ANNUAL REPORT

2018-2019

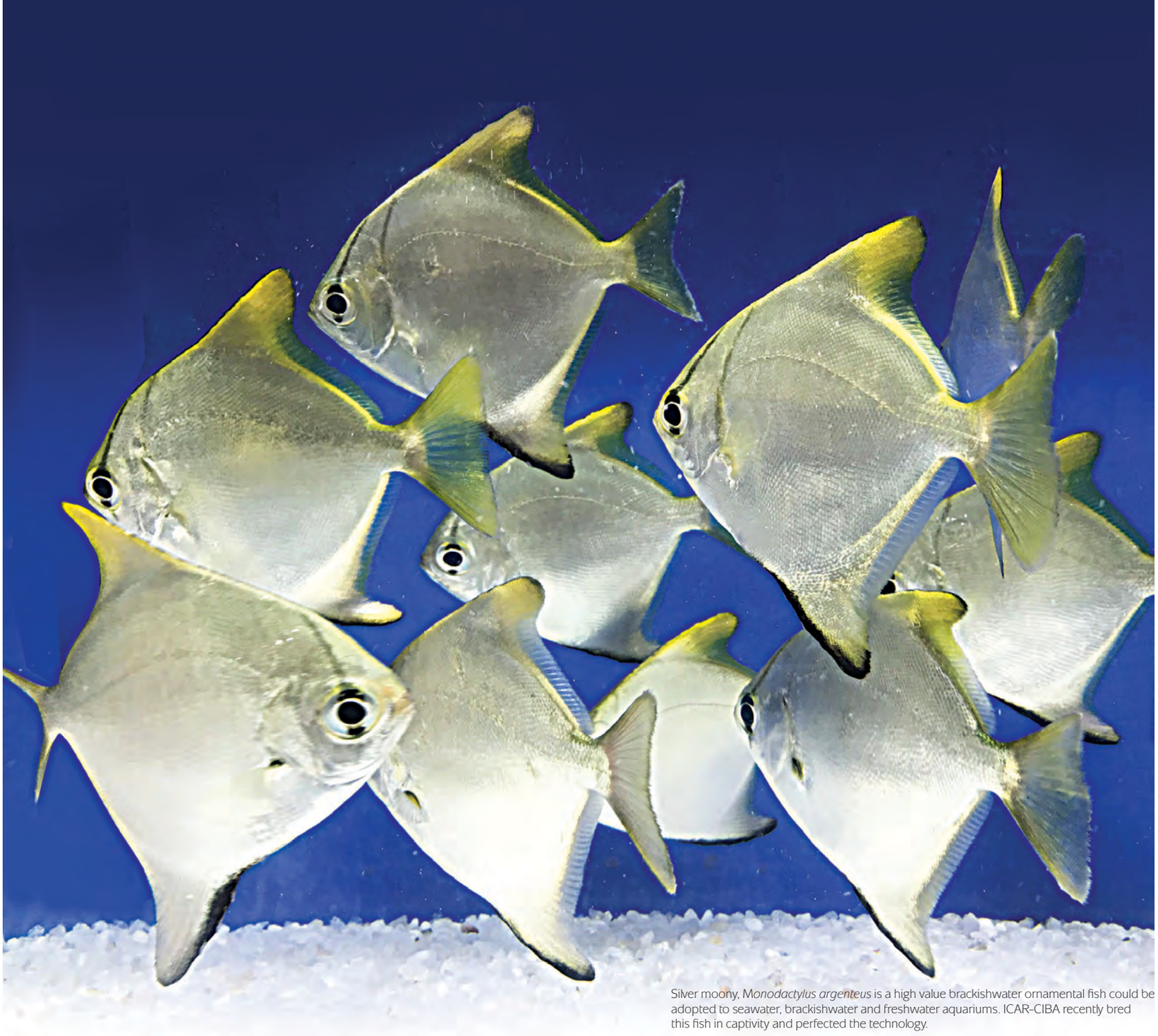


Asian seabass, *Lates calcarifer* is a high-value food fish from brackishwater. ICAR-CIBA perfected the technology for year-round breeding, seed production, feed and farming of seabass as pioneer in India.

CIBA

ICAR-CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE

भा.कृ.अनु.प.–केन्द्रीय खारा जलजीव पालन अनुसंधान संस्थान



Silver moony, M*onodactylus argenteus* is a high value brackishwater ornamental fish could be adopted to seawater, brackishwater and freshwater aquariums. ICAR-CIBA recently bred this fish in captivity and perfected the technology.

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2018-19

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PREFACE



We are promoting community based brackishwater aquaculture in coastal states to improve the quality of rural life and diversifying the livelihood opportunities. In general, brackishwater aquaculture is considered to be high valued and cost intensive, and therefore, rural poor were excluded from the real benefits of this form food production system that theoretically offered

Fish is one of the most-traded food commodities worldwide with more than, half of the global production coming from developing countries. World per capita fish supply peaked at 20/kg in 2014, mainly due to development in aquaculture. Fisheries and aquaculture are expected to contribute significantly to the food security and nutritional requirement, for the projected global population of 9.8 billion by 2050. Brackishwater aquaculture, particularly shrimp farming, is one of the most dynamic and fast growing food producing sectors, contributing substantially to the economy and sustainability of coastal communities worldwide. Indian brackishwater aquaculture production alone has touched 0.75 million tons, valued at 7 billion US $, in the year 207-2018. Modern day aquaculture is rapidly evolving with the support of scientific innovations and technological support in the areas of genetics, breeding and stock improvement, nutrition and feed biotechnology, disease and health management, farm management and social aspects.

The year 2018-19 was remarkablefor ICAR-CIBAwith the conduct of a world conference on brackishwater aquaculture, BRAQCON 2019, a significant event in the context of brackishwater aquaculture, food security and societal development.It was a unique platform that brought a large number of Indian and overseas researchers, academicians, farmers, and other private sector stakeholders. BRAQCON has been conceived as a biannual world conference, representing the bracksihwater aquaculture sector on world platform, that provide an excellent opportunity to exchange latest scientific information and ideas, and more importantly it represents a new and exciting chapter in the scientific journey of CIBA

Brackishwater aquaculture plays a leading role role in the nutritional and financial security of the country. The major mandate of CIBA has been to innovate, catalyse and transform brackishwater aquaculture towards the goal of sustainability. In India, the growth engine and economic face is the shrimp farming sector, it has been almost synonymous to the aquaculture of Pacific white shrimp, Penaeus vannamei. After achieving a record growth in farmed shrimp production, currently the industry has been confronting sustainability challenges, due to multitudes of reason ranging from emergent disease to the the fluctuation in market rates. The institute has been addressing this issue holistically by developing diversified production systems and species, and formulating science based strategies for better biosecurity protocols. A cost effective biofloc based nursery system has been developed and demonstrated in Odisha and Andhra Pradesh. Within 28 days of rearing, animals reached almost 1 g with a survival of 94%. This intervention effectively reduced the total production cost

Diversification of species has been well acknowledged as an option for achieving sustainable development. As Indian brackishwater aquaculture heavily depends on a single exotic species, it is imperative to find a 'desi' option to complement and the single species development. Indian white shrimp, Penaeus indicus, has been identified as the national priority species for domestication and genetic improvement. Demonstration trials have been carried out in the different agro climatic zones, and it is confirmed that growth and production of this species are comparable to vannamei, in size ranges of 15-22 g, at lower and higher salinity regimes are similar. Further, we are a step closer to the domestication of Penaeus indicus by developing F0 generation, and successfully producing F1 generation of P. indicus under captivity. A procedure for in vitro fertilization of P. indicus has been successfully developed, and it provides an opportunity to remove the barriers of natural mating in breeding programs as well as in the hybridization programs particularly in closed thelycum species.

The recycling of waste in the fish market and landing centres into useful product is one of the

efficient management measures to improve ecosystem health and diversification of the livelihood of coastal fishers. Almost 25 to 50% of fish in the fish markets becomes waste; the institute has made an efficient method to transform these wastesinto a useful commercial product, a plankton booster ('Plankton Plus') in aquaculture ponds fertilizer for horticulture crops, and quality fish meal. Application of plankton plus in shrimp ponds, resulted in significant improvement has been obtained in the average daily growth, specific growth rate, total biomass gain and survival even when 30% less feed was offered.

Deciphering draft genome sequence of organisms has major impact on multiple research fields, and it would provide knowledge on entire genetic architecture of their biology. Genetics and biotechnology group of CIBA was able to decipherabout 73% of the genome of Indian white shrimp, Penaeus indicus, using Pacbio sequel technology. By the end of this year we expect that we would have a complete genome sequence of this species only second shrimp genome, after vannamei. This understanding would catalyse research progress in several fields of biology, particularly selective breeding program of this priority species.

We are promoting community based brackishwater aquaculture in coastal states to improve the quality of rural life and diversifying the livelihood opportunities. In general, brackishwater aquaculture is considered to be high valued and cost intensive, and therefore, rural poor were excluded from the real benefits of this form of food production system that was theoretically offered. We, in collaboration with the Mangrove cell, Maharashtra have initiated three-tier seabass farming program such as nursery rearing, pre-grow out and grow out culture in mangrove coastal ecosystemas a community based farming. It provides novel employment opportunity to the coastal communities also producing the valuable and quality fish such as seabass through brackishwater cage farming in backwaters.

Although most aquaculture production is devoted to food production, ornamental fish production for aquarium trade is an important and vibrant component of aquaculture world over. Whilst most aquarium trade focuses on freshwater species, there is a continued interest in developing new salt water species. During the last year our fish breeding group was successful in developing a captive rearing technology for an important brackishwater ornamental species, silver moony, Monodactylus argenteus. This is an important step for the transition of ornamental fish trade of this species from wild caught stocks to more sustainable breeding based mode.

One of the highlights of the year 2018-19 was that our nutrition scientific team won the prestigious ICAR team award, Nanaji Deshmukh ICAR Award. The team has successfully developed indigenous feed processing technologies and cost-effective feeds for all the life stages of potential candidate brackishwater shell fish and finfish species cultured in India. At CIBA, feed biotechnology research team could successfully downsize the commercial feed mill machinery and customize the requirements and processing conditions as per the demand of the clients, and successfully commercialising the technologies for the benefit of stakeholders.

As a research and development organization, the success is measured by the output of the scientists who implemented the research projects. In the the current year, CIBA scientists published forty five research articles in reputed national and international journals. CIBA's Technology management unit has seen a significant success during this year. In order to expand the adaptation of research, technologies and intellectual assets, the institute has made 21 partnership agreements with private farmers, industry and government.

It has been greatly rewarding to serve as the Director of this prestigious Institute, and closely work with motivated and resourceful players. Looking back at what CIBA has done during the last one year makes me immensely happy. Our contribution is tangible and visible, although we have a long way to go in the journey of sustainability. I look forward to having much greater achievements in multidisciplinary brackishwater aquaculture research. It will help us to evolve a sustainable aquaculture with economic benefits.

What I narrated in this brief preface is only a snapshot of CIBA's achievements of the current year. I invite you all to peruse the full report in print or online. The following pages are the testimony for our combined and dedicated passion to provide scientific solutions for challenges and problems in the brackishwater aquaculture.

We are incredibly grateful to all the stakeholders and farming community who supported us. I am immensely grateful to Dr Trilochan Mohapatra, the Director General of ICAR and Secretary DARE without his professional support all these research performance and achievements would not have been possible. I am deeply indebted to Dr J.K. Jena, Deputy Director General (Fisheries) for his keen support, enthusiasm and timely help. I sincerely thank Dr Pravin Puthra, Assistant Director General (Marine Fisheries) for his continued support and guidance. ■



K.K.Vijayan
Director

EXECUTIVE SUMMARY

The current year, 2018-19 was an important and productive year for CIBA. The institute has been pursuing research and development for the development of sustainable brackishwater aquaculture. With twenty-nine in-house and external funded research grants, and with several out-reach activities, CIBA has contributed remarkably towards the development of science of brackishwater aquaculture. As a research and development organization, the success and effectiveness of the organization have been measured by the outputs of scientists/researchers. The current year, the scientists from CIBA has published 39 peer –reviewed research articles in the various reputed national and international journals. Further, thirty-one commercial agreement has been signed with the stakeholders during the current year. The institute maintained the quality of the research and it is evidenced by winning the most prestigious ICAR team award, Nanaji Deshmukh ICAR Award for outstanding interdisciplinary team by the Fish nutrition division of CIBA. Further, Dr M. Kumaran, Principal Scientist of CIBA obtained Swami Sahajanand Saraswati Outstanding Extension Scientist Award. Some of the highlights of research and development accomplished by the institute during the last year are presented below.

DEVELOPMENT OF POND REARED INDIAN WHITE SHRIMP STOCK

Shrimp farming in India, which is almost exclusively based on exotic *Penaeus vannamei*, is at a cross road due to the emerging disease, reduced survival, increase in the cost of production and recent falls in the prices. At this context, development of a native species is a viable option to ensure sustainability of shrimp farming. Indian white shrimp, *P. indicus*, has been identified as suitable candidate species for domestication and genetic improvement. Experimental trials have been carried out to develop captive/pond reared broodstock of P. indicus, which is the primary requirement of any selection program. Hatchery reared post larvae of P. indicus were grown to broodstock size (25-35 g) in earthen pond, These F0 generation were successfully bred under captivity, and F1 generation offspring were are being further reared.

POLYCULTURE OF INDIAN WHITE SHRIMP (*PENAEUS INDICUS*) AND MILKFISH (*CHANOS CHANOS*)

Polyculture of shrimp has been proved to be viable alternative to reduce the nutrient waste from the aquaculture facilities and to optimize the economy shrimp farming. In order to evaluate the production performance of polyculture of *P. indicus* (stocking density: 25 PL/m^2) and *C. chanos* (0.25 no/m^2 and 0.5 no/m^2), a 75 day culture experiment was carried out. Highest survival (79.33± 1.88 %) and production (1451.28± 22.15 kg/ha) of shrimp was recorded in the pond which P. indicus reared with milkfish at a stocking density of 0.5 ind. /m^2, although significantly higher average body weight obtained at the pond stocked with milkfish at a stocking density of 0.25 m^2.

BIO-FLOC BASED NURSERY REARING TECHNOLOGY FOR *PENAEUS VANNAMEI*

Bio-floc technology has been an emerging alternative towards the environmental friendly aquaculture. This technology is characterized by reduced water exchange, reduced feed use and improved biosecurity. *Penaeus vannamei* PL were reared at a stocking

density3500 PL/m^2 in 350 mt capacity nursery tank designed by the institute for a period of 28 days. Nursery reared animals were grown up to 0.92 ± 0.15 g with a survival of 94.20± 2.86 %)

EVALUATION OF AQUA-MIMICRY TECHNOLOGY ON GROWTH PERFORMANCES, WATER QUALITY AND IMMUNE RESPONSES IN RAS ENVIRONMENT

A RAS based nursery rearing was carried out with addition of carbon source and rotifer as feed supplement. The survival and growth was monitored every 15 days in each treatment. The treatments included as C: control, T1: only Biofloc, T2: Biofloc and rotifer, T3: only Rotifer. At the end of Experiment the rotifer with biofloc condition showed better growth (3.89±0.25) and survival (91%) which is significantly different from control animals (3.24±0.29, 85%).

GROWTH PERFORMANCE, OSMOLARITY OF INDIAN WHITE SHRIMP JUVENILES REARED AT DIFFERENT SALINITY

A 50-day experiment was carried out to study the growth performance, water quality, osmolarity and serum mineral profiles of *P. indicus* juveniles (0.4-0.5g) reared at different salinity. Osmolarity study reveals serum osmolarity changes proportionately with ambient water salinity

NURSERY REARING OF *PENAEUS INDICUS* IN THE ESTUARINE ECOSYSTEM AS A LIVELIHOOD ACTIVITY:

A nursery rearing model for Indian white shrimp, Penaeus indicus, has been demonstrated for self-help groups at Uyallikuppam village (Palar backwaters) near Kalpakkam (Tamil Nadu). Penaeus indicus (n= 400) of 1.5g size were separately stocked in 4 hapas (2 m x 1m size) and reared for sixty days. On an average of 8.50 g size of P. indicus were obtained with 90 % survival

DEVELOPMENT OF SUBMERSIBLE CAGE SYSTEM FOR MUD CRAB GROW OUT PRODUCTION:

Mud crabs are benthic organisms, and therefore, pelagic/floating cages adversely affect the physiology of these animals owing to the relatively higher surface and sub surface temperature. In order to circumvent the issues of subsurface/floating cages, easy-to-manage submersible cages have been developed, and evaluated the culture performance with reference to the floating cages. Average weight gain was >100 g in submersible system whereas it is significantly less in floating system (<15 g) indicating that submersible system outperforms traditional floating system. It could be concluded that implementation of submersible cum floating crab culture system provide higher growth compared to conventional one for crab fattening.

OPEN WATER CAGE AQUACULTURE IN MANGROVE REGIONS OF MAHARASHTRA

In collaboration with Mangrove cell, Maharashtra CIBA initiated three-tier seabass farming involving in and around of mangrove coastal waters in Sindhudurg, Maharashtra with participation of self-help groups. (SHGs). Around six nurseries, a pre-grow-out and 33 grow-out cage cultures with the participation of SHGs have been formed. The SHGs have generated a total revenue of Rs. 3.16 lakhs through seabass nursery and pre grow out rearing work. From the grow out farming it is expected to grow 400-500g with an estimated total revenue generation of 10-12 lakhs.

INTEGRATED MULTI-TROPHIC AQUACULTURE (IMTA) OF SEABASS AND GREEN MUSSELS

To develop and propagate family farming models of candidate finfish and shellfish species in the west coast of India, initiated IMTA cage culture in Gad creek of Malvan, Sindhudurg. At present seabass have grown to size 400 g from the stocking size of 60 g with survival ranging from 79.30-90.03%. Harvest of 400-500g seabass is expected in mid-June 2019 with estimated total revenue generation of 2-2.5 lakhs.

JUVENILE MILKFISH AS ORNAMENTAL "SILVERFISH"

Milky white glittering, shining body, agility, semi-transparent V-shaped caudal fin, swifte movement pattern, wide salinity tolerance, voracious gracing on tank algae and disease resistance qualifies milkfish juveniles as a potential ornamental fish called "Silverfish". Being a highly compatible fish with other ornamental tankmates, were sold @Rs. 50/- /10 pair.

MILKFISH FARMING IN WEST BENGAL AS DECAN HILSA

Considering demand and preference of milkfish by local Bengalis, CIBA took efforts to popularize milkfish as 'Decan Hilsa' in West Bengal. By farming in four different culture systems, 1.3 ton of milkfish was harvested and well accepted by the Bengalis by the name Decan Hilsa.

FARM INPUTS USAGE PATTERN IN INDIAN SHRIMP CULTURE

A survey was conducted during 2017 to understand the input usage pattern in the shrimp producing states, Andhra Pradesh, Tamil Nadu, Gujarat and Maharashtra. The study showed use of environmental modifiers being used highest quantity to improve soil and water quality, followed by probiotics (water, soil and gut probiotics) and disinfectants. No record of use of anti-microbial product was observed during the study.

GROWOUT FARMING OF HILSA IN PONDS

Hilsa has good market potential in West Bengal, and there is a huge demand for table size hilsa. Two months old fingerlings were further reared in two different system viz. earthen pond and RAS using pelleted feed. After 11- months fishes reached around 80 g size, and the performance was better in ponds.

WIDE SALINITY TOLERANCE OF STREAKED RABBIT FISH, *SIGANUS JAVUS*

Streaked spine foot Rabbit fish, *Siganus javus* considered as important food fishes because of their fast growth rates, herbivorous food habits, and economic value. An experiment was carried out for 30 days to know their salinity tolerance levels. This experiment for the first time documented the wide salinity tolerance of *Siganus javus*, a potential herbivorous food fish for brackishwater farming

MALE REPRODUCTIVE QUALITY OF *PENAEUS INDICUS*

Spermatophore and sperm quality of penaeid shrimp often determine the success of seed production, particularly under captive condition. It is reported that reproductive tract development and spermatophores generation are generally compromised under captive condition. In order to evaluate the underlying principle of the process of reproductive development male shrimp reared in tanks and ponds were evaluated, and compared with wild caught shrimp. Sperm count was found to be significantly lower at the pond reared and tank reared animals compared to the wild caught shrimps.

EFFECT OF SHORT TERM CHILLED STORAGE ON THE SPERMATOPHORES QUALITY OF *PENAEUS INDICUS*

Storage of male gametes would eliminate the need to keep breeders for artificial fertilization. In order to evaluate the effect of chilled storage on quality of male gamets, spermatophores were refrigerated at 4 °C and sperm quality was evaluated at different intervals. Number of normal sperms was significantly higher in the first day of sampling than the fifth day of sampling. Acrosome reaction was also observed in the stored spermatophores at five days of preservation. Beyond five days, the sperm cells were disintegrating and viability was also not observed. This study proves the applicability of chilled storage as a preservation method for spermatophores

IN-VITRO FERTILIZATION AND HYBRIDIZATION POTENTIAL OF INDIAN WHITE SHRIMP, *PENAEUS INDICUS*

Procedure for *in vitro*-fertilization of penaeid shrimp was successfully developed. Successful intra specific fertilization of *P. indicus* was achieved with a hatching rate of 4.8%, and 29% of nauplii developed into post larvae.

EFFECT OF VARIOUS FEEDING REGIMES ON THE PHYSIOLOGICAL CHARACTERISTICS OF CAPTIVE *PENAEUS INDICUS* BROODSTOCK

This study was carried out to evaluate the effect of different levels of maturation diet (5%, 15% and 25% of body weight per day) and captive rearing on physiological changes such as growth, molting rhythms and maturation hormone levels of captive *P. indicus* broodstock. Molting frequency was found to be higher at treatment group fed at 15% of body weight. Further, after 45 days of captive rearing, this treatment group had the minimum GIH mRNA level.

SEABASS SEED PRODUCTION ACCOMPLISHED NEWER HEIGHTS

CIBA being a pioneer in captive breeding and seed production of seabass, recently standardised the protocols for natural spawning in captive condition. Out of 5.53 million eggs spawned in the last year, 2.66 million eggs spawned spontaneously and 2.87 million from induced spawning. An all-time high of 0.59 million fry seeds were sold in the year 2018-19 and a revenue of Rs. 1.72 million was realized. Additionally, 1.20 lakhs seeds were completely weaned for artificial feed and sent to Maharashtra.

BREEDING PERFORMANCE OF TWO DIFFERENT GEOGRAPHICAL STOCKS OF MILKFISH (*CHANOS CHANOS*)

While comparing the reproductive performance of milkfish from different geographically isolated stocks of east coast, Chennai stocks showed better performance with extended period of spawning. Both the stocks showed multiple spawning, and exposed the scope for year-round breeding of milkfish in captivity.

A GOOD PROGRESS IN CAPTIVE BREEDING OF GREY MULLET USING FARM REARED PARENTAL STOCKS

In 2017 mullet spawned and eggs got fertilized for the first time, but the larvae survived only for eight days. In 2018, due to intensive efforts lead to resulted in mass larval production 0.75 million. The larvae survived up to 28 days. Further optimizations on larval rearing is in progress.

MATURATION OF *LIZA PARSIA* REARED IN POND CONDITIONS

A study attempted with 300 number of *Liza parsia* (Goldspot mullet) for the reproductive maturation evidenced the ease of captive maturation with optimum water conditions and feed. Oocytes having less than 100 µm in diameter are non-vitellogenic in nature and, attained the maximum GSI and oocytes diameter of 606.55±17.02 and 18.31±2.0, respectively in captive condition. This observation evident that broodstocks of Liza parsia could be easily developed in pond conditions.

A GOOD PROGRESS IN CAPTIVE MATURATION OF MANGROVE SNAPPER

Targeting the technology on captive breeding of mangrove snapper, a total of 90 adult fishes are being maintained in broodstock holding systems. Oozing males were observed in during June to October 2018 and February to March 2019, indicating 8-21% male stocks were attained maturity. However, female maturation has not been achieved and indications are there for oocyte development.

INDUCED MATURATION AND SPAWNING OF SPOTTED SCAT IN RAS BASED HOMESTEAD FISH BREEDING MODEL

For simplification breeding in spotted scat, a RAS of 3000 L capacity and 12.9 m3/day flow rate with central drainage was fabricated and experimented. Adult scats were induced with varying level of and combinations of hormones. Female fishes were induced successfully with LHRHa 25 µg/kg/month, whereas combined dose of LHRHa + 17-αMT @ 25 + 25 µg/kg/ month was helpful to increase sperm density in males. These optimized doses would be useful for attaining spawning and larval production under RAS based homestead models.

CAPTIVE BREEDING OF SILVER MOONY, *MONODACTYLUS ARGENTEUS*

Captive breeding and seed production of this potential brackishwater ornamental fish was achieved using hormonal induction. The diameter of the egg was 860 ± 14.11 µm, hatched out in 18 h, and the hatching percentage was 90%. Newly hatched larvae were 1.60-1.67 mm. This will pave way for mass production and transition in use of wild caught to captive bred fish for export.

WSSV, EHP AND IMNV ARE MAJOR THREATS TO INDIAN SHRIMP FARMING

Active disease surveillance of shrimp farms during 2015-19 suggests that white spot syndrome virus (WSSV) and *Enterocytozoon hepatopenaei* (EHP) are the predominant pathogens affecting two major shrimp farming states AP and TN. The prevalence of WSSV ranged between 11-40% and EHP between 21-43%. The infectious myonecrosis virus (IMNV) has emerged as another major challenge with prevalence rate of 15% during 2018-19.

POLYCHAETE WORMS CAN TRANSMIT *ENTEROCYTOZOON HEPATOPEANEI* TO SHRIMP

CIBA studies revealed that the polychaete worms (*Marphysa* spp.) serve as carrier for shrimp pathogens such as WSSV and EHP. The EHP is horizontally transmitted from infected shrimp to polychaetes and *vice versa*. However, no evidence of vertical transmission was recorded in different developmental stages of polychaetes.

EHP SPORES REMAIN INFECTIOUS FOR MORE THAN A YEAR IN SEAWATER AT ROOM TEMPERATURE

The EHP spores were found to retain infectivity for a period of over 1 year in seawater at room temperature. The activity at such storage condition was lost only after 1 ½ years. However, spores stored at 4°C, -20°C and -80°C showed dramatic decrease with complete loss of spore viability and infectivity after one month.

GERMINATION OF EHP SPORES COULD BE EXPERIMENTALLY INDUCED

Germination of EHP spores was induced by using dyes such as potassium hydroxide and phloxine. The entire event of germination takes place in fewer than two seconds. The germinating spores infect the nearby potential host cell by striking the cell and piercing its membrane.

VERTICAL TRANSMISSION OF WSSV IN SHRIMP

In the experimentally infected *Penaeus indicus*, intranuclear inclusion bodies reactive to the VP28 probe were observed in WSSV infectied ovarian cells, suggesting that even a lower dose of WSSV infection has the possibility of vertical transmission.

MASS MORTALITY OF FARMED MUD CRAB, SCYLLA SERRATA IN ANDHRA PRADESH

Mass mortality of mud crab *Scylla serrata* culture was observed in Nagayalanka, Krishna district, Andhra Pradesh in 2018. Diseased crab samples were positive for white spot syndrome virus (WSSV). They were also heavily infested with metazoan crustacean parasite, stalked barnacle, *Octolasmis* spp. The haemolymph of infected crab showed increased total plate count and total Vibrio count compared to that of healthy ponds.

TILAPIA LAKE VIRUS (TILV) CAN BE TRANSMITTED TO SEA BASS

During disease Surveillance of sea bass farms co-cultured with tilapia, sea bass experienced chronic mortalities associated with haemorrhagic encephalitis were found to be affected with TiLV. Challenge experiment conducted to test the inter species transmission of TiLV from infected tilapia to seabass showed successful transmission of TiLV to sea bass with high cumulative mortalities.

PREVALENCE OF PARASITIC INFECTIONS IN BRACKISHWATER FINFISHES

Profiling of parasitic diseases during 2016-19 in brackishwater candidate fish species and crab suggested the presence of six major parasites such as *Argulus, Caligus, Lernanthropus, Zeylanicobdella, Anisakis* and *Octolasmis*. However, no parasitic infections were recorded in in mullets and milk fish.

MICROBIAL PROFILING OF ZOEA SYNDROME

Metagenomic study was conducted to figure out the etiology of the zoea-2 syndrome. Overall a total of 46 genera were seen specific to healthy, 328 specific to diseased and 371 genera common in both. Some of the genera were more abundant in zoea-2 syndrome affted samples are Devosia, Unclassified Rhodobacteraceae, Nonlabens, Muricauda, Unclassified Flavobacteriales, and Pseudoalteromonas.

MICROBIAL PROFILING OF CIBAMOX

The 16s rDNA based metagenomic microbial profiling revealed several novel bacteria involved in nitrogen metabolism. Bacterial group belonging to Caldilineaceae family were also dominant in ammonia oxidation besides *Nitrosomonas* and *Nitrobacter.* A large percentage of microbes identified in the AOB and NOB enrichments belonged to the phylum *Proteobacteria.*

CHARACTERIZATION OF QUORUM SENSING SYSTEM IN *VIBRIO HARVEYI* CLADE

To understand the virulence, quorum sensing system was characterised in sixty genomes of *Vibrio harveyi* clade. The autoinducer 2 synthesizing *luxS* gene was present in all the isolates of *V. harveyi* clade. However, autoinducer 1 synthesizing gene *luxM* was present in *V. harveyi, V. campbellii, V. jasicida* and *V. ovensiii* but absent in *V. natriegens* and *V. rotiferianus.*

RAPID DETECTION TECHNIQUE TO DIFFERENTIATE VIABLE AND DEAD EHP SPORE

A staining technique to assess the viability of EHP spores was developed. The viable spores stained by Calcofluor White appeared as turquoise-blue through the violet filter (395-415 nm). The dead spores stained by Sytox Green appeared as yellow-green oval bodies through the blue excitation filter (470-490 nm) and white-yellow through violet filter (395-415 nm).

DEVELOPMENT OF REAL TIME PCR ASSAY FOR DETECTION OF IRIDOVIRUS INFECTION IN FISH

SYBR Green based real time PCR assay was developed for detection of Iridovirus with detection limit of 10 viral particles. A membrane cofactor protein gene based PCR was also standardised for detection of iridovirus.

MATERNAL TRANSMISSION OF WSSV IN WILD *PENAEUS INDICUS* SPAWNERS:

Vertical transmission of WSSV, directly through gametes, has yet to be proved. In order to test this hypothesis, reproductive tissues of WSSV infected females were diagnosed for WSSV through qRT PCR, and found that reproductive tissues had only 50 to 60 copies of WSSV, and only 36% of reproductive tissues of infected females showed the presence of WSSV. However, in situ hybridization studies did not reveal positive signal for WSSV.

ISOLATION AND CHARACTERIZATION OF GUT MICROBES:

The Biofloc system is found to be advantageous and allows colonizing beneficial bacterial population in the gut region. Out of 94 strains screened, 36 strains were found to produce amylase enzyme, 20 strains protease, 27 strains lipase and 6 strains cellulase and 8 strains xylanase. Totally 21 isolates selected for further identification and different species of *Cobetia, Exiguobacterium, Bacillus, Marinilactibacillus, Staphyllococcus* and *Novosphingobium* genera from biofloc treatments were identified. In control strains of Bacillus and Exiguobacterium only observed. Among all, the genus Exiguobacterium identified in all treatments and control.

COMMERCIALIZATION OF WATER ANALYSIS KIT

A multi-parameter portable water analysis kit for dissolved oxygen, ammonia (0.1 to 2 ppm), nitrite (0.05 to 1 ppm), calcium & magnesium minerals, total hardness, carbonate, bicarbonate and total alkalinity in different source and pond waters of varying salinity has been developed and commercialised to New Bio Science Company, Mysore.

AQUACULTURE PLANNING WEB TOOL

CarryCap – An online aquaculture planning web tool for the estimation of carrying capacity of water bodies was developed and being used for the aqua zonation work by AP State Govt. for optimization of aquaculture development and to avoid conflicts among resource users.

SOIL WATER HEALTH CARDS AND LOCATION SPECIFIC BMPS

About 55 Soil water and water health cards were distributed to aqua farmers of Chidambaram and Nagapattinam Districts, TN. The SWHCs database has been analysed to capture the geographical variation which helps in framing Location Specific BMPs.

NUTRIENT DYNAMICS UNDER DIFFERENT CULTURE PRACTICES

Study on *P. vannamei* culture under simulated earthen and lined tanks under 25 ppt salinity with zero water exchange showed that water quality is comparatively better in lined ponds especially redox potential and metabolites were low in the lined ponds. However, the growth rate was 21% high in earthen ponds.

ADAPTATION OF *P.VANNAMEI* UNDER A SUDDEN CHANGE IN CLIMATE

Study on the adaptability of *P. vannamei* under the sudden decrease of salinity from 25 to 5 ppt revealed

that although the water osmolality varied drastically, serum osmolality varied within a short range of 510-687 mOsmol/kg at 5 hrs and still the range reduced and stabilized (639-665 mOsmol/kg) at 24 hrs. It shows that *P. vannamei* is able to adapt quickly to changes in salinity due to its osmoregulatory capacity

EFFECT OF CLAY POLYMER ADSORBENT ON GROWTH AND NITROGEN METABOLITE CONCENTRATION IN *P.VANNAMEI* CULTURE

Application of clay polymer composite @ 2.5g/ 100 litre at weekly interval to *P.vannamei* culture reduced the TAN by 88.3 and 78.9 percent during the first week and it reduced to 45.1 and 43.2 percent in the last week at lower (60 and 90 no/m^2) and higher stocking density (90 no/m^2), respectively.

EFFECT OF OXYGEN RELEASING COMPOUND ON WATER QUALITY

Application of developed oxygen releasing product at 3, 4 and 5 kg/ha enhanced the dissolved oxygen level to 7.5, 9.2 and 12.1 ppm, respectively and reduced the total ammonia nitrogen to 0.025 from 0.125 ppm after 2 hrs of application. Based on the DO levels and other water quality products, the optimum dose was found to be 3 kg/ha.

ASSESSMENT OF SUITABLE SITES FOR INLAND SALINE AQUACULTURE IN PUNJAB AND HARYANA

The salinity, pH, hardness and alkalinity of inland saline waters from selected districts of Punjab and Haryana ranged from 2-20 ppt, 7.2 to 8.3, 540-6570 ppm and 126-601 ppm respectively. The source waters are rich in calcium but deficient in magnesium and potassium warranted for mineral supplementation. The water-soluble and exchangeable potassium of inland saline soils of Rajasthan varied between 15 to 223 kg/ha and 27 to 814 kg/ha.

MYCOTIC BIOREMEDIATION OF TOTAL AMMONIA NITROGEN IN VARYING WATER SALINITY

In vitro studies were conducted on mycotic bioremediation of total ammonia nitrogen (1 and 2 mg l-1) using the *Pleurotus species* in different salinities of 1, 15, 30 and 45 ppt. Total ammonia nitrogen showed a reduction of more than 80% in 1, 15 and 30 ppt and less than 80% in 45 ppt within 72 hrs.

CARBON DYNAMICS IN RELATION TO OTHER NUTRIENTS IN SHRIMP AQUACULTURE

The variation in carbon concentration along with other nutrients like nitrogen and phosphorus in pond sediments under varying in salinities were studied. The organic carbon and available nitrogen content were found to decrease with salinity, whereas available phosphorus content was observed to follow the reverse trend. The water-soluble carbon was found to increase with salinity, varying from 1.4 mg/kg to 2.5 mg/kg: WSC 45> WSC 25> WSC11> WSC 6

ROLE OF REARING TEMPERATURE ON WSSV OUTBREAK IN SHRIMP

Shrimp in room temperature of 300C and 32 °C experienced 100% mortality within 6 days post challenge and the dead/moribund shrimps tested 1st step positive by PCR. The shrimps reared at 34 and 35 °C experienced 0% and 7% mortality respectively and both were 2nd step positive. The study confirms the role of temperature on WSSV infectivity and mass mortality.

GHG EMISSION IN AQUACULTURE PONDS

P.vannamei culture pond soils during the fallow period after the first and second months of harvest exhibited more GHGs emission, particularly CO_2. Drying practice followed by liming contributed more to global warming potential. During the culture, the inclusion of 40% Fermented soybean meal and Bacillus strains at the dose of 10^6 CFU/ml as dietary and microbial interventions mitigated the emission of N_2O compared to CO_2 and CH_4.

APPLICATION OF BROWN SEAWEED EXTRACT AS GROWTH PROMOTOR FOR SHRIMP

Brown seaweed (*Ascophyllum nodosum*) extract was used as growth promoter for shrimp juvenile. The shrimp fed with the micro algal preparation registered 20% higher growth at three-fold dilution. However, higher concentration of seaweed extract had negative effect on growth and survival.

FEED SUPPLEMENTED WITH LACTIC ACID BACTERIA IMPROVE GROWTH AND SURVIVAL OF *P. VANNAMEI*

A feeding trial was conducted on *P. vannamei* with feed supplemented with two isolates of lactic acid bacteria (LAB) viz., Lactococcus lactis subsp. lactis SDKRC-5 and Lactobacillus isolate (SDKRC-6). After 63 days of feeding trial, the LAB supplemented group recorded 14% higher growth and 10% enhanced survival over the control.

EMAMECTIN BENZOATE EFFECTIVE AGAINST CRUSTACEAN PARASITIC INFESTATION IN ASIAN SEABASS

A therapeutic trial with emamectin benzoate (EB) against *Caligus minimus* infestation in Asian seabass provided 92% improvement in survival and reduction in parasitic load after fifth day of treatment. No parasite could be recovered after 7th day of treatment, suggesting that EB could be employed in controlling parasitic infestations in finfish.

INFLUENCE OF PH ON OXYTETRACYCLINE (OTC) DEGRADATION UNDER VARYING SALINITIES

A study on influence of pH and salinity on OTC degradation in seawater was carried out. The degradation of OTC was faster at lower pH compared to higher pH irrespective of the salinity.

WITHDRAWAL OF CHLORAMPHENICOL IN SHRIMP MUSCLE TISSUE

Withdrawal period of chloramphenicol in *Penaeus vannamei* was studied by feeding commercially available feed coated with chloramphenicol at 500 mg kg-1 feed for 7 days. Post cessation of chloramphenicol feeding, the concentration in the muscle tissues dropped drastically within two days (0.64±0.08 ppm) with complete elimination of residue by 20 days.

Release of diagnostic, preventive and therapeutic technology for aquatic diseases Aquatic Animal Health division of CIBA released several technologies related to diagnostics (Improved WSSV real time PCR kit and EHP real time PCR kit), preventive (CIBAMOX – water probiotic) and therapeutic (Lumiphage – for control of Vibrios). The Improved WSSV real time PCR kit and EHP real time PCR kit was commercialized to Coastra Biosolutions Pvt. Ltd., Chennai and CIBAMOX to Tata Rallis (India) Ltd, Mumbai. For further, improvement of Lumiphage technology, an MOU was signed in association with IIT-M and TATA Rallies India Ltd.

NATIONAL REFERRAL LABORATORY FOR BRACKISHWATER AQUATIC ANIMAL DISEASES

Aquatic Animal Health and Environment Division of CIBA is serving as National Referral Laboratory for brackishwater aquatic animal diseases. As part of Aquatic Quarantine and Certification Services (AQCS), a total of 63 samples including imported *Artemia* cyst, frozen tissue and feed samples were tested during 2018-19 for OIE listed shrimp and fish pathogens. All the samples were tested negative for OIE listed pathogens.

A NOVEL METHOD OF CONVERTING FISH WASTE TO PLANKTON BOOSTER, PLANKTON^{PLUS}

An effort was put by CIBA for cleaning the fish market to diminish sanitary problems due to fish waste through its transformation into products, branded as Plankton^{Plus} having protein content of 47-49% and lipid of 20-22%, which can be used for boosting plankton in aquaculture pond or as ingredients for feed formulation and also as manure for agriculture/ horticulture.

EFFECT OF PLANKTON^{PLUS} APPLICATION ON PLANKTON STATUS AND GROWTH PERFORMANCE OF *SHRIMP/FISH*

Plankton^{Plus} supplementation @20 ppm with split application significantly ($P<0.01$) increased the average daily gain, specific growth rate, total biomass gain and survival of *P. vannamei* even when 30 % less feed was offered. Whereas, Plankton^{Plus} supplementation at the same dose can save 50 % of feed without affecting growth performance and survival of *Chanos chanos*. Plankton^{Plus} supplementation helped to increase the density of beneficial microalgae like Bacillariophyceae, Prasinophyceae, and Dinophyceae, etc. and zooplankton.

LIVE FEED ENRICHMENT

Plankton ^{Plus} supplementation can improve artemia

biomass production and reduce the usage of algae by 50 % for artemia culture. Thraustochytrids, unicellular monocentric fungi-like protists, rich in PUFA can be used for enriching artemia being used for larval rearing of finfish and shellfish.

EVALUATION OF NEWER FEED INGREDIENTS AND FEED ADDITIVES FOR USE IN AQUAFEEDS

Weevil infested sweet potato, yeast fermented groundnut cake, *Leucaena leucocephala* leaf meal can be incorporated 5 to 10% in shrimp and fish diet. Seaweed, *Gracilaria* tenuistipitata was found to have the potential to be used as a natural binder in shrimp diet.The study revealed that C-Phycocyanin extracted from spirulina can be incorporated @750 to 1000 ppm in the shrimp feed formulations for boosting growth and immunity. Study also revealed that 0.4 % of krill oil might be incorporated in the diet of Penaeus vannamei juveniles for getting better growth and survival.

DEMONSTRATION OF FEED AND NOVEL PRODUCTS DEVELOPED BY CIBA

There was a significant increase (12.31%) in survival, and enhancement of *P. vannamei* yield to the tune of 1.71 t/ha in pond supplemented with Plankton ^{Plus} compared to control. Enhanced growth performance of *Penaeus* vannamei might be due to the augmented density and diversity of phytoplankton (Bacillariophyceae, Prasinophyceae, and Dinophyceae, etc.) and zooplankton in the Plankton^{Plus} supplemented ponds. Demonstration of crab (*Scylla serrata*) culture in open water cages revealed that total biomass harvested was higher (7.27 kg) in bottom cages fed pellet feed. Crab (*Scylla olivacea*) culture in box with formulated feed showed similar ovary weight gain and gonadosomatic index when compared with low- cost fish.

EFFECT OF VARIOUS FEEDING REGIMES ON THE PHYSIOLOGICAL CHARACTERISTICS OF CAPTIVE *PENAEUS INDICUS* BROODSTOCK:

This study was carried out to evaluate the effect of different levels of maturation diet (5%, 15% and 25% of body weight per day) and captive rearing on physiological changes such as growth, molting rhythms and maturation hormone levels of captive *P. indicus* broodstock. Molting frequency was found to be higher at treatment group fed at 15% of body weight. Further, after 45 days of captive rearing, this treatment group had the minimum GIH mRNA level.

OPTIMIZATION OF NUTRIENT REQUIREMENTS AND FEED DEVELOPMENT

For the development of milkfish larval feed, the requirement of taurine and Vit E (α-tocopheryl acetate) were optimized and were found to be 1 % and 196–218 ppm of feed, respectively. Larval feed developed for Asian seabass (Seebass Larvi ^{plus}) showed higher growth performance while compared with commercial feed available for larval rearing of seabass.

For the development of broodstock diet of hilsa, mobilization of fatty acids in hilsa during different stages of maturity has been studied. It was found that even though arachidonic acid (C20:4) is the least mobilized fatty acid from the muscle, it is the highest retained (96%) in the ovary whereas the palmitoleic acid (C16:1) is the highest mobilized fatty acid, but its retention in the ovary is the lowest (22.7%).

FEED MANAGEMENT OPTIONS

Effect of delayed initial feeding on growth and survival of milkfish, *Chanos chanos* larvae has revealed that the feeding of milkfish larvae must be initiated at 24 h post-hatching for getting better growth and survival. Study on shrimp culture in Aqua mimicry system revealed that natural feeds concentration available in the system could help only to realize a good growth performance in lower stocking densities. The shrimp which had access to biofloc & feed had a maximum final weight (19.58g) and survival (>90%) compared to the shrimp (4.19g) which had access to the only biofloc generated by using ground rice bran as organic carbon source.

miRNAS EXPRESSION PROFILING DURING WSSV INFECTION

In recent years, the importance of viral and host microRNAs (miRNA) in mediating viral replication and control of host cellular machinery, has been realized and increasing efforts have been taken in order to

understand the interactions of miRNAs from host and pathogen during infection. small RNA sequencing was performed to identify the miRNAs involved in shrimp (*Penaeus vannamei*) immune responses under WSSV infection condition. The expression profiles of miRNAs of shrimp infected with WSSV under two contrasting conditions of field outbreak and controlled experimental conditions were compared and as a result, 23365 known miRNAs and 481 novel miRNAs were identified. Our study, therefore, provides the comparative analysis of miRNA expression from shrimp during WSSV infection in two different conditions.

CONTIG-LEVEL ASSEMBLY OF *PENAEUS INDICUS* GENOME WITH LONG-READS

PacBio sequence data was generated on pacific biosciences sequel platform. The 20 Kb sequencing libraries were used for sequencing where inserts over 17 Kb size were retained based on BluePippin size selection. About 20,857,430 reads of 176,539,267,324 bases length of sequence data which is equivalent to 71X coverage of genome was used for building contig-level genome with assemblers Falcon, Canu and WTDBG2. Generation of optical map and HiC data, scaffolding and chromosome linking are in progress.

dbVAST: DATABASE OF VARIATIONS ASSOCIATED WITH SHRIMP TRANSCRIPTS

In order to promote the search and use of potential genomic resources that could augment culture production, a database of variations associated with shrimp transcripts was created. The single nucleotide polymorphisms (SNPs) in coding sequences of three shrimp species, *Penaeus vannamei, Penaeus indicus* and *Penaeus aztecus* were documented and presented for browsing as a user-friendly on-line tool.

MRF: MISSING REGION FINDER

The uniqueness of white spot syndrome virus (WSSV) genome, not exhibiting similarity to any other pathogen, has severely limited its annotation. A web tool named Missing Region Finder (MRF) was developed to gain insights in to WSSV genome. MRF compares the query genome against a reference genome to find deleted genome regions in query and tabulate the CDS in these deleted regions as per the annotations of reference genome. Thus, findings of comparative genome analysis in the annotation nomenclature of a single reference would be easily comprehensible. Such a tool has potential to sort the nomenclature issue concerning WSSV genomes, as users can compare several genomes against a single reference genome.

PHYLOGENOMICS OF SHRIMP IN SUBORDER, DENDROBRANCHIATA

Controversy and confusion exists among researchers on the taxonomic revision in Genus *Penaeus sensu* lato. The maximum likelihood and Bayesian phylogenetic inferences conducted on complete mitochondrial DNA genome sequences indicated monophyly of *Penaeus sensu* lato. Further, the average amino acid identity (AAI) estimates also suggested monophyly of Penaeus sensu lato.

SEX DISCRIMINATION IN FISH

The expression of anti-mullerian hormone (*amh*) indicated a male specific expression in grey mullet, *Mugil cephalus* and red snapper, *Lutjanus argentimaculatus* suggesting the possibility of using *amh* as sex discrimination marker in fish.

POPULATION GENETIC STOCKS OF PEARLSPOT, ORANGE CHROMIDE AND GREY MULLET

The population diversity in commercially important brackishwater finfish were examined based on the analysis using mitochondrial ATPase 6/8. Significant genetic difference was observed among all the stocks of *Etroplus suratensis* examined, but isolation by distance was non-significant. Significant genetic divergence was observed between the Vembanad and Pulicat stocks of *Etroplus maculatus*. In *Mugil cephalus,* the results indicated the presence of two distinct genetic stocks along the Indian coast, one between Odisha and Kerala and the other between (Goa and Gujarat).

GROWTH PERFORMANCE OF PEARLSPOT FULL-SIB FAMILIES

Growth performance of two pearlspot (*Etroplus suratensis*) full-sib families recorded indicated higher coefficient of variation (CV) for body weight than the total body length in both the families.

POPULATION GENETIC STRUCTURE OF INDIAN WHITE SHRIMP ACROSS INDIAN COAST USING MICROSATELLITE MARKERS

Comparison of 7 loci microsatellite data in *P. indicus* along Indian coast revealed that the Chennai and Quilon stocks differed significantly from other stocks. This information would be helpful in conservation and stock specific selective breeding programmes.

FIRST RECORD OF THE JAVANESE RICEFISH, *ORYZIAS JAVANICUS* (BLEEKER, 1854) (BELONIFORMES: ADRIANICHTHYIDAE) IN THE NATURAL WATERS OF INDIA

The distribution of *O. javanicus* in the natural waters of the Indian peninsula was confirmed for the first time bringing the number of *Oryzias* species recorded from India to five. The presence of yellowish sub-marginal bands on the dorsal and ventral sides of the caudal fin makes it easily distinguishable from other Indian species. The nucleotide genetic distance between the populations occurring in India and Indonesia was found to be indistinguishable.

CRISPR-CAS9 MEDIATED GENOME ENGINEERING FOR GROWTH IMPROVEMENT OF *ETROPLUS SURATENSIS*

Experiments were conducted to disrupt the myostatin gene in *Etroplus suratensis* using CRISPR/Cas9, a powerful tool for targeted genome editing. Fertilized eggs were microinjected with CRISPR/Cas9 protein and the embryonic development was documented.

VANAMI SHRIMPAPP

Vanami Shrimpapp – the first interactive mobile app for shrimp aquaculture in India. As on March 2019, more than 15500 downloads across the world with 4.5/5.0 review rating. It is extensively used by the shrimp farmers and fishery extension workers in India and elsewhere. Farmers can post their queries and receive counseling within 48 hours. The Bengali version of shrimp app called "Chingri app" was developed under the International collaborative DBT project.

PUBLICATION OF AQUASTAT INDIA 2018

Publication of AquaStat India 2018, a comprehensive database of aquaculture and the same will be regularly updated. Further, the online version of the same will also be created. The Database includes aquaculture resources, production, trade and consumption database for World, India & various states of India.

TECHNO-ECONOMIC VIABILITY OF THREE-TIER CAGE FARMING OF ASIAN SEABASS

Techno-economic viability of three-tier cage farming of Asian Seabass fish in open brackishwater bodies indicated that the technology is technically feasible and economically viable for fishers groups. Through this technology, each member of the group obtained a monthly income of Rs.8000, Rs.4900 and Rs.8500 per cycle of production respectively in nursery rearing, pre-grow out and the grow out farming.

ICAR-CIBA'S TECHNOLOGIES FOR LIVELIHOOD OF COASTAL FISHERS

ICAR-CIBA's technology for Planton^{plus} , and Horti^{plus}, ornamental fish production activities, nursery rearing of potential brackishwater candidates fishes given a confidence to the brackishwater fishers especially the women. It generates additional income, job-sharing, employment which could be taken up throughout the year as a livelihood activity for resource poor farmers/ fishers.

कार्यकारी सारांश

चालू वर्ष 2018-19 सीबा के लिए एक महत्वंपूर्ण एवं फलदायक वर्ष रहा है। संस्थांन, सतत खारा जलजीव पालन के वकिास हेतु अनुसंधान एवं वकिास कार्यों में संलप्तिय है। संस्थारनकि और बाहरी संगठनों द्वारा वत्ति पोषति 29 अनुसंधान परयिोजनाओं और अनेक आउटरीच गतविधियिों से सीबा ने खारा जलजीव पालन के वज्ञिान में उल्लेखनीय योगदान दयिा है। अनुसंधान और वकिास संगठन होने के नाते इसकी सफलता और प्रभावकारति को वैज्ञानकिों/अनुसंधानकर्ताओं के आउटपुट से तौला जाता है। चालू वर्ष में सीबा के वैज्ञानकिों ने वभिन्नि8 प्रख्यात राष्ट्री य और अंतर्राष्ट्री य जर्नलों में सहकर्मी की समीक्षा वाले 39 अनुसंधान लेख प्रकाशति कए हैं। चालू वर्ष के दौरान स्टेऔकहोल्डरों से 31 वाणज्यिकि करारनामों पर हस्ता क्षर कए गए हैं। संस्थारन ने अनुसंधान की गुणवत्ता3 को बनाए रखा और संस्थाखन को प्राप्त आईसीएआर का प्रतष्ठिति टीम एवार्ड, सीबा के मत्यखा पोषण प्रभाग को उत्कृष्टस अंतर्वषियक टीम के लिए नानाजी देशमुख आईसीएआर एवार्ड इसका प्रमाण है। सीबा के प्रधान वैज्ञानकि डॉ. एम. कुमारन को स्वामी सहजानंद सरस्वाती उत्कृतष्ट वस्तिाषर वैज्ञानकि पुरस्कार प्राप्त हुआ। संस्थामन की पछिले वर्ष की कुछ अनुसंधान एवं वकिास की उपलब्धयिों को नीचे दर्शाया गया है।

तालाब में संवर्धति इंडयिन व्हापइट श्रम्पि। स्टॉकक का वकिास

भारत में झींगा पालन, जो लगभग पूरी तरह वदिशी प्रजाति *पीनयिस वन्नामेय* पर आधारति है, अब यह उभरते रोगों, घटती उत्तसरजीवति दर, उत्पासदन लागत में बढोत्त री तथा हाल ही में मूल्यों में गरिावट के कारण चौराहे पर खड़ा प्रतीत होता है। इन स्थतियिों में झींगा पालन की सततता बनाए रखने हेतु स्थाकनीय प्रजाति का वकिास एक व्यावहारकि वकिल्प है। भारतीय सफेद झींगा, *पी. इंडकिस* को पालतू बनाने एवं आनुवांशकि सुधार के लिए उपयुक्त प्रत्यासशी कस्मिा के रूप में पहचान की गई। बंद/तालाब में संवर्धति *पी. इंडकिस* की प्रजनन संपदा के वकिास हेतु प्रयोगात्मक परीक्षण कए गए, जो कसिी भी चयन कार्यक्रम के लिए एक प्राथमकि आवश्याकता है। हैचरी में संवर्धति *पी. इंडकिस* के पोस्टस लार्वा को मट्टिी के तालाबों में ब्रूड स्टौक (25-35 ग्रा.) तक पालन कयिा गया है, इन एफ0 पीढी का बंद स्थतियिों के अंतर्गत सफलतापूर्वक प्रजनन कराया गया और एफ1 पीढी की संततयिों को आगे पालन कयिा जा रहा है।

भारतीय सफेद झींगा (*पीनयिस इंडकिस*) तथा मल्कि्फशि (*चनोस चनोस*) का पॉलीकल्च र

जलजीव पालन संसाधनों में पोषण तत्वों को नष्ट होने से बचाने के लिए तथा कम लागत से झींगा पालन के लिए झींगों का पॉलीकल्च र एक व्येहार्य वकिल्प प्रमाणति हुई है। *पी. इंडकिस* (संग्रहण घनत्व: 25 पीएल/वर्गमीटर) और *सी. चनोस* (0.25 नग/वर्गमीटर और 0.5 नग/वर्गमीटर) के पॉलीकल्चपर में उत्पा दन संबंधी नष्पिोदन के मूल्यांतकन हेतु एक 75 दनिों का प्रयोग कयिा गया। *पी. इंडकिस* के साथ मल्किफफशि (0.5 नग/वर्गमीटर) संग्रहीत तालाब में उच्चगतम उत्त:रजीवति (79.33±1.88%) तथा उत्पामदन (1451.28±22.15 कि.ग्रा./हे.) दर्ज कयिा गया, तथापि 0.25 नग/वर्गमीटर संग्रहण घनत्वा से संग्रहीत मल्किफफशि के तलाब में उल्लेखनीय रूप से उच्चततर औसत शारीरकि भार प्राप्तं हुआ।

पीनयिस वन्नालमेय के लिए बायो-फ्लॉक आधारति संवर्धन प्रौद्योगकिी

पर्यावरण अनुकूल जलजीव पालन की दशिा में बायो-फ्लॉक प्रौद्योगकिी एक उभरता वकिल्पआ है। जल वनिमिय कम होना, घटता आहार उपयोग तथा उन्नोत जैवसुरक्षा इस प्रौद्योगकिी की वशिषता है। *पीनयिस वन्नामेय* पीएल को 28 दनिों तक 3500 पीएल/वर्गमीटर संग्रहण घनत्वत की दर से संस्थामन द्वारा वकिसति 350 मेट्रकि टन क्षमता

वाले नर्सरी टैंक में संवर्धन किया गया। नर्सरी में पालित जीवों का शारीरिक भार 0.92±0.15 ग्रा. तथा उत्त रजीविता दर 94.20±2.86% दर्ज की गई।

आरएएस इन्वीरॉनमेंट में वृद्धि निष्पा।दन, जलीय गुणवत्ता. और प्रतिरक्षा प्रतिक्रियाओं पर एक्वा-मिमिक्री का मूल्यां कन

कार्बन स्रोत को उपलब्धल कराते हुए एवं पूरक आहार के रूप में रोटीफर देते हुए एक आरएएस आधारित नर्सरी संवर्धन कार्य किया गया। प्रत्ये क उपचार में 15 दिनों के अंतराल पर उत्तआरजीविता एवं वृद्धि की लनगरानी की गई। उपचारों में सी : सामान्यश, टी1 : केवल बायो-फ्लॉक, टी2 : बायो-फ्लॉक एवं रोटीफर, टी3 केवल रोटीफर सम्मलिति है। प्रयोग के अंत में बायो-फ्लॉक के साथ रोटीफर की स्थिति बेहतर वृद्धि (3.89±0.25) और उत्तदरजीविता (91%) दर्शायी है जो सामान्यी जीवों (3.24±0.29, 85%) से उल्लेखनीय रूप से भिन्न है।

वभिन्निर लवणीय स्तरों में संवर्धित भारतीय सफेद तरूण झींगों का वृद्धि निष्पा दन और परासारिता (आस्मो लारिटी)

वभिन्निर लवणीय स्तरों में संवर्धित *पी. इंडिकस* के तरूण झींगो (0.4-0.5 ग्रा.) का वृद्धि निष्पिादन, जलीय गुणवत्ता, परासारिता तथा सीरम मनिरल प्रोफाइल के अध्य0यन हेतु एक 50 दविसीय प्रयोग किया गया। परासारिता अध्ययपयन से स्प ष्टम हुआ है कि परिवेशी जलीय लवणता के साथ सीरम परासारिता अनुपातिक रूप से बदल जाता है।

आजीविका के रूप में ज्वाारनदमुखी परितंत्र में *पीनयिस इंडिकस* का नर्सरी संवर्धन

कलपक्काम (तमलिनाडु) के निकिट उयलीकुप्परम गांव के स्वयिं सेवी समूह के लिए भारतीय सफेद झींगा पीनयिस इंडकिस के एक नर्सरी संवर्धन मॉडल का नरिूपण किया गया। *पीनयिस इंडकिस* (400 नग) के 1.5 ग्रा. भार वाले तरूण झींगों को 4 हापाओं (2 मी. X 1 मी. आमाप) में 60 दिनों तक संवर्धन किया गया। *पी. इंडकिस* झींगों का औसत भार 8.50 ग्रा. और 90% उत्तीरजीविता प्राप्तर हुई।

कीचड़ केकड़ों के पालन के लिए नमिज्जति पजिरा प्रणाली (सबमर्सीबल केज सस्टि म) का वकिास

कीचड़ केकेड़े बेन्थकि जीव होते हैं, अत: पेलाजकि/ तैरने वाले पजिरें सापेक्षकि रूप से उच्चतर सतह और उपसतह के तापमान के कारण इन जीवों की कार्यकिी पर प्रतकिूल डालते हैं। उपसतह/तैरने वाले पजिरों की पहलुओं के समाधान हेतु नमिज्जति पजिरों का वकिास किया गया है। नमिज्जति प्रणाली में शारीरिक भार का औसत लाभ >100 ग्रा. है जब कि तैरने वाली पजिरा प्रणाली में यह कम (<15 ग्रा.) है, जसिसे यह सूचित होता है कि परम्परिागत तैरने वाली पजिरा प्रणाली से नमिज्जति प्रणाली बेहतर है। नष्कि र्ष के रूप में कहा जा सकता है कि केकड़ों के वकिास के लिए परम्पजरागत पद्धति की तुलना में नमिज्जति सह तैरने वाले पजिरों में केकड़ा पालन प्रणाली से उच्चहतर वृद्धि प्राप्त होती है।

महाराष्ट्रा के मैंग्रोव क्षेत्र में खुले जल में पजिरा जलजीव पालन

मैंग्रोव सेल, महाराष्ट्रो के सहयोग से सीबा ने स्वयं सेवी समूहों की प्रतभिागिता द्वारा सन्धिूदुर्ग में मैंग्रोव तटीय जल और आसपास के क्षेत्र में तीन चरणीय सीबास फार्मगि प्रारम्भ किया। स्ववयं सेवी समूहों की प्रतभिागिता से 6 नर्सरयिां, एक प्रि-ग्रो-आउट तथा 33 ग्रो-आउट केज कल्चसर तैयार किया गया। स्वायं सेवी समूहों ने सीबास नर्सरी तथा प्रि-ग्रो-आउट संवर्धन कार्य से कुल 3.16 लाख रूपयों का राजस्वव अर्जित किया। ग्रो आउट पालन से आशा है कि 400-500 ग्रा. तक पालन किया जा सकता है और इसका आकलित राजस्वर उत्परत्ति 10-12 लाख होगी।

सीबास और ग्रीन मसल्स2 का एकीकृत बहु-पोषी जलजीव पालन (आईएमटीए)

भारत के पश्चमिी तट में प्रत्या शी पखमीन एवं कवचमीन मछलयिों के पारविारिक उत्पा दन मॉडल के वकिास एवं प्रवर्धन हेतु मलवन, सन्धिूदुर्ग के गाद क्रीक में आईएमटीए प्रारम्भ किया गया। वर्तमान समय में सीबास मछलयिां, संग्रहण आमाप 60 ग्रा. से बढ़कर 400 ग्रा. की हो गई हैं और इनकी उत्तमरजीविता दर 79.30-90.03% है। सीबास की 400-500 ग्रा. की मछलयिों की उपज मध्यइ जून, 2019 में प्राप्त होने की संभावना है और उत्प न्न-कुल राजस्वी का आकलन 2-2.5 लाख रूपए हैं।

रंगीन 'सलिवरफशि' के रूप में तरूण मलि0फशि

दुधिया सफेद भडकीला, चमकता शरीर, चपलता, अर्ध-पारदर्शी V आकार का पुच्छन पख, त्वीरति गति से तैरने की पद्धति, व्याापक लवणता के प्रति सहष्णिुमता, टैंक शैवाल का भक्षक और रोग प्रतरिोधी गुण तरूण मलि्क फशि मछलयिों को

संभावति रंगीन/अलंकारकि मछली बनाता है जसिे सल्विैरफशि कहा जाता है। अन्य रंगीन मछलयिों के साथ सुसंगत के कारण इन मछलयिां की एक जोड़ी मछलयिों की कीमत 50-100 रूपए है।

पश्चमि बंगाल में डेक्ककन हल्सिाल के रूप में मल्किंफशि का उत्पाहदन

मल्किमफशि की मांग और स्थाीनीय बंगालयिों की पसन्दू पर वचिार करते हुए सीबा ने पश्चमि बंगाल में मल्केिफशि को 'डेक्कान हल्सिाम' के रूप लोकप्रयि बनाने का प्रयास कयिा। चार भन्नि पालन परतिंत्रों में उत्पानदन कर, 1.3 टन मल्कोफशि उपज प्राप्त् कयिा गया जसिे बंगालयिों ने डेक्कशन हल्सिान के रूप में स्वीककार कयिा।

भारतीय झींगा पालन में फार्म नविशों के उपयोग की पद्धतर्ि

वर्ष 2017 के दौरान झींगा उत्पादिन वाले राज्योंद आन्ध्रक प्रदेश, तमलिनाडु, गुजरात और महाराष्ट्र1 में नविशों के उपयोग की पद्धतर्ि जानने हेतु एक सर्वेक्षण कयिा गया। अध्यतयन से ज्ञात हुआ है कर्ि मृदा और जल की गुणवत्तात में सुधार हेतु बड़े पैमाने पर पर्यावरण संशोधकों का उपयोग कयिा जा रहा है और इसके बाद का स्था न प्रोबायोटक्सि (जल, मृदा और आंत प्रोबायोटक्सि) और नस्सिं क्रमकों का है। अध्यथयन के दौरान सूक्ष्मयजीव वरिोधी उत्पाकदों के उपयोग संबंधी सूचनाएं नहीं मलिी हैं।

तालाबों में हल्सिा मछलयिों का ग्रो-आउट पालन

पश्चमि बंगाल में हल्सिाद मछलयिों के वपिणन की अच्छीा सम्भाविनाएं हैं और खाने योग्यत आमाप की मछलयिों की भारी मांग है। दो माह आयु वाली अंगुलकिाओं पेल्लेयटेड आहार के उपयोग से को दो भन्नि प्रणालयिों जैसे मट्टिी के तालाब और आरएएस में आगे का संवर्धन कयिा गया। ग्यादरह माह बाद मछलयिों का आमाप 80 ग्रा. हो गया है और मट्टिी के तालाबों में नष्पिारदन बेहतर रहा है।

लवणता के प्रतर्ि धारीदार रेबटि फशि *सगिनस जावस* की व्याअपक सहष्णिोता

तेज वकिास दर, शाकाहारी आहार प्रवृत्तर्ि तथा आर्थकि महत्व0 के कारण स्ट्रीक्डय स्पायइन फुट रेबटि फशि *सगिनस जावस* को महत्व्पूर्ण खाद्य मछली माना जाता है। इन मछलयिों की लवण सहष्णिु ता जानने हेतु 30 दनिों का एक प्रयोग कयिा गया। इस प्रयोग से पहली बार *सगिनस जावस* की व्याशपक लवण सहष्णिुाता का प्रलेखन कयिा गया, जो खारा जलजीव पालन के लएि एक संभावति शाकभोजी खाद्य मछली है।

नर *पीनयिस इंडकिस* झींगों की प्रजनन गुणवत्ता

पेनोयड झींगों का शुक्राणु कोश और शुक्राणओं की गुणवत्ता, अक्स र बीज उत्पा दन की सफलता का वशिषकर बंद स्थतियिों में, नर्धिारण करता है। यह सूचना मलिी है कर्ि सामान्य तः बंद स्थतियिों के अंतर्गत रप्रिोडक्टवि ट्रैक्टा का वकिास तथा शुक्राणु कोश की उत्पनत्तति बाधति होती है। जनन संबंधी वकिास की प्रक्रयिा के मूल सद्धिांतों के मूल्यांकन हेतु नर झींगों का मूल्यां कन टैंकों और तालाबों में कयिा गया और इनकी तुलना वन्यक रूप से प्राप्त झींगों से की गई। वन्यऔ रूप से प्राप्तव झींगों की तुलना में टैंकों और तालाबों में संवर्धति झींगों में शुक्राणुओं की संख्याश काफी कम पायी गयी।

पीनयिस इंडकिस की शुक्राणु कोश गुणवत्ताय पर अल्पकालकि शीत भंडारण का प्रभाव

नर युग्मसकों (गैमीट) के भंडारण से कृत्रमि नषिचन हेतु प्रजनकों के रखरखाव की समस्याल हल हो सकती है। गुग्माकों, शुक्राणु कोश की गुणवत्ताप पर शीत भंडारण के प्रभाव को मूल्यांतकति करने हेतु इन्हें 4° से. के तापमान पर संग्रहीत कयिा गया और भन्नि भन्नि अंतरालों पर इनका मूल्युंकन कयिा गया। पांचवे दनि के नमूने की तुलना में प्रथम दनि के नमूने में सामान्य शुक्राणु काफी अधकि पाए गए। पांच दनिों के पररिक्षण में भंडारति शुक्राणु कोश में एक्रोसोम प्रतक्रियिाएं देखी गई। पांच दनिों के बाद शुक्राणु कोशकिाएं वघिटति होने लगी हैं और जीवष्णिुति (वयाबल्टिी) भी नही देखी गई। इस अध्यकयन से शुक्राणु कोश के पररिक्षण पद्धतर्ि में शीत भंडारण की प्रयोजनीयता प्रमाणति होती है।

भारतीय सफेद झींगा *पीनयिस इंडकिस* का कृत्रमि परविशीय नषिचन और संकरण क्षमता

पेनोयड झींगों के कृत्रमि परविशीय नषिचन पद्धतर्ि का सफलतापूर्वक वकिास कयिा गया। पी. इंडकिस का अंतः वशिष्टि नषिचन में सफलता प्राप्तप की गई जसिमें नषिचन दर 4.8% और 29% नौप्लीन को पोस्टन लार्वा में वकिसति कयिा गया।

पीनयिस इंडकिस के बंदी प्रजनकों की शारीरकि वशिषताओं पर वभिन्नि् आहारीय व्यवस्थाशओं का प्रभाव

बंद स्थतियिों के अंतर्गत *पी. इंडकिस* को परपिक्वओन आहार (प्रतदिनि शारीरकि भार का 5%, 10% तथा 25%) तथा बंद स्थतियिों में पालन से होने वाले शारीरकि बदलाव जैसे वृद्धा, मोल्टगि रदिम तथा परपिक्वधन हार्मोन स्त र पर प्रभाव के मूल्यांमकन हेतु यह अध्य,यन कयिा गया। झींगों को शारीरकि भार के15% आहार दएि जाने वाली समूह में मोल्टगि आवृत्त अधकि पायी गयी। आगे 45 दनिों के बंद स्थतियिों में पालन से इस समूह में न्यू नतम GIH mRNA पाया गया।

सीबास बीज उत्पादन की नई ऊंचाईयां

सीबा, बंद प्रजनन और सीबास बीज उत्पोदन में अग्रणी है, हाल ही में बंद स्थतियिों में प्राकृतकि अंडजनन प्रोटोकॉल को मानक बनाया है। पछिले वर्ष जनति 5.53 मलियिन अंडों में से 2.66 मलियिन अंडों का स्वाभावकि अंडजनन तथा 2.87 मलियिन अंडों का प्रेरति अंडजनन हुआ। वर्ष 2018-19 में एक सर्वकालकि उच्चज, 0.59 मलियिन पोनों को बेचा गया जसिसे 1.72 मलियिन का राजस्व प्राप्तव हुआ। इसके अतरिक्ति, 1.20 लाख बीजों को कृत्रमि आहार के पूरी तरह अलग करके महाराष्टए भेजा गया।

