consumption.

Keywords : Canned Fish, *E. coli*, *Staphylococcus aureus, Salmonella spp., Vibrio spp., Listeria spp.*, Physiochemical Parameters, Heavy metal analysis.

Paper ID 16257

Bioaccumulation of heavy metals in commercially important freshwater fishes and marine fishes from Nagapattinam, India

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The present research study was designed to assess the concentrations of the heavy metals (Cd, Cu, Fe, Pb and Zn) in different tissues of six commercially important freshwater and marine fish species caught in Nagapattinam region using inductively coupled plasma-mass spectrometry (ICP-MS). Various organs (liver, eye, kidney gill, gut, gonad, skin, and muscle) of six fish species i.e. *Channa straiata (CS), Labeo rohita (LR), Mugil cephalus (MC), Oreochromis mossambicus (OM), Pangasius hypophthalmus (PH) and Rastreliger kanagurta,(RK)* were analyzed. High concentration of heavy metals, especially Zn and Pb were noticed in the liver, kidney, and gill tissues of the fishes, which are higher than the WHO standards. Among the studied fishes, *CS* and *PH* showed higher levels of bioaccumulation in terms of toxic metals. The highest metal concentration was reported in the carnivore fishes as compared with the planktivore and omnivore.

Keywords : Heavy metals, Bioaccumulation, Fish, Seafood, Food Safety, Pollution

Paper ID 16259

Occurrence of microplastics in commercial salts and fish samples from Nagapattinam region of South India

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Microplastics (<5 mm) are considered to be global environmental pollutants. In this study, we investigated the occurrence, physical properties, polymer composition, surface morphology and element composition of MPs(Microplastics) present in food-grade salts produced from commercial salt manufacturing salt pans and fishes landed in different landing centers of Nagapattinam, Southeast coast of India. Ten different brands of sea salts and eight numbers of fishes were collected from the Coastal region of Nagapattinam. The surface morphology of MPs as exhibited in the SEM-EDAX images obtained in the study revealed the presence of microplastics in salts and fish samples. All the microplastics retrieved were fibers which were black, red, blue, green, white, brown, and colorless. FT-IR results showed that 4 types of polymers, namely, Nylon, Polypropylene (PP), Polyethylene (PE), and Polyethylene Terephthalate (PET) were present in the samples. The results of this study instigated that demersal fishes presented a higher amount of MPs than pelagic fishes, indicating the ingestion of plastics in fish may relate to the feeding habitat.

Keywords : Microplastics, Fish, Salts, Gastrointestinal Tract, Sem-edax, Ftir.

Paper ID 16266

Isolation, identification and evaluation of seafood spoilage organisms against natural extracts

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Seafood is a rich source of protein, vitamins, minerals and more importantly polyunsaturated fatty acid (PUFA). Seafood is more susceptible to microbial spoilage than other perishable foods. Factors responsible for low shelf life in seafood are high moisture content, protein and fat content, improper handling etc. This present study is aimed at isolation, identification of spoilage microorganisms and their susceptibility evaluation against natural extracts from varied plant sources. Fish samples were kept for spoilage and then bacterial isolates were picked using standard plating techniques; and identified at the genus level. The evaluation of antimicrobial activity was performed against seven natural extracts obtained from the plant sources such as Cinnamon bark, Oregano leaves, Manjistha root, Sappan bark, Sweet basil leaves, Orange peel and Pomegranate peel using water and hydroxy ethanol solvent individually. The findings of antimicrobial assay indicated that the water and hydroxy ethanol extracts of the Manjistha root, Sappan bark and Pomegranate peel resulted in the maximum zone of inhibition against ten isolates followed by Cinnamon bark, Oregano leaves, Sweet basil leaves and Orange peel. Ethanolic extracts of *Punica granatum* exhibited the maximum inhibition range of 37mm, 33mm, 32mm, 28.5mm, 27mm, 26mm, 25mm, 21mm, 19mm, 11mm against the 10 bacterial isolates. This study throws up some light to develop a commercial preservation technology for effective control of microbial spoilage in seafood as an alternative approach for non-chemical and non-thermal seafood processing methods.

Keywords : Natural Extract, Antimicrobial Activity, Microbial Spoilage Of Seafood, Pomegranate Peel, Manjistha Root, Sappan Wood

Paper ID 16311

Effect of Cooking on the persistent organic pollutants in India's most traded seafood *(Penaeus Vannamei)* and its human health risk assessment in India and the USA

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Pesticide residues (PRs) and toxic metals (TMs) pose substantial food safety concerns globally. This study examines the effects of cooking on TMs and PRs in farmed shrimp (*P. vannamei*) and the potential health hazards. PRs in shrimp ranged from 0.005 (Hg) to 0.396 (As) mg/kg for raw, not detected (Hg) to 0.136 mg/kg for boiled, ND (Hg) to 0.231 (Pb) mg/kg for fried, ND (Hg) to 0.121 (Pb) mg/kg for grilled and ND (Hg) to 0.402 (As) mg/kg for microwaved (MWC) shrimp. All the processing methods significantly affect As (75 and 95%), whereas grilling and microwave cooking showed a noticeable impact on Hg (53 and 58%). Boiling (49%) and grilling (50%) showed a significant effect on Pb level, while frying (7%) and MWC (3%) had a negligible effect. TMs were below the MRL of 0.5 mg/kg set by the European Union. PRs in shrimp ranged from 0.007 to 0.703 µg/kg for raw, not detected (ND) to 0.917 µg/kg for boiled, ND to 0.506 µg/kg for fried, ND to 0.573 µg/kg for grilled, and ND to 0.514 µg/kg for microwave cooked shrimps. PRs in raw and cooked shrimps were below MRL set by CAC and the EC. The processing factor (PF<0.7), paired t-test ($t<0.05$), Tukey test ($p<0.05$), Bray-Curtis similarity index, and matrix plot exhibited that all the four thermal processing methods have a considerable impact on pesticides in the processed shrimps. However, frying (59.4%) and microwave cooking (60.3%) significantly reduced PRs than the boiling (48.8%) and grilling (51.3%). THQ and TTHQ for TMs and HQ and HR for PRs were <1, indicating no health risks for shrimps consumers in India and USA. Culinary processes such as boiling and grilling are recommended to reduce TMs while frying and microwave processing are better methods for minimizing PRs in seafood

Keywords : *Penaeus vannamei*, Chemical Residues, Thermal Processing, Maximum Residual Limit, Risk assessment

Paper ID 16314

Safety assessment of chemical contaminants in farmed shrimps (*Penaeus vannamei*) at different growth stages of culture farmed along the southeast coast of peninsular India

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Shrimps are a preferred and nutritious food because of their low fat, low calorie, and protein omega-3 fatty acids and essential minerals. Over the culture period, shrimps can accumulate toxic substances from the environment, such as heavy metals, pesticides, and antibiotics. The hazardous metals (HMs) and pesticide residues (PRs) in farmed shrimp, *P. vannamei,* and the corresponding human health risk status through ingestion are investigated in this work. HMs and PRs were extracted using the AOAC and QuEChERS procedures, respectively, and analyzed using ICP-MS and GC-MS. HMs concentration in the water, sediment and shrimp ranged from not detected (ND) (Hg) to 91.05 (Fe) µg/L, 0.01 (Hg) to 19, 246.33 (Fe) mg/kg, and ND (Hg) to 13.98 (Fe) mg/kg, respectively. Toxic HMs such as Cd ranged from ND to 0.161±0.10 mg/kg, Hg from ND to 0.171±0.12 mg/kg, as from ND to 2.11±0.21, and Pb from ND to 0.448±0.15 mg/kg. They were found in all growth stages of shrimp (from DOC-01 to DOC-90), and their levels were below the maximum residual limit (MRL) of 0.5 mg/kg set by the EC and FSSAI. Between DOC-01 to DOC-90, PRs in shrimp ranged from not detected (ND) to 1.053±0.17 g/kg. Endosulfan, HCH, and aldrin were the most prevalent PRs, and their concentrations were below the CAC and EC MRLs. According to Pearson correlation analysis, the concentration of HMs and PRs in shrimps increased from DOC-01 to DOC-90. According to a human health risk assessment study, HMs and PRs found in shrimp pose no non-carcinogenic or carcinogenic health risks. This study offered baseline data on the existing condition of environmental pollutants in farmed shrimps, which will aid farmers in increasing output to improve the Indian export market.

Keywords : *Penaeus vannamei*, Growth Stages, Heavy Metals; Pesticides, Hazard Quotient, Hazard Index.

Paper ID 16348

Heavy metal concentrations in the edible oyster and yellow clam collected from the Gulf of Mannar region, Southeast Coast of India

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Molluscun bivalves are able to accumulate heavy metals (HMs) due to their filter-feeding behaviour and impose health hazards to consumers. Concentrations of 10 heavy metals such as cadmium (Cd), copper (Cu), zinc (Zn), lead (Pb), nickel (Ni), chromium (Cr), antimony (Sb), mercury (Hg), Arsenic (As) and tin (Sn) were examined in the two bivalve's species, *Crossostera spp* (edible oyster) and *Meretrix meretrix* (yellow clam) collected from the Gulf of Mannar region along the Thoothukudi coast using Inductively Coupled Plasma Mass spectrometry (ICP-MS). The concentration of toxic HMs (As, Cd, Hg and Pb) in the oyster 0.808 , 0.322 , 0.008 and 0.094 ppm while that of clam was 1.587 , 0.032 , 0.012 and 0.065 ppm respectively. The concentration of toxic heavy metals were found to be below the maximum residual limits (MRLs) prescribed by European Commission. Therefore, the HM concentration in oysters and clams indicated that it does not cause any long-term health effects and they are found to be safe for human consumption.

Keywords : Heavy Metals, Edible Oyster, Yellow Clam, Maximum Residual Limit, Health Risk

Paper ID 16480

Virulent gene screening and antibiotic resistance pattern of *Pseudomonas aeruginosa* isolates from fresh seafood marketed in Kochi, Kerala

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Fish are commonly marketed in chilled conditions under aerobic storage. *Pseudomonas spp.* and *Shewanella putrefaciens* are the major microbial flora seen under aerobic ice storage. In this study, phenotypic and genotypic characterization of *Pseudomonas aeruginosa* was done considering its role as an opportunistic pathogen and its ability to cause acute and chronic infections which are life-threatening. Samples were collected from 3 major markets in Cochin within a period of 8 months. A total of 48 unique isolates were obtained, which were then subjected to a series of biochemical tests for the confirmation of the genus *Pseudomonas*. Thirty-six isolates were presumptively identified as *Pseudomonas sp.* of which 9 were further confirmed as *P. aeruginosa* by 16SrRNA PCR. All these 9 *P. aeruginosa* isolates were then checked for the presence of 7 major virulent genes namely, *oprI, oprL, lasB, toxA, exoS, nan1* and *phz* by PCR using specific primers. All the isolates were found to be positive for *oprI* and *oprL* genes which are unique factors used for the rapid identification of this species. Further, *lasB* gene was detected in all the 9 isolates, whereas *exoS* gene was detected only in 6 isolates. None of these isolates were found to be positive for *toxA, nan1,* and *phz* by PCR. Antibiogram analysis was performed against a set of 18 clinically used antibiotics. All were found to be sensitive to gentamycin, tobramycin, amikacin, aztreonam, ciprofloxacin, doripenem, imipenem, meropenem, norfloxacin, colistin, and polymyxin B, but showed intermediate status to piperacillin-tazobactam. Only one isolate named PA05 carrying *lasB* gene was found to be resistant to 4 antibiotics namely, ceftazidime, ciprofloxacin, norfloxacin, and ofloxacin and the MAR index was calculated as 0.22. Altogether, the study demonstrated the prevalence of *P. aeruginosa* in common seafood consumed domestically in Kochi and provides basic information on the virulent and antibiotic resistance profile of this pathogen, one of the most challenging organisms involved in a variety of nosocomial infections of humans.

Keywords : Spoilage, 16s rRNA, Virulence, Antibiogram

9.ECO FRIENDLY FISHING TECHNIQUES

Paper ID 15557

Satellite remote sensing technique to locate the potential fishing grounds of mid-water trawl fishery in the North-Eastern Arabian Sea

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Fishes are frequently changing their distribution ranges by influencing preferred environmental conditions. Knowledge on the relationship of fish abundance and their environmental preferences is foremost to improve the understanding of fishing grounds and sustainable harvest. Mid-water trawlers operated from north-west coast of India was investigated by analysing catch against remotely sensed environmental factors during August 2017 - December 2019. The time series images of Sea Surface Height anomaly (SSHa), Sea Surface Temperature (SST), Chlorophyll-a concentration (CHL) and Euphotic depth (Z_{eu}) derived from Aqua-MODIS and Copernicus Marine Environment Monitoring Service. Time series analysis shows that bio-physical parameters were closely coupled process in the region. SSHa, SST and Z_{eu} were co-varying whereas CHL was inversely correlated with them. The synergistic analysis of spatial signatures in SSHa, SST, CHL and Z_{eu} were carried out for randomly selected weeks revealed cold core eddy locations with low SSHA and SST values, high CHL and lower Z_{ue} were well visible. Catch points overlaid on the image of environmental factors shows that lower catch points were located near cold core, high CHL, turbid waters whereas relatively high CPUE were observed near warm eddy with lower CHL concentrations and clear low turbid waters. Application of Generalized Additive Model (GAM) was performed on the fishery data to derive the suitable ranges of SSHa, SST, CHL and Z_{eu} for fish abundances to the fish catch rate from mid-water trawler.

Keywords: PFZ, Fishing Grounds, Chlorophyll, Remote Sensing, Gam

Paper ID 15627

Study on the heart-in shaped funnel design with two different rear end opening perimeters and their fish catching efficiency in serial collapsible fish traps

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The two different trap units were fitted with Heart-in shaped rear end with two different perimeters of 560 mm (H_1) and 700 mm (H_2) were tested. Each trap unit was fabricated with three chambers. The first unit had a 560 mm perimeter rear end funnel opening and the other unit had a 700 mm perimeter rear end funnel opening. The testing of these two units of serial collapsible fish traps was conducted in a coastal fishing ground of mandapam of Tamil Nadu (Lat: 09^0 14.141'N; Long: 079^0 09.433' E). The soaking duration of each of the experimental fishing trials was kept as 24 hours. Totally 24 fishing trials were carried out. Among the two units of trap, the trap unit fitted with 560 mm perimeter Heart-in shaped rear end funnel caught more amount of fish (82 numbers/24 soaking days) than the other unit of trap fitted with 700 mm perimeter Heart-in shaped rear end funnel (37 numbers/ 24 soaking). This study revealed that the trap unit fabricated with a 560 mm perimeter Heart-in shaped rear end funnel had performed better than the similar shaped funnel having 700 mm perimeter.

Keywords: Serial Collapsible Fish Trap, Fishing Trial, Catching Efficiency, Heart-in Shaped Rear End Funnel, Funnel Design.

Paper ID 15631

Fishermen demand for anti-depredation devices – a case report from Olaikuda, Rameswaram

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During, Pradhan Mantri Matsya Sampada Yojana (PMMSY) programme organised at Olaikuda fishing village near Rameswaram in Ramanathapuram district of Tamil Nadu a need assessment study was undertaken in 2021 to understand the problems faced by the fishers. Fishermen of Olaikuda follows traditional ways of fishing practices and fishing methods like trap fishing, hook and line, and gill netting. However in recent years the predation of Dolphin is a major problem faced by the fishermen and considerable size of their catch is damaged by these cetaceans. Damage or removal of captured fish from fishing gear is called depredation. Cetacean interaction in long-line and other fishing operation is a well-known fact in other parts of the world; however this is the first time fishermen reports this interaction in this coast and wanted a remedy for this problem. A lot of work has already been done on producing Cetacean deterrents for different types of fishing gear world over. One such device is anti-depredation pingers which are commercially available in the international markets, and these are effective in chasing away dolphins. Anti-depredation pingers are acoustic devices designed to scare dolphin from poaching fish and to reduce gear damage, by producing a randomised unpredictable sound that startles dolphins when in close proximity to the net. Anti-depredation pingers are battery operated and can be threaded onto ropes joining net panels on either the head rope or foot rope. In India, as such the use of anti-depredation devices hasn't begun, however regulatory measures need to be formulated to use such underwater acoustic devices, before fishers adopts these techniques independently.

Keywords: PMMSY, Dolphin Pingers, Anti- Depredation, Acoustic Devices

Paper ID 15688

Biogenic nanoparticle-based coating for protection of TMT rod in marine environment

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Development of biogenic nanoparticle and extract for protection of TMT Rod in marine environment is described in this work. The main aim of developing the biogenic nanoparticle and extract for the protection of TMT rod is an attempt to prevent the deterioration of marine structures such as Harbours, Jetties warfs, bridges and landing centres structural elements. Strength of structures mainly depends on the reinforcement provided in concrete and corrosion of reinforcement will drastically reduce the performance of structures, poses threat and economic losses. The coatings used for preventing corrosion using inorganic materials are efficient in prevention of corrosion but at the same time it is harmful to marine species or toxic to the environment. Therefore, the biogenic materials as corrosion protective agent for reinforcement corrosion may be useful in protecting the environment as well as cheaply available due to abundance in nature. The biogenic nanoparticle was prepared using Thespesia populnea leaves, nanoparticle and its extract was evaluated using different concentrations and variations in number of coatings. The inhibition efficiency was measured. Weight loss studies and electrochemical measurements were used to investigate corrosion inhibition in the presence and absence of inhibitor. The biogenic inhibitor prepared from Thespesia populnea extract has exhibited the maximum inhibition effectiveness of around 92.0% at 150 ppm concentration. The adsorptions of Thespesia populnea extract on mild steel followed the Langmuir and Temkin isotherms. This adds to the evidence that adsorption of inhibitor from plant extract is responsible for the outstanding anticorrosion effect. Biogenic nanoparticle coating tested under marine environment by reinforcing the coated TMT rod in concrete cubes at brackish water indicated that the coating was efficient in protecting TMT from corrosion in marine environment.

Keywords: Biogenic Nanoparticle, Corrosion Inhibition, Plant Extract, Marine Corrosion

Paper ID 15690

Development of piezoelectric tiles from crustacean shells for eco-friendly energy harvester

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In this paper, we have developed piezoelectric tiles from a piezoelectric thin film of processed shrimp and crab shells. These tiles will generate electricity in the form of an alternative environment-friendly energy source, as we apply the slightest pressure. The piezoelectric tile was placed in the ground in a particular area occupied by people, and then the output voltage was measured. The variation in output voltage is due to different mechanical stresses applied each day and causes the output voltages to decrease and increase. The output power of piezoelectric tiles depends on the weight of the person, the type of movement, and the number of steps per tile. Piezoelectric thin film tiles of processed crustaceans such as shrimp and crab shells will be used in energy harvesting devices.

Keywords: Piezoelectric Tiles, Shrimp Shell, Crab Shell, Eco-friendly, Voltage, Energy Harvester

Paper ID 15691

Observations on shift in fishing for blue swimmer crab along Palk bay coast of Tamil Nadu

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The Palk Bay ecosystem in the southeast coast of India is unique with seagrass meadows which supports the fishery of green tiger prawn *Penaeus semisulcatus* and blue swimmer crab *Portunus pelagicus*. The trawlers operating in Palk Bay target green tiger prawn and land the blue swimmer crab as bycatch along with prawns. Observations on the fishery off Kottaipattinam in Pudukottai district after one year of deployment of artificial reefs along the Palk Bay coast (between 10° 4' 393":79° 18' 696" and 10° 6' 413": 79° 26' 620") indicated that the reefs supported a good fishery of *P. pelagicus* which had been in a declining stock status. Exploitation of *P. pelagicus* is being done with a modified trawl net, locally called *mixed madi* with mesh size of 20, 30, 40, 60 and 80 mm; the larger mesh webbing is used to retain crabs rather than prawns in the net whereas Prawn trawl net webbing mesh size is usually 20, 30, 40 and 50 mm. A sudden rise in the market price of *P. pelagicus* to Rs. 900-950/ kg (Grade-I) from July 2021 to January 2022 was observed. This has probably led to a shift in fishing from *Penaeus semisulcatus* to *Portunus pelagicus* in the Palk Bay. The fishing is carried out during night with operations from 16.00 hours to 06.00 hours' time duration with a total of 10 hauls which last for one hour each. The trawling area is mainly adjacent to the artificial reefs at a depth of 6-7 m which yields 10-15 kg/hours of blue swimmer crab of 60-171 mm carapace length. The crabs are sold at the rate of Rs.300-950/kg based on the grade size. The positive impact of artificial reefs in the Palk Bay is evident and provides scope for developing suitable fisher-participatory management measures in sustainable resource enhancement.

Keywords: *Penaeus Semisulcatus*, *Portunus Pelagicus*, Blue Swimmer Crab, Artificial Reef, Palk Bay

Paper ID 15695

Squid jigging in Palk bay and Gulf of Mannar using Fish Aggregating Devices (FADs)

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The total cephalopod landing by squid jigging ("*Kanavai Thoondil*") in 2020 was 623 and 313 t in Gulf of Mannar (GoM) and Palk Bay (PB), respectively. Squid jigging is practiced by 25 fishing villages in PB and 23 in the GoM. The fishermen usually commence the activity between 03.00 and 04.00 hrs, operating from *Vallam* or FRP boats. Fishing is carried out at a distance of 12-20 km from the shore, at 13-25 m depth in GoM, whereas in PB it is between 8 and 10 km at 5-8 m depth. Two types of methods of squid jigging are practised. In the first type, jigs are deployed directly from the *vallam*/FRP boats; the crew size is limited to 6-9 persons. In second type fishing is carried out from small thermocol (polystyrene) boats of 1.8 m length; 12-20 persons carrying one thermocol boat each, travel in the main boat and upon reaching the fishing ground, they demount and carry out the jigging by sitting over the thermocol boats individually around Fish aggregating devices. Whole plants/branches of *Tephrosia purpurea, Prosopis juliflora* and *Casuarina equisetifolia* are used as Fish Aggregation Devices. The fishing is carried out for about 5-7 hrs. The peak fishing season is between August and September and the CPUE ranges from 3 to 15 kg/unit. *Sepioteuthis lessoniana*, *Sepia pharaonis, S. prabahari* and *Amphioctopus aegina* were the major species in PB whereas, *S. pharaonis*, *S. lessoniana* and *Octopus cyanea* were the major species in GoM; *S. pharaonis* was the dominant species in the landings in both the regions. Cuttlefish, squids and octopus respectively contributed 61%, 35% and 4%, and 40%, 35% and 25% of the landings in GoM and PB respectively. The market price (rate/kg) was Rs. 300-450 for *S. pharaonis*, Rs. 300-400 for *S. lessoniana* and Rs. 80-150 for all octopuses.

Keywords: Squid Jigging, Gulf of Mannar, Palk Bay, Fish Aggregating Device, Cephalopod

Paper ID 15720

Traditional fishing practices of Muthupet Lagoon of Tamil Nadu

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Muthupet lagoon is one of the vast potential areas of fishing resources in South- east coast of Tamil Nadu. The fishing practices involved in this lagoon such as Muthupet, Maraikakarai, Kilathangi, Koraiyeru and Pamini and also 30-40 years of experienced fishermen are found to be involved fishing in this lagoon. Traditional type of inflated tyre tube used to operate the gill nets involved canal fishing. Four villages namely melathondiakkadu, Mulankkadu, Karpaganatharkulam and Keelavadiakkadu especially involved multiday fishing. There are six type of gill nets used in this lagoon such as mesh size are 10-12 mm & 20-22 mm used to catch the Anchovies (5-10 gm), 28-30, 32 mm used to catch the Oil sardine (20-30 gm), Flower tail shrimp (5-7 gm), catfish, Black tiger shrimp (16-20 gm), *Penaeus indicus* (25-30 gm), 40 mm used to catch the mullet (250-500 gm), 32 mm & 110 mm used to catch the shrimp (16-20 gm) , 120 mm (koduva valai) used to catch the sea bass (4-6 kg in size) and 40 & 50 mm used to catch the crabs (250-1 kg in size). Bottom set gillnet also in practice locally called as Paduvalai dominating catches were found to be recorded three spot crab, croackers, flower tail shrimp and anchovies. Especially April month not much catches due to higher wind force. The peak fishing season was during the month of November to March and also maximum income generating during these months. The dominant catches were found to be recorded as *Penaeus indicus* and *P. monodon*. Rarely catch of bigger size live three spotted crab getting foreign export value while using bottom set gill nets. Marketing purely dependent on local buyers, Thanjavur retailers and other companies.

Keywords: Traditional Fishing, Inflated Tyre Tube, Muthupet Lagoon, Paduvalai, Gill Net, Canal Fishing

Paper ID 15784

Fish detection and tracking using sift-opencv python in raspberry Pi 3b+

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In this paper, a real-time vision-based system is proposed to monitor objects. The Raspberry Pi embeds with an image-processing algorithm called scale-invariant feature transform (SIFT), which monitors an object with its extracted features. The essential aim of fish detection and tracking system is to establish communication between human and computerized systems for sake of control in fish processing industry. The recognition of fish objects proceeds by matching individual features to a database of features from known fish objects using SIFT technique. These approaches to recognition can robustly detect and track the fish objects among clutter and occlusion while achieving near real-time performance.

Keywords: Fish, Opencv, Python, Raspberry Pi 3b+, Sift, USB Camera

Paper ID 15812

Size selectivity characteristics of 35mm square and diamond mesh cod-ends trawl with respect to *Thryssa Mystax* (bloch & Schneider, 1801) of Kakinada, Andhra Pradesh

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Abstract

Size selectivity of 35mm square and diamond mesh cod-end of bottom trawl net with respect to *Thryssa mystax* was studied off Kakinada, Andhra Pradesh using covered cod-end method. The L_{50}, L_{25} and L_{75} values of *T.mystax* for 35 mm square mesh cod-end were 7.59, 5.09 and 10.08 cm while selection range (SR), selection factor (SF) and selection ratio (Sr) were 4.99, 0.21 and 0.14 respectively. The L_{50}, L_{25} and L_{75} of *T.mystax* for diamond mesh cod-end were 6.84, 4.64 and 9.03 cm respectively. Selection ranges (SR), selection factor (SF) and selection ratio (SR) were 4.39, 0.19 and 0.12. Size selectivity of square mesh cod-end was relatively higher in comparison to diamond mesh cod-ends for *T.mystax*.

Keywords: Diamond mesh; Size Selectivity; Square mesh; Trawl

Paper ID 16137

Variation in trawl catch composition of the Mumbai coastal water as determined by experimental trawling

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During experimental trawling, the composition of the catch was observed. Fishing operations were conducted between 19°06'66" N and 19°12'15.09" N latitude and from 72°41'23.20" E to 72°48'502" E longitude, at a depth range of 6-21 meters. A total of 127 species includes 92 species of finfishes belonging to 68 genera, 40 families, and 14 orders and shellfishes include 34 species belonging to 25 genera, 9 orders, 27 families were recorded. The ichthyofaunal diversity includes finfishes order: Perciformes dominantes with 51 species (74%) followed by Clupeiformes (13 species; 19%), and Tetraodontiformes (5 species; 7%); in shellfishes order: Decapoda were dominantes (21 species; 81%), followed by Neogastropoda (5 species 19%). The maximum catch was contributed by Sciaenids (19%) contributed, followed by Squilla (13%), Elasmobranch (11%), Flatfishes (10%); Ribbonfish, Golden anchovy (9%); Hermit crab, and Shells (4%); Pomfret and miscellaneous (3%); Pufferfish, Crab, Shrimps, and Lobster (2%); Eels, Goby, Jellyfish, Cephalopods, and Catfishes (1%). The maximum contributions of discard catch (59%) followed by non-target catch (34%) and target catch (7%). The depth-wise distributions of commercial and discard catch species was the maximum number of species 66 recorded in the depth of (15-18 m) followed by 60 species in depth ranged of (12-15 m) and the minimum number of 36 species recorded in the depth of (6-9 m). In the present study, the mean monthly discard catch generated by experimental trawling ranged from 4.5 to 24.75 kg h^{-1} and commercial catch 4.1 to 12.2 kg h^{-1}.

Keywords: Experimental Fishing, Finfishes, Shellfishes, Commercial Catch, Discard Catch

Paper ID 16144

Community-based fisheries management and fishers in Pulicat lake, India: classification, production, marketing, and institutional structure of Paadu fisheries

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The study was conducted to examine the functional details of *Paadu* system of fisheries management in Pulicat Lagoon, India (lat.13.5593° N, long.80.2098° E). Data were collected through interview schedule and group discussion from a total of 150 respondents covering seven to ten fishermen from each fishing village – 180 *Paadu* fishing grounds. Based on the operation of fishing villages and their gears – either stake net operation or non-stake net operation– the fishing grounds could be categorized into six group's namely Group-I, Group-II, Group-III, Group-IV, Group-V and Group-VI. The Panchayat Union President was used to play a vital role in managing the system through the allocation of "One Fishermen group per Day" and resolving conflicts between the fishing villages. Self-regulations among fishers were found to increase the productivity and equality in sharing the fishery resources of the Lake. Unknowingly fishermen from Pulicat Lake follow the system of Community Based Fisheries Management. This study reveals the concepts, ideals, workings of *Paadu* and its linkages to the management of the system. The study suggests that existing *Paadu* fishing system in Pulicat Lake should be continued without any introduction of unhealthy things; however, the government intervention to legal guidelines is need of hour to use recourses as sustainable way.The overall selectivity analysis revealed that fishing gears used for shrimp harvesting showed that they harvest more quantity of small size shrimps instead of Minimum Legal Size (MLS). To harvest the shrimp resources gears like AdapuValai, SuthuValai, KalluValai and Kondai valai used whereas Siruvalai and Baadi valai used to harvest mullet and fishes; Nandu Kacha, Nandu Valai employed to capture crabs and Uthaa was used to capture crabs, shrimps and fishes. The maximum landing and returns were observed in Baadi valai of 580 kgs and Rs.65,000 per month respectively whereas other fishing gears showed 100 kg and > Rs.20,000 respectively .