मलिकफिशि (*चनोस चनोस*) के दो भन्नि् भौगोलकि सम्पइदाओं के प्रजनन का नष्पिामदन

पूर्वी तट से पृथक कएि गए मलिकोफशि के दो भौगोलकि सम्पदाओं की जनन क्षमताओं की तुलना में, चेन्नई की सम्पटदा का नष्पिाकदन बेहतर पाया गया जसिमें अंडजनन का वस्ति रति अवध देखी गयी। दोनों की सम्पनदाओं में एक से अधकि अंडजनन हुआ और बंद स्थतियिों में मलिकेफशि का वर्षभर प्रजनन का अवसर देखा गया।

प्रक्षेत्र में पालति पैतृक सम्पेदा के उपयोग से ग्रे-मुल्लेअट के बंद प्रजनन में अच्छाी प्रगत

वर्ष 2017 में मुल्लेलट का अंडजनन हुआ और पहली बार अंडों का नषिचन हुआ, परन्तु लार्वा केवल 8 दनिों तक जीवति रहें हैं, तीव्र प्रयासों बृहत स्तओर पर 0.75 मलियिन लार्वा का उत्पादिन कयिा गया। लार्वा 28 दनिों तक जीवति रहें हैं। आगे लार्वा संवर्धन के अनुकूलन कार्य प्रगत पर है।

तालाब की स्थतियिों में संवर्धति *लजिा पार्सयिा* का परपिक्वयन

लजिा पार्सयिा की प्रजनन परपिक्वतता के लएि 300 मछलयिों पर एक प्रयोग कयिा गया, जसिमें अनुकूलतम जल की गुणवत्ताक और आहार से बंद स्थतियिों में परपिक्वता का प्रमाण मलिें हैं। प्रजनन परपिक्वता के लएि 300 नंबर लजिा परसयिा (गोल्ड्सपोट मलेट) के साथ कएि गए एक अध्ययन ने इष्टतम पानी की स्थति और फ़ीड के साथ कैप्टवि परपिक्वता की आसानी का सबूत दयिा। अंडाणु जनिका व्यापस 100 µm से भी कम है, वे प्रकृत से नॉन-वटिल्लो जेनकि होते हैं और बंद स्थतियिों में अधकितम जीएसआई और अंडाणुओं का व्या स क्रमश: 606.55±17.02 और 18.31±2.0 प्राप्तप कएि हैं। इस अध्य यन से प्रमाणति होता है क *लजिा पार्सयिा* के प्रजनकों को आसानी से तालाब की स्थतियिों में वकिसति कयिा जा सकता है।

मैंग्रोव स्ने प्प र का बंद स्थतियिों में परपिक्व ता की अच्छी प्रगत

मैंग्रोव स्ने प्प र के बंद प्रजनन प्रौद्योगकिी को लक्ष्यस बनाकर, 90 वयस्कर मछलयिों का ब्रूड्स्टॉसक होल्डगि सस्टिरम में रखरखाव कयिा जा रहा है। जून से अक्टूबिर, 2018 तथा फरवरी से मार्च, 2019 के दौरान स्रावी नर मछलयिों को देखा गया, जसिसे सूचति होता है क 8-21% नर मछलयिां परपिक्वपता प्राप्ता कर रहीं हैं। तथाप, मादा परपिक्वन प्राप्त नहीं हुआ है और अंडकों के वकिास के संकेत मलिें हैं।

आरएएस आधारति होमस्टेकड फशि ब्रीडगि मॉडल में स्पाँटेड स्कारट की प्रेरति परपिक्ववता और अंडजनन

स्पॉकटेड स्काट के प्रजनन को सरल बनाने हेतु 3000 ली. क्षमता, सेन्द्रल ड्रैनेज सस्टिेम तथा 12.9 घनमीटर/प्रतदिनि प्रवाह दर वाला एक आरएएस तैयार कर उसमें प्रयोग कयिा गया। वयस्कों स्का9ट मछलयिों हार्मोनों के भन्नि खुराकों तथा संयोजनों से प्रेरति कयिा गया। मादा मछलयिों LHRHa 25 µg/क.ग्रा./माह से सफलतापूर्वक प्रेरति हुई जब क नर मछलयिों में LHRHa + 25 + 25 µg/क.ग्रा./माह की दर से 17-αMT के मश्रिति खुराक से शुक्राणु घनत्व में वृद्ध में सहायता मलिी है। आरएएस आधारति होमस्टैड मॉडलों में इन अनुकूलति खुराकों से अंडजनन और लार्वा उत्पाादन में सहायता मलिेगी।

सल्विलर मूनी मोनोडेक्टीटलस अर्जेन्टयिस का बंद प्रजनन

हार्मोनल प्रेरण से संभावति खाराजलीय रंगीन मछली का बंद प्रजनन और बीज उत्पा7दन प्राप्तल कयिा गया। नषिेचन 18 घंटों में हुई और अंडों का व्या स 860±14.11 µm तथा नषिेचन दर 90% रही है। नव वकिसति लार्वा की लम्बाईं 1.60-1.67 मि.मी. पायी गयी। वन्यट रूप से प्राप्ते मछलयिों से हटकर बंद प्रजनन से नर्यिात के लएि व्यामपक उत्पा दन का मार्ग प्रशस्तल करेगा।

भारतीय झींगा पालन के लएि डब्यूत य एसएसवी, ईएचपी और आईएमएनवी के बड़े खतरे

वर्ष 2015-19 के दौरान झींगा प्रक्षेत्रों में रोगों की सक्रयि नगिरानी में पाया गया है कि झींगा उत्पायदन करने वाले दो प्रमुख राज्यों त तमलिनाडु और प्रदेश में व्हाबइट स्पॉहट सड्रिोम वायरस (डब्सू015 एसएसवी) तथा एन्टेरोसाइटोजून हेपाटोपेनेय (ईएचपी) प्रमुख रोगजनक हैं। डब्सूब्ल एसएसवी का फैलाव 11-40% और ईएचपी का फैलाव 21-43% है। वर्ष 2018-19 के दौरान संक्रामक माइवनक्रोससि वायरस (आईएमएनवी) एक और चुनौती के रूप में उभरी है, जसिका फैलाव 15% है।

पॉलीकीट कृमयिों के माध्यैम से झींगों में *एन्टेएरोसाइटोजून हेपाटोपेनेय* संक्रमण

सीबा के अध्ययनों से स्पाष्टस हुआ है कि डब्सूएचप एसएसवी और ईएचपी जैसे रोगजनकों को झींगों तक पहुंचाने में वॉलीकीट कृमयिां वाहक की भूमकिा नभिाते हैं। ईएचपी क्षैतजि रूप से फलती है, संक्रमति झींगों से पॉलीकीट में और पॉलीकीट से झींगों में। तथापि पॉलीकीट के वभिन्नि वकिासात्मीक अवस्थालओं में ऊर्ध्वाधर संचरण के प्रमाण नहीं मलि हैं।

परवेशी तापमान पर समुद्री जल में ईएचपी के बीजाणु एक वर्ष तक संक्रामक रहते हैं

समुद्री जल में परवेशी तापमान पर ईएचपी के बीजाणुओं की संक्रमणता एक वर्ष से अधकि समय तक रहती है। इस प्रकार की भंडारण स्थतियिों में सक्रयिता डेढ वर्ष बाद छूटी है। तथापि 40 से., -200 से., तथा -800 से में भंडारति बीजाणु में, एक माह के बाद बजाणुओं की व्यीवहार्यता पूर्ण रूप से नष्ट- और संक्रमणता नाटकीय रूप से कम हो गयी है।

ईएचपी बीजाणुओं के उद्भेदन (जर्मीनेशन) को प्रयोगात्म क तौर पर प्रेरति कयिा जा सका है।

पोटाशयिम हाइड्राक्साीइड तथा फ्लोक्साणइन जैसे डाइस के उपयोग से ईएचपी बीजाणुओं के उद्भेदन को प्रेरति कयिा गया। उद्भेदन की सम्पूर्ण क्रयिा दो क्षण से भी कम समय में पूर्ण हो जाती है। उद्भेदति बीजाणु कोशकिा को भेद कर और अपनी झल्लिीस को चुभोकर आस-पास के संभावति मेजबान कोशकिा को संक्रमति करती है।

झींगों में डब्लनयूएसएसवी का ऊर्ध्वाधर संचरण

प्रयोगात्म क रूप से संक्रमति *पीनयिस इंडकिस* में, डब्यू णत एसएसवी संक्रमति गर्भाशय कोशकिाओं में वीपी28 प्रोब के प्रतपि्रतक्रियित्मरक इंट्रान्यू क्ली यर बॉडीस देखा गया है जसिसे स्प ष्ट होता है कि डब्यूरत एसएसवी के नमि्नू स्तोर का संक्रमण से भी ऊर्ध्वाधर संचरण की सम्भाषवना होती है।

अन्ध्रा प्रदेश में कीचड़ केकड़ों स्का इला सेर्राटा की खेती में व्यालपक मार्त्याता

वर्ष 2018 में आन्ध्रत प्रदेश राज्यि में कृष्णाट जलि के नागयालंका में कीचड़ केकड़ों की खेती में बड़े पैमाने पर मृत्युं दर देखी गई। मृत केकड़ों व्हाकइट स्पॉनट सड्रिोम वायरस के प्रतसिमारात्मपक पाए गए। उनमें मेटाजोन क्रस्टा सयिन पारासाइट, स्टापल्ड्म बार्नेकल, ओक्टोतलास्मसि एसपीपी का भी भारी संक्रमण पाया गया। स्वस्थ, तालाबों की तुलना में संक्रमति केकडों के हेमोलम्पिन में कुल प्लेपट काउंट और कुल वाइब्रयिो काउंट में वृद्धि देखी गई।

सीबास में तलिापयिा लेक वायरस (TiLV) का संचरण

तलिापयिा के साथ सीबास की खेती वाले प्रक्षेत्रों में रोग नगिरानी के दौरान, सीबास में TiLV से प्रभावति हेमोरहेजकि एनसेफालटिसि से जुड़ी क्रोनकि मार्त्य ता देखी गई। संक्रमति तलिापयिा से सीबास में अंतर प्रजातीय संचरण के परीक्षण हेतु चुनौतीपूर्ण प्रयोग में देखा गया कि TiLV से सीबास में उच्चक समुच्चतय मृत्युर दर के साथ सफल संचरण हुआ है।

खाराजलीय पखमीन में परजीवीय संक्रमण

वर्ष 2016-19 के दौरान खाराजलीय प्रत्या शी मत्यषण प्रजातयिों तथा केकड़ों के परजीवीय रोगों

के प्रोफाइलगि से ज्ञात होता है कि 6 प्रमुख परजीव जैसे *अरगुलस, कैलीगस, लेरनानथ्रोपस, जेलानीकॉडेल्लाज, अनसिाकसि* और *आक्ट्रोलाससमसि* मौजूद हैं। तथापि मलेट और मल्किपफशि में कोई परजीवीय संक्रमण दर्ज नहीं हुई है।

जोआ सड्रिोम का मैक्रोबयिल प्रोफाइलगि

जोआ-2 सड्रिोम की एटयिालॉजी जानने के लिए मेटाजेनोमकि अध्य यन कयिा गया। समग्र रूप से स्वासस्य् ि के लिए वशिष्टिं 46 वंश, अस्वयस्थ ता के लिए वशिष्टि् 328 वंश तथा दोनों के लिए समान 371 वंशों को देखा गया। जोआ-2 से प्रभावति नमूनों में कुछ वंशों जैसे डेवोसयिा, अवर्गीकृत रोडोबैक्टे रासी, नॉनलबेंस, मुरीकौडा, अवर्गीकृत फ्लावोबैक्टीवरयिलेस तथा सूडोआल्टेरिोमोनास की प्रचुरता पाई गई।

सीबामाक्सि का मैक्रोबयिल प्रोफाइलगि

16s rDNA आधारति मेटाजेनोमकि मैक्रोबयिल प्रोफाइलगि से स्पलष्टा हुआ है कि नाइट्रोजन उपापचय में अनेक अनोखे जीवाणु सम्मलिति हैं। अमोनयिा आक्सी करण में *नाइट्रोसोमोनास* और *नाइट्रोबैक्टरि* के अतरिक्ति काल्डी लनिएिसी कुल संबंधति जीवाणु समूह की भी आधक्यिता है। एओबी तथा एनओबी समृद्धता में पहचान की गई सूक्ष्माजीवों का बड़ा भाग प्रोटयिोबैक्टेरयिा समुदाय से संबंधति है।

वाइब्रयिो हार्वेयी क्लेड में कोरम सेंसगि सस्टिैम का गुणचत्रिण

वषिैलेपन के समझने के लिए, वाइब्रयिो हार्वेयी क्लेड के 60 जेनामों के कोरम सेंसगि सस्टिेम का गुणचत्रिण कयिा गया। *वी. हार्वेयी* क्लेड के सभी पृथककरणों में आटोइनड्यूसर 2 सथिसाइजगि luxS जीन मौजूद हैं। तथापि, *वी. हार्वेयी, वी. कैम्प बेल्ली , वी. जासीसडि* और *वी. ओवेनसी* में आटोइनड्यूसर 1 सथिसाइजगि जीन luxM मौजूद है परन्तु *वी. नेट्रीजेन्स* और *वी. रोटफिैरयिानस* में गैर-मौजूद है।

व्यवहार्य और मृत ईएचपी बीजाणुओं में वभिेद करने हेतु त्वतरति पहचान करने की तकनीक

ईएचपी बीजाणुओं की व्य वहार्यता के मूल्यांकन के लिए एक अभरिंजन (स्टै नगि) तकनीक का वकिास कयिा गया। कैलकोफ्लूअर व्हा इट से अभरिंजति व्य वहार्य बीजाणु वायलेट फलि्ट र (395-415 nm) में फरिोजा-नीले रंग में प्रतीत होता है। साइटाक्स ग्रीन से अभरिंजति मृत बीजाणु ब्लू4 एक्साइटेशन फलि्टैर (470-490 nm) में पीले-हरे अंडाकार शरीर वाले तथा वायलेट फलि्टफर (395-415) में सफेद-पीला प्रतीत होते हैं।

मछली में इरडिोवायरस संक्रमण की पहचान हेतु SYBR Green आधारति रयिल टाइम पीसीआर परख तकनीक का वकिास।

मछली में इरडिोवायरस संक्रमण की पहचान हेतु SYBR Green आधारति रयिल टाइम पीसीआर परख तकनीक का वकिास कयिा गया जसिकी पहचान करने की सीमा 10 वायरल अणु हैं। इरडिोवायरस पहचान करने हेतु एक मेम्बरेन कोफैक्टेर प्रोटीन जीन आधारति पीसीआर का मानकीकरण कयिा गया।

वन्यआ *पीनयिस इंडकिस* अंड़जनकों में डब्यूभे एसएसवी का मातृ संचरण (मेटर्नल ट्रासमशिन)

युग्ममकों के माध्यंम से प्रत्यंक्ष रूप से डब्यूसवी एसएसवी का ऊर्ध्वा धर संचरण को प्रमाणति करना अभी बाकी है। इस कल्पसना के परीक्षण के लिए, डब्यूतृ एसएसवी से संक्रमति मादा मछलयिों के प्रजनन ऊतकों का क्यूआरटी पीसीआर के माध्यम से डब्ल्यू एसएसवी रोग की पहचान की गई और पाया गया कि प्रजनन ऊतकों में डब्यूब् एसएसवी के 50 से 60 प्रतयिां ही हैं, और संक्रमति मादाओं के 36% प्रजनन ऊतकों में ही डब्यूएस एसएसवी की मौजूदगी देखी गयी। तथापि स्वतस्थाकन पर संकरण अध्य यनों में डब्यूब् एसएसवी के सकारात्मक संकेत नहीं मलि हैं।

अंतड़यिों के मैक्रोब्सथ का पृथक्कंरण तथा गुणचत्रिण

बायोफ्लॉक प्रणाली लाभप्रद पाया गया और आंतडियों क्षेत्र में लाभदायक बैक्टीणरयिो की उपनविशीकरण में सहायक होती है। कुल 94 नस्लोंन (स्ट्रेभइन) की जांच की गई और पाया गया कि 36 नस्ल एमलिेज एंजाइम उत्पन्न(करते हैं, 20 नस्लक प्रोटयिेज, 27 नस्लम लपिेज, 6 नस्लक सेल्लुललेज और 8 नस्ल(जइलानेज उत्प,न्नज करते हैं। कुल 21 वयिोजको (आइसोलेट्स) को आगे की पहचान हेतु चयन कयिा गया और बायोफ्लॉक ट्रीजटमेंट्स से *कोबेटयिा, एक्सीगुओबैक्टेरयिम, बेसलिस, मेरनिलिैक्टीबबेसलिस, स्टाफाइल्लोकोकस* तथा *नोवोस्पगिोबयिम* के वभिन्निक प्रजातयिों की पहचान की गई। बेसलिस और *एक्सीगुओबैक्टेसरयिम* के सामान्यज नस्लों में ही देखा गया। इन सभी

नस्लों में से, जीनस *एक्सीगुओबैक्टेसरयिम* की पहचान सभी ट्रीटमेंट्स और कंट्रोल में की गई।

जल वशि्लेगषण कटि का वाणज्यिकिरण

वभिन्नि स्रोतों और भन्नि् भन्नि लवणीयता स्तेर के तालाब जल में घुलति आक्सीजन, अमोनयिा (0.1 से 2 पीपीएम), नाइट्राइट (0.05 से 1 पीपीएम), कैल्शयिम एवं मैग्नशियिम खनजि, कुल कठोरता, कार्बोनेट, बाइकार्बोनेट तथा कुल क्षारीयता के मापन हेतु एक मल्टी-पारामीटर पोर्टेबल वाटर एनालाइससि कटि का वकिास कयिा गया और इसका वाणज्यिकिरण न्यूट बायो साईस कम्प नी, मैसूर के साथ कयिा गया।

जलजीव पालन वेब टूल

जल नकियों की वहन क्षमता के आकलन के लिए एक ऑनलाइन एक्वाकल्चर प्लानगि वेब टूल 'कैरीकैपद्ध' वकिसति कयिा गया और आंध्र प्रदेश राज्य सरकार द्वारा जलजीव पालन वकिास के अनुकूलन और संसाधन उपयोगकर्ताओं के बीच टकराव से बचने के लिए एक्वा ज़ोनेशन कार्य के लिए इसका उपयोग कयिा जा रहा है।

मृदा जल स्वास्थ्य कार्ड और स्थान वशिष्टि बीएमपी

तमलिनाडु के चदिंबरम और नागपट्टनिम जलिों के जलजीव पालकों को लगभग 55 मृदा और जल स्वास्थ्य कार्ड वतिरति कए गए। भौगोलकि भन्निता को समझने के लिए एसडब्ल्यू एचसी डाटाबेस का वशि्लेषण कयिा गया, जो स्थान वशिष्टि बीएमपी को तैयार करने में मदद करता है।

वभिन्नि पालन पद्धतयिों के अंतर्गत पोषक तत्व गतशिीलता

शून्य जल वनिमिय के साथ 25 पीपीटी लवणता के अंतर्गत सम्युलेटेड (कृत्रमि) मट्टिी और पक्के तालाब में *पी. वन्नामेय* पालन पर कए गए अध्ययन से पता चला है कि रेखति तालाबों (लाइन्डम पांड्स) में पानी की गुणवत्ता, वशिेषकर अपचयोपचय क्षमता तुलनात्मक रूप से बेहतर है और मेटाबोलाइट्स रेखति तालाबों में कम थे। यद्यपि, मट्टिी के तालाबों में वकिास दर 21% अधकि थी।

जलवायु में आकस्मकि परविर्तन के अंतर्गत *पी. वन्नामेय* का अनुकूलन

लवणता में आकस्मकि रूप से लवणता 25 से 5 पीपीटी तक पर घटने की स्थतियिों में *पी. वन्नाकमेय* की अनुकूलन क्षमता पर कए गए अध्ययन से पता चला है कि हालांकि जल ऑस्मोलैलटिी में व्यानपक भन्निता है, 5 घंटे में सीरम ऑस्मोलैलटिी 510-687 mOsmol/कि.ग्रा. की कम सीमा में है तथा 24 घंटे में यह सीमा कम तथा स्थरि (639-665 mOsmol/कग्रिा) की गई। यह दर्शाता है कि *पी. वन्नामेय* अपनी ओस्मोरेगुलेटरी क्षमता के कारण लवणता में परविर्तन के प्रति जल्द अनुकूलन करने में सक्षम है।

पी. वन्नामेय पालन में वृद्धि और नाइट्रोजन चयापचय संकेंद्रण पर मट्टिी पॉलमिर अवशोषण का प्रभाव

पी. वन्नामेय पालन में साप्तासहकि अंतराल पर 2.5 ग्रा./100 लीटर की दर से मट्टिी के पॉलीमर यौगकिों के अनुप्रयोग ने पहले सप्ताह के दौरान टीएएन (TAN) को 88.3 और 78.9 प्रतशित कम कर दयिा और यह अंतमि सप्ताह में नम्नि0 (60 और 90 नग/वर्ग मीटर) और उच्च (90 सं/वर्ग मीटर) संग्रहण घनत्व में क्रमशः 45.1 और 43.2 प्रतशित घट गया।

जल गुणवत्ता पर ऑक्सीजन रलिीज करने वाले यौगकि का प्रभाव

वकिसति 3, 4 और 5 कि.ग्रा./हेक्टेयर की दर से ऑक्सीजन रलिीज करने वाले उत्पाद के अनुप्रयोग से घुलति ऑक्सीजन स्तर को क्रमशः 7.5, 9.2 और 12.1 पीपीएम तक बढ़ गया और अनुप्रयोग के 2 घंटे बाद कुल अमोनयिा नाइट्रोजन स्त1र को 0.25 पीपीएम से 0.025 तक कम कर दयिा। घुलति ऑक्सीजन स्तर और अन्य जलीय गुणवत्ता प्राचलों के आधार पर, अनुकूलतम खुराक 3 कि.ग्रा./हेक्टेयर पाया गया।

पंजाब और हरयिाणा में अंतर्थ्लीय लवणीय जलजीव पालन के लिए उपयुक्त स्थलों का आकलन

पंजाब और हरयिाणा के चयनति जलिों से अंतर्स्थलीय लवणीय जल की लवणता, पीएच, कठोरता और क्षारीयता क्रमशः 2-20 पीपीटी, 7.2 से 8.3, 540-6570 पीपीएम और 126-601 पीपीएम तक पायी गयी। स्रोत जल कैल्शयिम से भरपूर हैं, लेकनि मैग्नीशयिम और पोटेशयिम की कमी दूर करने हेतु पूरक खनजिों का उपयोग बाध्यैकारी है। राजस्थान की अंतर्थ् मलीय लवणीय मृदाओं में जल घुलनशीलता और वनिमिय योग्यै पोटाशयिम में भन्निता 15 से 223 कि.ग्रा./हेक्टेयर और 27 से

814 कि.ग्रा./हेक्टेयर के बीच है।

जल की वभिन्नि लवणताओं में कुल अमोनयिा नाइट्रोजन का माइकोटकि जैवोपचार

भन्निच भन्नि5 लवणताओं 1, 15, 30 और 45 पीपीटी में *एलुरोटस एरजातयिों* के उपयोग से कुल अमोनयिा नाइट्रोजन (1 और 2 मि.ग्रा./ली.) के माइकोटकि जैवोपचार के लएि एक *कृत्रमि परविशीय* अध्ययन कयिा गया। 72 घंटे के भीतर कुल अमोनयिा नाइट्रोजन में 1, 15 और 30 पीपीटी में 80% से अधकि और 45 पीपीटी में 80% से कम की कमी आयी।

झींगा जलजीव पालन में अन्य पोषक तत्वों के संबंध में कार्बन की गतशिीलता

वभिन्नि लवणीयताओं में तालाब के तलछटों में नाइट्रोजन और फास्फोरस जैसे अन्य पोषक तत्वों के साथ कार्बन की सांद्रणता में भन्निता का अध्ययन कयिा गया। लवणता के साथ जैवकि कार्बन और उपलब्ध नाइट्रोजन की मात्रा में कमी पाई गई, जबकि उपलब्ध फॉस्फोरस मात्रा में वपिरीत प्रवृत्ति देखी गई। लवणता के साथ जल में घुलनशील कार्बन में वृद्धि देखी गई, जो 1.4 मि.ग्रा./कि.ग्रा. से 2.5 मि.ग्रा./कि.ग्रा. के बीच है : डब्यू एससी 45> डब्या म एससी 25> डब्यूंर एससी 11> डब्ल्येूएससी 6.

झींगों में डब्यूं एसएससवी के प्रकोप पर पालन तापमान की भूमकिा

रोग चुनौती के 6 दनिों के भीतर 30०से और 32०से के परवेशी तापमान में झींगों की 100% मृत्यु दर पायी गई और पीसीआर परीक्षण में मृत/रुग्ण झींगों में प्रथम चरण की सकारात्मरकता देखी गई। झींगों को 34०से और 35०से तापमान में पालने से क्रमशः 0% और 7% मृत्यु दर देखी गई और दोनों ही तापमानों में दूसरे चरण की सकारात्मकता पायी गई। इस अध्ययन से डब्ल्यूएसएससवी संक्रमकता और सामूहकि मृत्यु दर पर तापमान की भूमकिा की पुष्टि होती है।

जलजीव पालन तालाबों में जीएचजी उत्सर्जन

पी. वन्नामेय पालन तालाबों में उपज प्राप्ति के प्रथम और दूसरे माह के दौरान जीएचजी का अधकि उत्सयर्जन देखा गया वशिषकर कार्बनडाइऑक्सारइड। तालाब को सुखाने तथा चूना डालने की प्रथा ने ग्लोबल वार्मगि की संभावनाओं को बढ़ाया है। पालन के दौरान, आहार में 40% कण्विति सोयाबीन और बेसलिस स्ट्रेंलस 10^6 सीएफयू/मि.ली. की खुराक के समावेशन तथा सूक्ष्म जीवीय हस्तक्षेप से कार्बनडाइऑक्सा इड और मथिेन की तुलना में नाइट्रोजन उत्सर्जन कम हुआ है।

झींगा के लएि वृद्धि नयिामक के रूप में भूरे समुद्री शैवाल एक्ससट्रैक्ट का अनुप्रयोग

तरूण झींगों के लएि वृद्धि नयिामक के रूप में भूरे समुद्री शैवाल (*एस्कोफाइलम नोडोसम*) एक्साट्रैक्टध का उपयोग कयिा गया। सूक्ष्मू शैवाल मश्रिण से तैयार आहार देने पर तीन गुना तरलीकरण में भी 20% अधकि वृद्धि दर्ज की गई। हालांकि, समुद्री शैवाल एक्समट्रैक्टइ की उच्चक सांद्रणता से वृद्धि तथा उत्तरजीवति पर नकारात्मक प्रभाव पड़ा।

लैक्टकि एसडि बैक्टीरयिा के पूरक आहार से *पी. वन्नामेय* की वृद्धि और उत्तरजीवति में सुधार

लैक्टकि एसडि बैक्टीरयिा (एलएबी) के दो वयिोजकों (आइसोलेट्स) नामत: *लैक्टोकोकस लैक्टसि* उपप्रजाति लैक्टसि एसडीकेआरसी-5 और *लैक्टोबैसलिस* वयिोजक (एसडीकेआरसी-6) के पूरक आहार के साथ *पी. वन्नोमेय* पर एक आहारीय परीक्षण कयिा गया। आहारीय परीक्षण के 63 दनिों के बाद, एलबीए पूरक आहार दए गए समूह में सामान्यह की तुलना में 14% उच्चतर वृद्धि और 10% अधकि उत्तरजीवति दर्ज की गई।

एशयिाई सीबास में क्रस्टेशयिन परजीवी संक्रमण के वरिूद्ध इमामेक्टनि बेंजोएट की प्रभावकारति

एशयिाई सीबास में *कैलगिस मनिमिस* संक्रमण के वरिुद्ध इमामेक्टनि बेंजोएट (ईबी) के साथ एक उपचारात्म क परीक्षण कयिा गया और उपचार के पांचवें दनि के बाद उत्तरजीवति में 92% सुधार और परजीवीय भार में कमी पाई गई। उपचार के 7वें दनि के बाद कोई परजीवी प्राप्ता नहीं कयिा जा सका जसिसे यह सुझाव मलिता है कि पखमीन मछलयिों में परजीवीय संक्रमण के नयिंत्रण हेतु इमामेक्टनि बेंजोएट दयिा जा सकता है।

वभिन्निा लवणताओं के तहत ऑक्सीटेट्रासाइक्लनि (ओटीसी) क्षरण पर पीएच का प्रभाव

समुद्री जल में ओटीसी क्षरण पर पीएच और लवणता के प्रभाव पर एक अध्ययन किया गया। लवणता के किसी भी स्तर पर, उच्चग पीएच की तुलना में निम्नि पीएच स्त र पर ओटीसी का क्षरण तेज गति से होता है।

झींगा मांसपेशियों के ऊतकों से क्लोरमफेनिकॉल की निकासी

पीनियस वन्नामेय में क्लोरमफेनिकॉल की निकासी के अध्यचयन हेतु वाणज्यिकि रूप से उपलब्ध आहार पर 500 मि.ग्रा./कि.ग्रा. आहार की दर से क्लोवरैम्फे निकॉल लेपति करके 7 दनिों तक आहार दिया गया। क्लोरमफेनिकॉल खलिाना बंद करने के बाद दो दनि के भीतर ही मांसपेशियों के ऊतकों में सांद्रता तेजी से कम (0.64±0.08 ppm) हो गई तथा 20 दनिों में अवशेष पूरण रूप से समाप्त। हो गए।

जलीय रोगों के लिए नैदानिक, रोगनरिोधी और चकित्सिकीय प्रौद्योगिकी का विमोचन

सीबा के जलीय जीव स्वास्थ्य प्रभाग ने नैदानिकी (उन्नसत डब्लूएसएसवी रियिल टाइम पीसीआर किट और ईएचपी रियिल टाइम पीसीआर किट), रोगनरिोधी (सबिामॉक्स - वाटर प्रोबायोटिक) और चकित्सिकीय (लुमपिज - वाइब्रोस के नयिंत्रण के लिए) संबंधी कई तकनीक जारी किया है। उन्नयत डब्लूएसएसवी रियिल टाइम पीसीआर किट और ईएचपी रियिल टाइम पीसीआर किट का कोस्ट्रा बायोसोल्यूशन प्रा. लि., चेन्नई से और सीबामॉक्सक का टाटा रैलसि (इंडिया) लमिटिड, मुम्बई के साथ वाणज्यिीकरण किया गया। इसके अतरिक्ति , लुमफिज प्रौद्योगिकी में सुधार के लिए आईआईटी-एम और टाटा रैलसि इंडिया लमिटिड के साथ एक समझौता ज्ञापन पर हस्ताक्षर किया गया।

खारा जलीय जीवों के रोगों के लिए राष्ट्रीय रेफरल प्रयोगशाला

सीबा का जलीय जीव स्वास्थ्य और पर्यावरण प्रभाग, खारा जलीय जीवों के रोगों के लिए एक राष्ट्रीय रेफरल प्रयोगशाला के रूप में कार्य कर रहा है। जलीय संगरोधन और प्रमाणन सेवाओं (एक्यूसीएस) के एक भाग के रूप में वर्ष 2018-19 के दौरान ओआईई सूचीबद्ध झींगा और मछली रोगजनकों के लिए कुल 63 नमूनों का परीक्षण किया गया जनिमें आयातति *आर्टीमिया सस्टि*, फ्रोजन टशि्यू तथा आहार नमूने सम्मलिति हैं। ओआईई सूचीबद्ध रोगजनकों के संदर्भ में सभी नमूनों में नकारात्मकता पायी गयी।

मछली के अपशष्टि को प्लवक बूस्टर में परविर्तति करने की एक अनूठी वधिि, प्लैंकटन*प्लस*

स्वच्छता समस्याओं को कम करने की दृष्टि से सीबा ने 47-49% प्रोटीन तथा 20-30% लपिडि वाले प्लैंकटन*प्लस* मत्स्येलो उत्पा7द की तैयारी के माध्य0म से मछली बाजार के अपरद्द की सफाई हेतु प्रयास किया जसिे जलकृषि तालाबों में प्लमवकों की वृद्धि करने या आहार सूत्रण में घटक के रूप में उपयोग करने तथा कृषि/बागवानी में खाद के रूप में उपयोग किया जा सकता है।

प्लवकों के स्त र और झींगा/मछली के वृद्धि निष्पिोदन पर प्लैंकटन*प्लस* के अनुप्रयोग का प्रभाव

प्लैंकटन*प्लस* पूरक आहार को 20 पीपीएम की दर के भागों में बांटकर देने पर पी. वन्नामेय की उल्लेखनीय रूप से (पी <0.01) दैनकि औसत भार में वृद्धि, वशिष्टि वृद्धि दर, कुल बायोमास प्राप्ति और उत्तरजीविता में वृद्धि हुई जबकि 30% कम आहार दिया गया। यद्यपि, प्लैंकटनप्लस पूरक की इसी खुराक से *चनोस चनोस* के वृद्धि निष्पि्ादन और उत्तरजीविता को प्रभावति किए बनिा 50% आहार की बचत की जा सकती है। प्लैंकटन*प्लस* पूरक से बेसलिरियिोफाइसे, प्रसनिोफाइसे और डनिोफाइसे आदि लाभदायक सूक्ष्म शैवालों के घनत्व को बढ़ाने में सहायता मलिी है।

जीवंत आहार का समृद्धकिरण

प्लैंकटन*प्लस* पूरक पोषण से आर्टीमिया बायोमास उत्पादन में सुधार हो सकता है और आर्टेमिया पालन में शैवाल का उपयोग 50% तक कम किया जा सकता है। पख मीन और कवच मीन मछलियों के लार्वा पालन में उपयोग हेतु आर्टेमिया के लिए पीयूएफए से समृद्ध थ्रॉस्टोचाइट्रड्सि, यूनीसेल्यूपलर मोनोसेंट्रकि कवक जैसे प्रोटस्टि का उपयोग किया जा सकता है।

जलजीव आहार में उपयोग के लिए नए आहार घटकों और आहार योगजों का मूल्यांकन

झींगा और मछली के आहार में घुन से संक्रमति शकरकंद, खमीर कण्विति मूंगफली खली, *लीउकेना ल्यूकोसेफला* पत्ती आहार को में 5 से 10% तक समावेश किया जा सकता है। समुद्री शैवाल, *ग्रेसलिरियिा टेनुइस्टपिटिाटा* को झींगा आहार में एक प्राकृतकि योजक के रूप में उपयोग करने की क्षमता पाई गई। अध्ययन से पता चला है कि वृद्धि और

प्रतरिक्षा बढ़ाने के लिए स्परिुलिना से नकिाले गए सी-फाइकोसाइनिन को झींगा आहार सूत्रण में 750 से 1000 पीपीएम तक समावेश कयिा जा सकता है। अध्ययन में यह भी ज्ञात होता है कि बेहतर वकिास और उत्तरजीवति प्राप्त करने के लिए *पीनयिस वन्नायमेय* के तरूण झींगों के आहार में 0.4% क्रलि ऑयल का समावेश कयिा जा सकता है।

सीबा द्वारा वकिसति आहार और नवीन उत्पादों का नरिूपण

तालाब में सामान्यय की तुलना में प्लैंकटन*प्लस* पूरक पोषण से *पी. वन्नामेय* की उत्तरजीवति में उल्लेखनीय वृद्धि (12.31%) और 1.71 टन/हे. उपज वृद्धि हुई। प्लैंकटन*प्लस* पूरक पोषण दिए गए तालाबों में संवर्धति घनत्व% और पादप प्लवक (बेसलिारयिोफसिे, प्रोसनिोफसिे और डाइनोफसिे आदि) और जंतु प्लमवक की ववििधिता *पीनयिस वन्नायमेय* में बढ़े हुए वृद्धि निष्पा दन का कारण हो सकता है। खुले जल के पजिरों में केकड़ा (*सकाइला सेराटा*) पालन नरिूपण से पता चला कि तलहटी पजिरों में गुटकि आहार से कुल बायोमास की प्राप्ति अधकि (7.27 कि.ग्रा.) थी। कम लागत वाली मछली की तुलना में सूत्रबद्ध आहार दिए गए बॉक्सण में पालति केकड़ों (*सकाइला सेराटा*) में इसी प्रकार की अंडाशय भार प्राप्ति तथा गोनाडोमेस्टकि इंडेक्स प्राप्त हुआ।

कैप्टवि *पीनयिस इंडकिस* ब्रूडस्टॉक की कार्यकिीय वशिेषताओं पर वभिन्नि आहार पद्धतयिों का प्रभाव

यह अध्ययन परपिक्वता आहार के वभिन्नि स्तरों (शारीरकि भार का 5%, 15% और 25% प्रति दनि) तथा बंद स्थतियिों में पालन से कैप्टवि *पीनयिस इंडकिस* ब्रूडस्टॉक में कार्यकिीय बदलाव जैसे वृद्धि, मोल्टगि रथिम, परपिक्वरता हार्मोन स्तपर पर पड़ने वाले प्रभाव के मूल्यांकन के लिए कयिा गया था। शारीरकि भार के 15% की दर से आहार दिए गए समूह में मोल्टगि आवृत्ति अधकि पाई गई। इसके अलावा, बंद स्थतियिों पालन के 45 दनिों के बाद, इस समूह में न्यूनतम GIH mRNA स्तर पाया गया।

पोषक तत्वों की आवश्यकताओं का अनुकूलन और आहार वकिास

मल्किफशि लार्वा के आहार वकिास के लिए टॉरनि और वटिामनि ई (α-टॉकोफेरल एसीटेट) की आवश्यकता को अनुकूलति कयिा गया और यह क्रमशः आहार का 1% और 196-218 पीपीएम पाये गये। सीबास के लार्वा पालन के लिए उपलब्ध वाणज्यिकि फीड की तुलना में एशयिन सीबास के लिए वकिसति लार्वा आहार (सीबास लार्वी*प्लस*) से उच्च वृद्धि निष्पादन दर्ज कयिा गया।

हलिसा के ब्रूडस्टॉक आहार के वकिास के लिए परपिक्वता के वभिन्नि चरणों के दौरान हलिसा के फैटी एसडि के जमाव पर अध्ययन कयिा गया। अध्ययन में यह पाया गया कि भले ही मांसपेशी में कम से कम जमा हुआ फैटी एसडि एराकडिोनकि एसडि (सी 20:4) है परंतु यह अंडाशय में सबसे अधकि (96%) है, जबकि पामटिोलेनकि एसडि (सी 16: 1) सबसे अधकि जमा हुआ फैटी एसडि है लेकनि अंडाशय में इसकी मौजूदगी सबसे कम (22.7%) है।

आहार प्रबंधन वकिल्प

मल्किफशि, *चनोस चनोस* लार्वा की वृद्धि और उत्तरजीवति पर वलिंबति प्रारंभकि आहार के प्रभाव से ज्ञात होता है कि बेहतर वकिास और उत्तरजीवति प्राप्त करने के लिए मल्किफशि के लार्वा को आहार देने की प्रक्रयिा नषिचन के 24 घंटे के बाद शुरू की जानी चाहिए। एक्वा ममिक्रिी सस्टिम में झींगा पालन पर कए गए अध्ययन से पता चला है कि सस्टिम में उपलब्ध प्राकृतकि आहार सांद्रता केवल कम संग्रहण घनत्वों में अच्छे वृद्धि निष्पादिन में मदद कर सकती है। जैवकि कार्बन स्रोत के रूप में ग्राउंड राइस ब्रान के उपयोग से बनाए गए बायोफ्लाक का ही सेवन करने वाले झींगों (4.19 ग्रा.) की अपेक्षा बायोफ्लॉक और आहार का सेवन करने वाले झींगों में अधकितम अंतमि भार (19.58 ग्रा.) तथा उत्तरजीवति (> 90%) देखी गई।

डब्यूका आरएनएवी संक्रमण के दौरान miRNAs की अभवि्यक्ति प्रोफाइलगि

हाल के वर्षों में वषिाणु पुनरावर्ति तथा मेजबान कोशकिीय तंत्र की सम्बद्धिता में वषिाणु तथा होस्ट (मेजबान) माइक्रो आरएनए (miRNA) के महत्वे का पता चला है तथा संक्रमण के दौरान मेजबान और रोगजनक से miRNAs के सहसंबंध को समझने के लिए प्रयास तेज कए गए हैं।

डब्यूए ह एसएसवी संक्रमण की स्थति में

झींगा (*पीनयिस वन्नामेयी*) की प्रतरिक्षात्मडक प्रतक्रियिाओं में सम्मलिति miRNAs की पहचान करने के लिए छोटे आरएनए अनुक्रमण कयि गये। प्रक्षेत्र की दो वपिरीत परस्थितियिों अर्थात प्रकोप और नयिंत्रति प्रायोगकि स्थतियिों के अंतर्गत डब्यूरत एसएसवी से संक्रमति झींगा के miRNAs

की अभव्यिक्तप्रिोफाइल की तुलना की गई और इसके परणिामस्वरूप 23365 ज्ञात miRNAs और 481 नवीन miRNAs की पहचान की गई। इसलिए, हमारा अध्ययन दो अलग-अलग स्थतियिों में डब्यू की एसएसवी संक्रमण के दौरान झींगा के miRNA अभव्यिक्तिका तुलनात्मक वश्लिेषण प्रदान करता है।

लांग-रीड्स वाले *पीनयिस इंडकिस* का कांटगि-लेवल एसेम्बंली

पेसफिकि बायोसाइंसेस सीक्वल प्लेटफॉर्म पर PacBio सीक्वेंस डाटा का सृजन कयिा गया। सीक्वेंसगि के लिए 20 केबी सीक्वेंसगि लाइब्रेरी का इस्तेमाल कयिा गया था, जहां ब्लूपीपनि साइज सेलेक्शन के आधार पर 17 केबी साइज से अधकि इंसर्ट्स रखे गए थे। सीक्वेंलस डाटा के 176,539,267,324 आधार की लंबाई के लगभग 20,857,430 रीड्स, जो जीनोम के 71X कवरेज के बराबर हैं, का उपयोग फाल्कन, कैनु और डब्ल्यूटीडीबीजी 2 असेम्बगलर्स के साथ कांटेग-लेवल जीनोम के नर्मिाण के लिए कयिा गया था। आप्टकिल मैप तथा HiC डाटा का सृजन, स्कैफफोल्डगि और क्रोमोजोम लकिगि कार्य प्रगतिपर है।

dbVAST: झींगा ट्रांसक्रप्टिों के साथ जुडी ववििधिताओं का डाटाबेस

पालन पद्धतिके उत्पादन में वृद्धिके लिए संभावति जीनोमकि संसाधनों की खोज और उनके उपयोग को बढ़ावा देने के लिए, झींगा ट्रांसक्रप्टिों से जुडी ववििधिताओं का एक डाटाबेस बनाया गया। तीन झींगा प्रजातयिों *पीनयिस वन्नाकमेय, पीनयिस इंडकिस* और *पीनयिस एजटेकस* के कोडगि अनुक्रमों में सगिल न्यूक्लयिोटाइड बहुरूपता (एसएनपी) का प्रलेखन कयिा गया और ब्राउज़ करने के लिए उपयोगकर्ता के अनुकूल ऑन-लाइन टूल प्रस्तुत कयिा गया।

एमआरएफ : मसिगि रीजन फाइंडर

कसिी भी अन्य रोगज़नक़ के साथ समानता प्रदर्शति न करने वाले व्हाटइट स्पॉट सड्रिोम वायरस (डब्यू के एसएसवी) जीनोम की वशिष्टिता है कि इसके एन्नोटेशन सीमति है। डब्ल्यू एसएसवी जीनोम पर सम्पूर्ण ज्ञान प्राप्तव करने के लिए मसिगि रीजन फाइंडर नाम से एक वेब टूल वकिसति कयिा गया। क्वेरी में डलिीट कए गए जीनोम रीजन को ढूंढने के लिए एमआरएफ, क्वेरी जीनोम की तुलना संदर्भ जीनोम से करता है तथा संदर्भ जीनोमों की व्यारख्याए के अनुसार डलिीट कए गए इन रीजंस की सीडीएस को सारणीबद्ध करता है। इससे एकल संदर्भ की व्याएख्यास नामकरण में तुलनात्मक जीनोम वश्लिेषण के नष्किर्ष आसानी से समझ में आ जाएंगे। डब्यूरीज एसएसवी जीनोमों से संबंधति नामकरण वर्गीकरण के मुद्दे में इस प्रकार का टूल क्षमतावान है क्योंकि इसमें उपयोगकर्ता एकल संदर्भ जीनोम की तुलना कई जनिोम से कर सकते हैं।

उपसमूह, डेंड्रोब्रानचयिाटा में झींगा के फाइलोजीनोमक्सि

जीनस *पीनयिस सेंसु* लेटो में टैक्सोनोमकि संशोधन पर शोधकर्ताओं के बीच मतभेद और भ्रम मौजूद है। संपूर्ण माइटोकॉन्ड्रयिल डीएनए जीनोम अनुक्रमों पर कए गए अध्य न में अधकितम संभाव्य ता और बेसयिन फाइलोजेनेटकि नष्कि र्ष से *पीनयिस सेंसु* लेटो में मोनोफाइली सूचति हुआ। इसके अतरिक्ति , औसत अमीनो एसडि पहचान (एएआई) के अनुमान में भी *पीनयिस सेंसु* लेटो के मोनोफाइली की सूचना मलिी है।

मछली में लगि वभिेद

एंटी-मुलेरयिन हार्मोन (*एएमएच*) की अभव्यिक्तिसे ग्रे मुलेट, मुगलि सेफालस और रेड स्नैपर *लुटजानुस अरजेंटमिकुलैटस* में एक नर वशिष्टि अभव्यिक्तिका संकेत मलिा कि मछली में सेक्स वभिेद मार्कर के रूप में *एएमएच* के उपयोग की संभावना है।

पर्लस्पॉट, ऑरेंज क्रोमाइड और ग्रे मुलेट के समष्टिआनुवंशकि स्टॉक

वाणज्यिकि रूप से महत्वपूर्ण खारा जल पखमीन में माइटोकॉन्ड्रयिल एटीफेज 6/8 के उपयोग से वश्लिेषण के आधार पर समष्टिविविधिता की जांच की गई। परीक्षति *इट्रोप्लस सुराटेंसेस* के लगभग सभी स्टॉधकों में उल्लेएखनीय आनुवंशकि ववििधिता देखी गई परंतु दूरी से अलगाव गैर-उल्लेखिनीय था। *इट्रोप्लस मैकुलाटस* के वेंबानाड और पुलकिट सम्पददाओं के बीच महत्वपूर्ण आनुवंशकि वचिलन देखा गया। *मुगलि सेफालस* में, परणिामों ने भारतीय तट में दो अलग-अलग आनुवंशकि सम्पफदाओं अर्थात एक ओडशिा और केरल के बीच और दूसरा (गोवा और गुजरात) के बीच मौजूद होने का संकेत दयिा है।

पर्लस्पॉट फुल-सबि फैमलिी का वृद्धिनष्पिाादन

दर्ज कए गए दो पर्लस्पॉट (*इट्रोप्लस सुराटेंसेस*) फुल-सबि कुलों के वृद्धिनष्पिोदन में दोनों कुलों

INTRODUCTION

As the global demand for seafood is increasing every year against the plateauing wild fishery catches, aquaculture is looked up to with a lot of hope and responsibilities. Aquaculture is the fastest growing food-producing sector across the world currently produces 47 percent of food fish for the world, and it supplies over 60 percent of food fish to the Asian population. India is the second largest producer of farmed fish and offers a vast potential for aquaculture development and doubling the farmer's income. Though aquaculture is possible in all types of water resources (freshwater, brackishwater and seawater), the pressure on freshwater resources due to multi-user demands and climate change-related impacts constraint its expansion in the freshwater sector, hence the future aquaculture development is expected to occur mostly in salty brackishwater.

Out of a total 3.9 million ha of the brackishwater area estimated, 1.2 million hectares of coastal saline lands have been identified to be potentially suitable for brackish water farming. Also, about 9 million hectares of salt-affected inland soils in the hot semi-arid and arid ecoregion of northern plains and central highlands in the states of Haryana, Rajasthan, Punjab, Uttar Pradesh, Maharashtra and Gujarat are found suitable. Estimates show that only 11% of the potential coastal area available is utilized for farming. Hence this resource assessment was done long back, CIBA targeted to re-estimate the potential brackishwater resources with the advent of advanced satellite mapping and GIS tools. This mapping will help in planning for future expansion and management of brackishwater farming.

It is inspiring to witness the spectacular growth of this industry in India, spearheaded by shrimp farming with an export of about 7 billion US$ plus in 2017-18, which was only a nascent industry during the early 1990s. The





aquaculture sector is also confronting severe challenges, such as the impact of climate change and variability, disease outbreaks, environmental degradation, increasing input costs, anthropogenic activities, and related social and economic changes, increasing intra-regional trade and public health concern over food safety. Therefore, addressing these issues through research and development, and policy formulation is of utmost necessity.

At ICAR-CIBA, we support cutting-edge science and research to develop customized technologies suitable for different agro-climatic conditions to grow sustainable aquaculture in India and reap its social, economic, and environmental benefits. The institute has been advocating diversification of brackishwater aquaculture with alternative shellfish and finfish species and optimally utilising suitable brackishwater bodies with appropriate rearing systems through stakeholders' participation. We foster responsible aquaculture that provides safe, sustainable seafood; creates employment and business opportunities in coastal communities; and complements CIBA's comprehensive strategy for maintaining healthy and productive biological resource, ecosystems, and vibrant coastal communities.

Established in the year 1987, ICAR-CIBA headquartered at Chennai has its experimental station at Muttukkadu (MES), Tamil Nadu and research centres at Kakdwip (KRC), West Bengal in east coast and Navsari, Gujarat (NGRC) in the west coast. Established on 7th June 2018, research center in Navsari Gujarat (NGRC) is a CIBA's first aquaculture research center on the west coast of India. The main objective of the center is catering to the needs of aquaculture development along the west coast of India.

This annual report is a comprehensive combined report on ICAR-CIBA's research progress and administrative activities throughout the year 2018-19. Expectantly this report will provide adequate information about events, performance, and contribution to the brackishwater farming sector. ■



ABOUT ICAR-CIBA

Central Institute of Brackishwater Aquaculture (CIBA) is one among the 101 institutes under the nation's apex body, Indian Council of Agricultural Research (ICAR), New Delhi. The institute was established on 1st April l 987, and serves as the nodal agency for research and development of brackishwater aquaculture in the country. ICAR- CIBA with a vision of environmentally sustainable,economically viable and socially acceptable brackishwater aquaculture. It is involved in research and development related to fish seeds, cost effective feeds, environmental monitoring, farm and hatchery management, disease diagnosis, disease monitoring and social research etc. The institute is headquartered at Chennai with an experimental field station at Muttukadu, a backwater zone of the Bay of Bengal located about 30 km south of Chennai. The Institute has one research centre at Kakdwip, Sunderban in West Bengal.



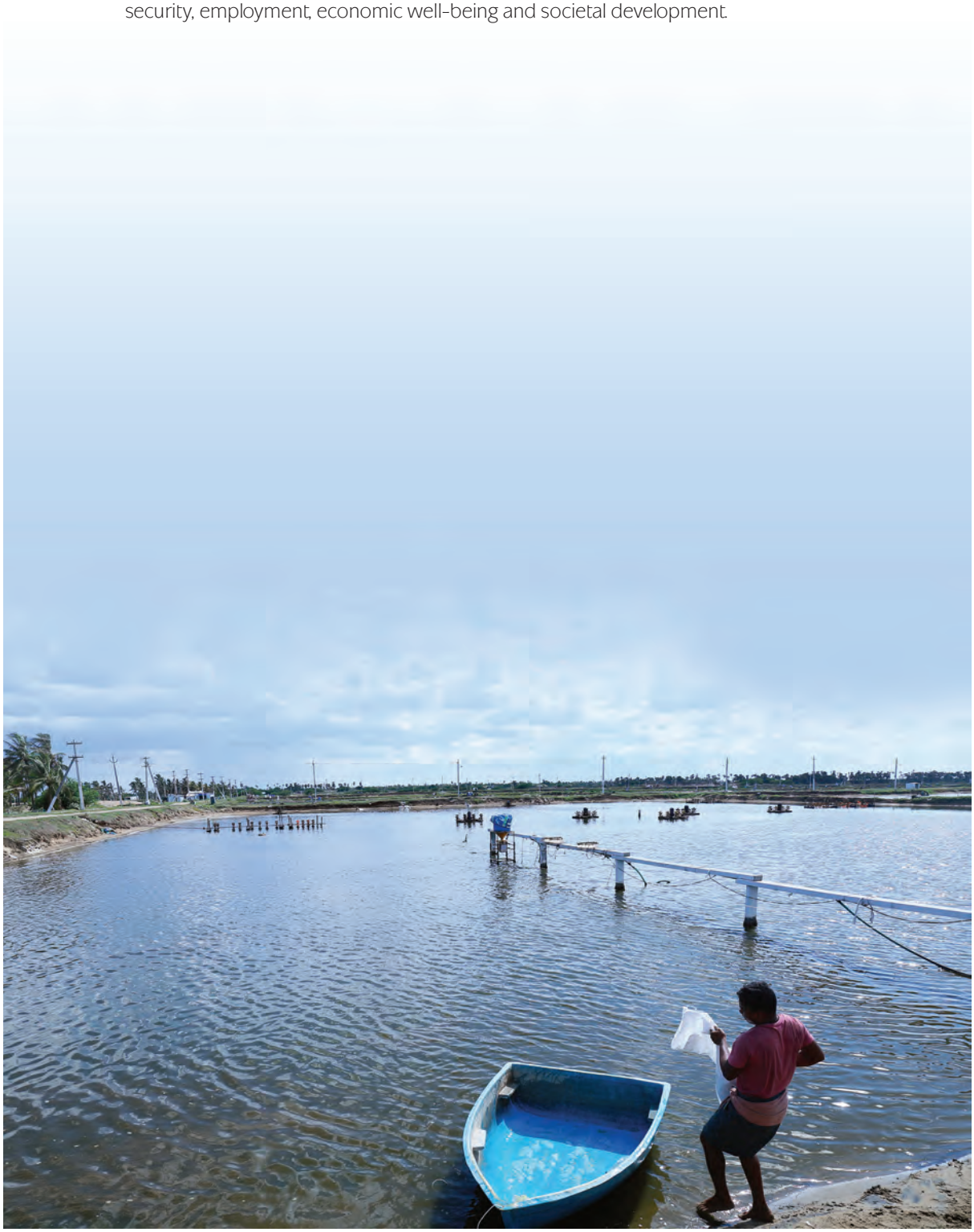
VISION

CIBA envisages its role as one of the world's foremost scientific research institute in brackishwater aquaculture through the pursuit of excellence in research and innovation that contribute modernization and development of sustainable brackishwater aquaculture in the country.



MISSION

Our mission is to realize this vision through basic and applied research, and providing technological backstopping suitable for Indian conditions for the development of sustainable brackishwater aquaculture. This would provide much-needed food, nutritional security, employment, economic well-being and societal development.



MANDATES

Basic, strategic and applied research for techno-economically viable and sustainable culture systems for finfish and shellfish in brackishwater.

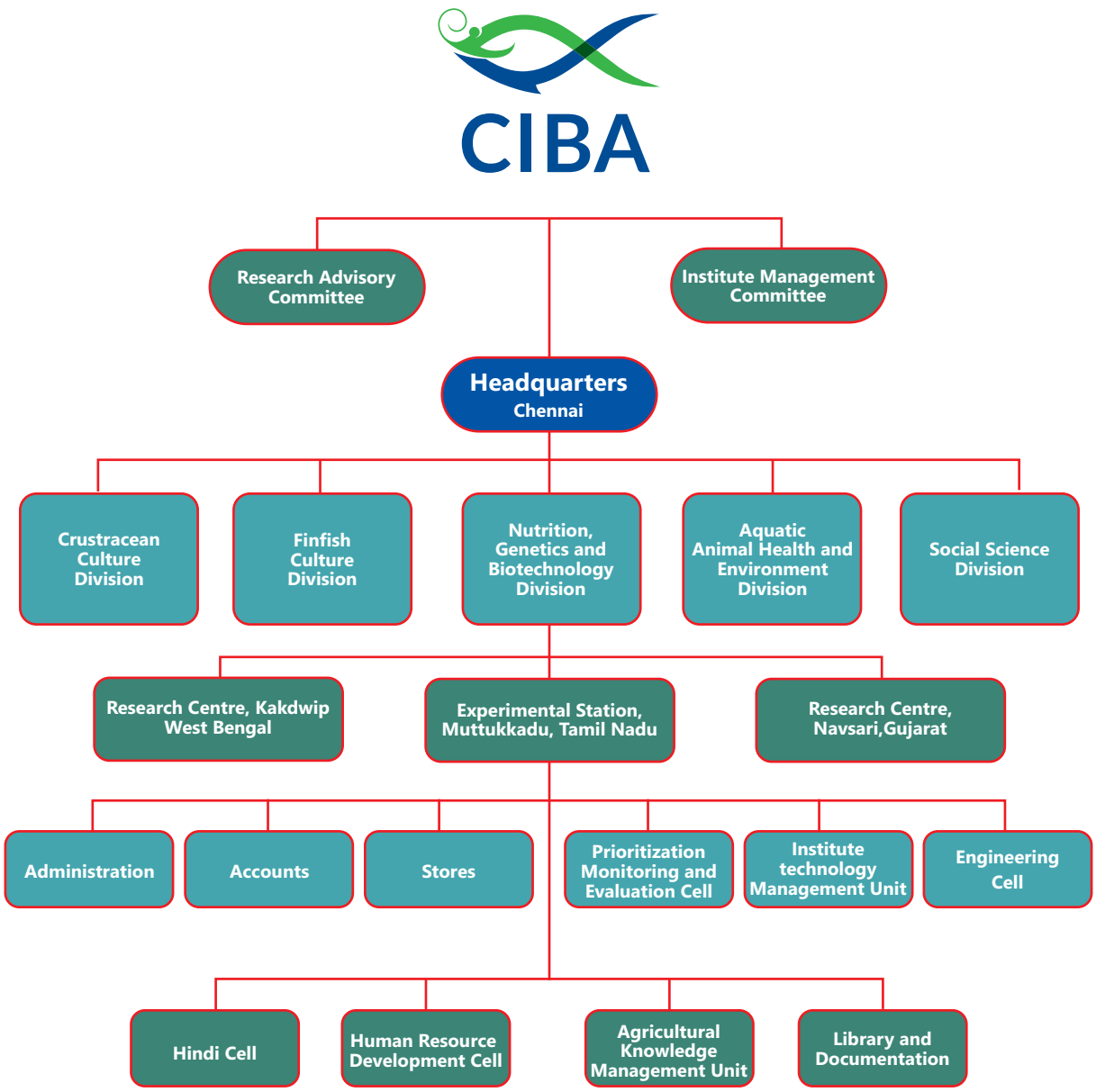
Species and systems diversification in Brackishwater aquaculture.

Act as a repository of information on brackishwater fishery resources with a systematic database.

Human Resource Development, capacity building and skill development through training, education and extension.



ORGANIZATON CHART



UNIFIED BUDGET OF CIBA FOR THE YEAR 2018-19

Rs. in lakhs

S.No.	Sub-Head	BE 2018-19	RE 2018-19	Actual expenditure during 2018-19
	Grants for creation of CAPITAL ASSETS (Capital)			
1	Works - Office building	220.00	139.00	139.00
2	Equipments	68.00	72.86	72.85
3	Information Technology	15.00	15.00	15.00
4	Library Books and Journals	10.00	10.00	10.00
5	Furniture & Fixtures	7.00	6.99	6.99
	Sub-total (A)	**320.00**	**243.85**	**243.84**
	Grants in Aid - SALARIES (Revenue)			
1	Establishment Expenses - Salaries	1797.00	2390.00	2389.96
	Sub-total (B)	1797.00	2390.00	2389.96
	Grants in Aid - GENERAL (Revenue)			
1	Pension & Other Retirement Benefits	1550.00	2071.00	2070.99
2	Traveling Allowances	30.00	35.00	35.00
3	Research & Operational Expenses	216.00	216.00	216.00
4	Administrative Expenses	1061.00	770.73	770.73
5	Miscellaneous Expenses (HRD & Others)	18.00	19.00	19.00
	Sub-total (C)	**2875.00**	**3111.73**	**3111.72**
	TSP			
1	Capital	36.00	17.00	17.00
2	Revenue	26.00	32.00	32.00
	Sub-total (D)	**62.00**	**49.00**	**49.00**
	SCSP			
1	Capital	0.00	26.15	26.11
2	Revenue	0.00	94.27	94.27
	Sub-total (E)	**0.00**	**120.42**	**120.38**
	GRAND TOTAL (A+B+C+D+E)	**5054.00**	**5915.00**	**5914.90**

STAFF POSITION

(as on 31.03.2019)

Category	Sanctioned	Filled	Vacant
Director	1	1	0
Head of Divisions/Principal Scientist	5	1	4
Senior scientists	10	6	4
Scientists	52	59	(+) 7
Technical Officers / Technical Assistants	25	22	3
Administrative Officer	1	0	1
Finance & Accounts Officer	1	1	0
Deputy Director (OL)	1	0	1
Assistant & Administrative Officer	3	3	0
Junior Accounts Officer	1	1	0
Private Secretary	1	1	0
Personal Assistants	2	2	0
Stenographers Gr. III	1	1	0
Assistants	7	6	1
Upper Division Clerks (UDC)	3	3	0
Lower Division Clerks (LDC)	5	2	3
Skilled Support Staff	55	25	30
Grand total	**174**	**134**	**47**

ON-GOING RESEARCH PROJECTS

CRUSTACEAN CULTURE DIVISION		
INSTITUTE FUNDED PROJECTS		
	Project Title	**Project Team**
1	Novel approaches for technology refinement and upscaling of diversified systems and species of shrimp for sustainable development	**PI: Dr. A. Panigrahi** **Co-PIs:** Dr. M. Jayanthi, Dr. C.P. Balasubramanian, Dr. P. Nila Rekha, Dr. S. Kannappan, Dr. P. Shyne Anand, Ms. L. Christina, Shri R. Aravind, Shri Jose Antony, Dr. N.S. Sudheer, Shri I.F. Biju, Dr. T.N. Vinay, Dr. S. Sivagnanam, Shri S. Rajamanickam, Dr. K. Ambasankar, Dr. R. Geetha, Dr. T.K. Ghoshal, Dr. M. Kumaran, Dr. Sanjoy Das, Dr. Suvana Sukumaran, Shri Pankaj Amrut Patil
2	Breeding biology, reproductive challenges and larviculture of candidate crustacean species of brackishwater aquaculture	**PI:Dr. C.P. Balasubramanian** **Co-PIs:** Dr. M. Jayanthi, Dr. A. Panigrahi, Dr. S. Kannappan, Dr. P. Nila Rekha, Dr. P. Shyne Anand, Ms. L. Christina, Dr. T.N. Vinay, Dr. N.S. Sudheer, Shri Jose Antony, Shri R. Aravind, Shri I.F. Biju, Dr. K.C. Neethu
3	Technological backstopping and promotion of sustainable aquaculture in west coast with particular reference to the state Gujarat	**PI:Dr. C.P. Balasubramanian** **Coordinator:** Shri Pankaj Amrut Patil **Co-PIs:** Dr. M. Kailasam, Shri Jose Antony, Shri Tanveer Hussain, Dr.P.K. Patil,Dr. P. Mahalakshmi, Dr. R. Saraswati, Dr. K. Ambasankar

EXTERNALLY FUNDED PROJECTS			
	Project Title	**Funding**	**Project team**
4	Upgradation of breeding P. indicus through stock evaluation and culture demonstrations	**NFDB**	**PI: Dr. A. Panigrahi** **Co-PIs:** Dr. G. Gopikrishna, Dr. S. Kannappan, Dr. P. Mahalakshmi, Dr. K.P. Kumaraguru vasagam, Dr. K. Vinaya Kumar, Dr. P. Shyne Anand, Ms. L. Christina
5	Seaweeds for bioremediation in recirculatory aquaculture system	**DST**	**PI: Dr. P. Nila Rekha** **Co-PIs:** Dr. K. Ambasankar, Dr. A. Panigrahi, Dr. K.P. Kumaraguru vasagam
6	Evaluation and refinement of indigenous automatic feeder for shrimp farming	**NFDB**	**PI: Dr. P. Nila Rekha** **Co-PIs:** Dr. K. Ambasankar
7	Healthy shrimp and 'GIFT' tilapia production through bio-floc based farming system: Development of technology and standard operating procedure	**DBT**	**PI: Dr. A. Panigrahi** **PI: Dr. S. Felix, VC, TNJFU** **Co-PIs:** Dr. M. Shashi Shekhar, Dr. P. Nila Rekha, Dr. K.P. Kumaraguru Vasagam Dr. Antony Cheryl, TNJFU Dr. A. Gopalakannan, TNJFU
8	Optimization of aerators use to reduce production cost of shrimps under different brackishwater farming conditions	**NFDB**	**PI: Dr. M. Jayanthi** **Co-PIs:** Dr. T. Ravisankar, Dr. M. Muralidhar, Dr. R. Saraswati, Dr. Aritra Bera
9	Mapping of coastal resources and identifying suitable areas for expanding Integrated Multi-Trophic Aquaculture (IMTA) in Maharashtra	**IMTA Maharashtra**	**PI: Dr. M. Jayanthi** **Co-PIs:** Dr. C.P. Balasubramanian Dr. M. Muralidhar, Dr.C.V. Sairam, Dr. K.P. Kumaraguru Vasagam, Dr. P. Kumararaja, Shri Pankaj Amrut Patil

FINFISH CULTURE DIVISION			
	INSTITUTE FUNDED PROJECTS		
Sl.No.	**Project Title**	**Funding**	**Project Team**
10	Application of improved techniques for captive maturation, assessment of reproductive biology, system development of induced breeding larval rearing and seed production of brackishwater candidate finfish species		**PI: Dr. M. Kailasam** **Co-PIs:** Dr. M. Makesh, Dr. Satyanarayan Sethi, Dr. Krishna Sukumaran, Dr. G. Biswas, Dr. Prem Kumar, Dr. Aritra Bera, Smt. Babita Mandal, Smt. M.U. Rekha, Shri Pankaj Amrut Patil, Shri Tanveer Hussain, Shri T. Sivaramakrishnan, Shri Dani Thomas, Dr. K.C.. Neethu, Shri R. Subburaj
11	Development and evaluation novel culture technologies for candidate brackishwater finfishes for sustainable aquaculture.		**PI: Dr. M. Makesh** **Co-PIs:** Dr. M. Kailasam, Dr. Satyanarayan Sethi, Dr. Krishna Sukumaran, Dr. G. Biswas, Dr. Prem Kumar, Dr. Aritra Bera, Smt. Babita Mandal, Smt. M.U. Rekha, Shri Tanveer Hussain, Shri Dani Thomas, Shri Pankaj Amrut Patil , Shri T. Sivaramakrishnan, Shri R. Subburaj
AQUATIC ANIMAL HEALTH AND ENVIRONMENTAL DIVISION			
	INSTITUTE FUNDED PROJECTS		
12	Prevention and management strategies for viral, microbial and parasitic diseases of candidate species in brackishwater ecosystem		**PI: Dr. S. V. Alavandi** **Co-PIs:** Dr. K.K. Vijayan, Dr. K.P. Jithendran, Dr. M. Poornima, Dr. P.K. Patil, Dr. S. K. Otta, Dr. Sanjoy Das, Dr. P. Ezhil Praveena, Dr. R. Ananda Raja, Dr. Sujeet Kumar, Dr. T. Bhuvaneswari, Dr. Vidya Rajendran, Shri T. Sathish Kumar, Shri Mary Lini, Shri Joseph Sahaya R ajan **Associates from other division** Dr. M. Makesh, Dr. N. Lalitha, Dr. Prem Kumar, Ms. Leesa Priyadarshini, Dr. Satheesha Avunje

Sl.No.	Project Title	Funding	Project team
13	Abiotic stress management for enhanced productivity and environmentally sustainable shrimp farming		**PI: Dr. M. Muralidhar** **Co-PIs:** Dr. R. Saraswathy, Dr. N. Lalitha, Dr. P. Kumararaja, Dr. Satheesha Avunje, Dr. Suvana Sukumaran , Dr. A. Nagavel
	EXTERNALLY FUNDED PROJECTS		
14	National surveillance programme for aquatic animal diseases	**NFDB**	**PI: Dr. S. V. Alavandi** **Co-PIs:** Dr. K.K. Vijayan, Dr. K.P. Jithendran, Dr. M. Poornima, Dr. Sanjoy Das, Dr. Sujeet Kumar, Dr. P. Ezhil Praveena, Dr. T. Bhuvaneswari, Dr. R. Ananda Raja, Shri T. Sathish Kumar, Dr. Vidya Rajendran Dr. Joseph Sahayarajan
15	All India network on fish health	**ICAR**	**National Coordinator: Dr. K.K. Vijayan** **PI: Dr. P.K. Patil** **Co-PIs:** Dr. S.V. Alavandi, Dr. S.K. Otta, Dr. R. Ananda Raja, Dr. T. Bhuvaneswari, Dr. Satheesha Avunje, Dr. M. Makesh, Dr. R. Saraswathy, Dr. N. Lalitha, Dr. P. Kumararaja, Dr. C.V. Sairam, Dr. T. Ravisankar, Dr. R. Geetha
	Consortium research platform on vaccines and diagnostics	**ICAR**	**Project Coordinator:** Dr. M. Makesh
	a. Development of RNAi –mediated prophylaxis and therapy of white spot syndrome virus (WSSV)		**PI: Dr. S.K. Otta** **Co-PIs:** Dr. S.V. Alavandi, Dr. M. Makesh

Sl.No.	Project Title	Funding	Project team
	b. Development of vaccine for betanoda virus infecting seabass, Lates calcarifer		**PI: Dr. M. Makesh** **Co-PIs:** Dr. M. Poornima, Dr. K.P. Jithendran, Dr. P.K. Patil, Dr. Sujeet Kumar
	c. Biocontrol of vibrios in shrimp hatcheries using bacteriophages		**PI: Dr. S.V. Alavandi** **Co-PIs:** Dr. Satheesha Avunje, Dr. Vidya Rajendran Dr. Sujeet Kumar, Dr. Joseph Sahaya Rajan
	d. Development of probiotics and immunostimulants for shrimp		**PI: Dr. P.K. Patil** **Co-PIs:** Dr. S.V. Alavandi, Dr. Satheesha Avunje, Dr. T. Bhuvaneswari, Dr. R. Ananda Raja
	e. Development of improved diagnostics to existing and emerging pathogens of shrimp and fish		**PI: Dr. M. Makesh** **Co-PIs:** Dr. S.V. Alavandi, Dr. Ezhil Praveena, Dr. M. Poornima, Dr. S.K. Otta, Shri T. Sathish Kumar, Dr. Vidya Rajendran Dr. Joseph Sahaya Rajan
17	Network project on antimicrobial resistance	**ICAR**	**PI: Dr. S.K. Otta** **Co-PIs:** Dr. Satheesha Avunje, Dr. Vidya Rajendran
18	National Innovations in Climate Resilient Agriculture (NICRA)- Impact of climate change on aquaculture and mitigation options for minimizing green house gases from aquaculture sector	**ICAR**	**PI: Dr. M. Muralidhar** **Co-PIs:** Dr. M. Jayanthi , Dr. J. Syama Dayal, Dr. A. Panigrahi, Dr. M. Kumaran, Dr. R. Saraswathy, Dr. S.K. Otta, Shri J. Ashok Kumar, Dr. N. Lalitha, Dr. P. Kumararaja, Dr. Aritra Bera, Dr. Satheesha Avunje, Dr. Suvana Sukumaran, Dr. A. Nagavel

NUTRITION, GENETICS & BIOTECHNOLOGY DIVISION

INSTITUTE FUNDED PROJECTS

Sl.No.	Project Title	Project Team
19	Application of advanced molecular and bioinformatic tools for improvement of brackishwater fish and shell fish	**PI: Dr. G. Gopikrishna** **Co-PIs:** Dr.K.K. Vijayan Dr. M. Shashi Shekhar, Dr. Sherly Tomy, Dr. K. Vinaya Kumar, Dr. B. Sivamani, Dr. J. Raymond Jani Angel , Ms. Misha Soman Dr. M.U. Rekha
20	Novel approaches for development and improvement of sustainable shrimp and fish feeds	**PI: Dr. K. Ambasankar** **Co-PIs:** Dr. J. Syama Dayal, Dr. T.K. Ghoshal, Dr. Debasis De, Dr. K.P. Kumaraguru vasagam, Shri K.P. Sandeep, Ms. Leesa Priyadarsani Shri T. Sivaramakrishnan

EXTERNALLY FUNDED PROJECTS

	Project title	Funding	Project team
	Outreach activity on fish feeds and nutrient profiling of brackishwater fish and shrimp	**ICAR**	**PI: Dr. K. Ambasankar** **Co-PIs:** Dr. J. Syama Dayal, Dr. T.K. Ghoshal, Dr. Debasis De, Dr. K.P. Kumaraguru Vasagam, Ms. Leesa Priyadarshini Shri T. Sivaramakrishnan
	Outreach activity on fish genetic stocks (Lead Centre: NBFGR, Lucknow)	**ICAR**	**PI: Dr. G. Gopikrishna** **Co-PIs:** Dr. M. Shashi Shekhar, Dr. B. Sivamani, Dr. C.P. Balasubramanian, Dr. Sherly Tomy, Dr. J. Raymond Jani Angel , Dr. T.N. Vinay, Ms. Misha Soman

Sl.No.	Project Title	Funding	Project team
	Whole genome sequencing of Indian white shrimp Penaeus indicus	**ICAR**	**PI: Dr. M. Shashi Shekhar** **Co-PIs:** Dr. G. Gopikrishna, Dr. C. P. Balasubramanian, Shri J. Ashok Kumar, Dr. K. Vinaya Kumar, Dr. S.K. Otta
	Poverty alleviation through prevention and future control of the two major socio economically important diseases in Asian aquaculture	**DBT**	**PI: Dr. M. Shashi Shekhar** **Co-PIs:** Dr. K.K. Vijayan, Dr. G. Gopikrishna, Dr. K. Vinaya Kumar, Mr. T. Sathish Kumar
	Investigations on pathogenic microorganisms of shrimp aquaculture using metagenomic and other bioinformatics approaches	**ICAR**	**PI: Shri J. Ashok Kumar** **Co-PIs:** Dr. S.V. Alavandi Dr. K. Vinaya Kumar Dr. Satheesha Avunje Dr. Joseph Sahayarajan
Social Sciences Division			
INSTITUTE FUNDED PROJECTS			
19	Research on socio-economics, frontline extension and information technology for sustainable brackishwater aquaculture sector	**ICAR** **PI: Dr. C.V. Sairam** **Co-PIs:** Dr. T. Ravisankar, Dr. B. Shanthi Dr. D. Deboral Vimala, Dr. M. Kumaran Dr. P. Mahalakshmi, Shri J. Ashok Kumar Dr. R. Geetha, Dr. K.C. Neethu	
EXTERNALLY FUNDED PROJECTS			
	Project title	**Funding**	**Project team**
Sl.No.	**Project Title**	**Funding**	**Project team**
20	Brackishwater cage culture with multi-trophic candidate species diverse rearing systems for alternate livelihood and societal development in Maharashtra	Mangrove cell Maharashtra	**PI: Dr. C.V. Sairam** **Co-PIs:** Dr. M. Kailasam, Dr. C.P. Balasubramanian Dr. Pankaj Patil, Shri Tanveer Hussain Shri T. Sivaramakrishnan, Shri K.P. Sandeep

21	Cage culture in brackishwaters of Puducherry and karaikal regions of Puducherry Union Territory A - feasibility study	**FIMSUL**	PI: Dr. M. Kumaran Co-PIs: Dr.M. Jayanthi Dr. D. Deboral Vimala Dr. C.V. Sairam Dr. M. Muralidhar Dr. K.P. Kumaraguru Vasagam Smt. Babita Shri R. Subburaj

Kakdwip Research Centre

INSTITUTE FUNDED PROJECTS

Project Title		Project Team
22	Development and dissemination of economically viable and sustainable brackishwater aquaculture technologies for livelihood improvement of small and marginal farmers of Indian Sundarban	PI: Dr. T. K. Ghoshal Co-PIs: Dr. Sanjoy Das, Dr. G. Biswas, Dr. Prem Kumar, Ms. L. Christina, Smt. Leesa Priyadarsani

EXTERNALLY FUNDED PROJECTS

Project Title		Funding	Project team
23	Elucidation of molecular mechanism of dopamine action on final oocyte maturation of Goldspot mullet (Lisa parzia, Hamilton, 1822)	**DBT**	PI: Dr.Prem Kumar Co-PIs: Dr. G. Biswas, Dr.T.K. Ghoshal

OTHER PROJECTS

24	Agri-Business Incubation centre (ABI) at CIBA, Chennai	**NAIF - ICAR**	PI: Dr. T. Ravisankar Co-PI : Dr. P.K.Patil
25	Intellectual property Management and Transfer/ Commercialization of Agricultural Technology Scheme (Up-scaling of existing components i.e. Intellectual property Right (IPR)	NAIF - ICAR	Dr. T. Ravisankar, OIC Dr.P.K. Patil, Coordinator Divisional Members Dr. R. Geetha, SSD Dr. T.N.Vinay, CCD Dr. Raymond Jani Angel, NGBD (Genetics) Dr. K.P. Sandeep, NGBD (Nutrition) Shri Dani Thomas, FCD





RESEARCH HIGHLIGHTS

BRACKISHWATER PRODUCTION SYSTEM RESEARCH

CRUSTACEAN FARMING

Shrimp aquaculture has been mainstay of Indian aquaculture sector that accounted for almost 70% of Rs 45000 crore seafood export revenue last year. Although shrimp farming sector has witnessed spectacular growth during recent decades, it has reached almost 0.6 million ton last year, this valuable industry is currently constrained due to multiple reasons. The institute continues to conduct research efforts to improve and refine this production system.

PENAEUS VANNAMEI

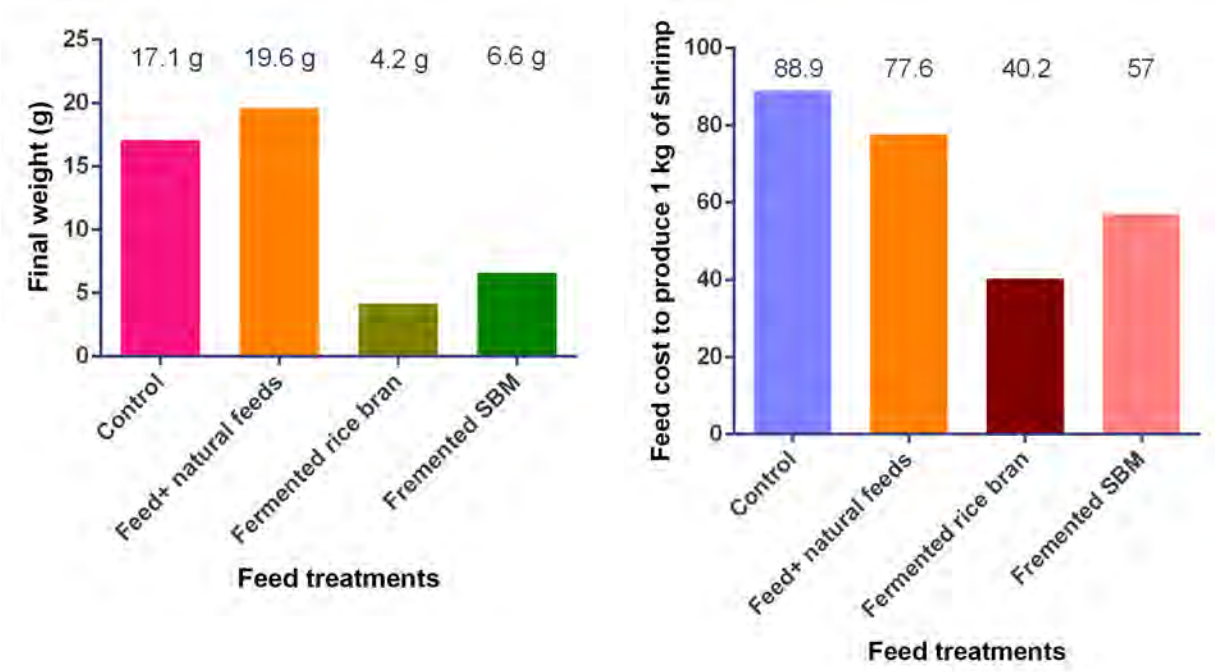
Exotic Pacific white shrimp was introduced to India in 2009, and thereafter this specific pathogen free and genetically improved stock dominated shrimp farming sector in India. Although growth of industry has been spectacular during this decade, currently P.vannamei production systems have been facing severe challenges due to multiple reasons ranging from emergent disease to fallen market prices. During this period we have been addressing several issues in vannamei production system.



Harvested white legged shrimp Penaeus vannamei

GROWTH PERFORMANCE PENAEUS VANNAMEI IN SIMULATED EXPERIMENTAL SYSTEM THAT MIMICS THE NATURAL ESTUARINE WATER CONDITION (AQUA MIMICRY)

Farming methods of shrimp is rapidly evolving by adopting advancements in the aquaculture and allied sectors. Biofloc based farming is widely practiced in intensive shrimp farming. Although biofloc technology has been successful in many cases, the operating cost of the biofloc system is exorbitantly high, and further many misconceptions exist about the biofloc technology. A potentially more balanced approach is the use of biofloc and natural biota together, aquamimicry. To evaluate the potential of aquamimcry in shrimp production system a 90-day feeding trial with vannamei shrimp juveniles (70 shrimps/m^3) in outdoor microcosm was conducted.



Key growth performance indicators of shrimp under different feeding regimes

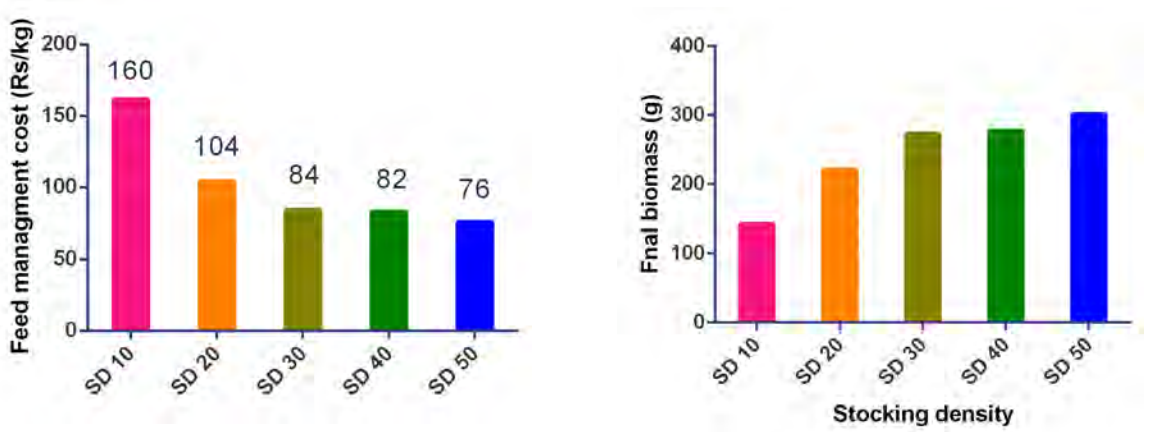
There were four treatments with different feeding regime; control (Clear water only with formulated feed), natural feed with formulated feed, fermented rice bran and fermented soybean meal. Rice bran and fermented soybean meal were used as carbon source for biofloc formation. Self-cleaning microcosm tanks served as rearing system. The shrimp which had access to biofloc & feed had a maximum final weight (19.58g) and survival (>90%) compared to the shrimp (4.19g) which had access to only biofloc generated by using ground rice bran as organic carbon source.

The results of this study will be useful in further fine tuning the nutritional elements in the practical shrimp feed, and cost can be further reduced without compromising the growth performance of the shrimp.

AQUAMIMICRY: EFFECT OF DIFFERENT SHRIMP STOCKING DENSITY

Shrimp stocking density is known to have much impact on the utilization of feed and growth performance of the shrimp. Farmers do shrimp farming in varying densities ranging from 30 to 90

shrimps per square meter. In this experiment we evaluated the influence of stocking density in the absence of feed in the system which is rich in natural feeds. A 72 day feeding trial was conducted with shrimps post larvae of 18 days age. Stocking densities such as 10, 20, 30, 40 and 50 shrimps per meter square were evaluated. To have uniform natural feeds in the form of biofloc, mixture of SBM+ RB fermented for 24 hours was used as carbon source. Self-cleaning microcosm tanks served as rearing system. This study concludes that there is an apparent direct correlation between stocking density in the absence of feed. It indicates that natural feeds concentration available in the system could help only to realize a good growth performance in lower densities and not higher densities. Therefore, this study establishes that biofloc based natural feed not only play role in maintaining water quality in zero water exchange-based system, but also contribute to the nutrition of the shrimps reared. Planning of feed ration for this kind of systems should be adjusted considering the natural feeds to have cost saving.



Growth performance of the shrimp at different stocking densities

COMPENSATORY GROWTH IN SHRIMP VANNAMEI

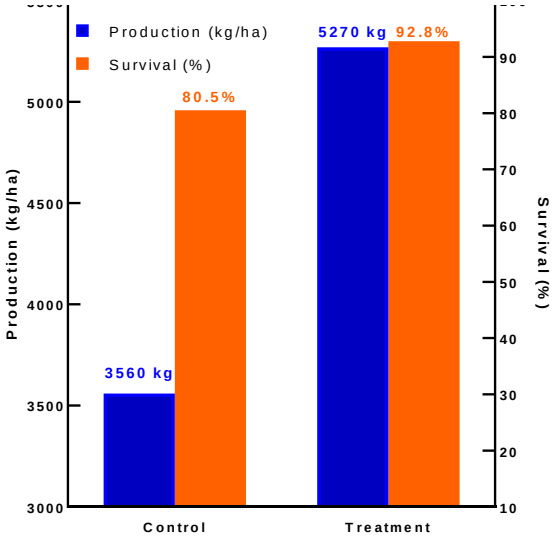
Compensatory growth is already proved in fishes. However, the reports on such a compensatory growth in shrimp are clashing. In fact, this kind of compensatory growth is beneficial for the farmers in management point of view. Therefore, to confirm the presence or absence of compensatory growth this study was conducted with stunted shrimp from the aqua mimicry feeding trials. Here the shrimps were brought to normal feeding regime as our standard shrimp feeding chart. The growth performance was observed for another 55 days. Self-cleaning microcosm tanks served as rearing system. The stunted shrimps were found to have faster growth compared to the normal shrimps. The weekly weight gain in the stunted shrimps was more than 3 g per week, while it was only around 1.6 g per week in the normal shrimps. Compensatory growth in shrimp is evidenced from the results of this study.

PLANKTON PLUS: A COST EFFECTIVE PLANKTON BOOSTER IN VANNAMEI FARMING:

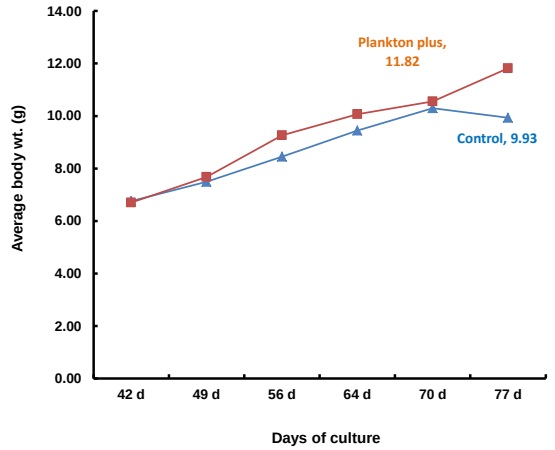
The recycling of the waste in the fish market and landing centres into useful product is one of the efficient management measures to improve the ecosystem health and diversification of livelihood of coastal fishers. Almost 25 to 50% of fish in the

fish markets becomes waste; the institute has made an efficient method to transform these wastes into a useful commercial product, a plankton booster ('Plankton ^{Plus}') in aquaculture ponds

A 77 days trial was conducted in *Penaeus vannamei* ponds at Bapatla, Andhra Pradesh, India to study the effect of Plankton ^{Plus} on augmenting plankton in shrimp culture pond. Plankton ^{Plus} was supplemented @ 10 ppm in split doses. Control ponds were supplemented with rice bran-yeast-mollases juice and dolomite as and when required to maintain the bloom and water quality. At the end of the culture period, average weight of shrimp was higher (11.82 g) in pond supplemented with Plankton ^{Plus} compared to control (9. 93 g). There was a significant increase (12.31%) in survival, and enhancement of yield to the tune of 1.71 t/ha in pond supplemented with Plankton ^{Plus} compared to control. Plankton ^{Plus} supplemented ponds were dominated by beneficial microalgae (Bacillariophyceae, Prasinophyceae and Dinophyceae etc.) and zooplankton. Enhanced growth performance of Penaeus vannamei might be due to the augmented density and diversity of phytoplankton and zooplankton in the Plankton ^{Plus} supplemented ponds.



Production performance in control and plankton plus treated pond



Growth performance in control and Plankton ^{plus} treated ponds



Shrimps grown on plankton ^{plus}



Sampling of plankton productivity

BIOFLOC BASED NURSERY REARING TECHNOLOGY FOR PENAEUS VANNAMEI

Biofloc technology has been an emerging alternative towards the environmental friendly aquaculture. This technology is characterized by reduced water exchange, reduced feed use and improved biosecurity. In order to develop a cost effective nursery system, the institute has conducted two demonstration trials at farmers' field in Odisha. *Penaeus vannamei* PL were reared at a stocking density3500 PL/m2 in 350 mt capacity nursery tank designed by the institute for a period of 28 days. Nursery reared animals were grown up to 0.92 ± 0.15 g with a survival of 94.20± 2.86 %)

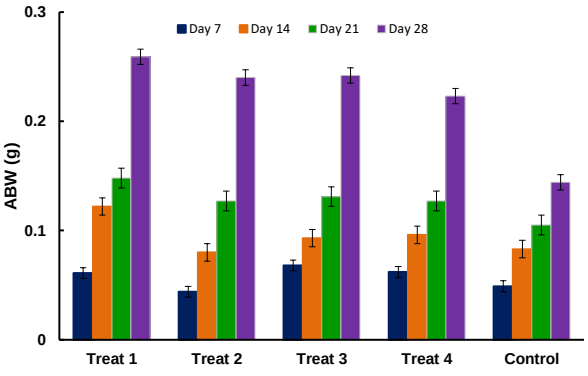
In an another demonstration trials at Andhra Pradesh, two stage nursery system were demonstrated with first phase (N1) for 10days with high stocking (20000 to 30000nos per cum) followed by second phase (N2) for 15 to 20 days with stocking of up to 7000 individuals and finally harvested at ABW 250 – 350 mg within 4 weeks. The CN ratio manipulation with addition of carbon sources customized with biofloc consortium could induce bacterial flora to reduce the nitrogenous metabolites like TAN, Nitrite and Nitrate



Biofloc based nursery tanks

ISOLATION AND CHARACTERIZATION OF GUT MICROBES: THEIR EFFECT ON GROWTH, WATER QUALITY, MICROBIAL DYNAMICS AND ENZYME ACTIVITIES:

Experiment conducted with four different treatments: carbon sources with probiotic consortium, probiotic consortium without biofloc, sugar and probiotic consortium, mixed carbon sources without probiotic consortium and a set of control tanks were reserved without biofloc treatments. The result revealed that the survival rate of mixed carbon sources treated tanks were elevated (80%) contrasting other treatments (76%), while, control showing relatively low survival (67%). The ABW were relatively higher in biofloc treated tanks compared to control. The Biofloc treated shrimps were found to be colonized with beneficial bacteria in the gut region. Among the enzymatic microflora, amylase producer is common in all the treatments and control. Likewise, other enzyme such as protease, lipase, cellulase and xylanase producers were found high in biofloc treated tanks specifically higher in mixed carbon sources treatment. The gene expression study showed relative expression levels of potential immune genes were significantly up-regulated in shrimps grown in biofloc system, particularly with mixed carbon sources, than the control. The Biofloc system is advantageous and allows to colonized beneficial bacterial population in the gut region. Out of 94 strains screened, 36 strains were found to produce amylase enzyme, 20 strains protease, 27 strains lipase and 6 strains cellulase and 8 strains xylanase. Totally 21 isolates selected for further identification and different species of *Cobetia, Exiguobacterium, Bacillus, Marinilactibacillus,*

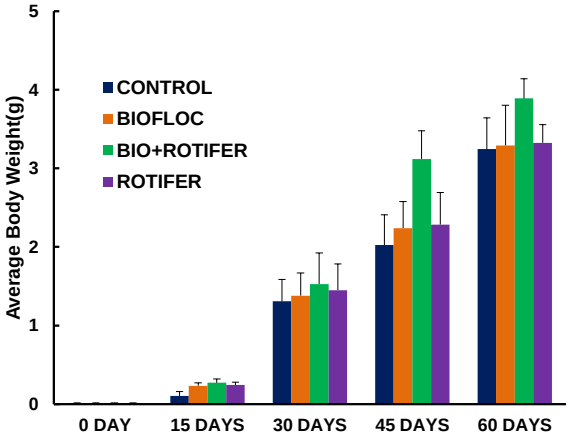


Average body weight of Penaeus vannamei post larvae reared in different treatments

Staphyllococcus and *Novosphingobium* genera from biofloc treatments were identified. In control strains of *Bacillus* and *Exiguobacterium* only observed. Among all, the genus *Exiguobacterium* identified in all treatments and control.

EVALUATION OF AQUA-MIMICRY TECHNOLOGY ON GROWTH PERFORMANCES, WATER QUALITY AND IMMUNE RESPONSES IN RAS ENVIRONMENT

A RAS based nursery rearing was carried out with addition of carbon source and rotifer as feed supplement. The survival and growth was monitored every 15 days in each treatment. The treatments included as C: control, T1: only Biofloc, T2: Biofloc and rotifer , T3: only Rotifer. At the end of Experiment the rotifer with biofloc condition showed better growth (3.89±0.25) and survival (91%) which is significantly different from control animals(3.24±0.29, 85%). The rotifers culture added @ 2 litre/tank in two split dose, one at morning and other at afternoon. The rotifers were cultured with standard procedure by giving chlorella as feed. The rotifers collected by scooping with 200um mesh hand net from cultured tanks.



Growth performance of Penaeus vannamei in Aqua mimicry experiment

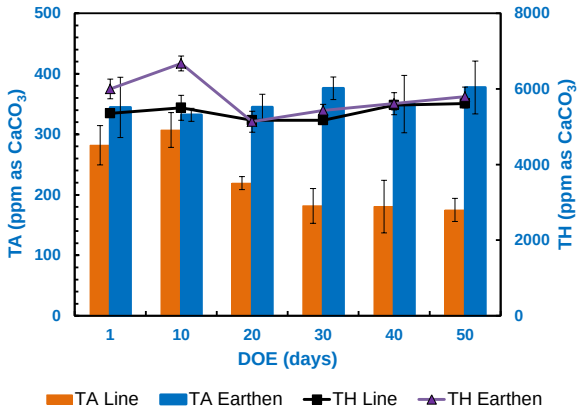
NUTRIENT DYNAMICS UNDER DIFFERENT CULTURE PRACTICES

Shrimp aquaculture is generally practiced in the coastal zone owing to the availability of the brackishwater. However, some of aquaculture ponds constructed in these areas are swampy or sandy, that type of soils do

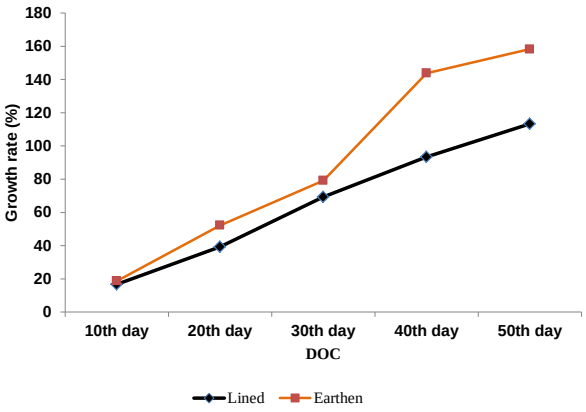
not hold sufficient water level. Further some of these soils are acid sulphate, which is characterized by low pH level Use of plastic pond liners are reported to be effective management scheme to separate the pond and soil. This study was aimed to evaluate the water quality and production performance of *P. vannamei* in a plastic lined system. *Penaeus vannamei* (~4 g) post larvae were stocked in 500 L simulated earthen and lined tanks (40 shrimps per tank) at 25 ppt salinity. The treatments were replicated thrice and no water exchange was carried out during the experimental period. After 50 days of rearing the growth rate was 21% high in earthen ponds. Dissolved oxygen was higher in lined tanks than earthen. In both the practices, the negative value of redox was recorded after 10 DOC and the values were comparatively high towards the positive side in lined ponds whereas, there was no trend in temperature. There was a significant decrease in total alkalinity (282-175 ppm as $CaCO_3$) as culture progressed in lined ponds. Total hardness varied from 5170-5610 and 5133 to 6673 ppm as $CaCO_3$ in lined and earthen ponds respectively. Increase in metabolites with DOC is comparatively lower in lined ponds.

Comparison of metabolites and nutrients under lined and earthen ponds

Characteristics	Lined pond	Earthen pond
DO (ppm)	5.3-6.4	4.9-5.9
TAN (ppm)	0.065-0.941	0.06-1.202
NO2 (ppm)	0.068-0.714	0.077-0.895
NO3(ppm)	0.7-1.5	0.7-1.8
PO4(ppm)	0.2-2.9	0.2-1.9



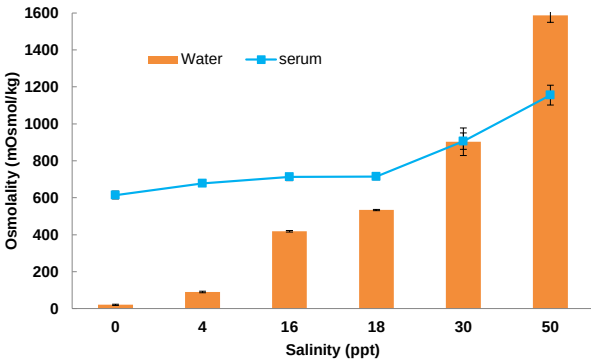
Total alkalinity and total hardness in the lined and earthen ponds



Growth rate of Penaeus vannamei in simulated lined and earthen experimental system

ADAPTATION MECHANISM OF P. VANNAMEI UNDER VARIOUS SALINITIES

In order to evaluate adaptability of *P.vannamei* from fresh water to hyper salinity, animal samples were collected from shrimp culture ponds of varying salinity (0, 4, 16, 18, 30 and 50 ppt) at periodical intervals and osmolality was analysed in both water and serum. The mean water and serum osmolalities were 90, 534 and 1587 mOsmol/kg and 678, 714 and 1155 mOsmol/kg under 4, 18 and 50 ppt salinity, respectively. Due to the lower variation in serum osmolality despite wider variation in rearing medium and osmoregulatory capacity of *P. vannamei*, shrimp adapts to varying salinities and grows without much stress. The iso-osmotic point is 858 and it fits under polynomial 2nd order regression equation (R2: 0.9794).



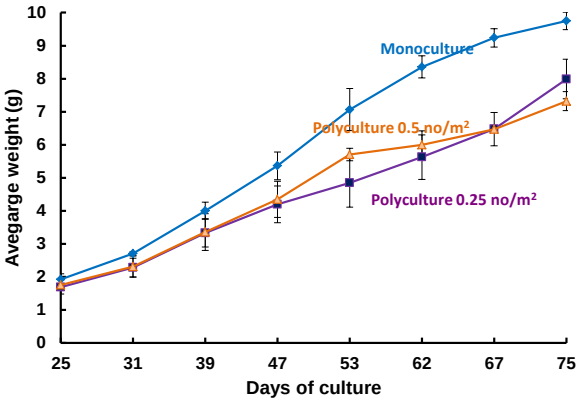
Influence of salinity on water and serum osmolality

PENAEUS INDICUS



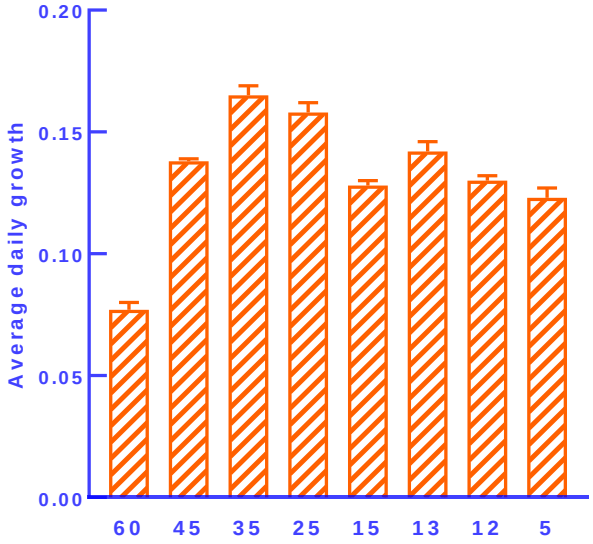
POLYCULTURE OF INDIAN WHITE SHRIMP (*PENAEUS INDICUS*) AND MILKFISH (*CHANOS CHANOS*)

Polyculture of shrimp has been proved to be viable alternative to reduce the nutrient waste from the aquaculture facilities and to optimize the economy shrimp farming. In order to evaluate the production performance of polyculture of *P. indicus* and *C. chanos*, a 75 day culture experiment was carried out at the earthen ponds in Kakdwip Research Centre of CIBA (KRC of CIBA). *Penaeus indicus* was stocked (25 PL/m^2) along with milk fish at two stocking densities (0.25 ind/m^2 and 0.50 ind/m^2), and reared for 75 days. The production performance was compared with monoculture *P. indicus* at the same density. Highest survival (79.33± 1.88 %) and production (1451.28± 22.15 kg/ha) of shrimp was recorded in the pond which *P. indicus* reared with milkfish at a stocking density of 0.5 ind. /m^2, although significantly higher average body weight obtained at the pond stocked with milkfish at a stocking density of 0.25 m^2. No significant ($p < 0.05$) difference in the load of total heterotrophic aerobic bacteria (THAB) and total Vibrio (TV) was observed between polycultured and monocultured ponds. However, significantly higher TAN and NO_2-N were recorded in the control monoculture pond. This study indicates the potential of system diversification for optimizing economics of pond culture and to keep the environmental wellbeing of the pond system.



Average growth rate of Penaeus indicus in mono and polyculture systems

In order to evaluate the production performance of *Penaeus indicus* at different salinities, field levels trials were carried out at different coastal regions, where salinity ranges from 1 to 60 ppt. Production performance was almost similar at lower and higher salinities. Further, average daily growth rate (ADG) was found to be similar at all the salinities except 60 ppt, where adg was almost half compare to other salinities irrespective of lower and higher.



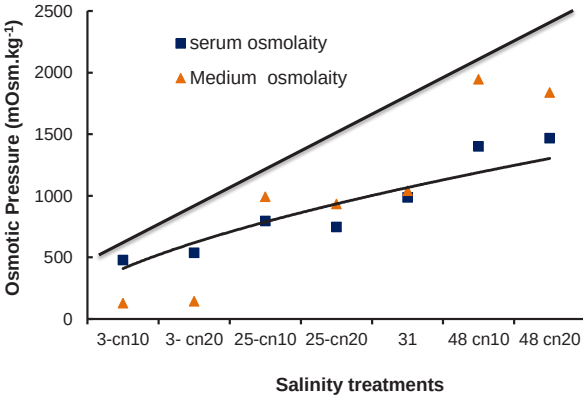
Average growth during culture of Penaeus indicus at different salinities

DEMONSTRATION OF INDIAN WHITE SHRIMP CULTURE ACROSS DIFFERENT LOCATIONS

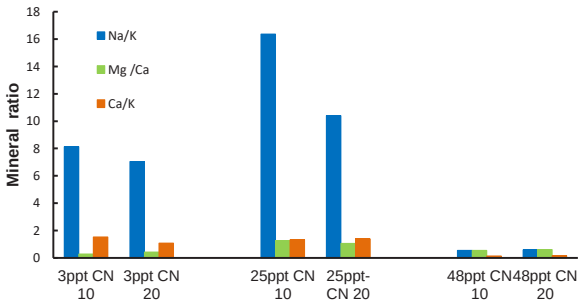
To further refine the performance of Indian White Shrimp *Penaeus indicus* with indigenous technology using 'indicus *plus*' (35% CP) feed, high density culture carried out in farmers' ponds ha in Andhra Pradesh. At the end of 100 -110 days of culture period, a final body weight of 17-19g with a survival up to 85--98 % and a production ranging from 3 to 4.5 tons/ ha was obtained in moderately high stocking density (30 to 35 pc/sq m) ponds, which was sold at a farm gate price of Rs 300/-.

GROWTH PERFORMANCE, OSMOLARITY OF INDIAN WHITE SHRIMP JUVENILES REARED AT DIFFERENT SALINITY IN C:N RATIO MANIPULATED SYSTEM

Osmoregulatory capacity of penaeid shrimp and serum mineral profile aid in understanding about the physiological adaptation of Indian white shrimps related to ambient salinity that indirectly regulate growth performance of shrimps at different salinity. Keeping this in view, a 50 day experiment was carried out to study the growth performance, water quality , serum mineral profiles of *P. indicus* juveniles (0.4-0.5g) reared at different salinity in 100 L FRP tanks at 12 individual/tank using low protein feed (CIBA feed-30%) and fermented carbohydrate supplementation (CN 10 and CN 20). Osmolarity study reveals serum osmolarity changes proportionately with ambient water salinity- shows strong hyper-hypo osmoregulatory pattern (Osmolarity capacity-at low salinity-hyper OC and high salinity hypo OC). Minerals play an important role in osmoregulation. Among major minerals, calcium (Ca) and magnesium (Mg) are considered important for molting and new shell formation. The ratio of Na (Sodium) to K (Potassium) and Mg (Magnesium) to Ca (Calcium) in should be



Serum osmolality (mOsmo. kg -1) and osmolality constant of Penaeus indicus reared at different salinities



Serum mineral profile ratio of Na K Ca Mg and CaK ration of Penaeus indicus at different salinities

preferably 28:1 and 3:1 and Ca:K should be 1:1. Serum mineral profile ratio revealed that at low salinity 3 and 25 ppt shrimp had Ca/K ratio were 1.3-1.5 whereas at 48 ppt ,it was only 0.5.

NURSERY REARING OF PENAEUS INDICUS IN THE ESTUARINE ECOSYSTEM AS A LIVELIHOOD ACTIVITY

A nursery rearing model for Indian white shrimp, *Penaeus indicus*, has been demonstrated for self-help groups at Uyallikuppam village (Palar backwaters) near Kalpakkam (Tamil Nadu). *Penaeus indicus* (n= 400) of

1.5g size were separately stocked in 4 hapas (2 m x 1m size) and reared for sixty days. The salinity, pH and temperature were observed from 21-28 ppt, 7.10 to 8.0 and 25- 28 °C respectively. On an average of 8.50 g size of *P. indicus* were obtained with 90 % survival and a biomass 3.24 Kg

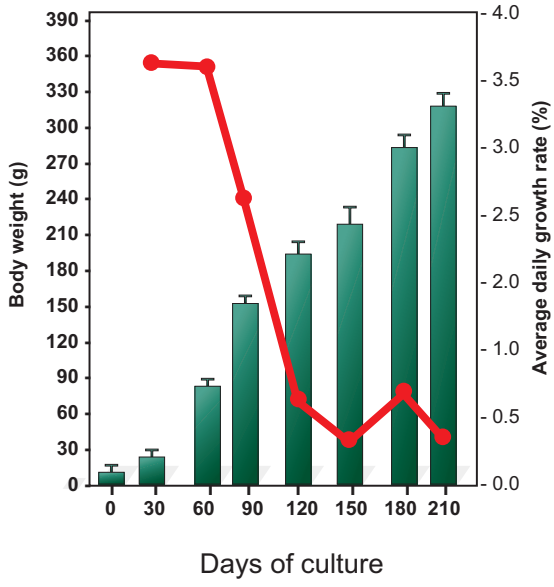
MUD CRABS

PEN CULTURE OF SCYLLA SERRATA IN MANGROVE ECOSYSTEM

Integrating pen culture of mud crab in mangrove habitats provide alternate livelihood opportunities for coastal communities through economic benefits of aquaculture and ensure participatory conservation of these vulnerable resources. The present study was therefore carried out to gather scientific data on production and economic feasibility of mud crab rearing in a mangrove based pen culture system. The culture site was located at Assolna village mangrove creek, Goa, India (Lat 15^{O} 10^{I} 39.29^{II} N, Long73^{O} 58^{I} 06.23^{II} E). Pen culture system was constructed in an intertidal area surrounded by mangrove trees and associated vegetation. The pen was constructed using 10 mm high density polyethylene netting (HDPE, twine size 2.0mm) stretched using casuarina poles driven to the creek bed. Lower margin of nets was buried 35 cm in to the lake bed and upper margin was stretched using a 10 mm polypropylene rope. A poly vinyl chloride sheet (PVC, width-20 cm) was tied to the free board area of netting to prevent escape of mud crabs. Dimensions of the pen were 50 m × 20 m, thus enclosing an area of 1000 m^2. Mud crabs, S. serrata with an average weight of 10.6 g were stocked in pen and reared for a period of 207 days.



Fig 16 Pen constructed for mud crab culture



Growth of mud crab in pen culture system

Mud crab harvest has been started from the system since 5 months from the stocking using scoop nets and baited circular traps. Only half of the stocked crabs were harvested in the first harvest due to the differential growth in the mud crab species. The harvested mud crabs were weighed and a representative sample of 100 individuals of both male and females were collected to determine the carapace width and body weight distribution. A total of 426 numbers (123.3 kg) of mud crab, 10 kg of penaeid shrimps, 10 kg pearl spot, 15 kg milkfish, 10 kg mullets, 10 kg red snapper, 3 kg silver biddies, 2 kg sea bass, 13 kg crescent perches and 4.5 kg other fish species were harvested. The total returns obtained from pen pond including various species of fish and penaeid shrimp was Rs. 85,705. The total operational cost incurred for the culture system including labour was Rs. 45,825. The benefit-cost ratio was estimated at 1.87 for the current year.

EVALUATION OF FORMULATED FEED IN BOX CULTURE OF SCYLLA OLIVACEA

Mud crab (*Scylla olivacea*) is a native species of Sundarban, West Bengal and is known for its delicacy. Owiing to the h high export demand of this species particularly, gravid females, many farmers



Box culture of mud crab

started culturing this species in pond and fiber boxes. Conventionally crabs are fed with low cost fish but major constraints are uncertainty in supply, price fluctuation and poor quality of raw fish. Pellet feed was prepared and offered to crabs maintained individually in 10 fiber boxes for a period of 28 days to observe its effect on growth and maturation. As a control, conventional low cost fish was offered in another 10 fiber boxes having individual crab. **The increase in ovary wt. and gonadosomatic index of crab fed pellet feed was at par with low cost fish**.

Performance of mud crab with conventional feed vs. formulated feed

Pellet feed	Control (low cost fish)	Formulated feed
Initial body wt., g	106.76±6.04	118.97±3.27
Final body wt., g	120.13±6.7	134.84±3.29
Survival %	70±00	80±00
Initial ovary wt., g	5.80±0.41	5.24±0.26
Final ovary wt., g	22.75±0.83	24.40±0.06
Initial GSI	4.51±0.39	4.12±0.23
Final GSI	15.51±0.85	16.59±0.44

DEVELOPMENT OF SUBMERSIBLE CAGE SYSTEM FOR MUD CRAB GROW OUT PRODUCTION

Mud crabs are benthic organisms, and therefore, pelagic/floating cages adversely affect the physiology of these animals owing to the relatively higher surface and sub surface temperature. In order to circumvent the issues of subsurface/floating cages, easy-to-manage submersible cages have been developed, and evaluated the culture performance with reference to the floating cages. In the submersible cage system, a rectangular PVC frame with a facility to fill-in and drain-out the water was constructed, and cages are installed on this frame. When animals are fed, the water in the PVC frame is pumped out, and after feeding and cleaning the cages, the water is pumped into the frame again and the entire system becomes submersible. Growth performance of crabs was compared between two systems after two months of rearing. Surface water temperature was observed as 34 – 35 °C whereas bottom temperature was 4 °C lower than surface at morning. Initial body weight of crabs for both systems was not significant ($p > 0.05$, independent samples t-test). Specific growth rate and average weight gain found significantly higher in submersible cages compared to floating system after two months of cultivation ($p < 0.05$, independent samples t-test). Average weight gain was >100 g in submersible system whereas it is significantly less in floating system (<15 g) indicating that submersible system outperforms traditional floating system.
It could be concluded that implementation of submersible cum floating crab culture system provide higher growth compared to conventional one for crab fattening.



Sub merged mud crab cages

FINFISH FARMING

SEABASS

OPEN WATER CAGE AQUACULTURE AS ALTERNATE LIVELIHOOD AND SOCIETAL DEVELOPMENT IN AND AROUND MANGROVE REGIONS OF MAHARASHTRA

Sindhudurg accounts for 3% of Maharashtra's total mangrove cover but houses more of its coastal biodiversity than any other district in the state. Deforestation of mangroves timber for boat fabrication, firewood for human settlements, illegal aquaculture activities has also impacted on the nursery and breeding grounds of marine fishes, mammals, birds, etc. Hence to provide employment opportunities for improving income/livelihood generation, nutritional security, etc., ICAR-CIBA, Chennai in collaboration of Mangrove cell, Maharashtra have initiated three-tier seabass farming technologies such as nursery rearing, pre-grow out and grow out culture in and around of mangrove coastal waters in Sindhudurg district of Maharashtra with participation of self-help groups (SHGs). In such initiative, around six nurseries, a pre-grow-out and 33 grow-out cage cultures with the participation of SHGs comprising of male and female beneficiaries have been formed.

ASIAN SEABASS NURSERY AND PRE-GROW OUT REARING IN HAPPAS

For nursery rearing, happas (2 x 1 x1 m, 2 mm mesh size) were installed in a pond (0.8 ha) with a water depth of 1.5 m and salinity 25 ppt. Seabass seeds (1.2-2.0 cm) from CIBA fish hatchery were provided to SHGs in the range of 7200-10000 fishes and stocked at a density of 500 per happa-1. The fry was fed with CIBA formulated Seabass larval feed (0.2 mm-1.2 mm) @ 8-10% body weight two times a day. Regular grading was done at an interval of four days to separate shooters and to maintain uniform size. After 65-75 days, seed reached to fingerlings size of 6-12 cm and 10-14 g with an average survival of

Details of seabass nursery rearing & pre-grow out culture trials, and SHGs income generation in Sindhudurg, Maharashtra

SHG Name	Seed Supplied	Feed	Period	Fingerling production	Survival (%)	Income (Rs.)
Jai Ganesh Nivati, (6 W +2 M)	7600 (1.2-2.0 cm)	CIBA seabass feed (0.2 -1.2 mm)	65-75 days	5394 (10-12 cm)	71.0	Rs.1,07,880
Dolphin, Redi (6 W +2 M)	10000 (1.2-2.0 cm)		65-75 days	4394 (8-10cm)	44.0	Rs. 64,971
Jay Gajanan, Redi (6 W +2 M)	7200 (1.2-2.0 cm)		65-75 days	2179 (6-10cm)	30.2	Rs. 27,447
Samrudhi, Redi (6 W +2 M)	10000 (1.2-2.0 cm)		65-75 days	5513 (6-10cm)	55.13	Rs. 65,470
Chanak, Redi (6 W +2 M)	2500 (1.2-2.0 cm)		65-75 days	1513 (16-20 cm)	60.5	Rs. 50,656



Stocking of seabss seeds in hapas for nursery rearing



Collection of seabass seeds from hapa for grading



Women fisher women involved in grading of seabass seeds



Women fishers carry the graded seeds back in to hapa



ICAR CIBA, Chennai Mangrove Foundation and SHGs Success News in Maharashtra Media and Distribution of revenue generation cheque to different CIBA seabass nursery SHGs of Sindhudurg towards the production of seabass fingerlings by delegates of BRAOCON Farmers Conclave Programme on 22 January 2019 at CIBA, Chennai

52.16 %. The harvested fingerlings were sold @ Rs. 20 per fingerlings. In pre-grow out trial, a total of 2500 seabass (6-10 cm) fingerlings from nursery growers are stocked @ 400 fishes/net cage (6m^2). Farm made slow sinking pellet feed supplied @ 6-8% daily in two rations. After rearing of 60 days, fish reached to stockable fingerlings size of 14-18 cm and 20-25 g with the survival of 60.52 %. The harvested stockable fingerlings were sold @ Rs. 33 per fingerlings. The SHGs have generated a total revenue of Rs. 3.16 lakhs through Seabass nursery and pre grow out rearing work.

GROW-OUT FARMING IN LOW VOLUME CAGES

A total number of 33 cages of 4 x 4 x 2 m (32m^2) dimensions were fabricated using Galvanized Iron (GI) pipes (1.5" and 1.25") and were allotted to 8 SHGs units comprising of 90 men and 9 women of Sindhudurg. HDPE knotless cage nets were used for culture and to avoid cannibalism net is modified with an internal partition to make two internal compartments of 2 x 2 x 2 m inside the cage nets to facilitate re-stocking of two size graded seabass fishes

in each compartment. The whole cage structure was floated with six HDPE barrels each of 210 L capacity and anchored in creeks with 85 kg of mild stainless-steel anchors. From October 2018-February 2019, seabass fingerlings (6-18 cm & 4-14 g) procured from Seabass Nursery fish farmers of Andhra Pradesh and CIBA Nursery units, Sindhudurg were stocked in total 20 cages @1000 fishes/cage. The fishes were fed



One unit Four Cages Talashil Village



Two unit –Four Cages - Kothewada Village



On-site Fish Grading by Farmers

with CIBA seabass slow sinking grow-out feed of size 2-6 mm @ 8% body weight two times a day. The cage culture is in progress with the seabass have grown to the size of 40-200 g with an average survival of 42.5% and the harvest of 400-500g seabass is expected in mid-June 2019 with estimated total revenue generation of 10-12 Lakhs. In Maharashtra, this is one of the first kinds of activity which motivated the SHG's especially to women fishermen's to participate in seabass production and to generate the additional income through conservation of the ecosystem.

INTEGRATED MULTI-TROPHIC AQUACULTURE (IMTA) OF SEABASS AND GREEN MUSSELS IN CAGES INSTALLED IN CREEKS

To develop and propagate family farming models of candidate finfish and shellfish species in the west coast of India, initiated IMTA cage culture in Gad creek of Malvan, Sindhudurg. Three families comprising of two men and one woman having a background of brackishwtaer fishing in creeks were selected from villages of Tondavali, Talashil, and Pan-Khol Juva, Taluka-Malvan, District-Maharashtra for IMTA culture of Seabass and Green Mussels in cages installed in creeks. Three pre-fabricated GI Pipes frame cages (8 x 4x 1.2 m), on 27 October 2018 two cages were stocked with seabass fingerlings (8-10 cm and 10-12 g). The fishes were fed with CIBA seabass slow sinking grow-out feed of size 2-6 mm @ 8% body weight two times a day. On 8 January 2019 Green mussel, *Perna viridis* (2-2.5 cm) attached to nylon ropes consisting of 200-250 green mussels (total weight of rope 650-950 g) were procured from fish farmers of Kumta, Karnataka and stocked to the outer periphery of each IMTA Cages at a density of 80 ropes/ cage. To achieve good fish growth, survival and to avoid



IMTA cage at Talashi village



Fully grown mussel in ropes inside IMTA cages

Integrated Multi-trophic Aquaculture (IMTA) Culture in Cages installed in Creeks of Sindhudurg, Maharashtra

cannibalism, regular fish grading at the interval of 15 days was carried out at each IMTA cage sites. During the culture, regularly visited to each site for inspection of the cages, performance of the IMTA beneficiaries, scientific and technical inputs to the beneficiaries, monitoring, and sampling of the fishes to assess the growth and health status of seabass. The IMTA cage culture is in progress and mainly due to good cage culture management practices implemented by the IMTA families, the seabass have grown to size of 60-400 g with survival ranging from 79.30-90.03% and the harvest of 400-500g seabass is expected in mid-June 2019 with estimated total revenue generation of 2-2.5 lakhs to three IMTA families within

MILKFISH

SEABASS AND MILKFISH FARMING IN A POND ON A POLYCULTURE APPROACH

To propagate the polyculture of prominent candidate brackishwater aquaculture finfishes, conducted a trial of polyculture of Asian seabass, *Lates calcarifer* fingerlings and milkfish, *Chanos chanos* seed in Pond with the participation of local fish farmers (8 number) of Mayane village, Taluka-Vengurla, Sindhudurg, Maharashtra. The polyculture was conducted in the same pond where seabass nursery was functioning and an artificial partition by using crab fencing net was created to make one acre of the pond in 0.8 ha pond with a depth of 1.5 m. The milkfish after reaching to the fingerling size, a total of 550 number of stockable seabass fingerlings (18-25 cm, 150-300 g) procured from previous year IMTA farmers were stocked in a partitioned area of a pond and fed slow sinking pellet feed@3-6% bodyweight twice a day. A total of 166.5 kg seabass fish along with 750 kg of milkfish (300-1000 g) was harvested. The harvested medium and big sized seabass and milkfish realized a farm gate price of Rs. 150/Kg, 400/kg, and 100/Kg thus resulting in total revenue of Rs. 1,31,400 lakhs to the group of 8 farmers even after the escape of fishes during monsoon flood.



Fig 30 Harvested seabass and milkfish and from polyculture



Harvested size and biomass of Milkfish at Goa Fisheries Departmental Pond

MONOCULTURE OF MILKFISH IN A POND IN COLLABORATION OF FISHERIES DEPARTMENT, GOA

To promote species diversification and sustainable aquaculture practices of important candidate brackishwtaer species in the west coast of India, conducted a trial of milkfish, *Chanos chanos* monoculture in collaboration with Fisheries Department of Goa. About 4000 milkfish seed (ABW 0.1-0.3g) were stocked in the departmental pond located at Ela-Dhauji, old Goa, Goa. Without nursery rearing, the seed were directly stocked in the 1.2 ha pond with water depth of 1.5 m and salinity 30 ppt. During the culture, the milkfish seed were fed with Indian Major Carp feed (28-30% protein) @ 3-5% body weight two times a day and salinity ranged from 5-40 ppt. After the culture of 11 months, a total production of 1.4 tonnes milkfish (ABW 400-750g) with survival of 80% was obtained. The harvested fishes were sold at the rate of Rs. 180-200/-kg in the retail market of Goa.

JUVENILE MILKFISH COULD BE A POTENTIAL ORNAMENTAL FISH: SILVERFISH

Characters of juvenile milkfish such as milky white glittering, shining body, agility, semi-transparent V-shaped caudal fin, swift movement pattern, wide salinity tolerance, voracious gracing on tank algae and disease resistance qualifies milkfish juveniles as a potential ornamental fish called "Silverfish". Freshwater acclimatized milkfish Juveniles handed over to private aqua shop owners at Chennai to understand the acceptance by aquarium hobbyist in the sector. The initial response was positive and 10 pair of milkfish juvenile sold @ Rs. 50/-. Further initiatives are taken to popularize this fish as an alternative revenue generative species in the paradigm of ornamental fishes. Small experiments were conducted to know its compatible tankmates.

Table Compatibility of milkfish with other common aquarium fish

ISH	COMPATIBILITY	REASON
Tinfoil Barb	Compatible	Swims like milkfish
Red tailed shark/ Rainbow shark	Compatible	Bottom dweller; no competition
Black Shark	Compatible	Bottom dweller no competition
Tiger Barb	Incompatible	Caudal fin nibbling behaviour



Milk fish as an ornamental fish

POPULARIZATION OF MILKFISH FARMING IN COASTAL DISTRICTS OF WEST BENGAL AND ITS ACCEPTANCE AS DECAN HILSA

Milkfish is fast growing herbivorous fish which has a similar outlook and culinary properties like hilsa. Considering demand and preference of milkfish by local Bengalis, CIBA took efforts to popularize milkfish as '*Decan Hilsa*' in West Bengal. About 8000 hatchery produced milkfish fry were distributed among four beneficiaries in Haldia block of East Midnapur district. For the first time seeds were distributed to beneficiaries through state fisheries machinery to achieve maximum visibility. Four different culture system was followed such as monoculture (Salinity 7-8 ppt), polyculture with *P. monodon* & *M. rosenbergii* (4 ppt), Nylon net cage culture (10-12 ppt) and polyculture with IMC (0 ppt).

Approximately 1.3 ton of milkfish was harvested. This culture demonstration was successful and created mass awareness among local communities and also in Bangladesh (Dhaka Times) as print media covered these trails extensively. It was very well accepted by the Bengalis by the name *Decan Hilsa* .



Stocking of milkfish seeds in West Benagal for popularising it as Deccan Hilsa

MULTIPLE STOCKING AND MULTIPLE HARVESTING (MSMH) TECHNIQUE OF MILKFISH CULTURE

Milkfish is a suitable species for low input-based culture system easily adoptable by small and traditional farmers. For small farmers return from farming at regular intervals is most desirable to meet up their day to day needs. In this context, MSMH technique of milkfish culture could be suitable to these farmers. Moreover, this method could augment the productivity of a small pond by many folds. Therefore, to evaluate the performance of this technique in brackishwater ponds, a trial was conducted with two stocking densities (7500 and 15000/ha) as treatments. Milkfish fingerlings (6-8 g) were stocked and reared in fertilized ponds (500 m^2) provided with CIBA formulated feed (CP 30%; Price: Rs. 35/ kg) @5-3% of body weight daily. After 100 days, harvesting was started when the fish attained at least 150 g and ponds were restocked with the same quantity of advanced fingerlings (25-40 g) at 15 days intervals keeping the total number of fishes same to that of the initial stocking. This system exhibited higher production of 3.6 ton/ ha in the high density compared to 2.8 ton/ ha in the low density culture in 160 days suggesting the suitability of the former density.



ইলিশের বদলি মিল্ক ফিশ

যজ্ঞেশ্বর জানা
হলদিয়া, ৭ জুন

এবার পুজোতেই বাঙালির থেকে ঢুকছে 'মিল্ক ফিশ'। বিজ্ঞানসম্মত নাম 'চ্যানস চ্যানস'। স্বাদে, গন্ধে এবং গুণে অবিকল ইলিশ। পাওয়া যায় সমুদ্রে। ইলিশের মতোই চকচকে রুপোলি আঁশ। তবে ইলিশের তুলনায় পেটের দিকটা কম চওড়া। কাঁটা ইলিশের মতোই, তেল সুস্বাদু। কয়েক শতাব্দী আগে ইন্দোনেশিয়া, তাইওয়ান, ফিলিপিন্সে এই মাছের চাষ বাণিজ্যিকভাবে শুরু হয়েছিল। আমাদের দেশে দক্ষিণ ভারতের রাজ্যগুলির সমুদ্র উপকূলে মিল্ক ফিশ পাওয়া যায়। এবার মিল্ক ফিশ চাষের সম্ভাবনা তৈরি হয়েছে পশ্চিমবঙ্গে। 'আত্মা' প্রকল্পে পুকুরে সমুদ্রের নোনা জল ঢুকিয়ে কৃত্রিমভাবে এই মাছচাষের পাইলট প্রকল্প গ্রহণ করেছে হলদিয়া ব্লক মৎস্য দপ্তর। ব্লকের মৎস্য সম্প্রসারণ আধিকারিক সুমনকুমার সাউ বলেন, 'মৎস্য দপ্তরের উদ্যোগে ইতিমধ্যেই পুকুরের মিঠা জলে কই, কাতলা ও মৃগেল মাছের উৎপাদন বাড়ানোর কাজ শুরু হয়েছে। পাশাপাশি রজের পুকুরে নোনাজলের মাছ চাষ করে মাছের উৎপাদন বৃদ্ধির লক্ষ্যেই এমন উদ্যোগ নেওয়া হয়েছে।'

মাস ছ'য়েক সময়ের মধ্যে একেকটি চারামাছ ৪০০-৬০০ গ্রাম ওজনের হবে এবং এক শতাংশে ৮০০-৯০০ গ্রাম ছাড়িয়ে যাবে। দাম হবে কই-মৃগেলের দুই বা আড়াই গুণ। এই মাছের আয়ুষ্কাল ১৫ বছর। হলদিয়ার মৎস্য সম্প্রসারণ আধিকারিক সুমনকুমার সাউ বলেন, 'আন্তর্জাতিক বাজারে থাকলেও ইলিশ আর মিল্ক ফিশ খুব দূরের প্রজাতি নয়। মাছের পেটের না ছোঁড়া, পুরু-আঁশটে ইলিশের মাংসগুলো ভাই বলাই যায়। এখন যে দামি পোনা জলে ছাড়া হল, সেগুলি পুজো-নাগাদ বড় হয়ে যাবে। তারপরেই চাহিদা বৃদ্ধির জন্য বাজারের পাশে হাঁড়ির হাটে চালাতে মিল্ক ফিশ।'

হলদিয়ায় মিল্ক ফিশ। পাশে ইলিশ।

News in meadia on farming of milkfish in West Bengal

DEMONSTRATION OF LOW INPUT-BASED MILKFISH CULTURE IN SUNDARBAN

To promote milkfish farming scientifically, CIBA has developed seed production technology of milkfish by achieving the first breakthrough on captive breeding in June 2015. As an activity to popularize this species in traditional farming systems of Sundarban, a low input-based culture demonstration was conducted in a collaborative research mode. CIBA provided hatchery-bred 2800 number milkfish fingerlings (8 g) after conducting a nursery rearing phase at its Kakdwip Research Centre to an enterprising fish farmer, Mr. Animesh Das from Debichak, Ramganga. Milkfish fingerlings stocked in a 0.14-ha brackishwater pond provided with nylon net fixed vertically at epilimnion as a substrate for periphyton growth. Additionally, fish were fed with a floating feed (CP: 28%) at 2-3% of biomass daily. This culture yielded 600 kg (4.2 ton/ ha) in 6 months with a production cost of Rs. 90/ kg and selling price of Rs. 160-180/ kg, and was economically viable.

HILSA

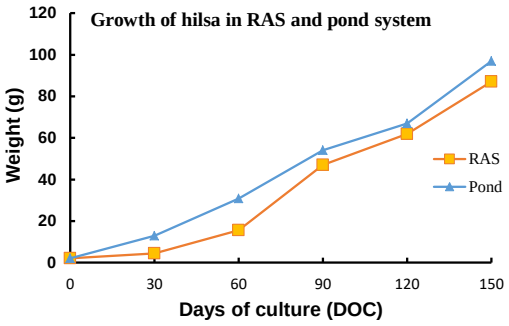
GROWOUT PRODUCTION

Hilsa has good market potential in West Bengal, and there is a huge demand for table size hilsa. However, the demand needs to be fulfilled by the wild catch, and there is no farming attempt so far in a commercial scale. In this backdrop, two months old nursery-reared fingerlings of 34 numbers (4.8 to 5 cm; 2.2 to 2.4 g) were equally stocked in two different system viz. earthen pond (1000 m^2) and RAS (8 m3) in the month of May. In both the systems, fishes were fed with pelleted feed (38% protein and 8% lipid) @ 5% of biomass. At 15 days interval, lime and GNOC was applied @ 150 and 50 Kg ha-1, respectively. At fort

Milkfish harvest from a pond with low inputs



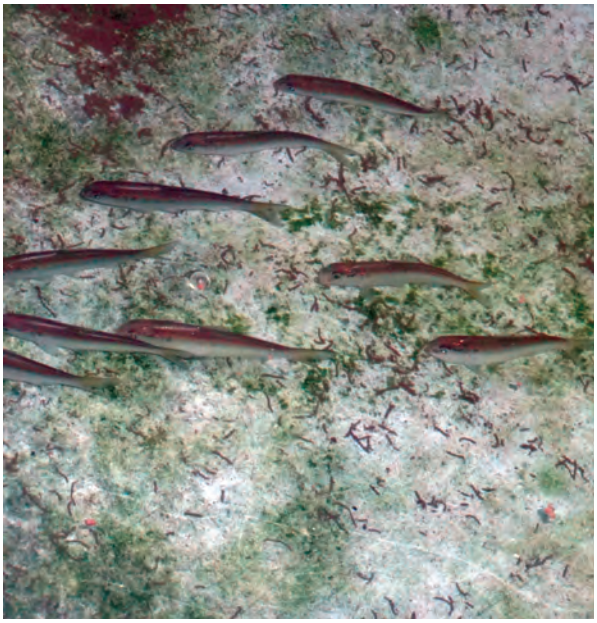
night interval regular water quality such as dissolved oxygen (6.5 ppm), pH (8.2) and salinity (6 to 8 ppt) were measured. After 11- months of culture, the growth performance of hilsa was visible good in pond system than RAS.



Growth of Hilsa in RAS and pond systems



Pond reared Hilsa



Hilsa fish reared in RAS

MYSTUS GULIO

EFFECT OF FEEDING FREQUENCY IN NURSERY REARING OF MYSTUS GULIO IN NET CAGES

Brackishwater catfish, *Mystus gulio* has good market demand as a high-value species in Eastern India. Standardized homestead hatchery technology of this species has been popularized among farmers. The hatchery produced 10-15 day old fry are further reared in the nursery to produce fingerlings suitable for stocking in grow-out system. To refine the nursery rearing method in hapa system, a trial was conducted to find out suitable feeding frequency. Among different feed management strategies, feeding frequency plays an important role in regulating the feed intake, growth, survival and waste outputs of fish. Twelve-day old fry (0.01-0.02 g/ 9-12 mm) were stocked in net cages (hapa: 2×1×1 m) at 250 no./ hapa. The fry were fed @ 10 to 4% of body weight with CIBA formulated diet (CP 30%, CF 6%; Price: Rs. 35/ kg) at four feeding frequencies (1, 2, 3 and 4 times/ day) as treatments. After 50 days, fry attained significantly higher growth of 1.29±0.41 g at 4 times feeding a day compared to other groups ($P<0.05$). Moreover, higher survival in 2, 3 and 4 times feeding differed significantly from that of 1 time feeding a day ($P<0.05$). Therefore, a feeding frequency of 4 times daily is suggested for nursery rearing of *M. gulio* in hapa system.



Mystus catfish reared in hapa

Effect of feeding frequency on growth and survival of Mystus gulio during nursery rearing in hapa.

Feeding frequency (FF)	Final length (mm)	Final wt. (g)	Survival (%)
1	46.8±2.15	0.95±0.18b	79.2±1.2b
2	48.02±2.70	1.05±0.27b	92.8±1.6a
3	48.01±2.26	1.02±0.36b	89.6±2.5a
4	49.44±2.96	1.29±0.41a	90.4±2.4a

Means with different superscripts in a column differ significantly (P<0.05); values are mean ± SD of two replicates.

RABBIT FISH

WIDE SALINITY TOLERANCE OF STREAKED RABBIT FISH, SIGANUS JAVUS THE IMPACT OF SALINITY ON GROWTH, SURVIVAL AND SERUM OSMOLALITY

Streaked spine foot Rabbit fish, *Siganus javus* , is considered as important food fishes because of their fast growth rates, herbivorous food habits, and economic value. The study was carried out to determine salinity tolerance of streaked spine foot rabbitfish, *Siganus javus* with varying salinity and its impact on growth, survival and serum osmolality. A total of 270 nos *Siganus javus* juveniles (10.45±0.26 cm and 15.15±0.76 g) were stocked in 300 l tanks containing 30 ppt seawater to have 15 juveniles in each tank. Later the salinity was reduced by 5 ppt at every 12 hrs intervals to have a final salinity of 5, 10, 15, 20, 25 ppt with three replication per salinity treatment. The experiment was carried out for 30 days and the fishes were fed with artificial feed @ 5 % of the biomass. At the end of the trial, the serum osmolality was significantly varied among the salinity levels highest osmolality in 30 ppt (control) and lowest in 5 ppt (380.11±2.72). The mean body weight and the total length of fish also varied significantly among the treatments (P<0.05) as presented in the table. Overall, better growth performance was shown by the fishes reared in the higher salinity compared to the lower ones. However, survival was not affected by salinity. This experiment for the first time documented the wide salinity tolerance of *Siganus javus*, a potential herbivorous food fish for brackishwater farming.

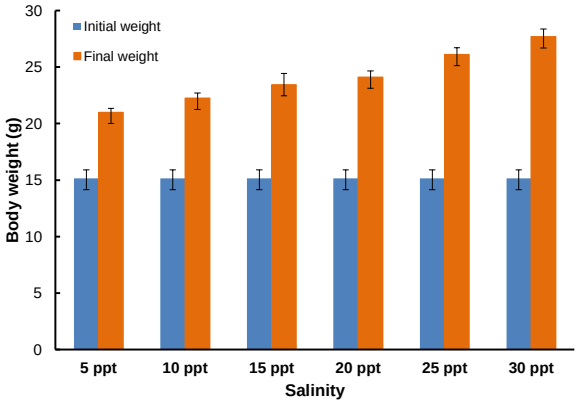


Streaked spinefoot (Rabbit fish) Siganus javus

Serum osmolality of *Siganus Javus* for a period of 30 days

Salinities (ppt)	Water osmolality	Serum osmolality
5	(mmol kg-1)	(mmol kg-1)
10	138.91±1.81	380.11a±2.72
15	281±2.75	390.33b±4.40
20	433.75±2.81	391.67b±2.75
25	565.33±4.88	395.44b±3.21
30	689.58±8.92	402.67c±1.90
	859±3.60	421d±2.23

Mean value with same superscript did not show any significant difference (P>0.05)



Growth performance of Siganus javus in different salinities for thirty days

ORNAMENTAL FISHES

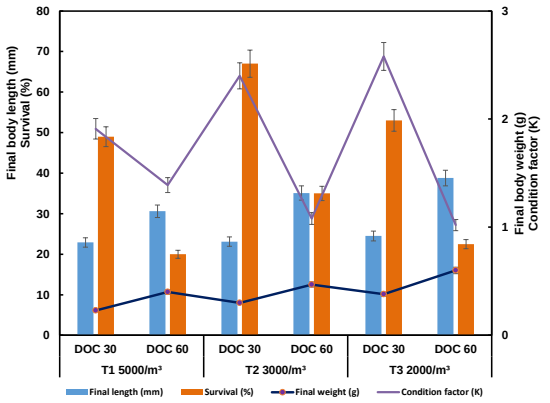
OPTIMUM SCAT FRY STOCKING DENSITY FOR THEIR NURSERY PHASE FOR SUSTAINABLE JUVENILE PRODUCTION IN THE POND AND OPEN WATER SYSTEMS

Scat juveniles (2 – 5 cm) have huge demand in ornamental trade due to its spotted rhombic appearance and easy upkeep in aquaria. Being an herbivore fish, its nursery rearing can be popularized as low cost and short-term income generation activity by fisher / tribal groups. Hapa based nursery rearing mode was adopted in the pond and open water systems to optimize the rearing density for enhanced survival. Thirty days post-hatch hatchery-produced larvae with initial T.L. 10 ± 0.2 mm were stocked at three different stocking density (5000, 3000, 2000 nos/m3) in hapa (2 X 1 X 1 m) in a fertilized pond. Feeding was done with 30 % crude protein crumbled floating feed at the rate of 5 % body weight twice a day. Larvae reached marketable size 35.1 ± 1.19 mm with the highest 35 % survival after 60 days of rearing in 3000 nos/m3 density. Highest larval size 38.8 ± 5.1 mm was achieved in density of 2000/m^3.