Keywords: Paadu System, Pulicat Lake, Fisheries Legislation, Community-based Fisheries Management

Paper ID 16211

Design and operational performances of wire mesh fish traps of Thoothukudi coast

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The study was carried out at Therespuram one of the important fishing villages of Thoothukudi coast operating traps to catch fishes like *Scarus* Spp (Parrot fish), *Lutjanus* Spp (Snappers), *Siganus* Spp and *Epinephalus* Spp (Groupers) in good quantity. Around 200 fishermen families were found depending on trap fishing for their livelihood. They operate 25-30 numbers of traps per boat (Vallam) and have the dimension of 27 ftx10 ftx6 ft. The traps were arrow head shaped with dimension of 90cm Lx 76cm Bx 40cm H and had hexagonal shaped meshes panels. The traps were operated with the soaking duration of 24 hrs. The trap had oval shaped funnel with dimension of 38cm (L), 18cm (B), and 35cm (H) and rear end diameter of 9cm. The rear end of the funnel was bent towards the bottom to prevent escapement of trapped fishes. The trap had a bait bag fabricated by Polyethylene webbing of 20mm mesh size and was filled with the baits during fishing operations. Shrimp waste was used as bait at the rate of 1kg/trap. Iron rod with weight of 1Kg fixed was at bottom of the trap as sinker besides two bags filled with sand each with the weight of 5kg was used as sinkers by attached on each end of the iron rod to position the traps for operation. Twelve species of finfishes were found caught in fish traps with the total catch of 263 Nos/trip. *Scarus quoyi, Epinephalus coioides*, *siganus canaliculatus, Lethrinus nebulosus, Acanthurus nigricauda, Lutjanus rivulatus, Parupenus indicus* ,*Epinephalus areolatus, Plectorhincus schotaf* , *Plectorhincus albovittatus* , *Lethrinus microdon* and *Lutjanus indicus* were caught in fish traps. With respect to length, weight and price basis *Scarus quoyi* (35cm,1.062 Kg& Rs.800/Kg) species that contributed highest to the catch was found to be the highest and *Siganus canaliculatus* (20cm,162 Kg& Rs.60/kg) was found to be the least dominant species. Regarding the species wise catch rate *Scarus quoyi* showed that highest representation in terms of number (120 Nos/trip) caught in the traps.

Keywords: Fish Traps, Shrimp Bait, Trap Design, Therespuram

Paper ID 16222

Catch Differences of Hand Line for Commercial Fishes Using Different Methods of Kombudurai Village of Thoothukudi Coast

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A study was carried out at Kombudurai fishing village of Thoothukudi coast to find out commercially captured marine fishes. The peak fishing season was found from September to January. Three different types of hand lines were operated in Kombudurai village, two types of lines for food fishes like seer fish and carangids, one for capturing bait fishes. Among these, the bait fish hand lines were found to have maximum number of branch lines of 10 numbers each of 0.2 m long. The length of the carangid handline was found as high as 55 m. Each hand lines were found to have different type of hook arrangement. Seer fish lines were found attached with 2-3 hooks per line while carangid hand lines, had only one hook and the bait fish hand lines were designed with 10 branch likes each attached with single hook of anyone size of hook no 15, 16 or 18.According to result the average weight of catch recorded in single boat ranged between 29.20 kg during October and 38.67 kg during November. The estimated total catch was observed in minimum range during January (15,380 Kg) and was found in maximum range during November (46, 790 Kg). According to result the maximum average number of boats operated for handlines was 55 during November while the minimum being 25 during January. The average weight of catch recorded in single boat ranged between 29.20 Kg during October and 38.67 Kg during November. This study suggested that the improving design of three types of handline units of Thoothukudi districts of Kombudurai village.

Keywords: Hand Line, Bait, Hook, Kombuthurai Thoothukudi

Paper ID 16226

Development of biodegradable artificial fish bait derived from biopolymers and bio attractants from seafood processing wastes.

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The study dealt with evolving an artificial fish bait suitable for longline fishing by incorporating bio attractant concentrates derived from seafood processing wastes by enzymatic hydrolysis and they were fish waste concentrate (FWC), squid waste concentrate (SWC), and shrimp processing concentrate (SPWC). The concentrates were characterized based on amino acid content and the presence of different functional groups using FTIR. Among the three concentrates, SWC was found to have the highest amino acid content of 60.85mg/100mg followed by FWC (42.21 mg/100mg) and SPWC (24.82 mg/100mg). Further, the FTIR analysis revealed the presence of aromatic compounds and organic acids in SWC which were found responsible for its superior attractability over FWC and SPWC. Nine artificial fish baits were prepared by incorporating FWC, SWC, and SPWC at three different levels viz., 1% (w/w), 3% (w/w), and 5% (w/w) levels with the fish gelatin-based bait matrix. The developed artificial fish baits were subjected to protein leaching, solubility in sea water besides testing for acceptability by the red snapper (*Lutjanus fulvus)* in the laboratory. The study revealed that the bait incorporated with SWC at 3% level was found be the most ideal, with the protein leaching rate of 24.82 mg/g/h, solubility rate of 36.6 mg/g/h and the attractability score of 29/30. Among the three concentrates, SWC was found to have the highest amino acid content of 60.85mg/100mg followed by FWC (42.21 mg/100mg) and SPWC (24.82 mg/100mg). Further, the FTIR analysis revealed the presence of aromatic compounds and organic acids in SWC which were found responsible for its superior attractability over FWC and SPWC. Nine artificial fish baits were prepared by incorporating FWC, SWC, and SPWC at three different levels viz., 1% (w/w), 3% (w/w) and 5% (w/w) level with the fish gelatin-based bait matrix. The developed artificial fish baits were subjected to protein leaching, solubility in sea water besides testing for acceptability by the red snapper (*Lutjanus fulvus)* in the laboratory. The study revealed that the bait incorporated with SWC at 3% level was found to be the most ideal, with a protein leaching rate of 24.82 mg/g/h, solubility rate of 36.6 mg/g/h and the attractability score of 29/30. The standardized bait was tested for amino acid leaching for 8h. The leaching rate was 3.11mg/h/100mg and it was found to contain five amino acids such as glycine, proline, glutamic acid, alanine and serine which have been reported to have bait stimulating properties of fishes. The study revealed that the hydrolyzed squid waste concentrate can be incorporated at 3% (w/w) with fish gelatin-based bio-matrix during gelation to prepare artificial bait suitable for longline fishing.

Keywords: Fish Waste Utilisation, Alternative Fish Bait, Amino Acid Leaching, and Gelatin Based Bait Matrix

Paper ID 16239

Study on longline fishing methods for commercial fishes along Kombuthurai village, southeast coast of Tamil Nadu.

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A study was carried out at Kombudurai fishing village of Thoothukudi coast to find out the long line fishing methods commercially used to capture marine fishes like seer fishes, tuna, carangids, grouper, cobia, needle fishes, sailfish and rays. Three types of long lines were found to operate in the Kombuthurai fishing village namely Seer fish long line, Carangids long line and Grouper long line. The grouper long lines were found operated as bottom set lines ranged from 5000 to 6000 m. The length of the mainline of carangid long line ranged from 7000 to 8000 m and seer fish long line ranged from 4000 to 5000 m. Both had branch lines ranged from 100 to 140 numbers and were found operated as mid water longlines. The length of branch line was minimum for the bottom set grouper longline (3.6 m) and the maximum for carangid longlines (23.6 m). However, in the case of seer fish long line, the length of branch lines ranged from 10.7 to 12.7 m. The length between two consecutive branch lines was found to be 47.8m, 56.4m and 14.5 m for seer fish, carangid and grouper long lines respectively. The peak fishing season was found between February to May although year round fishery could be observed. According to result the maximum average number of boats operated for long lines was 70 during February while the minimum being 25 during May. The average weight of fish caught from long lines of Kombudurai varied from 21.49 kg during March to 70.16 kg during April. This study suggested that the improving design of three types of long line units of Thoothukudi districts of Kombudurai incorporating basic components such as swivel and snood wire in the branch lines.

Keywords: Long Line, Fish Catch,fishing Boats,kombuthurai Thoothukudi

Paper ID 16244

Design specifications and catch rates of trolling lines operated along Coromandal coast of Tamil Nadu

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The study was carried out from October 2021 to march 2022 and the data were collected to analyse the design specifications and catch rates of trolling lines operated along the coast of Parangipettai (Lat.11°50'N long.79°76'E) and Sothikuppam (Lat.11°71'N long.79°76'E) fishing villages located along the Coromandal coast of Tamil Nadu. The study revealed the involvement of 30 trolling line fishing vessels throughout the year. Each Trolling line unit consisted of six main lines made up of polyamide monofilament with the length ranging from 3 to 6 meters with 0.9 mm dia. The inter distance between two main lines was found to be 0.3 m. A single outrigger boom made up of either with River red gum tree*(Eucalyptus camaldulensis*) or Casuarina tree(*Casuarina equisetifolia*) to facilitate the operation of trolling lines.Modern fishing gear accessories like swivel and snood wire were found used in the trolling line studied.Three different pattern of hooks such as single J hook (No.4,5,7,8), double hook(No.5) and triple hook (No.7) were found to used.The total duration of operation was found to be 8hrs/trip. Both natural and artificial jigs were found used in the trolling lines. Mackerel was mainly found used as live bait. Among the three different patterns of hooks used Double hook was found contributing highest catch rate of (190 Kg) compared to J hooks (90Kg) and triple hook (50Kg). Among the four hook sizes of J hooks the hook No.4 showed the highest catch rate ranging from (30 to 40 kg) followed by No.5 (20 to 25 kg), No.6 (20 kg) and No.8 (10 to 15 kg).With regard catch rates by different types of baits, mackerel showed highest catch rate compared to trolling jigs.The peak fishing season of operation was found to be from April to June. Fast swimming predatory fishes such as Yellowfin tuna (*Thunnus albacares)*, Sail fish (*Istiophorus platypterus),* Seer fish (*Scomberomorus commerson*), and Dolpin fish (*Coryphaena hippurus)* were found contributed to the catch. The overall catch rate was estimated as 330kg/ trip. Regarding species wise catch rate,*Thunnus albacores* (200 kg/trip) was the most dominant followed by *Istiophorus platypterus* (60 to 80 kg/trip) *Scomberomorus commerson*(10 to 20 kg/trip), and *Lethrinus microdon* (30 kg/trip).

Keywords: Troll Line, Outrigger Boom, Hook Pattern, Catching Rates, Cuddalore

Paper ID 16342

Documentation of marine gill net fishing practices in Kameswaram fishing village of Nagapattinam, Tamil Nadu

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The documentation of marine gill nets was carried out from September 2021 to January 2022 at Kameswaram fishing village of Nagapattinam district of Tamil Nadu (Lat 10.62º N Long 79.85º E). Mostly all the fishermen are depending on the gill net fishery in the coast of kameswaram. Seven different types of gill nets with various mesh sizes were found to be in operation. Gill nets are mostly classified by target catch of species namely mackerel gill net, Salmon gill net, pomfret gill net, cuttlefish gill net, crab gill net, and sardine gill net. In this present study showed that two kinds of gill nets were used for sardines. Gill net with mesh size of 30-35 mm locally called as Maapu valai (double layer of gill net) used only with the craft with Yamaha speed engines 9.9 hp in the peak sardine season and the gill net with the mesh size of 36mm commonly called Disco valai used other than peak season in the Greaves outboard lambaadi engine craft 10hp. Gill nets of different mesh sizes ranging from 20 to 140 mm targeted at different groups of fishes are prevalent along the coast. Besides, trammel net known as salangai valai used to catch shrimp. This present study showed that the peak season for sardine is during May to November from which the fishermen maximum profit.

Keywords: Gill Net, Mesh Size, Trammel Net, Fishery, Season, Craft

Paper ID 16361

Analysis of drag resistant of trawl nets operated at Thoothukudi, Southeast coast of India

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A study conducted to analyze the design features of trawl nets of three different size class vessels of Thoothukudi fishing harbour, (8º47'N &78º9.5'E) viz) Type 1 trawler (45' OAL), Type 2 trawler (55' OAL) and Type 3 trawler (65' OAL) revealed that energy efficiency is greatly the function of surface area of the net and drag resistance. The drag resistance was estimated based on the surface area of the nets and trawling speed of the vessel. The Head Rope Length (HRL) of trawl operated from Type 3 trawler was found to be about 25.2 % higher than the optimal length recommended by Koyama (1970). The total stretched lengths of trawls invariably operated from different size class vessels were found to be 1.48 to 1.77 times higher. Further the stretched length of overhang of trawls operated from all the three size class of trawlers were around 2 to 3 times greater than the recommended stretched breadth. All the trawl designs were also found to have low horizontal hanging co – efficient ranging from 0.05 to 0.25, leading to excess accumulation of webbing at the mounting region which lead to excess surface area of the net in trawlers of all vessel types. This error reflected as the excess drag resistance of 52%, 87% and 91% in Type 1, Type 2 and Type 3 trawlers while trawling. The study implied that the trawl net of Thoothukudi have been designed with the core aim of increasing the mouth opening so as to sweep a larger area and collect more fishes. However, in contrast excessive mounting of webbing in the head rope lead to the increased drag resistance and ultimately resulted in excess drag and thereby for increased fuel consumption.

Keywords: HRL, Surface Area, drag Resistance

Paper ID 16406

Estimation of longline hook selectivity of brown-lined grouper *epinephelus undulosus* in Gulf of Mannar

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A survey was carried out to study the selectivity of the brown-lined grouper, *Epinephelus undulosus* using three different sizes of traditional 'J' type hooks, hook No. 12, hook No. 9, and hook No. 6 along Gulf of Mannar coast from February 2020 to February 2022. The hook selectivity curves were derived by applying the SELECT (Share Each Length Class Total) methodology (Millar, 1997) available in TropFishR package of R software. Under unimodel function, three types of selection models such as normal location, normal scale and log-normal were used. Further, under bimodal function, two types of selection models such as bi-normal and bilog-normal models were used. The different models were evaluated using statistical tools such model deviance, dispersion parameter and residual plots to determine the degree of fit of the selectivity data. The bilog-normal model was found to be the best fitted model with the lowest model deviance of 23.86. In addition, log-normal model was found to be the next better fitted model with model deviance 29.09. The dispersion parameter was found to be greater than unity for both the best fitted (bilog-normal) and better fitted (log-normal) models. This suggests that there is an over dispersion in the catch data and this may be attributed to the representation of larger sized fishes caught in the catch of smaller sized hooks revealing lack of fit in the selection data.

Keywords: Selectivity, long Line, Brown-lined Grouper, R Software, Gulf of Manner

Paper ID 16427

Comparative analysis on the technical status and economics of operation of deep-sea fishing vessels of Thengapattinam and Tharuvaikulam fishing villages of Tamil Nadu

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A comparative study carried out on the technical status of Deep Sea Tuna Gillnets of Kanyakumari and Thoothukudi districts respectively. However, it revealed no notable differences in design aspects despite notable variations on the depth of operation. Large meshed drift gill nets were operated by Gill Netting cum Longliners (GNCL) in Thengapattinam and Gill Netters (GN) of Tharuvaikulam fishing villages. Though the Deep sea tuna Gill Netter (GN) of Tharuvaikulam, which is situated in the east coast were also found operated along the west coast relatively near shore at a dsitance of 100-700 Nm. However the Gill Netter cum Longliner (GNCL) of Thengapattinam were found involved in gill netting in the fishing grounds far off from the coast with the depth ranging from 12m to 16m. There were about 800 deep-sea tuna fishing vessels were found operated, of which 500 boats were Gill netter cum longliners (GNCL) and the remaining 300 boats were exclusively longliners, whereas in Tharuvaikulam all the 220 fishing vessels were engaged in gill netting at a depth of 10m to 14m. During the year 2020, the CPUE for Gill Netter cum Long liner (GNCL) of Thengapattinam and GN of Tharuvaikulam was determined as 769.40 kg/day and 590.963 kg/day, respectively. There existed significant differences with the respective CPUE of GNCL of Thengapattinam and GN of Tharuvaikulam. The economics of the operation of deep sea gill nets was worked out for five months for GNCL of Thengapattinam and GN of Tharuvaikulam. The Benefit Cost Ratio (BCR) revealed that BCR value of 1.32 for the GNCL of Thengapattinam against 1.19 for GN of Tharuvaikulam was estimated.

Keywords: Deep Sea Tuna, GN, GNCL, CPUE, Thoothukudi and Kanyakumari

Paper ID 16433

Gill net selectivity of deep sea tuna fishes (*Thunnus Albacares*, Bonnatere. 1788 and *Katsuwonus Pelamis*, Linnaeus. 1758) on Thengapattinam And Tharuvaikulam fishing villages in Tamil Nadu

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The selectivity parameters were derived for two deep sea Tuna species viz. *Thunnus albacares* and *Katsuwonus pelamis* by using fishing vessels of Gill Netter cum Longliner (GNCL) at Thengapattinam and Gill Netter (GN) of Tharuvaikulam fishing villages from Tamilnadu. Length frequency data from gill nets of three different mesh sizes viz. net 'A' (130 mm), Net 'B' (135 mm) and Net 'C' (140 mm) were used for the estimation of gill net selection factors. The optimum mesh size to capture the commercially significant length groups of *T. albacares* from Thengapattinam fishing village by GNCL vessels was estimated as 175.5 mm, whereas the optimum mesh size for *K. pelamis* was found to be 140.9 mm. Further in the case of Tharuvaikulam the optimum mesh size to capture the commercially significant length groups of *T. albacares* by GN of Tharuvaikulam was estimated as 160 mm and 129.5 mm for *K. pelamis*. The study revealed that the gill nets with 130 mm mesh size must be banned in both the fishing villages as its operation would lead to be capture of *T. albacares* before attain its first maturity stage. In general, the mesh size of deep-sea gill nets may be increased beyond 140mm to facilitate capture of bigger sized fishes of both *T. albacares* and *K. pelamis* by enmeshing instead of by entangling.

Keywords: Gill Net Selectivity, GNCL, GN, *Thunnus Albacares, Katsuwonus Pelamis* and Mesh Size

Paper ID 16442

Appraisal of trawl designs operated along Cochin coast, Kerala

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This study presents design details of the trawl net operated along Cochin coast during 2020-2021. The study has been conducted in four landing centers and 20 design details of trawls were collected and ten were documented using AutoCAD v 2021 software. All the designs of trawls being operated from the trawlers of Cochin coast fishing harbour were unique in their design characteristics. The trawls on Cochin coast can be broadly classified into three types based on the target groups, viz., fish trawls targeted for finfish, shrimp trawls for shellfish, and cephalopod trawls for cuttlefish and squid. The study found that the main material for trawl net fabrication on the Cochin coast was exclusively high-density polyethylene (HDPE) and rope material was poly propylene (PP), the mesh size of trawl nets used along the Cochin coast ranged from 60 to 15000 mm, depending on the type of trawl net, while the twine size of the webbing used at times varied between 0.5- and 3.0-mm. The findings showed variations in the mesh size of Fish trawls in the forepart of the net increased from 60 to 15000 mm to reduce the drag, Two seam fish trawls with head rope ranging from 45 to 122 m with codend mesh size 20 to 30 mm was widely used for finfish at depth of operation from 20 to 180 m, while mesh size for Shrimp trawls ranged from 1000 to 1500 mm with head rope ranging from 50 to 53.5 m and codend mesh size 18 to 25 mm was used at depth of operation 20 to 100 m, and mesh size for Cephalopod trawls ranged from 4000 to 15000 mm with head rope ranging from 106 to 114 m and codend mesh size 20 to 40 mm was used at depth of operation 100 to 160 m in Cochin coast of Kerala. Majority of the trawlers in the study area use V-form steel otter boards weighing 100-160 kg and the smaller boats found to be using wooden flat rectangular boards.

Keywords: Trawl Net, Designs, Mesh Size, Cochin Coast, Kerala

Paper ID 16486

Comparative fishing efficiency of semi-collapsible fish traps with traditional trap

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Comparative experimental fishing trials were carried out for two different designs of Semi-collapsible fish traps viz., Type 1 and Type 2 both with the similar dimension of 125 x 80 x 55 cm at Keezhakarai coast along with traditional trap of Keezhakarai. In Type 1 trap, interconnecting stainless steel rods with the thickness of 16 mm was used to stretch the trap whereas in Type 2 trap two cross bars with a breadth of 2.5 cm and thickness of 0.75 mm at the centre were used to stretch. Both the traps had the equal operational volume of 0.55 m^3. However, the Type 1 trap had a stack volume of about 0.1 m^3 whereas in the Type-2 trap had the stack volume of 0.2 m^3. During the study period 22 species belonging to 10 families were constituted the catch in all the Type 1, Type 2 and Traditional traps. The contribution by the members of the family during April, May, June and July were 17%, 23%, 19% and 22% respectively. There was no significant difference in the representation of various fish species among the traps tested. Considering its low stack volume the Type-1 trap was found to be superior over Type 2 and the traditional traps. Further the Type 1 trap was found to have easy operational characteristics because of easy removal of interconnecting rods for stacking on board the vessel after operation. Both the experimental traps (Type 1 and Type 2) were found to have increased estimated life span of 3 years against 6 months for traditional trap of keezhakarai.

Keywords : Comparative Efficiency, Experimental Fish Traps, Catch Details, Stack Volume, Life Span

Paper ID 16490

Preliminary study of trace metals concentrations in abandoned, discarded or lost fishing gears at Thoothukudi Coast, Gulf of Mannar, India

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The Abandoned, Lost or otherwise Discarded Fishing Gear (ALDFG) are commonly found in the ocean these days due to the negligence of the fishermen. Abandoned, lost and discarded fishing gear (ALDFG) can pose substantial ecological and socioeconomic problems. Over the past decade there has been increasing international recognition of the need for multilateral efforts to address transboundary problems resulting from ALDFG, including ghost fishing. The present study aims to identify the discarded fishing gear sample and determine metals' absorption rate by ALDFGs. The identification of the ALDFG was done with the help of Attenuated Total Reflectance-Fourier Transform Infrared spectroscopy (ATR-FTIR) in which it was confirmed that the samples are mostly made of nylon 6. Adsorption of trace metals by Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS) confirmed the presence of elements such as Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Nickel, Phosphorus, Potassium, Sodium, Vanadium and Zinc in the identified plastic sample. The adsorption of elements by the surface of the sample was confirmed by Scanning Electron Microscopy (SEM) micrographs, which demonstrated the level of adsorption of trace metals in abandoned, lost, or otherwise discarded fishing gear.

Keywords: Fishing Gears, Lost Fishing Net, Abandoned Fishing Gears, Trace Metal Concentrations, Discarded Fishing Gears

10. SOCIOECONOMICS, POLICY, MARKETING, LIVELIHOOD AND ICTS IN FISHERIES

Paper ID 15525

Role of biosecurity for Aquatic health management: a step towards immunization of Aquaculture following the covid era

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The Covid 19 pandemic has adversely affected all most every sector of the economy across the globe. The fisheries and aquaculture sector has also experienced the same due to reduced domestic demand and export of sea food items. The SARS-CoV-2 virus is highly contagious and adoptive in nature. It causes severe acute respiratory syndrome (SARS) in human body. The glycoprotein on envelop has a very high affinity toward the human cell and that's why it is getting transmitted by a simple physical contact. Some evidences have been found regarding the transmission of Covid 19 virus through the sea food contamination in Wuhan city and researchers have detected the presence of SARS-CoV-2 in the waste water of some urban infected areas of many countries like China, Germany, Japan, France, India, Israel, Chili, Italy and Australia. There are also cases of detection of Covid 19 virus in the pets of some infected persons in some countries and also in the wild animals like tiger, lion etc. The persistent positive reverse transcription-polymerase chain reaction (RTPCR) result of the animals was accepted as positive by the University of Hong Kong and the World Organization for Animal Health as a true positive case of Covid 19 for a true infection. Although no evidences has been observed regarding the direct contamination by fish or any other aquatic animal, but the possibility cannot be ruled out. In the backdoor of varying mutations of SARS-CoV-2, possibilities of aquaculture getting impacted cannot be completely ruled out .The waste water that can be used as a sustainable source of fresh water, has shown the presence of SARS-Cov-2 virus, but the number of virus can be reduced after proper treatment. It is therefore imperative that, some strategies should be followed to minimize the risk of introduction of any infectious diseases, This is termed as 'Biosecurity". The application of Biosecurity in Aquaculture sector will help in improving immunity of the aquatic species through scientific measures in this Covid era and will help the economy of aquaculture sector to become more comfortable with the "New normal" terms.

Keywords: Biosecurity,immunisation,aqauaculture,covid-19

Paper ID 15543

Need of organizing capacity development programmes for Shrimp farmers based on scientific training needs assessment

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Shrimp aquaculture is currently the fastest growing food-producing sector in the world. In cultured shrimp production, India stands at second position with production of 8.0 lakh tons. Amongst all the states, Andhra Pradesh ranks first and Maharashtra is at sixth position. Maharashtra has a huge potential for the development of shrimp farming as out of 10,400 ha suitable farming area, only 12% area is presently used. Studies have highlighted the importance of training for shrimp farmers. But scientific training need assessments in this area are few. Keeping this in mind a study was conducted to assess and prioritize training needs of shrimp farmers of in Maharashtra. Guidelines laid down by Coastal Aquaculture Authority (CAA) intend to assist shrimp farmers in adopting Best Management Practices (BMPs) were taken as a broad framework to locate the training areas for shrimp farmers. Out of 165 registered shrimp farmers in Maharashtra, information was collected from 151 shrimp farmers from four coastal districts. Borich Need Assessment Model was used to assess the farmers perceived level of importance and competency for training areas using five-point scale. Mean Weighted Discrepancy Score (MWDS) was calculated to rank and prioritize training needs. Based on the MWDS the prioritized training needs were shrimp diseases, symptoms, identification, prevention and management, nursery management, feeding management, use of biosecurity measures and use of drugs and chemicals. Kruskal-Wallis test revealed that, there was no significant difference in training needs among the different coastal districts. It is suggested that capacity development programmes should be organized for shrimp farmers based on scientific training needs assessments.

Keywords: Scientific Need Assessment, Shrimp Farmers, Capacity Development Programmes, Maharashtra

Paper ID 15589

Mapping vulnerability of Indian inland fisheries to Climate change

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Identification of spatial gradient in vulnerability of inland fisheries to climate is imperative in formulation and implementation of suitable climate change adaptive measures. Quantitative vulnerability indices are obliging in this endeavor to capture the significant aspects of vulnerability. Here we built a state-level composite vulnerability index for India using 29 variables to map the inland fisheries exposure under observed climate change. Infrastructure, governance, and demographics were incorporated to assess each State's adaptive capacity. The results of this study show that the relationship among the exposure, sensitivity and adaptive capacity varied (0 to 1) among the States. Kerala (0.61), Chandigarh (0.61), Goa (0.62), Puducherry (0.63) and Maharashtra (0.66) were highly vulnerable to change in climate whereas Andhra Pradesh (0.33) was moderately vulnerable and the other 24 States were vulnerable (0.42 to 0.60). Finding of this study will be helpful to develop countermeasures to abate the risk of inland fisheries to climate change.

Keywords: Vulnerability, Adaptive Capacity, Climate Change, Indian Inland Fisheries

Paper ID 15638

Vulnerability status of Coral reef Ecosystem of Gulf of Mannar, Tamil Nadu, India

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Marine ecosystems are commonly vulnerable to climatic and non- climatic variability and change. The Gulf of Mannar is one of the prominent marine bioreserve which has climate and non climate-sensitive mangrove, coral reef, rockshore, sandy shore, seaweed, sea grass ecosystem that suffers a lot from risks associated with various stressors. The vulnerability determinants (exposure, sensitivity, and adaptive capacity) of the coral reef ecosystem to various climatic and non-climate variability and change diverge across marine-ecological systems (MESs). Consequently, the aim of this study was to investigate MES- Coral Reef Ecosystem Specific Vulnerability (MES-CRESV) to climatic and non-climate variability in Gulf of Mannar (Tamil Nadu). We interview 120 respondents randomly selected from 2 districts namely Ramanathapuram and Tuticorin district as the distribution of coral reef is reported in their mainland and associated islands. Additionally, focus group discussion (FGDs) and key informant interviews were also carried to supplement and corroborate the quantitative data. The Environment vulnerability index (EVI) is modified for coral reef ecosystem consecutively, employed to evaluate the coral reef ecosystem vulnerability extracted from coral reef dependent beneficiaries to climatic and non- climatic variability and change. Data on various attributes (criteria) namely ecosystem intactness, hydrological integrity, anthropogenic disturbances, biotic community- flora and fauna response, climatic were collected through identified indicators were pooled to arrive indices and vulnerability score was calculated for coral reef ecosystem. A coral reef ecosystem vulnerability indices for entire Gulf of Mannar is calculated. Our results suggest that ecosystem specific resilience-building adaptation strategies are vital to reduce the vulnerability of various marine ecosystems. The measures taken should consider eco-specific marine-ecological system requirements to trim down the vulnerability of marine environment as a whole. Since the approach based on the information realization from ecosystem dependent fishers, any strategy intended based on such assessments is pertinent to local condition.

Keywords : Gulf of Mannar, Coral Reef Ecosystem Vulnerability, Eco-specific Marine-ecological System

Paper ID 15639

A very first report on sustainability status of Mangrove ecosystems of Gulf of Mannar, India

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Gulf of Mannar is imperative to the economies, security and livelihoods of India. The present study was initiated to evaluate the sustainability status of various marine ecosystem from the climatic, non-climatic stressors in the region of Gulf Mannar on the aim of preventing mangrove ecosystem from thwarting.In order to gather the data, a pre-structured ecosystem context- specific interview schedule was distributed to 120 resource users (beneficiaries) of mangrove ecosystem among two districts of GOMBRT as identified ecosystem is distributed. To evaluate Mangrove ecosystem sustainability index the identified criteria such as Quality of ecosystem ,effectiveness of Governance, Social Well being of human, flora, fauna associated information on identified indicators for various criteria obtained from resources benefiters and computed mangrove ecosystem sustainability Index additionally , tested for goodness of fit. The study showed a significant level of sustainability of mangrove ecosystem in Gulf of Mannar (GoM) due to the Fishing, aquaculture, Climatic, biotic agriculture, and anthropogenic factor. The evaluation showed that three variables appreciably hinders the sustainability of Mangrove ecosystem. The present survey figure out the need ecosystem specific management to prolong the sustainability of marine ecosystem towards sustainable blue economy in Tamil Nadu that endorse growth, advance conservation, construct sustainable fisheries, and stop IUU (illegal, unreported and unregulated) fishing. Ecosystem-specific- sustainability evaluation framework, improved governance is obligatory to develop and pull through the sustainability of livelihood and ecosystem towards blue economy. Innovative financing to direct investments into assorted economic activities is also looked-for to boost ocean health. A additional pace would be to estimate how possibly will the human inputs or enhanced management practices may perhaps be concerned in improving the ecosystem service.

Keywords : Keywords: Sustainability, Quality Of Ecosystem, Effectiveness Of Governance, Social Well Being

Paper ID 15653

Techno-economics of mechanized Fishing vessels operated from Gangolli landing centre of Karnataka, India

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The fisheries sector provides livelihood to about 25 million fishers and fish farmers at the primary level and almost twice the number along the value chain. The state of Karnataka is endowed with rich marine fishery resources in terms of 320 km coastline, 27000 sq. km continental shelf, and 87000 sq. km. EEZ. The purse-seiner and trawlers are major means of the large-scale harvest of marine fishery resources along the Karnataka coast. Gangolli landings centre is one of the key marine fish landing centre of the Udupi district of Karnataka. The present study evaluated the economic performance of both single-day trawler and purse-seiner operated from the landing centre. The key economic indices like Benefit-cost (BC) ratio, operating ratio (OR), net present value (NPV), internal rate of return (IRR), and cost efficiency were estimated to evaluate the economic performance. The BC ratios for purse-seiner were estimated at 1.20, whereas it was 1.12 for the single-day trawlers. The respective operating ratio were 0.56 and 0.67. The estimated IRR for the purse-seiner was 37.18%, a slightly higher IRR was observed for single-day trawler (39.01%). The cost efficiencies for purse-seiner were 0.847 and 0.939 at a constant and variable return to scale, respectively. Similar cost efficiencies were also observed for the single-day trawlers. It was observed that the mechanized fishing sector is operating under a narrow profit margin. The declining revenue due to the decrease in the quantum of high-valued fish in catches and escalating fuel prices have been identified as the major factor leading to the deteriorating economics of the mechanized sector in the region.

Keywords: Bcr, Cost Efficiency, Operating Ratio

Paper ID 15666

Recycling of fish waste to value added products, CIBA-Planktonplus and CIBA-Hortiplus for livelihood support and doubling of farmer's income: A success story

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A unique technology has been developed in which fish waste/trimmings generated in fish markets and fish processing units has been converted to two value-added, cost effective, eco-friendly products branded as CIBA-Plankton*Plus* and CIBA-Horti*Plus*. The group of seven people from Nambikkai Nagar, Pattinapakkam, Chennai formed a self-help group "Nambikkai Fish Farmers Group" and they have been incubated as a start-up for imparting the technical know-how to produce value added products from fish waste. This has considerably changed the socio-economic status of them. The products are being sold to shrimp/fish farmers of Kerala, Tamil Nadu, Andhra Pradesh, Gujarat, Odisha and West Bengal as well as horticulture farmers of Tamil Nadu, Andhra Pradesh and Karnataka. The SHG has realized more than Rs.15 lakhs per year by the production of about 15-20 tonnes of Plankton*Plus* and about 1.5-2 tonnes of Horti*Plus* per year.This technology has given employment opportunities for more than 100 coastal women and men in and around Chennai and West Bengal for upliftment of their socio-economic status. More than 500 fisher folk and farmers were trained/got awareness about recycling of fish-wastes to value added products through this technology. The Nambikkai Fish Farmers Group was recognized as the "Best Fisheries Self Help Group 2020" by National Fisheries Development Board, Department of Fisheries, Ministry of Fisheries, Government of India. Looking at the potential of these products in aquaculture and horticulture, one of the group member of Nambikkai Fish Farmers Group, Mrs.K.Velankanni, taken the technology from ICAR-CIBA and started a micro-level enterprise as "V.S.FishWaste Hydrolysate" at Kasimedu Fishing Harbour, Chennai, for manufacturing of value added products from fish waste. This technology has the potential in cleaning the fish markets across the country, and also creates livelihood support and doubling of farmers' income to the coastal communities as well as increasing of their socio-economic status.

Keywords: Fish Waste Hydrolysate, Circular Economy, Recycling, Doubling of Farmers Income

Paper ID 15668

Machine learning based data aggregation model for the development of Cage Aquaculture monitoring system

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Cage culture is becoming a prominent and profitable model in aquaculture. The dynamic natures of environmental parameters are collected using sensor-based network systems in the rising technology era. In addition, limited power and processing capabilities of sensor-based network systems, it is essential to find techniques that improve the flow of information. Therefore data aggregation process using advanced Machine Learning (ML) techniques such as fuzzy logic, neural networks, deep learning etc. is required to minimize the cost and time spent in communication activity. In this backdrop, data aggregation models using Mamdani and Sugeno fuzzy based ML techniques have developed and validated and compared for efficiency for the development of cage aquaculture monitoring system, which will be useful to reduce traffic and enhance the performance of the sensor networks.

In the model developed, trapezoidal and triangular membership functions were used for defining the input variables such as pH, Salinity, Dissolved Oxygen and Temperature and output variable such as aggregation area. Totally, 375 fuzzy rules with logical AND operator, truncation implication, and centriod method for defuzzification were employed to develop an efficient Mamdani and Sugeno fuzzy models for aggregating the input values. The model was implemented in MATLAB. The developed models have validated with cage aquaculture data in terms of efficiency and execution time and to identify the suitable model for the development of cage aquaculture. The results shows that the Sugeno model responds to the whole range of aggregation value [1-4] compared to Mamdani model [0.5-3.5]. It also shows that the average execution time of Mamdani model is 2.05 minutes and Sugeno model is 1.71 minutes. Based on the performance of full range of aggregation values and execution time, and data processing efficiency, Sugeno model works well for the development of wireless senor network based Artificial Intelligence cage aquaculture monitoring system.

Keywords: Mamdani, Sugeno, Machine Learning, Data Aggregation Model, Cage Aquaculture

Paper ID 15674

Bioeconomic analyses of coastal Cages co-cultured with Asian seabass, Lates calcarifer and Pearl spot Etroplus suratensis in Kerala, southwest coast of India

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Abstract

This paper aimed at providing a basic bioeconomic analysis of co-culture of sea bass and pearl spot in cage farming in Kerala, Southwest coast of India. For obtaining the bioeconomic information, data from 499 cages installed by 414 beneficiaries of the CMFRI-NFDB project on open water cage culture in selected districts of Kerala. The data from cage farms and farmers in Kannur, Calicut, Malappuram, Trissur, Ernakulam, Alappuzha and Kollam Districts in Kerala were collected during 2018-2021. The details collected included information on beneficiary households, biological parameters and economic analysis of the crop. Since 2015, co-culture of Asian seabass *Lates calcarifer* along with pearl spot *Etroplus suratensis* in coastal cages has been proven as a successful and viable alternative livelihood and income generating opportunity for coastal community in Kerala. It has been found to be a very profitable venture for fish farmers of the eight coastal districts in Kerala. Production and total revenue are the highest in Ernakulam and Trissur Districts, reflecting relatively high stocking rates, more number of cages and harvest prices. Cost per unit production is almost uniform for all cage farmers in all the districts. The major cost for these farms are seed and feed (40–60% of total costs) and to a lesser extent for labour (12–19%). The average feed conversion ratio for these systems, where seabass were fed exclusively trash/ low value fish, is calculated to be 1:3. Farmers had two crops per year and in some cases more crops and multiple harvests ranging from 2-5 were also done. The economic rate of return was as high as 100% in many cases. Average fish production of 800 kg /cage was recorded per crop with a stocking of 1500 nos of sea bass and 500 nos pearl spot. The aggregate production from all cages for single crop was 398.4 tonnes. The mean farm gate price was Rs.450/kg, with total revenue of Rs.17.928 crores. Pearl spot which fetched premium price on harvest was not fed extra exclusive diets in majority of the cages, which added to the revenue of farmer; rather compensated to the high input cost for seabass. Improving the income and livelihood of coastal fish farmers in Kerala is dependent on reducing their dependence on trash fish for feed and expanding area and number of crops per year by better management practices. If cost-effective pellets are to be widely adopted by farmers, poor acceptability and slow growth rates compared with trash fish, need to be overcome.

Keywords: Bioeconomics, Coastal Cages, Sea Bass, Pearl Spot

Paper ID 15677

Popularization of seed production and farming technology of estuarine catfish, Mystus gulio in West bengal and Andhra pradesh

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Whisker catfish, *Mystus gulio* (Ham.) is a commercially important euryhaline catfish, which is traditionally farmed in brackishwater pond and paddy field of West Bengal and Odhisa. The farming is dependent on wild seed resources, which is seasonal and cumbersome. Therefore, ICAR-Central Institute of Brackishwater Aquaculture (CIBA) has developed and popularize the seed production and farming technology of *M. gulio*. In brief, the technology comprises of broodstock development in earthen pond (1000 m^2) at the density of 2 m^{-2}. During the rearing fisher are fed with broodstock diet to the satiation. Mature male and female (oocyte diameter > 900 µm) are induced to spawn with any one of the inducing agents (human chorionic gonadotropin @ 210 IU g^{-1}, LHRHa @ 5 µg g^{-1} and commercial hormone @ 20 µl g^{-1}). In the larval rearing, larvae are reared for 30 days and fed four times with *Artemia* spp. nauplii at the density of 3,000 numbers L^{-1} for 7 days and thereafter gradually wined to larval feed. During nursery rearing, 30 days old larvae are reared in net cage hapa (2x1x1) for 60 days. Six months of monoculture at the stocking density of 10 m^{-2} give a production of 1.2-2.4 ton ha^{-1}. Two tier farming with crab showed promising results. CIBA initiatives were to popularize the technology and increase the aquaculture production of *M. gulio* through farmer's trainings, demonstrations, consultancies and workshops in the state of West Bengal and Andhra Pradesh. This seed production technology was transferred to many small and marginal farmers of West Bengal and Department of Fisheries, Krishna District, Machilipatnam, Andhra Pradesh and farming technology was demonstrated among farmers. Overall the popularization of the technologies has helped in employment generation, poverty alleviation, nutritional security and socio economic upliftment of small and marginal farmers of the area.

Keywords: Brackishwater, Mystus Gulio, Popularization, Seed Production, Socio Economic Upliftment

Paper ID 15702

Maa kharakhai fish farmers producers company ltd- A case study

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Maa Kharakhai Fish Farmers Producers Company Ltd. was established at Pimpudi, Rajkanika, Kendrapara, Odisha-754220 having CIN-U01110OR2019PTC030912. Promoted by Gram Uthan, an NGO located at Rajkanika, Kendrapara, the FPC came into existence in 2019. It has 10 directors and had 364 shareholder members. All the members of the FPC are women. They all have subscribed Rs. 1000 as share and raised a capital of Rs. 3,64,000/-. The FPC draws members from 33 gram panchayats and 160 villages of Kendrapara district. The total operational area was divided into 5 zones (East, West, North, South and Central) and 2 Directors were chosen for each zone for coordination among the members. The FPC has developed a sound business plan and according to it 1% of total members were assigned for rearing of spawn and fry to fingerlings, 4% were assigned to rear fingerlings to yearlings and 95% of members were taking grow out culture. This helps them in easy and ready availability of quality fish seed at right time and in the required size. This approach has rendered the group self-sufficiency in fish seed. The grow out farmers practice four month culture cycle and once the fish attains a body weight of 500 gm or more they start selling the produce. They sell the table fish in the local market and get Rs. 140-160 per kg of fish. However, for selling of Vietnam climbing perch, Gift tilapia and other diversified fish species it avails the services of traders as there is less demand in the local market. These species are in demand in Kolkata market and the FPC sells it to Royal Fish agency, a private trader. In one consignment 1-1.5 ton of climbing perch and 2.5 ton of tilapia are normally sent to Kolkata in live condition to get premium price. Their main challenges are non-availability of cold storage, processing unit and high cost of inputs. To overcome this, the FPC has taken the dealership of ABIS fish feed and entered into agreement with other feed companies like Pasupati feeds, Mohan feeds and Grow well for bulk procurement. This has reduced the input cost significantly. The FPC procures 15-18 ton of fish feed per month.

Keywords: Fpc, Business Plan, Dealership, Diversified Fish Species

Paper ID 15712

Digital Revolution in the ornamental Fish sector

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Recent advancements in disruptive technologies such as the Internet of Things (IoT), Blockchain Technology etc., has digitized conventional markets in all sectors and paved a new age of 'e-market'. In the case of the Fisheries and Aquaculture sector, the lucrative backyard revenue-generating ornamental fish farming is found to be largely influenced by such technological evolution. Considering this scenario, the present study attempted to compare and capture the pros and cons of existing conventional and digital markets of ornamental fishes in the Chennai (Kolathur) region of Tamil Nadu. Data for the study was collected from 30 ornamental fish producers and 150 consumers through a pre-designed schedule. The study revealed that the digital market has more 'win-win' situations for both producers (farmers/entrepreneurs) and consumers in terms of product value and quality. However, existing Government guidelines are not in favour of promoting digital marketing in ornamental fish sales. The study, therefore, recommended certain changes that can be considered at the policy level that will foster both the self-employment of youth and the ornamental fish sector in the country.

Keywords: Digital Market, Disruptive Technolgies, Oranamental Fish Sector

Paper ID 15715

Uncertainty following military conflict between Russian-Ukraine on exports of Indian fish and fishery products to the region

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Recent military conflict between Russia and Ukraine is a significant event after the end of cold war that changed the world order. This military conflict has affected the international trade of most of the commodities including fish and fishery products. India is the fourth largest exporter of fish and fishery products in the world worth US$ 5.96 billion during 2020-21. Following the recent reduction in the Indian exports to EU, seafood trade with Russia and other neighboring countries such as Ukraine, Belarus, Kazakhstan and Moldova have seen upward trend. Seafood is one of the top three commodities exported to Russia. The bilateral trade between India and Russia was worth US$ 9.4 billion while US$ 2.35 billion with Ukraine (2021-22). Indian exports of fish and fishery products to Russia increased from US$ 85 million to US$ 133 million and to Ukraine from US$ 1.5 million to US$ 10 million during 2018 to 2021. The competitive advantage of India over the trade may be disrupted due to suspension of trade to the destinations. Due to altered equations between trading countries energy market is expected to see the unexpected fluctuations. Higher cost of petroleum products would increase the cost of seafood production reducing the profit margins. In the event of decline by 25% in the seafood trade, the study estimated an economic loss of US$ 33 million (Russia) and US$ 2.5 million (Ukraine). Duration of the conflict determines the extent of the impact on the Indian seafood trade in the international market.

Keywords: Fish Exports, Military Conflict, Russian-Ukraine, Economic Loss

Paper ID 15725

Fish for health and nutrition: A study on consumption, determinants and health profile of major tribes in Kerala.

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Fish is a major contributor for marginalised communities in the fight towards hunger, food and nutrition security. Fish purchase preferences and consumption behaviour vary between communities. Using data collected from six major tribes of Wayanad, Kerala; the study documents the tribal fish purchase preferences and consumption profile, investigates the determinants of fish purchase and consumption, health profile and symptoms in relation with iron deficiency anaemia of tribes and association between fish consumption and health profile of tribes. Data were gathered from 200 tribal households covering different socioeconomic backgrounds of Wayanad. Results identified that Adiyan followed by Vettakuruman tribes had highest per capita fish consumption. While Sardine is the most consumed and preferred fish among Wayanad tribes, the percapita consumption (1.03kg/month) was estimated far below the Kerala average. Price of fish ranked as the most important barrier of tribal fish purchase and consumption while the 12 determinants of fish consumption analysed were found highly associated with the health values of tribes. The determinant factors identified in the study can serve projects and policies aimed towards increasing awareness on health benefits of fish consumption and capacity building of tribals in preparing fish-based products based on local taste and preferences. The study can aid guidelines for improved fish consumption in alleviating health and nutrition status of the tribal population.

Keywords: Fish Consumption, Determinants, Nutrition, Health Profile, Tribes, Kerala

Paper ID 15727

Why Shrimp Crop Insurance in India is failing to forward?

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Due to concerted efforts of lobbying to bring back shrimp crop insurance in India, the four Public Sector Unit (PSU) general insurance companies and a private insurance company have shown some interest in bringing out shrimp crop insurance products as evidenced from policy drafts put up in their websites. Based on online and offline Focus Group Discussions (FGDs) held with three Insurance companies and one insurance broking company to redesign their product suiting farmers' requirements, and facilitating farmers' meetings to negotiate terms of insurance policies, the following constraints and mismatches were observed. The meetings were held in Chennai, Gudur of Andhra Pradesh and farm clusters in Thiruvallur district of Tamil Nadu in the year 2021-22. A product gap analysis is performed between the current state of insurance offers and desired state of consumers' expectations for shrimp crop insurance, identifying gaps along with remedies. Firstly, on the premium rate, which is most crucial for both the sides, insurers expected a percentage of the sum insured (input cost) at 2.7 to 4 % while farmers consider 1-2 % is the premium affordably payable. Farmers' awareness of insurer's need to breakeven be increased. Even cash crops of vegetables and flowers, the premium rates charged are higher than 2%. Government support, if materializes for 50% premium, will fill the gap. Secondly, Insurance companies are willing to give cover only total loss; farmers want insurance cover for partial loss also. Thirdly, indemnity Coverage offered by insurance companies is 80% of input cost while farmers demand 100% of input cost. Government support on premium, if forthcoming, may offset this gap to certain extent. While insurance companies are more comfortable with parametric or weather based farmers are interested in comprehensive cover. Fourthly, duration of cover is given as 135 to 180 days in most of the insurance products. Farmers prefer natural calamity cover for full crop and disease loss cover for 45 to 60 days. Insurance companies should be made aware of insurance requirement from farmers' point of view. The discussions with farmers' elucidated their willingness to take up shrimp crop insurance. But farmers' are expecting support from government on premium subsidy. The other expectations of farmers are full coverage, comprehensive insurance including disease cover, and for about two month period. The analysis of this desired state with current state of offer brings out the necessity of government support at least during kick start period and conducting nationwide awareness campaigns to insurers and farmers to make the gaps to be bridged.

Keywords: Aquaculture Insurance, Shrimp crop Insurance, Natural Calamity Cover, Disease Cover, Premium subsidy

Paper ID 15728

Economic and Livelihood impacts of the decline in Indian Oil Sardine landings in Kerala State, India

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The Indian oil sardine (IOS), *Sardinella longiceps* Valenciennes, 1847 a prominent marine fish in India which showed considerable decline in landings in the recent past. Kerala State is a significant contributor of Indian oil sardine and IOS landings in the state declined from 3,22,102 t in 2011 to a meagre 13,116 t in 2020 . The ring seiners contributed more than 90 per cent of the Indian oil sardine landings in the State in the past decade and the livelihoods of small scale fishers operating ring seiners were largely affected by the decline. In this context analysis of the economic impact of oil sardine decline on marine fisheries sector and livelihood impacts on small scale fishers was conducted in Kerala State. The economic impacts were assessed in terms of changes in gross value and inflation at landing centre and retail levels during 2011- 2020 period. The livelihood impacts were assessed in terms of loss of employment, income and alternate livelihood options based on the survey conducted in 600 fisher households. During 2011-2020, the gross value of oil sardine declined from Rs.1256 crores to Rs.171 crores at landing centre level and from Rs.2287 crores to Rs.269 crores at retail level. The average employment for the small scale fishers dropped to 140 days compared to 237 days per annum prior to the decline. Likert scale analysis of the fishers perceptions on the causes of the catch decline indicated climate change (79.33%) and marine pollution (65.50 %) as the two major causes. Sixty six percent of the respondents strongly supported the actions for protection of fisher's livelihoods and pointed out that incentive (74.33 per cent) and regulatory (58.17 per cent) based fisheries management measures necessary for sustaining the small scale fisher's livelihoods

Keywords : Indian Oil Sardine, Decline, Kerala, Economic Impact, Livelihood Impact, Perceptions

Paper ID 15735

Comparative growth analysis of Shrimp production sector in India

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Shrimp farming is the most economically viable enterprise in Indian aquaculture. India exported fish and fishery products worth US$ 5.96 billion where farmed shrimp contributed 51% by volume and 74% by value during 2020-21, of which shrimp occupies a share of 73.8 %. As per 2020-21 statistics India has produced 8.43 lakh tonnes of farmed shrimp from an area of 1.67 lakh ha. During the same period, the export earnings from frozen shrimp accounted for Rs. 32520 crore per annum. Andhra Pradesh, Gujarat, Tamil Nadu, Odisha, West Bengal are the major shrimp producing States in the country, followed by Kerala, Karnataka, Goa and Maharashtra. Andhra Pradesh tops the country with an annual shrimp production of 6.39 lakh tonnes, accounting for 75.8% of the Indian shrimp production. Availability of SPF *P vannamei* seeds, Best Management Practices, institutional support from various Research and Development agencies are the major reasons for increasing trend in shrimp production in India in general and Andhra Pradesh in particular. In any farming system, production could increase due to increase in area or increase in productivity which is respectively termed as area effect and productivity effect on production. This paper based on secondary data analysis on area, production and productivity of shrimp in India. In addition, the paper also envisages for zonal wise trend in area, production and productivity.

Keywords: Shrimp Production Sector, Growth Rate, Area Effect, Productivity Effect, Interaction Effect

Paper ID 15740

Constraints perceived by the Shrimp farmers in managerial efficiency of Farming practices at Nagapattinam District, Tamil Nadu

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Abstract

The managerial efficiency is necessary for an individual to improve shrimp farming practices with scientific management. It will open up new opportunities for the shrimp farmers to earn a substantial income. The present study was designed with the objectives to depict the constraints perceived by the shrimp farmers in managerial efficiency of farming practices and to list out their suggestions to overcome those constraints. A total of 150 respondents of shrimp farmers in three blocks of Nagapattinam district (Keelvelur, vedharanyam and Nagapattinam) were interviewed to understand the major constrains in shrimp farming and their recommendation for better management practices. The primary data were collected from the villages under three blocks through a proportionate random sampling method, analysed using frequency and percentage analysis. The findings of this study revealed 10 major constraints, with a higher response to disease outbreak (95.33 %) followed by price fluctuation, poor quality of seed, high feed cost, lack of availability of skilled labour, lack of electricity power supply and high tariff, lack of knowledge on scheme about shrimp farming, incidence of weather changes and cyclones, lack of government support and poor credit and insurance facilities. The most valuable suggestion offered by the respondents to overcome those constraints in decreasing order of importance were establishing a disease diagnostic centre with affordable service cost (72.66 %) followed by the establishment of stable market price governed and information about market price through mass media by state fisheries department, setting up of seed certifying agencies by fisheries department, control on feed cost, skilled labour requirement, electricity power concession, involvement of educated people, weather forecast announcement by the state fisheries department, government support and provide credit and insurance facilities by government. Thus, our study will greatly contribute towards directive actions by creating new alternative researches in shrimp farming that could provide a sustainable production.

Keywords: Constraints In Shrimp Farms, Managerial Efficiency, Shrimp Disease, Shrimp Farming, Sustainable Production.

Paper ID 15751

Research priorities in Social sciences aspects of Brackishwater Aquaculture in India

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Brackishwater aquaculture is a money spinning sub-sector in the fisheries sector of India. India exported fish and fishery products worth US$ 5.96 billion where farmed shrimp contributed 51% by volume and 74% by value during 2020-21. Shrimp occupies top position in terms of annual foreign exchange earnings to the tune of 5.9 lakh tonnes worth about USD 4.4 billion. Research on social sciences plays a vital role for the economic growth and development of this sector on a sustainable basis. In this background, the present study was undertaken to analyze the major thematic areas of research undertaken in aquaculture economics, aquaculture extension and ICT aspects of brackishwater aquaculture in India for the period 2011-21 and also suggest suitable reorientation with newer thematic areas. During the past one decade, in the case of aquaculture economics, studies on production economics and international trade aspects were given more emphasis. In the case of aquaculture extension, field demonstrations of cultural aspects in shellfish and finfishes were undertaken concentrated more. Further, application of ICT principles in knowledge management among aqua farmers was given prominence under the social sciences research. Based on the analysis and considering the dynamic nature of both domestic and international scenario, the study recommends some level of reorientation of research in social sciences meeting the current requirements in production, disease management, frontline extension, policy planning, domestic marketing and international marketing and trade sector. Further the study also emphasize the need for policy interventions and vision oriented planning for proper integration of research and development activities for sustainable growth of brackishwater aquaculture in India

Keywords : Brackishwater Aquaculture, Socio-economics, Technology Transfer, Ict Applications

Paper ID 15755

Economic efficiency of traditional Fishing crafts and gears: A comparative analysis

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Analysis of economic efficiency indicators in a fishery provides valuable insights in to economic decisions in terms of investment in crafts, gears and manpower, optimum fleet strength to be deployed in a fishery, which enable fishers to take informed decisions in order to reap maximum profits by administering the optimum use of resources. The economic efficiency of the traditional crafts and gears of Poovar fishing village, Thiruvananthapuram district, Kerala was analyzed for 192 crafts in the fishery consisting of boat seine, shore-seine, Hook and line and *"Thangal Vallam"*. The results indicated that, the capital productivity was highest for shore seine (0.70) among the fishing methods studied. The Net operating income/trip was highest for Boat seine. (Rs. 33,587) The value of catch constituted by the major species in shore seine was Tuna (36.46%) followed by squid (23.37%) and in Boat seine it was Black tip trevally (49.72%) followed by cuttlefish (42.98%).

Keywords : Economic Efficiency, Fishing Operations, Economic Indicators

Paper ID 15757

Does it make economic sense! Capturing the bio-economic dimensions of Lobster farming in Sea cages

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Sea cage farming of lobsters in India has undergone a decadal transformation in terms of technological and biological innovations. However, its economic interface has always been under-represented. As production systems gather momentum across Spatio-temporal boundaries, farmers are confronted with problems over how best to allocate and regulate technical, biological, financial information resources to the system so as to arrive a tangible tradeoff between investments made, managerial decisions and maximum economic returns. In this context, a decision support economic forecast model has been developed to evaluate the economic dynamics of lobster farming in sea cages. By revisiting the farming practice inputs, outcomes and possible risks, we use a 10-year span of temporal model, which simulated the performance of the culture system in response to biological, economic and technical parameters acting in tandem.The propensities of a profitable venture were brighter when two crop cycles were undertaken annually since the IRR increases by 18.5% from single to two crop scenarios. There exists only an 8.9% variation when farming strategy shifts from two to three crop cycles/year. The model further captures that, the payback period of 2.04 years in the two-crop cycle whereas it is only 6.8 months in a three-crop cycle. But at the same time the two-crop cycle is observed to generate an increase of 276% in net profits in stark contrast to only a marginal increase of 44.2% in a three-crop scenario. The developed model and simulation scenarios could aid in effective enterprise decisionsto establish their strategies in support of the expansion of lobster farming in sea cages.

Keywords : Sea Cage, Lobster, Economic Model, Decision-making, Feasibility

Paper ID 15791

Trade swings in Indian fish and fishery products exports following implementation of stringent sanitary and phytosanitary measures by European union

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Sanitary and phytosanitary (SPS) measures play an important role in the trade between the countries. Among the agricultural commodities traded internationally, import refusals due to presence of chemical residues were found to be high among fish and fishery products. India exported 1.15 million tonnes of fish and fishery products worth US $ 5.96 billion in 2020-21. The USA, EU, Japan, China and other Southeast Asian countries are the major export destinations for Indian fish and fishery products. European Union implemented increased border checks from 10 to 50% of fish and fishery consignments from India. Five year moving average share of Indian exports to EU before the implantation of new guidelines (2011-2016) was 20.40% which declined to 14.75% during 2016-2021. This decline is strongly indicated by the change in compound growth rate (CGR) from 5.96% to -6.86%. However during the period, overall volume of Indian fish and fishery product exports has increased from xxx during 2011-12 to xxx during 2020-21. Transitional probability matrix values indicated (2011-12 to 2020-21), India lost 59% share of EU fish market which was diverted to Middle East countries (47%) and Japan (35%). This measure also led to the decrease in the unit rejection rate of Indian exports to EU suggesting the overall improvement in the quality of the produce. The results of the study indicate implementation of stringent SPS measures led to trade diversion and improvement in the quality which might have significant economic and social implications.