Another trial was conducted in the open water of village Kuvathur (Kancheepuram district) with tribal fisher folks. Hapas (2 X 1 X 1 m) were tied inside a pen structure and stocked with two stocking densities of 500/m^3 and 200/m^3 60 days post-hatch larvae of T.L. 22.9 ± 2.03 mm. Feeding was done with 30 % crude protein crumbled floating feed at the rate of 4 % body weight twice a day. Hapas were cleaned fortnightly. 100 % survival and 44.1 ± 7.18 mm T.L. was achieved after 45 days of rearing in 300/m3density. These juveniles were sold @ ₹ 15/fish to ornamental traders. Both the nursery rearing models were found to be suitable for rearing scat in cost-effective way.



Scat juveniles produced from pond based nursery system



Survival and growth performance of scat juveniles in hapas placed inside ponds



Captive reared orange chromide with famers participation

MASS PRODUCTION OF ORANGE CHROMIDE WITH FARMERS PARTICIPATION

Orange chromide has good demand in the domestic as well as in the international ornamental fish market. Fry produced in our hatchery were presented to the coastal fisher women's Uyyalikuppam near Kalpakkam and Kuvathoor near Kovalam, reared up to market size and sold to the aquarium shops. Initial Average length & Weight of Orange Chromide was 3.87 ± 0.20 cm, 1.085 ± 0.163 g respectively at 32 ppt salinity. After 3 months of rearing the average length & Weight was 5.87 ± 5.21 cm, 4.8 ± 1.0 g respectively at 30 ppt salinity and Survival was 89.1%.

SEA WEEDS

Cultivation of seaweed has been one of the predominant forms of aquaculture in the world aquaculture scenario. *Gracilaria tenuistipitata* is economically important seaweed, which is extensively cultivated in South East Asian countries. This species survives well below 20 ppt salinity. The present study was therefore carried out at the tide-fed brackishwater pond system of Kakdwip Research Centre of CIBA with the objective of estimating the optimum initial biomass intensity to be stocked. The experimental trial was conducted with four initial stocking intensities: 25, 50, 100 and 200 g/m2 at water depth of 0 – 0.3 m (identified as the most suitable culture depth by the experimental trial 1) in nylon net bags (1 m x 1 m, mesh size 2 mm) in a tide-fed pond of 600 m2 from July 2018 to December 2018 in triplicate. Seaweed biomass was measured once a month Significantly hihger SGR was found at the lower stocking densities (25 and 50 g/m^2) compared to higher stocking densities.

Specific growth rate of seaweed at different stocking densities



Harvested seaweed, Gracilaria tenuistipitata

Experimental culture of seaweed

COMPARISON OF AERATION REQUIREMENTS IN BIO FLOC -BASED SYSTEM AND EARTHEN POND SYSTEMS

Bio floc shrimp culture systems are gaining importance for cost-effective production where water is limited or land is expensive. Aeration requirement in bio floc-based systems were analysed based on the primary data collected from the biofloc based shrimp culture ponds at Tamil Nadu and Andhra Pradesh and compared with the aeration use in earthen ponds. Air diffuser systems operated using air blowers have been widely used in bio floc systems (Fig. 1), whereas different types of surface aerators are used in earthen ponds. Findings revealed that the aeration requirements in biofloc system vary from 6.2-12 HP/ m3 volume of water. Assessment in the farmers ponds indicated that the aeration requirement per cubic meter water in earthen pond varied from 2.3 to 4.5 HP/ m^3 volume of water. Study indicated that bio floc systems require around 170 % of higher aeration compared to earthen pond culture as aeration is needed continuously to keep solids in suspended in the water column at all times and bio flocs (algae, bacteria, protozoans, and other kinds of particulate organic matter such as feces and uneaten feed) also consumes dissolved oxygen.



EVALUATION OF SOLAR BASED AERATOR SYSTEMS AT MUTTUKADU EXPERIMENTAL STATION OF CIBA

The model solar aerator was developed and installed (Fig. 2) at Muttukadu pond, with four panels supporting 1 HP aerator. Variable frequency drive has been installed for the automatic switchover to electrical current based to run the aerator during a power failure. On-farm trials of the Hybrid system powered aerators indicated that it can run the aerator for six hours. The battery capacity for four hours was incorporated in to system during power failure. Hence the technical feasibility of providing aeration in night hours and economic feasibility has been evaluated considering the dynamic nature of the sector and long-term investment in the solar energy systems.



Solar based aerator

MAPPING OF RESOURCES FOR AQUACULTURE IN MAHARASHTRA

Assessment of coastal resources using remote sensing techniques and the ground truth survey in the coastal districts of Maharashtra was carried out to assess suitable land and water resources for aquaculture and also the seasonal variation of water quality characteristics. The mangrove extent and its spatial spread in the coastal districts of Maharashtra was mapped from the Sentinel data of the year 2018, indicated the mangrove extent of 13.71 ha, 37.58 ha, 141.21 ha 36.80 ha, 46.43 ha in Sindhudurg, Ratnagiri, Raigad, Palgar and Thane districts. The comparison with forest survey of India data indicated the increase in mangrove extent from 238 ha in 2017 to 278.73 ha. in 2018.

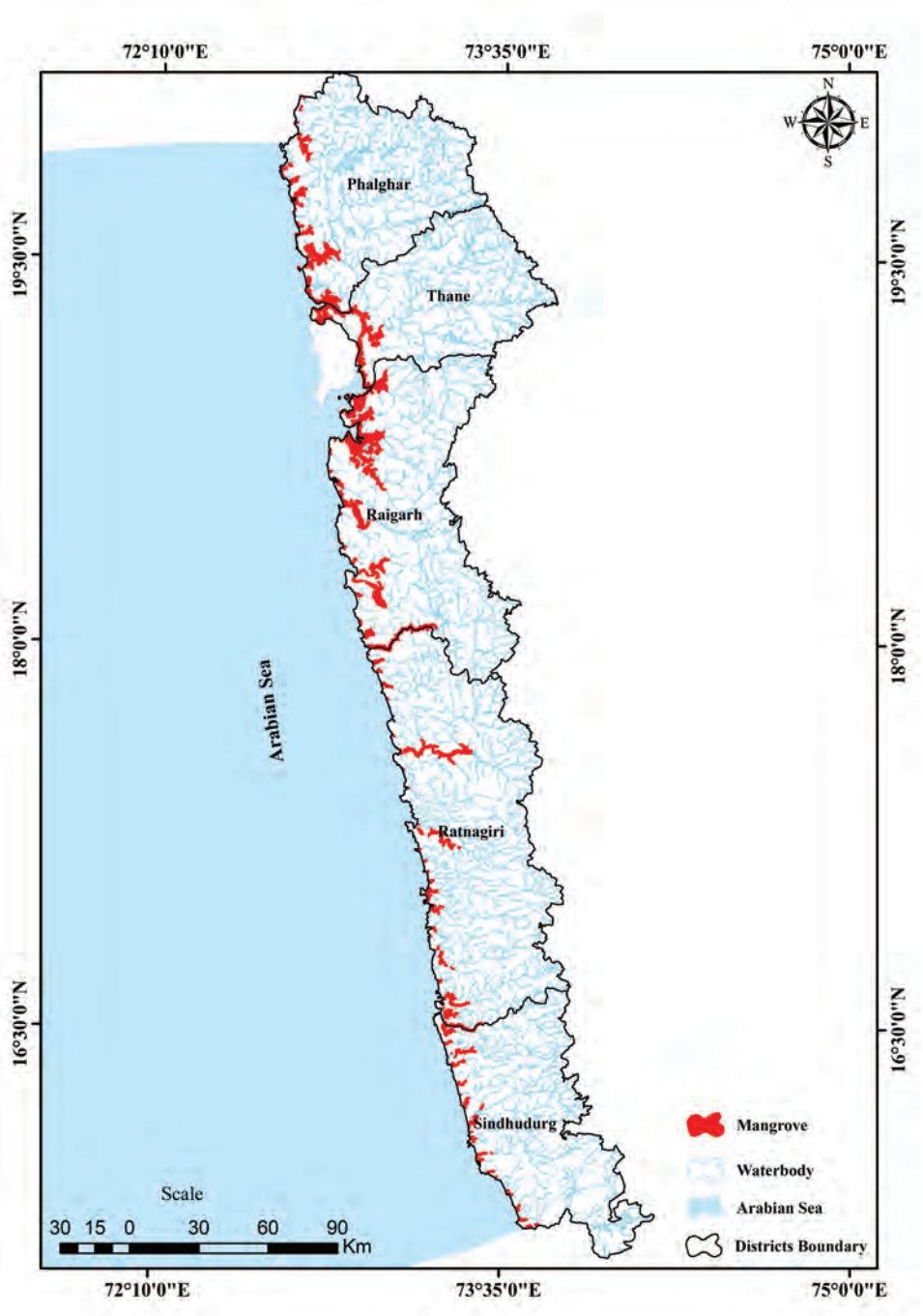
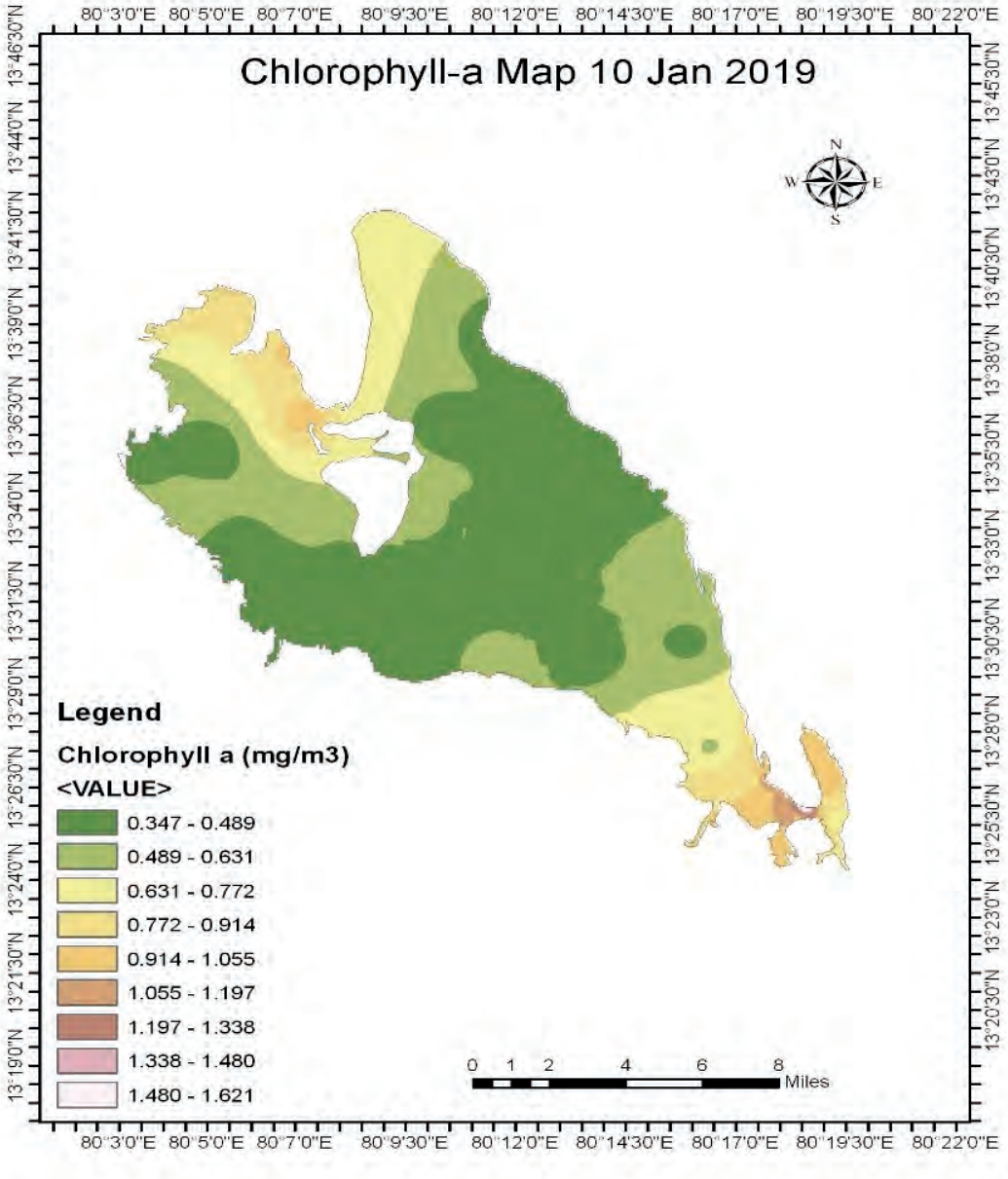


Fig 45 Coastal area map of Maharashtra district, India

PULICAT MAPPING -PRIMARY PRODUCTIVITY ASSESSMENT OF PULICAT LAKE USING GIS & REMOTE SENSING

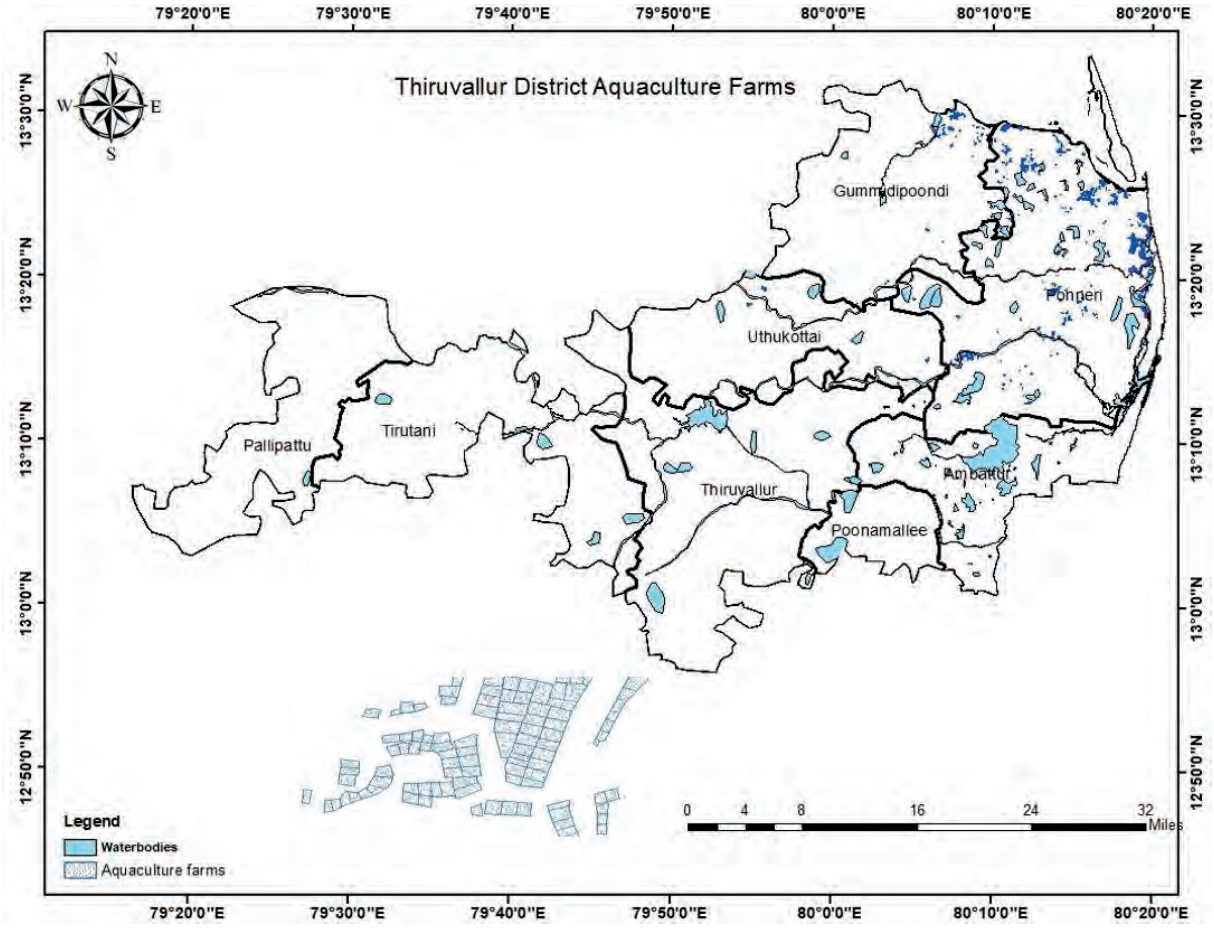
Water Samples have been collected at periodic interval from October 2018 to December 2018 from twenty-five-point locations in Pulicat lake covering a distance of 400 km stretch from mouth of the lake to Jameelabad at the upstream of the lake. Regression models for chlorophyll-a, turbidity and salinity were developed using remote sensing reflectance extracted from Landsat 8 OLI and observed water quality parameters. Results indicate that the dual band ratio of Rrs483/Rrs865 (R^2=0.7677) was most effective in estimating chlorophyll a whereas for turbidity and salinity single band algorithm was effective with Rrs655 (R^2=0.7938) and Rrs655 (R^2 =0.7669) respectively. The regression models are shown in figure 2. Spatial map of empirically estimated water quality parameters is shown in figure 3.4, 3.5 & 3.6. This model is used for estimating post monsoon water quality parameters and the model differs for other regions. Water depth varies from 92 cm to 320 cm during 2017 and 90 to 210 cm during 2018.



Pulicat map, distribution of chlorophill

THIRUVALLUR DISTRICT AQUACULTURE FARM MAPPING

Thiruvallur district is located between 13°8′26.16′ North 79°54′21.6′ East and it covers an area of 3423 km2. There are five rivers flowing in Thiruvallur district which are Kosathalaiyar River, Cooum River, Adyar River, Arani River and Nadari. Aquaculture farms in Thiruvallur district has been mapped using Geo eye 1 satellite image in ArcGIS 10.2. Around 1337.62 hectares are under shrimp farming and most of them falls under Ponneri and Gummidipoondi taluk.



Thriruvalluvar district, Tamil Nadu Aquaculture map

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INDIGENOUS AUTOMATIC FEED DISPENSER FOR SHRIMP FARMING SOLAR POWERED FEEDER – REFINEMENT

Refinement of the existing design by rectifying minor drawbacks and utilization of DC motor for energy

efficient direct usage of solar power was done. Three units have been fabricated for on farm trials and on farm demonstration of the refined indigenous automatic feeder was done at *P. Vannamai* farm, Kattur during Feb 2019 as the farming season has started then. Weekly observation is being carried out for soil quality, water quality and feed conversion ratio parameters for refined auto feeder installed pond and a control pond viz., manual feeding pond at the same farm, Feed dispersion distance was 30 m diameter and Quantity of the feed dispensed is 500g in 7 sec. Based on the body weight of the shrimp farmers themselves adjusted the timer and operated the automatic feeder, Solar power was utilised by installing one solar panel along with control unit and 2 nos of 65 AH battery for store solar energy and utilise in the absence of solar energy time.

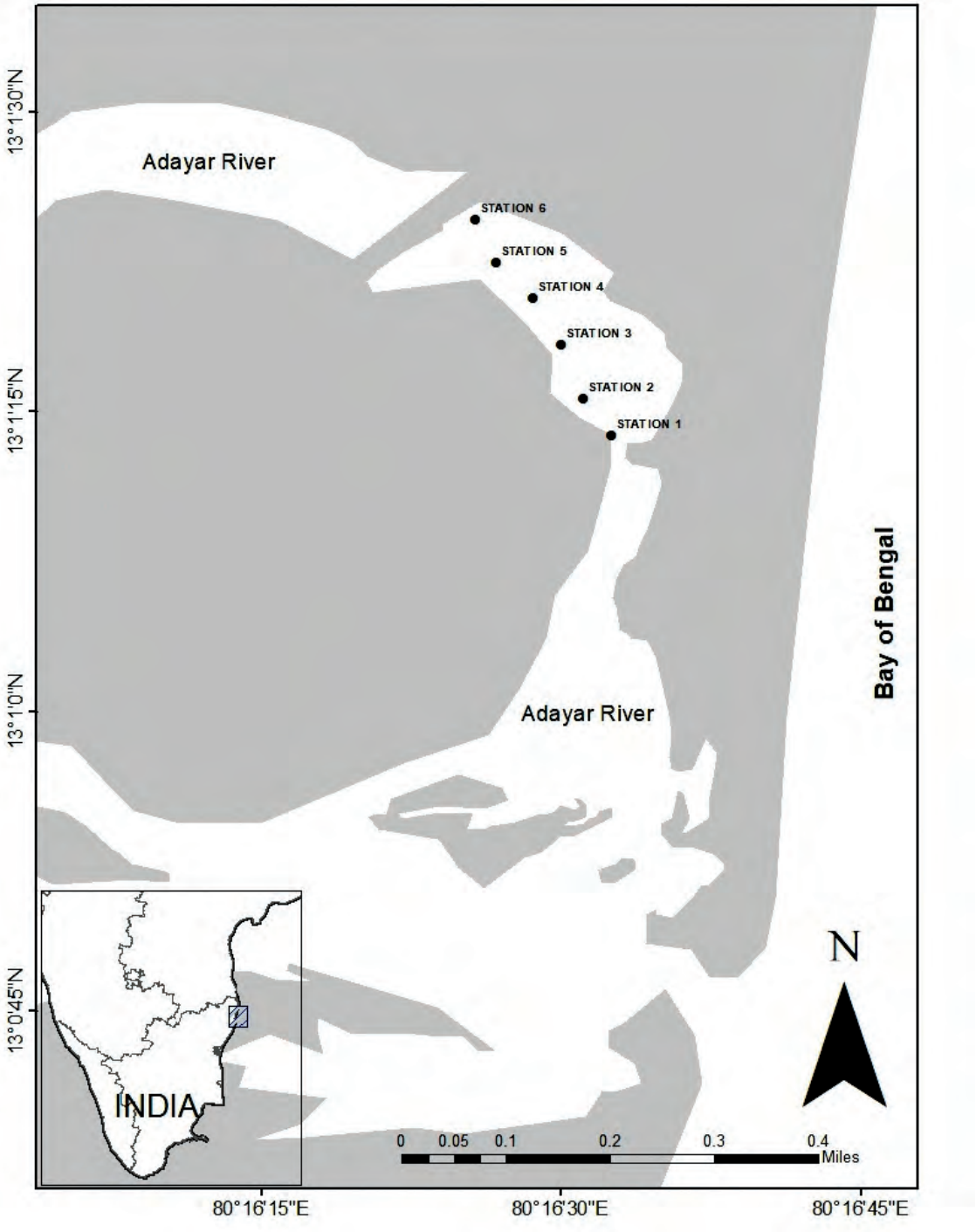
PHYTOPLANKTON AND ZOOPLANKTON DIVERSITY AND SEASONAL DYNAMICS IN ADYAR ESTUARY

Due to the rapid urbanization and human settlement, Adyar creek and estuary, Chennai, has become one of the most polluted riverine ecosystem. Recently, Chennai River Restoration Trust has taken massive effort to restore this important ecosystem. As a first step to optimally utilize this ecosystem for brackishwater aquaculture for diversification of livelihood, ICAR CIBA has taken steps to evaluate the health of ecosystem by studying the dynamics of phytoplankton and zooplankton of this estuary. Knowledge on primary and secondary productivity of any natural ecosystem is fundamental to assess the site selection for cage and pen culture. Plankton sample was collected from 6 stations located in Adyar creek, Srinivasapuram during January to December 2018. Phyto and zooplankton density was counted fortnightly and analyzed using PRIMER 7 software. Overall results conclude that among the phytoplankton, *Chlorella* sp, *Thalassiosira* sp, *Coscinodiscus* sp and *Chaetoceros* sp is dominating in all stations and Rotifers and Copepod was dominating among zooplankton (Fig 11). Maximum density of phytoplankton was observed during Monsoon with an

Autofeeder installed in farmer's pond



average cell density of 1000 cells/mL and maximum density of zooplankton was found during Monsoon 100 individuals/mL of water sample respectively. Maximum diversity was observed during pre-monsoon period followed by Monsoon > Summer > Winter. Among 6 stations, maximum diversity was observed at Station 3 and Station 2 with optimum water quality parameters though out the study period. Hence it can be conclude that Station 3 and Station 2 can be selected for brackishwater farming practices.



Adyar estuary map

REPRODUCTION, BREEDING AND LARVAL REARING

Complete control over reproduction under captivity has been the most elusive goal of aquaculture since its inception. Further development of aquaculture will ultimately be determined by efficiency of reproductive technologies in par with other livestock production.

Diversification of farmed species has been well acknowledged as a tool for sustainable development of aquaculture. Indian brackishwater aquaculture is almost synonymous to penaeid shrimp aquaculture, particularly farming of exotic *Penaeus vannamei*. An aquaculture industry based on a single non-native species has always been constrained by inherent limitations, for example: limited source of supply, issues of emerging diseases and decline in the quality of broodstock. Development of potential native species is one of the options to resolve the issues related to exotic *P. vannamei* culture. Indian white shrimp, *P. indicus* has been identified as the national priority species for domestication and genetic improvement. With respect to faming of new species, several issues have to be resolved, particularly issues in captive reproduction and hatchery production. For the last five years the institute has been focusing on captive reproduction and domestication of candidate species for brackishwater aquaculture.

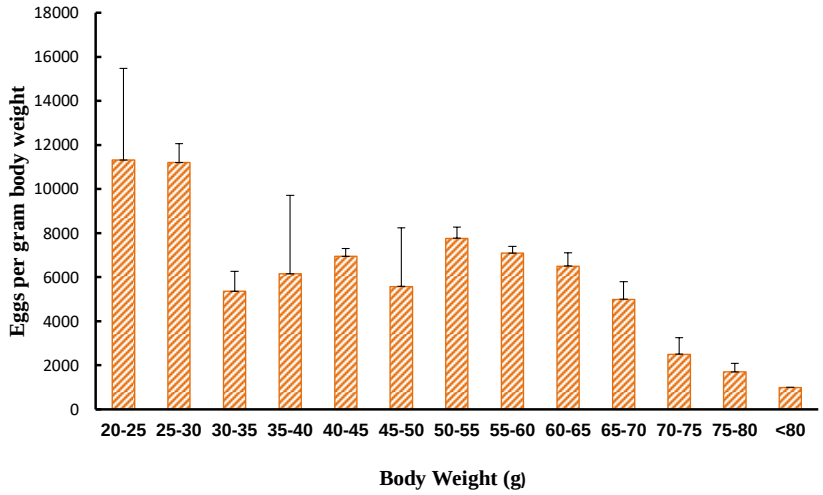
PENAEUS INDICUS

Development of captive reared broodstock of Indian white shrimp, *Penaeus indicus*: This research program was aimed to develop captive reared brood stock for *P. indicus*. More than 700 wild-caught *P. indicus* brooders were screened for WSSV, and seven experimental hatchery cycles were carried out using WSSV negative brooders. Although absolute fecundity was higher in highest size group (> 80 g), relative fecundity, eggs/gram body weight was highest in the lowest size group (20-25 g).

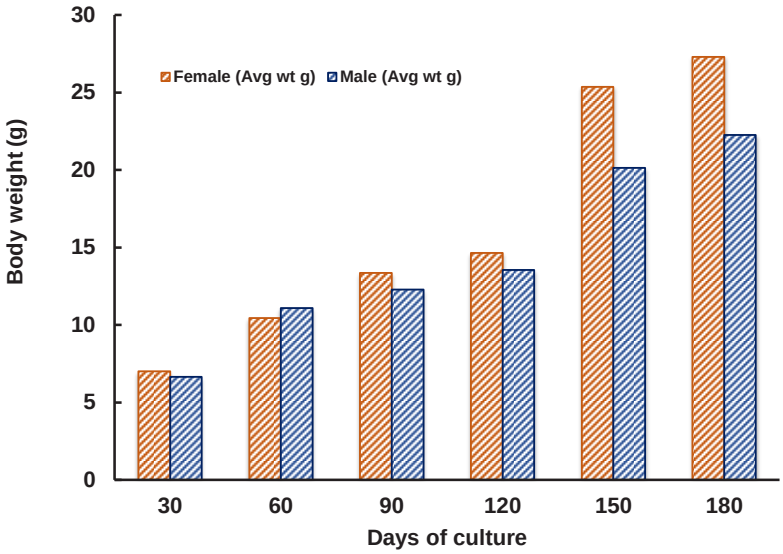
Eggs per gram body weight (mean ±SD) of Penaeus indicus brooders spawned during study period

Juveniles of *Penaeus indicus* (0.16±0.02 g) were reared in a polythene lined pond of 800 m^2 area at a stocking density of 5 ind./m^2 as well as in indoor cement tanks of 8 tonne capacity in 15, 30 and 60m^2 stocking density for 180 days. Growth characteristics were recorded in an interval of 30 days and sexual differentiation was possible in animals of 6-7 g average body weight by observing the secondary sexual characteristics. In the males, fully joined petasma and presence of spermatophores in terminal ampoule was observed in 11-12 g size class. Superior growth trend was observed for females from 90 days of culture onwards. Towards the end of the 180 days of culture, early maturing females were observed but accounted only 10% of the total female population. The tank reared animals exhibited poor growth and survival, which made sexual dimorphism visible post 140 days of culture. Significant difference was not observed in the final average bodyweight in the three different stocking densities after the completion of 180 days of culture at $P<0.05$. The tank reared females and males did not exhibit any sex related growth pattern, but fully developed spermatophores in the terminal ampoule was observed in males.

The pond reared females were further reared until reaching 30-45 g size, and noticed 100% mating and impregnation. Seventy percent of the impregnated females from pond reared stock were showed gonad development between advanced second stages to 3 rd stage of ovary development after 7 month



Eggs per gram body weight of Penaeus indicus brooders



Average body weight of male and female Penaeus indicus reared in plastic lined ponds for a period of 180 days

pond rearing at 1 no/sq.m. The matured female had an average weight 36.11±5.5 g , 15.38±0.48 cm, 3.61±0.34 CL. Female were subjected to unilateral eyestalk ablation and 16% female showed advanced gonad development after 3rd day of eye stalk ablation with 8% had spawning. Further to standardize the role of reproductive hormone in P. indicus brooders, 17β-estradiol was administered at a dose of 200 µL/female. Seventy percent of female at 2+ stage of ovary development stage spawned (fecundity: 75,000) with 80% hatchability.

COMPARATIVE EVALUATION OF THE SPERMATOPHORE QUALITY OF *PENAEUS INDICUS* IN WILD CAUGHT AND REARED IN CAPTIVITY (POND AND CEMENT TANKS)

A comparative evaluation of the spermatophore quality was done in 180 days old cement tank reared and pond reared *Penaeus indicus*. The spermatophores were collected from both the groups and sperm count, spermatophore weight, viability etc. was analyzed. Both the experimental groups had the same age group but the body weight of the pond-reared animals were significantly higher. Additionally spermatophores qualities of wild caught males were also studied. Although spermatophores weight of the wild and pond reared males are similar, number of sperms in the wild male was significantly higher than the pond reared animals. The sperm count was



Male genital tract of Penaeus indicus

significantly lower in the cement tank reared animals but significant difference was not observed in the normal morphology of the sperm. The no of dead sperms was significantly higher in the tank reared animals (Table 1).

Comparative spermatophore quality parameters of *Penaeus indicus*

Variable	Tank	Pond	Wild
Body weight (g)	11.17±0.38[a]	20.63±1.34[b]	30.18±1.76 [c]
Spermatophores without sperm (%)	10	Nil	Nil
Spermatophore weight (mg)	79±0.3[a]	142±0.01[b]	144±0.02 [b]
Sperm count (106 Cells)	0.94±0.17[a]	19.87±3.22[b]	43.05±8.04 [c]

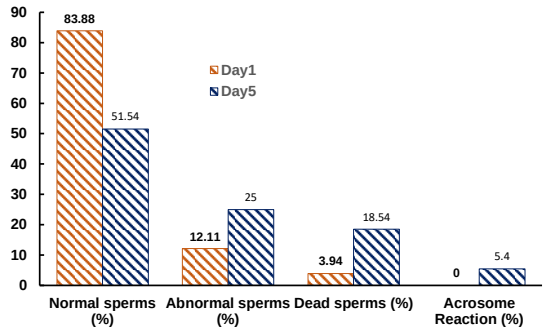
Data expressed as Mean ± S.E. Observations having different alphabet in the same row are significantly different at P<0.05.

EFFECT OF SHORT TERM CHILLED STORAGE ON THE SPERMATOPHORES QUALITY OF PENAEUS INDICUS

To study the effect of short term chilled storage, spermatophores were collected in calcium free saline from inter-molt stage male *Penaeus indicus*. The collected spermatophores were stored at 4 °C and spermatophore quality characteristics such as viability, normal morphology and acrosome reaction was analysed. Number of normal sperms was significantly higher in the first day of sampling than the fifth day of sampling at P<0.05. Acrosome reaction was also observed in the stored spermatophores at five days of preservation. Beyond five days, the sperm cells were disintegrating and viability was also not observed. This study proves the applicability of chilled storage as a preservation method for spermatophores.

EFFECT OF VARIOUS FEEDING REGIMES ON THE PHYSIOLOGICAL

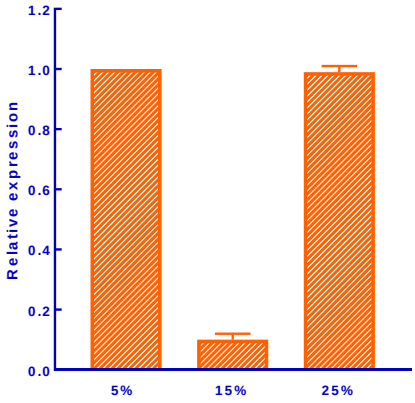
> ***Male spermatophores of Penaeus indicus can be preserved at 4 ° C without losing the viability***



Percentage of nomal sperms dead sperms abnormal sperms in the chilled stored spermatophores

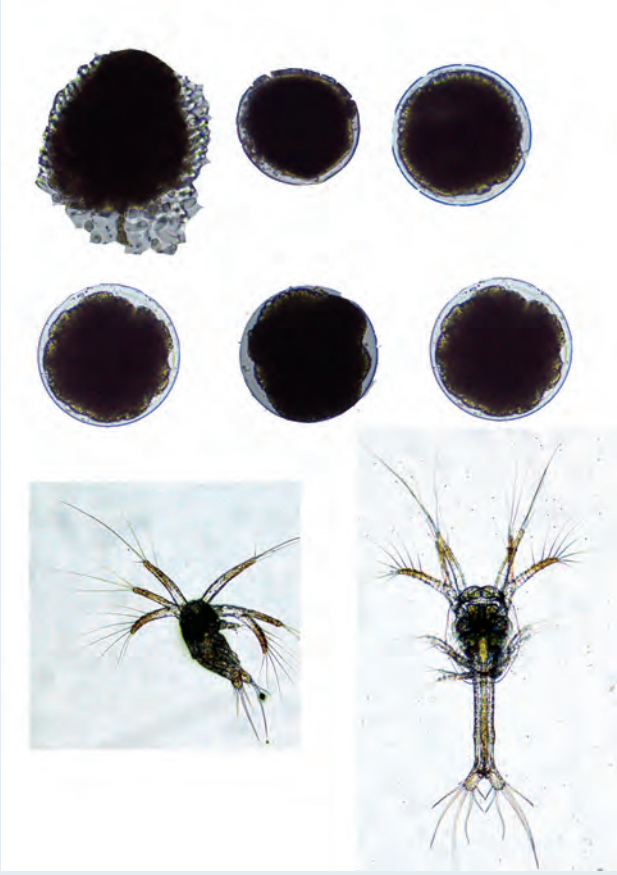
CHARACTERISTICS OF CAPTIVE PENAEUS INDICUS BROODSTOCK:

This study was carried out to evaluate the effect of different levels of maturation diet and captive rearing on physiological changes such as growth, molting rhythms and maturation hormone levels of captive *P. indicus* broodstock. Wild caught *P. indicus* brood stocks (TL-155±5 mm; BW-32.0±3g) were reared for 45 days at stocking density of 1:1 male and female ratio under standard hatchery conditions. The feeding regime of each treatments were maintained as 5%, 15% and 25% of body weight in triplicate with clam meat and formulated feed two times a day. After 30 days of rearing, the weight gain and specific growth rate of the each animal was measured. Mean weight gain of animals feed with 5%, 15%, and 25% were 0.45±0.12g, 1.11±0.9g, 0.72±0.35g respectively which indicate that the adult stage animals would not grow, and the moulting may not for the growth of the animal. The moulting frequency of both male and female varied significantly from each feed group where the 15% BW showed higher moulting frequency 2



Relative expression levels of GIH mRNA in the eyestalk of female Penaeus indicus reared under captivity

IN-VITRO FERTILIZATION AND HYBRIDIZATION POTENTIAL OF INDIAN WHITE SHRIMP, *PENAEUS INDICUS*



Various steps of embryonic and larval development

Management of reproduction of farmed shrimps under captive condition is the essential tool for developing selective breeding programs as well as for the interspecies hybridization procedure. Although reproductive biology of the shrimp has been studied in considerable details since the inception of commercial shrimp farming, mechanism of fertilization in penaeid shrimp has not been addressed in detail. The objectives of this study were: 1) to evaluate the feasibility of fertilizing capacity of preovulatory oocyte in vitro and trace the events of fertilization in Penaeus indicus, and 2) to examine the potential of hybridization of P. indicus with P. monodon. In the first experimental trial, females with ripe ovaries were dissected out, and ~1 million oocytes were mixed with 1 ml of sperm suspension. Fertilization and embryonic development were evaluated at every 15 minutes. The study shows that pre ovulatory eggs are capable for egg activation and fertilization. Hatching rate was calculated as 4.8% from the total number of egg fertilized, and 29% of nauplii developed up to PL stage. In the second trial, hybridization potential of P. indicus with P. monodon was evaluated using the procedure developed in the first trial.

Successful intra specific fertilization was obtained, although percent of fertilization was low (10%). The results suggest that the in vitro fertilization has been an effective tool in selective breeding and hybridization in penaeid shrimps. Further the study demonstrates that hybridization between interspecific species is possible even with evolutionary distant species, and that could be effective non transgenic tool for producing hybrids with improved aquaculture traits

times in 30 per animal. Further, the feeding regime showed indirect relationship to the moulting stage and positively correlated with the moulting frequency. After the 45 days rearing GIH mRNA reduced to the minimum level at the treatment group where animals fed at the rate of 15% of body weight.

MODIFICATION OF BROODSTOCK REARING SYSTEM WITH SOIL BASE INCREASES IMPREGNATION IN CLOSED THELYCUM PENAEUS INDICUS

Captive rearing of *P. indicus* broodstock to close the life cycle is one of the major thrust areas of research to develop breeding program. Successful mating in confined indoor is a one of the challenge in breeding cycle of closed thelycum shrimps as impregnation is important for gonad development After 8-9 month indoor tank reared female reached average body weight 15.4±0.89g (14-16 g) carapace length, 2.82±0.15cm, and male 13.13±1.18 g (12-14 g) with carapace length 2.71±0.12. The male and females were restocked for maturation in soil based tanks system at 1:0.75 ratio and maintained photoperiod (18D:6L).The shrimps were fed with maturation feed (60%) and 40% live feed (mussels and Artemia). After 30 days , 57.14% male had milky white developed spermatophore and 60% of female were impregnated.

ADMINISTRATION OF SEX STEROID, E2 (17β-ESTRADIOL) TO INDUCE MATURATION AND SPAWNING OF PENAEUS INDICUS

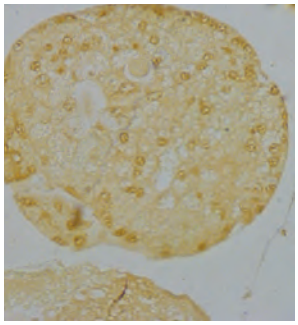
Artificial reduction of gonad inhibiting hormone (GIH) titre by unilateral eyestalk ablation has been the most widely used inducement method for spawning in commercial shrimp hatcheries. The success of this procedure largely depends on the physiological status of the animals. In order to optimize the induced maturation procedure, we have refined this technique by using downstream reproductive hormones such as 17β-Estradiol in addition to the eyestalk ablation. Administration of 17β-Estradiol (200µL/female) in ablated spawners triggered spawning with 75,000 fecundity and above 80% hatchability.

MATERNAL TRANSMISSION OF WSSV IN WILD PENAEUS INDICUS SPAWNERS

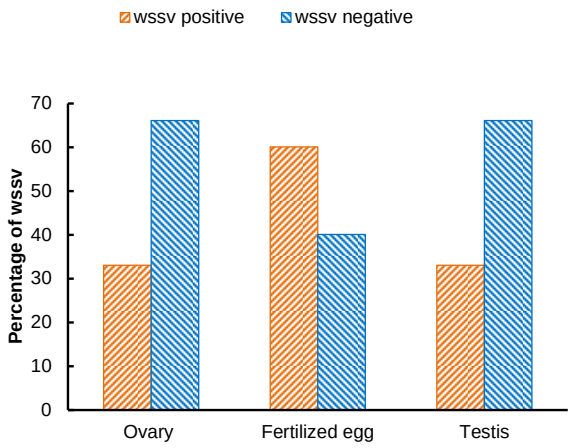
Indian white shrimp, *Penaeus indicus,* has been identified as the species of national priority for domestication and genetic improvement program in India. The viral pathogen, white spot syndrome virus (WSSV) is the most economically important virus that has been challenging the shrimp industry for the last two and half decades. WSSV prevalence were recorded during 2018-19 in different season revealed an average WSSV prevalence 45% and above 90% of the wssv positive brooders were only second step positive. Fertilized eggs and gonad tissue of the infected brooder were analysed further to quantify and tissue localization through real time PCR, *insitu* hybridisation and H&E stain. The preliminary WSSV quantification revealed low level infection with WSSV DNA copies below 50-70 copies /µL. Only 36% of gonad tissue, ovary and testis found to be infected whereas fertilized eggs recorded 60% WSSV positive while *insitu* hybridisation study of the fertilized infected egg and ovarian tissue did not give WSSV positive localization.



WSSV infected ovary



WSSV infected eggs In situe hybridization



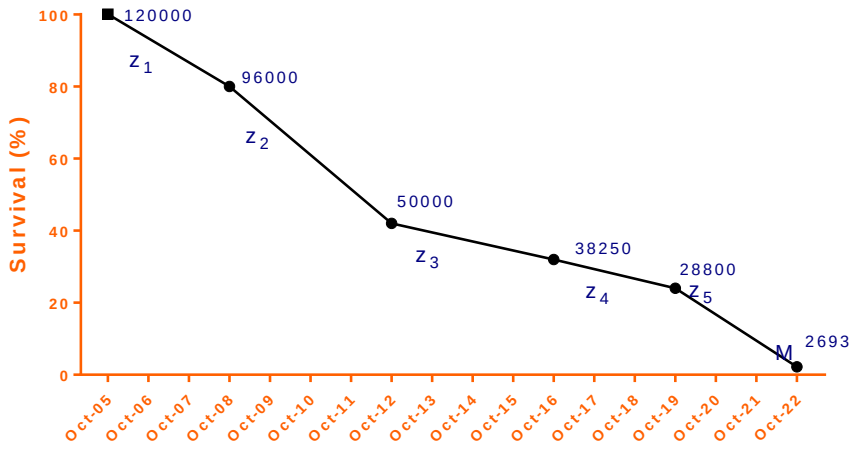
Percentage of WSSV infection in ovary, testis and fertilized eggs of P.indicus wild spawner

MUD CRAB

Mud crab, *Scylla serrata* has been the focus of diversification of brackishwater aquaculture in India. Salient observations of the research work carried out during this year are: A total of four hatchery runs were carried (and three were successful) out with a production of 2600 to 3200 megalopa per one unit of production system with a capacity of 4 mt with an average survival of 3. 2%.

HATCHERY PERFORMANCE OF MUD CRAB SCYLLA SERRATA

Stage	Batch 1	Batch 2	Batch 3
Hatched	500000	1800000	4400000
Larvae reared	120000	156000	158000
Megalopa	2693	3200	2660
Megalopa/ larvae X 100	2.2	2.1	2

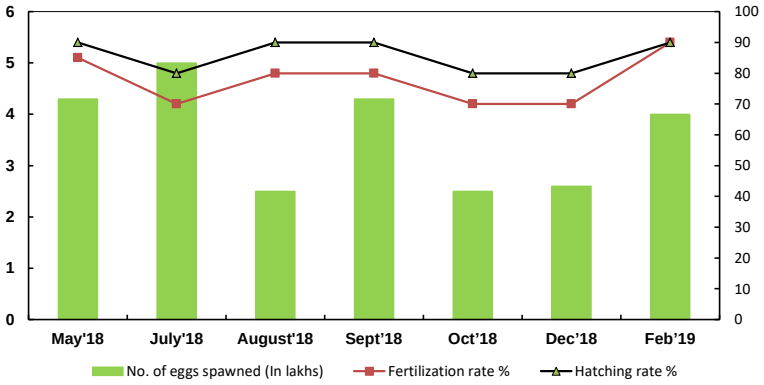


Larval survival of in a representative hatchery run of Scylla serrata (Z1 to Z5 Zoea 1 to 5 stages; M Megalopa)

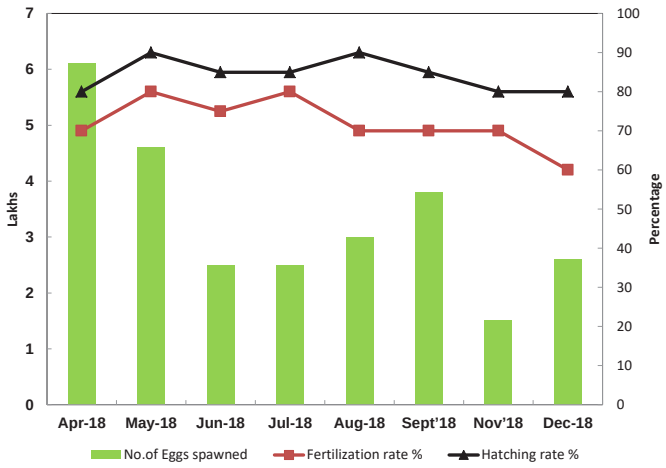
SEA BASS

CIBA'S CAPACITY IN SEABASS SEED PRODUCTION ACCOMPLISHED NEWER HEIGHTS WITH THE INCREASING DEMAND FOR SEEDS FROM THE FARMING SECTOR

After the breakthrough in captive breeding and seed production of seabass by CIBA in the early '90s, farming seabass went through several stages of success and failures due to several technical and non-technical reasons. CIBA continue to support seabass as a diversified potential candidate for farming in brackishwater. In recent years, there is good progress in expansion seabass farming in both ponds and open water cages, using indigenous formulated feed. Realizing feed and seed are the two key drivers in the expansion of seabass farming, CIBA is putting enormous effort with advanced science to back



Induced spawning details of Lates calcarifer during 2018 19



Natural spawning details of Lates calcarifer during 2018 19

up these two areas. A total of 43 numbers of seabass broodstock is being maintained in different systems, viz. 20 numbers in open 100-ton RCC tanks, 18 numbers in two maturation units under RAS and five numbers in earthen pond. Eight broodstock procured from Machilipattinam, Andhra Pradesh were added to the existing stock during the year 2018-19. Further, CIBA is preparing to add broodstocks of diverse genetic make-up to the existing stock and to maintain them in open water cages as back up for the future. In breeding seabass under captivity, CIBA had succeeded in both natural spawning without hormonal induction and induced breeding with hormones. Nearly half of the spawning occurred in the last year was natural ones, in the optimum rearing conditions, almost throughout the year. A total of 5.53 million eggs were spawned, 2.66 million eggs spawned from spontaneous spawning and 2.87 million from induced spawning. We observed that the number of eggs spawned and the fertilization rate was higher in spontaneous spawning compared to the induced one using hormones.

To ensure the supply of disease-free seeds to the farmers, hatchlings were screened for VNN by nested PCR, and negative hatchlings only were further reared and sold to farmers.

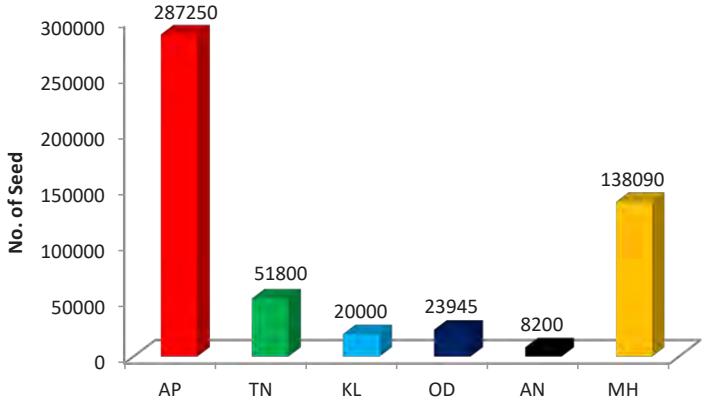
HIGHLIGHTS IN THE SEED PRODUCTION AND SALE LAST YEAR

An all-time high of 0.59 million fry seeds were sold in the year 2018-19 and a revenue of Rs. 1.72 million was realized from the sale.

For the first time, more than 1.20 lakhs seeds were completely weaned for artificial feed in the tank-based nursery, reared to more than 2 cm size and were supplied to Mangrove cell project being operated in Sindhudurg, Maharashtra.

A total of 32 farmers were supplied with seabass seeds during the year with about

54.27% seeds sold to Andhra Pradesh farmers followed by Mangrove cell Project, Maharashtra (23.5%).



Highlights in the sale of seabass sea production during 2018-19

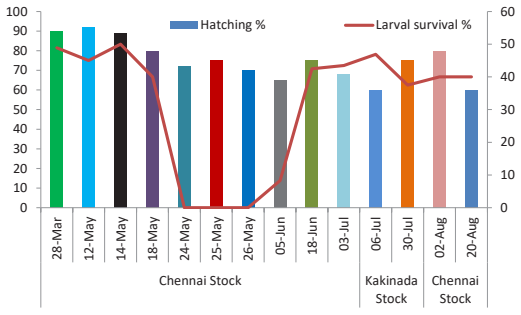
MILK FISH

CAPTIVE BREEDING OF TWO DIFFERENT GEOGRAPHICAL STOCKS OF MILKFISH (CHANOS CHANOS)

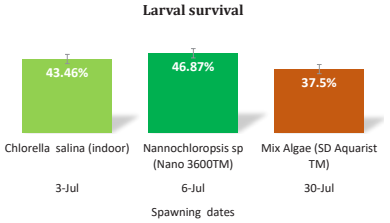
CIBA continue to do further fine-tuning and optimization of the captive breeding of milkfish after the first-time breeding of milkfish under captive conditions achieved on 8th June 2015, at our Muttukkadu fish hatchery. To evaluate the difference in reproductive performance of broodstock from two geographical locations in the east coast (Chennai (Avg. body weight 5.47 kg) and Kakinada (Avg. body weight 4.36 kg)), experiments were conducted simultaneously with the regular seed production process. Chennai stocks showed an extended breeding horizon for eight months (Feb-September) in 2017, compared to the broodfish sourced from Kakinada. Five does of combined hormone pellet were administered in both the stocks following similar breeding protocol and resulted in 14 total spawnings for six months (March-August) out of which two spawnings was from Kakinada population during month of July. It appears that the lunar cycle positively influences the milkfish spawning in Chennai population compared to Kakinada and the highest numbers of spawning occurred around 3.16 days around the new moon or full moon. Total 5.68 lakh hatchlings produced from 7.41 lakh fertilized eggs collected from both the population and under improved larval rearing protocol maximum larval survival achieved till 45 %. The milkfish fry were distributed among farmers and state fisheries departments of Kerala, West Bengal, Goa, Maharashtra, Gujarat, and Tamil Nadu. Total of Rs. 3, 74,084 revenue was generated from seed sale. Extended and multiple spawning of milkfish from both the population gives the possibility to overcome the challenges of year-round seed production, and pave the way to initiate satellite seed rearing centers outside CIBA hatchery.

ENRICHED ROTIFER AND LENGTH-BASED SIZE GRADATION TO MANAGE DIFFERENTIAL GROWTH IN MILKFISH LARVAE

Uniform healthy larvae are success indicator in hatchery production of milkfish. Milkfish larvae show differential growth after three weeks of rearing. Differential size variation causes slow growth, the emergence of shooter, and price drop in commercial milkfish hatchery. An initiative was taken to compare the potential of live chlorella , commercial algal paste of *Nannochloropsis oculata* (Nanno 3600 TM , 68 billion cells/ml) and mix cocktail of six marine microalgae (SD Aquarist^{TM}) – *Isochrysis,Pavlova, Tetraselmis, Chaetoceros calcitrans, Thalassiosira weissflogii* and *Thalassiosira pseudonana* as rotifer enrichment source for larvae. Mass cultured *Brachionus plicatilis* (140 – 210 µm) were collected and enriched with frozen green commercial algae paste *Nannochloropsis oculata,* and fresh *Chlorella salina* (1:1 ratio) in a 100 L volume container overnight and were supplied as initial feed to the larvae @ 20-30 numbers ml-1 from 3 dph to 21 dph. Similar enrichment protocol carried out for SD Aquarist. *Nannochloropsis oculata* enrichment showed better survival (46.87%) compared to the other two sources, although size variation was evident in all the groups. Three size groups of milkfish larvae arise after third week i.e. large: 1.68-1.70 cm, medium: 1.09-1.11 cm and small: 0.74-0.76 cm. Larvae were collected from 8 t LRT and manually graded in commercially available sieves to uniformly stock in 1t LRT without altering previous feeding regimes. The initial result suggests 15 days post grading (till 30-32 dph) larvae achieves homogenous growth pattern of 1.9 to 2.5 cm and can be sold @ Rs. 4.0 /- per seed. Stakeholders can easily accept this practice without establishing a costly algal culture unit while undergoing satellite seed rearing.



Breeding response from two geographical population of milkfish (2018)



Different algae for rotifer enrichment and larval survival

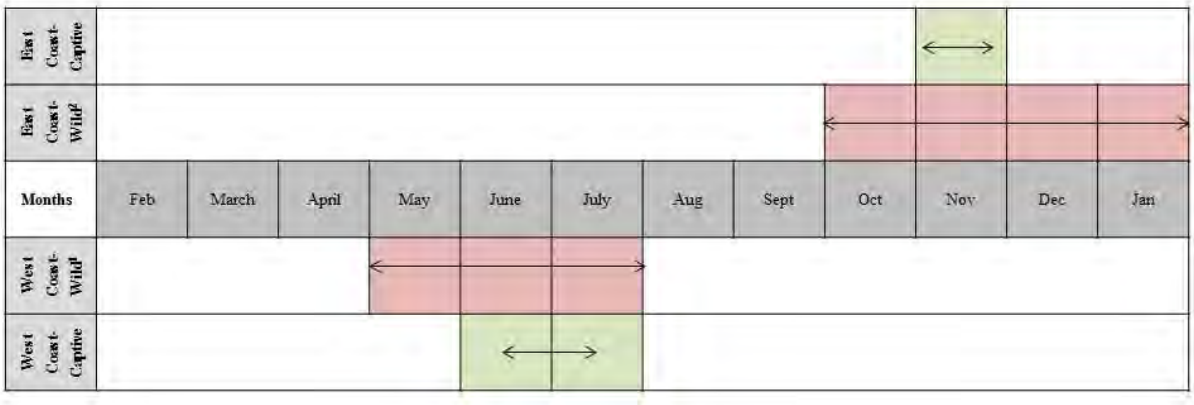
GREY MULLET

UPRIGHT PROGRESS IN CAPTIVE BREEDING OF GREY MULLET USING FARM REARED PARENTAL STOCKS

Grey mullet *Mugil cephalus* is one of the most significant candidate brackishwater finfishes priced for its roe in global markets and valued as a high-value food fish in domestic markets. An increasing concern is being raised over the dwindling natural seed resources, which have affected the traditional fishermen and grey mullet farmers alike. As an innovative approach, since 2017, CIBA is attempting to use a low volume RAS based breeding system for captive reproduction of the species within the farm premises and then transporting the fertilized eggs to a hatchery facility for further hatching and rearing. During June-July, 2017, five successive breeding trials resulted in larval production and the fertilized eggs were transported to CIBA's pilot-scale hatchery at Muttukadu for further rearing. Larvae survived only for 8 days post-hatch. In 2018, despite a drastically low salinity of 4 ppt in



Developmental statges of grey mullet larvae



Spawning seasons of two geographical groups of grey mullet captivity in relation to wild (West coast wild grey mullet (Rekha et al., 20191); East coast wild grey mullet (Mohanraj et al., 19943)

the pond system, three breeding attempts resulted in mass larval production. Female fish with average oocyte diameter of 535-550 µm were used. After a latency period, 15-16 h, 0.7 - 1.1 million eggs were obtained by dry stripping. Fertilization rate was observed to be 60%, and the size of fertilized egg and oil globule was 790- 810 µm and 290-300 µm respectively. Size of newly hatched larvae was 2.1 mm. At hatchery site, 1.25 lakh larvae were reared, using rotifer, *Brachionus plicatilis,* 5-20 no ml/ml, copepods and *Artemia* nauplii. Nanochloropsis, 1-2 lakhs cells per ml was used as the background phytoplankton. With all these differential efforts compared to the last year attempt, we obtained good survival up to 20dph this year as significant progress in captive breeding of mullet. Critical periods were recorded at 8 DPH and 13-15 DPH. Further refinements in larval rearing are in progress to standardize the captive breeding protocol of grey mullet in the near future.

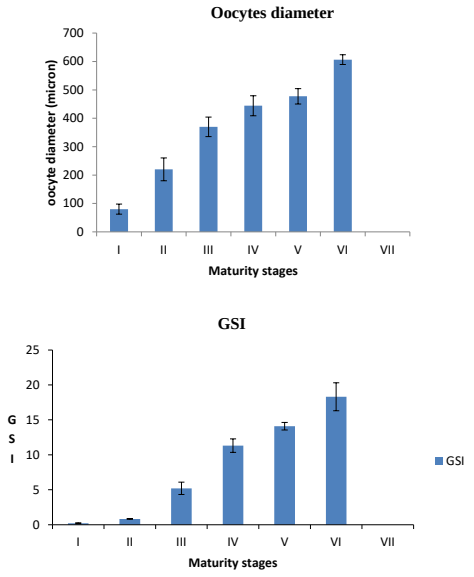
GEOGRAPHICALLY ISOLATED GREY MULLET STOCKS DISPLAY ASYNCHRONY IN SEASON AND EXTENT OF SPAWNING IN CAPTIVITY

Globally grey mullet aquaculture is carried out without any distinctions between the groups of the grey mullet species complex. However, some recent studies show that biological differences may also have significant economic implications for aquafarmers. Our observations from captive reproduction conducted in east and west coast show that the peak spawning period of the two geographical groups is asynchronous. Grey mullet stocks from east coastal waters and reared in captivity spawned in the beginning of November, while stocks from west coast showed active spawning during between mid-June and mid-July. We also noticed there is a significant difference in the extent of spawning season in relation to the wild and captive stocks irrespective of the origin. In the east coast and west coast, spawning in wild happens during captivity October to January and May to July respectively. This indicates that captivity affected the onset and duration of spawning periods differently in grey mullets. Our attempts at captive breeding between 2016-18 using these two geographical stocks of grey mullet have yielded varying results, some of these may indicate their biological differences.

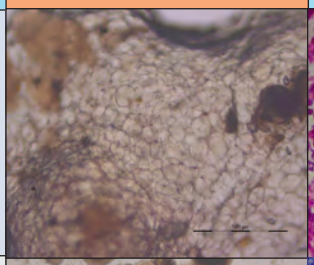
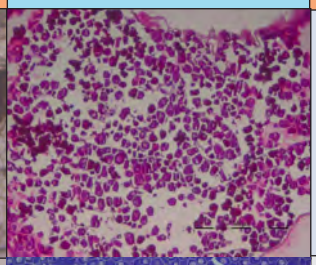
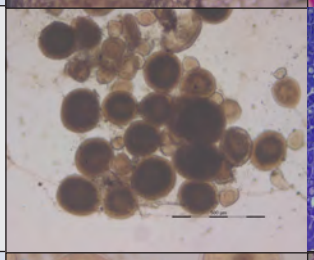
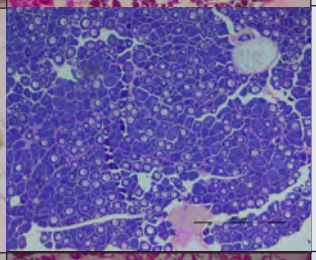
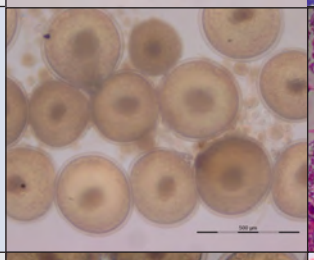
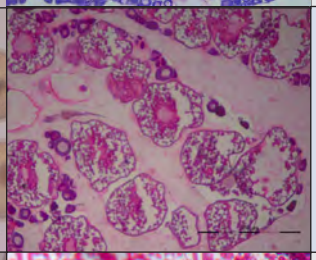
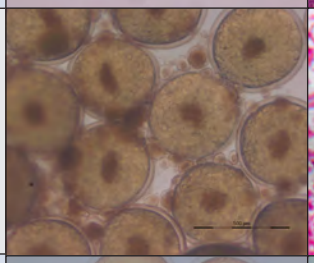
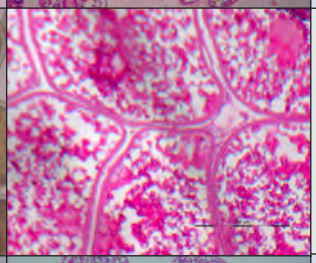
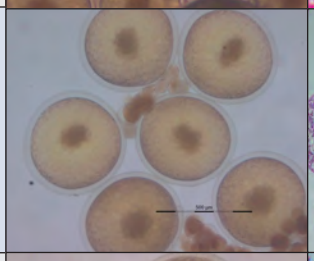
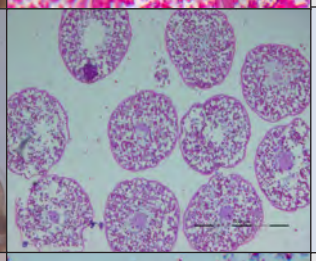
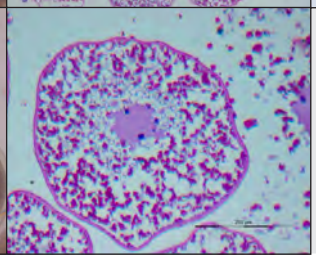
GOLD SPOT MULLET

GONADAL DEVELOPMENT OF LIZA PARSIA REARED IN BRACKISHWATER POND

A total of 300 sub-adult and adult Goldspot mullet, *L. parsia* (size: 50 to 110 g) were stocked in pond and fed with broodstock diet (32% protein and 8% lipid) @ 5% body weight twice daily. During the breeding season (November to January) gonad development is studied. During spawning season, dissolved oxygen, salinity, Ph was 6.4, 7 ppt and 8.2, respectively. Female fish (size: 70-110 g, n= 6) of different maturity stages were collected from the pond. Different maturity stages were defined as: immature (stage I &II), early maturing (stage III), late maturing (stage IV), mature (V) and ripe (stage VI). Gonadosomatic index and oocyte diameter of different maturity stages are shown in figures. The result showed that stage I, II and III have central GV; Stage IV have migrating/ eccentric GV; Stage IV have peripheral GV; Stage V showed germinal vesicle breakdown (GVBD); Stage VI showed ovulated oocytes. Further, it is observed that oocytes having less than 100 µm in diameter are non-vitellogenic in nature and *Liza parsia* attained the maximum GSI and oocytes diameter of 606.55±17.02 and 18.31±2.0, respectively in captive condition. This observation evident that broodstocks of *Liza parsia* could be easily developed using the the apt feed in pond based system, and there won't be any much trouble in getting brood fish for captive breeding.



Oocytes diameter and GSI at different maturity stages Gold Spot mullet

Stage of maturity	Oocytes	Histology	Vitellogenesis
Stage I (Immature-I, <100 µm)			Non-vitellogenic
Stage II (Immature-ii, Stage oocyte dia- 100-350 µm)			Previtellogenic
Stage III (early maturing, Oocyte dia- 350-400 µm)			Previtellogenic
Stage IV (late maturing oocyte dia- 400-450 µm)			Mid-vitellogenic
Stage V (Mature, (oocyte dia-450-500 µm)			Post-vitellogenic
Stage VI (Ripe, oocyte dia-500-600 µm)			Non-vitellogenic

Oocytes diameter

PEARL SPOT

FARMERS ADOPT SEED PRODUCTION OF PEARLSPOT ETROPLUS SURATENSIS FOR ADDITIONAL INCOME GENERATION

Pearlspot fish culture has been constrained by the availability of quality seeds in the required quantity. Fish seed costs have been increasing over the years and range between Rs 4-10 per fish based on the size. Because of complex parental care and low fecundity, pearlspot could be an ideal species for homestead farming models and seed production. Year-round seed production provides an avenue to the farmers for additional income generation with simple infrastructure. Mr. Keerthiram, Alappuzha a fish farmer from Alappuzha signed MOU with ICAR-CIBA for adopting ICAR-CIBA's model for pearlspot seed production. He has successfully been producing pearlspot fry repeatedly from pairs of parent fish (breeding interval, 17- 35 days) through larval separation at the wriggler stage. He has been conducting larval rearing using *Artemia nauplii* and the fry produced has been used for stocking in his farm and sold to neighboring farmers. Farmers Mr. Baiju, Thrissur also successfully conducted homestead pearlspot seed production. Mr. Unni, from Ernakulam, has also initiated the activity after learning from them. This model may be promoted widely in Kerala, where this fish fetches good price.









Seed production of pearl spot

HILSA

CAPTIVE BREEDING AND NURSERY REARING OF HILSA, TENUALOSA ILISHA IN AN EARTHEN POND SYSTEM

Hilsa, *Tenulosa ilisha* is an important commercial fish of the Indo-Pacific region, especially Bangladesh, India, and Myanmar. At present, the total catch has declined in these countries due to obstruction of natural migration for breeding, overfishing, water pollution and sedimentation in rivers. Therefore, to conserve and develop aquaculture of this species domestication and development of captive stock is essential. Wild mature migratory fishes were breed through dry-stripping, and larval rearing methodology was developed by using earthen ponds. Oozing male (270±5.0 g) and female (780±15 g) fish during its spawning migration (February to April) were captured from Hooghly River at Godakhali, and breed through dry stripping. Fertilized eggs were incubated and after hatching three different age group of larvae such as: 3 days post hatching (dph)-before yolk sac utilization, 5 dph- after yolk sac utilization and 12 dph-before oil globule utilization were stock in well prepared nursery ponds (100 m2). Stocking density in each pond were approximately 100000 individuals. During nursery, larvae were fed with *Artemia nauplii* (2 g Artemia cyst in each treatment) along with powder feed (20 g). At weekly interval, fermented GNOC (100 g) was applied in each pond. After 60 days of the nursery, it is found that the significantly higher survival (5%) and low average weight (0.8 g) in 3 dph than the other two groups. However, the average size was significantly larger (1.8 g) in 12 dph group than the other two groups. Using this methodology, we were able to produce 5000 hilsa fry, and further reared to observe its performance in captivity.



Artifical fertilization in hilsa fish

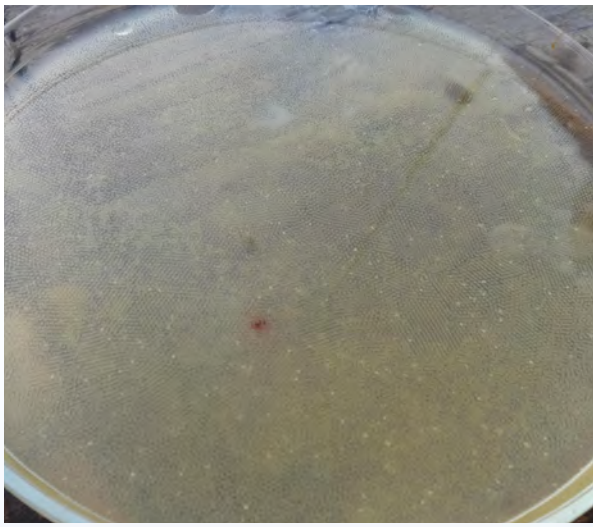


Artifical fertilization of hilsa





Larval developmental stages of fish hilsa



Feritilized eggs of hilsa



View experiemental ponds where hilsa is reared



Larval developmental stages of fish hilsa a



12dph larvae (little oil globule)



Young fry of fish hilsa



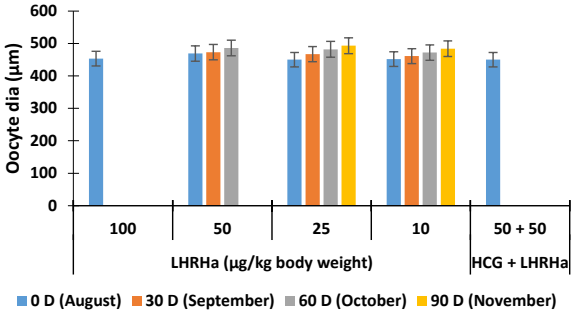
Juveiles of hilsa fish stocked in ponds

ORNAMENTAL FISH

INDUCED MATURATION AND VOLITIONAL SPAWNING OF SPOTTED SCAT: IN RAS BASED HOMESTEAD FISH BREEDING MODEL

Spotted scat is a well-known euryhaline species which is valued as ornamental and food fish. Simplified Induced maturation and breeding techniques in captivity will boost the seed production by small scale farmers in their backyard or in simple, compact hatcheries cater to the growing market demand. A Recirculatory system of 3000 L capacity and 12.9 m^3/ day flow rate with central drainage was fabricated. Pairs were kept at 1:1 stocking density in each maturation/spawning tank. Females were induced either with varying doses of LHRha (100, 50, 25, 10 µg/kg body weight) or combination dose of LHRha + HCG (50 µg/kg b.w.+50 IU) which were delivered intramuscularly via cholesterol-based pellet. Males were induced with combination hormone dose of LHRHa + 17-αMT (25 + 25 µg/kg body weight).