Keywords : Eu Sps Measures, Border Check, Indian Fish Exports, Transitional Probability Matrix

Paper ID 15801

Cage culture a new avocation for the coastal population: success of a technology transfer programme in Sindhudurg

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Fish farming in coastal waters using floating cages has become a lucrative, advanced and eco-friendly technology that opened new doors of opportunity for the coastal people to easily involve in fish culture resulting in increased fish production and sustainable income generation. The soundness of the technology as well as its user-friendly nature encourages its easy adoption by many people along with their other occupations like fishing, shrimp filtration, agriculture and chinese dip net operations etc. In order to popularize and disseminate the cage culture technology as a means of women empowerment, livelihood and for doubling farmers income, ICAR-CMFRI undertook a NFDB (National Fisheries Development Board) funded project "Brackishwater cage culture in Sindhudurg district in Maharashtra" at Sindhudurg, Maharashtra. The beneficiaries were 20 women SHGs (Self-help groups) comprising 10 – 14 women members for 200 cages from 4 taluks viz. Kudal, Malvan, Vengurle and Devbag. CMFRI gave the technical support from the site selection to the farming till the harvest. Initially a skill development training programme was conducted for the members of the women SHGs. They were trained on the fabrication of 4 x 4 x 3m size galvanized iron cages. Seeds of Asian seabass were nursery reared in hapas attached to these cages and later stocked in nets procured from the Matsyafed net factory Kochi. A feeding schedule was given as 10% of the body weight in three times during initial 3 months and 5 – 7% in the subsequent months. An average of 385 kg of seabass was harvested per cage and generated a revenue of Rs 1.25 crores after a period of 5-8 months. All the fisher women beneficiaries were introduced to a new avocation and an avenue for doubling their income. More than 500 people were also trained in different aspects like cage fabrication, its mooring and maintenance, procurement and nursery rearing of seeds and fish farming in cages during the technology transfer programme.

Keywords : Cage Culture, Sea Bass, Cages, Cage Fabrication

Paper ID 15829

A proven livelihood model for coastal families through Seabass fingerling production

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The Kilarkollai village in Koovathur Panchayat of Chengalpattu district of Tamil Nadu is bestowed with open brackishwater sources around the village periphery which remained under-utilized. It was brought into use by the ICAR-CIBA team under the Scheduled Caste Sub Plan Scheme (SCSP) of the Government of India and the team has suggested the farmers for taking up seabass fingerling production activity. Accordingly, during (2017-2021), six cultures have been taken as a means of supplementary livelihood to the villagers. During 2017, the team in consultation with the village leaders and fish farmers arranged a demonstration of seabass nursery rearing in hapas. Four coastal families were trained on the nursery rearing of Asian Seabass (*Lates calcarifer*). Comprehensive training in cultural aspects of nursery rearing like fry selection, stocking, feeding, grading, regular water quality management and harvesting were given. Nursery rearing of seabass in hapa was demonstrated. Out of 5000 fry stocked for each culture, the survival of the fingerlings ranged from 1790 (35.80%) to 2691 (53.82%) with the size ranging 3 cm to 14 cm. The fry was fed with formulated feed (Seebass Nursery ^{plus}) developed by ICAR-CIBA. The net income per cycle among the different families varied between ₹ 28000/- and ₹51000/- with an average of ₹ 39500/- and each family got an income of ₹ Rs. 7000/- to ₹ 12750/- for two months with an average of ₹ 9875/-.This model proved to be ideal to supplement the livelihood activities of the villagers using the naturally available source of brackishwater and spending two hours daily in their routine activities. This technology encouraged them to engage in partnership farming with the financial and technical support of ICAR-CIBA and helped them to express their individuality and also increased self-confidence among members.

Keywords : Brackishwater, Seabass Fry, Fingerlings, Net Income, Livelihood

Paper ID 15837

Knowledge, perception and attitude on Fish consumption in Tamil nadu

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Diverse knowledge, perception and attitude have influenced the consumption of fishes among the people of Tamil Nadu. In order to study these factors and obtain the fish consumption pattern, a questionnaire was developed with sixteen questions pertaining to personal attributes and 46 questions pertaining to knowledge, perception and attitude, which influences the fish consumption. Out of 408 respondents, 26.7% are 21 years old, 70.8% are graduates and 57.4% reside in rural areas. Further, 34.8% were found to consume fish once in two weeks and 27.2% were found to consume fish every week. The results of the study elucidates that 48.5% respondents were aware of identifying the quality of fish using gill colour and 84.6% respondents have knowledge on the nutritional benefits of fish which contains Omega 3 fatty acids. This study also shows that people are not aware of heavy metal contaminations in seafood. Around 30.7% respondents perceive that iced fishes are good for consumption. Though there are several fish varieties available for consumption, 79.7% respondents were hesitant to buy new fish variety. It also emphasizes that people prefer fish to other meat products because fish is healthy and suitable to their monthly budget. The findings of this study will be helpful in understanding the knowledge, perception and attitude of people towards fish consumption and its pattern in Tamil Nadu.

Keywords : Fish Consumption, Knowledge, Perception, Attitude

Paper ID 15839

Designer Freshwater Pearl farming technology in Farmers' Fields: A Success story

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Abstract

Owing to concerted efforts of ICAR- CIFA, designer freshwater pearl farming has proved to be a successful venture in the farmers' fields as the technology has infiltrated deep into different nooks and corners of the country. The scientific team at the institute has trained farmers/ entrepreneurs through a very well-designed training module which includes hand-holding with different implantation techniques, pre-and post-operative management, culture of pearl mussels, extraction of matured pearls, value addition etc. There are numerous farmers/ entrepreneurs who have been trained by the institute and associated to the institute and adopted the fine-tuned technology and achieved success. Some of the notable farmers like Rulen Hazarika of Nagaon (Assam), Arjun Sahoo and Balram Behera of Bhadrak, Ms. Nina Singh of Balasore, Akshaya Pradhan of Ganjam (Odisha), Vivek Patel (Jalaun) and K. S. Shukla (Chitrakoot) of Uttar Pradesh, Ms. Madhu Patel of Nalanda, Bihar, and Ms. Niharika Kondalkar (Pune), Maharashtra are successfully producing designer pearls in their own culture systems. It has been seen that the farmers/ aquapreneurs who have taken up this venture are able to make good amount of profit, especially women farmers who have been very forthcoming in adopting this technology. For example, Ms. Nina Singh has established a state-of-art facility to produce designer pearls in cement cisterns and produces pearls to the value of Rs. 300-400 each. Similarly, Rulen Hazarika is producing a range of pearl based items, including designer pearls, shell by-products such as jewellery, and buttons from MOP, using his unique processes to turn waste into wealth with a meagre investment of Rs. 60,000/-. As a result, freshwater pearl farming is helping the farmers in alleviating poverty, ensuring the economic viability of their families. Moreover, successful cases of pearl farmers have been elucidated and duly documented which can be used as model cases for promoting sustainable agricultural techniques including pearl farming.

Keywords : Designer Pearl, Pearl Farming, Farmers, CIFA

Paper ID 15846

Consumers' Perspective on Online Purchase of Seafoods

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The online purchase of seafood is gaining popularity among consumer in the urban areas. In this paper, researcher has investigated the consumers' preferences and perceptions towards online purchase of seafoods with respect to the factors viz., website quality, price, product quality, convenience, costs and risks. A survey was conducted among 110 respondents through a structured questionnaire. The data were analysed through correlation, One sample t-test, Friedman's two-way Analysis of Variance and Chi-square to draw meaningful conclusion. It is evident from the analysis that online purchase of seafood is found to be convenient for the consumers as it facilitates them to do hassle-free shopping without waiting in long queues and enables them to compare prices, and so on. However, consumers are hesitant towards product quality risk and payment risk. Hence, it is recommended that online vendors need to focus on the strategies which provide the quality products, good services and secure payment methods.

Keywords : Online Purchase, Seafood, Consumer Preference, Consumer Perception

Paper ID 15850

A study on Awareness of Vannamei Feed With Special Reference to Charoen Pokphands Foods (cpf) At Nagapattinam

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Aquaculture is fast-growing sector, in the current scenario, in several countries. In India, shrimp farming has been fast-spreading and vannamei feed market has a huge potential in domestic market. The present study was conducted to find the buyer behavior of vannamei feed with special reference to Chareon Pokphand Foods (CPF) at Nagapattinam region of Tamil Nadu. The comprehensive study was based on both the primary and secondary information collected from the Nagapattinam aqua farmers. A total of 165 respondents were interviewed and their responses were collected through questionnaire and date analyzed with the help of various statistical tools like Percentage analysis, Likert scale analysis and Chi-square analysis. The results of the study revealed that the "quality of feed" is the most important factor in selecting the vannamei feed which is followed by "ease of availability and service". The reach of the CPF brand towards the customer is found to be remarkable and it has been accepted among the customers in Nagapattinam District.

Keywords : Vannamei Feed, Chareon Polphand Foods (cpf), Buying Behavior, Brand Awareness.

Paper ID 15851

A Study on production and marketing Constraints of Fish Cage Culturists in Vidarbha Region of Maharashtra

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This study was conducted to identify the constraints faced by farmers with respect to production and marketing of cage aquaculture. A sample of 43 farmers practicing reservoir cage culture in Vidarbha region of Maharashtra was selected and the required data were collected using a structured interview schedule in the year 2021. Garrett ranking technique was used to analyze the constraints ranked by the farmers according to their perception of importance. Seven production constraints were identified and among them, high cost of fish feed was ranked first. They identified six financial constraints, of which, lack of funds for starting and running business activities was the single most important constraint. Among the 6 marketing constraints identified, fish price fluctuation was found to be the most important one. Among the four extension constraints that affected market access, lack of contact between producer and wholesaler was identified as most important one. Flood topped among the four natural constraints.

Keywords : Farmer, Cage Culture, Ranking, Production And Marketing Constraints.

Paper ID 15853

A case study of ornamental fish trade in Kolathur, Chennai

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The present study was conducted to review the current status of aquarium fish trade, particularly to find out production and marketing of fighter fish, *Betta splendens* and also to assess the constraints faced by the ornamental fish farmers in Kolathur, Chennai. The descriptive study was based on both the primary and secondary information collected from the respondents of *Betta splendens* farmers in kolathur, Chennai. A total of 40 respondents were interviewed and their responses were collected through structured questionnaire. Data analysis were done through the SPSS software tool. Most of the respondents had only school level education, and most of the farmers are running rented farms. 50% of the farmers' annual seed production ranges from 5 to 10 lakhs and 92% of the respondents are doing ornamental fish farming as their primary occupation. Most of the farmers do not import the fighter fish. Majority of the respondents are selling the fighter fish to the exporters. This study suggested that farmers may locate their farms on Google maps and also they may develop website for generating more income through online marketing. All the farmers are aware of the government schemes and subsidy available for the improvement the ornamental fish farming and marketing.

Keywords : Ornamental Fish, Marketing Channel, Ornamental Fish Trade, Betta Splendens,

Paper ID 15856

Constraints analysis of Shrimp farming in Marakkanam, Villupuram district, Tamil Nadu

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Shrimp farming is an age-long livestock farming business that exists in freshwater and marine environment. In this study, the researcher seeks to investigate the constraints faced by the shrimp farmers in Marakkanam area, Villupuram District of Tamil Nadu with respect to factors such as finance, cost-related, government administration and production-related issues. Data were collected from both primary and secondary sources. The primary data were collected from the shrimp farmers through a structured questionnaire and secondary data were collected from published sources. A total of 60 shrimp farmers in Marakkanam area were surveyed using structured questionnaire. The collected data were analysed using the weighted average method and one-sample t-test. Based on data analysis, the study found that financial constraint has a significant impact on shrimp framing. Further, the shrimp framers encounter lack of insurance, lack of credit facilities by a bank and inadequate government aids. Hence, it is suggested that shrimp farmers need to participate in awareness programmes in order to obtain enough information about various government schemes and to equip themselves with emerging technologies to address the issues.

Keywords : P. Vannamei, Shrimp Farming, Shrimp Farmers, Constraints

Paper ID 15859

Consumers' perception towards Marine and Freshwater fish in TNFDC, Chennai

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Consumers' perception summarizes how consumers feel about a product including every direct and indirect experience they have had with the products or services. By monitoring consumers' perception, a firm can spot common user pain points and improve the consumers' experience in terms of products or services. The present study was conducted to find out the consumers' perception towards marine and fresh water fishes and also to assess the marketing mix elements by measuring effectiveness of existing marketing strategies of the Tamil Nadu Fisheries Development Corporation (TNFDC) at Chennai. The descriptive study was based on both primary and secondary data collected from the TNFDC and its customers. A total of 102 respondents were interviewed and their responses were collected through semi-structured questionnaire. Data were analysed with the help of SPSS. The results of the study revealed that the respondents usually came to know about the TNFDC through word of mouth rather than promotional activities. Majority of the respondents are satisfied with the overall services and varieties of fishes offered by the TNFDC outlets. The study suggested that the TNFDC needs to establish few more outlets and enhance its promotional activities.

Keywords : Fish Marketing, Consumer Perception, TNFDC.

Paper ID 15863

Livelihood vulnerability of coastal Fisher communities to Climate change: A gendered analysis in the South west coast of India

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Climate change poses one of the greatest challenges the world faces today and its impacts are far severe and faster than predicted jeopardising the sustainability of environment and socio-economic development. United Nations Framework Convention on Climate Change (UNFCC) identified the state of Kerala as one of the climate vulnerable hotspots threatened by extreme events in the future. Coastal fisher communities across the world are highly vulnerable to climate change considering the dependence on fishery based livelihoods, depletion of marine resources, low resource possession, lack of fishing rights and environmental hazards. In view of the low resilience of women and children to climate change, gender based livelihood vulnerability assessments are essential for effective decisions on adaptation strategies within the constraints of local resources and infrastructure. In this backdrop a livelihood vulnerability assessment in a gendered perspective was conducted among the small scale coastal fisher households in Ernakulum district of Kerala. A composite livelihood vulnerability index (LVI) in tune with the sustainable livelihoods framework was developed based on the data collected from 400 small scale fisher households consisting of 340 male headed households and 60 female headed households. The LVI was constructed across eight major components consisting of socio-demographic particulars, livelihood strategies, health, water, food, infrastructure and financial capital, social networks, natural disasters and climate variability. The major components were derived from 35 subcomponents and equal weights assigned to each component. The results indicated that overall vulnerability of female headed households was more (LVI-0.40) compared to male headed households (LVI- 0.36). Female headed households also showed more vulnerability to most of the subcomponents including socio-demographic particulars, food, water and social networks. The study suggest the need for gender inclusive approach in the national, state and local level action plans on climate change adaptation and disaster risk reduction programmes

Keywords : Climate Change, Coastal Fisher Communities, Gendered Analysis, Livelihood Vulnerability

Paper ID 15867

Fisher's perception on problems affecting coastal fisheries and mitigation/livelihood options – Indications from a pilot survey in coastal districts of North Tamil Nadu

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With increasing concern over threats faced by the fisheries sector from several quarters including non-judicious fishing practices influenced by exponential growth in demand, destruction of aquatic habitats through pollution and destructive fishing methods, rupture of trophic food webs by increased exploitation of top-level predators, impacts of climate change and increased incidences of natural disasters, there is urgent need to evolve resource-, area-, habitat- and livelihood-specific management tools to revive, sustain or improve India's coastal marine resources and the ecosystems and production systems they support. Stakeholder participation has become a necessity to ensure the successful outcome of such interventions. Since the inception of the project National Innovations in Climate Resilient Agriculture (NICRA) in February 2011, ICAR-CMFRI has conducted several stakeholder workshops, trainings and meetings in coastal fishing villages of north Tamil Nadu coast in the districts of Thiruvallur, Chennai, Kancheepuram (now Chingleput) and Cuddalore. A pilot survey of participant fisherfolk was conducted during 2019-2020 to gauge their perception of the problems affecting coastal fisheries, particularly the traditional sector. Two hundred respondents were selected from five villages in each district (10 respondents from each village). The respondents were asked to identify and rank (1) the major problems faced by coastal fisheries, and (2) mitigation and livelihood measures as perceived by them. The responses were ranked using Garret ranking. Habitat loss, pollution and climate change were the top-ranked problems. Among the mitigation and livelihood support measures ranked by the respondents, pollution control, aquaculture and habitat restoration were the most popular choices. The results of this study will be useful in focused sensitization programs such as skill development in aquaculture, habitat restoration through artificial reefs and awareness generation on the importance of participatory activities and also in evolving need-based and region-specific management options for sustainable fishing and supporting livelihoods of the fisherfolk.

Keywords : Climate Change, Fishing, Habitat Restoration, Pollution, Stakeholder Participation

Paper ID 15888

Techno-economic efficiency of Freshwater Fish Culture in Odisha, India

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A study was performed to understand the technical and economic viability of freshwater fish culture in Odisha, India, and to identify the operational constraints in farming practices. Forty freshwater fish farmers were randomly selected for the study, and information based on the specified objectives was collected using a structured interview schedule. Only pond-based grow-out culture farms were selected as most of the fish farmers of Odisha belong to this category, and it also helped in maintaining uniformity. The study revealed that the average experience in the farming activity of fish farmers is 6.85 years. The farmers were categorised as small-scale (<2ha area), medium-scale (2-5ha area), and large-scale (>5ha area) farmers. Among them, medium-scale farmers occupied the major share (50%). Among the reported, >3 species combination was adopted by 60% of the total farmers. The study revealed that most (52.50%) of the farmers belonged to the middle age group. The majority of the farmers (47.50%) were educated up to graduation level. 75% of the farmers were engaged in fish culture alone for their livelihood. The economics of carp culture was calculated by estimating the operational cost, gross income, and net income with an average output of 4452.5 kg/ha/crop and a net income of Rs. 94,000.61/ha @ Rs. 110/kg Selling price. The average BC ratio was 1.51, indicating a high-profit margin. Among the variable inputs, feed cost accounted for the majority of the share, i.e., 35.66%. 57.5% of farmers went for a crop cycle of 6 months, followed by 30% for a crop cycle of 8 months, 12.5% for a crop cycle of 10 months. High standard of education among fish farmers (7.07), Proper training, consultancy with government fisheries officers, adoption of the latest technologies were the main reasons for the success of the freshwater fish farmers of Odisha.

Keywords : Techno-economic Survey, Freshwater Fish Farming, Net Income, B-c Ratio

Paper ID 15893

Assessment of small-scale Bivalve fishery in Swarna-sita estuary, Karnataka

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Bivalves comprising of *Meretrix casta*, *Paphia malabarica* and *Crassostrea madrasensis* are indigenous to Swarna-Sita Estuary and support a traditional fishery of local significance. This small-scale fishery is characterised by low levels of investment for harvesting, easy access to fishing grounds during low tides, live marketing necessitating low processing expenses, and good intra-state and inter-state market demand. The fishery is largely unorganised and hence a larger share of the production likely remains unrecorded. Despite being an important small-scale fishery, hardly any management measures are in place due to lack of a proper data collection system. Therefore, this study was undertaken for monitoring the bivalve harvests in the estuary since 2005. Estimation of clam abundance in biomass and numbers in Swarna-Sita Estuary including the water quality parameters and sediment texture in the natural settlement sites were also carried out. The clam production was estimated at 2,384 t in 2005 which continued to decline till 2011. The year 2012 recorded an increase in production (2,872 t tons) which further continued to decline. Average annual clam production over the period from 2005 was estimated at 795 tonnes. This study presents the stock status using the Bayesian Schaefer State-Space Surplus Production Model and suggest management measures for sustainable exploitation of the resource.

Keywords : Bivalves, Fishery, Livelihood, Small-scale

Paper ID 15894

Assessment of the socio-economic status of fishermen communities from Chandragiri estuary, Kasargod, Kerala

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Fishing is an important source of income for fishing communities that rely on estuaries for their livelihood. The goal of this study was to gather information on the economic and livelihood conditions of fishermen in order to identify significant concerns that could be considered in sustaining their livelihoods and ensuring their participation in fish biodiversity conservation. Data was gathered by interviewing 50 people who were chosen at random during 2020-2021. According to the survey, 32% of the respondents are between 41-45years, about 20% of them were illiterate, and 82% of the respondents live in their own homes. Sixty six percent houses were tiled, while 34% were concrete houses and all the families were found to have electricity facility. Fifty eight percent of houses have sanitation facility with septic tank. Majority of them (42%) had their own well water as a drinking source. The family size of fishing community usually consisted of 2-9 members and 86% of them were nuclear families. BPL cards are held by 86% of households. Majority of the respondents have their own craft and gears. Depending on the season, an average of 3-10kg of fish is caught per day. Average gross revenue per trip is Rs.200-1000/-, with an operating cost of Rs. 60-150/-.The monthly average income of fishermen was around Rs.10,000-25,000/-. Fishermen preferred to borrow money from self-help groups. The present study has shown that the fishermen require additional institutional, organisational, and technical assistance to improve their socioeconomic and livelihood situation.

Keywords : Estuary: Fishermen; Social Status; Economy; Estuary; Conservation

Paper ID 15909

Covid pandemic implications on the Indian marine fisheries sector: A stakeholder analysis

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COVID-19 outbreak has been deemed a global health emergency and has unraveled extreme shock for the Indian economy. The pandemic has severely disrupted the demand and supply chain of the Indian marine fisheries sector. The short, medium and long-term effects of the pandemic on the marine fisheries sector in India are not very well documented. Given the resource constraints and challenges faced by the sector, it is pertinent to devise feasible strategies to overcome the adverse effects of the pandemic. In this backdrop, the present study examines the socio-economic implications of the Covid-19 pandemic across the marine fisheries value chain constituents including fish landings, effort, employment, and export. Moreover, the study also examines the effect of the pandemic resulted fishing holidays on the marine fisheries resource distribution and landings. The study covered the coastal states of the country and employed relevant estimation techniques. A general impact of the pandemic was assessed employing the word cloud technique by scrutinizing the media reports and articles for the period March 2020 to March 2021. The study relied on marine fisheries landings data for the period 2015 to 2021 (Source: Fisheries Resource Assessment Division) and the socioeconomic data including the prices realised across species and different points of sales (Source: Socio-Economic Evaluation and Technology Transfer Division) of ICAR- Central Marine Fisheries Research Institute. The word cloud analysis indicated the areas within the marine fisheries sector which are mostly affected. The results indicated a significant reduction in the volume of landings, effort and fisher labour days. However, the export revenue realisation remained unabated. The study also realised some positive externalities such as resource replenishment and increased species diversity. The study has significant policy implications as it provides insights toward developing adaptation/mitigation plans for coping up with the impacts of the pandemic and identifying appropriate guidelines to meaningfully engage the stakeholders.

Keywords : Marine Fsiheries, Covid 19, Word Cloud Anaysis,impact Assessment

Paper ID 15913

Success of cage farming of Marine finfishes in doubling farmers' income: Collective case studies from Andhra Pradesh

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Mariculture is the future of the marine fisheries sector in India and opportunities are tremendous for the development of mariculture in the country. Opportunities exist in expanding the number of species that can be cultured, standardizing seed production technologies, production of small sized live feed and development of bio-secured brood fish facilities. In the years to come, the marine sector will have to meet the protein requirements of the increasing population of our country. In this context, cage culture is receiving more attention by both researchers and commercial producers. In view of the high production attainable in cage culture system, it can play a significant role in increasing the overall fish production and household income. In Andhra Pradesh, culture of marine finfishes such as Indian Pompano and Asian Seabass has been demonstrated in cages in Krishna and Godavari backwaters by Visakhapatnam Regional Centre of ICAR-CMFRI, by involving fishermen and marginal landless aqua farmers. Open sea cage culture of Orange-spotted Grouper and Indian Pompano has also been demonstrated in Visakhapatnam, Srikakulam and East Godavari districts. Different training and awareness programmes were organised to bring awareness and inculcate technical knowhow on cage culture of marine finfishes among the beneficiaries. Many success stories of CMFRI's technological interventions on cage farming resulting in doubling farmers' income were documented. This abstract presents the collective case studies from Andhra Pradesh on the success of cage farming of marine finfishes in doubling farmers' income. The impact was realized on livelihood enhancement due to the technological interventions of cage culture under the technological, social and economic dimensions. The cash-in-hand got in bulk from cage culture improved their savings, purchasing power, ability to repay the old debts, and ultimately improved their standard of living. As the government is marching towards with the aspirations to double the income of every Indian farm household by 2022, the success stories on cage culture is a proof for the same, as these beneficiaries of ICAR-CMFRI had already experienced in doubling their income through cage culture.

Keywords : Cage Farming, Doubling Farmers' Income, Success Stories

Paper ID 15924

Economic efficiency of Tuna fishing and trade in Andhra Pradesh, India

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Andhra Pradesh is the largest fish producing state in the country, producing 4.27 million tonnes in 2019-20 of which the marine fisheries sector contributes 13.2 per cent share of total fish production in the state. Tuna is one of the major species which lands in Andhra Pradesh and it contributes to 6.1 per cent of the total landings of tuna in India during 2019. In Andhra Pradesh, the total tuna catch ranged from 1,776 t to 14,589 t during 1985 to 2019 with an annual average catch of 5,615 t. The yellow fin tuna forms the dominant species in Andhra Pradesh fisheries with a total production of 6,330 t in 2019, which were almost insignificant landings in 1990. Of the 234 landing centers in Andhra Pradesh, Poodimadaka is one of the major fish landing centers situated in Atchutapuram mandal of Visakhapatnam district of Andhra Pradesh. This landing center offers a good market for the tuna trade in the state and elsewhere. The present paper explores the economic efficiency of tuna fishing operations and the trade patterns. The **e**conomic analysis of tuna motorized boats in Poodimadaka showed that for the multi day fishing (4-6 days) using theppa, diesel requirement was 150 liters per trip. Average cost of fuel is Rs. 15,000. The expenditure on food was approximately Rs. 2,000. Thirty per cent of net revenue was shared towards boat, engine and gears ownership and 70 per cent of net revenue was paid as crew share after deducting the input costs from the gross revenue. Average operating cost per trip was worked out as Rs.80, 000/-. Wages for crew and expenses on diesel accounted for 80 % of the total operating cost. The operating ratio worked out at 0.80 and the labour productivity worked out to 114.29 kg/crew/trip. The tunas are assessed and exported as first, second, or third grade, but not as sashimi grade. The graded fish are gutted, carefully washed, cooled, and transported by road to Chennai, from where they are exported to Japan, United Kingdom, and the United States of America. A portion of the enhanced fish is iced and shipped to Chennai processing plants, where it is gutted, skinned, deboned, and processed into fillets, ribbons, or canned. The value-added products are processed and exported to Southeast Asian countries. Tunas have very little local preference in Andhra Pradesh. The study indicated that Andhra Pradesh tuna fishery has two distinct value chains: the domestic market value chain and the export market value chain.

Keywords : Tuna, Economics, Value Chain Analysis, Andhra Pradesh

Paper ID 15936

Fish consumption Paradigms in India : A Geospatial Outlook

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The Indian fisheries sector continues to show an impressive growth rate and focuses on boosting fish production efficiency, improving fishermen's welfare, ensuring equity, increasing export and commerce, creating meaningful employment and ensuring food security. Fish assumes to be a major constituent of the diet with more than 60 per cent of the Indian populace consuming fish and consumption patterns varies spatio-temporally across the different social fabrics. On one side fish continues to be a poor man's protein ensuring food security and on another side, it offers a delicacy of huge prices. Nevertheless, the fish consumption demand improved mostly due to the increased fish consumption among existing fish consumers rather than adding new consumers into the fold. There exists a sizeable difference in the fish consumption pattern across the length and breadth of the country. In order to assess the trends and pattern the fish consumption pattern, drivers of fish consumption and assessing the major constraints in fish consumption a primary data collection was done along with the coastal states of Kerala, Andhra Pradesh, Orissa, West Bengal and Gujarat representing the different zones. The study covered four districts representing urban/ rural districts and coastal/non-costal locations. Different statistical and econometric tools such as conjoint analysis, preference assessment index and discriminant analysis were used for analysing the data. The consumption assessment indicated that marine fish is more preferred than others and the urban area fish consumption is more than the rural populace. The limiting factors towards fish consumption included lack of fresh and preferred fish, high price, wide fluctuations in price, irregular supply and lack of hygiene in purchase sources served as limiting factors in augmenting fish consumption

Keywords : Consumption ,urban, Rural, Geo Spatial, Costal ,non- Coastal, Constraints

Paper ID 15946

Fishery and Economic characterization of Swimming Crab trap fishery along Odisha Coast, Northwestern Bay of Bengal

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Swimming crabs are considered as one of the commercially important coastal resources along the Odisha coast both in the domestic and export markets. Present study was conducted to characterize the fishery and economic performance of trap fishery for swimming crabs along the Odisha coast during 2020-21. Out Board Fiber Glass Boats, 31.5 feet L_{OA} with engine of 9 hp were used to carry the collapsible rectangular traps locally called as 'Box Jala' for capturing swimming crabs along the inshore waters, 2-4 (3.1) km from the shore with water depth, 8-10 (9.4) m. The trap is box shaped with dimensions, 55×37×20 cm having two slit entrances, made up of galvanized rod frame (4 mm) covered with green polyethylene square-shaped mesh net of 20-35 mm size. Usually, 200-400 traps were carried and deployed onboard by fishermen with a long-line setting. Each trap connected to a 2 m long polypropylene branch line rope with main line. All traps are bated with approximately of the same size from fresh species of eels, mullets, sardines, croakers, kelee shad and other small fishes pierced and bound by wire at the center bottom of the traps. Fishing was carried out during winter season (December to March) in night time only with the crew size of 4-6 (5). During the fishing season, the total catches of crabs ranged from 200-800 kg/boat. The net operating income was Rs. 3,523 per trip with capital productivity of 0.59 and the input-output ratio is 0.11. The Gross Value Added as a percent to gross returns is 88.76. The labour productivity was estimated at 24.6 kg/crew/trip. The average landing centre price realized for the crab was Rs.70/kg. The study revealed that only single species of portunid crabs namely, three spot swimming crab *Portunus sanguinolentus* dominant the crab trap fishery which constitute more than 95% of the total catch. The carapace width and total weight of crabs caught in the traps ranged from 90-150 (120) mm and 40-160 (105) g, respectively. Trap ghost fishing is occurred if it lost in the sea and measures need to undertake to reduce its negative impacts on the marine ecosystem. The detailed procedures involved in pre-processing of crab meat at landing sites are also discussed in detail in this study.