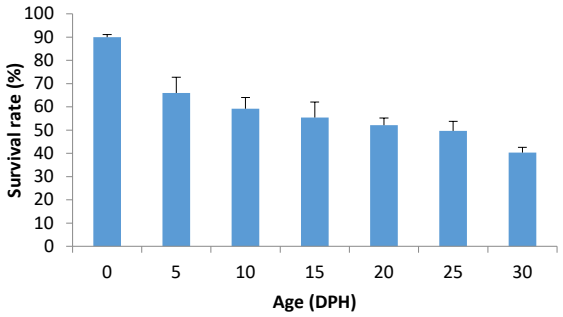
Experiment was successfully conducted for four months where hormone dose of 25 and 10 µg/kg could sustained the gradual increment of oocyte size. Oocyte size increased from initial dia of 450 ± 38.12 µm to 493 ± 18.5 µm with monthly LHRHa dose of 25 µg/kg and later led to successful spawning. Sperm density in males also increased from initial 17.68 ± 5.17 (X 10^9 spz/ml) to 25.21 ± 3.18 (X 10^9 spz/ml). Female scat brood fishes could be successfully induced to spawn with 25 µg/kg b. w. LHRHa monthly dose whereas combined dose pellet of 25 + 25 µg/



Effect of different hormone doses (Pellet) on oocyte diameter of female spotted scat



Just hatched scat larvae

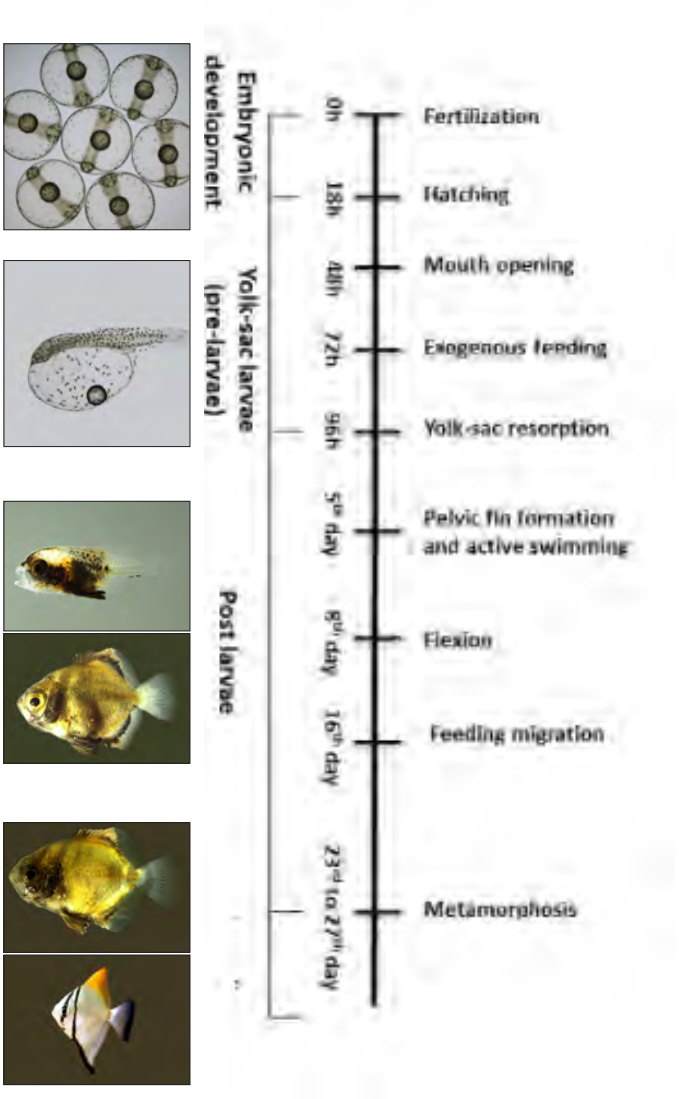


The survival rate of Monodactylus argenteus during the larval rearing

kg of LHRHa + 17-αMT was helpful to increase sperm density in males. These optimized doses would be useful for attaining volitional spawning for larval production under RAS based captive conditions.

CAPTIVE BREEDING OF SILVER MOONY, MONODACTYLUS ARGENTEUS A POTENTIAL FISH FOR BRACKISHWATER AQUARICULTURE

Silver moony, *Monodactylus argenteus* is a species of high demand in the international ornamental fish industry. CIBA for the first time attempted the broodstock maturation, induced breeding and larval rearing of silver moony in captivity for the first time. Sub-adults of silver moony collected from Vennangupattu backwaters, Tamil Nadu, India (n=200 avg weight, 50 ± 7g) were maintained in fixed cages in pond system at Muttukadu Experimental Station on formulated broodstock feed (2mm, CP: 52%, CL: 10%) and *Artemia* biomass and monitored for sexual maturation in captivity. The breeding system consisted of FRP tanks, capacity 500 l (salinity 31ppt, temperature 28^{0}C,) provided with hideouts. Female with oocyte diameter > 500 µm and males with oozing milt were selected to maintain a sex ratio of, male: female; 2: 1 in the breeding tank. Hormonal induction for breeding was done using LHRHa. Natural spawning and fertilization were observed after 36 h of hormone administration. The fertilized eggs were transparent, pelagic, non-adhesive with single oil globule. The diameter of the egg was 860 ± 14.11 µm. Fertilized Incubation was done in 200 l black, cylindroconical tanks. The incubation period was observed to be 18 h, and the hatching percentage was 90%. Newly hatched larvae were 1.60-1.67 mm.



The main events of larval development in Monodactylus argenteus

Development of seed production in captivity of silver moony will pave the way for the transition of ornamental fish trade of this species from wild caught stocks to more sustainable breeding based mode.

BROODSTOCKS DEVELOPMENT OF CANARA PEARLSPOTS, AND ORANGE CHROMIDE UNDER CAPTIVE CONDITIONS

Canara Pearlspot and Orange Chromide are high values chromides highly preferred in the ornamental fish industry. Broodstocks development of Canara Pearlspots, *Etroplus canarensis* and Orange Chromide, *E. maculatus* were carried out at MES, Muttukadu. Adults of Canara Pearlspots, *E. canarensis* were subjected to different brackishwater condition. But there were no spawning notices in brackishwater conditions. But there was continuous spawning in freshwater conditions. We are expecting there will be in spawning in brackishwater after exposing the fish for generations in brackishwater. In orange chromide, spawning is noticed in all the salinities.





Brood parents of Canara Pearlspots

STOCK MAINTENANCE OF POTENTIAL BRACKISHWATER ORNAMENTAL FISH SPECIES FROM SUNDARBAN TO EXPLORE THE CHANCES OF CAPTIVE BREEDING

Brackishwater ecosystem is the natural habitat of several ornamental fish species. Among them, only a few are being traded and have captive breeding protocols available. However, efforts in developing and popularization of seed production of untapped indigenous species will go a long way for building a robust ornamental fish industry in India. For this purpose, an 800 m^2 pond was prepared with crab and bird fencing as broodstock pond at KRC. Three different species, green pufferfish, *Dichotomyctere fluviatilis* (2 no.), mudskipper, *Pseudapocryptes elongatus* (215 no.) and Boddart's goggle-eyed goby/ mudskipper, Boleopthalmus boddarti (105 no.) were collected from Hooghly estuary and stocked at the broodstock pond. This stock is being strengthened further for captive breeding purpose.



Green pufferfish Dichotomyctere fluviatilis



Mudskipper elongatus, Pseudapocryptes



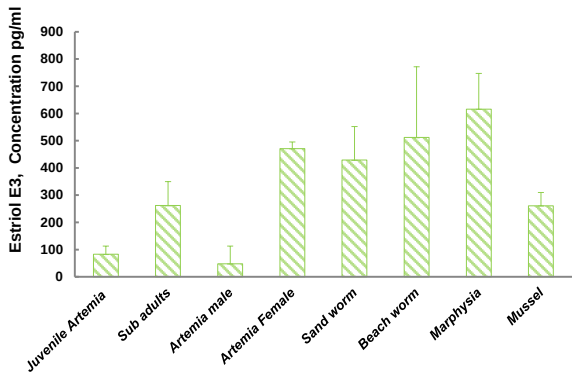
Boddart's goggle-eyed goby/ mudskipper, Boleopthalmus boddarti

LIVE FEED

Although *Artemia* is not a natural diet of any of the aquacultured species, it is most convenient, least-labor-intensive and most widely used live feed in aquaculture facilities. *Artemia* has been one of the major focuses of research of CIBA for the last decades. The current year we have explored the potential of *Artemia* biomass as a maturation diet and as a vehicle for hormone delivery. Further, as a part of the diversification of live feed organism, we have studied the potential of copepod and nematodes. Copepod constitute the major part of the diet of early life stages of many finfishes, and crustaceans, however, use of copepod as a live food organisms in the aquaculture facilities is still limited. To address this issue, the potential for mass culture possibility of copepod has been explored during the current year.

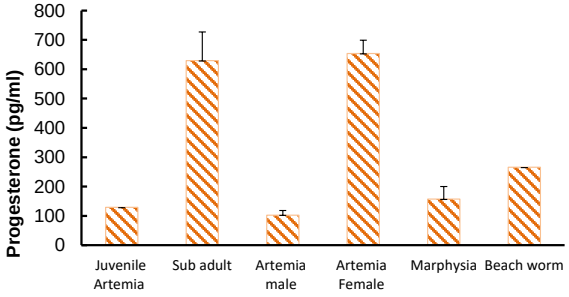
ARTEMIA BIOMASS AS A QUALITY BROODSTOCK DIET AND BIOVEHICLE FOR HORMONE DELIVERY

To understand the role of *Artemia* biomass as a quality broodstock diet for penaeid shrimps, presence of vertebrate sex - steroid hormones, for example: progesterone and estradiol in different life stages and sexes of *Artemia* was studied and compared with conventional maturation diets (e. g. polychaetes: sand worm, Neries sp., Blood worm, *Marphysia*, beach worm and mussesls: *Perna virdis*). The level of estriol E3, major metabolite of estradiol, was found to be highest in in adult female Artemia 471±24.60 pg / ml E3 However, among the all tested maturation diet,



Concentration of Estriol E3, a major metabolite of estradiol level (mean ±SD) noticed in different life stages of Artemia and different types of polychaete worms.

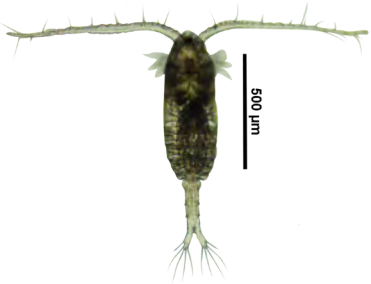
polychaete Marphysa spp had highest E3 titre (616 ± 131 pg / ml) To understand its role as a vehicle for hormone delivery, Artemia was enriched with 20 mg estradiol/3 ml alcohol. After enrichment, 22 fold increases in estriol bio encapsulation efficacy was noticed. The preliminary studies indicated the potential for replacing polychaete with Artemia biomass.



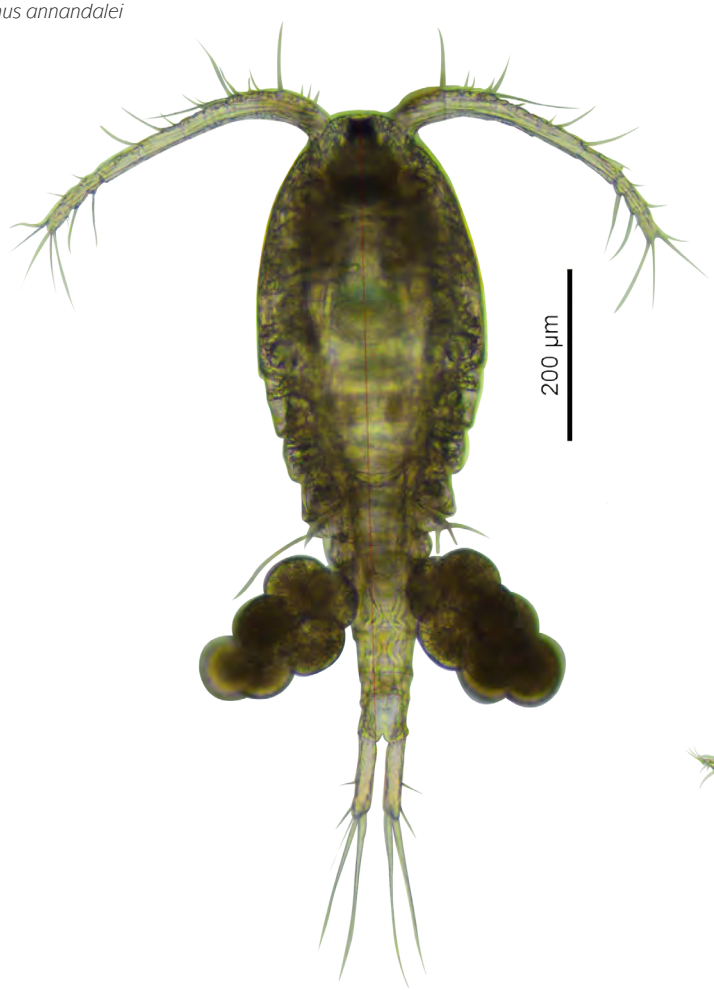
Concentration of progesterone (mean ±SD) noticed in different life stages of Artemia and different types of polychaete worms.

Artemia biomass production in indoor system recorded highest biomass 3.29±0.5 kg/m^3 at 500 nos/L followed by 1000 (2.69±0.3 kg/m^3) and 2000 nos/L (2.59±0.5 kg/m^3). At lower density more than 90% of population attained maturation

Copepods: Copepods are important crustacean live feed, and it has been increasingly used as a live prey in finfish and crustacean larviculture. Several experiments were carried out to develop a commercially viable mass culture procedure for copepods. The growth performance of three species of copepods: *Dioithona* sp (Cyclopoida), *Pseudodiaptomus annandalei* (Calanoida) and *Evansula pigmaea* (Harpacticoida) were evaluated under different combinations of microalgae for a period of 20 days. Highest density was observed in the treatment with *Dioithona* sp (4000±155nos/l) with in a period of 7 days with a combination of *Nannochloropsis* sp and *Isochrysis* sp (cell density of 35000 cells/ml) followed by *Pseudodiaptomus annandalei* (2700±78 no /L) with in a period of 10 days using a combination of *Chaetoceros* sp and *Thalassiosira* sp and *Evansula pigmaea* (1800± 65 nos/L) with in a period of 8 days with a combination of *Chaetoceros* sp and *Isochrysis* sp. *E. pigmaea* had smallest nauplii (48±1.1µm), and *P. annandalei* had the largest *nauplli* (75±2.6 µm).). Among 3 copepod species, maximum density can be produced within short duration is *Dioithona* sp



Pseudodiaptomus annandalei



Dioithona sp

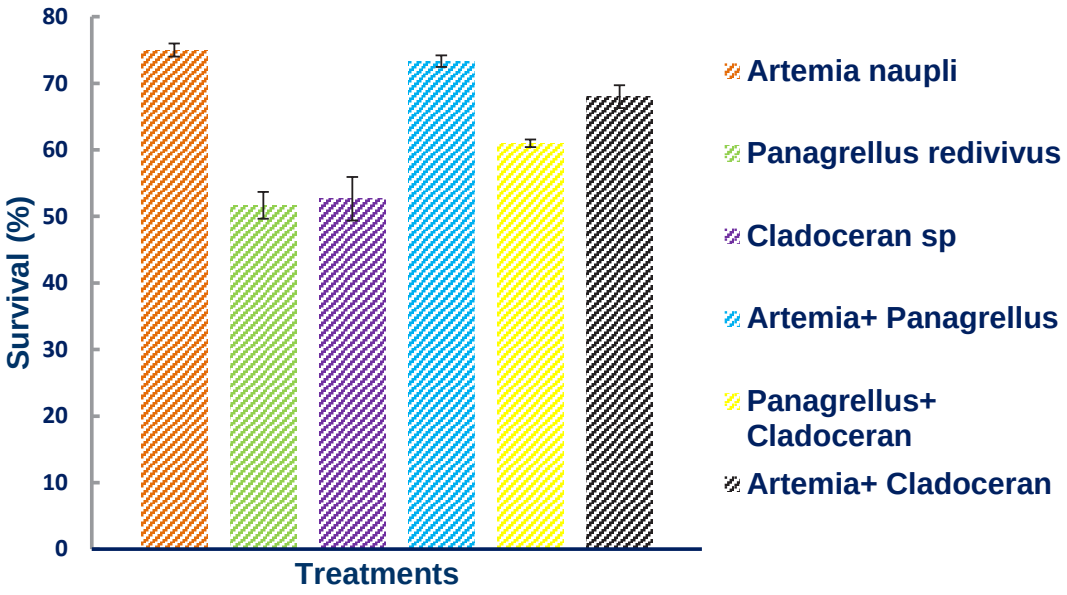


Evansula pigmaea

Potential of Nematode and Cladoceran as live feed with reference to conventional Artemia based live feed: Ninety percent of *Artemia* cysts used in the global aquaculture industry comes from a single source (Great found lake, USA), where climatic changes would generate unforeseen issues in exploiting the wild Artemia cyst. At this background, potential of live feed such as Nematodes and Cladocerans were evaluated as shrimp larval feed with reference to the conventional Artemia based live feed. Nematode can survive up to 60ppt salinity, and can be cultured easily using yeast media and reached a maximum density of 0.1 million/ml within 2 days of culture period. An experiment was conducted using nematode species (*Panagrellus redivivus*) and Cladoceran species during the mysis stages of *P. indicus*. Experiment was conducted in 20 L plastic tubs with *P. indicus* zoea 3 with a stocking density of 100 numbers. *Artemia* naupli and Cladoceran species was fed at a rate of 10 no/ml and nematode at the rate of 100 no/ml and also in combination (1:1). No significant difference was observed among the treatments with control and combination of *Artemia* naupli and nematodes. Over all result indicate that microworm can be effectively used along with *Artemia* naupli during the mysis stage of *P. indicus* to reduce the cost of production.



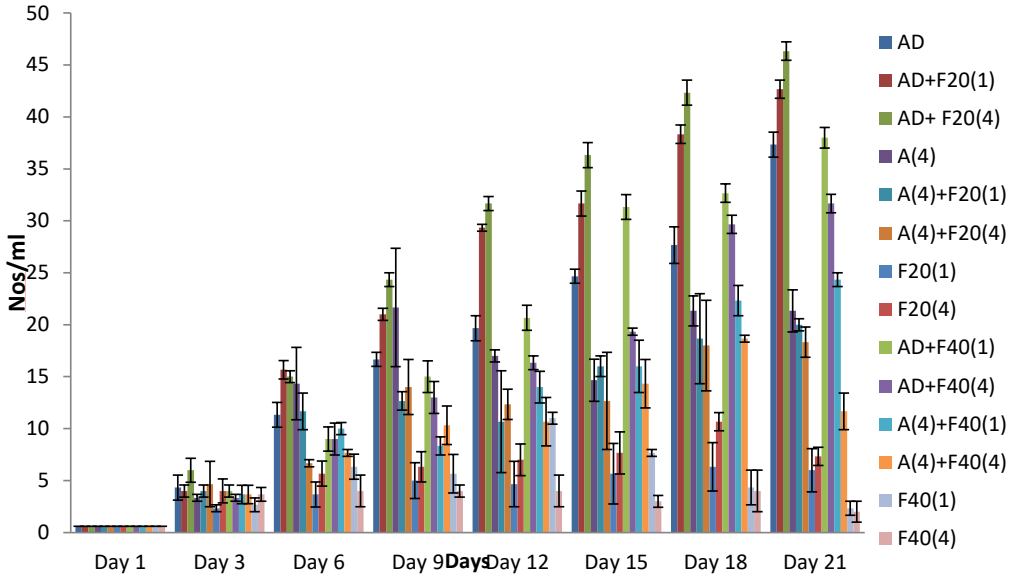
Panagrellus redivivus



Percentage survival of P. indicus larvae in different treatments

FISH TRIMMING HYDROLYSATE (FTH) AS PLANKTON BOOSTER FOR COPEPOD SP

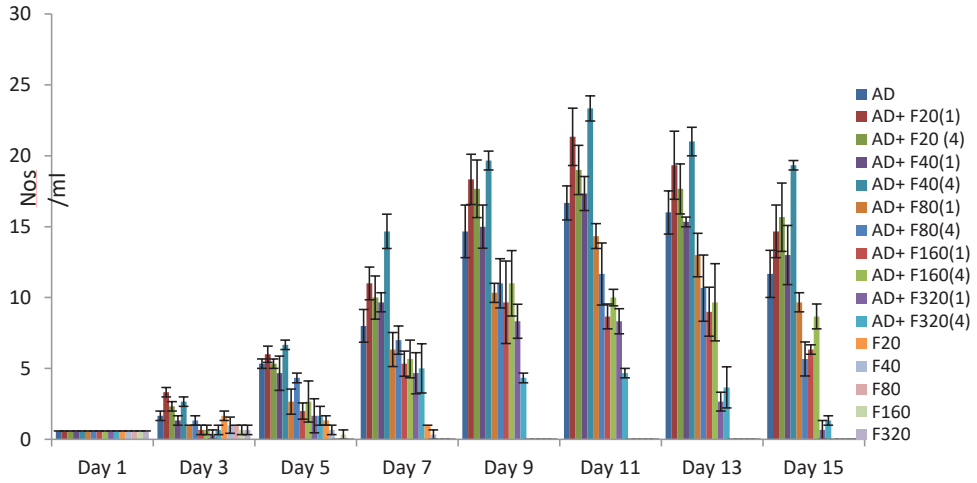
An experiment was conducted using Cyclopoid copepod added with Fish Trimming Hydrolysate (FTH) at concentration of 20 and 40 ppm on daily basis and 4 days interval in combination with *Thalassiosira* sp and *Nannochloropsis* sp for a period of 20 days in 20L Plastic tubs. Copepod was added at the rate of 600 nos/l and counting was done in 3 days interval. Maximum density (Fig 3 & 4) was observed in the treatment added with 20ppm FTH on 4 days interval (46±0.9 nos/ml) followed by treatment with single dose (20ppm) i.e. 43±0.9nos/ml followed by treatment with single dosage of 40ppm i.e.38±1nos/ml with daily inoculation of algae and control treatment (37+1.2nos/ml). There is a significant difference was observed between in control and treatment added with 20ppm FTH on 4 days interval dosage ($p<0.05$). Minimum density was observed in the treatment with FTH alone (Fig 5). Over all result indicates that FTH can be used as plankton promoter in combination with microalgae at a concentration of 20ppm.



Density of copepod/ml in different experimental treatments

FISH TRIMMING HYDROLYSATE (FTH) AS PLANKTON BOOSTER FOR CLADOCERAN SP

An experiment was conducted using Cladoceran sp (*Eurycercus berinji*) FTH at a concentration of 20, 40, 80, 160 and 320ppm on daily basis and in 4 days interval in combination with *Thalassiosira* sp and *Nannochloropsis* sp for a period of 20 days. Cladoceran was inoculated at a rate of 600 nos/L and counting was done on 2 days interval. Maximum density was observed in the treatment added with 40ppm FTH (23+0.9nos/ml) on 4days interval dosage>FTH at 20ppm on single dose (21+2.02nos/ml)> FTH at 20ppm on 4 days interval (19+1.7nos/ml)> control (17+1.2nos/ml) with daily dosage of algae on 11th day. Minimum density was observed in treatment with FTH alone. Overall result found that FTH can use as plankton booster for Cladoceran species in combination with microalgae at lower concentration (40ppm on 4 days interval).



Density of Cladoceran in different experimental treatments

AD- Daily algae (NAN+THL)	FX(1)- FTH @ X ppm at single dose	FX(4)- FTH @ X ppm at 4 days interval	FX- FTH @ X ppm

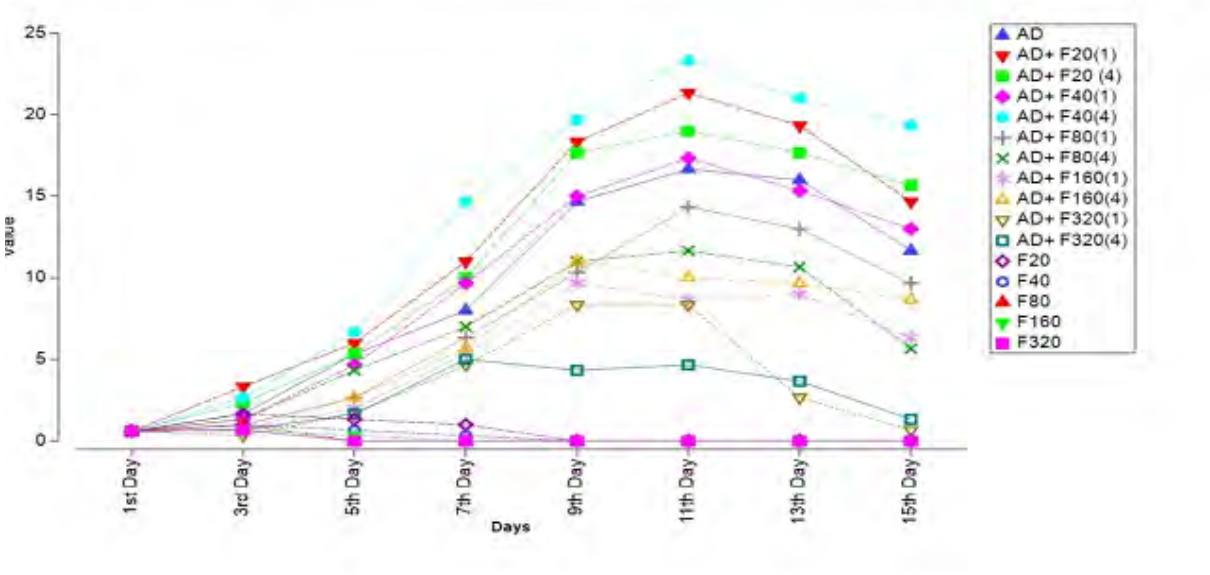
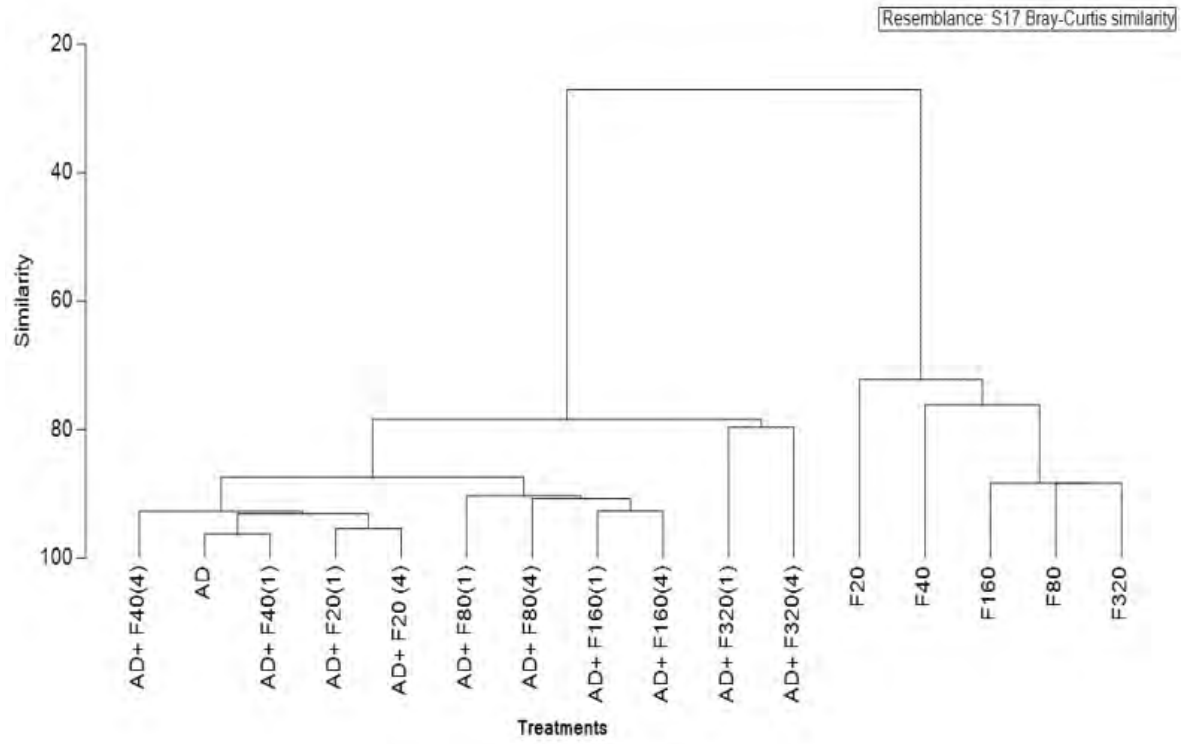


Fig 7. Dominance plot showing the density of cladoceran during different interval periods

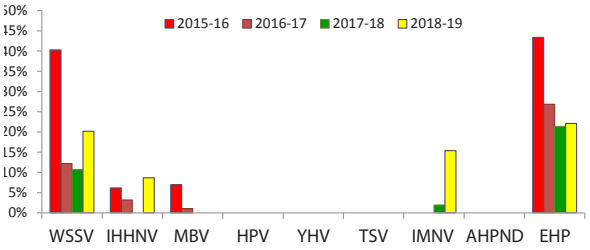


Cluster diagram showing similarity of different treatments

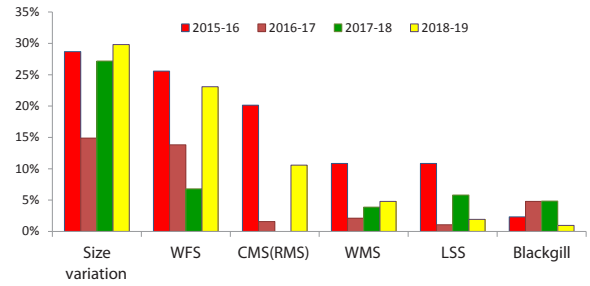
AQUATIC ANIMAL HEALTH

WSSV AND EHP CONTINUE TO BE THE MAJOR INFECTIOUS AGENTS LIMITING PRODUCTIONS IN INDIAN SHRIMP FARMING

Diseases are the biggest threat in shrimp aquaculture growth and sustainability. As part of the on-going active shrimp disease surveillance programme since the year 2014, a total of 523 shrimp farms have been screened for OIE listed pathogens in three maritime states viz., Tamil Nadu (TN), Andhra Pradesh (AP) and West Bengal (WB). During the last four years,the white spot syndrome virus (WSSV) and Enterocytozoon hepatopenaei (EHP) have been recognised as the predominant pathogens affecting shrimp farming in the two major shrimp farming states AP and TN. The hepatopancreatic microsporidiosis caused by E. hepatopenaei had the highest prevalence rate of 43% during 2015-16. However, the prevalence of EHP decreased over the years and during 2018-19, its prevalence was about 27%. The prevalence of the most dreaded white spot disease (WSD) was about 40% during 2015-16,which declined to 11%in 2017-18 and again increased to 20% during 2018-19. Infectious myonecrosis virus (IMNV) was first time observed during 2017-18 in India. Its prevalence was found to increase to about 15% during 2018-19. The prevalence of infectious hypodermal and haematopoietic necrosis (IHHN) disease ranged between 3-9%, over the last four years. The prevalence of other disease syndromes, attributable to poor farm management such as stunted growth, white faeces syndrome (WFS), loose shell syndrome (LSS), running mortality syndrome (RMS), white muscle syndrome (WMS)and black gill was about 15-30%, 7-26%, 1-11%, 0-20%, 2-11% and 1-5% respectively. White faeces syndrome (WFS) and stunted growth or size variation continue to be major issues due to poor farm management during the past four years.



Prevalence of viral, bacterial and fungal diseases in Andhra Pradesh, Tamil Nadu and West Bengal during 2015 – 19 (n= 523 farms)



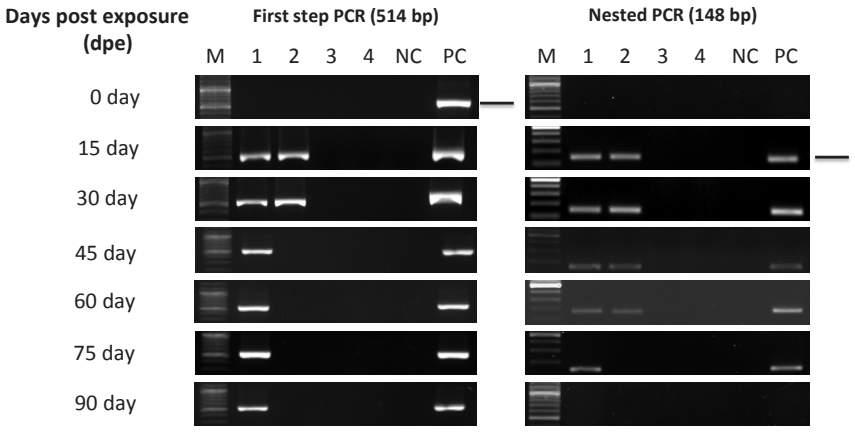
Prevalence of disease syndromes of shrimp in Andhra Pradesh, Tamil Nadu and West Bengal during 2015 – 19 (n= 523 farms)

The Indian brackishwater aquaculture was free from other OIE listed diseases such as taura syndrome (TS), yellow head disease (YHD), acute hepatopancreatic necrosis disease (AHPND) and necrotising hepatopancreatitis (NHP).

POLYCHAETE WORMS CAN TRANSMIT ENTEROCYTOZOON HEPATOPEANEI TO SHRIMP

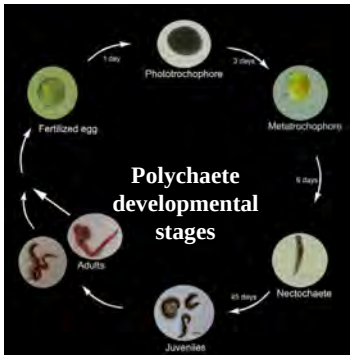
Earlier studies at CIBAhad revealedthat thepolychaete worms (Marphysa spp.) serve as carrier for shrimp pathogens such as WSSV (8.5% of the samples), EHP (7.6%of the samples) and multiple pathogens (WSSV and EHP in 3.6% of the samples). In an experimental study, EHP-infected shrimp faeces, when fed to polychaetes, the polychaetes attained the status of carriers and were capable of transmitting EHP to naïve SPF-Penaeus vannameiproviding evidence that the polychaetes can be the source for EHP infection in shrimp hatcheries and vice versa. The study confirmed the horizontal transmission of EHP from infected shrimp to polychaetes &vice versa. However, no evidence of vertical transmission was recorded in different developmental stages of polychaetes.

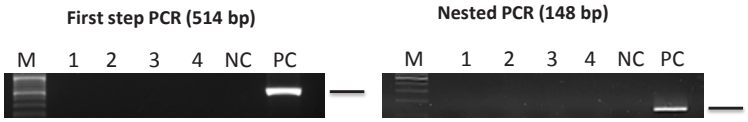
Polychaete group (n=20/tank)	PCR(SWP)	Days post exposure (dpe)of EHP						
		0	15	30	45	60	75	90
Tank A	1st step	-	+	+	+	+	+	-
	Nested	+	+	+	+	+	+	+
Tank B	1st step	-	+	+	-	-	-	-
	Nested	-	+	+	+	+	-	-
Tank C	1st step	-	-	-	-	-	-	-
	Nested	-	-	-	-	-	-	-
Tank D	1st step	-	-	-	-	-	-	-
	Nested	-	-	-	-	-	-	-



Lanes: M- Marker (100 bp), 1- Tank A, 2-Tank B, 3- Tank C, 4- Tank D, NC- Negative control, PC- Positive control

Horizontal transmission of EHP from shrimp to polychaete by oral feeding: PCR screening of polychaete worm for EHP at different days of post exposure (dpe) (0, 15 & 30)





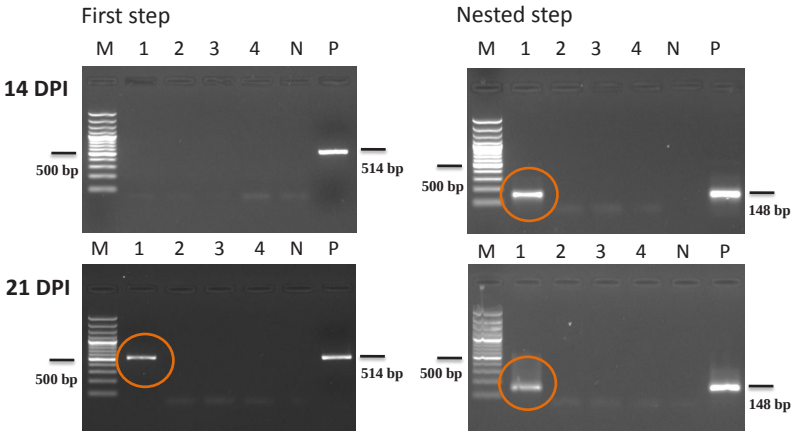
Lanes: M- Marker (100 bp), 1- Fertilised egg, 2- Metatrochophore, 3- Nectochaete, D- Juvenile, NC- Negative control, PC- Positive control

PCR screening suggests that EHP is not transmitted vertically among polychaetes

EHPSPORES REMAIN INFECTIOUSFOR MORE THAN A YEAR IN SEAWATER AT ROOM TEMPERATURE

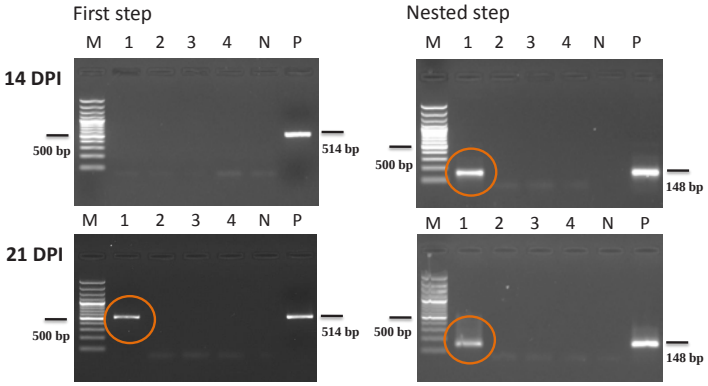
Changes in the temperature strongly influence the viability of microsporidians such as EHP. Viability and infectivity of EHP spores stored in pond water with salinity 26‰at different temperatures was examined. Pondwater collected from shrimp farm with history of EHP infection was stored at different temperatures (room temperature (RT), 4oC, -20oC and -80oC) and the infectivity of EHP was studied by bioassay experiments in shrimp post larvae for a period of three months. The EHP spores stored at 4oC, -20oC and -80oC for one month were unable to induce EHP infection in shrimp post-larvae up to 30 days of observation period by PCR. However, the EHP spores stored at room temperature were found to produce infection in shrimp within 14 days post-exposure (dpe). First detection of EHP infection (by nested PCR) was possible at 14 dpe, while the same group of animals showed first step positive at 21 dpe onwards till the end of the experiment. The spores were found to retain infectivity even after three months of storage at room temperature in seawater. The spores preserved at room temperature in seawaterlost infectivity after 1 ½ years. The study concluded that spores stored at 4°C, -20°C and -80°C showed dramatic decrease in spore viability and infectivity to shrimp PLs, but spores stored in seawater

Viability and infectivity of EHP spore in seawater stored at different temperatures



M- 100 bp marker, Lanes: 1 to 4 EHP- spiked water samples stored at different temperatures (1- at room temperature, 2- at 4°C, 3- at 20°C and 4- at 80°C), N Negative control, P- Positive control

Viability and infectivity of EHP spore in seawater stored at different temperatures

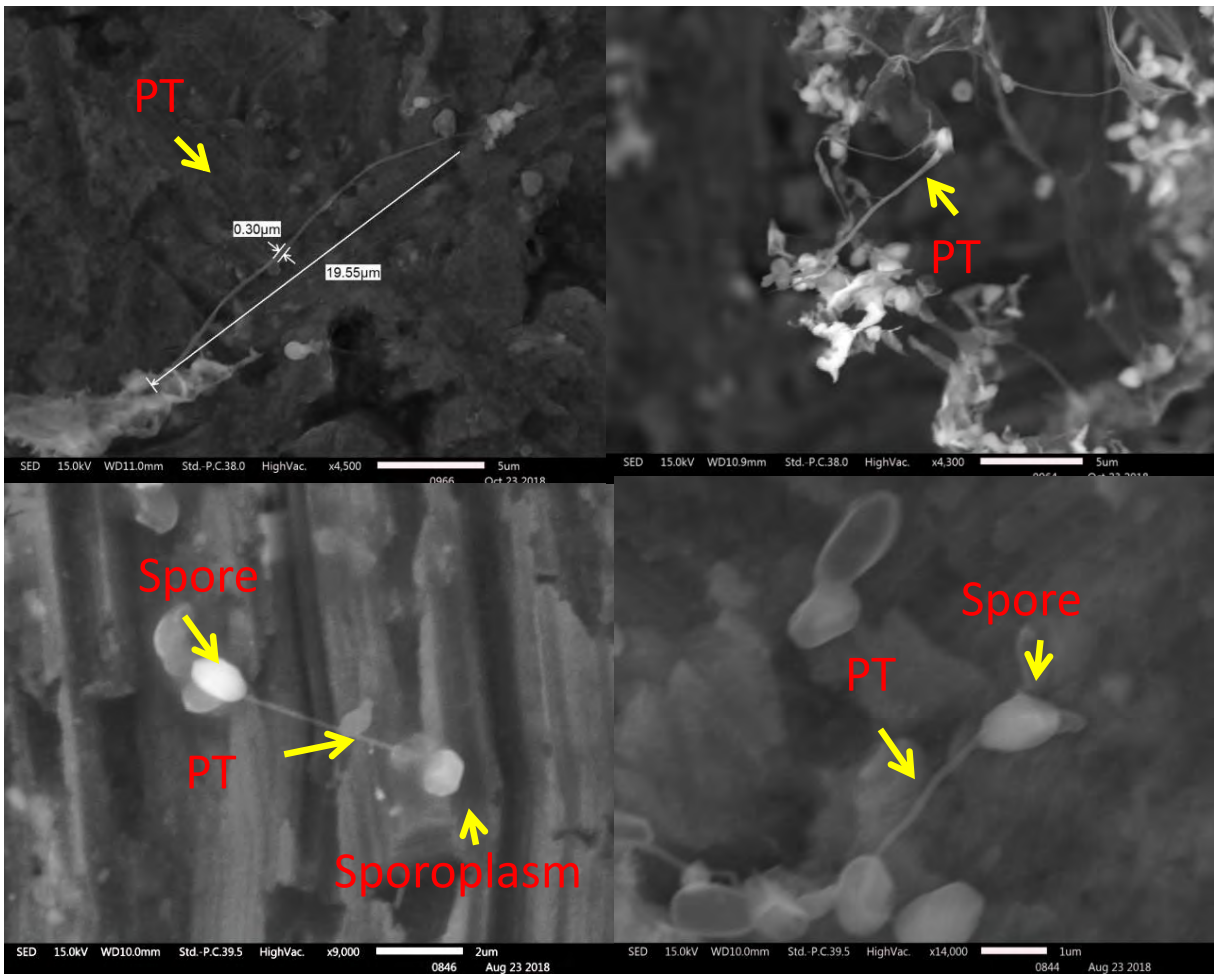


M- 100 bp marker, Lanes: 1 to 4 EHP- spiked water samples stored at different temperatures (1- at room temperature, 2- at 4°C, 3- at 20°C and 4- at 80°C), N Negative control, P- Positive control

at room temperature were found to produce infection in shrimp within 14 days post-exposure and retained their activity up to1 ½ years.

GERMINATION OF EHP SPORESCOULD BE EXPERIMENTALLY INDUCED

Generally, spore germination begins with an environmental trigger, which varies for different species depending on their habitat. Germination of EHP spore starts with general swelling of the spore followed by specific swelling of the polaroplast. The internal pressure of the spore culminates the discharge of the polar filament by eversion. The discharged polar tube can range in length from 50– 500 µm in length. The entire event of germination takes place in fewer than two seconds. If a potential host cell lies nearby, the discharging tube can strike this cell and pierce its membrane. Once the polar tube is fully discharged, the continued pressure within the spore forces the sporoplasm through the polar tube. Germination of EHP spores was induced by using several dyes, hydroxides, chlorides and buffers at different pH levels. In our preliminary investigations, germination of EHP spores was successfully attained by using potassium hydroxide and phloxine.



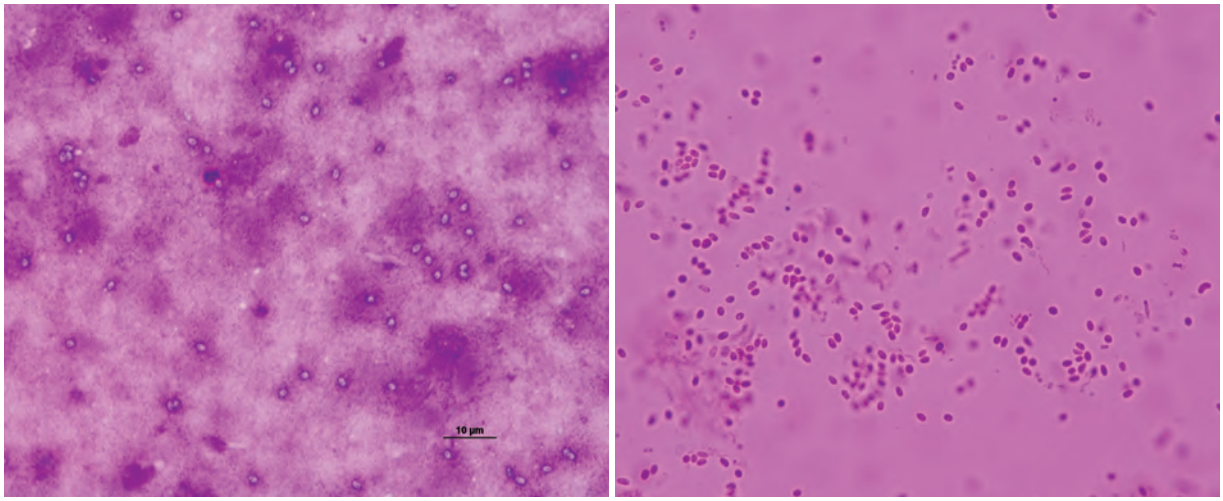
Scanning electron microscopic image of induced germination in EHP spores (PT- Polar tube, SP- Sporoplasm)

EHPIS THE LIKELYCAUSATIVE AGENT OF WHITE FAECES SYNDROME (WFS)

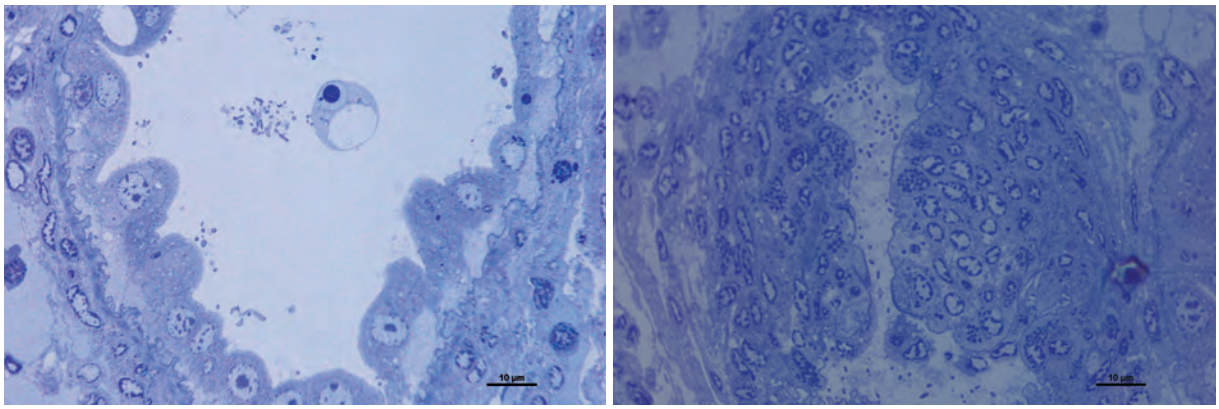
EHP infections in shrimp have been often reported to be associated with reduced feed consumption, growth retardation and white faeces syndrome (WFS). To study the association of EHP with WFS, a detailed investigation was carried out using affected animals collected from shrimp farms. The microscopic examination of squash preparation of hepatopancreas (HP) revealed aggregated transformed microvilli (ATM) like structures and dense EHP spores. Squash preparations of white faecal string collected from EHP affected shrimp farm also revealed presence of large numbers of mature EHP spores.Scanning electron microscopy (SEM) of white faecal threads also revealed dense mature EHP spores and rod-shaped bacteria. Transmission electron microscopy (TEM) showed immature and mature spores in epithelial cell cytoplasm and degenerated and germinated spores in tubule lumen.

In an experimental study, when the juvenile shrimps were fed with white faecal threads collected from WFS affected ponds, purified spores, EHP infected HP tissue,after 24-36 hrs, challenged animals produced only transparent and non-floating faecal threads. These faecal threads when tested were found to be positive for EHP by PCR. Further, dense mature EHP spores could be observed by scanning electron microscopy in the transparent and non-floating faecal threads.

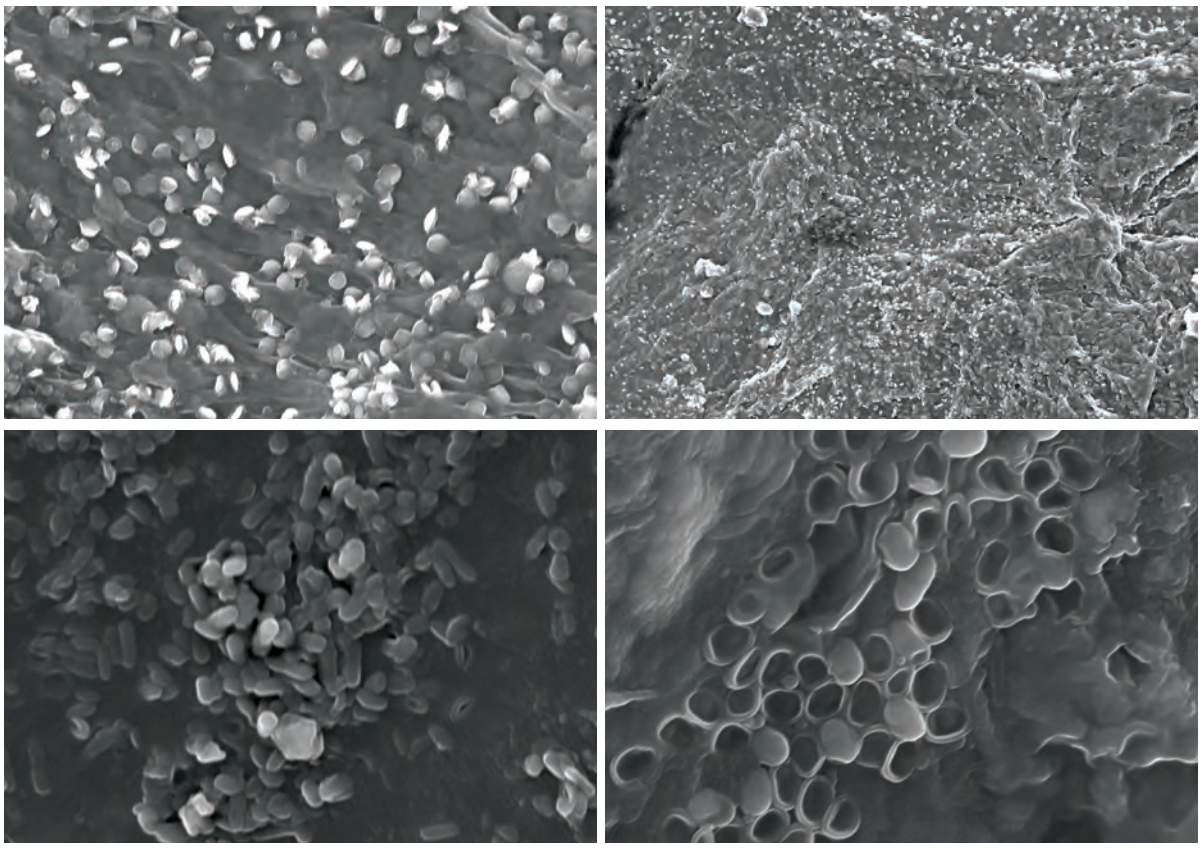
In our earlier studies EHP was detected by PCR in all the WFS affected and also in EHP-recovered animals. Further, epidemiological investigations in 322 farms also revealed a significant role of EHP with the increased frequency of WFS occurrences. However in EHP experimental infection studies, white faecal threads could not be produced under laboratory conditions. Thus it is evident that white faecal threads are one of the clinical sign of EHP and it also construed that white faeces syndrome probably caused by EHP.



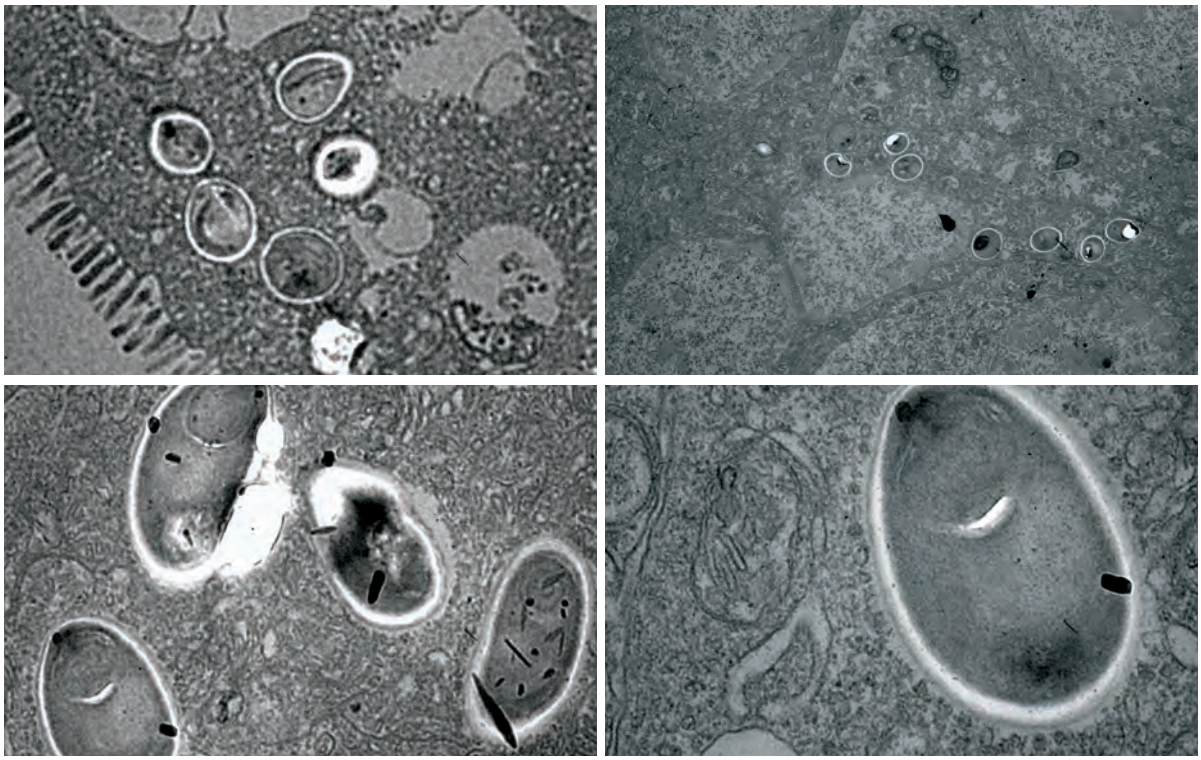
Squash preparations of WFS affected hepatopancreas (A) and WFS faecal strings (B) show dense EHP spores.



Semi-thin sections of HP tubules revealed sloughing of B cells and EHP spores (arrow) in epithelial cell cytoplasm and lumen of WFS affected HP tubules (E & F).



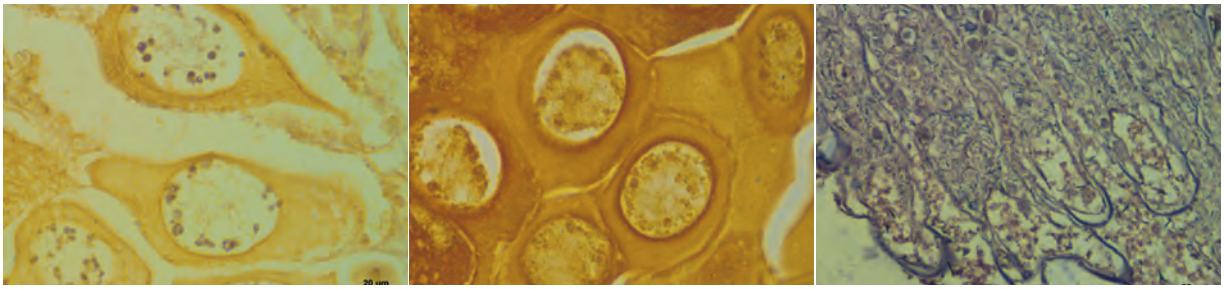
Scanning electron microscopy (SEM) unveiled dense mature EHP spore (red arrow) and also rod-shaped bacteria (yellow arrow) in white faecal threads.



Transmission electron microscopy (TEM) showed immature spores in ephithelialcell cytoplasm and degenerated spores in tubule lumen.

VERTICAL TRANSMISSION OF WSSV TO LARVAL SHRIMP IS A POSSIBILITY

To assess the vertical transmission of WSSV, a controlled laboratory trial was conducted in Indian white shrimp Penaeus indicus. The animals collected from the wild and tested negative for WSSV were divided into four groups and injected with 50 µlof WSSVsuspension having 101, 102, 103 and 104 copy numbers µl-1. After 58 hours post-infection, the animals became moribund with clinical signs of WSSV infection. At this stage, shrimps were sacrificed and gill and ovary samples were collected in Davidson's fixative for histopathology and 90% alcohol for PCR (pleopod, gill and ovary).PCR analysis of samples from injected groups indicated all the samples to be positive for WSSV by 1st step PCR (Kimural et al.1996).Gill and ovary samples were processed for histopathology and subsequently byin situ hybridization. Intranuclear inclusion bodies reactive to the VP28 probe were observed in WSSV infectied ovarian cells. Control cells did not have any such cells. The study indicates



Infected Ovary 100 x | Ovary (Control) 100 x | Gill WSSV infected 100 x

WSSV VP28 probe reactive intranuclear inclusion bodies in ovary cells and gills of WSSV infected shrimps (Arrow)

that even a lower dose of infection by WSSV have the possibility of vertical transmission.Mass mortality of farmed mud crab, Scylla serrata in Andhra Pradesh

MASS MORTALITY OF FARMED MUD CRAB, SCYLLA SERRATAINANDHRA PRADESH

Commercial scale mud crab culture is fast developing in the coastal areas of Andhra Pradesh. The total area under mud crab culture was about 7360 hectares during 2017-18 as per the information from the Department of Fisheries, Andhra Pradesh. Occasional disease and mortality is not uncommon in mud crab culture. Apart from availability of seeds, in the current year, disease outbreak and mass mortality of farmed crabs was found to be the major stumbling blockin profitable mud crab culture. Mass mortality of mud crab Scylla serrataculture was reported during September to November 2018 in Nagayalanka, Krishna district, Andhra Pradesh. For investigation of the problem, a total eight farms were selected, four affected with disease and four healthy ponds. All earthen ponds were stocked at 1000 per hectare using green local (GL) crabs (100-200g). Culture was done for 90 days to obtain a final average body weight (ABW) of 750g with survival between 50 and 55%, and FCR of 2.3-4.3. Crab mass mortality was observed with clinical signs such as white spots on the carapace, lethargy, fungal growth over the exoskeleton, chitinolytic spots on the abdominal flap, fouling, physical deformities of claw and chelate legs, light greenish to yellowish or pinkish discoloration followed by death. Mortality was observed during 65th day of culture (DOC) and progressed up to 75% in a period of 10 days. Water salinity, pH, dissolved oxygen and temperature were 16.84 ppt, 8.13, 3.8% and 26.7oC, respectively. Post mortem examination revealed that the gills were heavily infested with metazoan crustacean parasite, stalked barnacle, Octolasmis spp. Abdominal cavity contained about 30-40mL serosanguinous fluid. Microbial load estimation in pond sediment, water and haemolymph of infected crab showed that there was significant increase in total plate count (TPC) and total Vibrio count (TVC) compared to that of healthy ponds. Polymerase chain reaction (PCR) screening revealed that the diseased samples were positive for white spot syndrome virus (WSSV). Histological studies showed that there was degeneration of gill tissue and were

characterized by hypertrophied nuclei with marginated chromatin and eosinophilic to basophilic intranuclear inclusions. Haematological investigation revealed that total haemocyte count (THC) was lower in diseased crabs (6.90±0.48 x 106 cells mL-1)compared to healthy Scylla serrata(17.28±0.46 x 106 cells mL-1). In healthy crabs, small non-granular haemocytes (SNGH) constituted 14.13±0.83% of the circulating haemocytes (2.43±0.10 x 106 cells mL-1) while large non-granular haemocytes (LNGH) constituted 45.25±2.32% (7.81±0.41 x 106 cells mL-1). Semi-granular haemocytes or small-granular haemocytes (SGH) constituted 9.88±1.64% (1.70±0.27 x 106 cells mL-1) while large granular haemocyte (LGH), constituting 30.75±1.55% (5.33±0.40 x 106 cells mL-1). SNGH, LNGH, SGH and LGH (x 106 cells mL-1) among the diseased crabs were significantly low as 1.85±0.20 (26.63±1.68%), 3.85±0.32 (55.63±1.14%), 0.42±0.07 (6.25±1.13%) and 0.79±0.08 (11.50±1.37%), respectively.



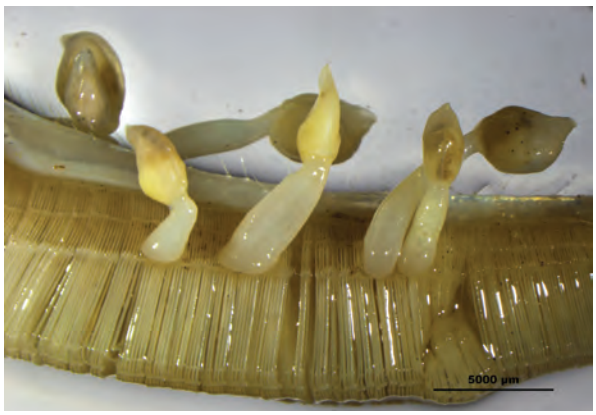
Crab mortality with clinical signs such as white spots on the carapace, fungal growth over the exoskeleton and fouling.



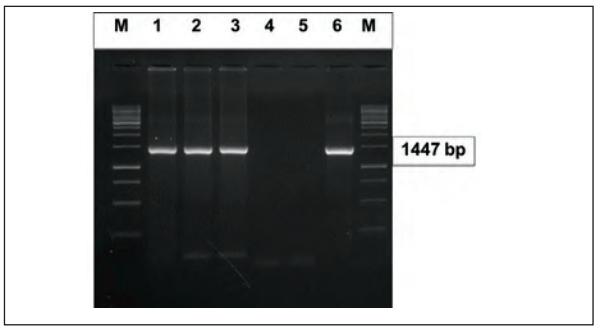
Crab with clinical signs such as fungal growth over the exoskeleton, chitinolytic spots on the abdominal flap and fouling.



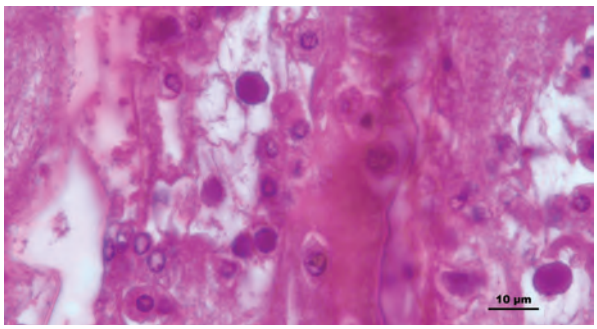
Crab with heavy infestation of stalked barnacle, Octolasmis spp. in the gills (low power).



Crab gills with heavy infestation of stalked barnacle, Octolasmis spp. Scale bar: 5000 µm.



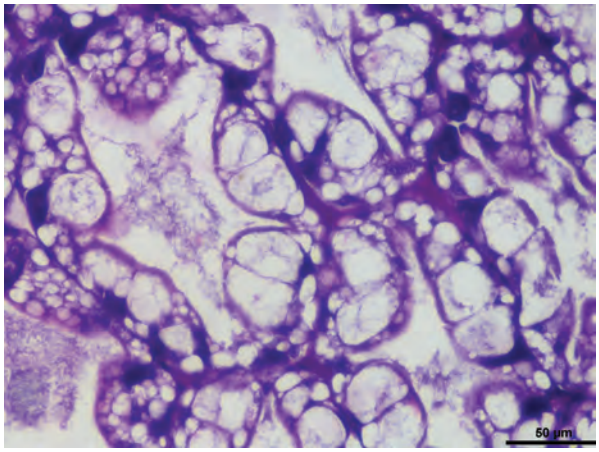
Lane M: Ladder; Lane 1-3: Crab sample positive for WSSV; Lane 4&5: negative control; Lane 6: positive control.



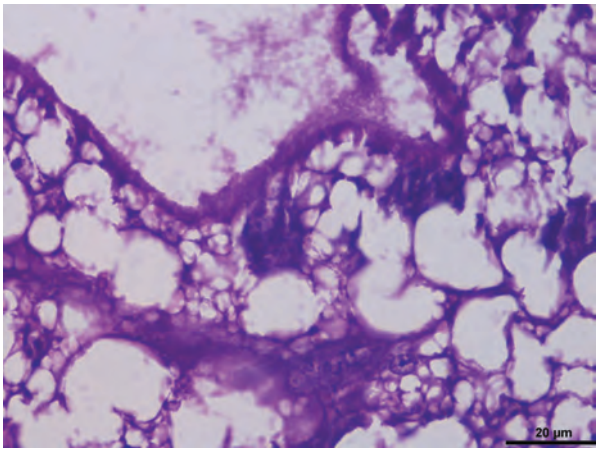
Histopathology of gill tissue showing degeneration and hypertrophied nuclei with marginated chromatin and eosinophilic to basophilic intranuclear inclusions. H&E. Scale bar: 10 µm.

COMPARATIVE PATHOLOGICAL CHANGES IN SHRIMP HEPATOPANCREAS IN RESPONSE TO VIRAL AND PARASITIC INFECTION

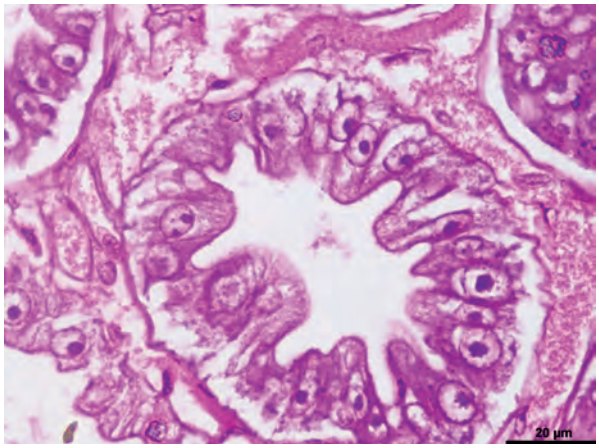
The hepatopancreas is a primary digestive organ of shrimp which plays the dual role of secreting digestive enzymes and absorbing nutrients. Due to its pivotal role in digestion and metabolism, it is considered as shrimp powerhouse, which also serves as primary target organ for many of the pathogens. Histopathological examination of hepatopancreas in response to infection often serves as first step in identifying any new pathogens. Shrimp samples confirmed positive by PCR for WSSV, IHHNV, WSSV & IHHNV and EHP were preserved in Davidson fixative were processed as per the method described by Lightner et al, (2004). The histological changes observed in hepatopancreas of WSSV infected shrimps were increased vacuolization of B cells, increased number of F and R cells, degeneration of hepatopancreatic tubular epithelial cells in few cases with presence of proteinaceous exudate in the tubule. The IHHNV infected shrimp hepatopancreas had normal hepatopancreatic cells like B, F, R & E cell with no changes. Few cases showed degenerated tubular epithelial cells. The combined WSSV and IHHNV infection had hepatopancreatic lesions similar to that of the WSSV infection. In comparison, EHP infected shrimp hepatopancreas had tubular cells like B, F, R cell necrosis and degeneration. Further haemolymph accumulation noticed between the tubules. The study suggests that these pathogens affect the hepatopancreatic architecture and thereby the functioning of the hepatopancreas.



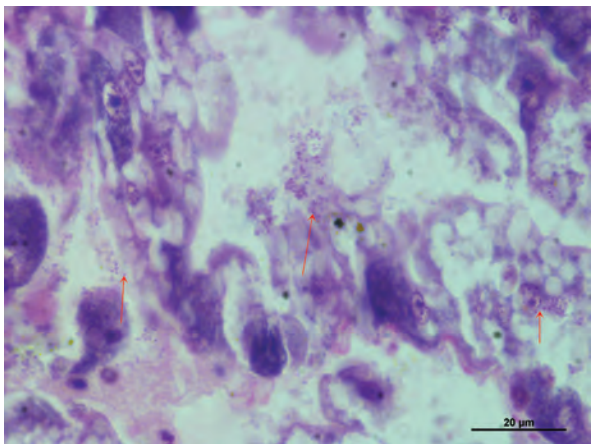
WSSV infected hepatopancreas showing increased vacuolization of B cells (H&E 100x)



WSSV & IHHNV infected hepatopancreas showing increased vacuolization of B cells (H&E 100x)



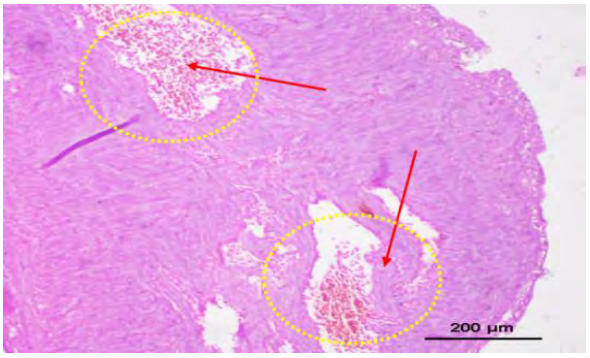
IHHNV infected hepatopancreas showing normal appearance



EHP infected hepatopancreas showing total necrosis and degeneration of hepatopancreatic cells (H&E 100x)

TILAPIA LAKE VIRUS (TILV)CAN BE CROSS-TRANSMITTED TO SEABASS

With the availability of sea bass seed from CIBA and RGCA, pond farming of seabass has been increasing. In a finfish disease surveillance investigation, the L.calcarifer samples collected from nursery, monoculture, cage culture and co-culture with tilapiafrom Andhra Pradesh and TamilNadu, when screened for Viral Nervous Necrosis (VNN), Iridovirus and Tilapia Lake virus (TiLV),all were found negative for VNN and Iridovirus infection. However, two farm samples co-cultured with tilapia experienced chronic mortalities and suffering with haemorrhagic encephalitis had TiLV infection. Challenge experiment conducted to test the inter species transmission of TiLV from infected tilapia to seabass showed successful transmission of TiLV with cumulative mortalities in fish challenged by different routes with varied experimental duration in inducing the disease. TiLV induced pathognomonic lesions were observed in the liver and brain in experimentally infected fish. Such jumping viral pathogens from tilapia could be a serious threat to aquaculture diversification with sea bass.



Haemorrhages observed in infected fish (H&E 40x)

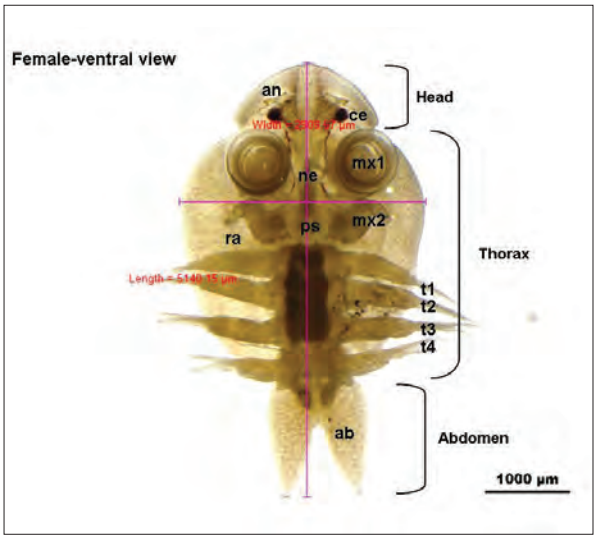


Seabass nursery sample collected from AP

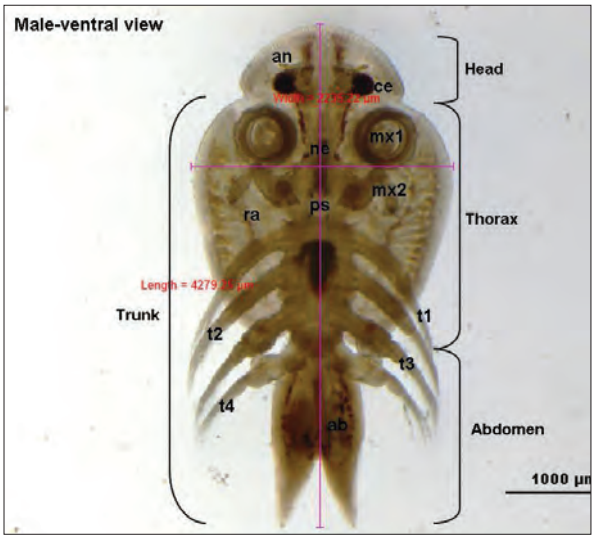
PREVALENCE OF PARASITIC INFECTIONS IN BRACKISHWATER FINFISHES

Increasing intensification with lack of adequate health management strategies result in increased incidences of parasitic infestations. Parasites are the major concern for health, productivity and reproductionof aquaculture species. Surreptitiouslyharbouring the host, theyare considered economically more significant than acute diseases. Hence, cataloguing the prevalence of the parasitic infestation would help in formulating the control measures in aquaculture. So, parasitic profiling was done during 2016-19 in a total of 3145 fishes and crabs of different species with varying sizes such as Lates calcarifer – 2237 no., Mugil cephalus – 170 no., Liza spp. – 26 no., Scatophagus argus – 81 no., Etroplus suratensis – 156 no. Chanos chanos – 267 no., Labeo rohita – 200 no. andScylla serrata – 8 no. collected from Tamil Nadu, Kerala, Andhra Pradesh and Maharashtra. Six major genuses such as Argulus, Caligus,Lernanthropsis, Zeylanicobdella, Anisakisand Octolasmis were found to infect finfishes and crabs as shown in the Graph 1 and Figure 1-10. No parasites were found in Liza spp. and C. chanos.

The tissue damages caused by these parasites were assessed by haematological and histopathological changes. Clinical signs such as lethargy, erratic swimming, reduced feeding, hanging at the surface, poor body condition, emaciated, anaemic, flashing and rubbing against surfaces with mortality of 80-100% was observed in fish affected with



Female crustacean ecto-parasite, Argulus quadristriatus collected from Asian seabass, Lates calcarifer. Scale bar: 1000 µm.



Male crustacean ecto-parasite, Argulus quadristriatus collected from Asian seabass, Lates calcarifer. Scale bar: 1000 µm.



Female crustacean ecto-parasite, Argulus siamensis collected from rogu, Labeo rohita. Scale bar: 1000 µm.



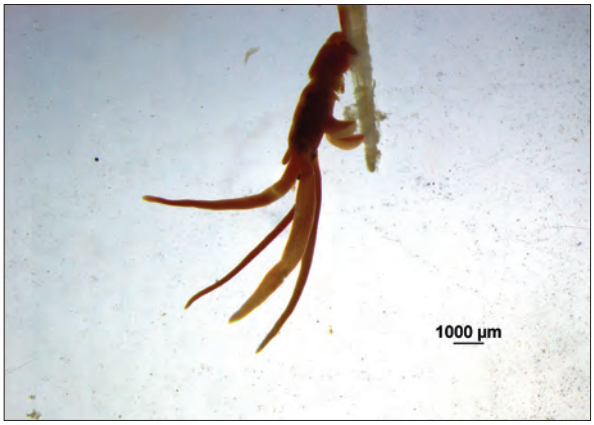
Male crustacean ecto-parasite, Argulus siamensis collected from rogu, Labeo rohita. Scale bar: 1000 µm.

parasitic infestations.Haematologically, there was significant (P<0.01, P<0.05) decrease in RBC, WBC, haemoglobin, PCV, thrombocytes and myelocytes population. But there was an increase in lymphocytes and monocytes, suggestive of chronic infestations.

Histologically, degenerative changes in gills, cloudy swelling, focal degeneration, fatty liver changes, diffuse tubular degenerative changes in kidney and increased white pulp with increased Melano-Macrophage Centres (MMC) was observed.



Female crustacean ecto-parasite, Lernanthropsis mugilii collected from mullet, Mugil cephalus. Scale bar : 5000 µm.



Male crustacean ecto-parasite, Lernanthropsis mugilii collected from mullet, Mugil cephalus. Scale bar : 1000 µm.



Female crustacean ecto-parasite, Caligus minimus collected from Asian seabass, Lates calcarifer. Scale bar : 1000 µm.



Male crustacean ecto-parasite, Caligus minimus collected from Asian seabass, Lates calcarifer. Scale bar : 500 µm.



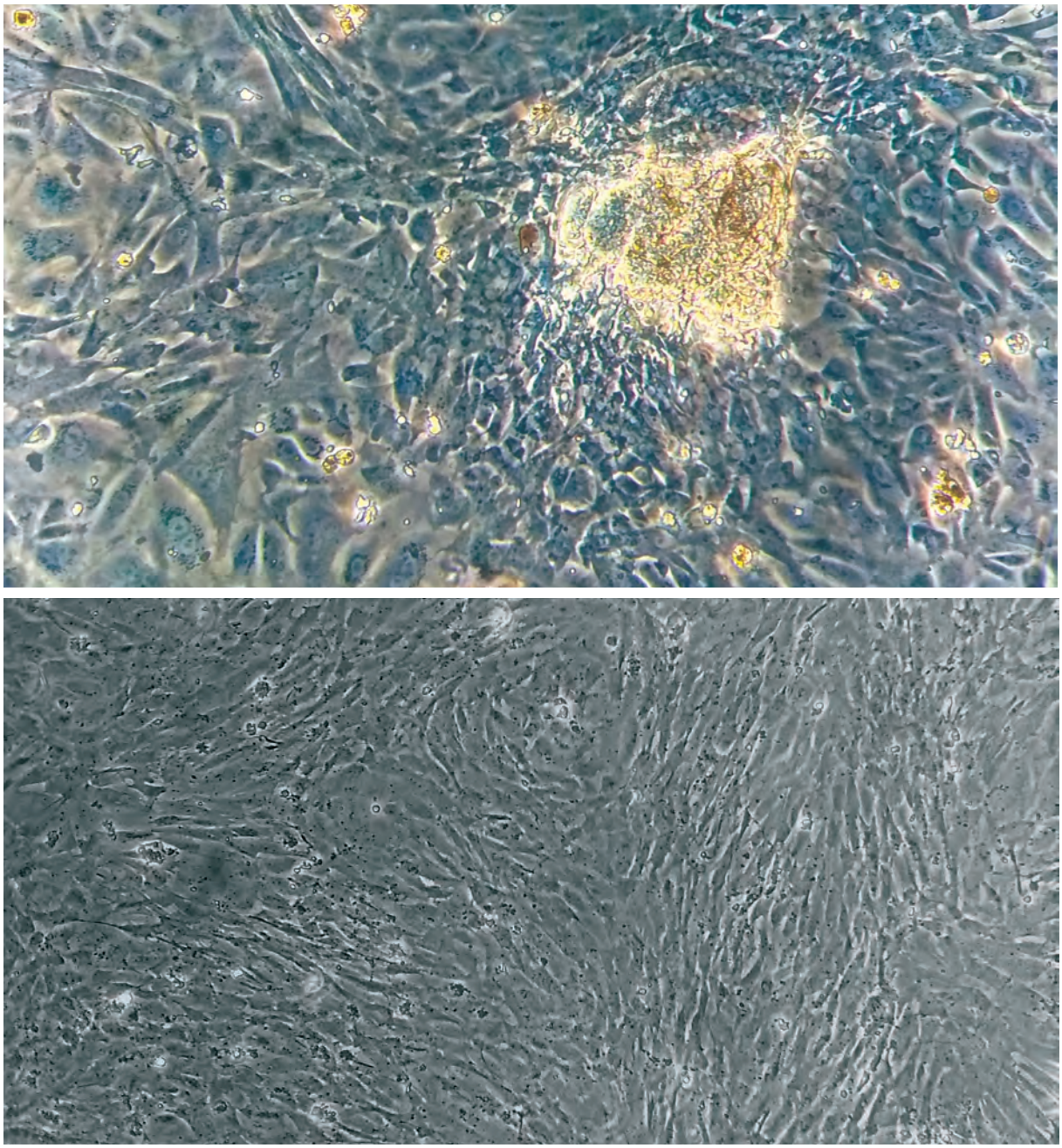
Leech, Zeylanicobdella spp. collected from Asian seabass, Lates calcarifer. Scale bar : 2000 µm.



Stalked barnacle, Octolasmis spp. collected from mud crab, Scylla serrata. Scale bar : 5000 µm.

PRIMARY CELL CULTURE OF MILK FISH

Milkfish (Chanos chanos) is a herbivorous euryhaline fish known for its relative resistance to disease and infections. Hence, it could serve as good model to study fish immune system, viral pathogenesis and preventive development such as vaccines. In the present work attempts were made to develop primary cell culture from fins, gills, spleen, kidney and brain tissues of milkfishusing L-15 medium and foetal bovine serum (FBS). The brain tissues developed a monolayer with 100% confluenceafter 12 days of incubation. On subsequent subculture of monolayer, the cell attachment and 100 % confluenceswas attained in 120 hours by five passages and 72-96 hrsby seven to ten passages. However, primary culture could not be developed with kidney, spleen, gill and fin tissue. EHP spores failed to be cultured in vertebrate cell lines



Development of primary cell cultures of milkfish brain in L-15 medium supplemented with foetal bovine serum

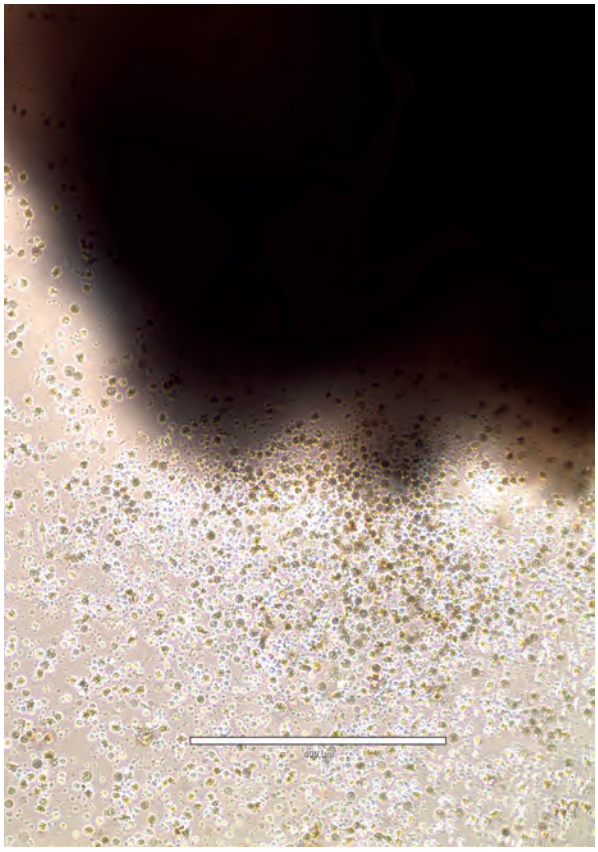
EHP has posed a serious threat to shrimp farming. To understand the pathogenesis and infectivity of EHP spores, its propagation was attempted in vertebrate (fish and mammal) cell lines. Striped snake head fish (SSN-1), and mammalian cell lines such as Vero and Madin-Darby canine kidney (MDCK) known to be susceptible for microsporidians were used to for EHP propagation. The two mammalian and fish cell lines inoculated with EHP-spores were intact without any cytopathology. Further, when second and third passages were tested, they were found negative for EHP by PCR, indicating that these cell lines were not suitable for propagation of EHP.

EHP SPORES FAILED TO BE CULTURED IN VERTEBRATE CELL LINES

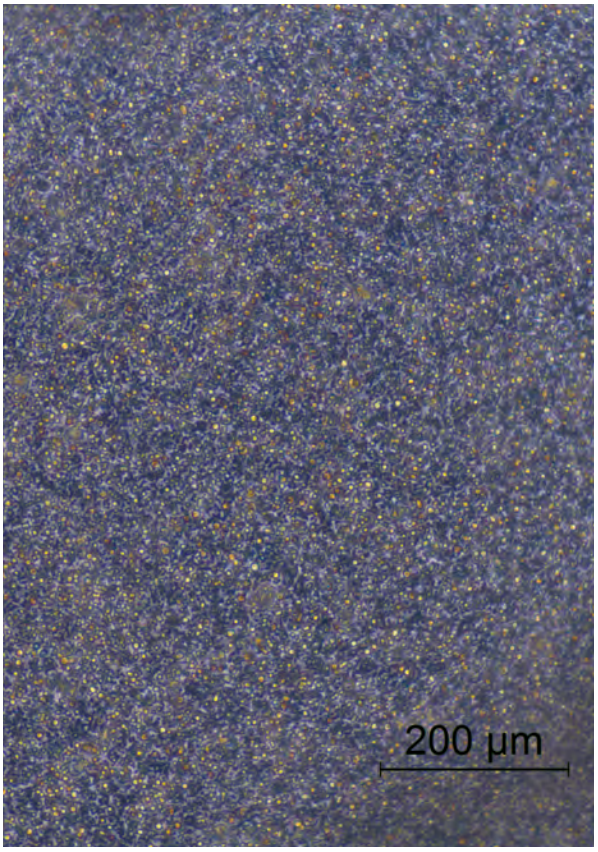
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DEVELOPMENT OF PRIMARY CELL CULTURE IN EDIBLE OYSTER, CRASSOSTREA MADRASENSIS

The explant culture from gill, mantle of Edible Oyster, Crassostrea madrasensis was carried out in L15 medium augmented with salt and incubated at 26 to 28 °C. Explant culture from both the organs showed the migration of epithelial cells at 24 h. The gill and mantle epithelial cells measured 13.82±2.04 µm and 13.04±2.12µm, respectively at 24h. Total 25 passages for mantle were successfully carried out. These explant cultures could be used for environmental toxicants and shrimp virus propagation studies.



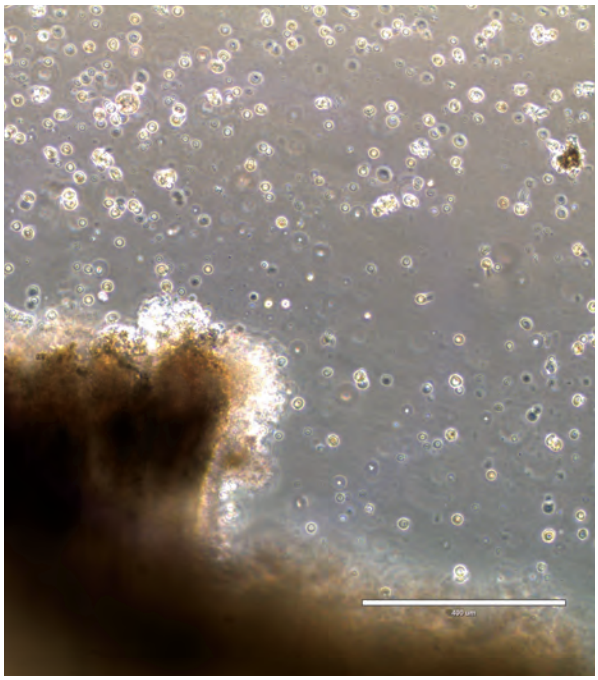
Explant culture (24 h) from mantle of edible oyster



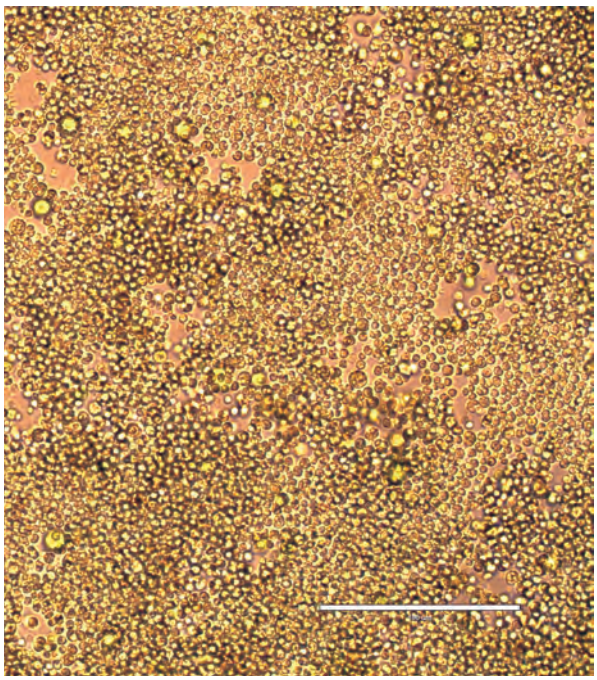
Primary cell culture (25th passage) from mantle of edible oyster

DEVELOPMENT OF PRIMARY CELL CULTURE INGREEN MUSSEL, PERNA VIRIDIS

The explant culture from mantle and gonads of Asian Green mussel, Perna viridis was carried out in L15 medium augmented with salt and incubated at 26 to 28 °C. Explant culture from both the organs showed the migration of cells at 24 h. The mantle and gonad cells measured 11.45±1.13µm, 13.17±2.77µm, respectively at 24 h. These explant cultures could be used for environmental toxicants and shrimp virus propagation studies. Five passages of gonad cells were successfully carried out.



Explant culture (24 h) from gonad of Green Mussel



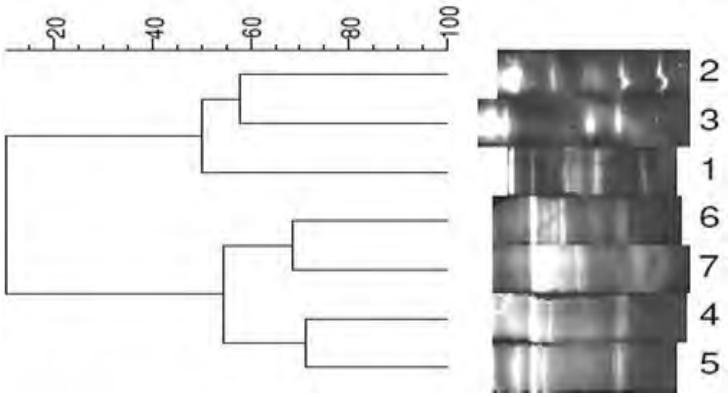
Primary cell culture (5th passage) from gonad of Green Mussel

STABLE COMMENSAL BACTERIAL ASSOCIATION FAVOURS HEALTHY LARVAL CYCLES IN MILKFISH AND ASIAN SEABASS

Commensal bacterial population protects fish larvae from the negative effects of pathogenic and opportunistic bacteria. Hence to understand the microbial dynamics, the larval production cycles of milkfish and seabass were investigated during 2017 and 2018 at fish hatchery facility at MES, CIBA. The bacterial quantification and characterisation were carried out in larvae and rearing water on 1, 4, 8, 12 and 18th day post hatching. The heterotrophic bacterial counts in the rearing water of milkfish were in the order of 103 cfu ml-1 and were stable throughout the cycle. However, in the seabass rearing systems the heterotrophic bacterial population were comparatively lower, unstable and of the order of 102 cfu ml-1 with a production loss at 14th day. The 16s PCR based DGGE profiles of milkfish and seabass larvae were also compared.The microbial characterisation in the seabass larval cycle revealed the presence of pathogenic and opportunistic vibrios such as V. vulnificus, V.chagasi, V.splendius. Non-opportunistic bacteria with high species diversity and stability were salient features of larval cycles of milkfish and productive cycles of seabass (Table). DGGE profiles of healthy and diseased cycles of seabass also revealed independent clustering of both cycles at 50% confidence interval in the neighbour joining tree (Fig). The study indicates that the non-opportunistic bacteria with high species diversity and stability in the early days of larval cycles inhibit the establishment of opportunistic and pathogenic bacteria.

Table. Bacterial isolates characterised biochemically from Milkfish and Asian seabass larval rearing system.

DOC	Milkfish larvae (Chanos chanos)	Asian seabass larvae (Lates calcarifer)
1(2017)	*V.littoralis, V.alginolyticus, V.calviensis, B. circulans*	*V.pectenicida, V.chagasii, V.littoralis, V.mimicus*
1(2018)	*V.alginolyticus, V.littoralis, V.metschnikovii, V.mimicus*	*V.littoralis, V.coralliilyticus*
4(2017)	*V.fisheri , B. circulans, V.littoralis, V.mimicus*	*V.vulnificus, V.mimicus, V.splendius, V.pectenicida, V.chagasii,V.rumoiensis*
4(2018)	*V.ponticus, V.alginolyticus, V.calviensis, V.littoralis*	*V. alginolyticus, V.proteolyticus, V. mimicus, V. pacinii,V.coralliilyticus*
8(2017)	*V.fisheri, V. hepatarius,V. superstes, B. circulans,B.polymyxa*	*V.vulnificus, V. calviensis, V.corallilyticus, V.chagasii*
8(2018)	*V.ponticus, V.alginolyticus, V.calviensis, V.littoralis,V.mimicus, V. proteolyticus*	*V.proteolyticus, V.coralliilyticus, V.littoralis, V.natriegenes, V. mytilli*
12(2017)	*V.alginolyticus, V.littoralis,*	*V.alginolyticus, V.chagasii, V.vulnificus*
12(2018)	*V.ruber, V.natriegenes, V.littoralis*	*V.coralliilyticus, V.littoralis, V.alginolyticus*
18(2017)	*V.alginolyticus, V.littoralis,V. hepatarius, V. superstes B.polymyxa, B. circulans, V. mytilli*	***Larval loss at 15th day***
18(2018)	*V.alginolyticus, V.ruber, V.natriegenes,* V.parahemolyticus, V.littoralis, V.fisheri	*V.cyclotrophius, V.littoralis, V.pacinii, V.coralliilyticus,V.proteolyticus, V.alginolyticus, V.pectenicida*



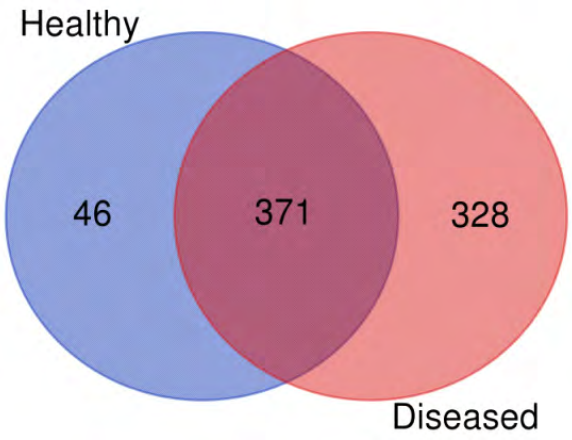
Microbial profiling of Milk fish and Asian seabass larvae using DGGE –PCR: 1,2,3 were DGGE profiles of 4,8,12 day old diseased seabass larvae, 4,5,6,7 were DGGE profiles of 4,8,12 and 18 day old milkfish larvae.

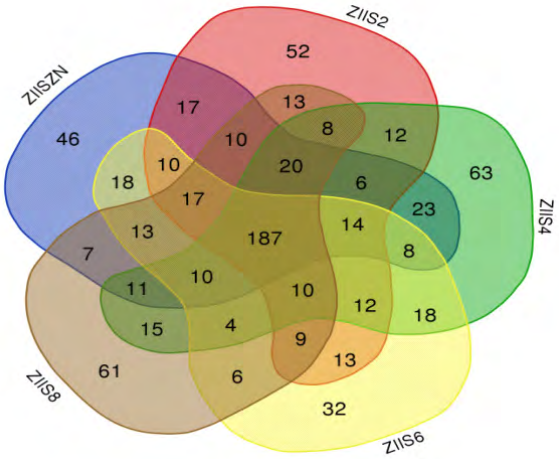
MICROBIAL PROFILING OF ZOEA SYNDROME

Zoea-2 syndrome has emerged as a serious threat to Indian shrimp hatcheries, especially after introduction of P. vannamei. It causes delayed molting or impairment of metamorphosis, followed by mass mortality at zoea II stage. Metagenomic study was conducted to figure out the etiology of the zoea-2 condition.Five samples namely, during the 2nd (ZIIS2), 4th (ZIIS4), 6th (ZIIS6) and the 8th (ZIIS8) day of syndrome and one healthy (ZIISZN) samplethat served as a control, were subjected to metagenomic analysis. Extracted DNA from these samples was sequenced on illumina platform and analysed using QIIME. The analyses revealed a significant microbial dysbiosis between healthy and diseased conditions. In total 49 phyla were identified, among which six were dominant, namely Proteobacteria, Firmicutes, Bacteroidetes, Actinobacteria, Planctomycetes, Cyanobacteria and which constitutes around 98.3% flora in all. In all the samples, Proteobacteria and Firmicuteswere found to constitute around 40% and 30%of the total microbial population respectively. Some of the phyla such as Proteobacteria, Firmicutes, Actinobacteria, Planctomycetes, Cyanobacteria, Chloroflexi, and Verrucomicrobia showed significantly lesser in abundance in diseased samples compared to healthy one. On the contrary, Bacteriodetes and Acidobacteria showed a considerable higher abundance in zoea syndrome affected samples.

Analysis of bacterial abundance at the genus level showed the presence of 745 genera out of which 187 were present in all the samples and 46, 52, 63, 32 and 61 were unique to ZIISZN, ZIIS2, ZIIS4, ZIIS6 and ZIIS8 samples respectively. Among core genera 16 were dominant and belonging to the phyla Proteobacteria, Firmicutes, Bacteroidetes, and Actinobacteria.

Some of the genera such Devosia, Unclassified Rhodobacteraceae, Nonlabens, Muricauda, Unclassified Flavobacteriaceae, Unclassified Flavobacteriales, and Pseudoalteromonas as were more abundant in zoea syndrome affected samples compared to the healthy larvae. There was no trend or pattern in the bacterial abundances with regard to dominant genera as the days of syndrome progressed. Overall, a total of 46 genera were seen specific to healthy, 328 specific to the syndrome and 371 genera common in both.





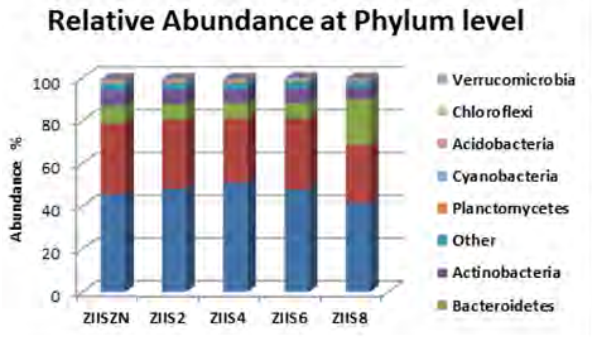
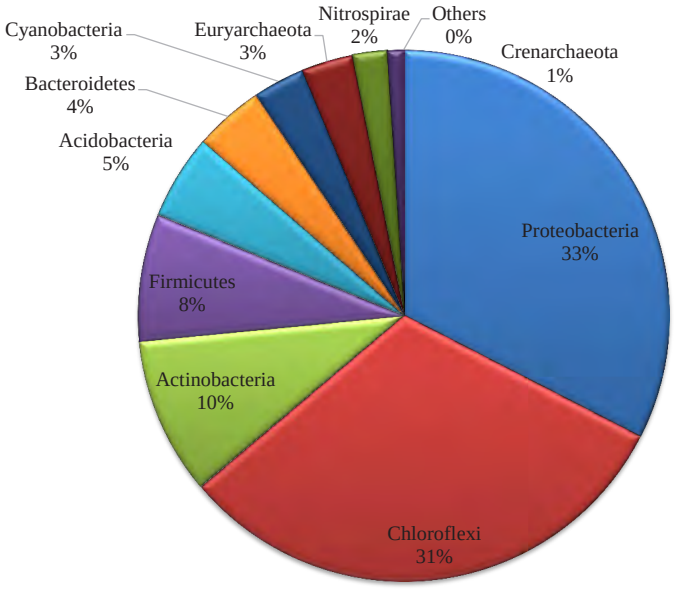


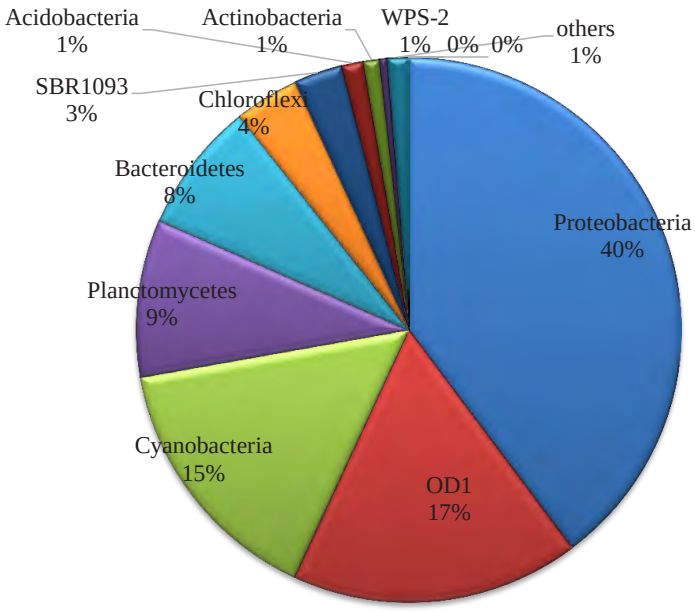
Fig: Bacterial abundance in zoea syndrome affected shrimp larvae at phylum level

MICROBIAL PROFILING OF CIBAMOX

CIBAMOX, a product of CIBA, developed for mitigation of nitrogenous wastes in aquaculture ponds was subjected to microbial profiling by 16s rDNA metagenomics. The analysis revealed several novel bacteria involved in nitrogen metabolism. From the sequence analysis it was observed that bacterial group belong to Caldilineaceae family were also dominant in ammonia oxidation besides Nitrosomonas and NitrobacterA large percentage of microbes identified in the AOB and NOB enrichments belonged to the phylum Proteobacteria, which are widely established in environments and play important roles in the process of nutrient cycling and mineralization of organic compounds.Nearly 62% of the sequences in these enrichments were found to be unclassified genera, which show that there might be novel microbial flora involved in ammonia oxidation or aiding ammonia oxidation process.



Microbial diversity in AOB consortia

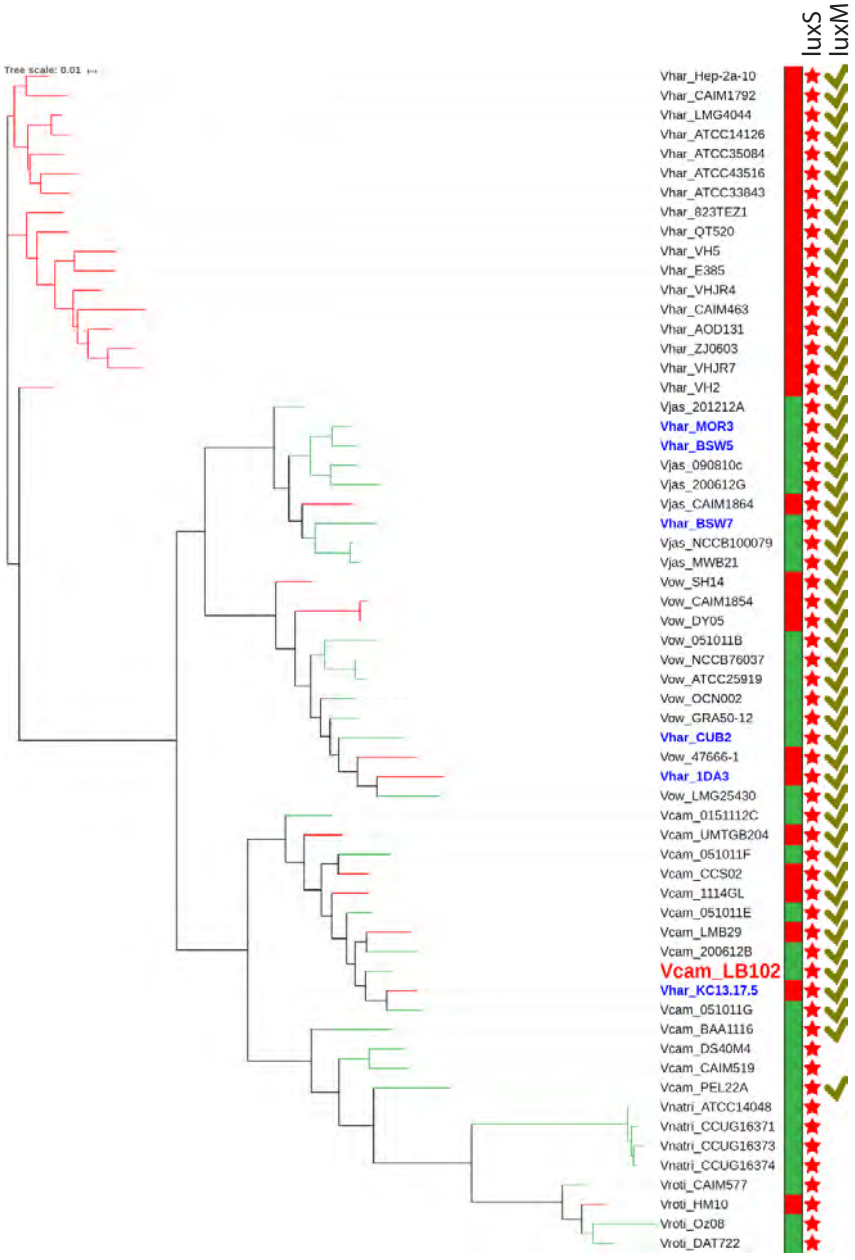


Microbial diversity in NOB consortia

BACTERIAL VIRULENCE

CHARACTERIZATION OF QUORUM SENSING SYSTEM IN VIBRIO HARVEYI CLADE SPECIES

Vibriosis is the major challenge in shrimp hatchery often leading to 100% mortality in mysis and early postlarval stages. For long it was considered that V. harveyi is the primary causative agent for luminescent vibriosis. However, the recent reports suggest that it is also caused by several other related bacterial pathogens such as V. campbellii, V. owensii, V. rotiferianus, V. jasicidawhich together form the part of Harveyi clade. To understand the virulence, quorum sensing system was characterised in sixty genomes of Vibrio harveyi clade (Table). The autoinducer 2 synthesizing luxS gene was present in all the isolates of V. harveyi clade. However, autoinducer 1 synthesizing gene luxM was present in V. harveyi, V. campbellii, V. jasicida and V. ovensiii but absent in V. natriegens and V. rotiferianus.Seeing, the differential conserved nature the luxM gene can be used for diagnostic purpose.

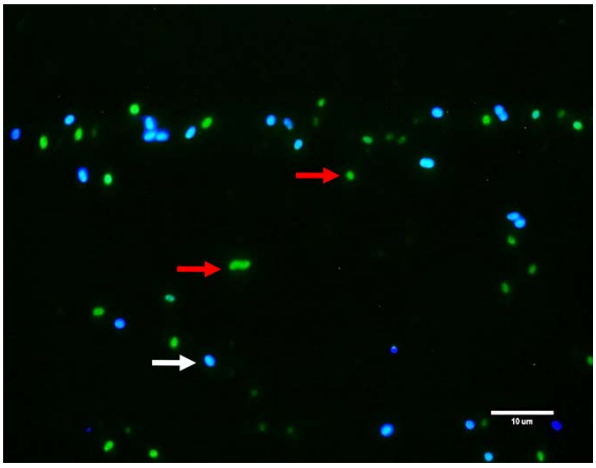


Distribution of quorum sensing genes in Vibrio species under Harveyi clade

DEVELOPMENT OF DIAGNOSTICS

RAPID DETECTION TECHNIQUE TO DIFFERENTIATE VIABLE AND DEAD EHP SPORE

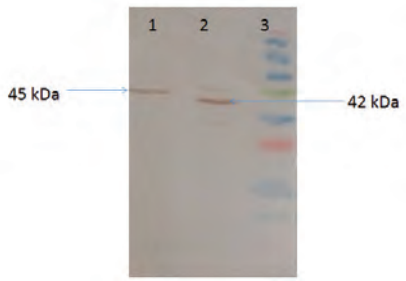
Purification of EHP spores are usually attempted by centrifugation step in different media using refrigerated centrifuge, which often render spore unsuitable for experimental infections. Hence, methods are required to ascertain the infectivity of the purified spores to assess the effect of treatments. The present study demonstrated a staining technique to assess the viability of EHP spores by combining the nucleic acid stain Sytox Green and the chitin binding stain Calcofluor White. These two stains were used to differentiate the live (freshly harvested) and dead (boiled) EHP spores. Dead spores were stained by Sytox Green and appeared yellow-green oval bodies through the blue (470-490 nm) excitation filter and white-yellow through violet filter (395-415 nm). The viable spores were stained by Calcofluor White which appeared as turquoise-blue through the violet filter (395-415 nm). This study demonstrated a staining technique to assess the viability of Enterocytozoon hepatopenaeimicrosporidian spores by combining the nucleic acid stain Sytox Green and the chitin binding stain Calcofluor White.



Fresh (live) and boiled (dead) spores of EHP stained with Sytox Green and Calcofluor White
[Note: When viewed through a blue filter (470-490 nm), live spores are not visible, while dead spores fluoresce yellow green; When the same area is viewed under a violet filter (395-415 nm), dual stained live spores as turquoise-blue ovals and dead spores appear as bright white-yellow ovals]

DEVELOPMENT OF INDIRECT SANDWICH ELISA FOR DETECTION OF BETANODAVIRUS

Viral nervous necrosis caused by betanodavirus results in 100% mortality in Asian seabass fry. The virus is transmitted both vertically and horizontally. Control of the disease is by using virus free broodstock and by stocking disease free seeds. Detection of the virus in the broodstock and the larval stages using a cost effective, high throughput test will help in controlling the disease. An indirect sandwich ELISA has been developed using rabbit polyclonal and mouse monoclonal antibodies against nervous necrosis virus. The monoclonal antibodies against the capsid protein of NNV was developed in collaboration with Centre for Bioseparation Technology, Vellore Institute of Technology, Vellore. The specificity of the antibodies to NNV was verified by western blot. An indirect sandwich ELISA was optimized by titrating the polyclonal capture antibody, monoclonal detection antibody and the conjugate by checker board titrations. The indirect sandwich ELISA had a sensitivity of 0.781 µg of antigen. The test can be employed to screen samples of brain from suspected fishes for the presence of NNV and to estimate the antigen content in the infected cell culture supernatants and vaccine preparations.

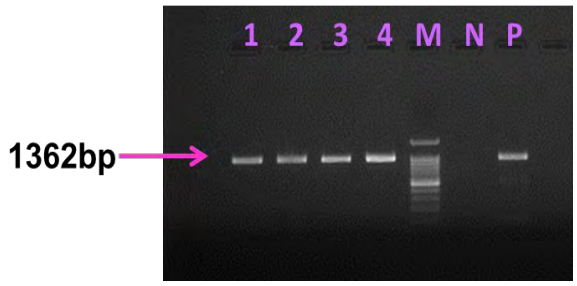


Lane 1 NNV Recombinant Protein
2 Inactivated NNV
3 Protein ladder

Western blot for NNV with MAb H5H2

DEVELOPMENT OF REAL TIME PCR ASSAY FOR DETECTION OF IRIDOVIRUS INFECTION IN FISH

Iridovirus is an emerging finfish pathogen in India. SYBR Green based real time PCR assay has been developed for detection of iridovirus with custom designed primers. The PCR products were cloned and the copy numbers determined using online tools and standard curve analysis that generated a linear range of 101–106 DNA copies. Melting curve analysis showed the specific target gene amplification. The detection limit of the assay was found to be as low as 10 copies.Amembrane cofactor protein(MCP) gene based PCR was also standardised with custom designed primers for detection of iridovirus. The phylogenetic analysis of sequences from the Indian isolate formed clade distinct from the isolates from China and Taiwan.



MCP gene based PCR for detection of iridovirus

FARM INPUTS USAGE PATTERN IN INDIAN SHRIMP CULTURE

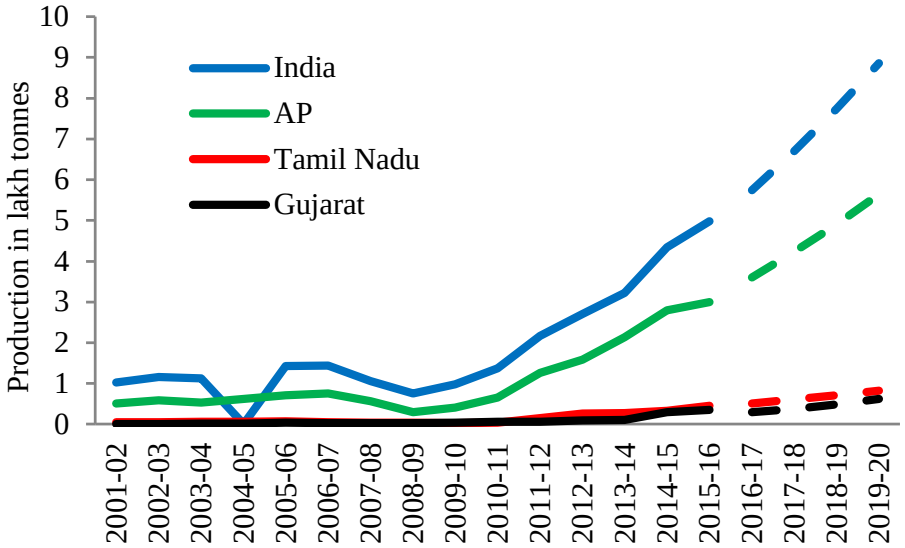
A number of inputs are used in shrimp farms presumably for enhancing productions and for various other purposes. A survey was conducted during 2017 to understand the input usage pattern inthe shrimp farms. The study was carried out in major shrimp producing states, Andhra Pradesh, Tamil Nadu, Gujarat and Maharashtra. The farm inputs were classified into five major groups based on application as disinfectants, probiotics, environmental modifiers, nutritional supplements, and anti-microbial. Quantity of the farm inputs used was determined per tonne of shrimp produced. The study showed use of environmental modifiers being used highest quantity to improve soil and water quality, followed by probiotics (water, soil and gut probiotics) and disinfectants. No record of use of anti-microbial product was observed during the study.

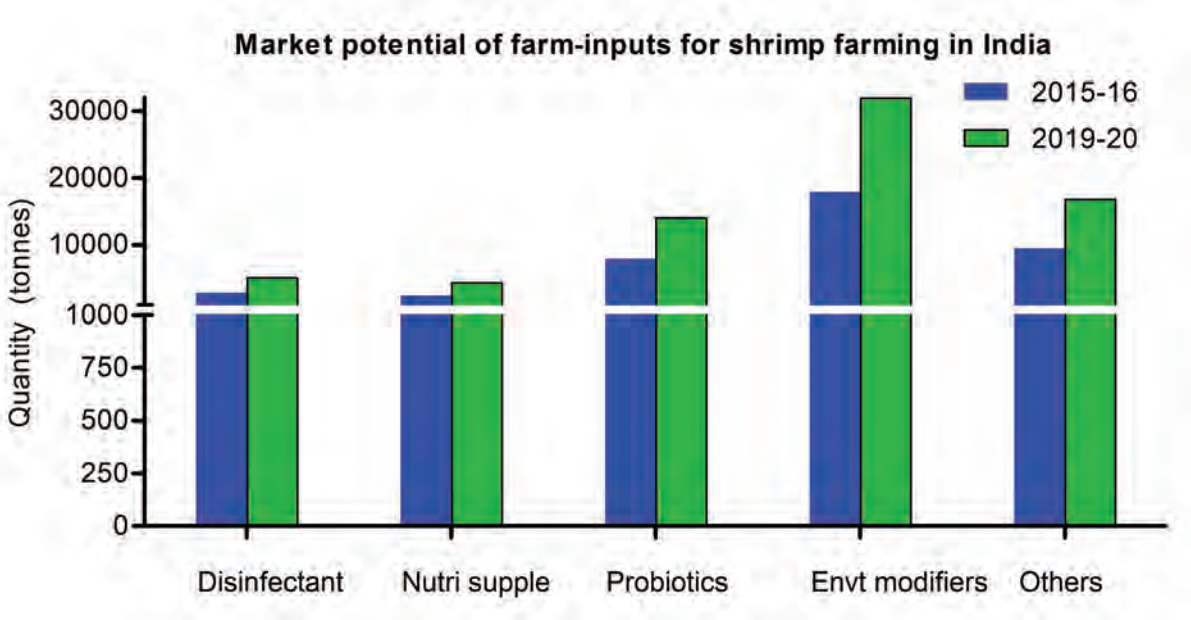
Table: Classification of farm inputs used for shrimp aquaculture in 2017 (kg ton-1 of shrimp production)

Farm inputs	TN	AP	Gujarat	Maharashtra
Disinfectants				
Oxidizing Agents	0.89	4.10	4.48	1.04
Detergents	3.13	1.88	4.20	6.76
Total	4.02	5.98	8.68	7.80
Probiotics				
Water Probiotics	7.75	2.95	7.25	8.35
soil Probiotics	6.13	17.06	5.18	4.99
Gut Probiotics	1.16	1.12	0.33	1.73
Total	15.04	21.13	12.75	15.07
Nutritional supplements				
Vitamins and Minerals	1.40	3.54	1.69	1.66
Binders	1.08	0.00	0.11	0.73
Total	2.49	3.53	1.80	2.39
Environmental modifiers				
Oxidising agents	5.74	0.00	2.85	0.00
Ammonia controlling agents	4.17	0.41	0.10	0.00
pH modifiers	0.43	3.00	3.20	0.00
Minerals	43.83	30.03	23.91	57.20
Total	54.17	33.44	30.07	57.20
Others				
Total	**11.36**	**24.97**	**0.12**	

MARKET POTENTIAL OF FARM INPUTS IN INDIAN SHRIMP CULTURE

Market potential of various farm inputs for shrimp production of India was estimated. Various parameters such as production, area and risk of environmental parameters, disease outbreaks for the years 2015-16 and 2018-19 were taken into account. Demand for disinfectants, probiotics, nutritional supplements and environmental modifiers for the four years from 2015-16 to 2018-19 was 2831, 7882, 2423 and 17919 tonnes respectively, whereas, forecasted demand for the year 2019-20 will be 31915 tonnes.





PROBIOTICS

MILK FISH CAN REDUCE THE BACTERIAL LOAD IN P. VANNAMEI CULTURE POND

The mucus of some species of fish including milkfish (Chanos chanos) is known to be antibacterial. The levels of total heterotrophic aerobic bacteria (THAB) and total Vibrio (TV) in pond water were monitored periodically in milk fish - vannamei co-culture pond water. Control ponds were stocked with only P. vannamei (40 Nossqm-1). Milk fish was stocked with two different stocking densities along with P. vannameiat 0.2 Nos sqm-1 and 0.4 Nossqm-1. Water samples were collected between 10:00 and 11:00 AM from three different locations in the pond, pooled and THAB and TV wereenumerated on tryptone soy agar (TSA) containing 1% NaCl (w/v) and thiosulfate citrate bile salt sucrose (TCBS) agar with 2% (w/v) NaCl, respectively. No significant difference in terms of level of THAB and TV was observed upto 80 DOC of culture period. However, at 100DOC, the level of THAB was found significantly higher ($p < 0.05$) in the control ponds (only vannamei) in comparison with milk fish vannamei co-culture. At DOC 100, the total Vibrio level was found higher in control group in comparison to two groups culturing milk fish, but significant difference was not observed ($p < 0.05$). No significant difference was observed while considering the average bacterial load throughout the culture period both in case of THAB and TV among different experiment group. The present study showed that the introduction of milk fish helps in reduction of bacterial load in the shrimp culture ponds.

Table.Microbial counts during milk fish-vannamei co-culture

Duration of culture (Days)	THAB Log10 CFU ml-1 (Mean ± SE)			TV Log10 CFU ml-1 (Mean ± SE)		
	A	B	C	A	B	C
DOC 0	3.630 ± 0.182	3.460 ± 0.194	3.358 ± 0.174	2.649 ± 0.036	2.720 ± 0.399	2.820 ± 0.322
DOC 20	4.387 ± 0.093	4.347 ± 0.041	4.428 ± 0.522	3.255 ± 0.105	3.199 ± 0.175	3.173 ± 0.188
DOC 40	4.911 ± 0.790	4.721 ± 0.152	4.974 ± 0.396	3.563 ± 0.033	3.711 ± 0.068	3.568 ± 0.539
DOC 60	4.929 ± 0.394	4.594 ± 0.171	4.498 ± 0.027	3.170 ± 0.159	3.112 ± 0.104	3.176 ± 0.141
DOC 80	4.716 ± 0.422	4.636 ± 0.089	4.793 ± 0.382	3.277 ± 0.310	3.134 ± 0.155	3.245 ± 0.200
DOC 100	5.491 ± 0.036[a]	4.635 ± 0.216[b]	4.652 ± 0.183[b]	4.066 ± 0.394	3.680 ± 0.226	3.613 ± 0.113
Average during culture	4.677 ± 0.252	4.399 ± 0.024	4.450 ± 0.172	3.330 ± 0.102	3.259 ± 0.144	3.266 ± 0.173

$p < 0.05$

A = Control (Only P. vannamei 40 Nos./sq.m.

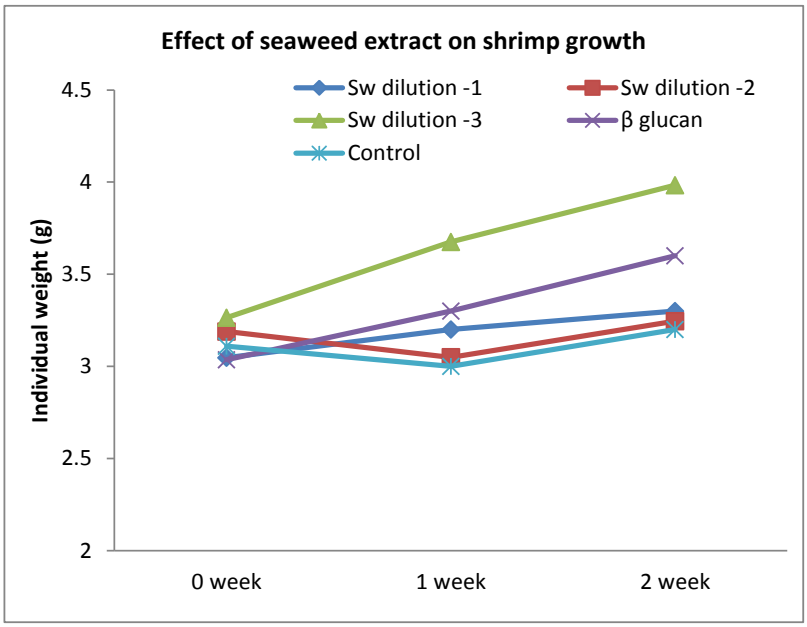
B = P vannamei (40 Nos./sq.m.) and Milk fish (0.2 No./sq.m.)

C = P. vannamei (40 Nos./sq.m.) and Milk fish (0.4 No./sq.m.)

APPLICATION OF BROWNSEAWEED EXTRACT AS GROWTH PROMOTOR FOR SHRIMP

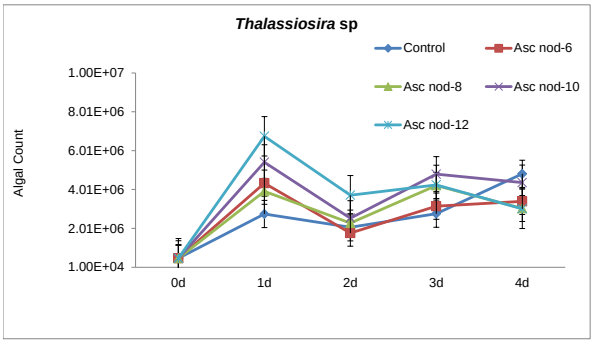
Brown seaweed (Ascophyllumnodosum)extract was used as immunostimulant and growth promoter for shrimp juvenile and growth enhancer for micro algae.

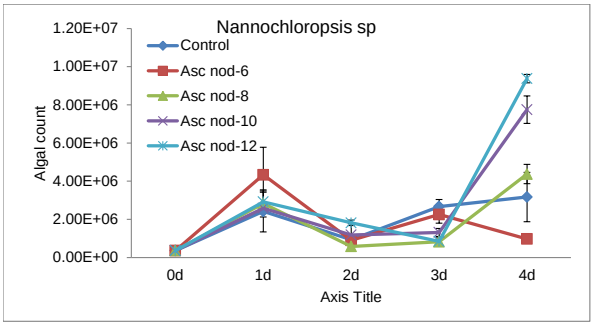
Crude extract of brown seaweed, was fed to shrimp (3.57±0.11) by feed-top dressing. The shrimp fed with the micro algal preparation registered improved growth by 20% in a span of two weeks at three-fold dilution. However, at higher concentration, the extract was having negative effect on growth and survival.



APPLICATION OF BROWN SEAWEED EXTRACT AS ALGAL GROWTH ENHANCER

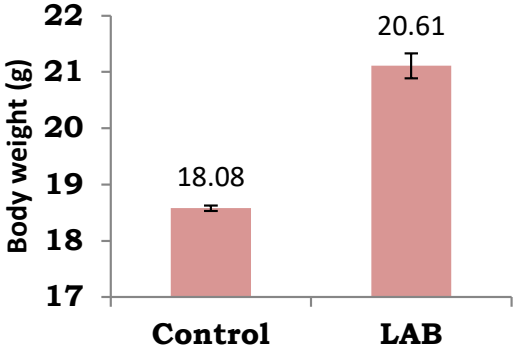
Thalassiosira sp and Nanochloropsis sp were used for studying the influence of seaweed extract on the growthof these algae.The brownseaweed extract was incorporatedin the microalgal culture media at different dilutions before inoculation. The study confirmed growth promotion activity of the seaweed extract in improving the algal cell density in short span of time. Thalassiosira sp recorded rapid increase in the cell density (100 fold in one day) however a rapid decline was observed in the cell density subsequently. The growth ofNanochloropsis sp recorded a gradual increase until four days except for highest concentration of the extract which caused reduction in cell density after one day. In both the cases, 10-12 concentration of the crude extract showed highest growth promotion activity.



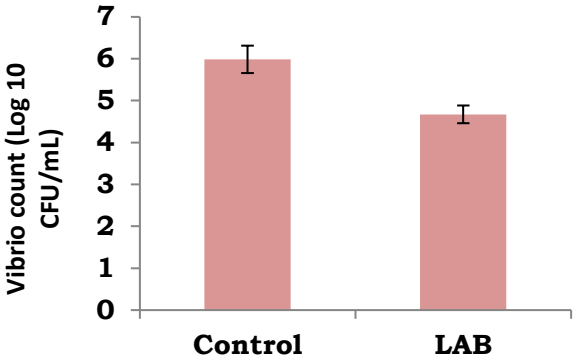


IMPROVED GROWTH PERFORMANCE AND SURVIVAL OF PENAEUS VANNAMEI WITH FEED SUPPLEMENTED WITH LACTIC ACID BACTERIA (LAB)

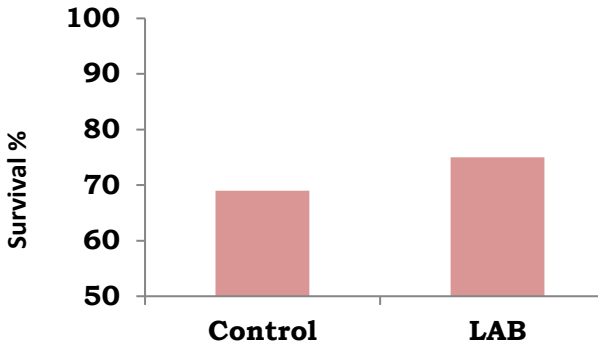
Different species of lactic acid bacteria (LAB) are known to have beneficial effect as gut probiotics and successfully used in shrimp culture in different countries.A feeding trial was conducted onP. vannamei(5.5 to 7 g) with feed supplemented with two isolates of lactic acid bacteria (LAB) viz.,Lactococcus lactis subsp. lactis SDKRC-5 (isolated from home-made curd)and Lactobacillus isolate (SDKRC-6) (isolated from gut of wild shrimp P. indicus) at the level of 107 CFU g-1 of feed. These two isolates were previously selected on the basis of maximum inhibitory potential against V. parahaemolyticus. After 63 days of feeding trial, the LAB supplemented feed yielded 14% higher growth over the control. The survival in the LAB supplemented and control group were 93.3 and 83.3 %, respectively.A challenge trial was conducted on juvenile P. vannamei with virulent V.campbelli strain (106 CFU l/M injection). After 8 days of challenge, the survival in treatment and control groups was 75 and 68.97 %, respectively. The Vibriocounts in the gut ofshrimp was significantly lower ($p<0.05$) in case of LAB treated group (4.671 ± 0.209 Log10 CFUg-1) as compared to control (5.987 ± 0.327 Log10 CFUg-1). The study showed that incorporation of two selected isolates of LAB aids in enhanced growth performance and survival of shrimp and also tolerant to challenge with virulent Vibrios.



Growth of P. vannamei fed with LAB incorporated feed after 63 days of culture



Vibrio count in gut of P. vannamei fed with LAB incorporated feed

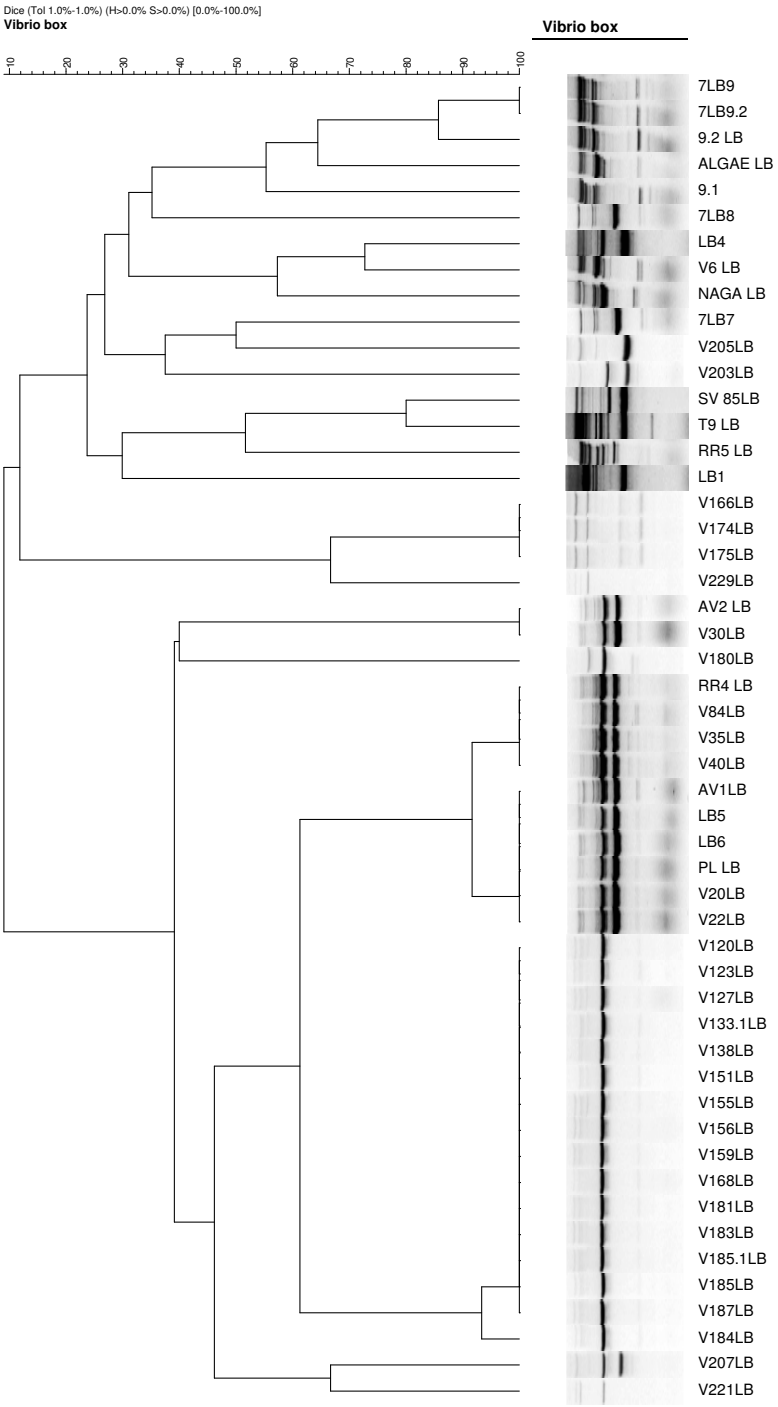


Survival in P. vannamei after challenge with V. campbellii

PROPHYLACTICS

BIOCONTROL OF VIBRIOS IN SHRIMP HATCHERIES USING BACTERIOPHAGES

New luminescent bacteria and bacteriophages were isolated from shrimp hatcheries were studied for their susceptibility/host range. During the field trials, fresh luminescent Vibrios (47 isolates) and corresponding bacteriophages (36nos) were isolated. Using BOX PCR,these luminescent Vibrios segregated into 17 groups at 60% hierarchical level.

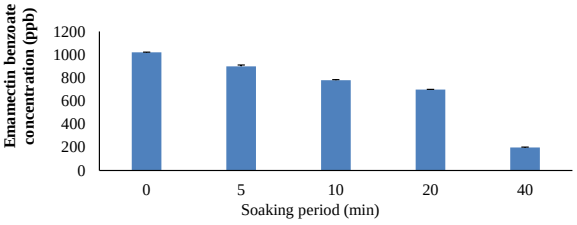


Diversity of luminscent Vibrios by BOX PCR

THERAPEUTICS

EMAMECTIN BENZOATE EFFECTIVE AGAINST CRUSTACEAN PARASITIC INFESTATION IN ASIAN SEABASS

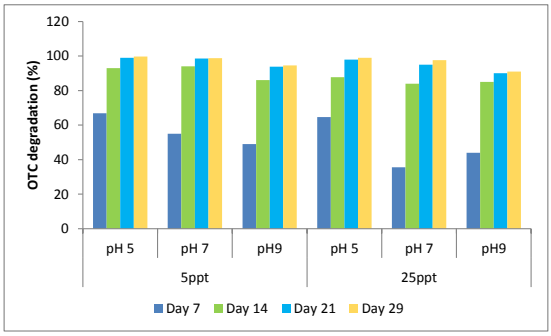
Finfish stocks often suffer parasitic infestation during captivity and culture. An experiment was conducted to assess the efficacy of emamectin benzoate (EB) against Caligus minimus infestation in Asian seabass. Proposed therapeutic treatment regimen of 50µg of EB kg-1 fish BW d−1 for 7 d was administered through feed. Significant improvement in survival (92%), reduction in parasitic load and improvement in haematological parameters were observed after fifth day of treatment. No parasite could be recovered on and after 7th day of treatment. In addition, leaching effect of EB was also determined at different time intervals by QTRAP 4000 LC-MS/MS analysis. It was found that there was 6.25 fold decreases in EB level after soaking the top-dressed feed in water for 40 minutes.



Withdrawal of emanectin benzoate (EB) from feed coated with 1250 ppb

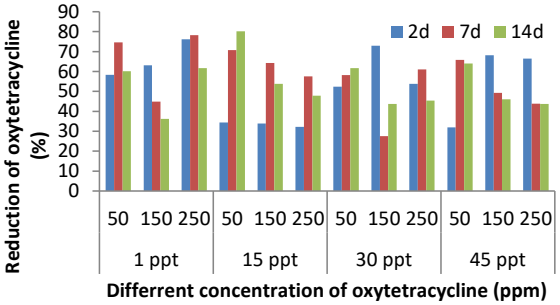
INFLUENCE OF PH ON OTC DEGRADATION UNDER VARYING SALINITIES

Oxytetracycline (OTC) is one of the few antimicrobials approved by the USFDA for use in aquaculture. Persistence of such antibiotics in the environment is an important issue and needs to be understood with regard to environmental characteristics. Influence of pH (5, 7 and 9) and salinity (5, 25 ppt) on OTC degradation at two different concentration of OTC (5 and 10 ppm) was studied. The yard experiment was conducted in 6 L plastic containers with 500 gm of soil and 5 L water mixed with 5 or 10 ppm of OTC. Water samples were collected periodically and the concentration of OTC was determined using LCMS/MS. It was observed that the degradation of OTC was faster in lower pH compared to higher pH irrespective of the salinity. The observed variation in the rate of degradation could be attributed to the chemical nature of the drug under different pH conditions. These results of the study suggest the role of pH in the degradation of OTC in brackishwater farming conditions.



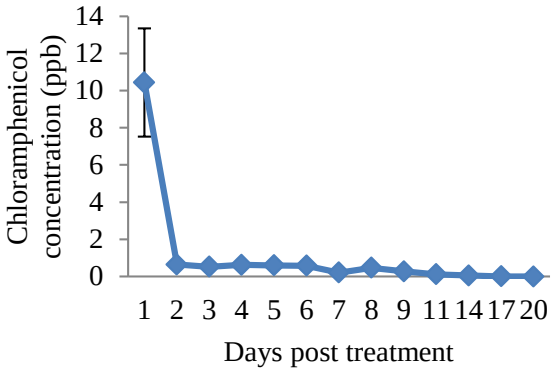
EVALUATION OF PLEUROTUS SP EDIBLE MUSHROOM ON DEGRADATION OF OXYTETRACYCLINE

The Pleurotus sp an edible mushroom was evaluated for the degradation of OTC. The experiment was conducted in vitro in different salinities (1, 15, 30 and 45 ppt) with soil base at three different concentrations of OTC (50, 150 and 250ppm) and treated with P. ostreatus with fungal load of 104 CFU ml -1 . The suspended water samples were collected at periodic intervals on 2, 7 and 14 days after treatment and estimated for antibiotic in treatment and control. It was found that the Pleurotus species degraded the OTC at all salinities.



WITHDRAWAL OF CHLORAMPHENICOL IN SHRIMP MUSCLE TISSUE

Withdrawal period of chloramphenicol in Penaeus vannamei(8 g) was studied by feeding commercially available feed coated with chloramphenicol at the dose of 500 mg kg-1 feed for 7 days. Concentration of the antibiotic in muscle tissue was determined by LCMS/MS. Concentration of chloramphenicol in the muscle tissues dropped drastically within two days (0.64±0.08 ppm)of stopping feeding shrimp with antibiotic fortified feed and complete elimination of the antibiotic was observed at 20 days post cessation of antibiotic treatment.



SERVICES TO THE SECTOR

NATIONAL REFERRAL LABORATORY FOR BRACKISHWATER AQUATIC ANIMAL DISEASES

CIBA's Aquatic Animal Health and Environment Division is serving as National Referral Laboratory for brackishwater aquatic animal diseases (NRLD) and serving the stakeholders including Aquatic Quarantine and Certification Services (AQCS), Southern region, Aquatic Quarantine Facility (AQF), Chennai, shrimp hatcheries and shrimp farmers. During April 2018 to March 2019, a total of 63 samples including imported Artemia cyst, frozen tissue and feed samples were tested for OIE listed shrimp and fish pathogens for the AQCS, Chennai. All the samples were tested negative for OIE listed pathogens.

Screening of samples for OIE listed pathogens

Sl.No.	Sample	No Tested	DNA viruses		RNA viruses			Bacteria		Parasite
			WSSV	IHHNV	IMNV	TSV	YHV	AHPND	NHPB	EHP
1	Prawn frozen feed	2	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
2	Imported Artemia cyst	59	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
3	Sea fish (Gallons)	1	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
4	Semi-moist feed	1	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
5	Total samples Tested	63	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve

NUTRITION AND FEED TECHNOLOGY

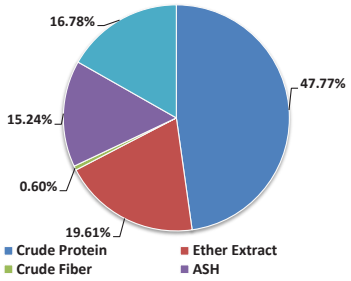
In any aquaculture, feed and its management cost often range from 40 to 60 % of the cost of production and a key factor in determining the profitability to the farmer. India's aqua feed sector was more vibrant with current production around 2 million metric tons of feed, and it is expected to grow further. Our dependency on overseas companies for the hatchery feeds is expensive recurring cost. Envisaging these situations, CIBA's nutrition research focus more on issues directly applicable to the stakeholders such as cost-effective grow-out feeds, indigenous hatchery feed technology, live feed, feed management options considering natural feeds etc.