Keywords : Swimming Crabs, Odisha Coast, Trap Fishery, Net Operating Income, Capital Productivity, Input-output Ratio

Paper ID 15950

Dynamics in Fish price behaviour across Species and markets towards Sustainable Fisheries Development

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The fish marketing system in India is rapidly changing in recent years due to the vast improvement in handling technology, transportation and consequent market penetration. Efficient and effective marketing ensures fish availability to consumers at the right time and in the right place. However, there is a visible geographic separation between the fish landing centres and consuming points which can be adequately addressed by the interventions across the fish value chain. The present study is an attempt to understand the varied complexions in fish prices across different states of India to provide an insight into the trends in price behaviour and identify the different transits in the fish trade. The study was based on the primary data of fish prices collected from the 28 highly diversified fish markets including landing centres, retail and wholesale markets across the states of Kerala, Andhra Pradesh, Maharashtra and Telangana during the period Jan 2019 – Dec 2020. The fish prices of the 28 highly diversified species with 7 species in each state were identified to estimate the transits in the fish trade. An attempt was made to forecast the future direction of the Indian fish trade using Markov Chain Analysis. The Markov chain analysis of the study identified that amidst the impacts of the different external forces such as weather conditions, regulated fishing seasons, consumption, demand and supply there was high retention of probabilities of fish prices among the different markets and species. The results of high probabilities of retention of the markets show the extent of price transmission from one market to another and the direction of fish trade with a high degree of integration and marketing efficiency. The study portrays the need for identifying and analysing the market structure in terms of conduct and performance of the different levels of markets at the production, distribution and consumption centres and also the profiling of the market functionaries. The development of the fish market and price information system will act as a decision support system ensuring fish market and price information dissemination about availability, accessibility and affordability of fish. The study reiterates the need for an E-auction platform that will act as a single-window platform where trading, auctioning and marketing will be accomplished thereby ensuring better marketing efficiency as well as better fisher livelihood sustenance and sustainable fisheries development.

Keywords : Markov Chain Analysis, Retention Probabilities, E-auction, Sustainable Fishery

Paper ID 15953

Assessing Human Development among Marine Fishers In Kerala: A Fisher Development Index (FDI) Approach

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Growth and development are two different connotations in the context of fishers. Over the years, the fisher community in Kerala has had a Human Development Index (HDI) which are lower (by 16%) than the general population of Kerala State. Many development indices take into account the state of fishers in a community. However, the fisher community is intertwined with the complexities of the natural resource system, whose mismanagement; unsustainable practices and other inter sectoral conflicts lead to situations wherein fishers are unable to get adequate returns. With this focus, an attempt was made to develop a Fisher Development Index (FDI) based on the fact that fisher well-being is dependent on resource sustainability, state of technology and infrastructure support; all of which lead to substantial externalities on the fisher development across the production and distribution domains. The study documents the fisher growth and development over years in terms of four components namely, social status, economic wellbeing, technological proficiency and resource sustainability. The results are a set of values comparable with the HDI. The study found that over the 15 years, the HDI scores were improved due to an increase in values for income and literacy. However, the FDI was improved by 74% due to very high improvements in technological proficiency and moderate improvement in the economic wellbeing of fishers. The wide use of communication and fishing aids has been attributed to the increased literacy rate of the fishers over time. There is also a positive relation between government expenditure on fisher welfare and the increase in FDI and HDI over the period pointing to an affirmative policy impact. The Fisher Development Index poses considerable options to the state policy planners in developing fisheries policies for ensuring continued fisher welfare ad sustainable marine fisheries management.

Keywords : Fishers, Development , Social, Economic Wellbeing Sustainability , Technology

Paper ID 15956

Fisher welfare impact assessment on the satellite based Ocean Information Services: An appraisal from Andhra Pradesh

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Fishing is a complex activity with many forces affecting the usefulness of the application of modern technology. With the advent of new technologies and new challenges like climate change in the fisheries sector, it is important that we use the technologies to our advantage so that we can maximise the gain in terms of landings and minimise the loss of livelihoods and assets through disaster ably supported by organisations like INCOIS, ISRO, IMD, MSSRF, and Reliance foundation etc. A holistic study to understand the loopholes in information technology dissemination is necessary for the welfare of fishermen and also the comprehensive use of technology developed by the various institutions. Thus, the study examines the extent of adoption of INCOIS services, the impact of INCOIS on fisher's welfare and future needs for better use of services in Andhra Pradesh. In total, 717 respondents were surveyed from selected landing centres in Visakhapatnam, Srikakulam, East Godavari and Krishna districts of Andhra Pradesh. Among them, 357 (50%) respondents were INCOIS information service users and 367 (50%) were non-users of the services disseminated. Since 2016, INCOIS services were delivered to the fisher folks of the region through the fisheries department and village knowledge centres. climate-weather forecast, wind-tide and current alerts, temperature, oil-spill, tsunami, storm and Potential Fishing Zones (PFZ) were the advisory services disseminated as audio-advisory calls through mobile phones, radio and fellow fishermen on both daily and weekly basis. The fishers had varied opinions on the applicability, accessibility and benefits of these services Fishes such as anchovies, tunas, mackerel and carangids were the major fish species caught from the PFZ directed by INCOIS. The identified constraints and suggestions given by the INCOIS users and non-users would be effective in improving the dissemination of ocean state forecast services and marine fishery advisory services more efficiently.

Keywords : Welfare, Impact .incois ,pfz ,advisory Services

Paper ID 15958

Assessing labour migration patterns in marine fisheries sector across coastal India: Reflections for the future

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The Indian marine fisheries sector is no longer a subsistence sector; with a landing of 3.56 MT providing direct employment to over 1.5 million fisher people besides others indirectly dependent on the sector. Over the years there has been a change in the fishing operations, a paradigm shift from single-day fishing to multiday fishing and targeted fishing, coupled with the ever-increasing demand for fish leading to "Employment imbalance". The migration of labour has become an important feature of the globalizing world, accompanied by many economic, social and political concerns. Income inequalities, climate change, demographic shift and conflicts had contributed much to the migration of labour in search of employment and security. Hence a study over labour migration as an adaptive or coping strategy has its own relevance in the current scenario. This study is investigative research on labour migration and alternative avocation in the marine fisheries sector. The empirical evidence presented in the study explores the reasons, problems, income and savings and the seasonality of the migrants. The study assessed the migrant labour pattern across the six coastal states of Kerala, Tamil Nadu, Karnataka, Orissa, Gujarat and Maharashtra. The migrant labour pattern indicated that in Kerala majority of the respondents are from Tamil Nadu, in Tamil Nadu majority from Andhra Pradesh, in Karnataka from Jharkhand and in Maharashtra majority of the respondent is from Bihar and Madhya Pradesh and in Orissa from Andhra Pradesh. The study identified unemployment as the main problem faced by the workers in the fishing industry which necessitates the need for labour migration. Moreover, income inequality, climate change, demographic shift and conflicts also contributed much to labour migration in search of employability and security..

Keywords : Migration, Globalizing, Climate Change, Fisher Folks

Paper ID 15959

Dimensions, indices and constraints in information management behaviour of coastal fishermen of Tamil Nadu, India – A comparative study

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It is important for daily sea going fishermen tohave the managerial relations among the dimensions of information management behaviour forfishing and community development. The proper development and delivery of content of fisheries information for its effective use during fishing is lacking among the fishermen of coastal districts of Tamil Nadu state, India. To address this research gap, this comparative investigation drawn to analyse the factors influencing the information management behaviour of fishermen and to identify the constraints affecting them in managing the fisheries information. The results corroborated that the level of information seeking, processing and storage behaviour of the respondents in control area were in low category followed by medium and high whereas in ICT impact area were in high followed by medium and low. It was also found that the overall information management behaviour of fishermen in the control area were in low (56 %) followed by medium (29 %) and high (15%) whereas in ICT impact area, level of information management behaviour of fishermen were in high level (57 %) followed by medium (28 %) and low (15 %). The R_1 and R_2 value represents the simple correlation is 0.806 and 0.861 for control and ICT impact area respectively with information management behaviour of fishermen on ICT tools for fishing. In this case, R^2 implied that the independent variables can predict information management behaviour of fishermen on ICT tools for fishing for control and ICT impact area with 65.00% and 74.10% accuracy respectively. The significance value of the paired t-test p=0.019 (t5=7.060, p=0.019) confirmed statistically that there is significance between the sample means of control and ICT impact area on dimensions of information management behaviourof fishermen.

Keywords : Information Management Behaviourial Dimensions Information Management Indices Information Management Constraints

Paper ID 15973

Attitude of the Shrimp Farmers towards Private extension services in Andhra Pradesh

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One of the key initiative attempt made to provide effective extension services for aquaculture development is to involve private sector . This new initiatives in extension management that was designed and developed by the private and voluntary sector has found to be more successful which are getting readily accepted by the farmers. Private Extension Services are playing a significant role in improving the socio economic standards of the shrimp farmers especially in Andhra Pradesh. Andhra Pradesh is contributing half of the total shrimp production of India and it has been cultured on commercial scale in 9 coastal districts The present study was carried out in four predominant shrimp farming districts namely Nellore, Guntur, Krishna & West Godavari of Andhra Pradesh. Data were collected from 400 farmers with the help of structured interview schedule. A total of 28 independent variables were selected to find out the significance with the attitude of farmers. Majority 88.25 percent of the farmers reported medium level of attitude followed by 6.75 percent of high level and 5 percent of low level of attitude towards Private Extension Services. Timely availability of services, inputs and information were found advantageous to majority (80.5 %) of the farmers from private extension services. Scientific orientation, social participation, economic motivation, information seeking behavior were found significantly associated with attitude of the farmers towards private extension services.

Keywords : Attitude, Shrimp Farmers, Private Extension Services.

Paper ID 16002

Economic Prosperity & Environmental Sustainability Through Integrated Multi-Trophic Aquaculture (IMTA)

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To achieve environmental sustainability and economic stability, an innovative idea of integration of seaweed with sea cage farming of cobia was demonstrated during 2014-17 at Munaikadu, Palk Bay, Tamil Nadu. A total of 16 bamboo rafts (12× 12 feet) with 60 kg of seaweed per raft were integrated for a span of 4 cycles (45 days/cycle) along with one of the cobia farming cages. The rafts were placed 15 feet away from the cage in a semi-circular manner, so as to enable the seaweed to absorb the dissolved inorganic and organic nutrient wastes which moves along the water current from the cage. Currently through IMTA, seaweed rafts integrated with cobia farming cage had a better average yield of 390 kg per raft, while in the non-integrated raft the yield was 234 kg per raft. An additional yield of 156 kg of seaweed per raft (67% additional yield) was achieved through the integration with the cage farming of cobia. An additional net income of Rs. 54,890/- was realized through integration of seaweed rafts with cobia cage. The carbon sequestered into the cultivated seaweed in the integrated and non-integrated rafts was estimated to be 435 kg and 261 kg, respectively. IMTA is an eco-friendly option ensuring sustainable income to the coastal fishers. It is also one of the significant mitigating measures for reducing the adverse impact of climate change and also earns carbon credit to our country.

Keywords : Imta, Seaweed, Seacage, Bio-mitigation, Economic Prosperity, Environmental Sustainability

Paper ID 16025

Management of culture-based fisheries in small reservoirs by population modelling – A case study

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Culture based fisheries in reservoirs is a successful aquaculture practice in vogue in many parts of the world and also in India for enhancement of fish production. There are 56 large reservoirs, 180 medium reservoirs and 19,134 small reservoirs covering a water spread area of 11,40,268 ha, 5,27,541 ha, and 14,85,557 ha respectively in the country. The average national yield from all Indian reservoirs is 27.9 kg/ha and the small reservoirs productivity is nearly 49.9 kg/ha (CIFRI, Barrackpore). Indian reservoirs hold enormous potential for intensification of aquaculture practices to enhance the productivity per unit area. Although annual fish production from reservoirs is around 93,650 MT, only 35% of the potential yield is realized in spite of availability of vast resources and conducive ecosystem which calls for proper scientific management and enhancement. The production in small reservoirs largely depends on several factors, including the productivity of the waters, extreme climatic events, stocking regime and optimum fishing effort. Enhancement is widely adopted in reservoir fisheries in pursuit of increasing catch and income of fishers. The population dynamics of stocked species at Aliyar reservoir was studied using density-dependent growth models (Lorenzen, 1995, 1996). The growth parameter K was estimated as 0.79, 0.72 and 0.50 for Rohu, mrigal and Catla indicating good growth performance for rohu and mrigal. The competition coefficients (c) estimated for the stocked species were very low ranging from 0.0028 to 0.0094 which shows the conduciveness of the water body for the growth of carps. Further evaluation of various management options using the density-dependent growth model for various stocking densities was done The predicted growth patterns indicated that fish kept at high stocking densities are expected to grow to a low asymptotic weight (W∞) at higher growth rate (K) whereas the same fish kept in reduced competitive environment for food, grow to a high W∞ at low K.

Keywords : Density Dependence, Culture-based Fisheries, Reservoirs, Growth, Management

Paper ID 16030

A study on job satisfaction levels of employees of M/s. kumaran fishnets private limited, Anandhanadarkudy, Kanyakumari district, Tamil Nadu

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The present study aims to understand the level of performance of employees of a company and which groups of employees are facing challenges in the organization. Fishing is an industrial activity, which is associated with many other ancillary industries. One among them is fishnet industry. There are different types of fishnets used based on the fishing operations. As the outcome of technical advancement, fishnets have been modernised. Hence, the present study was conducted to understand the levels of job satisfaction and challenges faced by the employees in M/s. Kumaran Fishnets Pvt Ltd., a leading fishnet manufacturing industry. The industry manufactures fishing lines and fishing nets that easily reaches to the fishermen due to its reasonable price. Simple random sampling technique was adopted during the survey for the study. The primary data was collected from 115 respondents and the data were interpreted using different statistical techniques like percentage analysis, exploratory factor analysis, Karl Pearson Bi-variate correlation, and multiple regression analysis. The results showed that the trainings help the employees to increase their competency and quality of the work. It was formed that a company with highly satisfied personnel has higher production level, lower wastage, lower accident rates, and less working stress etc.

Keywords: Employees, Job Satisfaction, Trainings, Performance.

Paper ID 16045

Addressing sustainable development goal through participatory fisheries technological interventions in Ox-bow lakes of India: experiences from developmental projects in Bihar

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Out of the 17 Sustainable Development Goals (SDGs), SDG-I aims to end poverty in all its form everywhere can be redressed by income generation through fisheries development in the ox-bow lakes of India. Ox-bow lakes occupy 4.01% of the total fisheries resources of the state that support part of the livelihood needs of thousands of fishers. Despite having immense scope for fisheries development and potential for fish production from these resources, their realization remains inadequate due to several reasons. Insufficient access to scientific knowledge and technologies, poor fisheries infrastructure, weak financial capacity, inadequate resource-based management approach, unorganized institutional arrangements, the poor linkage between line department and user groups and have constrained realizing their potential, thereby compromising issues of livelihood. Hence, the stressed fishers looked for their income from non-fisheries resources and migrate on large scale. The fish production potential of Kararia *(N26˚ 37´ 05.4´´; E 84˚55´57.8´´)* and Sirsa (N26˚36´29.8´´; E84˚59´38.9.9´´) lakes were estimated through primary carbon synthesis and found to be 3,437 and 1,332 kg/ha/year, respectively. Multi-pronged activities such as input supply, infrastructure development, technological interventions, habitat management, awareness, mobilization, sensitization, capacity and skill development of fishers, and fisheries management undertook to realize untapped potential and improved livelihood opportunities. The cumulative impact of these interventions has resulted in improving the average fish yield from 140 to 432 and 190 to 592 kg/ha/year and fishing days from 32 to 92 and 67 to 152 days/year for the Sirsa and Kararia lakes, respectively. The enhanced fish yield and fishing days have improved fisher's income, and increased their livelihood opportunity. The various technological interventions and management measures implemented with the active participation of fishers as experienced in the Sirsa and Kararia lakes of Bihar can help in addressing SDG-I in similar ecosystems across India.

Keywords : Sdg-i, Ox-bow Lakes, Fisheries Management, Bihar

Paper ID 16047

Geospatial mapping of aquaculture farms and potential regions for its expansion in northern coastal districts of Tamil Nadu, India

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Aquaculture has drawn global attention not only due to its economic importance, but also due to the environmental issues raised over its unregulated development. Aquaculture can make use of unutilized land and water resources to contribute to fish production, and improve socio-economic growth of coastal population if the development happens in a systematic manner after considering ecological importance of coastal ecosystems and multiple uses of coastal resources. The present study was aimed to assess the aquaculture locations and also identify the suitable areas for further development in Northern coastal districts, (Chengalpattu and Tiruvallur District) of Tamil Nadu using remote sensing techniques and Geographic information System (ARC GIS 10.6). Satellite data of Sentinel 2A of 2018 having 10 m resolution, topographical maps of Survey of India (SOI) were used for mapping the aquaculture farms and the suitable regions for expansion. The existing aquaculture farms have been delineated using image characteristics. The unused land classes such as mudflat, scrubland, salt-affected area were delineated and thee spatial regulatory restrictions as per the Coastal aquaculture authority (CAA) guide lines were applied using the spatial analysis tools. The mangroves, agricultural lands, and other ecosystems were eliminated and then the buffer zone of 50 m width was created between the unused land types and other productive ecosystems regions close to source water bodies. As the district had part of ecologically important Pulicat region, 1 km buffer was provided to protect the ecosystem. The regions suitable for aquaculture were mapped and accuracy assessment of present aquaculture farms and potential regions were carried out using Global Navigation Satellite System. The aquaculture farm area was 670 ha and 1453 ha, while the area available for its expansion was 716 ha and 654 ha in Chengalpattu and Tiruvallur districts respectively. The findings indicate that spatial tools can help to monitor the aquaculture development and provide the avenues for expansion.

Keywords : Geospatial, Aquaculture, Future Potential, Sentinel Data, Caa Act

Paper ID 16069

Economic valuation of ecosystem services provided by Black clam in the Vembanad estuarine system of Kerala

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Black clam *(Villorita cyprinoides)* resources are abundantly present in Vembanad estuarine system of Kerala which is one of the highest clams producing states in the country. Black clam provides various ecosystem services which sustains the Vembanad estuarine system and these can be classified into provisional and regulatory services. This paper quantifies the provisional services provided in terms of clam meat and shell. Similarly, estimated the monetary value of various regulatory services of black clam provided to restore the estuarine ecosystem such as water quality maintenance, nitrogen, and phosphorus removal and carbon sequestration has been estimated. Suitable valuation techniques were used to quantify the values of black clam ecosystem services.

The marketed value of harvested black clam is estimated about Rs 26.06 crores per annum, out of which 60% were generated by clam meat and 40% from clam shell. The major regulatory service of black clam is water quality improvement *i.e.* water filtering was estimated using replacement cost method and valued at Rs 2,700 crores. Also, the amount of carbon sequestered in the form of clam shell per annum was estimated at 4,123 tons of carbon and in terms of its value was Rs 2.61 crores which was estimated using shadow pricing techniques. Lastly the annual quantity of nitrogen and phosphorous removed by the clam in the Vembanad estuarine ecosystem were estimated at about 4,716 and 1,888 tons respectively and its value was Rs 9.44 and 6.77 crores respectively using alternative / shadow pricing method. Overall economic value of the regulatory service provided by harvested clam in the Vembanad lake during the year 2018-19 was estimated at about Rs. 2,729 crores. This paper concludes that black clam provides ecosystem services which are a vital ecological function to keep the waters healthy and sustainable management of the Vembanad estuarine system is thus necessary.

Keywords : Black Clam, Ecosystem Valuation, Carbon Sequestration, Water Filtration, Market Price Method, Replacement Cost Method

Paper ID 16070

Constraints analysis and developing strategies for improving the livelihood opportunities of Fish farmers in the northern regions of West Bengal

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Human society is currently confronting the vast challenge of having to offer food security and livelihood options for a populace more than nine billion people of the world by the middle of the twenty-first century. The fisheries and aquaculture highlight its contributions to the food, nutrition and employment for a huge number of people around the world. India is the world's second largest fish producing country, which accounts for 6.56 per cent of world production. Fish has been an integral part of people's social customs and beliefs in West Bengal and has played an important role in fish farming. West Bengal is the only state in India where fishes are grown in all kinds of water bodies and adoption of aquaculture technologies is one of the key factors in raising the level of fish production. The research work was carried out in northern districts of Kalimpong and Jalpaiguri of West Bengal. The sample size was kept at 160 which was chosen proportionate to the size of the population through random sampling. Through discussion with beneficiaries, non-availability of the quality feed was the major constraint (91.25%). High price of the fish feed (88.75%), less availability of quality seed (82.50%), difficulties of feed transport (75.63%), non-availability of hatchery (73.75%), lack of marketing facilities (71.25%), lack of financial support and subsidies (68.13%), lack of manpower (64.37%) and lack of feed mills (61.25%) were the major constraints reported by the fish farmers. Construction of feed mills (93.13%), construction of private hatcheries (70.00%), better marketing facilities (63.13%), certified high quality seeds from State Department Fisheries (61.25%) and schemes and subsidies for all category fish farmers (55.63%) were some of the suggestions for improving livelihood activities provided by fish farmers.

Keywords : Constraints, Strategies, Fisheries, Livelihood, West Bengal,

Paper ID 16073

A study on buying behaviour of Vannamei farmers on selection of seeds for culture in Tamil Nadu.

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After the introduction of the Pacific white leg shrimp, *Penaeus vannamei* the scenario of the aquaculture sector in India has entirely changed and playing a promising role for the development of Indian economy. The present study was conducted to observe the farmers' perception, behavior, and selection criteria on the buying of *P. vannamei* seeds and to suggest the marketing strategies for the sustainable development of shrimp hatcheries. The study was based on both the primary and secondary data collected from the farmer's and hatchery operators. Primary data were collected from 103 farmers in five major *P. vannamei* cultur area of Tamil Nadu, viz. Nagapattinam, Ramanathapuram, Pattukottai, Ponneri, and Kalpakkam. Statistical tools like percentage analysis, chi-square test, and multiple linear regression were used to interpret the data. The results revealed that the quality of seed was the primary factor for purchasing the seed followed by availability, price, service, goodwill of the hatchery, technician's suggestion, and promotional activity. SPF broodstock is considered as the most important criteria for maintaining the quality of the seeds. The study suggested that the hatchery operators emphasized for extraordinary care in maintaining the quality of the seeds to cope up the present demand for shrimp in global market.

Keywords : Penaeus Vannamei, Hatchery Operators, Buying Behaviour, Marketing Strategy.

Paper ID 16076

A Study on Fish marketing in Nagpur City, Maharashtra.

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Inland capture fisheries and aquaculture sectors are not only important livelihood generation; but also provide employment opportunities to the millions of people across the world. The per capita consumption has been continuously increasing over the past few decades. As a result of increasing income level and changing food of habits, the consumption of fish is expected to increase continuously in the coming years too. The present study was performed to know about the current status of fish market and to identify the various constraints faced by the buyers and sellers in Nagpur city. Two wholesale markets viz., Mayo market and Mangalvari market were surveyed for these studies Both primary and secondary data were collected and the results were using interpreted descriptive statistics. A total of 120 respondents were interviewed and their responses were recorded through a structured questionnaire, while the secondary data were collected through various published and reliable sources. The results of the study revealed that there is an increase in the fish consumption as people are becoming more conscious about the nutritional value of fish. Poor hygiene and lack of cleanliness of the market is the biggest constraint faced by both sellers and buyers. Price fluctuation, non-availability of fresh fish, stiff competition in the market are some of the minor problems faced by the sellers.

Keywords : Fish Consumption, Fish Market, Marketing Channels, Consumer Perception

Paper ID 16082

A comprehensive study on marketing and procurement strategies of TNFDC and factors affecting the TNFDC marketing in Tuticorin, Tirunelveli, Madurai cities of Tamil Nadu

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Tamil Nadu Fish Marketing Development corporation (TNFDC) is marketing fresh fish and seafood through its chain of retail fish stalls and mobile units in Chennai, Madurai, Coimbatore, Thoothukudi, Kanniyakumari and Thiruvannamalai. Marketing channel is considered as a pathway through which a fish moves between market intermediaries until it reaches to the final consumer. In fish marketing channel all those functions related to the supply of fishes are performed by auctioneer, commission agent, wholesaler, and retailer. A total number of 250 respondents (100 sellers and 150 buyers) were interviewed. Two separate survey schedules were arranged one for sellers and another for buyers. A pilot survey was conducted in the study area. Statistical techniques like descriptive statistics, Shepherd Approach, Percentage Analysis and Acharya Approach were deployed to interpret the data obtained from the survey. The study revealed that the quantity and quality of fish bought were positively associated with buying. Besides, the study suggests that certain sub factors are related to marketing and buying decision. The study found that factors such as gill colour, belly size, fish smell, finfish/ shellfish, live/ iced fish, taste, presence of dirt and presence of bones that are vitally important for consumers taking decision of buying fish.

Keywords : Fish Marketing, Marketing Channel, Consumption, Tnfdc.

Paper ID 16101

Post-monsoon Lime Shell Collection As an Alternate Livelihood avenue along the Malabar Coast – A Socio-economic assessment

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The collection of the molluscan shell for lime production is a source of income for many coastal fishers along the Malabar coast. The large quantities of dead molluscan shells which are washed to the intertidal areas during the monsoon season are collected. The shell collection is a seasonal avocation that starts from June and extends till September. The beaches of Ponnani, Elathur, Thikkodi, Kolavipalam and Azhiyur are some of the important centres where large quantities of shells are collected. The shells collected are heaped on the shore and are purchased directly by the lime industries located in the Kozhikode and Kannur districts of Kerala. These shells are transported on a weekly or fortnightly basis from different locations. There are five major collection centres for processing the shell mainly for the fertilizer, feed and lime industry. The species of the collected shells vary with location and the bulk of the shells are bivalves. One person collects approximately about 5 to 6 baskets per day and each basket of shell weighs about 25 kg. The price fixed by the agents for one basket of the shell is Rs. 75/-. The revenue obtained by one shell collector during one season is Rs. 30,000/-. The total revenue generated by the lime shell industry along the Malabar coast is estimated to be Rs.3.6 crores per year. The post-monsoon lime collection offers an alternate livelihood option, especially to women and acts as a viable economic activity supporting the fisher households and supporting women empowerment.

Keywords: Lime Shell, Alternate Livelihood, Socio-economic Evaluation

Paper ID 16110

Performance appraisal and economic benchmarking of Trawlers operating in East Coast of India

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Trawl fishing is a prominent fishing system that represented 52 percent of total mechanised fishing vessels and contributed 46 percent of fish landings in Andhra Pradesh State, East Coast of India. Even though, fishing vessels of same vessel size (LoA) showed inter-vessel differences in terms of input utilisation, cost-effectiveness, efficiency and financial performance. The paper aims at addressing the economic aspects of trawl fishing covering performance and benchmarking among the vessel categories. The efficiency of the trawl fishing system was analysed using Data Envelopment Analysis (DEA). Apart from that, the economic benchmarking of trawlers was also calculated using the three-class model (Best-Average-Worst classes). Among the trawlers studied around 41%, 48% and 32% of small, medium and large trawlers were found best. The financial feasibilities of trawlers revealed that the Net Present Value (NPV) was positive and high for large trawlers (Rs. 6.06 million) followed by medium (Rs. 3.93 million) and small trawlers (2.05 million). The Benefit-Cost Ratio (BCR) was found higher in medium trawlers (1.34%). The payback period of large trawlers was lower compared to the other two vessel categories. The paper emphasised that there is scope for further improvement towards ensuring cost-effective, sustainable and economic way of fishing in trawler sector.