Conversion of fish waste to Plankton^{Plus}

CONVERSION OF FISH PROCESSING WASTE (TRIMMINGS) TO VALUABLE PRODUCTS FOR USE IN AQUACULTURE (PLANKTON ^{PLUS}) AND HORTICULTURE HORTI ^{PLUS})

Fish trimmings represents 25-50% the total fish/ shrimp while processing for human consumption. Due to lack of proper disposal of the waste from the fish industry and fish market it creates sanitary and environmental problems. **An effort was put by CIBA to convert this processing waste to a more valuable products under the "Swachh Bharat" mission. A liquid product developed was branded as Plankton^{Plus}, which can be used for boosting plankton in aquaculture pond or as ingredients for feed formulation. The residual solid product can be as manure (Horti ^{plus}) for agriculture/horticulture crops. Plankton^{Plus}** has been tested for its efficiency in boosting phytoplankton and zooplankton. Its effect on growth performance in fish and shellfish showed promising results.



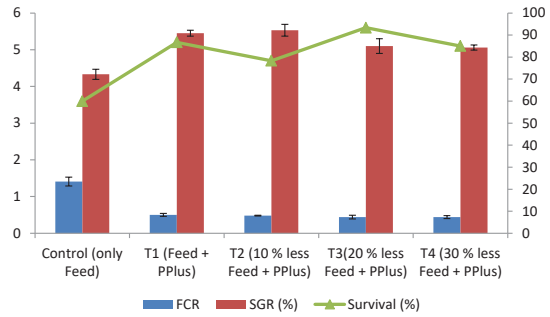
Proximate composition of Plankton^{Plus}

NUTRIENT PROFILE OF PLANKTON^{PLUS}

The Plankton ^{Plus} has protein content of 47-49% and lipid of 20-22% and is rich in lysine, cysteine, histidine, glutamic acid, docosa hexaenoic acid and eicosa pentaenoic acid. It is also a high source of calcium (Ca-4.03%), phosphorous (P-1.43%) and iron (Fe-3.54 %).

STUDY ON THE POTENTIAL OF PLANKTON^{PLUS} ON REDUCTION OF FEED REQUIREMENT IN P. VANNAMEI

A 45 days outdoor experiment was conducted to study the potential of Plankton^{Plus} on reduction of feed requirement in *Penaeus vannamei* culture without any water exchange. There was five treatments in the experiment; Control (only feed), T1 (Feed + PPlus), T2 (10 % less Feed + PPlus), T3 (20 % less Feed + PPlus), T4 (30 % less Feed + PPlus).The experiment revealed that **Plankton^{Plus} supplementation @20 ppm significantly (P<0.01) increased the average daily gain (ADG), specific growth rate (SGR), total biomass gain and survival of *P. vannamei* even when significantly less feed was offered**. Irrespective of dosages, a clear dominance of beneficial microalgae, *Isochrysis galbana* was noticed in all Plankton^{Plus} supplemented tanks. Weight gain was maximum when Plankton^{Plus}@20 ppm was

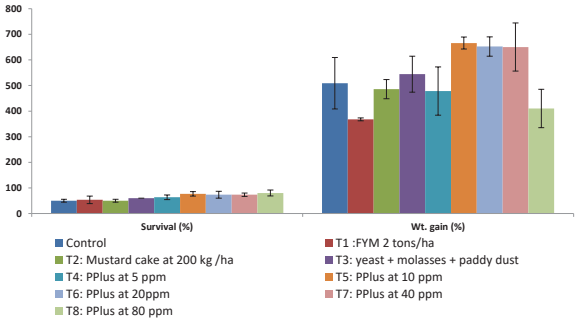


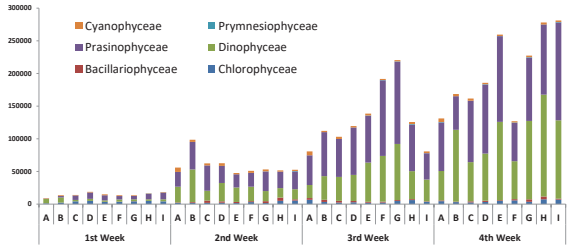
Effect of Plankton ^{Plus} supplemenation on growth, survival and feed utilization efficient in P. vannamei

supplemented without any reduction of feed quantity.

STUDY ON EFFECT OF PLANKTONPLUS APPLICATION ON PLANKTON STATUS AND GROWTH PERFORMANCE OF PEANEUS INDICUS IN TANK REARING SYSTEM

Effect of Plankton^{Plus} (PPlus) supplementation at different dose (5, 10, 20, 40, & 80 ppm) on plankton status and growth performance of *Penaeus indicus* (ABW 0.32±0.01g) was studied and compared with other conventionally used materials (Cattle manure 20 g/100 L, Mustard cake 2 g/100 L, Juice prepared with fermentation of yeast 0.04 g+ molasses 0.3 g+ paddy dust 0.6 g / 100 L) for boosting plankton in tank rearing system. Weight gain and survival of shrimp was found to be higher in Plankton^{Plus} supplemented (10, 20 & 40 ppm) groups. **Prasinophyceae group of phytoplankton (*Tetraselmis* sp and *Halosphaera*



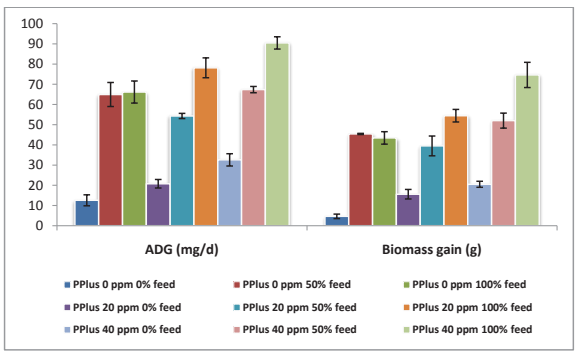


Number of cells of microalgae groups in PPlus tanks

sp) dominated in Plankton^{Plus} supplemented groups and abundance was increasing with increased concentrations of Plankton^{Plus}. Cyanobacterial percentage was invariably less in all Plankton^{Plus} supplemented tanks.

POTENTIAL OF PLANKTONPLUS ON REDUCTION OF FEED REQUIREMENT IN FISH

A 45 days outdoor experiment was conducted to study the potential of Plankton^{Plus} on reduction of feed requirement in milk fish (Chanoschanos) culture without any water exchange. The experiment was



Growth performance of Chanos chanos at different level of PPlus and feed supplementation

conducted in 3^2 factorial design where, factor 1 was Plankton^{Plus} supplementation (at three levels 0, 20 and 40 ppm) and factor 2 was feed supplementation (at three levels 0, 50 and 100 %). Study revealed that at both 20 and 40 ppm Plankton^{Plus} supplementation with 50 % feed expressed similar average daily gain (ADG), specific growth rate (SGR), and biomass gain in *Chanos chanos* when compared with group received 100% feed but without Plankton^{Plus} supplementation. There was clear dominance of microalgae like *Isochrysis* sp, *Chlorella* sp, *Tetraselmis* sp, *Nitzschia* sp etc in Plankton^{Plus} supplemented tanks and chain Blue Green Algae (BGA) was negligible. Therefore, it can be concluded that Plankton^{Plus} supplementation either @ 20 and 40 ppm can save 50 % of feed without affecting growth performance and survival of *Chanos chanos*.

FISH WASTE HYDROLYSATE RESIDUE (HORTI ^{PLUS}) AS MANURE FOR HORTICULTURE CROPS

The powdered form of fish waste hydrolysate residue was used as a manure and branded as Horti ^{plus}. Performance of Horti ^{plus} was tested in a pot experiment to determine its efficiency on the yield of vegetable crops, ladies finger (*Abelmoschus esculentus*) and brinjal (*Solanum melongena*). The treatments chosen for the study were Control i.e., Farm Yard Manure (FYM) @ 2t/ha, Horti plus @ 0.2 t/ha, Horti ^{plus} @ 2 t/ha, Horti ^{plus} @ 20 t/ha, FYM @ 2t/ha + Horti ^{plus} @ 2t/ha (mixed dose). **Higher yield of brinjal was found when Horti ^{plus} was applied @2t/ha. Yield of ladies finger was higher when Horti ^{plus} @2 t/ha along with FYM @ 2 t/ha**

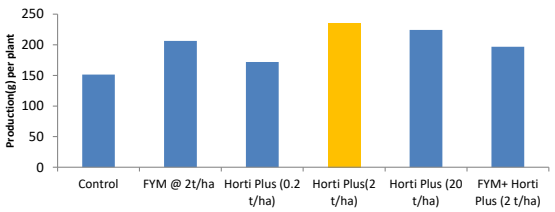


Fig : Effect of Horti^{Plus} on production of brinjal

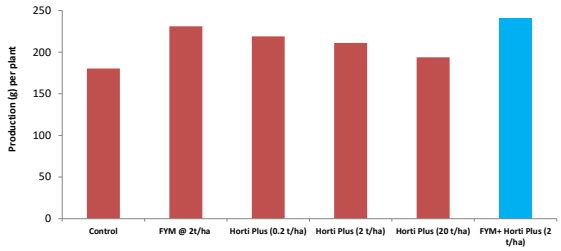
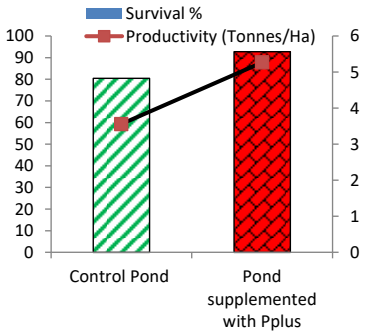


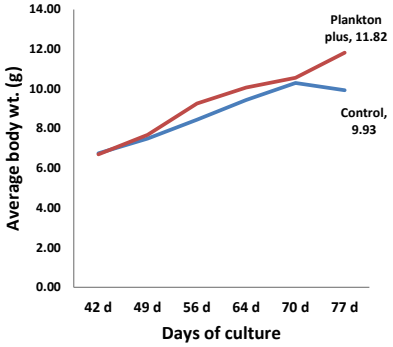
Fig : Effect of Horti^{Plus} on production of ladies finger

was used. Study revealed potential of Horti ^{plus} as promising manure to be used for raising horticulture crops.

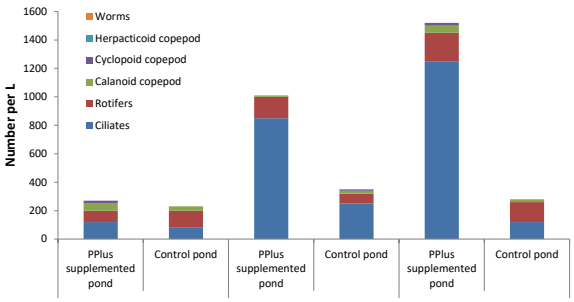
PLANKTONPLUS AS COST EFFECTIVE PLANKTON BOOSTER – A DEMONSTRATION IN FARMERS POND

A 77 days trial was conducted in shrimp (*Penaeus vannamei)* ponds at Bapatla, Andhra Pradesh, India to study the effect of Plankton Plus (PPlus) on augmenting plankton in shrimp culture pond. PPlus was supplemented @ 10 ppm in split doses. Control ponds were supplemented with rice bran-yeast-mollases juice and dolomite as and when required to maintain the bloom and water quality. At the end of the culture period, average weight of shrimp was higher (11.82 g) in pond supplemented with PPlus compared to control (9. 93 g). **There was a significant increase (12.31%) in survival, and enhancement of yield to the tune of 1.71 t/ha in pond supplemented with Plankton ^{Plus} compared to control. Plankton ^{Plus} supplemented ponds were dominated by beneficial microalgae (Bacillariophyceae, Prasinophyceae and Dinophyceae etc.) and zooplankton. Enhanced growth performance of *Penaeus vannamei* might**

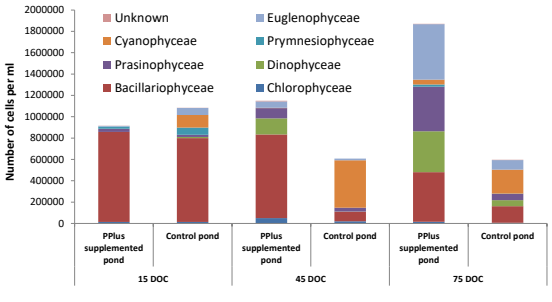




Healthy looking shrimps from farmers pond where PPlus was used



Status of Zooplankton in shrimp culture pond supplemented with Plankton Plus



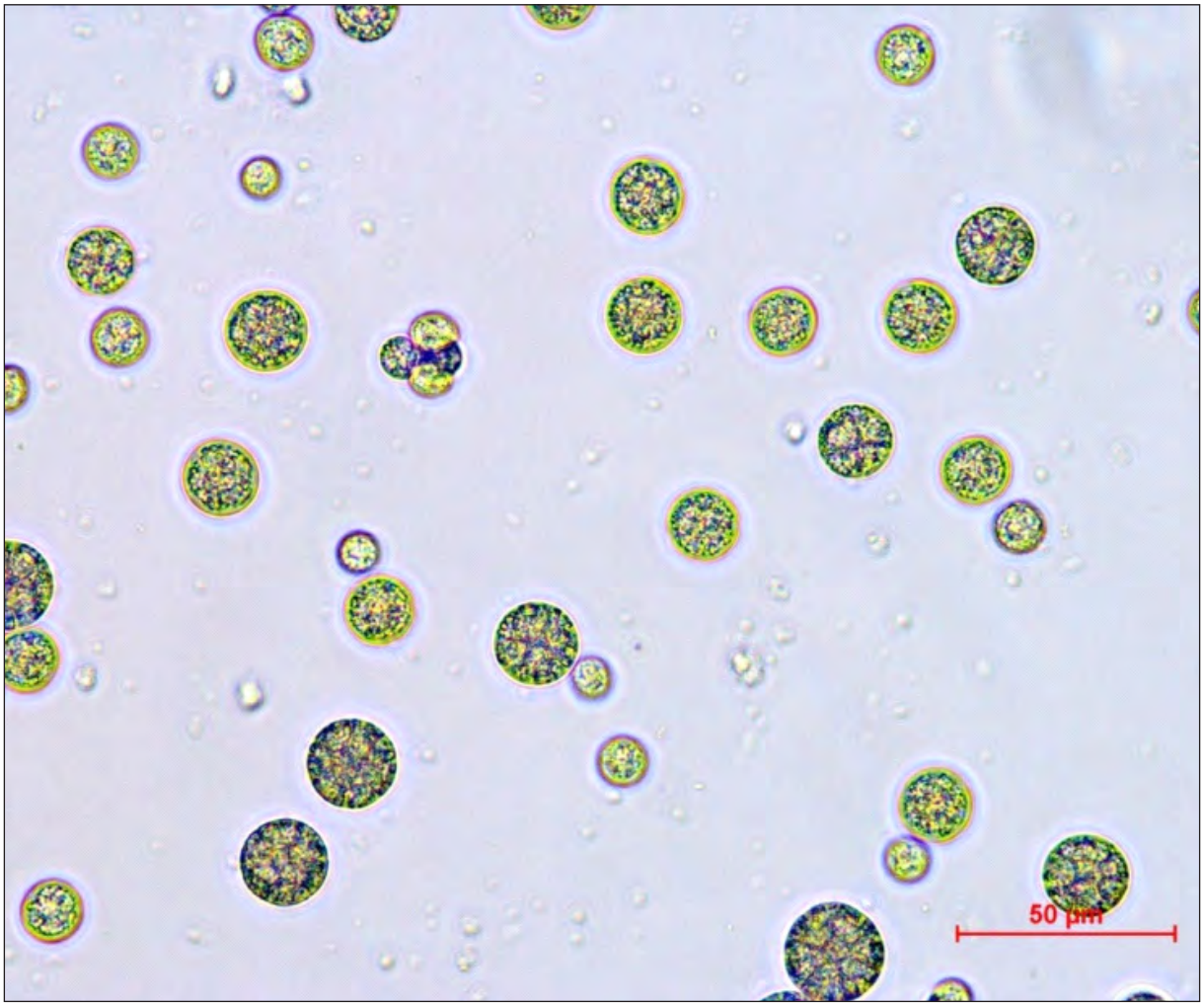
Status of Phytoplankton in shrimp culture pond supplemented with Plankton Plus

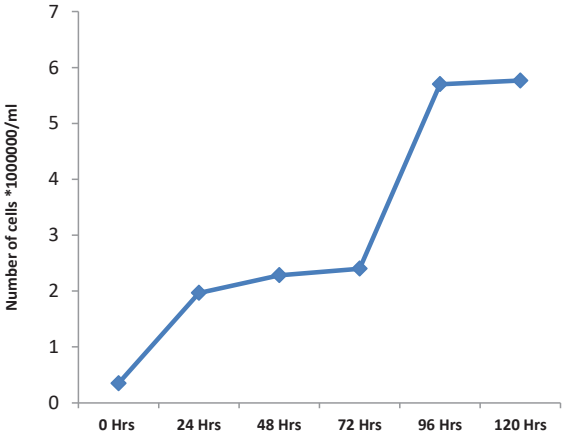
be due to the augmented density and diversity of phytoplankton and zooplankton in the Plankton ^{Plus} supplemented ponds.

LIVE FEED

PUFA ENRICHMENT IN ARTEMIA USING PROTIST, THRAUSTOCHYTRIDS: A NUTRITIONAL SOLUTION FOR MAXIMUM SURVIVAL AND GROWTH OF LARVAL FINFISH AND SHELLFISH

Thraustochytrids are osmoheterotrophic, oleaginous, eukaryotic, unicellular monocentric fungi-like protists. Thraustochytrids are one of the potential and richest sources of PUFA. Thraustochytrid isolate (*Aurantiochytrium* sp) was (Isolate from CUSAT, Cochin) developed in mass scale and evaluated its potential to culture and enrich artemia and rotifers (Lipid: 43.7 %, Protein 37.7% and DHA 40% of total fatty acids). Significant differences were observed in survival and growth of artemia fed with live and lyophilized *Aurantiochytrium* sp. **Average growth (total length 11 mm) and survival (97%) was maximum in artemia fed with microalgae Nannochloropsis along with 250 mg lyophilized *Aurantiochytrium* sp**.. Study revealed the prospective use of new isolates of Thraustochytrids in aquaculture nutrition.





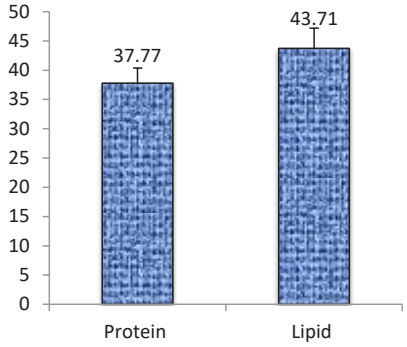
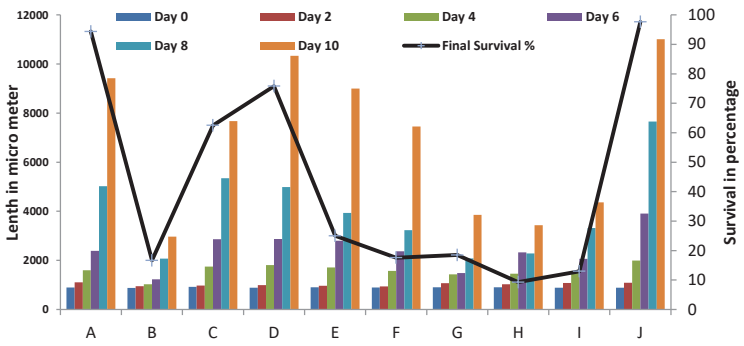


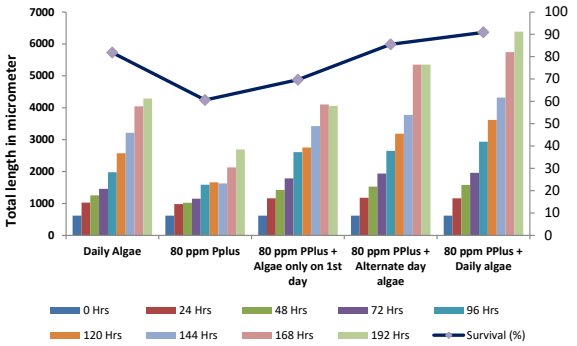
Fig. Growth curve of Aurantiochytrium sp, and percentage of protein and lipid content in Aurantiochytrium sp



Survival and growth of artemia. A: Fed with Nannochloropsis occulata, B: Without any feed, C: Freeze Dried Aurantiochytrium (FDA) @ 125 mg/1500 Nos, D: FDA @ 250 mg/1500 Nos, E: FDA @ 375 mg/1500 Nos, F: FDA @ 500 mg/1500 Nos, G: Wet Biomass Aurantiochytrium (WBA) @ 0.5 g/1500 Nos, H: WBA @ 1 g/1500 Nos, I: WBA @ 1.5 g/1500 Nos, J: FDA @ 250 mg/1500 Nos + Nannochloropsis occulata

PLANKTON ^{PLUS} PROMOTES GROWTH OF ARTEMIA

Potential of Plankton ^{Plus} for culturing the zooplankton (Artemia) was evaluated by feeding them with different concentrations of PPlus (20 ppm, 40ppm, 80ppm and 160 ppm) and 80 ppm was found to give better survival and growth compared to other doses. Study was conducted to reduce use of microalgae by supplementing PPlus for artemia culture. For this purpose, PPlus (80 ppm) was added along with microalgae (*Nannochloropsis occulata*) at different frequency of application, i.e., one-time (first day) application, alternate day application and daily application. The growth and survival of artemia were significantly ($p<0.05$) higher when PPlus was used with daily application of microalgae. Interestingly, the growth and survival of artemia were also higher when PPlus was supplemented with alternate day algae application compared to daily algae feeding without PPlus. The experiments clearly revealed that **Plankton ^{Plus} supplementation @ 80 ppm with microalgae improved artemia biomass production and can reduce the usage of algae by 50 % for artemia culture**.



Growth and survival of artemia fed with Plankton ^{Plus}

EVALUATION OF NEWER FEED INGREDIENTS FOR USE IN AQUAFEEDS

WEEVIL INFESTED SWEET POTATO MEAL AS A NOVEL INGREDIENT IN SHRIMP FEED

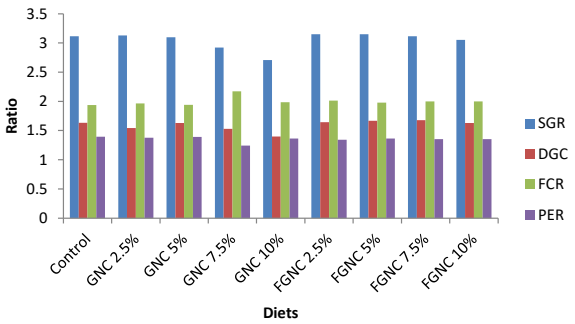
Sweet potato weevil is the most serious pest of sweet potato, with reports of losses as high as 97% in areas where the weevil occurs resulting in huge loss of the crop. This weevil infested sweet potato meal (WSPM) is unfit for human consumption and is disposed of as waste. In order to ascertain its potential as an ingredient in the diet of *P. vannamei*, nutritional

Nutrient/ ingredient	Weevil infested Sweet potato meal		
	Low infestation	Medium infestation	High infestation
			
Moisture	11.23	11.66	11.78
Crude Protein	4.13	4.21	5.1
Ether Extract	1.11	1.3	1.62
Total Ash	3.65	4.02	5.15
Crude Fibre	4.56	4.54	7.34
NFE	75.32	74.27	69.01
AIA	0.59	0.69	0.86

composition was analyzed and feeding experiment was conducted for 60 days in vannamei juveniles (4.26± 0.21) by using WSPM at 5,10,15, 20, and 25% replacing wheat, a commonly used carbohydrate source, on (W/W) basis in the shrimp diet. **The sweet potato meal contains higher NFE, indicating the nutritional richness of available carbohydrate**. As the level of weevil infestation increases, there is a slight increase in crude protein. The chemical analysis indicated that **weevil infested sweet potato could be explored as an alternate ingredient to wheat.** The results also revealed that WSPM could be effectively used up to 10% in the vannamei diet without affecting growth and FCR.

EFFECT OF YEAST FERMENTATION OF GROUND NUT OIL CAKE ON NUTRIENT DIGESTIBILITY, GROWTH AND NUTRIENT UTILIZATION IN P. VANNAMEI

Ground nut oil cake (GNC) was fermented with yeast, *Saccharomyces cerevisiae* at 60-65% moisture for three days. The fibre fractions are not much influenced by yeast fermentation in ground nut oil cake except the reduction of cellulose fraction (8.77 to 7.78%). The nutrient digestibility in terms dry matter and protein were determined by ingredient substitution method in *Penaeus vannamei* (Average initial weight 12.87g). The apparent dry matter and protein digestibilities increased from 56.92 to 60.87 and 79.07 to 85.12%, respectively from raw ingredient to fermented ingredient. For optimization of the inclusion level in shrimp feed, nine test feeds having 0, 2.5, 5.0, 7.5 and 10% levels of raw and yeast fermented GNC were prepared by replacing fishmeal. The results indicated that yeast fermented GNC can be included up to 10% whereas raw GNC could be included up to 5% in *P. vannamei*.



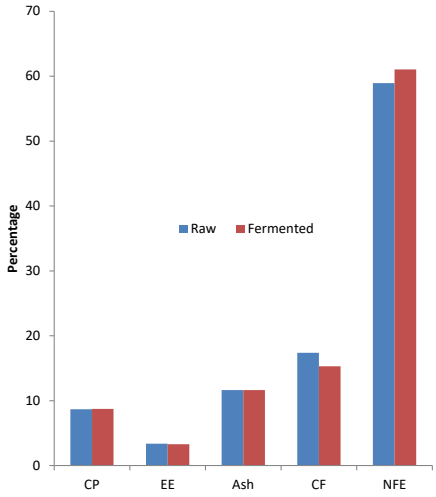
Effect of fish meal replacement with varying levels of unfermented and yeast fermented ground nut oil cake in the diets of P. vannamei on Growth and nutrient utilization

EFFECT OF FERMENTATION OF MANGROVE LEAVES ON PROXIMATE AND MINERAL COMPOSITION

In order to utilize the mangrove leaves as an ingredient in aquafeeds, the mangrove leaves, *Avicennia marina* were collected from Nagayalanka, A.P. The proximate and mineral profiles were analysed. These leaves contain 66.8, 2.88, 1.12, 3.86 and 5.77% of moisture, crude protein, ether extract, total ash and crude fibre, respectively on as is basis. The mangrove leaves contained 173, 245, 149, 805, 4.2, 2.7 and 0.5 mg/100g of Ca, K, Mg, Na, Fe, Mn and Zn, respectively. The effect of fermentation on changes in proximate composition has indicated not much variation except for slight reduction of crude fibre levels.

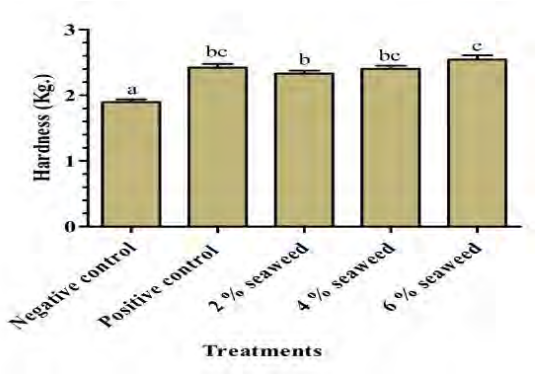
SEAWEED AS A SOURCE OF NATURAL BINDER IN SHRIMP FEED

Seaweed, *Gracillaria tenuistipitata* has been selected as a potential natural binder and its effect was studied in the diet of *P. vannamei* feed. Seaweed was included at 0 (negative control), 2, 4 and 6% in the CIBA Vanami^{Plus} feed and compared against the standard control diet containing synthetic binder as a positive control. Experimental feeds prepared were subjected for hardness and bulk hardness studies using TA. XT plus texture analyzer. Feed was compressed with 2 mm (for hardness) and 32 mm diameter (for bulk



Effect of yeast fermentation of mangrove leaves on proximate composition

hardness) cylindrical probes with 60 % compression, 1mm/sec speed, and 0.001 g trigger force. Results indicated that hardness of the pellets of different treatments was significantly different ($P < 0.05$). **Hardness (2.54 kg) and bulk hardness (21.22 kg) in 6% seaweed incorporated feed were similar with commercial feed (2.42 kg) indicating the potential of seaweed as alternate for the synthetic binder in shrimp feed preparation**. In addition, seaweed is also known to offer other nutraceutical benefits for the farmed shrimp.

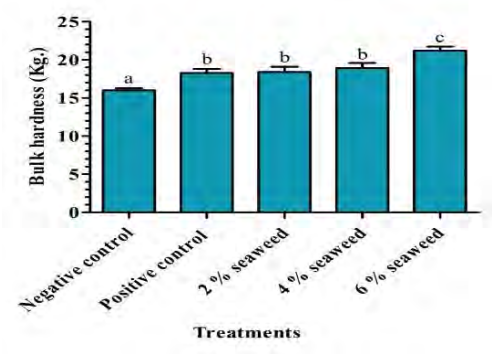


Hardness of single pellets of different feed (Mean ± SE, n=10).

PROXIMATE AND MINERAL COMPOSITION OF WILD AND CULTURED GRACILARIA TENUISTIPITATA

Comparative study was conducted to assess the nutrient composition of wild and cultivated seaweed. Crude protein was significantly higher in cultured Gracilaria compared to wild Gracilaria. Na, K, P, Mn and Se content were significantly higher in cultured compared to wild seaweed. Results indicated that cultured Gracilaria could be of use as a potential ingredient for aquafeed preparation.

Proximate (%) and mineral composition wild and cultured seaweed



Bulk hardness of single pellets of different feed (Mean ± SE, n=10).

NUTRIENT PROFILE OF MARINE MACROALGAE

Six species of marine macroalgae, Red algae (*Gracilaria corticata, Champia compressa*), Brown algae (*Turbinaria conoides, Dictyopteris*) and Green algae (*Halimeda macroloba, Caulpera racemosa*) were analysed for proximate, fatty acid and mineral compositions. Biochemical composition of collected seaweeds species revealed that crude protein, total Ash, crude fiber ranges from 5.03 to 9.17%, 37.31 to 70.22%, 8.1 to 14.56%, respectively on dry matter basis. Total lipids range from 420 to 1660 mg/100g while PUFA content was 52.41 to 376.70 mg/100g on dry matter basis. Mineral profile revealed that high Ca (g/kg) content was observed in *Halimeda macroloba* (141.43) and lowest was in *Gracilaria corticata* (8.321) while Se (g/kg) was high in *Halimeda macroloba*, *Gracilaria corticata* (0.91) and low in *Turbinaria*

Proximate composition (%) of wild and cultured seaweed

Proximate composition (%)	Wild	Cultured
Moisture	88.10 ± 0.04	90.16 ± 0.21
Crude protein	19.42 ± 0.14[a]	22.57 ± 0.08[b]
Crude lipid	0.55 ± 0.01	0.51 ± 0.06
Crude mineral	37.62 ± 0.02[a]	38.61 ± 0.03[b]
Insoluble mineral	8.47 ± 0.45	8.56 ± 0.84
Crude fiber	7.35 ± 0.15[a]	6.39 ± 0.15[b]

Table1.4b. Mineral composition (%) of wild and cultured seaweed

Mineral composition (g/kg)	Wild	Cultured
Calcium	2.31 ± 0.023[a]	2.23 ± 0.009[a]
Magnesium	6.28 ± 0.036[a]	6.38 ± 0.035[a]
Sodium	26.33 ± 0.007[a]	27.46 ± 0.009b
Potassium	107.48 ± 0.006[a]	108.48 ± 0.005[b]
Phosphorous	2.11 ± 0.052[a]	3.83 ± 0.004[b]
Iron	2.38 ± 0.005[a]	1.89 ± 0.667[a]
Copper	± 0.00[a]	0.01 ± 0.001[a]
Manganese	0.11 ± 0.001[a]	0.37 ± 0.007[b]
Zinc	0.31 ± 0.005[a]	0.18 ± 0.004[b]
Selenium	4.10 ± 0.057[a]	7.55 ± 0.008[b]
Crude fiber	7.35 ± 0.15[a]	6.39 ± 0.15[b]

Each value represents Mean ± S.E, n = 3. Values in the same row with different superscripts are significantly different (P < 0.05)

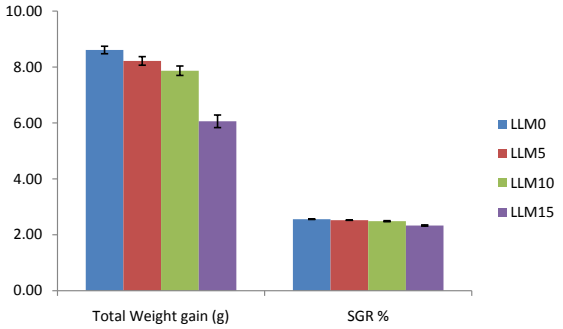
conoides (0.68) and Zn ranges from 0.02 to 0.26 g/kg. Seaweeds are rich source of minerals, low in crude protein, total lipids and PUFA. Among collected seaweed species *Halimeda macroloba* has shown higher mineral profile. Cultured *Gracilaria tenistipitata* contain lower Ca and Fe (0.235, 0.555) and higher P and Se (3.825 and 7.532 g/kg) in cultured seaweed samples compared to wild (2.863 and 2.371; 2.02 and 4.001 g/kg, respectively).

LEUCAENA LEUCOCEPHALA AS A LOW-COST FEED INGREDIENT IN MILK FISH (CHANOS CHANOS) FINGERLINGS

Leucaena leucocephala is a fast-growing leguminous plant which can be grown on dry lands. It is a cheap source of protein (CP-21.06 %) with high nutritional value. To reduce the cost of the feed this study has been conducted. Four iso-nitrogenous diets (CP-29%), with *Leucaena* leaf meal (LLM) at 0, 5, 10 and 15 % were formulated and tested on milk fish in a 49 days trial. No significant difference in average body weight gain was observed between control and 5 % LLM fed group. Body weight gain reduced (P<0.05) when LLM was incorporated above 5 % level. Histopathological observation revealed no effect on liver tissue at 5% level but degenerated nucleus and vacuole formation found at 10% and 15% level which indicates **LLM can be incorporated safely at 5% level without affecting growth and survival of milkfish**.

AVAILABILITY OF MARINE PROTEIN SOURCES IN SUNDARBAN, WEST BENGAL

Fish is an important part of the regular diet and is a cheap source of protein for the peoples of West Bengal. About 78% of total fish catch is consumed in fresh condition, 6% is used as dry fish and rest is used as frozen fish. Around 20% of the dry fish are used for fish meal/poultry feed. A survey was conducted during November 2018 to January 2019 to have information on availability of dry fish and common species used for making dry fish in Namkhana, Kakdwip and Sagar block of South 24 Parganas of West Bengal. Available dry fish species were *Trichurus russelli* (1.5 t), *Harpodon nehereus* (11 t), *Setipinna phasa* (8 t), *Coilia ramkarati* (10 t) and *Atrobucca nibe* (16 t). The highest protein content was found in Atrobucca nibe (CP-69.25%) whereas other species contained protein ranging from 62 to 64%. Total 15000 t of dry fish at Frazerganj, 18900 t at Kalisthan, 200 t at Kakdwip, 10150 t at Sagar and 450 t of Acetes at Mousumi were produced during last winter.



Growth performance of milk fish (Chanos chanos) fed different level of LLM in the diet



Harpodon nehereus (Bombay duck)

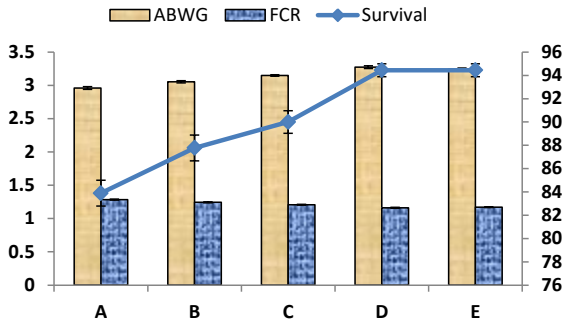


Women engaged in fish drying

FEED ADDITIVE

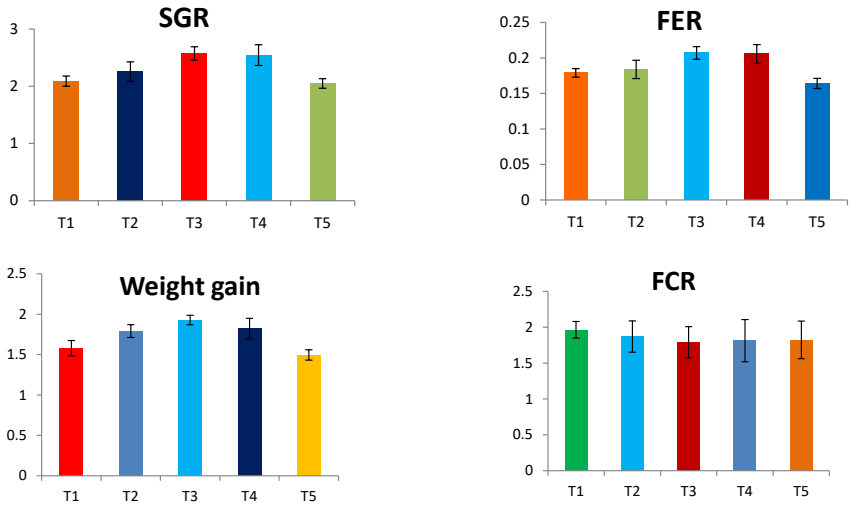
EFFECT OF DIETARY C-PHYCOCYANIN IN GROWTH AND HEALTH OF PENAEUS VANNAMEI

C-Phycocyanin, an intense blue pigment extracted from locally isolated spirulina, *Arthrospira maxima*, used to formulate shrimp feed with different concentrations. **A significant increase ($p<0.05$) of average body weight gain, survival rate and better FCR was observed in *Penaeus vannamei* juveniles fed with feed containing 750 and 1000 mg C-Phycocyanin/kg of experimental diet** compared to other treatments (250 and 500 mg/kg C-Pycocyanin inclusion) and control (0% C-PC) in a 45 days trial. A challenge study with pathogenic *Vibrio parahaemolyticus* for 5 days post feeding trial revealed that the animals fed with higher concentrations of C Phycocyanin (750 and1000 mg/kg) had better survival and less haemolymph vibrio load. Study revealed that C-Phycocyanin extracted from spirulina can be incorporated in the shrimp feed formulations for boosting growth and immunity.



KRILL OIL AS FEED ADDITIVES

A study was conducted to evaluate the effect of Krill oil supplementation on growth and immunomodulatory potential of *Penaeus vannamei* juveniles. Krill oil was included at 0.1% (T1), 0.2% (T2), 0.4% (T3), 0.8% (T4) and compared against the control diet without krill oil supplementation (0.0%). After feeding trial, shrimps from each treatment group were challenged with 0.1 ml of virulent *V. parahaemolyticus* suspension at a concentration of 10^7 CFU ml^{-1}. The post-challenge sampling was performed after 7 days of injection. The growth and survival rate of shrimps fed with krill oil diet was significantly ($p<0.05$) higher as compared to control group. Study revealed that 0.4 % krill oil may be incorporated in diet of *Penaeus vannamei* juveniles for getting better growth and survival.



Growth and nutrient utilization of Pacific white shrimp fed with krill oil.

OPTIMIZATION OF NUTRIENT REQUIREMENTS

EARLY WEANING OF SEABASS LARVAE WITH IMPROVED INDIGENOUS SEEBASS LARVI *PLUS*

A suitable micro-particulate feed is critical input for attaining optimal growth and survival after weaning the larvae from live feeds. A 12 day feeding experiment was conducted in triplicates for testing indigenous larval micro-diet in Seabass larvae. Experiment was conducted in 500 L capacity circular FRP tank. Seabass larvae, 21 dph (10.52±0.45 mg) stocked at a density of 500 larvae/tank were fed at 10% body weight twice daily. The final avg. body wt. and total length after 12 days were found to be 127.29±11.14 mg, 2.3±0.3 cm, respectively. Survival (%) was found to be 80.03%. **The relatively lower feed cost and higher growth performance with indigenous larval feed indicates its potential as an alternative to commercial feed for larval rearing of seabass**. Further studies are required for optimization of larval nutrient requirements and feed management practice to further reduce the feed cost and enhance the returns.

OPTIMIZATION OF LEVEL OF TAURINE IN DIET OF MILK FISH LARVAE

For optimization of taurine level in diet of milk fish (*Chanos chanos)* larvae, isoproteinous (CP-47 %) isolipidic (EE-9 %) feed was prepared with varying level of taurine i.e., 0, 0.25, 0.5, 0.75, 1.0 and 1.25 %. *Chanos chanos* larvae (Av. Body wt. 0.061±0.005 g) were randomly distributed in 18 glass tanks (90 L water each) of recirculatory aquaculture system (RAS) @ 20 larvae per tank and the feeding trial was carried out in triplicate for 60 days. **Average daily gain, Weight gain percent, specific growth rate were higher and FCR was lower in *Chanos chanos* supplemented with 1 % taurine.** Survival (%) was higher (P>0.05) in all taurine supplemented groups though statistically not significant. Survival was maximum in group supplemented with 1.0 % taurine. Experiment revealed that 1.0 % taurine supplementation was found to be optimum in diet of *Chanos chanos* larvae.

VITAMIN E REQUIREMENT FOR MILK FISH LARVAE

A forty five day study was conducted to examine the effect of dietary vitamin E supplementation on growth of milkfish larvae. Five iso-nitrogenous and iso-energetic (550 g protein per kg and 120 g lipid per kg) experimental diets were prepared with varying levels (0, 100,200,400 ppm) of vitamin E (α-tocopheryl acetate) supplementation. Milkfish larvae with a mean body weight of 48.25± 5.32 mg were fed with experimental diets in triplicates following a completely randomized design. Study revealed that milkfish fed with diet supplemented with 200–300 mg/kg of vitamins E showed enhanced ($p < 0.05$) growth performance, and survival. The results of the feeding experiment based on the second-order polynomial regression analysis revealed that the **dietary vitamin E requirement for optimal growth of *C. chanos* larvae was estimated to be in the range of 196–218 mg α-tocopheryl acetate per kg.**

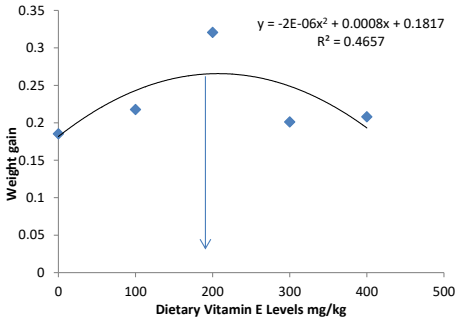
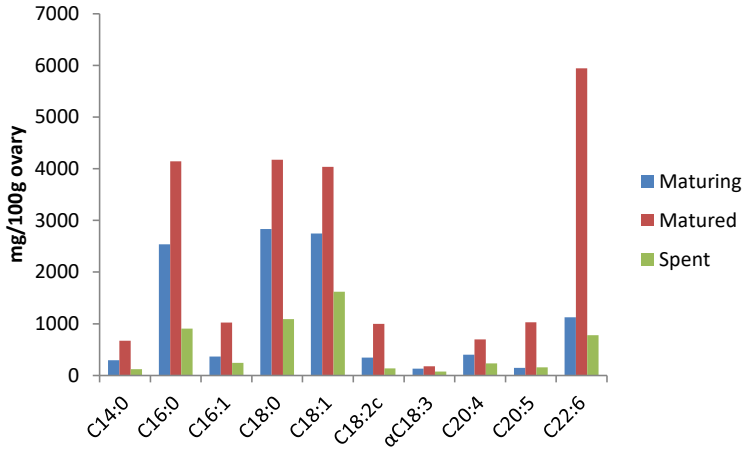


Figure: Estimation of dietary vitamin E requirement for optimum growth of C. chanos larvae using second-order polynomial regression analysis

MOBILIZATION OF FATTY ACIDS IN HILSA DURING DIFFERENT STAGES OF MATURITY

Hilsa, *Tenualosa ilisha* is a highly valued anadromous clupeid distributed in the Ganga-Brahmaputra-Meghna river. In order to develop a suitable brood stock feed, the mobilization pattern of fatty acids were analysed in pond reared brood stock at varying stages of maturity. The muscle of immature fish contains 2466, 796, 953, 1308,176, 284 and 1450 mg/100 g of C16:0, C16:1, C18:0, C18:1, C20:4, C20:5 and C22:6, respectively. The matured ovary contained



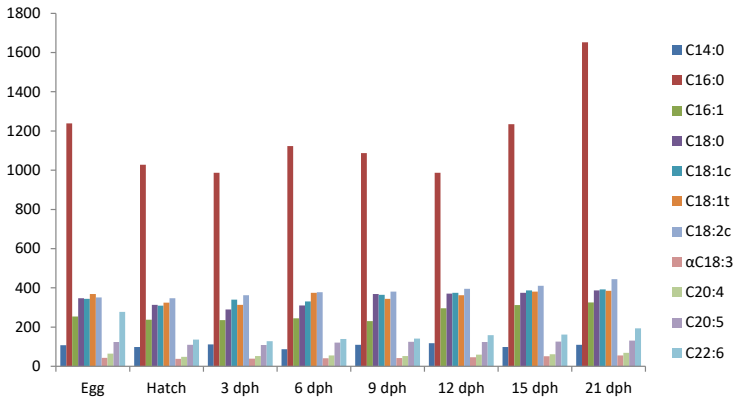
Fatty acid profiles in the ovary at different stages of maturity in Hilsa

4141, 1021, 4174, 4038, 695, 1028 and 5940 mg/100g of C16:0, C16:1, C18:0, C18:1, C20:4, C20:5 and C22:6, respectively.

The fatty acids like C14:0, C18:1, C18:2c, C18:3 have been reduced by more than 95% in matured fish muscle compared to immature fish muscle. Whereas the fatty acids like C16:0, C18:0, C20:5 and C22:6 were reduced by ~90% and C20:4 by 71%. The retention (%) of mobilized fatty acids in the ovary varied significantly among the fatty acids. **Even though C20:4 is the least mobilized fatty acid from the muscle it is the highest retained (96%) in the ovary whereas the C16:1 is the highest mobilized fatty acid but its retention in the ovary is the lowest (22.7%). The variation of retention (%) of fatty acids might be due to utilization of certain fatty acids like C16:0, C16:1 for energetic purposes and certain fatty acids like C14:0, C18:0, C20:5, C22:6 and C20:4 are selectively retained.** This information will be a base for developing broodstock diets for captive breeding of hilsa.

FATTY ACID PROFILES OF MILK FISH EGG AND LARVAL STAGES

Hatchery produced milkfish egg, larvae (0, 3, 6, 9, 12, 15 and 21 day) are analysed for fatty acid profiles. The DHA content of egg, hatch and 21day old larvae are 277, 136 and 194 mg/100 g. The reduction of fatty acids like DHA (51%), ARA (26%) and EPA (24%) is very high in hatchling, indicates their significance during the embryogenesis of milkfish egg. The changes in amino acid and mineral profiles are also studied.



Fatty acid profiles in different stages of milk fish larvae

FEED MANAGEMENT OPTIONS

EFFECT OF DELAYED INITIAL FEEDING ON GROWTH AND SURVIVAL OF MILKFISH LARVAE

This study investigated the effect of delayed initial feeding on growth and survival of milkfish larvae under controlled conditions. Growth parameters were evaluated by assessing morphometric characteristics of the larvae. Two experiments were conducted at different initial feeding time i.e., at 24 h, 48 h, 72 h, 96 h and 120 h. Milkfish larvae initiated first feeding at 120 h after hatching have achieved comparatively lesser growth in total length and total weight than that of 24 h and 48 h. **The morphometric characteristics (total length, head depth, body depth, eye diameter, gut height, musculature height, yolk volume) of 5 DPH larvae had significant differences between 24 h and 120 h initial feeding.** Similarly, significant differences were noticed between 24 h and 72 h initial feeding for all the morphometric characteristics. There was no significant difference in the yolk volume utilization of 1 DPH and 2 DPH larvae among different treatments. Experiment on the effect of delayed initial feeding on the survival of Milkfish larvae revealed that after 21 days of rearing, survival was higher in milkfish larvae initiated feeding at 24 h (40.86%) compared to 72 h (19.28%) and 96 h (7.72%). Complete mortality was recorded on 6 DPH for the larvae initiated feeding at 120 h. The present study suggests that the feeding of milkfish larvae must be initiated at 24 h post hatching for getting better growth and survival.

COMPENSATORY GROWTH IN SHRIMP VANNAMEI

Compensatory growth is already proved in fishes. However, the reports on such a compensatory growth in shrimp are clashing. In fact, this kind of compensatory growth is beneficial for the farmers in the management point of view. Therefore, to confirm the presence or absence of compensatory growth this study was conducted with stunted shrimp from the aqua mimicry feeding trials. Here the shrimps were brought to normal feeding regime as our standard shrimp feeding chart. The growth performance was observed for another 55 days. Self-cleaning microcosm tanks served as rearing system. The stunted shrimps were found to have faster growth compared to the normal shrimps. **The weekly weight gain in the stunted shrimps was more than 3 g per week, while it was only around 1.6 g per week in the normal shrimps.** Compensatory growth in shrimp is evidenced from the results of this study.

PENAEUS VANNAMEI-MILKFISH CO-CULTURE WITH LOW PROTEIN FEED

Penaeus vannamei (40 no./m2) was co-cultured with milkfish stocked at two densities (0.2 and 0.4 no./m2) for 107 days in 0.15 ha ponds. CIBA made low protein feed (CP-32%) was used for the culture. Milkfish was stocked (ABW-5 g) after 15 days of vannamei stocking. Culture of P. vannamei with the lower density milkfish (0.2 no./m2) yielded better production (shrimp- 5.8 ton/ ha, milkfish 0.5 ton/ha) and survival (Shrimp- 68%, milkfish- 100%).

Performance of vannamei with milkfish with low protein feed

	Vannamei with milkfish (0.2/ha)	Vannamei with milkfish (0.4/ha)
Final wt, g (Vannamei)	21.25±0.07	23.15±1.12
Final wt, g (Milkfish)	250.00±0.10	210.00±30.00
Feed Conversion Ratio	1.16±0.03	1.30±0.22
Productivity, kg/ha	5773.5 ±106.5	4676.5±636.5
Operational cost, Rs.	115300±200	109150±2450
Gross income, Rs.	271057±4795	228059±31563
Benefit Cost Ratio	1.67±0.0.02	1.77±0.09

Harvested milkfish and vannamei



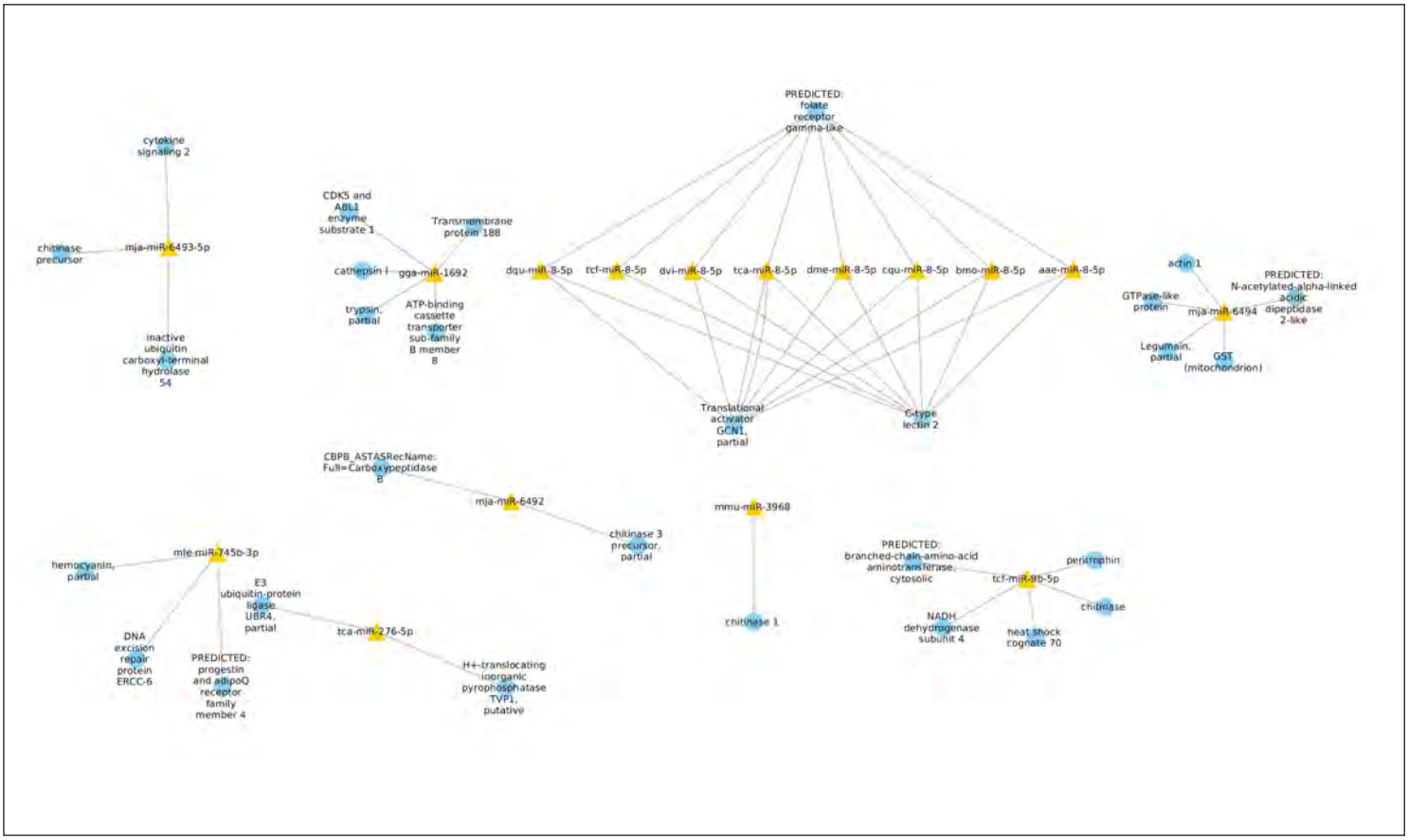
GENETICS AND BIOTECHNOLOGY

miRNAS EXPRESSION PROFILING DURING WSSV INFECTION

In recent years, the importance of viral and host microRNAs (miRNA) in mediating viral replication and control of host cellular machinery, has been realized and increasing efforts have been taken in order to understand the interactions of miRNAs from host and pathogen during infection. small RNA sequencing was performed to identify the miRNAs involved in shrimp (*Penaeus vannamei*) immune responses under WSSV infection condition. The expression profiles of miRNAs of shrimp infected with WSSV under two contrasting conditions of field outbreak and controlled experimental conditions were compared and as a result, 23365 known miRNAs and 481 novel miRNAs were identified. Amongst the most abundantly expressed miRNAs, the hypoxia related miR-210 and immune pathway related miR-29b were expressed only in infected shrimps of both conditions. The other miRNAs included miR-8-5p, having a functional role in modulation of chitin biosynthesis and miRNAs targeting chitinase, an important enzyme involved in growth and moulting in shrimps, indicating an interaction between WSSV infection with moult cycle of shrimp. The miRNA target prediction revealed several immune-related gene targets such as cathepsin, c-type lectin, hamocyanin and ubiquitin protein ligase. The shrimp miRNA mja-miR-6489-3p, was also found to target early virus gene wsv001 of WSSV. Our study, therefore, provides the comparative analysis of miRNA expression from shrimp during WSSV infection in two different conditions.

THE INTERACTIONS BETWEEN MIRNAS AND TARGET GENES OF WSSV INFECTED *L. VANNAMEI* SHRIMP CONTIG-LEVEL ASSEMBLY OF *PENAEUS INDICUS* GENOME WITH LONG-READS

PacBio sequence data was generated on pacific biosciences sequel platform using magnetic bead loading and 600-minute movies. The 20 Kb



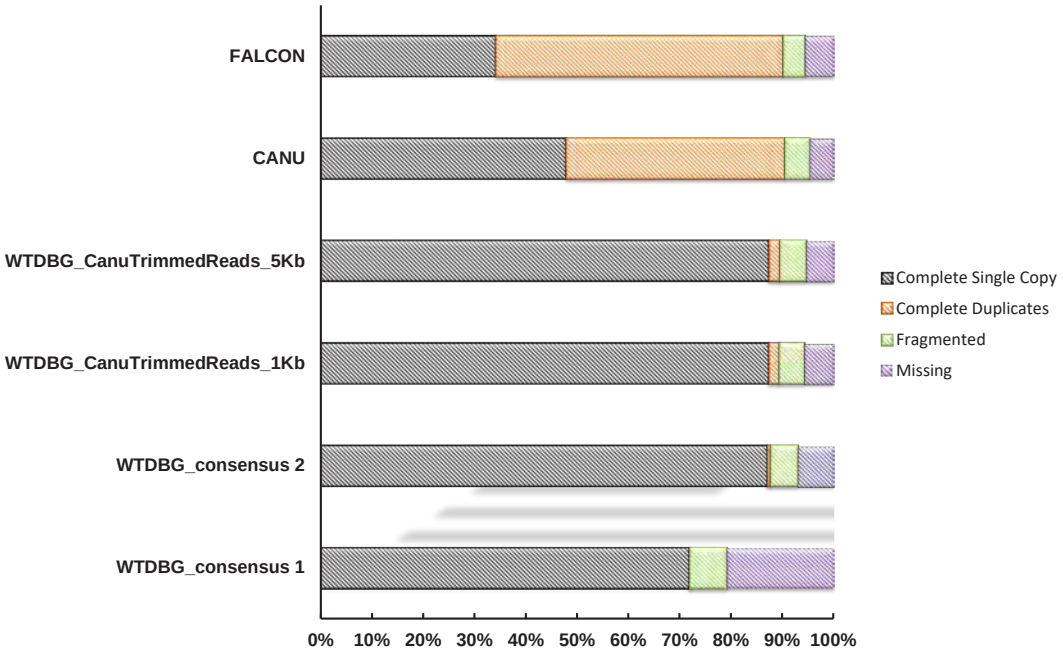
Interactions between miRNAs and target genes of WSSV infected Penaeus vannamei

sequencing libraries were used for sequencing where inserts over 17 Kb size were retained based on BluePippin size selection. About 20,857,430 reads of 176,539,267,324 bases length of sequence data which is equivalent to 71X coverage of genome was used for building contig-level genome with assemblers Falcon, Canu and WTDBG2.

The comparative quality metrics of various assemblies are presented in Table 1. The assembly with Canu is almost close to the total length of genome. The BUSCO scores for the assemblies generated is shown in Figure 1. The assemblies generated with WTDBG2 have higher BUSCO scores for complete single copy genes. Especially the assembly made with raw reads using consensus 2 algorithm has about 73% genome represented in 12,278 contigs with a N50 of about 1 Mb. Generation of optical map and HiC data, scaffolding and chromosome linking are in progress.

Quality metrics of various assemblies generated with Falcon, Canu and WTDBG2.

Statistics	CANU	FALCON	WTDBG			
			CANU reads, >1kb	CANU reads >5kb	consensus 1	consensus 2
Total Length, Gb	2.36	3.39	1.33	1.31	1.55	1.8
N50, bp	54 266	69 258	73 486	72 942	1 201 053	991 596
No of Contigs	83893	76547	37371	36715	2168	12278
BUSCO Score (%	95.2	94.2	94.2	94.6	79.3	93



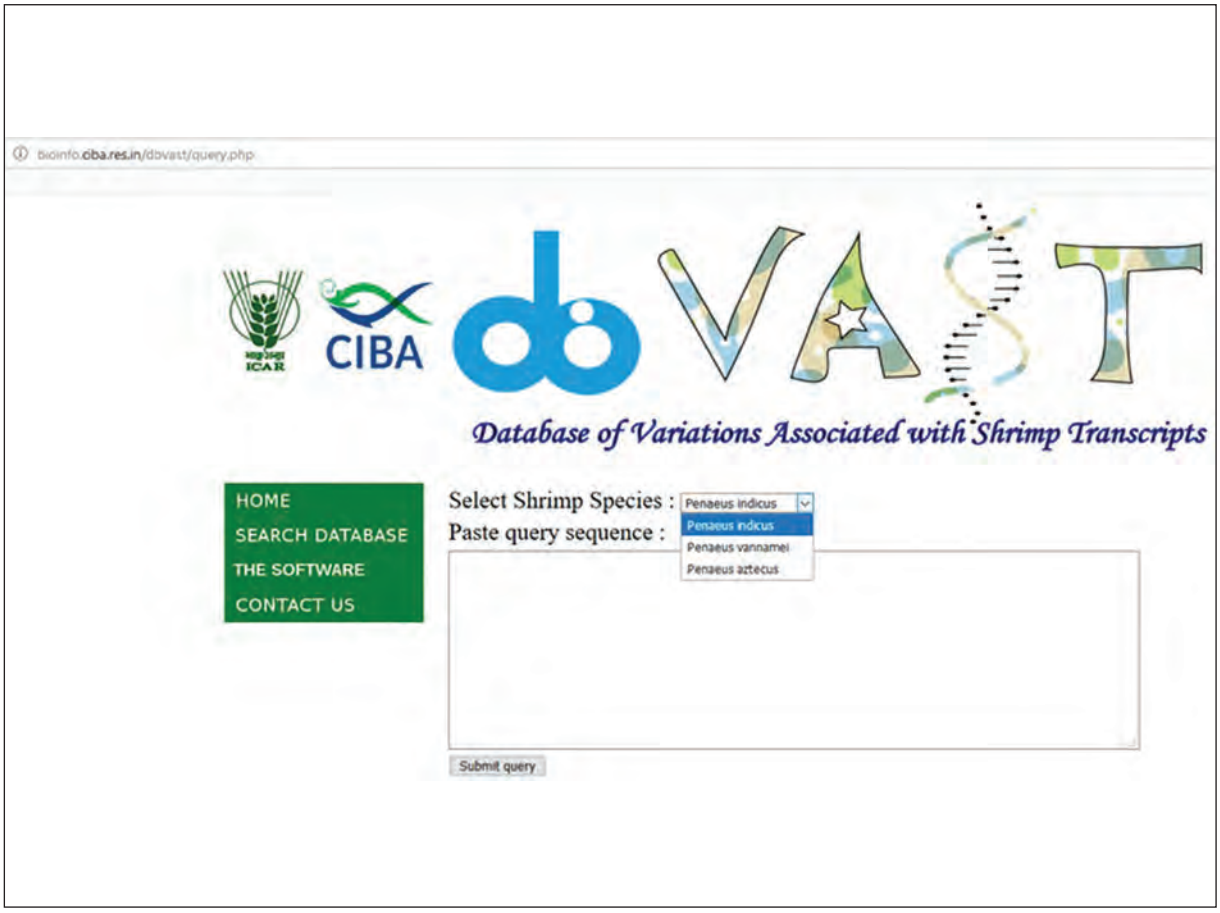
Busco statistics for six assemblies generated with Falcon, Canu and WTDBG2.

dbVAST: DATABASE OF VARIATIONS ASSOCIATED WITH SHRIMP TRANSCRIPTS

Farmed shrimp are an important export commodity for foreign exchange earnings in several coastal countries across the world. The shrimp constitutes one of the important aquaculture commodities which contribute significantly to human food consumption . Though genetic improvement programmes are in operation since two decades, the genomic resources that help in augmenting culture production are scanty. For example the Single Nucleotide Polymorphisms (SNPs) in coding sequences that could become potential selection criterion in selection programs are not yet documented. Therefore either by utilizing the datasets available at Genbank or the datasets generated at ICAR-CIBA, we have documented SNPs in annotated transcripts of three important shrimp species, *Penaeus vannamei, Penaeus indicus* and *Penaeus aztecus* and presented them for browsing as an on-line application in a friendly manner.

For *P. indicus*, the RNAseq reads SRX4808137, SRX4808138 and SRX4808143 were used for building reference transcripts. Whereas for *P. vannamei* and *P. aztecus*, the RNAseq data of *P. vannamei* obtained from GenBank, SRX3556257 and SRX3556279 was used to build reference transcripts. First, the good quality reads obtained after quality control with Trimmomatic V0.36 were assembled *de novo* in Trinity v2.3.2 to generate transcripts. Later, CD-HIT version 4.6 was used to cluster transcripts that were similar by more than 95% which were then annotated in Blast2GO v4.1.9.

Then pooled RNAseq datasets (SRX4808140, SRX4808141 and SRX4808142 for *P. indicus*; SRX1870278 for *P. vannamei*; SRX1871046 for P. aztecus) were utilized to document SNP variations against reference transcripts. The good quality reads of pooled-samples were aligned on to annotated transcripts using bowtie2 v2.3.2 to generate a sequence alignment map (SAM) file which is converted



A screen shot of dbVAST tool.

to binary alignment map (BAM) file and then sorted using samtools-1.2. Then a pileup was generated for sorted bam file using samtools-1.2 which is then piped to bcftools-1.3.1 to generate variant call format (VCF) file. The SNP variations that satisfy the following criteria were then extracted from VCF file, a) the raw read depth at SNP site is ≥ 10; b) both the reference and alternate alleles are supported by at least 5 reads; and c) the phred-scaled quality score for the assertion made in alternate allele is ≥ 20.

The data of blast and SNP statistics of the transcripts were loaded in to relational database as separate tables using MySQL ver. 5.5.24 database management system installed on debian server. A database retrieval system has been developed using PHP scripting language embedded into HTML pages as a web-tool, dbVAST. The database is presented as a user-friendly on-line tool, where users are required to select a shrimp species and submit a query sequence of interest (Figure 1). Input query would be searched against annotated transcripts of the database using blastn algorithm to find the most similar transcript. If the search gets a hit in the database, then the sequence of the most similar transcript along with its blast and SNP statistics would be retrieved from the corresponding data tables and displayed on the screen.

MRF: MISSING REGION FINDER

The white spot syndrome virus (WSSV) continues to be the major pathogen that has potential to inflict mass mortalities of shrimp during culture. Though first reported in 1995 and genome fully deciphered in 2001 (Feng Yang et al 2001), the WSSV is a difficult pathogen to contain in culture environments. The genome sequence of this virus does not show similarity to any other pathogen and this has severely limited the annotation of WSSV genomes. Therefore WSSV alone was aptly placed in a new Genus *Whispovirus* under Family *Nimaviridae*. Unique sequence coupled with circular nature of genome lead to difficulty in annotating the genome features of this virus. Except for few features all the other coding sequences (CDS) were annotated serially with a common prefix like WSSV (AF440570), wsv (AF332093), ORF (MF768985) etc. in the order in which they were assembled and submitted as linear sequence at GenBank. As the annotation nomenclature varies across genomes, the results inferred on a WSSV genome could not be easily comparable to other genomes. This has remained a grey area in comparative genomics studies of WSSV isolates. For example a CDS is annotated as wsv162 in AF332093, WSSV218 in AF440570, hypothetical protein in KT995472, KT995470 and KU216744, ribonucleotide reductase large subunit in KT995471, wsv161 in KY827813, orf90 in AF369029 and orf215 in MF768985.

Another issue of concern is very high similarity in sequence of WSSV isolates where complete genome sequence is available. In this case, traditional similarity-based methods estimate about 99% identity among isolates of WSSV. Despite high similarity, WSSV exhibits considerable variation in genome size from 280591 bp (MG702567) to 314232 bp (MG264599). In addition to variations in common sequence features, the CDS missing in some isolates might be correlated to some property of the virus and needs to be documented.

The need to study the deleted regions and to sort the nomenclature issue has motivated us to develop a tool that could compare two genomes of interest, one as reference and another as query and find the deletions (complete and partial) in query genome with respect to the reference genome. The deletions could be miniscule or regions stretching up to several kb. Then mapping of the deleted regions to generic feature format version 3 (gff3) table of the reference genome missing CDS in query genome could be fetched. Such a tool has potential to sort the nomenclature issue concerning WSSV genomes, as users can compare several genomes against a single reference genome. In such case, findings of comparative genome analysis in the annotation nomenclature of a single reference would be easily comprehensible.