Keywords : Performance, Economic Benchmarking, Trawl Fishing And Financial Performance

Paper ID 16125

Spatial planning for Integrated Multi Trophic Aquaculture in Palghar District, Maharashtra, India

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Integrated Multi Trophic Aquaculture (IMTA) offers different by-products to support other aquatic species in the same system and provides vast scope for environmental sustainability with economic gain. The identification of suitable land and water resources for IMTA would confirm that the particular land region / waterbodies will deliver an appropriate environment for fish production without affecting the ecosystem functions. The study assessed the suitability of land and water regions for IMTA using multiple criteria in the Palghar District of Maharashtra, using Sentinel data, topographical maps, field measurements, spatial mapping, Analytical Hierarchy Process (AHP) -based ranking, and spatial analysis. The major creeks supporting aquaculture in the study region were Dahanu Creek, Makunsar Creek, Murba Creek, Rangaon Creek, Vahindra Creek and Vaitrana River. The multiple criteria were grouped into four heads as landuse, water quality, soil characteristics, and infrastructure support. The study region had different land classes - agriculture (72982 ha), aquaculture (1361 ha), built-up (17362 ha), mangroves (3533 ha), mudflats (11392 ha), forest (54078 ha), saltpan (1606 ha), scrublands (35207 ha), waterlogged regions (102 ha), and others (11523 ha). The water quality factors incorporated in the selection were pH (7.16 – 8.14), temperature (23.7 – 35.50C), salinity (4 – 55‰), dissolved oxygen (3.45 – 9.87 mg/l), total ammonia nitrogen (0.001 - 0.200 mg/l), nitrate (0.002 – 0.823 mg/l), nitrite (0.001 – 0.684 mg/l), phosphate (0.003 – 0.141 mg/l), chlorophyll a (0.034 – 2.927 mg/m^3), current flow (0.01 – 1.37 m/s), turbidity (2 – 125 ntu), water depth (1 – 4.5 m). The measured soil characteristics were pH (7.1 – 8.2), electrical conductivity (3.54 – 11.73 ds/m), and organic carbon (0.38 – 1.41%). After integrating environmental conditions and Coastal aquaculture authority regulations, the available extent for land and creek-based IMTA was 2518 ha and 736146 m3, respectively. This study proves that geospatial techniques combined with field-level investigations can be useful for responsibly planning aquaculture

Keywords : Land Resources, Aquaculture, Environmental Characteristics,site Selection, Spatial Decision Support System, GIS

Paper ID 16128

Socio-economic upliftment of Tribal and Scheduled Caste Fisher Folks of Odisha by the demonstration of Poly-culture Techniques of Grey Mullet with Black Tiger Shrimp: A livelihood support cum skill development initiative

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Odisha, one of the coastal states of India, having 22.8% tribes which is quite higher than 8.6% tribal population for the country. Balasore, the northern most coastal district of Odisha is having rich fisheries and aquaculture potential. Nearly 12.4% of population of the district belongs to schedule tribe community and coming under the social and economically backward category. Twenty-six families belong to the weaker section of society (ST and SC) were selected from the district and provided training along with all necessary inputs required for poly-culture of grey mullet with black tiger shrimp. The saline ponds were prepared prior to stocking and wild caught seeds of grey mullet (*Mugil cephalus*) of 7-15 cm total length (20-30g body wt.) were procured and stocked in pond @ 10,500 nos. per hectare immediately after the termination of monsoon in September. After 5 months of culture, the same pond was again stocked with black tiger shrimp (*Penaeus monodon*) of 1 to 3 cm TL @ 12,000 nos. per hectare which were caught from wild by local fisher women. Better survival was observed in grey mullets (74%) compared to black tiger shrimp (60%) during culture operation. Fishes were fed with mixture of wheat flour and floating feed pellets possessing 28-30% protein level at 10% of their body wt. initially and decreased gradually to 5% body wt. daily after 3months. The crops were harvested after 8 months of culture on attaining an average weight of 750 g (wt. range 600-1000g) in the case of grey mullet and an avg. weight of 30 g (wt. range 25-35 g) in the case of black tiger shrimp. A total of 5 t of grey mullet and 225 kg of black tiger shrimp were produced per hectare from one hectare of culture area. A total revenue of 11 lakh was realized from sale of produce which was distributed to the beneficiaries identified under the ST and SC sub plan. The successful demonstration of the culture technique would lead to better livelihood support and increase the technical skill for further continuation of the activity for additional income generation and social upliftment of these socio-economically weaker section of the society.

Keywords : Poly-culture, Demonstration, Livelihood Support

Paper ID 16139

Ocean and Climate information forecast services: Evaluations from the Fisher Folk communities of the West and East Coast of India

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In comparison to the South-Asian countries, India tends to be high in range, experiencing the impact of the vicious spiral paradox between disaster, environment sustainability and coastal vulnerability. In order to address this discourse on the role of scientific and technological advancements in climate and weather forecast for the coastal communities, Ministry of Earth Sciences (MoES) and its branching institutions provides the ocean state information to all the seafaring communities and organizations. In serving this purpose, the current work was focused on gauging the extent of adoption of the scientific weather forecast services towards the fisher folk communities across the two coastal states of India. The work aims to ascertain on the future needs of the fishers in terms of technology development and dissemination. About 1240 individual respondents were surveyed along the two coastal states, Andhra Pradesh (523 respondents off the East coast) and Kerala (717 respondents off the West coast) of India. Multistage random sampling method was used for selecting study locations and sample size to be surveyed in each coastal state/union territory. The primary data collection was carried out through questionnaire survey from each fisher respondents during the months of June 2018 to December 2019. 47% are registered users of the INCOIS services and 53% are non-registered users reliant on the ocean information services from other weather forecast departments and organisations. In light of this background, this article concurs with studies that propose a framework for the integration of ITK with scientific forecasting for improved seasonal predictions in order to reduce climate risks and vulnerability.

Keywords : Climate Change, Disasters, Vulnerability, Scientific Forecast, Incois, Traditional Knowledge

Paper ID 16145

Moving towards sustainable aquaculture and production of a premium brand - A TSP initiative through participation of Irular fishers of Senjiamman Nagar, Pazhavercadu

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Nine coastal villages in Thiruvallur District in Tamil Nadu house the Irular community with ~500 families. Displaced from the Reserve Forest areas in Pulicat region in the northernmost part of Tamil Nadu (and partly, southernmost Andhra Pradesh) and the Barrier Island of Sriharikota, they got scattered and settled down all along the coast. The Madras Regional Station of ICAR-CMFRI started social survey in the area in 2013 and subsequently trained members of the youth in mariculture practices and technologies. Demonstration programmes and cage farming of seabass, pompano, mangrove jack, pearl spot, oysters and mussels were successfully carried out under Tribal Sub-Plan (TSP)-, FIMSUL- and ICAR-funded projects. Hand-holding support is extended in bringing about a farming model with successful marketing and premium branding as envisaged in the TSP programme. A trained team of fifty members at Senjiamman nagar is currently carrying out cage farming of finfish and raft culture of shellfish (oysters and green mussel) and sea weeds. They have also submitted proposals to take up cage farming with support from the National Fisheries Development Board (NFDB). Success stories and milestones achieved by the Irular youth in the programme are presented in this paper.

Keywords : Cage Farming, Shellfish, Mariculture, Tribal Sub-plan

Paper ID 16146

Development of an aquaculture hub in Kottaikkadu-Alambarai coastal stretch of Chengalpattu District, Tamil Nadu – An SCSP Initiative

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The fisher members of the Adi Dravidar community in Kottaikkadu (Cheyyur Taluk, Chengalpet District, Tamil Nadu) living in the village alongside the saline creek adjoining the Alambarai fishing hamlet, have been involved in edible oyster fishing and allied fishing activities for several decades. Oyster fishing is predominantly done by the women and the meat is sold to the shrimp hatcheries and local markets. The Madras Regional Station of CMFRI has been working with the community since 2010 in studying their social and economic status as well as the habitat and resource dynamics of the ecosystem in the saline creeks and coastal waters under the FIMSUL-, SCSP- and ICAR-funded programmes, and various trials and pilot scale operations of cage farming have been demonstrated for seabass. Three teams (Annai Teresal Meen Urpathialargal Angal Suya Udhavi Kuzhu-ATMASUK, Vivekaandar Meen Urpathialargal Angal Suya Udhavi Kuzhu-VMASUK and Nalloor Nathathnaar Meen Urpathialargal Angal Suya Udhavi Kuzhu-NNMASUK) of twelve members each were trained and developed to undertake cage farming operations. The first team has successfully completed two crops of seabass farming, while the other two have completed one crop. This paper discusses the results of these early trials and future potentials and plans of the community towards forming a fully self-reliant aquaculture production centre.

Keywords : Edible Oyster, Adi-dravidar, Nursery, Cage Farming, Hotel Chains

Paper ID 16150

Managing fisheries in artificial reef-based habitats and community responsibility-inferences from case studies in Tamil Nadu

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Fisheries management frameworks in India have mostly focused on stock assessment of target species and fishing regulations aimed at maximizing production. However, managing fisheries in isolation from what they affect and are affected by, tends to be relatively ineffective and unsustainable. A sustainable fishery management protocol necessarily adopts an approach equally levelled at interlinked fish stocks, habitats and livelihoods. Following the deployment of artificial reefs in the coastal waters of nearly 150 villages in Tamil Nadu, ICAR-CMFRI has been closely studying the impacts of the reefs on coastal productivity and also on the socio-economic status of beneficiary communities. During the early phases of artificial reef deployment, we observed that a sudden increase in coastal productivity within 3-6 months after deployment often led to competitive fishing and conflicts with fishers from adjacent villages. Gear-operator conflicts were also reported, with trawlers and in some cases, ring-seiners that ventured near the reef areas, even though these were mostly within the 5 nm traditional fisher limits. Thereafter, ICAR-CMFRI initiated institution building in all the reef-associated villages, with several stakeholder meetings before and after reef deployment. Reef subcommittees (RSC) were constituted in all these villages, encouraging youth participation; they were trained on different aspects of reef monitoring and logbook maintenance. We discuss here some case studies which indicate a clear evolution of local fishers from individual stakeholders to groups of proprietary managers.

Keywords : Reef Sub-committee, Proprietary Management, Socio-economics, Conservation, Sustainability

Paper ID 16153

Ornamental Fish Culture: ICAR-CIFRI intervention for income generation through women empowerment

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The increasing demand for ornamental fish is in the national and international markets gives a new face value to many people as well as women in the society by empowering themselves financially. To empower and encourage women, SCs, STs and other economically weaker sections and to provide self-employment opportunities, PMMSY takes a flagship to promote the development of the Ornamental Fish Industry. To fulfill the national goal ICAR-CIFRI is working at 11 different remote places in West Bengal, Odisha and Jharkhand and encouraged 342 rural SC and ST women to establish ornamental fishery units as an alternative source of income. The whole process of beneficiaries selection involved adopting either by a fishermen's society on a cluster of 15-20 women or through the recommendation of the state fisheries department by networking SSGs and NGOs. As initial input for ornamental fish unit establishment CIFRI contributes approx. Rs. 15,000/- per woman which includes a 500 L ornamental fish rearing fiber tank, livebearer fish seed (i.e. Molly, Guppy and Swordtail), fish feed, medicine and other accessories. A 3-5 days residential training or off-campus demonstration is also conducted for the beneficiaries. After 5-6 months of rearing, women started fish selling and their earnings started at Rs. 2000-3500/annum and growing continuously. Above 70% of the total women, beneficiaries established themselves as ornamental entrepreneurs. For those who are not yet upgraded themselves, CIFRI has also taken some more initiatives like regular monitoring, further handholding training, etc. for better involvement. Considering the proven success of women in the development of homestead enterprises in the farming of ornamental fish in different parts of the country, due encouragement must be given to the creation of Self Help Groups for such enterprises.

Keywords : Ornamental Fish, Economic Development, Women Empowerment

Paper ID 16185

Competence Gap Analysis of Vocational Education System: A Case of Marine Fisheries and Seafood Processing Sector in Kerala

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Competence as a construct is pervasive and relishes profuse admiration in all the areas of the post-modern world of work. Vocational education is a root and predictor of the competence level to attain SDGs 4 & 8 in a meaningful way. While listening to the 'skill-market signals', there is a considerable clamour and argument about the competence gap vis-à-vis the degree of inclination and commitment of the vocational education system in meeting the job market demand. Since the world of work competence basket stresses continuous revision in specificity and quality, based on vocation, time, and sector, it is very relevant to measure the particular knowledge-skill- trait gap to meet the employability a vocational course offers. It is more apparent in fisheries, especially the marine fisheries sector, where such methodological attempts seem to be rare. Against this context, an innovative framework to measure the competence gap in the vocational education system in the marine fisheries and seafood processing sector was designed. The framework addresses the measurement of educational, delivery, satisfaction, and market demand gaps in the current vocational education system. The study is based on the primary data collected with an exploratory research design considering higher secondary school students, teachers and the potential employer of the processing industry from three zones of Kerala. Significance and importance assumed with the different items included in the knowledge skill and trait domains were analysed based on the perceptions of both students and teachers. The findings of the study point to the specific areas of vocational education that need a pedagogic and pragmatic reconstruction. It also shows strategic policy considerations to place the learner's aspirations, gender, and vocational opportunities in a balanced way for a better vocational teaching-learning ecosystem.

Keywords : Competence, Knowledge, Skill, Trait, Gender, Fisheries, Seafood Processing

Paper ID 16200

The need for contemporary documentation of small-scale fisheries for blue growth and blue justice: Observations from Maharashtra, India

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Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines) have been developed as a complement to the 1995 FAO Code of Conduct for Responsible Fisheries (CCRF code). Many countries are going ahead with National and Regional -level assessments of the implementation status of SSF guidelines through policies and institutional approaches. Though Indian marine policies and legal institutions have recognized the importance of Small-Scale Fisheries (SSF) as well as acknowledge their diversity, the importance of SSF to fisheries has been overshadowed by the larger, commercial section of fisheries in the country, which is dominated by the mechanized sector. The issues faced by SSF in India, though recognized are often overlooked in mainstream fisheries research and management. As the country is rapidly moving towards Blue Economy, aimed at economic growth, the interests and concerns of SSF, which are already threatened by multiple challenges too must be addressed properly in the decision-making process, which needs contemporary documentation of the multiple dimensions of SSF. Currently, the documentation of marine SSF in the country is very limited and fragmented. A study was undertaken to characterize and detail the features of SSF in Maharashtra to overcome the lacunae in SSF studies in the country, which could enhance social justice and support future policy developments for strengthening SSF in Maharashtra and India.

Keywords : Ssf, Resilience, Challenges, Marine Fisheries, India, Blue Economy, Fish

Paper ID 16227

Study on selected statistical techniques used in the field of Fisheries Science

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Statistical techniques deals with the dual aspect of the theory of designing experiments and sample surveys and representing valid inferences from the use of selected statistical methods. The ability to illustrate valid conclusions depends on how the data was collected and analyzed. Depending on the purpose of this study, one should choose an appropriate statistical procedure to test the hypothesis. When the number of observations is large or when the researcher is interested in different aspects or time series study, such calculations are very tedious and time-consuming. In this perspective, it is essential that the faculty involved in teaching and research need to be trained in the application of various statistical techniques using R software. In this paper we have discussed about the statistical techniques of descriptive statistics, significance testing, design and analysis of experiments, non-parametric method and forecasting via time series models.

Keywords : Statistical Techniques, Fisheries, Test Of Hypothesis, Significance Testing, R Software

Paper ID 16231

Technological interventions in improvement of livelihood and socioeconomic status of fishermen community of Badradri Kothagudem district, Telangana

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Socio-economic survey was carried out to identify the beneficiaries and to assess the livelihood status, economical conditions of tribal fishermen communities of Badradri Kothagudem District, Telangana state. The main objective of the study was to enhance the income status and livelihood opportunities for the fisher folk in the region through demonstration of seed production of Indian major carps using FRP carp hatchery, Nursery and growout carp farming and ornamental fish farming. Part of the study, six villages were selected, each village consist of sixty fishermen and eight women SHG's. Total 360 respondents were acquainted skills and knowledge on fish farming through Awareness and training cum demonstration programmes. Total 75 lakhs of carp seed was produced through FRP carp hatchery. 60% survival was achieved during nursery rearing and in growout farming fish production was recorded at 2.62 tonnes/ha. Over all, Average income of the farmer was increased 2 folds and per capita income was generated through fish farming about Rs.8,000. The ornamental fish farming set up was established to train the women SHG's. The Ninety five households were participated in the training and fourty members were successfully adopted the backyard ornamental fish activity. They produced 2000 seedlings of live bearers per batch. The per capita income generated by each SHG member was Rs. 4,000. With the adoption of scientific fish farming, the fisher folk could get significant income and livelihood opportunity for their improvement of socio-economic status, as a holistic approach for sustainable development of the rural community.

Keywords : Tribal Fishermen, Socio-economic, Livelihood, Scientific Fish Farming

Paper ID 16263

Empowerment of wetland community through culture-based fisheries with intervention of enclosure culture in five wetlands of eastern part of India

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Wetland plays a pivotal role for sustenance of fish diversity and provides goods and ecological services to society including fisheries. India has more than 8.0 lakh ha of floodplain wetlands (beels, jheels, mauns, chaurs, pats, etc.) spread across the numerous river basins in the country. In the present endeavour ICAR-CIFRI, Barrackpore have taken initiative under "Scheduled Caste Sub Plan" to improve the productivity of the wetland. Under this project, pen-culture demonstration and technical support were provided to the five fishermen co-operative societies in Murshidabad district, West Bengal in collaboration with RKM-Dhanyaganga KVK, Sargachhi. Three candidate species of Indian major carp (*L. rohita, L. catla and C. mrigala*) were selected for rearing in enclosure culture. In each wetlands 200 kg. of fish seed were stocked (n= 56-62/kg.) in two pens (area of each pen 0.1 ha.) and reared for 90 days. Size of harvested fingerlings was varied species wise in each wetland. *Labeo rohita* (90-140 g.), *Labeo catla* (90-160 g.) and *Cirrhinus mrigala* (85-140 g.) were recorded from selected five wetlands. During the rearing period maximum enclosure production recorded from Asandighi (955 kg.) and minimum from Dadpur wetland (910 kg.). During the study period water samples were analyzed for pH, total hardness, dissolved oxygen (DO), conductance, salinity, carbonate, bICARbonate, total hardness, calcium, BOD etc. The dissolved oxygen (DO) varied from 5.6 to 8.6 ppm. The concentration of dissolved oxygen recorded during the rearing period showed favorable for aquatic production. Maximum production enhancement (44.46%) has been recorded from Rangamati Chandparabeel followed by Dumnidaha (42.13%), Sagarpara (37.24%), Dadpur (32.77%) and Asandighi (28.08%) respectively. The intervention of pen culture and suitable management in wetlands may be undertaken for sustenance of fish production and productivity enhancement and increased income of the wetland fisher's community. This model of in-situ rearing would serve for zero based farming system for production enhancement.

Keywords : Wetland; Fish Production; Pen Culture

Paper ID 16271

Study of agricultural practices and fisheries livelihoods in Godavari river basin

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River Godavari supports the livelihoods of millions of people in the agriculture and fisheries sector. Emerging threats such as climate change, point and non-point pollution are considered to affect the aquatic biodiversity and associated livelihoods of dependent communities. The present study focuses on generating profiles of agricultural practices, agrochemical usage and fisheries livelihoods in three selected landscapes, i.e. Adilabad, Karimnagar and West Godavari in the Godavari Basin. Five survey formats, developed jointly by ICAR-NBFGR and Bioversity International, were used to collect primary data from 123 agricultural farmers and fishers covering 32 villages. The study also follows the case study method, field observation and key informants' interview to enhance the validity of information. Besides case analysis, Power Bi was used for data visualization. The major farming practices were paddy, cotton, turmeric and maize crops. Given the availability of water resources through major irrigation projects in the state, paddy is cultivated twice a year and has a large area in both Adilabad and Karimnagar district. In West Godavari region, minor crops such as leafy vegetables, cauliflower and green gram farmed in Rabi season. Most farmers seek advice from pesticide shop owners to identify diseases and apply the desired pesticide to crops. Further, a special case of Kalmadugu fishing village in Adilabad landscape was studied to understand the livelihood dependence of fishing community in Godavari Basin. Fishers belong to Bestha (Gangaputra) community and actively involved for more than two generations in the fishing occupation. Fishers earn an average monthly income of ₹ 5500 rupees. The present study results will help in further quantification of usage of agrochemicals, other agricultural practices, and their impact on aquatic diversity, and would lead to the evidence-based program planning in riverine regions.

Keywords : Godavari River, Agriculture Practices, Agrochemical, River Fishing

Paper ID 16272

Fisheries and Sustainable Development Goals: The case of India

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Due to the population size and vast geographical area, attaining Sustainable Development Goals in India is critical to achievee the global SDG targets. In this background, the paper has examined the role of fisheries in attaining SDG in the case of India. Data from various secondary sources including the UNDP, World Bank, and FAO at the global level and from national-level agencies are used. The paper focuses on SDG 1 (poverty), SDG 2 (food and nutritional security), SDG 3 (Healthy life), SDG 4 (gender equality), SDG 8 (sustained economic growth), SDG 12 (sustainable production and consumption at the national level) and SGD 14 (conservation of biodiversity and the life below water), where fisheries have far-reaching impact. Fisheries and poverty are negatively correlated – at household, community, and at national levels. The contribution of fisheries towards nutritional security in term of protein and fatty acids were analyzed. Fish consumption is positively correlated with the Human Development Index, the health component of HDI, and life expectancy. It is negatively associated with various degrees of stunting (moderately and severely). Fish provided about 12.8% of India's total per capita animal protein supply (12 g/capita/day) in 2013. Fisheries contribute to gender empowerment by providing income and employment opportunities: fishing (mainly in inland waters), aquaculture, fish vending, and fish processing (SDG 4). The study also examined the role of fisheries in alternative service sectors, including tourism, and the role of fisheries in providing decent work, as in the case of SDG 8. The need for training and skill development toward achieving this was examined. SDG 14, which deals with 'Life below water' is the most important aspect where fisheries have a profound influence. The study examined the institutional and technological dimensions that could be leveraged to protect the life below water and undertake fisheries activities.

Keywords : Poverty, Nutritional Security, Gender Equality, Decent Work, Life Below Water

Paper ID 16293

Solar powered marine ornamental fish backyard farming technology - Success story on Warli women tribes livelihood enhancement

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ICAR-CMFRI's solar-powered marine ornamental fish backyard farming technology was extended to a group of women from the Warli Scheduled Tribe, Dharavali village, Mumbai, as part of the Tribal Sub Plan (TSP) Scheme. The recirculatory aquatic ornamental fish seed growing setup is powered entirely by solar energy. Percula clown, tomato clown, maroon clown, and designer clown fish were raised in captivity for 45 days. The women were trained thoroughly to maintain the RAS based culture setup as well as the key activities like feeding, water quality management, health management etc. CMFRI's marine ornamental fish feed – VARNA was used to feed the fish. The women could market the fish (2.5 to 3 inch size) for Rs 200-250 per piece. Through the technical intervention, the women are able to earn Rs 3,000 per month through farming and they have invested the profits for scaling up their operations

Keywords : Backyard Farming, Marine Ornamental Fish, Clown Fish, Warli Tribes

Paper ID 16295

Monitoring groundwater quality characteristics for Agriculture using the Geostatistical Approach in Nagapattinam District, Tamil Nadu, India

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Groundwater quality is an essential and indispensable resource for human life, agricultural activities, and other environmental well-being. Climate change impacts and anthropogenic activities continue to change water quality characteristics, which demand long-term variation in the groundwater quality assessment of geochemical parameters. The present study evaluated the spatio-temporal variation of groundwater quality from seventeen wells in Nagapattinam District, Tamil Nadu, based on the Irrigation Water Quality Index (IWQI). Pre and post-monsoon seasonal variation in IWQI for 1997, 2007, 2017 have been assessed based on fourteen geochemical parameters (pH, total dissolved solids, electrical conductivity, total hardness, nitrite, nitrate, calcium, sodium, potassium, magnesium, fluoride, chloride, carbonate, and bICARbonate) and six water quality indices (Percent Sodium, Sodium Adsorption Ratio, Residual Sodium Carbonate, Magnesium Hazard, Permeability Index, and Kelley's Index). Inverse distance weighted (IDW) interpolation techniques of Geographic Information System were used to interpolate the findings. IWQI range varied from 18.25 % in 1997 to 32.25 % in 2017. Wilcox and United States Salinity Laboratory diagrammes indicated that 41 % of assessed groundwater wells in Nagapattinam, Cauverypoompattinam, Panangudi, Vedarnyam, Thevur, Vilunthamavadi, and Voimedu were unsuitable for irrigation. The variation trend of IWQI revealed that the water quality suitability for agricultural activities has been decreasing over the years. Proper water conservation and management systems can improve groundwater quality by creating water harvesting structures and desilting water bodies at periodical intervals. Monitoring water quality at the periodical interval is the need of the hour to prevent further deterioration in the coastal regions of the state.

Keywords : Groundwater Quality, Geochemical Parameters, Irrigation Water Quality Index (iwqi), Bureau Of Indian Standards (bis), Geographical Information System (gis), Agriculture.

Paper ID 16328

Commensurable analysis of scientific communications published in reviews in Aquaculture applying scientometric analysis

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This study presents a longitudinal and visualization mapping of scientific communications published in Reviews in Aquaculture during the period 2011-2020, applying scientometric approaches to depict the scientific contributions, collaboration trends, and research hotspots in aquaculture. Metadata of 412 articles published in Reviews in Aquaculture was retrieved and downloaded from Scopus database. The network graphs were visualized using 'VOSviewer' and 'Gephi' software. The chronological growth of scientific communications published in the journal, most productive authors, institutions, and countries vis-à-vis collaboration trends amongst them were scrutinized. The subject facets engulfed by the journal were identified based on co-occurrence of keywords. From the year 2018 onwards, the publication trends of the journal witnessed exponential growth. This could be attributed to the recognition of growing significance of aquaculture globally as correspondingly the scientific outcome on the subject is also growing. Reviews in Aquaculture have witnessed contribution of articles from around the globe. A strong international collaboration trend was observed amongst nations as except Poland and Nigeria, all other 60 countries have international collaborations for one or more articles. European nations have contributed maximum number of records and consequently, institutions representing Europe emerged as predominant contributors of articles to Reviews in Aquaculture. Moreover, the top five countries having contributed highest number of articles also falls under the European Union with the focus on aquaculture practices with management strategies vis a vis environmental impacts. In conclusion, it has been observed that diverse facets of the aquaculture subject are being explored globally for strengthening of the sector in view of its growing and widening significance towards attainment of sustainable food security. Further, these findings would be useful not only for strengthening collaborative research, but also pay attention towards the slenderly explored sub-domains in aquaculture.

Keywords : Scientometrics, Aquaculture, Bibliometrics, Collaboration, Visualization

Paper ID 16331

Status of intensive Aquaculture technologies adopted during the pandemic: Comparative case studies from Kerala

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The state of Kerala has witnessed a sudden surge in interest for adoption of intensive aquaculture technologies like Biofloc and Recirculatory aquaculture systems during the pandemic associated lockdown. Extensive surveys conducted among the fish farmers of this period showed that more than half of them were newcomers to the sector and their chief source of education / motivation was the success stories popularized in social media and youtube channels. Policy initiatives of the Department of Fisheries, Government of Kerala too promoted this growth by providing generous subsidies and ensuring the availability of chief inputs like seed and feed. Exotic fast growing species like GIFT and basa were the chief species farmed initially, however, the decline in market value for these species after the removal of lockdown restrictions have greatly affected the profitability of the sector. Many new farmers have returned to their previous jobs after offices were opened. The present study attempts to compare the status of intensive aquaculture farmers from Urban and Rural areas in Trivandrum District of Kerala over a period of two years (during the lockdown and post-lock down periods) and assess the sustainability of activities. Overdependence on social media for information and Policy shifts of the Government Departments are also discussed. Data generated from the farmers through personal interviews based on a pretested questionnaire is analyzed with appropriate statistical tools. The conclusions drawn from the study are expected to guide policy makers in the popularization of aquaculture technologies in the future.

Keywords : Biofloc, Recirculatory Aquaculture, Covid 19, Gift

Paper ID 16349

Strengthening the fisheries governance mechanism through coastal fisheries information hub in the Car Nicobar Island – a concept appraisal

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Car Nicobar Island is the administrative headquarter of the Nicobar archipelago, which is a small, isolated island that was predominantly inhabited by the Nicobar traditional communities. Coastal fishing activity remains an important source of livelihood and income for the communities whose fishing methods are simple and traditional. Being on a remotely located Island, the traditional people who engage in subsistence fishing activities sometimes also relies on the fish supplies from nearby Islands. The coastal resources are not harnessed effectively considering the enormous potential around the Island waters leading to the reduced fish catches, decreased catch per unit effort and the dependency on fish supplies. The information gap on the fisheries resource availability, potential fishing locations, up-gradation of the existing fishing methods, fleet up-gradation, navigation etc were found to be the main hindrances towards a better and sustainable harvest. To address this issue and to strengthen the information on coastal fisheries resources in the Car Nicobar, an initiative on coastal fisheries information hub was conceptualized and launched in 2022 with the idea of developing a consolidated fisheries-based information centre to assist the traditional communities in the coastal fishing activities. The hub would engage the Nicobar traditional people in fishing activities through the capacity-building programs, developing learning tools, engaging in learning mechanisms and promoting community-based management of resources through the concept of citizen science. The proposed initiative shall develop an comprehensive inventory of the coastal fishery resources, the information on ecologically sensitive regions, the productive fishing locations, sustainable fishing methods and promotion of responsible fishing practices for sustainable coastal fishery in the Car Nicobar Island.

Keywords : Island, Livelihood, Traditional, Fishing, Knowledge, Science, Policy

Paper ID 16351

The extent of research focus on small-scale fisheries in South Asia during 2000-22: A scientometric analysis

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Small-scale fisheries is an essential aspect of the blue economy, which employs 44 percent of people directly engaged in fishing, globally. In developing countries, they are the primary source of food, nutrition and livelihood. In the present study, the research papers published during 2000-2022 on small-scale fisheries from South Asia viz., Bangladesh, India, Maldives and Sri Lanka were extracted from the Web of Science (WoS) platform in order to understand the research trends, focus, extent of collaborations, etc. A survey with a comprehensive set of key words search, yielded a total of 142 research publications on small-scale fisheries from the region. It showed that the number of publications were the highest from India (55.63%), followed by Bangladesh (33.1%) and Sri Lanka (11.27%). The number of publications over the study period was found to be steadily increasing, with 2021 being the year with maximum (n=32) number of publications. *Marine Policy* was observed to be the most preferred journal for publishing studies related to small-scale fisheries among the researchers from this region. ICAR-Central Marine Fisheries Research Institute (CMFRI), India and Sylhet Agricultural University, Bangladesh were the top institutes that focused on small-scale fisheries research in the Bay of Bengal region. The major focus of research was found to be climate change vulnerability, governance and socio-economics of small-scale fisheries. The study highlights the need for working on strategies for proper data collection, sustainable resource exploitation, and designing policies for the fishers. With the year 2022 having been designated as the UN International Year of Artisanal Fisheries and Aquaculture, the paper calls for intensifying research on small-scale fisheries sector and further strengthening the linkage between science and development policy.

Keywords : Small-scale Fishers, Bay Of Bengal, Web Of Science, Marine Policy

Paper ID 16368

A critical analysis of economic and marketing efficiency of freshwater fish culture in Manipur

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The present study was taken up to carry out the critical analysis and marketing efficiency of freshwater fish culture in Manipur during the period 2019-20. The study was undertaken with the objectives of documenting the socio-economic profile of the fish farmers, costs and returns of freshwater fish culture, marketing aspects of farmed fish and the constraints in the fish culture activity in Manipur. Based on the envisaged research objectives, the study was undertaken in three districts viz., Ukhrul, Imphal West and Bishnupur, where the fish culture activity and Phumdi fish farming were predominant. Tools of analyses include tabular, percentage, price spread, marketing efficiency and constraints analyses and the collected data were statistically tested in SPSS software. The results revealed that freshwater fish culture activity was highly dominated by males (96.7%) with an average farming experience of 12 years. Among the surveyed respondents, fishery was found to be the primary occupation for 88.9 per cent of the fish farmers, followed by other occupations (8.9%) and Agriculture (2.2%). The income distribution pattern clearly showed that 96.7 per cent of the fish farmers were realizing the income of above ₹ 80,000/-through the primary occupation. The average total cost, total returns and net returns for fish culture in farms were estimated as ₹ 1,32,294.82, ₹ 3,12,933.70 and ₹ 1,80,638.88, respectively. Similarly, for Phumdi farming, the average total cost, total returns and net returns accounted to ₹ 1,16,605.71, ₹ 3,68,840.00, ₹ 2,52,234.29, respectively. Among the identified channels of distribution, Channel I (43.3%) and Channel IV (23.3%) were found predominant. The price spread was found higher for Silver carp (₹ 52.10/kg), Common carp (₹ 51.15/kg) and Grass carp (₹ 50.72/kg). Based on the output of the study, certain suggestions for the development of freshwater fish culture activity in Manipur state were drawn and discussed.

Keywords : Manipur,analysis,phum

Paper ID 16383

Value chain analysis (VCA) of farmed *Penaeus vannamei* in Tamil Nadu

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The aquaculture sector of India witnessed a boom with the introduction of white leg shrimp (*Penaeus vannamei*) and having relatively higher demand in global market and hence research in line with developing a cost effective value chain model for competitive advantage in shrimp industry was attempted. The field information collected from 200 Coastal Aquaculture Authority (CAA) shrimp farmers in selected coastal districts of Tamil Nadu and their respective processors through structured survey instrument was quantitatively and qualitatively analysed and documented. The input market channels and logistics (inbound and outbound) were identified and the cost of value addition through the line of farming and processing was estimated besides profiling the socio-economic and business eminence of the shrimp farmers and seafood processors. The results stated that the estimation towards pre-stocking management was calculated at ₹ 26.35/kg (6.09%), and the value was increased to ₹ 406.01/kg (93.91%) after performing the value addition processes, with an increase of 93.51%, on an average to the farm gate price of ₹ 432.36/kg. The Multiple Linear Regression (MLR) results indicated that feed and feeding management, farmers' profit margin, pre-investment, power and fuel, application of probiotics, chemicals and minerals and labour management were found to be the most significant cost contributors to the farm gate price whereas, manuring and fertilization and water quality management were negatively correlated. Though the cost of production was observed high for IQF (Treated) (₹ 1139.44/kg) than the other identified products viz., block frozen (Treated & Non-treated) and IQF (Non-treated), it places a great demand with better profit margin (28.85%) and hence, there is a scope for inclusive growth in value addition of vannamei shrimp processing business in long-run. The driving changes as perceived by the stakeholders were documented and the cost effective shrimp value chain was suggested.

Keywords : *Peneaus Vannamei*, Value Chain Management, Comparative Advantage, Driving Changes

Paper ID 16386

Covid-19 and fish wholesalers' livelihood: The case of Chatrapati Shivaji Maharaj fish market, Mumbai

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Fishes are one of the most nutritious part of the global food chain and key source of employability generation among rural and coastal people. Fish and fish products are one of the most traded food products across the world with 38% of production entering the global trade. In India, more than 9 million active fishers directly depend on fisheries for their livelihood. Covid-19 pandemic related restrictions/lockdowns for most part of 2020 and 2021, affected and disrupted the fisheries sector as well from production to marketing to consumption. As the fish markets are a crucial link in the fish value chain, a study was conducted to assess the structure and conduct of the largest wholesale fish market in Mumbai, the Chatrapati Shivaji Maharaj (CSM) Fish Market, as well as understand the effects of COVID-19 pandemic/related restrictions on wholesalers. Data were primarily collected from key informant wholesalers in CSM Fish Market through market visits, observations and follow-up telephonic interviews. Data analysis was carried out using the FAO fish market checklist framework. FMIQI score for CSM fish market revealed the status to be 'poor' with 'hygiene and cleaning' dimension scoring 'very poor' (<19%). Price spread varied widely for the major species traded in the CSM market ranging between 20% & 57%, indicating great variations in marketing efficiency and margins. The wholesalers, though depended heavily on fisheries, gross income did take a hit but their share of margins remained more or less intact. However, changes in price spread were noticed because of Covid-19 pandemic/lockdown. Decreased consumer demand, lower supplies, and interference in transportation, ice supply, etc. directly affected the people engaged. The study has highlighted the need for major upgrade of the infrastructure in CSM Fish Market, development of smooth transportation corridor for the wholesale and retail marketing/distribution of fishes. Increased and concessional credit flow for the wholesalers rather than income compensation can help them cope up with such situations better.

Keywords : Chatrapati Shivaji Maharaj Fish Market, Price Spread, Covid-19, Lockdown

Paper ID 16390

Tamil Nadu fisheries: Empirical analysis of resources, production, staffing and budget

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Fisheries sector is witnessing a remarkable growth in recent years and drawing the attention of the policy makers but there is little focus on the dynamics of district and state level development scenarios as well as the public investments being made in the sector. The study assesses the water resources available for fisheries development in the districts of Tamil Nadu, the present fish production and the extent of yield gap, and the intensity of extension efforts and budgeted public expenditure. Secondary data and literature was compiled from multiple sources in the public domain and the fisheries department, while few key informant interviews helped clarify and fill the gaps. The results indicate that nearly twelve districts exhibit higher potential for fisheries development with an average resource area of more than 5 lakh ha. Pudukkottai, for instance, has the potential to produce 1.51 lakh tons against the present production of only 4,721 tons. On the flip side, only 21% of the staff in the fisheries department are technical while the remaining are administrative and supporting staff, calling for measures to increase this to atleast 50%. Tamil Nadu is among the top spending states on fisheries with an average annual expenditure of Rs.748 crores during 2016-2020, which is 0.32% of the state's total budgeted expenditure. A major shift in spending pattern could be seen during the last 5 years with a major share going to welfare provisions for marine fisher families, with a meager and declining share spent on inland fisheries / fishers. Increasing capital expenditure on inland fisheries and aquaculture, strengthening the extension system by bringing convergence among Department of Fisheries, ATMA, KVK, ZRS (TNJFU), and the NGOs at the district level besides increasing the budget allocation for training, capacity building and extension work would be critical to utilize the potential available.

Keywords : Fisheries, Tamil Nadu, Production Potential, Extension Efforts, Fisheries Budget

Paper ID 16392

Marginal livelihoods: IMTA- An model for sustainable fisheries knowledge level of fishers on IMTA -a sustainable livelihood alternative for coastal fishers

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India has the largest number of people who depend on agriculture and its allied sectors, including fisheries, for their livelihood. Indian marine fisheries provide employment opportunities to nearly 49.46 lakh people. Indian has fish production 37.27 lakh tons in 2019-20. Moreover, almost 67 % of fishers live below the poverty line. We are facing one of the severe problems of unemployment that is affecting the fishing communities as well. They do not have alternate choices other than fishing. So there is a need for alternative livelihood options for fishing communities. The future demand for an increased quantity of fish has to come from the brackish water aquaculture sector. To address this problem, ICAR-CIBA has proved integrated multi-trophic aquaculture (IMTA) model as one of the solution and conducted demonstrations in Muttukadu Experimental Station, Kakdwip Research Centre and Navsari Gujarat Centre of ICAR-CIBA and in farmer's field. In IMTA, one species' unutilized feed and wastes were converted as feed and energy for other cultured species. The villages namely Regunathapuram and Karankadu have been identified and a sample of 25 from each village was randomly drawn. Data was collected pertaining to socio-economic profile, knowledge about IMTA practices and constraints faced by fishers. The aquaculture knowledge of majority of the fishers (94%) on IMTA practices such as site selection, species selection, stocking density, feeds and feeding, soil and water management, health management, harvesting and marketing belonged to the low knowledge category. Constraint factors faced by them were lack of technical information on culture fisheries (96%), financial assistance (94%) and investment cost.

Keywords : Imta, Livelihood, Alternate Livelihood Options, Fishers.

Paper ID 16393

Impact of Covid-19 on the academic activities among fisheries professionals

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COVID-19- the global pandemic has caused havoc in every corner of the globe. Many sectors, including import and export, industry, stock markets, aquaculture, and economies, have suffered significant losses as a result of this. To have a better understanding of its influence on aquaculture and fisheries, we conducted an online survey via Google Forms among fisheries professionals. We have received responses from the professors and scientists of 16 fisheries colleges and universities in India. A maximum of them responded that they have worked from home during the lockdown. Among the 44 responses we got, 14 professionals responded that they have normal mental health status followed by 12 who informed that they are mentally very strong during this tough time. Almost 46% responded that they are involved in both taking online classes and conducting their project work. During online classes, the platforms like zoom (67.4%) and google meet (58.1%) gained more popularity among them. According to the professors they have got moderate responses from the students during the online classes and that's why they have concluded that online platforms would be effective for the students. Seventy percent of our respondents indicated that online classes are not at all compatible with all students. Due to the difficulties, more than 50% of them thought that academic sessions have to be extended. Among the respondents, 48.8% of them had project work but the work was then totally stopped due to the nationwide lockdown. 55.3% responded that only paper writing was going on about the question related to students' research work. 52.3% of our participants felt that the sustainability of aquaculture is moderately affected. This study suggested that the future education strategy should be capable of handling pandemic situations.

Keywords : Covid-19, Online Classes, Project, Research

Paper ID 16409

Supply chain management and marketing strategies of fresh seafood

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Supply chain management and marketing strategies of seafood markets were examined by two methods in this study. One was by conducting an online consumer survey (250 members) and knowing their perception towards online and local seafood marketing and another one was by knowing local vendors practices in seafood marketing. Result from survey shows that most of the consumers prefer the local market than online market, the main reason being tradition followed by most Indians. People felt that the local market is more affordable to them by both in terms of quality and quantity. Moreover, consumers thought it was safer to consume locally marketed seafood or meat because they are able visually examine the product. The main reason still online seafood or meat market stays a step backward than local market is because of lack of transparency. When it comes to local vendors, all the process was transparent from the initial stage (procurement) to the final stage (consumer). One drawback is that most of the local markets fail to follow the guidelines and regulations for food safety. They have difficulties in preserving the products under controlled conditions of low temperature. Another disadvantage in local markets is the limited choice, unless the market is a large one. In contrast, in online markets, there is separate list for each kind seafood or meat type. Therefore, online seafood shopping will become popular when people become aware of the advantages with respect to quality and variety of fresh, cleaned and marinated products.

Keywords : Supply Chain, Local Market, Unorganized, Quality, Marketing, Online Market

Paper ID 16430

Roadmap for the Indian ornamental fisheries sector 2.0

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Despite India being home to around 300 indigenous and exotic freshwater ornamental fish species and 700 marine ornamental fish species, only about 100 ornamental species are produced and traded in the Indian domestic market. We have a market share of less than 1% in the export market. The country has enormous potential for holistically improving the ornamental fisheries sector through methodical planning and implementation. With this in mind, ICAR-CIFA hosted a three-day stakeholder consultation to formulate a strategic action plan for ornamental fisheries development in the country, with more than fifty stakeholders and twenty experts debating various thematic areas of the sector. The strategies that emerged from the consultation are presented in this paper. The consultation called for a coordinated effort to put the development programme on a mission mode to encourage the sector's quick transformation. The key recommendations included: developing production units in clusters in strategic locations for domestic and export markets; improving marketing infrastructure and promoting the aquarium hobby; achieving self-reliance in aquarium accessories manufacturing; creating manufacturing units for quality feed and medicines; promoting aquatic plant production; boosting ornamental fish exports and issues in imports and mainstreaming the biodiversity conservation; fostering the policy research; reorienting research & development priorities, & enhancing the capacity-building initiatives. The plan also presented an investment roadmap for different subsectors of the ornamental fisheries industry.

Keywords : Ornamental Fisheries, Development Planning, Policy Research

Paper ID 16435

Value chain analysis of Asian Seabass Lates calcarifer seed production and marketing

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Asian seabass (*Lates calcarifer)*, a euryhaline high-value fish which can be farmed in ponds and cages in marine, bracakish and freshwater ecosystems is considered as a suitable candidate species for brackishwater aquaculture diversification. However, unavailability of stocking size seeds in adequate quantity, species specific functional feed, ready market and cold storage facility with differential growth and cannibalism are some of the constraints affecting the expansion of seabass aquaculture in India. ICAR-CIBA has taken initiatives to address these issues through demonstrations, training and interaction meets with stakeholders. ICAR-CIBA promoted seabass seed production activities by hatchery operators through technology transfer activities, namely satellite rearing, supply of spawn to seasonal hatcheries, supporting nursery rearing by small farmers/SHGs through demonstrations. Presently, two hatcheries, CIBA and RGCA produce about 5-6 million seeds annually and another 2 to 3 million are sourced from wild. This could meet about 10% seed demand against an estimated demand of about 60 million seeds/year. The value chain involved in the production of seabass fry, fingerlings, advanced fingerlings and adult fishes was analyzed. Entrepreneurs produced fry, fingerlings and advanced fingerlings from spawn sourced from hatcheries and sold at Rs.15, 40 and 55, respectively. Seeds of 4 to 5 inch size (35 to 50 g) are the most demanded ones for grow-out culture, for pond based nursery, early fry of 0.8 to 1.5 cm , and for hapa nursery, 1-2 inch seeds are preferred. The small size seed price ranged from Rs.2.5 to 4.0. The reared fingerlings of > 4 inch are sold atRs.40-55 depending upon size excluding transport cost. The rearing duration for pond and tank based systems to produce fry, fingerlings and advance fingerlings are 45, 60 and 75 days, respectively. The nursery rearing activity appears to be very remunerative since survival ranged from 60-70% with a short crop duration.

Keywords : Asian Seabass, Seed, Nursery, Fry, Fingerlings

Paper ID 16437

Fostering the knowledge dissemination for Aquaculture development in India - the case of Matsya Setu

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This informative paper presents the Matsya Setu, ICAR-CIFA's digital ecosystem for fostering the knowledge dissemination and information exchange between research institutes and farmers & stakeholders. The android app has two major components, the first is the virtual learning platform, which includes species and subject-specific self-learning online course modules in video format, in which renowned aquaculture experts explain the fundamental concepts and practical demonstrations on breeding, seed production, and grow-out culture of commercially important fishes such as carp, catfish, scampi, murrel, ornamental fish, pearl farming, and many other fishes. Farmers may use the app to ask questions and receive specialized advice from experts, as well as earn an e-certificate by passing a brief quiz. The app's second component is named "Aqua Bazar," which is a digital market place that connects buyers and sellers of various aquaculture input materials and services. Farmers may also post their produce on the platform to reach a larger audience. The app also has an AI-powered ChatBot that can answer users' basic questions. More than 32000 stakeholders utilize the app, with farmers accounting for 42% of users, followed by students (27%), fishery department officials (17%), and others (14%). The app has a large user base in North and Central India, with the area accounting for half of all users. The online training modules are currently accessible in English and Hindi, with six regional language modules on the way to serve farmers in their native language.

Keywords : Ict, Knowledge Dissemination, Matysa Setu

Paper ID 16462

West Bengal fisheries: Empirical analysis of resources, production, staffing and budget

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A vibrant extension system of the state Fisheries Department is a very powerful tool for addressing emerging challenges and steering the fisheries sector towards sustainable development. Its performance depends on the adequacy and quality of human resources and budgetary allocation, among others. Bestowed with a diversity of fisheries resources across the districts, West Bengal fisheries have immense and untapped potential. This study assesses the status and potential of the fisheries resource area (FRA) and production in each district, the availability of the human resource in comparison to the available resource area, and the pattern of public investment in the fisheries sector. The necessary secondary data was obtained from the West Benga Handbook of Fisheries Statistics 2017-18 and the open budget India portal. West Bengal has a total FRA of 1.6 lakh ha and a fish production gap to the tune of 3.22 lakh tons with North 24 Parganas district topping the list. Out of 749 technical posts, 259 posts i.e. 35% posts remained vacant which translates into an extension intensity of 6604 fishers per Dof staff. Although the government implements several developmental and welfare schemes, the annual fisheries budget was only Rs.422 crores which constitute 0.2% of the state budget. Moreover, capital expenditure constituted only Rs. 27 crores (9%), extension and training expenditure received less than 4%, while 26% of total expenditure went to salaries and related overheads. Based on the findings, a few policy suggestions emerge from this study.

Keywords : Fisheries, West Bengal, Fishery Resources, Fish Production, Human Resource, Budget

Paper ID 16482

Descriptive analysis of fisheries cooperative societies in Tamil Nadu, India

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In India, Fisheries plays an important role for ensuring food security, employment, and Income to all section of the people. Also, it fulfils the meditional requirement. India has rich resources in inland and marine fisheries. The fisheries sector plays an important role in Indian economy and its contribution to the GDP is 1.24 percent and almost 28 million people involved in the fisheries activities. Out of 136 Crores population, fisherman population is about 2 per cent. But fisherman population is ensuring food security for all. But a majority of the fishing communities are living in poor economic condition. In this situation, fisheries cooperation society plays a major role for development of their socio economic condition. A very few states have success story through fishermen cooperative society. Others, particularly Tamil Nadu have to be improved better. Tamil Nadu state is having rich sources of potentials in Inland and Marine fisheries. From this background, this paper tries to understand the situation and needs for fisheries development through their cooperative society. In this paper, secondary data sources are used for data collection and descriptive statistic tool were used for data analysis.

Keywords : Fisheries Cooperative Societies, India, Tamil Nadu

Paper ID 16494

Technical efficiency of coastal shrimp culture in Nellore District, Andhra Pradesh

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Brackish water aquaculture sector is dominated by the exotic vannamei shrimp farming, which is the economic engine of Indian aquaculture. In 2019-20, exports of 12,89,651 tonnes of Indian marine products fetched foreign exchange worth `46,662.85 crores and farmed shrimps accounted for about two-thirds of the shrimps exported. Regression analysis using Cobb-Douglas model had an R value of 0.9 meaning that 99 % of variations in the shrimp farm yield were explained by the input variables included in the analysis. Regression co-efficients for Feed, labour and fingerlings were positive and significant at 1 %, 5 % and 7%. The mean fixed cost, variable cost and total cost per ha per year worked out to ` 1,458, ` 4,40,091 and ` 4,41,547, respectively. The average yield obtained by the shrimp farmers was 2,583.8 kg/ha/crop and with a mean price of ` 360/kg. The total income realised averaged ` 9,30,203/ha/crop. The per ha farm business income and profit were ` 4,90,112 and ` 4,88,654, respectively. The average cost of production of vannamei shrimps was ` 170.88 with a mean profit of ` 181.12 per kg. Among the production constraints, high price of feed, uncertain quality of shrimp post-larvae stocked in the farms and disease and disease related issues were ranked as major constraints. The study showed that shrimp farming was profitable and found that shrimp farmers need to be more cost efficient along the production line since international market prices are beyond their control.

Keywords : Shrimp Farming, Economics, Socio Personal Status Of Farmer, Constraints

Paper ID 16498

Evaluating the effectiveness of scicom skill development training program

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Training evaluation assesses the effectiveness of the training and delivers ideas for the future. It measures a training program's success or utility and its shortfalls. Science Communication for Smart Scholars is one of the ICAR-Central Institute of Fisheries Education's flagship training programs offered online mode during first Covid-19 lockdown from May 5 to June 8, 2020 wherein 779 participants consisting of scientists, teachers, students, research scholars, etc. attended. The present study evaluates the effectiveness of the SciCom skill development program using Kirkpatrick's four-step (Reaction, Learning, Behavior & Result) training evaluation model. A structured online questionnaire prepared using Google survey form and communicated to all participants through email and whatsApp. A total of 200 participants responded within stipulated period of one month after consecutive reminders. Out of 200 respondents, 53% were women and 47% were men. About 82% of trainees rated the program favourably. Nearly 70% of them are said to have acquired adequate knowledge while only half of them (52%) said the same about the skills. Remarkably, 53% have put to use their newly acquired knowledge and skills. The mean effectiveness index score of the SciCom program was found 0.80 which demonstrates the very high effectiveness of SciCom program. The effectiveness index value at reaction (0.89) and learning (0.86) indicates the very high effectiveness whereas at behavior (0.77) and result (0.70) levels indicates high level of effectiveness. The Mann-Whitney U test revealed that male and female trainee's perception about effectiveness of SciCom program didn't differ significantly. The study recommends follow up trainings with same trainees, updating course content and tools time to time, more interactive hands on training sessions and develops custom-made modules separately for teachers, researchers and students for improving applicability of SciCom program.

Keywords : Effectiveness, Evaluation, Online Training, Scicom, Kirkpatrick Model

Paper ID 16503

Emerging class structure in the marine fisheries sector – A case study from India

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Studies on the revenue/profit sharing system in fisheries and its implication on fishers' welfare have received little attention among scientists. Revenue or profit sharing, a dominant system of compensation in fisheries, aids in spreading of the risks. One of the major features of the sharing system as against pure wage system is that owner and labour both take part in the decision-making process. The other aspect of the sharing system is that it is not conducive to capital accumulation. However, despite growing uses of capital-intensive technology, the revenue/profit sharing system is prevalent in fisheries. To understand the status of fishers in India, we analysed the number of crafts, craft ownership pattern, number of fishers, etc. As there is no public data on the income of fishers, we used asset profile of fishers (education, housing, and other non-durable assets) as a proxy. Interviews were carried out with fishers to understand their role in the decision-making process and concentration of ownership. Preliminary findings show that between 2005 and 2016 census years, the share of powered (mechanized and motorized) fishing crafts increased from 56% to 84%, a period during the average production recorded an increase by 23%. The population-employment ratio was observed to decline from 49% in 2005 to 40% in 2016, though the rate of literacy improved marginally from 56% to 60%. In terms of housing, between 2005 and 2016, share of families living in kutcha houses declined from 38% to 30% only. In absolute terms, only 15,000 families moved from kutcha to pukka houses in 10 years. The preliminary analysis of the share pattern shows signs of capitalist class structure emerging in the marine fisheries sector. Currently, the word 'fisher' is used as a collective noun in the fisheries policy and management to represent all involved in fishing sector. The study may be useful to unbundle 'fisheries' which could contribute to target the marginalized section within fishers, the issues of whom can be addressed with policy measures.

Keywords : Revenue Sharing, Small Scale Fisheries, Class Structure, Capitalism, Asset Profile

Paper ID 16504

Socio-contextual representations of 'fish' through symbolism in different cultures

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Symbols have been around for roughly 30,000 years. Cave paintings, a type of rock art that dates back to the Upper Paleolithic period, are the oldest known symbols used for communication. These artworks and symbolic representations contain knowledge passed down from our forefathers and communicate cultural and economic themes. 'Fish' in a symbolic form can be found in numerous symbolic representations across civilizations, representing rebirth, fertility, the unconscious or higher self, luck, love, change, health, and sentiments. The symbolisation of the fish is deep rooted and can be found holding significance over the historic, cultural and religious domains. Fish is also one of the most popular motifs of the early Harappan civilization. The Pandya Dynasty, which ruled over the southern part of India, used fish in their official flag and the Pandyan king is also referred to as "meenavan", to mean fisher in Tamil. The emblem with Two Fishes has been in use for several thousand years, under the religious context as well by Hindus, Buddhists, and Jains long before Christ. Decorative fish designs of the Greeks and Romans (often with mythological significance) were adopted by early Christians as religious symbols. In the twentieth century, fish were painted by many modern artists and in Japan and China, fish have been an important theme in art and their use has been highly symbolic. The paper will present the significance of the symbol of 'fish' in the contexts of history, religion and culture and trace the evolution of its symbolic representations in various mediums, so as to shed a deeper understanding of the change in perception and cultural importance of 'fish' and 'fishing' over the years.

Keywords : Fish Symbols, Historical, Culture, Communication

Paper ID 16093

Progress and prospects in adopting "Marine Citizen Science" to support marine fisheries management and ecosystem conservation in India.

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In marine fisheries research, the use of 'Citizen Science' has assisted public participation in natural resource management, resource conservation, environmental preservation, and decision-making all over the world. Since the trawl fishery was extended beyond a single day of operation, geographic data on trawling has been difficult to understand, and because regular monitoring of trawling requires a lot of money, gathering spatial data with current organisation machinery has become almost impossible. Fishermen on the Karnataka coast are progressive and understand the importance of having accurate data in order to build valid and effective regulatory policies. The current research aims to make the most of the enormous opportunity provided by 'Citizen Science,' which has been discovered to be a potentially cost-effective means for researchers to obtain vast data sets over large spatial scales. The project success was attributed to the selection of creative fishing industry partners and the correct training of those partners to supply reliable data. It was confirmed that the tools made for the job were simple to grasp and use without interfering with their regular duties at sea. Logistic issues arising from high costs for a ground fish distribution survey and identification of spawning regions were overcome by involving a local fishermen information source in research at a low cost, with little loss of scientific significance. When MCS data was combined with traditional data, it revealed a vast potential for investigating in situ growth, in situ migration, identification of spawning and juvenile seasons and their fishing grounds, identification of fishing pressure in various fishing grounds, and understanding conservational concerns in the marine ecosystem, all of which can aid in fisheries management and conservation. It was also discovered that involving stakeholders in the monitoring process encourages public ownership of the study, resulting in increased stakeholder acceptability of management decisions.

Keywords: Marine citizen science, spatial study, distribution, mapping, growth, GIS

11. GENDER IN AQUACULTURE & FISHERIES

Mainstreaming Gender in Aquaculture and Fisheries

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Fisheries and aquaculture are important sectors of the Indian economy, providing livelihoods to millions of people, returning impressive growth rates among agricultural commodities and contributing to the growth in agriculture GDP as well as the national exchequer by way of export earnings, and providing much needed animal protein to the population. Women are a key factor in this growth story, but much of their contribution continues to be invisible or barely recognised. They also face increasing marginalisation with the rapid changes the sector has been seeing like mechanisation of capture fisheries, rapid expansion of aquaculture, diversification of markets, increased capital influx and private investments etc. With a presence of about 50% in the labour force any further side-lining of women will have repercussions, not just on the sector, but also on incomes and wellbeing (mainly by ensuring nutritional security) of fisher household, as their fish work contributes significantly to these dimensions. Even with such a major presence, that their work goes unrecognised indicates deeper issues that have perpetuated inequality and has potential to affect the sector as a whole. Gender equality is an important development goal which countries have agreed upon to progress towards. Challenges women face have social, cultural, economic and political dimensions. Fisheries and aquaculture food systems also function in these complex scenarios. and women in these sectors have faced discrimination and several facets of their fish This presentation will discuss; valuing women's work, addressing data gaps, understanding marginalisation and strategies for mainstreaming gender for achieving gender inclusive development.

Morbidity profile, associated risk factors and treatment seeking behaviour of the small-scale fishers of Indian Sundarbans

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The present study was carried out from April, 2017 to March 2018 to understand the morbidity pattern and its related to risk factors as well as treatment seeking behaviour on small scale fisher across different age group covering six villages of Sundarbans area under Namkhana block of South 24 Parganas. The study revealed that morbidities were found more usual in males (39.33%) than females (28.5%) and fever (31%) is the most causative reason for morbidities followed by eye diseases (23%), low back pain (20%), scabies (17%) and respiratory illness (9%). Highest morbidities (25%) were recorded from the age group of 21-30 years in female fishers community followed by the below 10 age group and the 31-40 age group (14%) closely followed by the 11-20 (13%), 41-50 (12%) and 51-60 (11%) age groups, while in case of the male fishermen highest occurrence of morbidity was observed in the 11-20 years age group (20%) followed by the below 10 age group (16%), 31-40 (15%), 21-30 (13%), and 61-70 (11%). Associated risk factors for illness were identified as unsafe drinking water, poor sanitation, improper feeding practices for the infants and child, consumption of tobacco and alcohol, unsafe sex life during the study. Though healthcare facilities viz. Rural Hospital (RH), Block Primary Health Centre (BHPC), Sub-divisional Hospital (SDH), Primary Health Centre (PHC), Sub-centre (SC) are available on study area, but large number of sampled populace(16.5%) extremely belong to remote area dependent on unqualified medical practitioners known as “Quacks” due to910 easy accessibility , affordable fees and medicines, non-availability of qualified doctors at the public facilities. The present study revealed the health status of fishermen community is quite rattling. Lack of awareness, poor socio-economic status, lack of access, isolated geographic location are major limiting factors for maintaining healthy lifestyle by the small scale fishers of Sundarbans. Keywords: Morbidity, Sundarbans, Small scale fisheries, Health status

Gender Analysis Of Wild Seaweed Harvesting In Tamil Nadu

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Gender equality is not a basic right but a necessary foundation for a peaceful, prosperous, and sustainable society. While men are predominately active in fishing, women engage in offshore activities and play multi-faceted roles. Around 5,000 people in southern India make their living by collecting seaweed; most of them are women. However, gender-disaggregated data on wild seaweed harvesting is lacking. A study was undertaken in Ramanathapuram district of Tamil Nadu to assess the gender dimensions in wild seaweed harvesting with a sample of 60 households. For data analysis, Mann Whitney U test, Kruskal Wallis test, RBQ, etc., were used in MS Excel and SPSS. The study reported that women (86.67%) were primarily involved in seaweed harvesting, and few men (22.22%) had it as a secondary occupation, whereas fishing was the primary occupation for men (100%). Women and men seaweed harvesters earned an average of ₹64357 and ₹86566 per year, respectively, from seaweed harvesting. Mann Whitney U test revealed a significant difference between men and women in social participation ($p =<0.01$), extension participation ($p = 0.038$) and usage of information sources ($p =<0.01$), as well as a significant difference in drudgery level ($p = 0.012$), technology adoption ($p = 0.032$) and gender empowerment dimensions ($p = 0.002$) between men and women seaweed harvesters. The Kruskal Wallis test disclosed a significant difference in drudgery level ($p = 0.048$), technology adoption ($p =<0.01$), attitude towards livelihood ($p = 0.018$), and gender empowerment dimensions ($p =<0.01$) between women seaweed harvesters, men seaweed harvesters, and fishermen. Although women were more empowered than men; gender disparities exist in asset ownership, access to resources & services, usage of information sources, and being overwhelmed with productive and reproductive activities. Strategies include promoting joint ownership, gender-sensitive extension activities, gender-specific skill development, gender-friendly technological interventions, and gender sensitization.

Keywords : Seaweed Harvesters, Gender Empowerment Dimensions, Gender Analysis, Wild Seaweed Harvesting

Women seaweed growers of India- Exploring the intersection of farm and household dynamics at play

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Indian seaweed farming has witnessed almost three decades of steady growth and development, with the women farmers playing the archetypal roles in the work as well as domestic fronts in this family enterprise which they have nurtured over the years. Seaweed aquaculture is the emerging "mantra" to promote coastal livelihoods, meet the country's' self-sufficiency in carrageenan requirements and to promote its novel uses as biofuels and bio stimulants. As main actors of this small scale enterprise situated in Ramanathapuram district, Tamil Nadu, on the south east coast of India, , we explore how women prepare themselves to override the trade-offs in climate change, paucity for good quality seeding material, negotiate the uncertainties in supply and price and look forward for more profitable avenues in value addition. On the domestic front, we investigate the finer nuances of gender stereotypes in the backdrop of a normative patriarchal society and the struggles of women in fulfilling the dual roles of a spouse as well as income provider within prescriptive chattels of the community structure. We study the predictor variables which best characterize the difference between men and women sea weed growers, using discriminant function analysis. Decision making ability, possession of smart phone, family size, educational status and status as head of the family were the main predictor variables which were delineated as successful in explaining the gender divide.

Impact of COVID-19 on women fishers of Sundarban in India

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The Sundarban region in India is of critical importance in view of it being a vulnerable estuarine fisheries resource in the world. The role of women in fisheries of Sundarban has been well recognized as their traditional occupation and primary means of livelihood in shore fishing, fish and prawn seed collection, shell fish harvest and other ancillary activities. The COVID-19 impacts shifted the livelihood vulnerabilities to a more uncertain position. In this study, the performance of women (n=47) in fisheries as a result of COVID-19 pandemic has been assessed in terms of pre- and post-covid fish production and incomes at Gosaba, Sandheshkhali and Hingalganj blocks in South 24 Parganas and North 24 Parganas district in West Bengal. The blocks are popular in Sundarban as tiger reserve, bird watching sites, honey collection sites, river tourism and hobby tourism sites. The women fishers are mostly involved in open water estuarine fishing in small boats and by operating fishing gears on shore. The average age of the women fishers is 49.94 years with a range of 25 to 88 years. The average years of schooling attended by the women fishers is 7.5 years. Only 4.25% women fishers had fishing experience upto 10 years. Most of the women fishers possess homestead ponds in their houses with an average area of 0.06 ha. The average annual catch of the women fishers before COVID-19 pandemic was 91 kg per fisher with the highest production of 250 kg. After COVID-19 lockdown restrictions were imposed, the average production came down to 83.83 kg. The average annual income was ₹ 46,000. The correlation coefficients between pre-covid fish harvest, female education, post-covid fish-harvest and possession of family homestead ponds are found to be positive and significant at $p = 0.1$.

Keywords: Sundarban, Women Fishers, COVID-19, livelihood

Women's roles and challenges in diverse fisheries activities

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Women have been an integral part of the fisheries sector with their roles defined according to the social, cultural, political, economic framework in which they function. They play a major role in pre-processing of fish, processing and marketing. Women engaged in fishing mostly restrict themselves to inland fisheries and activities like seaweed farming which does not take them very far away from their households. Roughly women constitute 50% of the workforce in Indian fisheries. Gender mainstreaming in fisheries has pointed out the needs, limited access to resources, lack of decision making powers, wage parity of women as compared to their male counterparts etc. The policy and technology initiatives aimed to empower women in fisheries included enabling access to financial services through SHG-microfinance models, improving communication, skill upgradation, identification of potential fishery related livelihood activities. In spite of all these concerted efforts to strengthen and empower women in fisheries, they face difficulties like occupational health issues, access to inputs, operational difficulties, lack of policy which are specific to the type of activity pursued by them. This presentation discusses the gender specific issues and challenges persisting in various domains like stake net fishery, reservoir fishing and pre-processing based on case studies.

Key words : gender, fisheries, livelihoods, challenges

Women and Labor in Fisheries

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A lack of clarity and consensus on basic terminology related to gender and labor, and women working in fisheries could lead to women's invisibility, lack of recognition and acknowledgement of their existence and contribution in the sector. Towards a common understanding on gender and labor in fisheries, we define some basic terms commonly used when applying a gender lens to activities in fish value chains, fisheries statistics, policies, and interventions. It is important to consider labor along the whole fisheries value chain, since some interventions may focus only and collect statistics for, on just the production node (of fishing and fish farming). This ignores the other nodes where labor typically engages more people, and most specifically where women are involved more. A discussion on various types of work that women do in and around fisheries, such as productive, reproductive and community work are also included, to bring attention to their importance in contributing to household, economic and community well-being. These definitions recognize the work that women do in fisheries and may help responsible parties create opportunities, address needs, and reduce and/or eliminate workplace vulnerabilities.

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AMALA	SHAJEEVA J	802,804,805
AMANJIT	NAYAK	846
AMBARISH	P G	43, 51, 78, 180, 181, 356, 432, 447, 560, 601, 670

AMBASANKAR	K	13,16,30,104,156,161,164,171,173,193,194, 244,268,818,835
AMBIKA	BINESH	122,225,274,296,351
AMBILY	M N	1,26,878
AMBROSE	T V	599
AMIT	SINGH BISHT	529
AMIT	RANJAN	130,162
AMIT	PATIL	136, 679
AMIT	MANDAL	203
AMITHA	SALIAN	7,00,704
AMIYA	SAHOO	404,664
AMOGHA	K R	406,484
AMULYA KUMAR	MOHANTY	825
ANAND	CHANDRAN	163,187,892,904
ANAND	THEIVASIGAMANI	20,425,427,759,789,790
ANAND	V	43,78
ANANDAN	SWATHI	3,21,432
ANANTHAN	P S	894,895,902,905,912
ANASU KOYA	A	468
ANBARASU	M	323,875,876,101
ANBAZHAGAN	V	378
ANBU KUMAR	K	312
ANDREW	DESBOIS	378
ANEESH	U	41,44
ANGELA MERCY	A	762, 323, 324
ANGOM BALESHWOR	SINGH	512
ANGOM LENIN	SINGH	288
ANIL	PAWASE	177
ANIL	M K	42, 43, 51, 78, 121, 356, 432, 447, 475
ANIL	KEWET	714, 758
ANIL DUTT	UPADHYAY	129
ANIRBAN	PAUL	333, 358
ANISHA	SHAFNI JOHN	137
ANISHA	VALSALAM	343
ANIX	SANTHIYA	15
ANJALI	P C	180
ANJALI	PUSHP	613
ANJALY	JOSE	251, 252, 257
ANJANAYAPPA	H N	583, 608, 628, 629, 630, 634, 636, 638, 640, 642, 643, 658, 660, 674, 688, 704, 714, 848
ANJULEKSHMI	P	269

ANJUSHA	M	241
ANKHITA	CHUTIA	814
ANKITA	GODAVARIKAR	403
ANNAM	PAVAN KUMAR	273
ANOKHI	CHANDRABABU K	694
ANSAI	MOHAMMAD	451
ANSAR	C P	468
ANSUMAN	PANDA	602
ANTONY	AMBROSE	385
ANTONY JESU PRABHU	PHILIP	208
ANU	GOPINATH	471
ANUJ	TYAGI	95
ANUJ	SHARMA	379
ANUJA	A R	849, 852, 854, 931, 857
ANULEKSHMI	CHELLAPPAN	504, 586, 619, 659, 668, 669, 677, 678, 686, 880
ANUPAM	PANDEY	102, 192, 272, 295
ANUPAMA	RAVIKUMAR	467
ANUPAMA	T K	727, 770
ANURAJ	A	57, 269, 348, 377, 609, 834
ANUSHIADEVI	T	499
ANUSREE	NAIR	356
ANVAR	ALI P H	667, 672
ANWESHA	BEHERA	675
ANANDA RAJA	R	156, 161, 302, 345
APARNA	RADHAKRISHNAN	825
APARNA	CHAUDHARI	231, 239, 249, 273, 291, 293, 294
APARNA	S	332, 392
APARNA	ROY	878, 883, 911
ARISEKAR	U	627,760,765,781,782,783
ARABINDA	JENA	335
ARABINDA	DAS	400
ARASAN	SRINIVASAN	20, 420, 421, 426, 438, 442, 671
ARATHI	DHARMARATNAM	341
ARAVIND	REVI	457, 458
ARAVIND	R	47, 52, 94, 97, 268, 345, 449, 562
ARAVINDH	G	685
ARAVINTH	G	898
ARCHAN KANTI	DAS	878
ARCHANA	SATHEESH	42

ARCHANA	SIDDAIYA	779
ARCHANA	MISHRA	288, 291
ARCHANA	S	806, 807, 809
ARCHISMAN	RAY	281, 375, 480, 492, 511, 621
ARISEKAR	ULAGANATHAN	627, 760, 765, 781, 782
ARITRA	BERA	9, 38, 49, 58, 98, 104, 156, 259, 338, 821, 900
ARITREYEE	DATTA	330
ARJUN	ARULVEL	715
ARJUNAN	SATHIYANARAYANAN	298
ARMAAN ULLAH	MUZADDADI	695
AROCKIA KEVIKUMAR	JULIUS	788
ARPITA	SHARMA	813
ARUL	VENKATESAN	250, 397, 407
ARUL	OLI	858, 859
ARUL VICTOR	SURESH	215
ARUN	JENISH	787
ARUN	SUDHAGAR	131, 322, 339, 341, 392, 394
ARUN BHAI	PATEL	119, 120, 129, 212
ARUNA	THOMAS	597
ARUNA	S	416, 433, 440, 493, 622
ARUNACHALAM	R	35
ARUNACHALAM	SUBBURAJ	671
ARUNDAS	N H	12, 142
ARUNJYOTI	BARUAH	81, 105
ARVIND	SAHAY	643
ASHA	K K	755
ASHA	P S	127, 210, 494, 499, 646, 652
ASHA	T LANDGE	588, 602, 606, 680, 690
ASHA HEMA	MALINI	714
ASHISH	SAHU	657
ASHISH	JHA	770
ASHISH	P M	45, 334
ASHISH	MOHITE	739
ASHISH	KUMAR JHA	739, 770, 512
ASHOK KUMAR	J	235, 243, 244, 247, 819
ASHOK KUMAR	JAISWAR	540, 602, 616, 786
ASHUTOSH	LOWANSHI	69
ASHUTOSH.D	DEO	174, 172
ASHWIN	SIVASANKAR	75, 80
ASHWINI	GOPI	528

ASIM KUMAR	PAL	284
ASIT KUMAR	BERA	911
ASOKAN	P K	71, 73, 76, 121, 385, 455, 456, 468, 475, 554, 558, 559, 578, 583, 848, 870
ASWATHY	JOSHY	356
ASWATHY	ASWATHY	857
ASWATHY	NATARAJAN	820, 827, 844, 849, 852
ASWATHY	T	12
ASWINI	A	424, 498
ATCHUTHAN	PURUSHOTHAMAN	45, 334
ATHIRA	P K	870
ATHIRA	N R	827, 844, 852
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ATHITHAN	S	750
ATHULYA	C K	190
AUROBINDA	UPADHYAY	110, 125, 126, 389, 683
AVINASH	RASAL	357, 81
AVUNJE	SATHEESHA	39
AYESHA JASMIN	S	109, 7, 40
AYYARU	GOPALAKRISHNAN	137
AYYATHURAI	KATHIRVEL PANDIAN	405
AZAD	SAHEB	170
AZHAHIANAMBI	P	309
AZHAR	SHAHANSHA T S	253, 254
JOHNSON	B	230
JENNI	B	578
NAYAK	B B	588, 602, 606, 651 , 676, 680, 735, 745, 746, 755, 775,
GIRI	B S	313
MANOJ KUMAR	B	808
MADHUSUDANA RAO	B	698, 699
SONA	B R	447
BABITA	MANDAL	821, 9, 54, 232, 259
BABITHA RANI	ASANARU MAJEEDKUTTY	85
BABIYOLA	D	64, 144, 611, 711, 794
BAISAMPAYAN	BARAL	358
BALA AMARNATH	C	346
BALAJI	MATHIVANAN	778
BALAKRISHNA	CHINTADA	410

BALAKRISHNAN NAIR	T M	874
BALAMANIKANDAN	V	783
BALAMURUGAN	RAMACHANDRAN	250
BALAMURUGAN	JEYAGOBY	48
BALAMURUGAN	J	94
BALANGE	A K	419, 761
BALARAMAN	T	263
BALASUBRAMANIAN	C P	268, 562, 872
BALASUNDARI	S	705, 712, 747, 767
BANDLA	SESHAGIRI	201, 882
BARANIDHARAN	S	752
BAREEN MOHAMED	M	563
BASANT KUMAR	DAS	911
BASDEO	KUSHWAHA	286, 521
BASHEER	V S	292, 625, 114
BASKAR	K	877
BASKARALINGAM VASEEHARAN	VASEEHARAN	378
BAVASRI	R	611
BAVITHRA	R	14, 41, 44
BEENAMOL	C	809
BENAKAPPA	S	688
BHARATHI	S	211, 535
BHARATHI	RATHINAM R	390, 401, 651, 690
BHARATHIPRIYA	R	733
BHARGAVI	PRIYADARSHINI	120
BHAVANJALI	M R	636, 638, 658, 660
BHENKATESH	PADHAN	128
BHUPENDRA	SINGH	518
BHUVANESWARI	T	835
BIBHUBATTA	MISHRA	70, 133, 271
BIBU	MISHRA	132
BIJAY	BEHERA K	91
BIJI	XAVIER	90, 179, 189, 266, 267, 349
BIJU	FRANCIS	19, 47, 48
BIJU	I F	52, 63, 65, 87, 94, 96, 97, 268, 337, 562, 872
BIJU SAM	KAMALAM	192, 215, 272, 295
BIKASH CHANDRA	MOHAPATRA	70
BINCY	M RAJ	571, 610
BINDU	SULOCHANAN	446, 455, 474

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BINDU R	PILLAI	6,28, 46, 70, 81, 133, 200, 271, 501, 737, 837
BINEESH	K K	548, 670
BINESH	AMBIKA	122, 225,274, 276, 296, 351, 369
BINOY	BHASKARAN	820
BINSI	P K	694
BINU	VARGHESE	22
BIPIN	VISHWAKARMA	295
BISMAY	SAHOO	229, 258, 273
BISWAJIT	DASH	108, 491, 577, 663, 753, 873
BISWARUP	SAHA	897
DAS	B K	178, 603, 624
BOBY	IGNATIUS	820, 834
BOOBALAN	SIVAMURUGAN	163
BOOMIKA	R	144
BRAJESH KUMAR	DUBEY	7
BRIMAPUREESWARAN	R	708, 722, 752, 898
BRUNDA	A	607
SAIRAM	C V	819, 824, 826, 828, 830, 835
SUDHAN	C	445, 539, 541, 574, 593, 641, 649
LLOYD	CHRISPIN C	814, 823, 836
RAJESWARI SEKAR	C	416, 418
CANCIYAL	JOHNSON	552
CHADHA	N K	218, 85, 191
CHANDAN	G M	149
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CHANDANA	B L	292
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CHARAN	RAVI	114, 292
CHELLAMANIMEGALAI	P	502, 645
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CHIDAMBARAM	P	150, 152
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CHINMAYEE	MUDULI	340
CHINNADURAI	SHUNMUGAVEL	861
CHINNAMNAIDU	DASARI	410
CHINNASAMY	RAGAVENDRAN	350

CHINNIBABU	BATHINA	266, 267
CHIRANJIV	PRADHAN	165, 166, 186
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CHRISOLITE	B	705, 762, 768
COWSICAA	G M	722
DURAIRAJ	SUKUMAR	695,
MANIMEKALAI	D	420
PRAKASHAN	D	599
KARUNAKARAN	D	890
MANIKANDAVELU	D	8, 28, 221, 416,433, 440, 493, 622, 731, 733
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DABIR	PATHAN	739
DANI	THOMAS	9, 58, 77, 98, 104, 259
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DARSHAN	K S	629
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DAVID	SMITH	380
DAVID KINGSTON	SAMUEL	600, 604, 641
DAYAL	DEVADAS	673
DEBABRATA	PANDA	70, 133, 271
DESAI	A Y	538
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DEBOSHMITA	DEY	902
DEEPA	M	270
DEEPA	V	144
DEEPAK	AGARWAL	231, 233
DEEPAK	VAGHELA	495
DEEPIKA	KURRE	347
DEEPIKA	BASKAR	709
DEEPTHI	ANDE	859
DEVADHARSHINI	K	794
DEVADHARSHINI	SAKTHIVEL	706, 726, 761, 794
DEVANAND	T N	688

DEVANANDA	D	607
DEVANATHAN	J	896
DEVATI	JAISWAL	405
DEVIKA	N T	243
DEVIKA	S P	889
DEVIKA	PILLAI	387, 399, 402
DEVIVARAPRASAD REDDY	ALLA	374
DHAKSHINAANANDAN	V	611
DHALONGSAIH	REANG	249
DHAMODHER	MOTURU	320
DHANALAKSHMI	M	596
DHANANJAY KUMAR	VERMA	593
DHANPAL	KANDAN	503, 705, 709, 717
DHANUTHA	V R	355
DHARMAKAR	PADALA	138
DHARMENDRA KUMAR	MEENA	664
DHARSHAN	K S	628
DHEERAJ	S B	359, 363
DHEERAN	P	22
DHIJU DAS	P H	808
DHINESH	PALANIAPPAN	777
DHIVYADHARSHINI	KRISHNAN	306
DHRUBA JYOTI	SARKAR	511, 514
DIBAKAR	BHAKTA	564 , 617
DIBYENDU	KAMILYA	376
DILEEP	VASUDEVAN	330
DILIP	MUKHERJEE	300
DILLIP	OJHA	335
DILLIP KUMAR	BEHERA	335
DIMPAL	THAKURIA	365, 370
DINESAN	CHERUVAT	468
DINESH	KAIPPILLY	137, 142, 846
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DINESHBABU	A P	557, 580, 684, 908
DINESHKUMAR	E	805
DISHENKUMAR	B	877
DIVU	DAMODARAN	786
DIVU	D	432, 832
DIVYA	MERIL	436

DIVYA	VISWAMBHARAN	450, 451, 569
DIVYA	P R	283
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DUSHYANT	MAHAVADIYA	61
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ELAKKANAI	P	55,260,
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CHANDAPRAJNADARSINI	E M	578
ABDUSSAMAD	E M	567, 580, 586, 587, 597, 599, 668, 669, 677
EBCIFA	FERNANDEZ	25
ELAKKANAI	P	55, 260
ELANGOVAN	PRABU	160, 167, 169, 195, 196
ELAVARASAN	KRISHNAMOORTY	721, 723, 725, 727, 738, 751
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EZHIL PRAVEENA	P	327, 334, 337, 342, 346
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FATHIMA	ASHARAF	740, 742
FELIX	N	32, 33,34,111, 154, 156, 157, 158 , 159, 160, 165, 166, 167, 169, 195, 196, 199, 214, 240, 242, 398
FEMEENA	HASSAN	861
FEROLIN	JESSINA	399
FEROSEKHAN	S	68, 132, 200, 213, 216, 388
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GEEVARETNAM	JEYASEKARAN	670, 765, 766, 772, 781, 782

VIJAY	G	10
KAMEI	G	795
TAMILMANI	G	14, 41, 44, 181, 230, 323, 324, 860
GOPAKUMAR	G	230, 860
GOWANE	G R	230
TAMILMANI	G	14, 41, 44, 181, 230, 323, 324, 860
THIAGARAJAN	G	58, 72, 74, 77, 98, 104, 259, 821, 835, 900
BHUVANESWARI	RATHI G	27, 481, 508
SAHA	G S	822, 901
GADADHAR	DASH	400
GAJENDRA	GULLADI	700, 704
GANDHI	A	5,25,533
GANESAN	PONESAKKI	743
GANESAN	PANDI	705, 706, 726
GANESH	CHANDRA	115, 863
GANESH BABU	S	307, 312, 317
GANESH KUMAR	T	512
GANGARAJ	K P	247
GANGATHARAN	S	306, 307, 319
GANGESWAR	MOHAN	759
GARGEE	DAS	79, 299
GAUTAM	KUMAR	119, 120, 129
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GEETANJALI	DESHMUKHE	419, 502, 645, 649, 897
GEETHA	M	895
GEETHA	SASIKUMAR	447, 450, 475, 485, 499, 576, 605, 623, 650, 847
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GEETHALAKSHMI	VAIDHYANATHAN	861, 915
GEETHU	MOHAN	449
GEETHU	GOPINATHAN	870
GEEVARETNAM	JEYASEKARAN	695, 765, 766, 772, 781, 782
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GEORGE	NINAN	697, 724
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GIRISH	BABU	403
GIRISH	M H	608
GIRISHA	S K	359, 360, 363, 364, 608
GLADSTON	Y	670
GOBINATH	SEKAR	778
GOKUL RAJ	ARIVALAGAN	336
GOKULPRASANTH	MURUGAN	731
GOKULRAJ	S	722
GOMATHI	P	42, 43, 51, 78, 121, 447, 475, 578
GOMATHY	S	532, 533, 563
GONUGODUGU	PRAVEEN KUMAR	717
GOPAL	KRISHNA	31, 79, 175, 176, 183, 288, 293, 746
GOPAL	ROUT	61
GOPALAKRISHNAN	A	88, 90, 137, 181, 252, 257, 280, 372, 397, 407, 432, 461, 463, 468, 548, 578, 580, 589, 832, 834, 844, 913
GOPALAMANI	MURUGESAN	789
GOPALAN	P V	554, 558, 559
GOPIKA	R	825
GOPINATH	D	428, 452, 457, 458, 482, 528
GOUR SUNDAR	SAHA	822
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GOVINDHARAJ	SATHISHKUMAR	167, 169, 195, 196
GRACE	ANGEL	215
GREEN SEA	KENNEDY	815, 816
GREESHMA	S S	720
GRINSON	GEORGE	666
GRISHMA	TEWARI	635, 637, 639
GULGUL	SINGH	295
GUNJAN	KARNATAK	115, 863
GURPREET	SINGH	888
GYANARANJAN	DASH	108, 463, 491, 577, 581, 663, 753, 873
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HARINI	R	693, 754, 763
HARINIVAS	MANTHIRA MOORTHI	276, 296
HARISH	BISHT	66
HARISHA	RATHOD	377, 630
HARMANJIT SINGH	BANGA	888
HARSHA	NAYAK	603
HARSHAD	SOLANKI	495
HARSHATH	D G	636
HARSHAVARTHINI	M	262
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HASSAN	M A	115, 863
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HIMANSHU	PRIYADARSHI	129, 212, 613
HIMANSHU SEKHAR	SWAIN	91, 110, 125, 126, 375, 389, 480, 492, 683, 878
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HINDUJA	R	730
HIRABHAI M	BHINT	832
HITESH	KARDANI	561
HOILENTING	VAIPHEI	892
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JAMESAMMAL	S	499, 650, 652
JANGAM	ASHOK KUMAR	228, 234, 237, 245, 321
JASMIN	FELIX	460, 575, 576, 578, 652
JASMINE	S	280, 451, 468, 656
JASPAL SINGH	HUNDAL	95
JAWAHAR	P	20, 420, 421, 426, 438, 442, 454, 509, 515, 534, 538, 549, 600, 604, 641, 665, 671, 681, 682, 802, 815, 816, 866
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JAYARAJ	S	907
JAYARAMAN	R	838, 839, 840, 841, 842, 843, 862, 867, 868, 869, 904
JAYASANKAR	JAYARAMAN	278, 461, 463, 580
JAYASINGH	M	41, 44
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JESNA	P K	178
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SUNDHAR	SHANMUGAM	776
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SUNIL	MOHAMED	485, 623, 659, 686, 855
SUNIL	K T S	620, 632
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SUNIL KUMAR	NAYAK	249
SUNITHAKUMARI	K	475
SUPREET	KAUR	635
SUPRITI	BAYEN	487, 492
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SURESH BABU	P P	377
SURESH KUMAR	MOJJADA	414, 432, 832
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SURYAPRABA	V	836
SUSEELA	MATHEW	723, 825
SUSHANTA	CHAKRABOTY	572
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SUTANU	KARMAKAR	508
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SYAMA DAYAL	J	173, 185, 247, 334, 458, 459
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RETHEESH	T B	599
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TAMIL SELVAN	RAJARAJAN	665, 810
TAMILARASU	A	211
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TANUSHREE	BERA	480, 487
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TAPAS KUMAR	GHOSHAL	38, 171
TARIQ HUSSAIN	BHAT	72, 702, 710
TARUN	JOSEPH	666
TARVINDER SINGH	HANDA	888
TEJAPAL	C S	727
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THAKARE RHISHIKESH	D	642, 643
THAKUR	DAS	648, 659, 686
THAMARAI SELVI	MANIMANNAN	488
THAMARAISELVAN	R	270
THAMIZHVANAN	S	324
THANGJAM NIRUPADA	CHANU	487
THEIVASIGAMANI	ANAND	20, 425, 427, 759, 772, 789, 790
THIAGARAJAN	GOVINDARAJAN	58, 71, 74, 77, 98, 104, 259, 821, 826, 835, 900
THILLAINATHAN	R	752
THIRUMALAIKUMAR	ESWARAMOORTHY	379
THIRUMALAISELVAN	SHANMUGAM	434, 437, 439, 448, 524, 532, 533, 567,568, 615, 791, 792
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UTKAL LAXMI	MOHANTY	837
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