In this study, we developed a new tool, Missing Region Finder (MRF) and demonstrated its utility to gain insights about WSSV genomes. Main purpose of developing the MRF tool is to compare a query genome against a reference genome and find deleted genome regions in query and tabulate the CDS in these deleted regions as per the annotations of reference genome. This is achieved in two stages. First, the genomic regions that are missing in the query compared to reference are identified and their

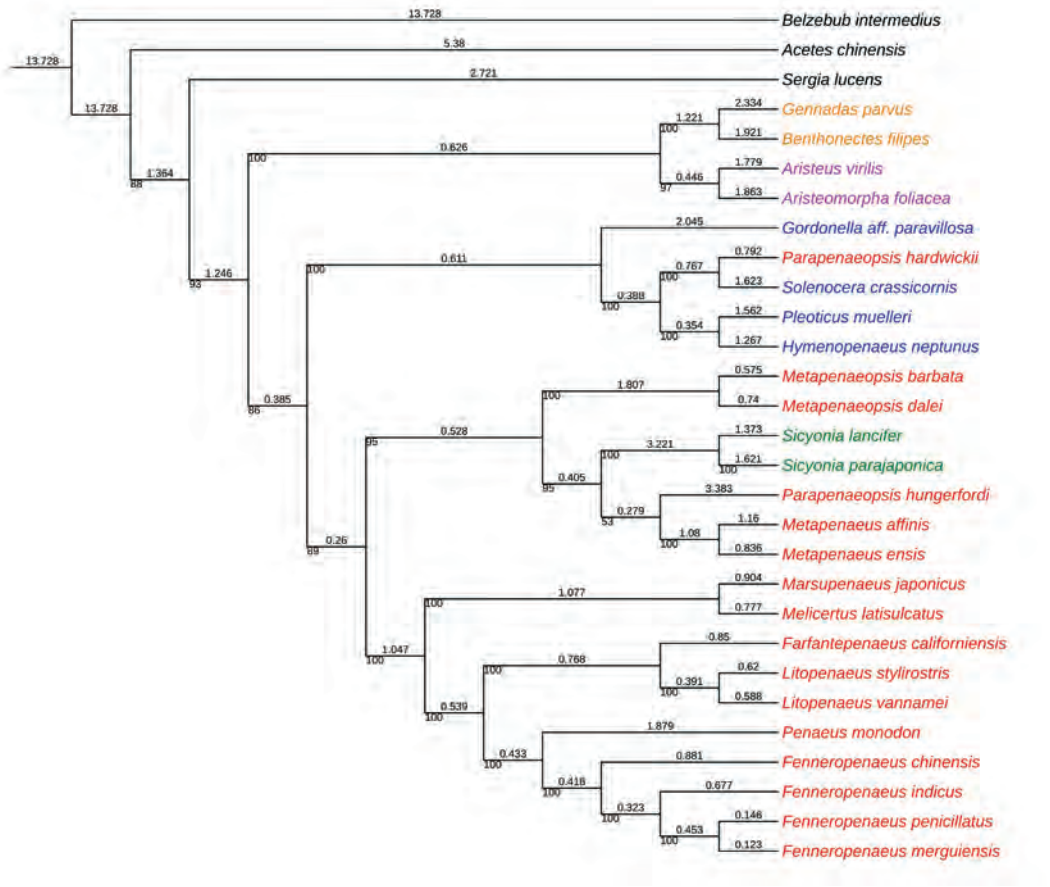


A screen-shot of MRF tool.

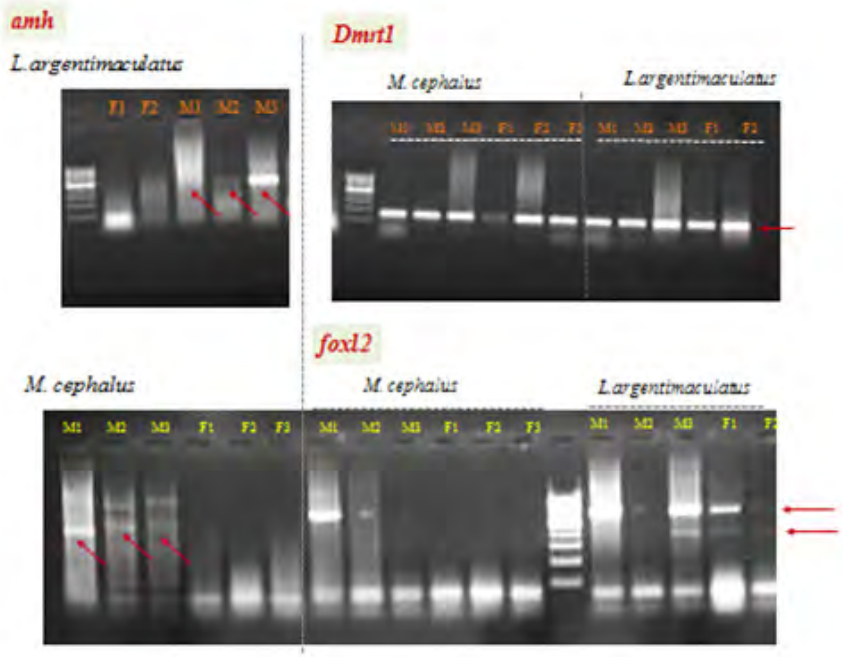
coordinates are mapped. Next, using gff3 table of the reference genome, the CDS present in missing regions of query genome are tabulated. The tool is made available to all users in a web based online platform. The back end of the tool was implemented in a perl program, which reads the input files from the user and computes the missing regions in the query genome. The graphic user interface (GUI) was implemented using PHP and HTML, with stYles rendered by CSS.

PHYLOGENOMICS OF SHRIMP IN SUBORDER, DENDROBRANCHIATA

The controversy surrounding the taxonomy of penaeid shrimp is well known. Researchers across the globe were divided on the taxonomic revision in Genus *Penaeus* sensu lato where six new genera were created. The Food and Agriculture Organization (FAO) which is the repository for aquaculture statistics still uses old genus names. Many stakeholders related to trade, policy matters etc. are often confused as some researchers are using old genus names and others prefer to use new genus names. To address this issue, earlier we had conducted maximum likelihood and Bayesian phylogenetic inferences on complete mitochondrial genome sequences which indicated monophyly of *Penaeus* sensu lato. This year, average aminoacid identity (AAI) which indicates genome-wide similarity was estimated between all the species in each genus of order, Decapoda. The genera where complete mitochondrial genome sequence is available for at least 2 species were considered. The comparison of AAI estimates in order Decapoda with the estimates among species of *Penaeus* sensu lato would throw additional evidence for splitting or retaining the single genus *Penaeus*. Overall for 162 species belonging to 45 genera in order Decapoda, 405 AAI estimates were obtained in this study. The arithmetic mean and median of these estimates is 88.86 and 88.57 respectively. In *Penaeus* sensu lato, 45 AAI estimates were obtained among 10 species. The arithmetic mean and median of these 45 estimates is 93.92 and 93.37 respectively. Both these averages in Penaeus s.l. are higher than that obtained for species in Order, Decapoda. All the AAI estimates obtained among species of *Penaeus* s.l. are higher than the average estimate obtained among species in Order, Decapoda. Though there are no set standard values for AAI estimates to fix different species in a



The plot of AAI estimates obtained between species of Penaeus sensu lato and between species of all other genera in order Decapoda.



Expression of sex related genes in M. cephalus and L. argentimaculatus

genus, it is expected that the species of same genus have high AAI estimates. When it comes to shrimps of Penaeus s.l., the AAI estimates are all above 90% (Figure 4). With such high estimates of AAI among them, these species qualify to be kept under one genus. The AAI estimates did not support polyphyletic status for Penaeus sensu lato and suggest restoration of old nomenclature.

SEX DISCRIMINATION IN FISH

Discriminating sex in most of the commercially important brackishwater finfishes are

difficult as no easily identifiable morphological difference exits between the sexes. In the absence of sexual dimorphism, identifying the sex markers was attempted in grey mullet, *Mugil cephalus* and red snapper, *Lutjanus argentimaculatus*. The expression of sex specific markers reported in other fishes namely doublesex and mab-3 related transcription factor 1 (*dmrt1*), forkhead box L2 (*foxl2*) and anti-mullerian hormone (*amh*) were analysed using genomic DNA. The results indicated male specific expression for *amh*, while both *dmrt1* and *foxl2* exhibited strong expression in both males and female fish, suggesting the possibility of using *amh* as markers for sex discrimination in fish.

POPULATION STRUCTURE OF GREY MULLET, *MUGIL CEPHALUS*

The flathead grey mullet (*Mugil cephalus*), the most widespread mugilid species, inhabits estuarine, intertidal, freshwater and coastal marine habitats and forms commercial and subsistence fisheries in many parts of the world (FAO, 2000). Knowledge on the genetic structure of fish populations is important for the development of management and conservation strategies. The genetic diversity and population structure of *M. cephalus* along the Indian coast was examined with a 842bp segment of ATPase 6/8 gene of mitochondrial genome. Samples of M. cephalus were collected from 6 locations along the Indian coast namely Puri (12), Nagayalanka (16), Chennai (13), Fort Vypin (12), Goa (10) and Gujarat (10). The genetic identification of the species was confirmed using mitochondrial gene CO1. ATPase 6/8 gene was amplified by PCR using universal Primers. The pair-wise FST values indicated the presence of two distinct stocks along the Indian coast, one between Odisha and Kerala and the other between (Goa and Gujarat). A total of 13 haplotypes were identified among the samples analysed. The highest nucleotide diversity was observed in Goa stocks.

ESTABLISHMENT OF PEARLSPOT FULL-SIB FAMILIES AND THEIR GROWTH PERFORMANCE

To fulfil the increasing demands for fish as food, progress must occur towards greater aquaculture productivity. The first step towards increasing the productivity would be to produce genetically improved fish varieties. Here we established two pealspot full-sib families on experimental basis to record the growth parameters which would be useful for selection.

Adult Pearlspot fish were grown in FRP tanks for breeding. Two pairs were identified and transferred to two different FRP tanks. After spawning, the larvae were cultured in the tanks to develop them into fries till 60th day. Meantime, hapas (1mX2m) were placed in the lagoon and it was surrounded by crab fencing

	Nagayalanka (Andhra Pradesh)	**Goa**	**Gujarat**	**Puri (Odisha)**	**Fort Vypin (Kerala)**	**Chennai (Tamil Nadu)**
Nagayalanka	---					
Goa	0.990*	---				
Gujarat	0.997*	0.068	---			
Puri	0.050*	0.984*	0.992*	---		
Fort Vypin	0.025	0.988*	0.996*	0.012	---	
Chennai	0.017	0.987*	0.995*	0.011	-0.002	---

FST estimates between stocks of Mugil cephalus

net (Fig.1) to avoid the entry of crabs and to protect the hapas from crab bite. The two full sib fries were then stocked in different hapas to culture them at Muttukadu lagoon. At the time of stocking the P^H and the salinity of the lagoon were 7.47 and 38PPT. The total body length and body weight of both the families were recorded and are presented in Table1. Coefficient of variation (CV) was higher for body weight than the total body length in both the families. Higher the CV indicates higher the variance exists among the individuals in the family which will facilitate to carry out selection among them efficiently.

Growth parameters of pearlspot stocked in lagoon

	Growth parameters	Family1	Family2
Total body length	Mean on the day of stocking (cm)	2.1 to 3.3 (60^{th} day post hatch)	1.2 to 2.0 (40^{th} day of post hatch)
	Mean on 30^{th} day of stocking (cm)	5.64±0.08	5.59±0.12
	Coefficient of variation (%)	6.5	8.4
Body weight	Mean on the day of stocking (cm)	0.9-2.1	0.7-1.8
	Mean on 30th day of stocking (cm)	4.7±0.2	4.3±0.25
	Coefficient of variation (%)	19.4	23.2

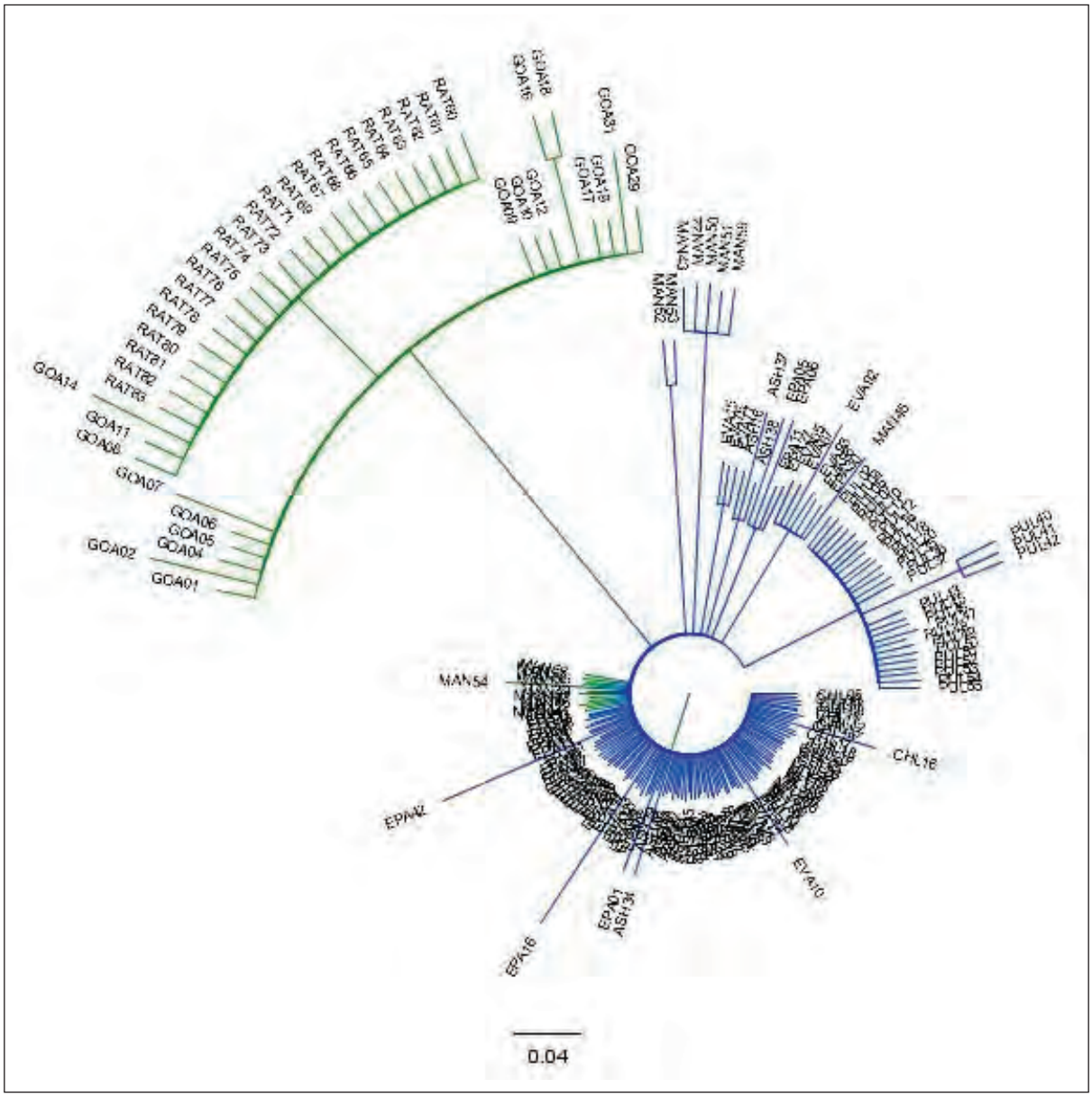


Full-sib families pearlspot cultured in hapas

POPULATION GENETIC STRUCTURE AND HISTORICAL DEMOGRAPHY OF PEARLSPOT FISH IN INDIAN WATERS

Etroplus suratensis (Bloch 1790) commonly known as pearlspot is the largest among the Etroplus species and distributed in the lagoons, brackishwater and backwater environment of southern peninsular India and Sri Lanka. It fetches higher price not only as a food fish but an ornamental fish too due to its delicacy and attractive coloration. Study on population genetic structure of the fish would be useful on conservation of intra-species diversity.

Sixteen tissue samples of *Etroplus suratensis* were collected from Ashtamudi Lake. ATPase 6/8 gene was PCR amplified, sequenced and included with the previously available data and reanalysed. The data includes Chilika (19), Nagayalanka(10), Pulicat (32), Vellayani (17), Ashtamudi (24), Vembanad (40), Mangalore (19), Goa (19) and Ratnagiri (23). AMOVA and FST based genetic differentiation were estimated using Arlequin3.5.2.2. Mantel test for isolation by distance was carried out using ade library of R 3.5.1. Phylogenetic tree was reconstructed by UPGMA method using Mega7.0 and by Mrbayes



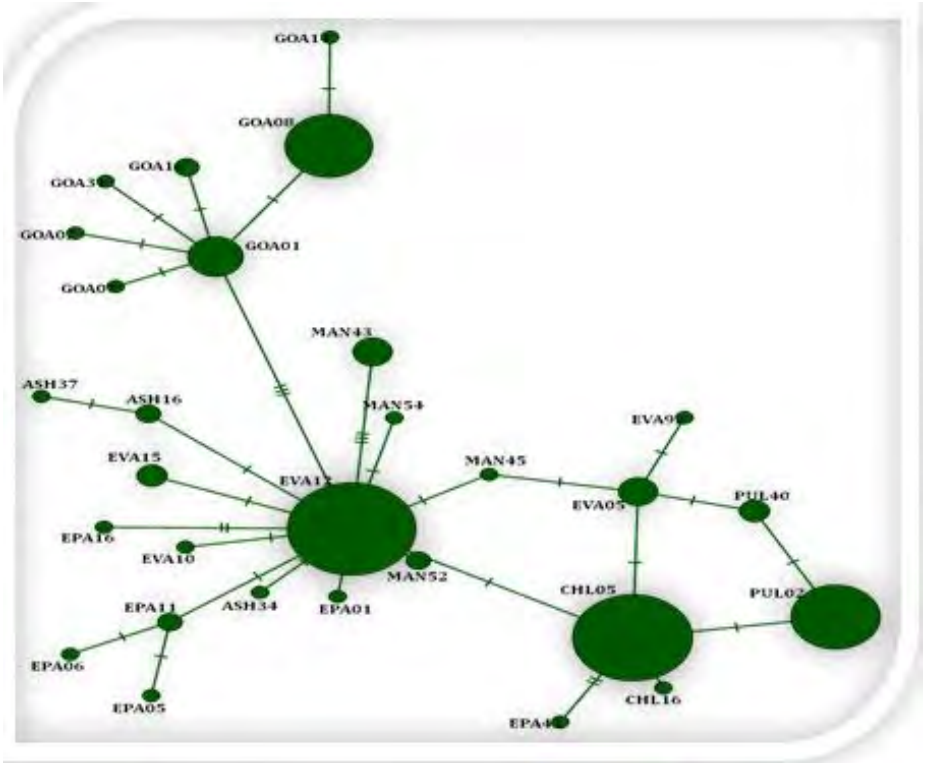
Phylogenetic tree reconstructed by Mrbayes for E.suratensis stocks

3.2.2 The best evolutionary model for the sequences was selected Using Bayesian information criterion implemented in Partition finder. Haplotype network was generated using PopART1.7.

The samples exhibited 31 polymorphic sites which include 16 singleton and 15 parsimony informative sites. The total haplotypes were 29 with the diversity of 0.85. Significant genetic differentiation (FST=0.75; P<0.01) was observed among all the stocks. Non-significant genetic differentiation was observed only between Chilika and Nagayalanka stocks. ATPase 6/8 gene revealed monomorphic pattern in Nagayalanka stocks. Mantel test (r = 0.46 P=0.025) suggests that the isolation by distance is non-significant. However, the positive correlation suggests smaller the differences between the nearer stocks than the farther one. The UPGMA tree established two haplo-groups; one of them includes Ratnagiri and Goa stocks and the second one consists of all the others. Non-significant Tajima's D (-1.47) and Fu's F statistic (-14.89) revealed there is no change in population size in the recent past.

VEMPANAD AND PULICAT STOCKS OF ORANGE CHROMIDE (*ETROPLUS MACULATUS*)FISH ARE GENETICALLY DIVERGENT

Genetic diversity is the outcome of the evolutionary processes adapted by the species to the spatial and temporal environmental changes since its origin. Hence the studies on species diversity are of paramount important to the conservation programs. *Etroplus maculatus*, commonly known as Orange chromide is a euryhaline fish endemic to brackishwater streams, lagoons, estuaries and the lower reaches of rivers in peninsular India and SriLanka. It is mainly utilized as freshwater and brackishwater ornamental fish due to its attractive coloring pattern. The population genetic diversity of *Etroplus maculatus,* in southern Indian waters was studied.



Minimum spanning Haplotype network for the haplotypes of E.suratensis stocks

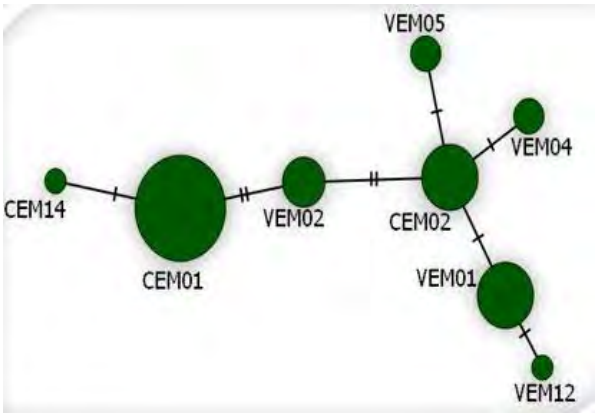
Twenty samples each were collected from Pulicat (South-East) and Vempanad lake (South-West) coastal regions were utilised to study the genetic structure using an mtDNA gene ATPase 6/8. Haplotype and nucleotide diversity were generated by Dnasp6.0. Haplotype network was generated using PopART1.7 (Fig.4). AMOVA and FST based genetic differentiation were estimated using Arlequin3.5.2.2. Phylogenetic tree was re constructed by UPGMA

method using Mega7.0 and by Mrbayes 3.2.2 (Fig.5). The best evolutionary model for the sequences was selected Using Bayesian information criterion implemented in Partition finder.

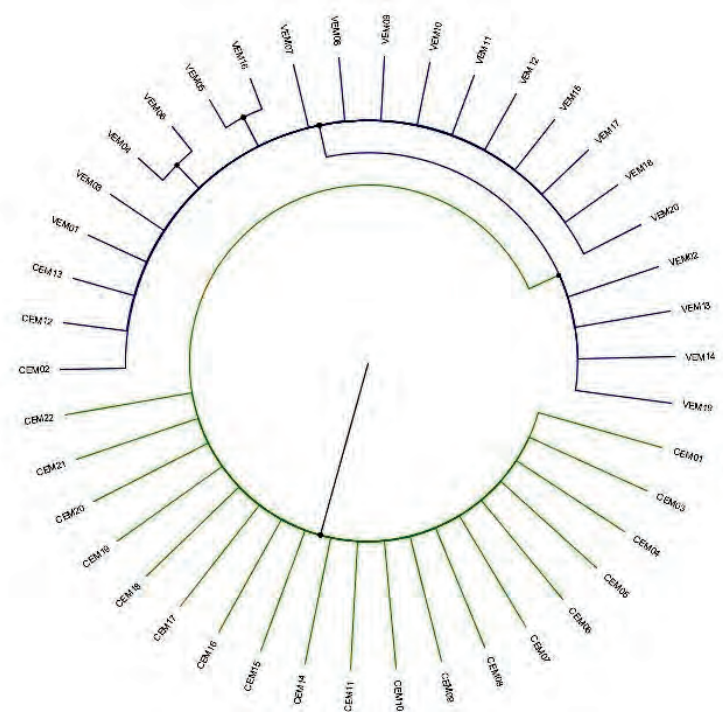
The sequences exhibited eight variable polymorphic sites which include one singleton and seven parsimony informative sites. The total haplotypes were eight with a diversity of 0.76. More and diversified haplotypes were found in Vempanad (six with the diversity of 0.82) compared to Pulicat stock (three with the diversity of 0.33). The phylogenetic tree constructed by both Bayesian and UPGMA methods revealed two separate clades. Non-significant Tajima's D (Pulicat:-0.63, Vembanad:-0.063), Fu's F statsitics (0.231) and bimodal mismatch distribution indicating stable population size historically. The genetic differentiation study (FST=0.42) imparted significant (P<0.001) difference between the stocks. The AMOVA revealed a variation of 42% between the populations and 58% within the populations.

POPULATION GENETIC STRUCTURE OF INDIAN WHITE SHRIMP ACROSS INDIAN COAST USING MICROSATELLITE MARKERS

Indian white shrimp (*Peaneus indicus*) is one of the important commercial penaeid species. Studying the diversity pattern of the species is considered important. 155 individuals of *P.indicus* collected across Indian coast i.e. Chennai (49), Kanyakumari (09), Puri (37), Quilon (47) and Mangalore (13). Ten microsatellite loci were genotyped by fragment analysis method. The alleles and genotypes were generated using the Fragman package of R statistical tool. The genotypes were tested for null alleles using micro-checker. Due to the presence of null alleles and monomorphic pattern three loci data were not included and the study comprises of seven loci data only. The average number of alleles among the populations was 8.5 with a range from 5.4 (Kanyakumari) to 11.4 (Quilon).



Minimum spanning Haplotype network for the haplotypes of E.maculatus stocks



Phylogenetic tree reconstructed by Mrbayes for E.maculatus stocks

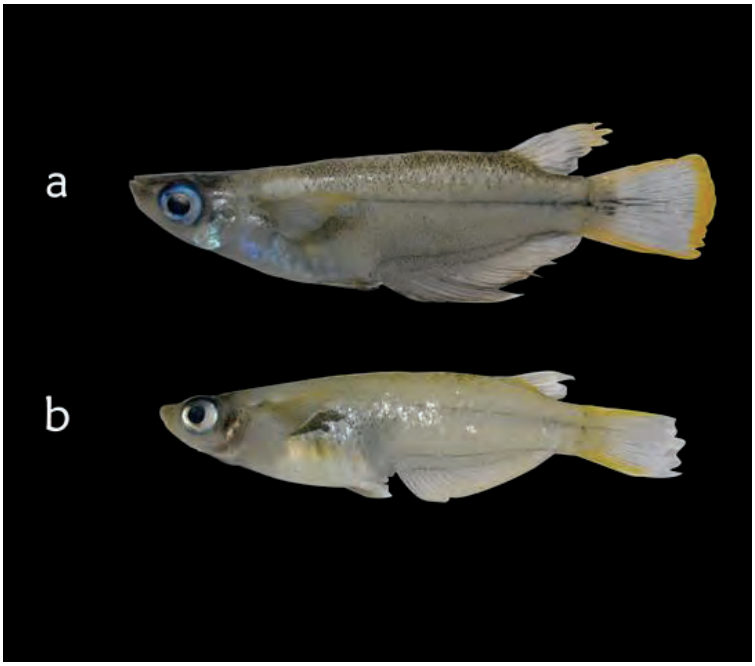
The mean observed heterozygosity ranged at sampled loci were high, ranging from 0.67 (Kanyakumari) to 0.76 (Puri). The analysis of molecular variance (AMOVA) revealed that 97% of the genetic variation was maintained within individual component, rather than shaped according to geographical regions. Pairwise FST (Table.2) (ranged from 0.01 to 0.053) estimates revealed Chennai and Quilon stocks differed significantly (P<0.01) with other stocks. However, Quilon did not differ from Mangalore stock. Bottleneck tests revealed all populations displayed a normal L shaped distribution in the mode-shift curve and the populations had no significant excess of heterozygosity for Wilcoxon's signed-rank test under the TPM model, which suggests the population did not undergo any reduction in the recent past. Mantel test indicated there was no significant correlation between genetic dissimilarity and geographic distance among populations (R= 0.0491; P =0.49). The above stock structure findings would be helpful in conservation and stock specific selective breeding.

Pairwise FST between the stocks

	Chennai (49)	Kanyakum (09)	Mangalore (13)	Puri (37)	Quilon (47)
Chennai	--------				
Kanyakumari	0.026**	----------			
Mangalore	0.050**	0.053*	--------		
Puri	0.347**	0.010ns	0.011ns	----------	
Quilon	0.011**	0.019*	0.010ns	0.013**	----------

FIRST RECORD OF THE JAVANESE RICEFISH, *ORYZIAS JAVANICUS* (BLEEKER, 1854) (BELONIFORMES: ADRIANICHTHYIDAE) IN THE NATURAL WATERS OF INDIA

The distribution of *O. javanicus* (Fig. 1) in the natural waters of the Indian peninsula was confirmed for the first time from Muttukadu lagoon, Tamil Nadu, bringing the number of *Oryzias* species recorded from India to five (the others being, *O. dancena* (Hamilton, 1822), *O. melastigma* (McClelland, 1839) (currently in the synonymy of *O. dancena*), *O. carnaticus* (Jerdon, 1849), and the endemic *O. setnai* (Kulkarni, 1940).



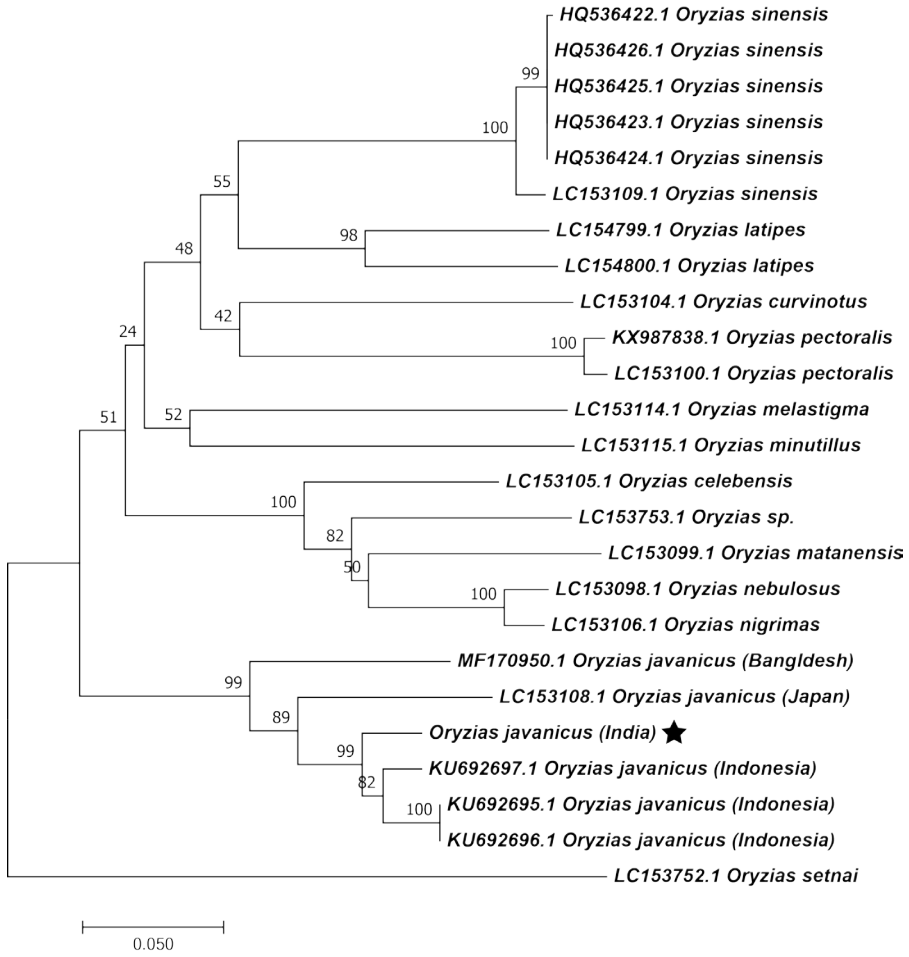
Male (a) and female (b) Oryzias javanicus collected from the Muttukadu lagoon, India

Comparison of meristic counts of *Oryziasjavanicus*

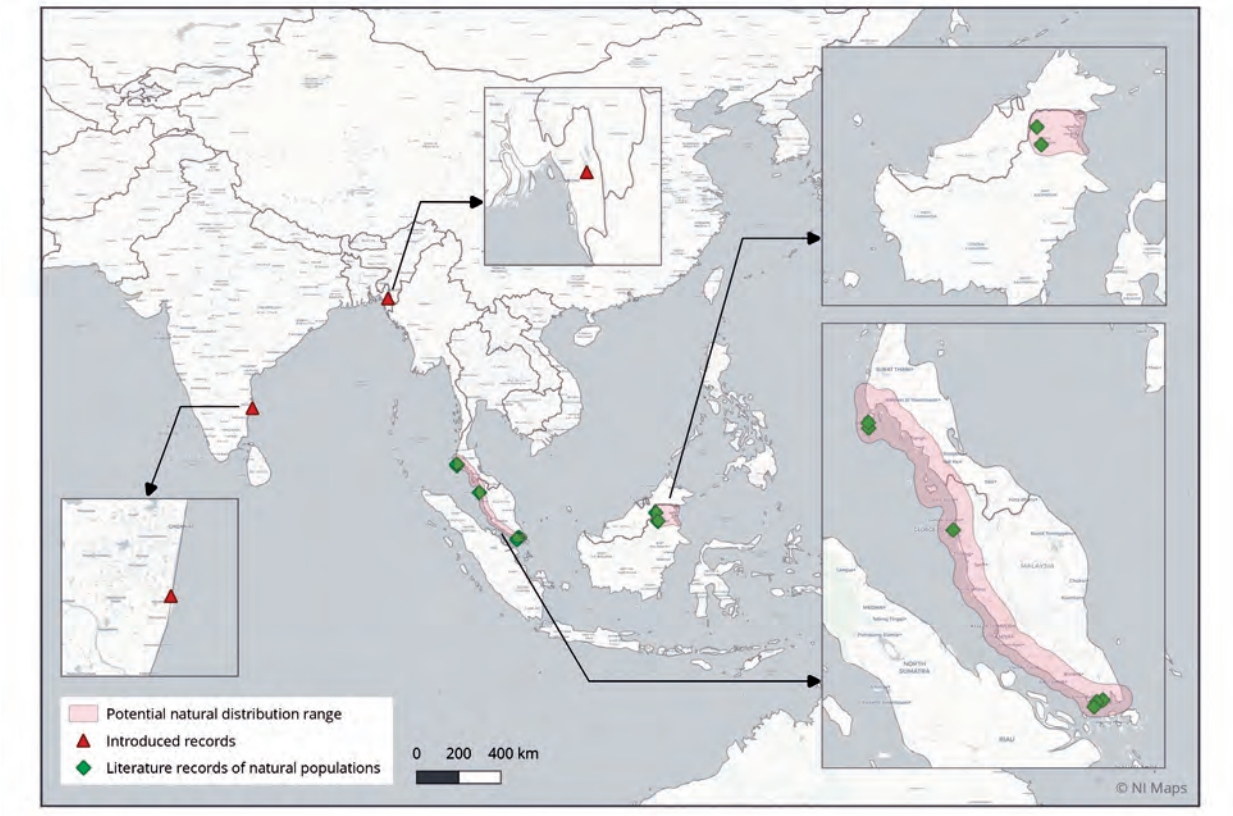
Meristic counts	Roberts (1998)	Parenti (2008)	Magtoon & Termvidchakorn (2009)	Yusof et. al., (2012)	Present study
Dorsal-fin rays	6-7	6-8	6-8	6	6
Anal-fin rays	21-25	18-25	22-26	21	20-21
Pelvic-fin rays	6	5-6	NA	6	6
Pectoral-fin rays	11	10-13	11-12	10-11	10-12
Principal caudal-fin raysa	5/6	i, 4/5, i	i, 4/5, i	i, 5/6, i	i, 4/5, i

The species shows population-level variations in their meristic counts (Table 1). *Oryzias javanicus* is very similar to *O. dancena* and *O. carnaticus,* species that are native to the Indian subcontinent; *O. javanicus* can be easily distinguished from the Indian species, by the presence of yellowish sub-marginal bands on the dorsal and ventral sides of the caudal fin.

Table adapted from Yusof et. al., (2012) with observations of the present study: [a] Rays of dorsal and ventral lobes are indicated separated by slash. Number



Neighbour-joining tree based on mtDNA COI gene of different Oryzias species together with the sequence generated in the present study.



Map showing the native distribution range of Oryzias javanicus in South East Asia, and the new record from India

of unbranched and branched rays is indicated by Roman and Arabic numerals, respectively.

The nucleotide genetic distance between the populations occurring in India and Indonesia was found to be indistinguishable, which showed the same evolutionary relatedness in neighbour-joining and maximum-likelihood analysis (Fig. 2)

The water bodies around Muttukadu currently comprise the westernmost distribution range of this species (Fig. 3). The presence of considerable number of this species in the Muttukadu lagoon of ICAR-Central Institute of Brackishwater Aquaculture (CIBA), suggests that *O. javanicus* is well established in the present locality.

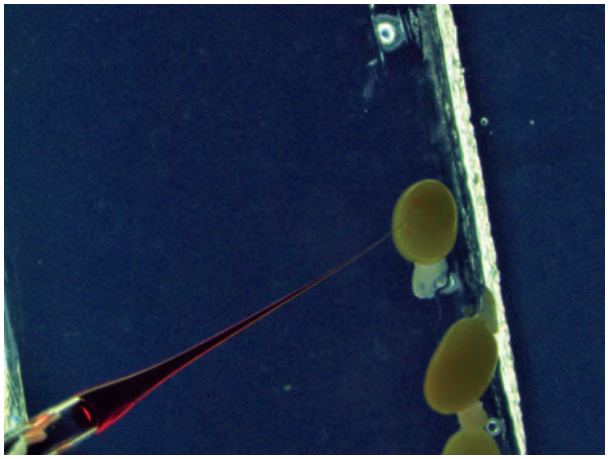
CRISPR-CAS9 MEDIATED GENOME ENGINEERING FOR GROWTH IMPROVEMENT OF *ETROPLUS SURATENSIS*

Currently, CRISPR/Cas9 is the most desirable tool for genome engineering. It efficiently introduces double-strand breaks (DSBs) in genomic DNA using cas9 and an appropriate guide RNA. For genome engineering, the myostatin gene of Etroplus suratensis has been characterized, and three different 20bp nucleotide sequences (target sequence) near to protospacer adjacent motif has been identified and synthesized. A standard PCR have done along with gene-specific oligos & constant oligonucleotide, to transcribe the target sequences into sgRNA using sp6 RNA polymerase enzyme. Three different stop codon cassette specific to each sgRNA were also designed and synthesized to include in CRISPR complex. 200ng/microliter sgRNA; 3 µM specific stop codon cassette, 600ng/microliter Cas9 Protein incubated at room temperature along with phenol red dye for 5 minutes to make CRISPR complex. About ten eggs of Etroplus suratensis were stacked one by one in an agarose gel, and each egg was injected with the injection mix @ 0.25µl using micromanipulator. Embryonic developmental stages and mortality of the eggs and larvae were documented.

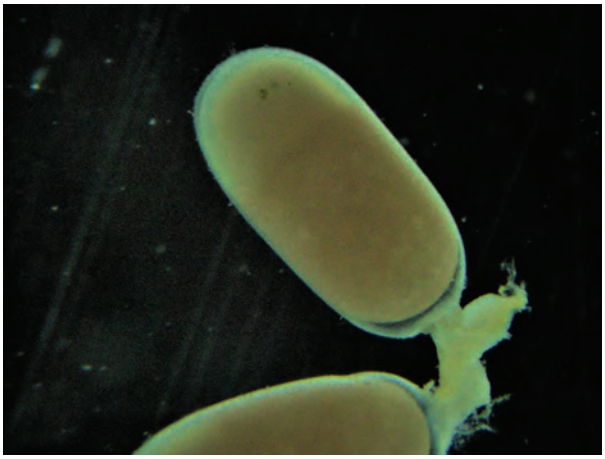




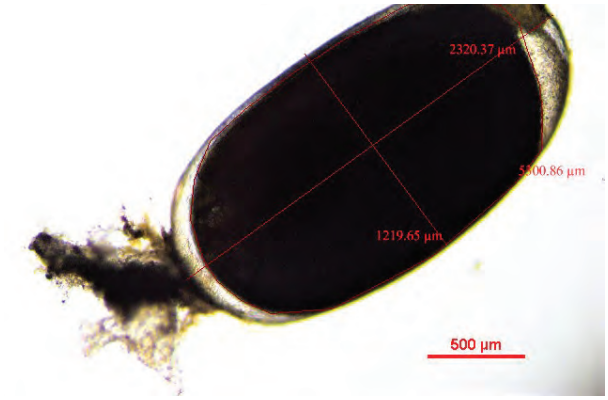
Etroplus suratensis breeding pair



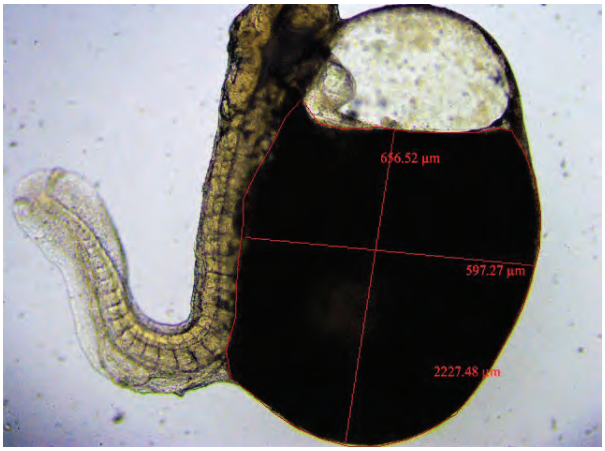
Microinjection



7hpf



24hpf



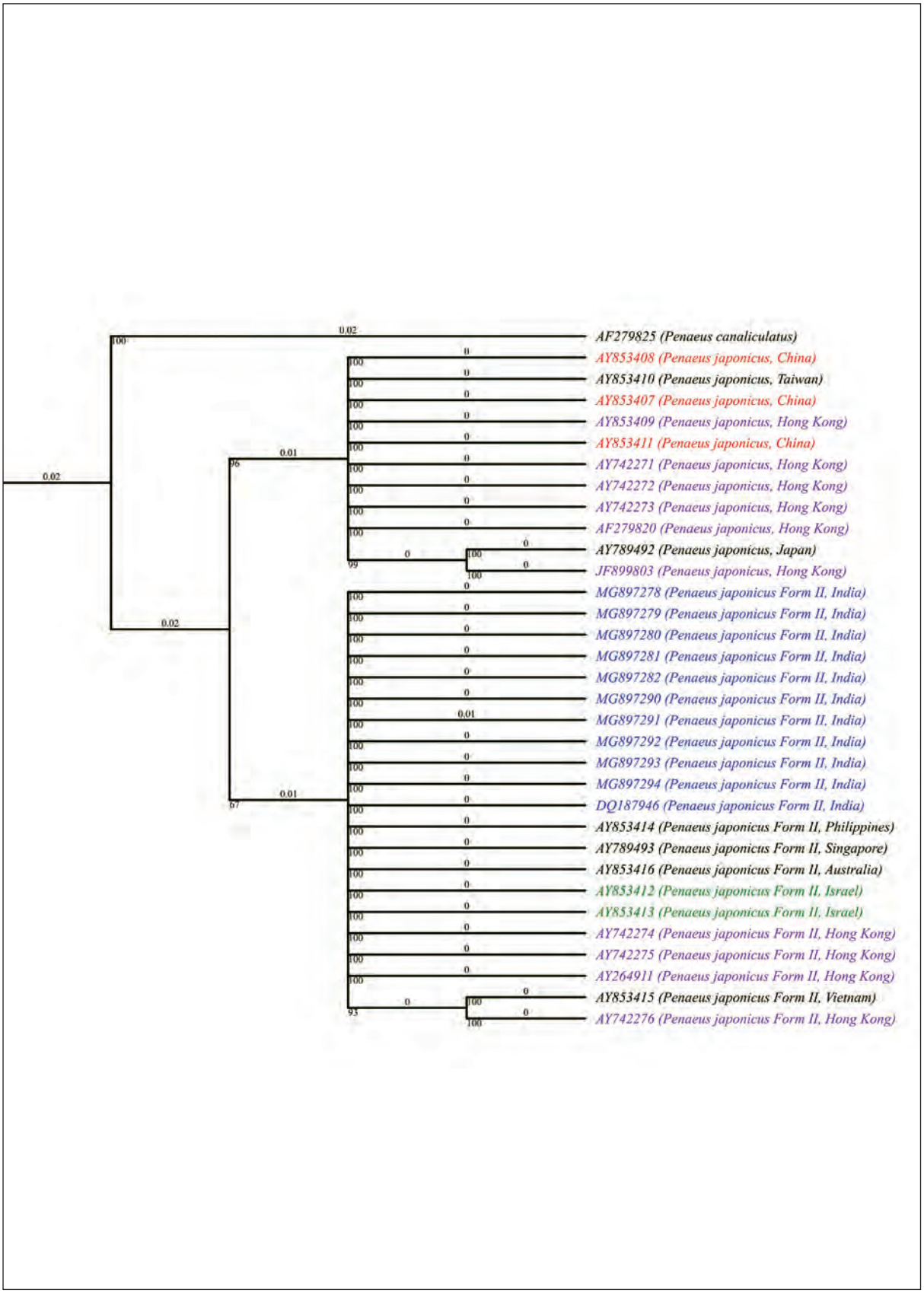
3dpf

CONFIRMING THE IDENTITY OF PENAEUS JAPONICUS FORM-II IN INDIAN WATERS USING MOLECULAR MARKERS

Penaeus japonicus was considered as a single species spread across Indo-West Pacific. However, recent studieshave shown the existence of cryptic species within kuruma shrimp, with a slight variation in banding pattern on carapace with no other noticeable morphological differences. Form-I exhibits two characteristic bands extending from the dorsal to the ventral carapace and in form-II, these bands do not extend to the lower half of carapace. Further it is confirmed through the genetic analysis that these morphologically similar varieties are genetically diverse and is reproductively isolated, forming different species. The form-I, due to the type locality of Japan retains the name P. japonicus and is confined to Japan. The form-II is verified by Tsoi et al. 2014 and fixed the name as Penaeus pulchricaudatus (Stebbing 1914)and it is widely distributed in South-East Asia, Australia, the western Indian Ocean, the Red Sea and the Mediterranean with type locality being South Africa (Great fish point). The presence of kuruma shrimp (P. japonicus) in both East and West coast of India is widely documented and has been reported in many reports. However, there is no genetic data available to conclude whether the species available in India is P. japonicusform-I or form-II.The morphological observations of Indian species matches with the form-II.Hence it is very important to identify and confirm the species in Indian waters. The phylogenetic analysis from partial mitochondrial DNA sequences from specimens obtained from both East and West coast of Indiawith the reference sequences of P. japonicusform-I and form-II revealed that the species is phylogenetically more closely allied to P. japonicus form-II/P. pulchricaudatus.



Cryptic species P. japonicus form-II/ P. pulchricaudatus, lateral view of female from Coromandel Coast.



Bayesian Inference phylogenetic tree of the 16S rRNA dataset. Numbers above branch indicates branch length and below indicates bootstrap values.

AQUACULTURE ENVIRONMENT AND CLIMATE CHANGE

IMPLICATIONS OF TRENDS IN SURFACE WEATHER PARAMETERS FOR BRACKISHWATER AQUACULTURE

Trends in surface weather parameters with base line data obtained from IMD for the years starting from 1969 to 2009 for vulnerable coastal districts identified by ICAR-CRIDA have been analyzed. Coastal districts identified include Surat in Gujarat, Alappuzha in Kerala, Nagapattinam in Tamil Nadu, West Godavari in Andhra Pradesh and 24 Paraganas in West Bengal. Annual and seasonal trends for maximum temperature, minimum temperature, amount of rainfall and number of rainy days have been projected. Analysis has been carried out using 'esd' library under R Stats environment.

Summary of trends in surface weather parameters for five coastal districts of India

Coastal district Weather parameter	West Godavari	Nagapattinam	Surat	Alapuzha	24 Paraganas
Annual					
MaxT					
MinT					
Precip					
Seasonal – MaxT					
Winter					
Summer					
Monsoon					
Post-Monsoon					
Seasonal – MinT					
Winter					
Summer					
Monsoon					
Post-Monsoon					
Seasonal – Precip					
Winter					
Summer					
Monsoon					
Post-Monsoon					
Rainy days					
➢ 1 mm					
➢ 3 mm					

Increase No trend Decrease

Increased trends were observed for maximum and minimum temperature for almost all the districts except for 24 Paraganas. The increased trends in maximum temperature will impact pond water salinity and DO levels, whereas increase in minimum temperatures would be beneficial to brackishwater aquaculture to certain extent during winter crop. There is a decline in total rainfall over the years which will impact water availability for the aquaculture. There have been negative trends observed for number of rainy days beyond 1mm and 3mm rainfall per day, indicating that the number of rainy days coming down over the years and maximum rainfall occurs in fewer days. This trend will cause sudden drop in salinity, DO, and temperature which in turn cause stress to animals and make them susceptible to diseases.

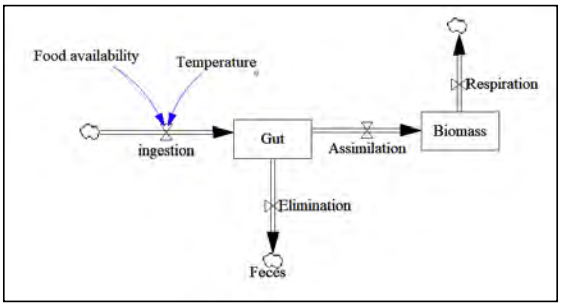
The annual average temperatures and total rainfall of base period were compared with multimodal climate change scenarios data obtained from IARI for RCP 4.5 of 2020s, 2050s and 2080s to project future values. Overall there has been around 2°C increase in the temperatures in 2080s compared to base period for all the districts under the study. There is a need to evaluate how these changes in surface weather parameters will actually impact brackishwater aquaculture through pond simulation models.

Change in climatic variables compared to base period.

Coastal district	Weather parameter	Base period	2020s	2050s	2080s	Increase
West Godavari	tmax	32.63	33.29	33.94	34.35	1.72
	timin	23.26	24.06	24.75	25.17	1.91
	Rainfall	1126.7	1121.36	1161.97	1198.57	71.84
Nagapattinam	tmax	33.36	34.8	34.8	35.2	1.84
	timin	24.29	25.84	25.84	26.26	1.97
	Rainfall	1455.2	1555.25	1555.25	1613.65	158.4
Surat	tmax	33.09	33.89	34.68	35.15	2.06
	timin	20.99	22	22.89	23.38	2.39
	Rainfall	585.81	572.9	592.7	602.67	16.86
Alappuzha	tmax	29.6	30.42	31.06	31.46	1.86
	timin	20.53	21.44	22.12	22.53	2
	Rainfall	2927.8	2827.36	2915.96	2995.7	67.93
24 Paraganas	tmax	31.16	31.88	32.65	33.13	1.97
	timin	22.09	22.99	23.76	24.24	2.15
	Rainfall	1803.7	1806.77	1871.33	1919.26	115.6

SYSTEM DYNAMIC CLIMATE MODELS FOR SHRIMP AQUACULTURE

System dynamics models are simulation models to abstract individual processes involved in aquaculture through mathematical functions. The processes such as feed conversion, growth dynamics, biomass production, nitrogen dynamics, carbon dynamics and changes that affect growth of the animal due to several biotic and abiotic factors during shrimp culture period need to be captured in the model. Relational diagram was developed by considering all the processes involved in shrimp aquaculture. Different stock variables in the model include body weight, biomass, total N, plankton, microbial load, DO levels, salinity etc. In order to check the impact of temperature on gut content, a model involving feed ingestion, assimilation and elimination processes was constructed. Python module PySD and XMILE scripts are being used for building the models.



Sub process to estimate impact of temperature on gut content.

DAMAGE TO SHRIMP FARMS DUE TO CYCLONIC STORM GAJA

The Cyclonic storm Gaja which had a land fall during the early hours of 17th November, 2018 and its associated floods have made substantial damage to shrimp farming area of approximately 1926 ha in Nagapattinam, Thanjavur, and Pattukottai districts of Tamil Nadu. About 50-60% of the farming area had a standing stock in the four districts and the crops were in the duration of 70-90 days. The average size of shrimps in the pond during the extreme event was 10-12 g. About 90% of the shrimp farms in the affected area were small and marginal to the tune of 2-3 ha. The wind speed of 120-140 kmph damaged the infrastructure (breach of farm bunds, store sheds, electrical lines, aerators, motors, pumps. etc) in the shrimp farms. In about 20% of the affected areas, the shrimp farms were in the low lying area and were totally inundated, shrimps escaped from the ponds and loss of production and infrastructure was 100% for those shrimp farmers. Many farmers were forced to go for distress harvests due to lack of electricity for providing aeration and disease outbreaks in the standing crop due to poor weather conditions and water quality deteriorations. The loss assessed by the State Fisheries Department was Rs. 711 lakhs, much less than the actual assessed damage. Farmers are demanding for separate relief package for shrimp farming to rebuild the farms and take up the farming in the coming season, a comprehensive insurance scheme to be developed and implemented for shrimp farming and support with an institutional credit scheme with a low interest rate to redevelop the infrastructure.



A



B

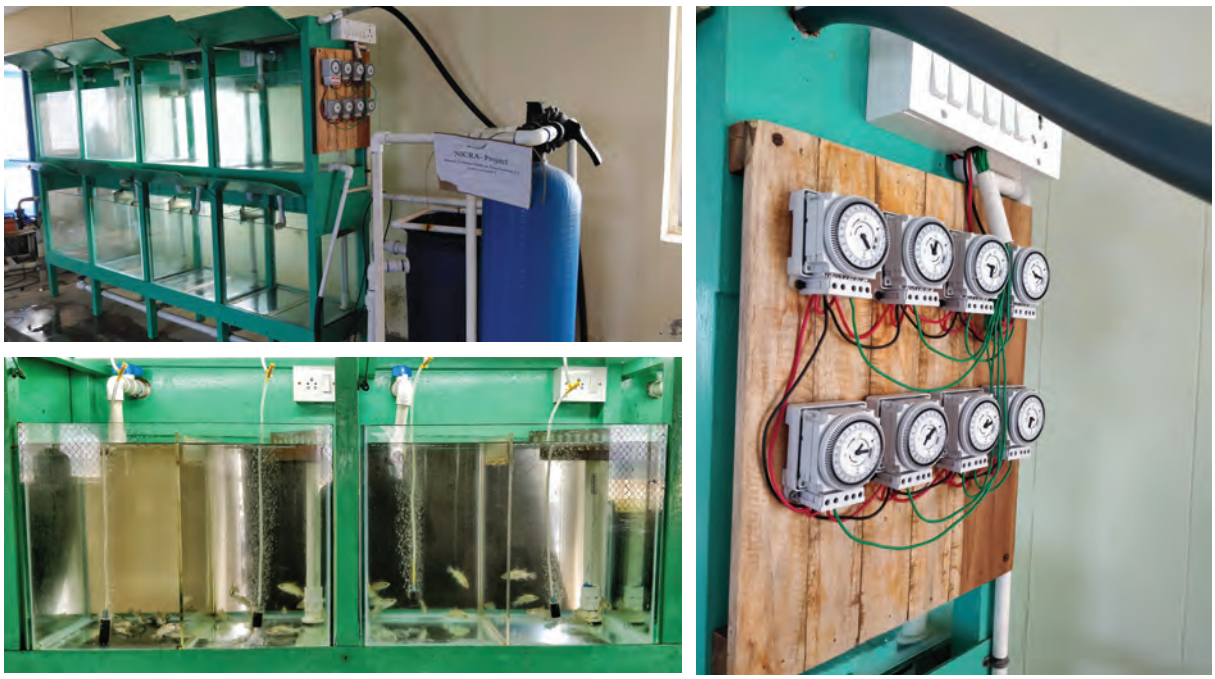


C

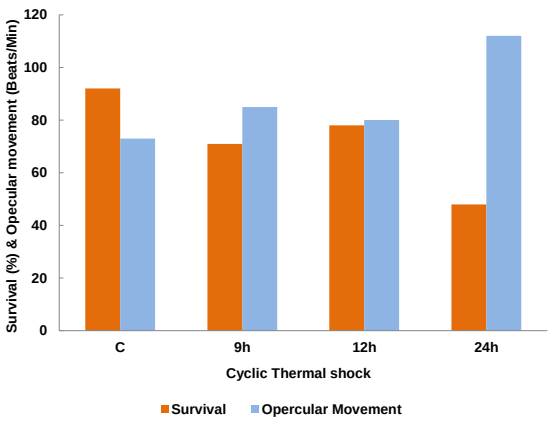
Gaja cyclonic storm damage to A. Farm shed and aerators
B. Pond dykes and C. Loss of stock due to power failure and water quality deterioration

EFFECT OF DIURNAL THERMAL SHOCK ON SEABASS JUVENILES

In the aim to mimic effect of heat waves shock *in vivo*, heaters were assembled in the fabricated environmental manipulation unit with automatic electronic timers. A 15 days experiment was conducted where diurnal heat shock (34 °C) of different durations i.e. Control (RT), 9h, 12h and 24h (chronic) generated to assess the sea bass (TL - 7.5 cm; average body weight - 5.5 g) response towards cyclic heat shock versus chronic heat shock. It was found that seabass is more sensitive towards daily 9h heat wave, as survival (71%) was significantly less than 12h group. As a sign of heat sensitivity, seabass fry performed more opercular beating (85 beats/min) in 9h group compared to 12h group (80 beats/min), may be due to increased physiological need for oxygen under thermal stress. It is evident that sea bass is more stressed when 9h shock is given as it has less time to adapt physiologically. Minimum survival (48 %) and maximum opercular movement (112 beats/min) were found in 24h (chronic) heat shock. This study confirms elimination of agro-climatic zones having average water temperature of 34 °C for more than 9 hours daily during summer months, as a nursery rearing area for seabass.



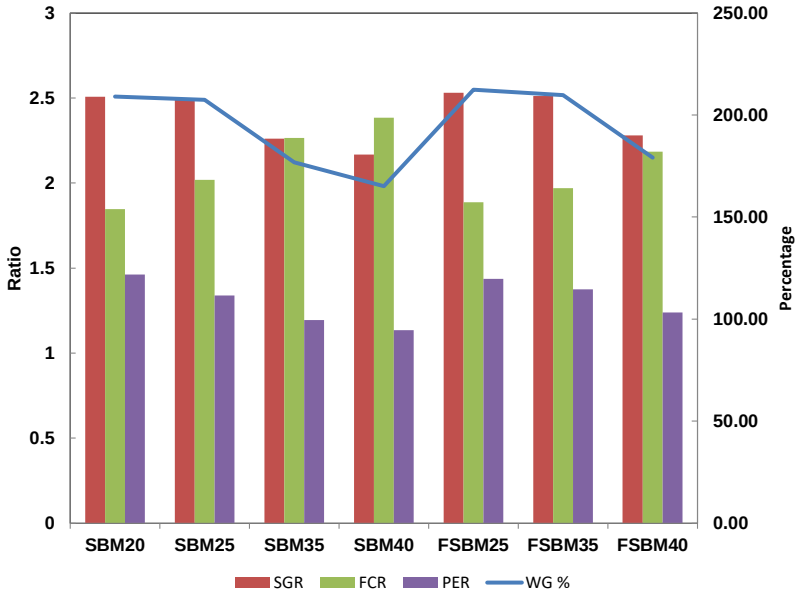
Automation in insitu environmental manipulation unit with electronic timers



Survival and opercular movement of Seabass exposed to heat wave shock

EFFECT OF SUPPLEMENTATION OF PHOSPHOLIPID, SOYLECITHIN FOR AMELIORATION OF TEMPERATURE STRESS IN P. VANNAMEI

In our earlier studies on the effect of temperature on growth and nutrient utilization at 29, 31, 33 and 35 ^{0}C in *P. vannamei,* better survival and growth was observed between 31 and 33 ^{0}C. Yard experiments were carried out to study the effect of supplementation of higher level of phospholipid, soylecithin at 31 and 35 oC. Three experimental diets were prepared with varying levels of lecithin viz., 1, 1.25 and 1.50% and tested in the juveniles (2.62±0.12 g) of *P.vannamei* in a 45 day feeding trial. The supplementation of 25% higher lecithin has improved the weight gain (%) from 134.2 in control to 144.03 at 31 °C. At 35 °C, the weight gain values were 109.0 and 134.9 at 1 and 1.25% lecithin inclusion, indicating better improvement at 35 °C. The increase of lecithin level beyond 1.25% has shown negative effect at both 31 and 35 °C.

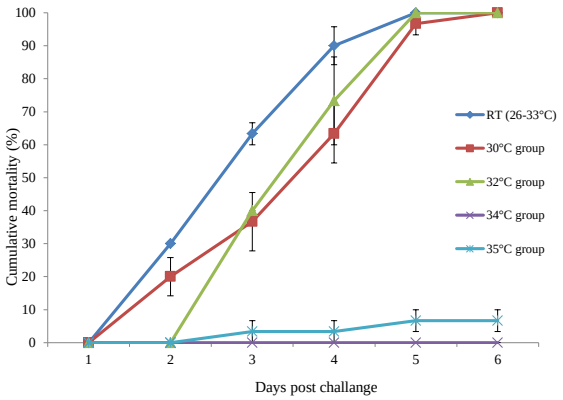


Effect of soylecithin supplementation for amelioration of temperature stress in P. vannamei

EFFECT OF REARING TEMPERATURE ON WSSV OUTBREAK IN SHRIMP

Regular monitoring for environmental parameters and pathogenic agents was carried out in two *P.vannamei* cultured shrimp farms in Pazhaverkadu area, Thiruvallur District. During the study period of 98 days of culture, the farm management kept environmental parameters ideal for farming and no pathogens were detected. In the month of November 2018, the region experienced heavy rain fall due to the cyclonic effect causing drop in water temperature (from 28-31°C to 21-22°C) and salinity. As a result, the shrimp farms in the region experienced WSSV outbreak resulting high mortality of the farmed shrimp. Customised environmental parameter controlled fish/shrimp rearing system was fabricated for studying the fluctuations in temperature and salinity on disease occurrence. P.vannamei were maintained in five groups, room temperature (26-33°C), 30, 32, 34 and 35°C for seven days and were challenged with WSSV (107 copies/L) for two hours by immersion and maintained at the respective temperature group to assess the infectivity and mortality rate. Shrimp in room temperature (RT), 30, and 32°C experienced 100% mortality within 6 days post challenge and the dead/moribund shrimps tested 1st step positive by PCR. The shrimps reared in 34 and 35°C experienced 0% and 7% mortality respectively and both were 2nd step positive. The study confirms the role of temperature on WSSV infectivity and mass mortality. Further study on the effect of diurnal variation in temperature and heat



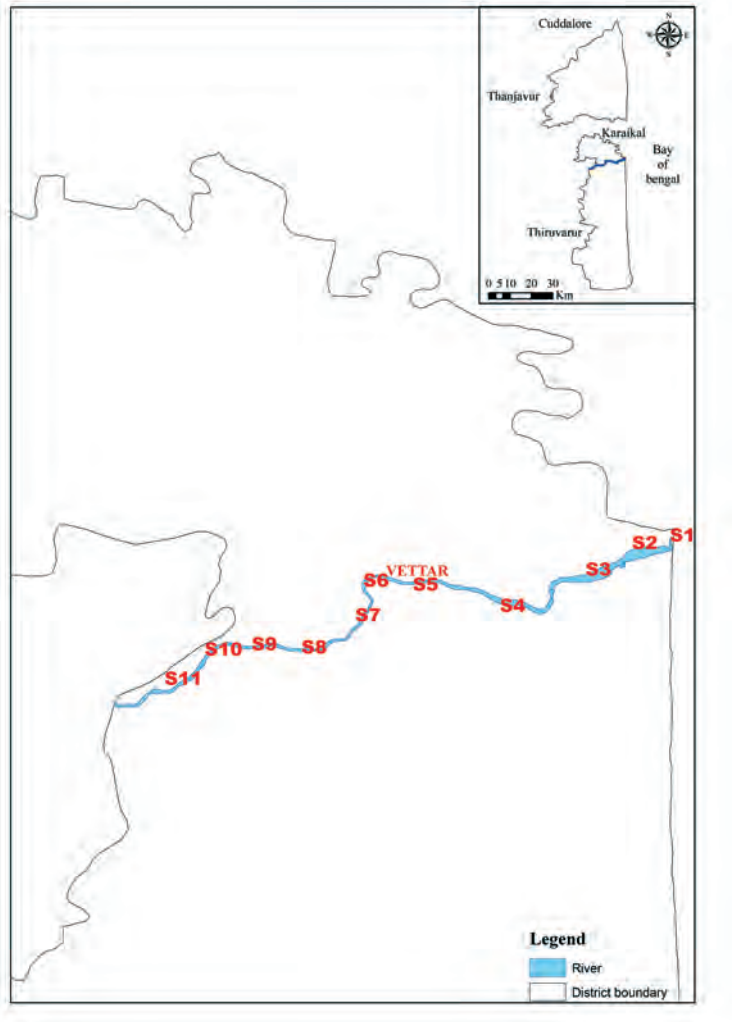


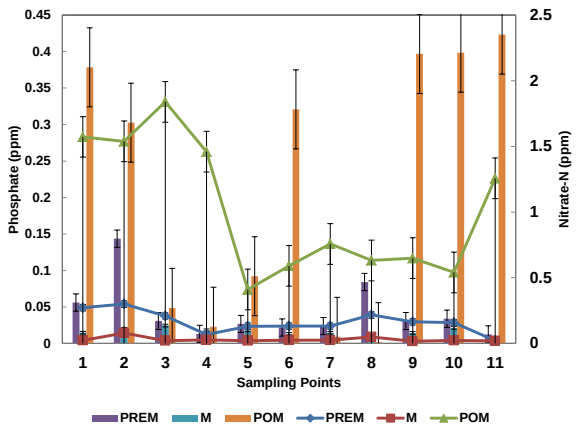
Influence of water temperature on shrimp mortality

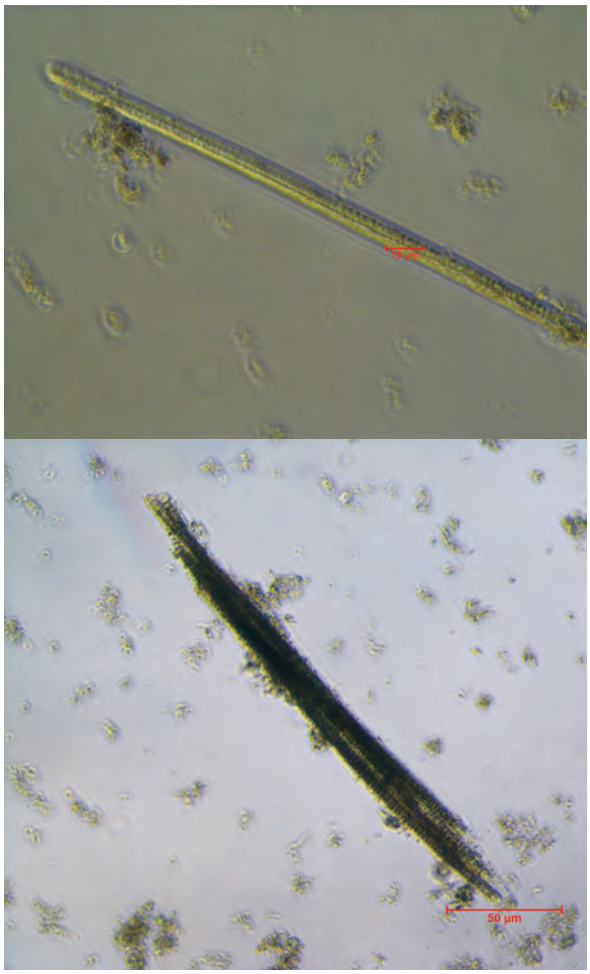
wave shock on disease outbreak will provide detailed insight into the role of weather parameters and climate change in induction of WSSV outbreak in shrimp farms.

EFFECT OF SEASONAL CHANGES ON WATER QUALITY PARAMETERS AND CARRYING CAPACITY OF VETTAR ESTUARY

Water samples were collected from 11 different sites in Vettar Estuary, Nagapattinam District, Tamil Nadu during pre-monsoon, monsoon and post-monsoon to assess the seasonal changes on water quality and its carrying capacity. The salinity and pH ranged from 30-44, 8-30 and 32-54 ppt and 7.3-8.3, 6.9-7.5 and 7.5 – 8.1 during pre-monsoon, monsoon and post-monsoon, respectively. The eutrophic nutrients such as nitrate and phosphate were found to be highest during post-monsoon (0.955 and 0.218 ppm) followed by pre-monsoon (0.164 and 0.039 ppm) and monsoon season (0.0.029 and 0.016 ppm). Phytoplankton dominance also varied with the season. *Oscillatoria* sp was dominant during post monsoon





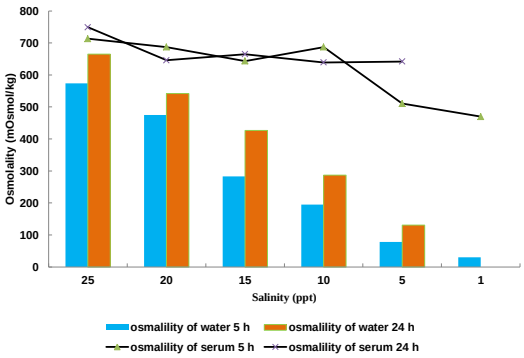


Dominant plankton species A. Oscillatoria sp. during post-monsoon and B. Trichodesmium sp. during pre-monsoon

and *Trichodesmium* sp was found to be dominant during pre-monsoon. The carrying capacity based on nutrients loading was found to be highest during the monsoon season with 133 kg/day followed by pre-monsoon (83 kg/day) and least during post-monsoon (64 kg/day). Nitrogen concentration was high during monsoon and pre-monsoon and during post monsoon season phosphate was the limiting nutrient which reduced the carrying capacity due to inflow of phosphate form the watershed area after the monsoon runoff.

ADAPTATION OF P.VANNAMEI TO CLIMATE CHANGE INDUCED SALINITY VARIATION

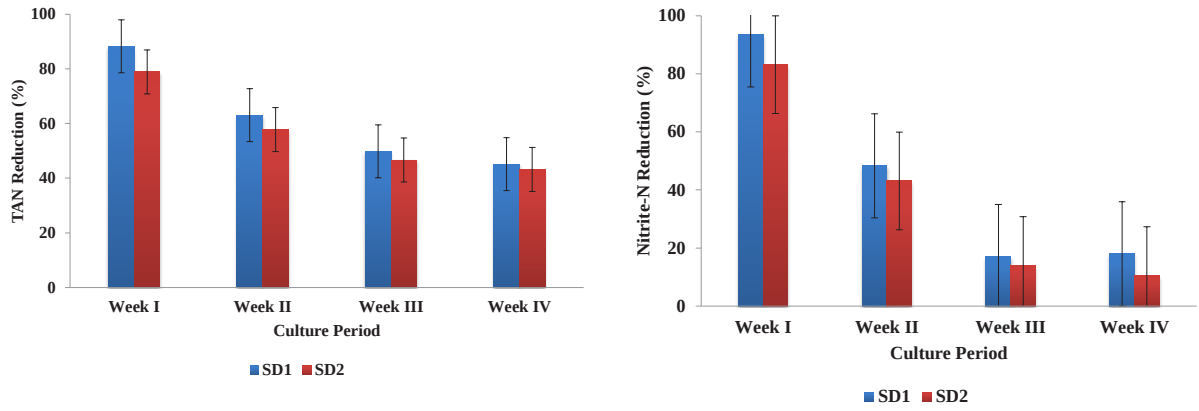
During extreme climatic events like flood, the salinity of shrimp pond water decreases sharply. To study the adaptation of *P.vannamei* under such sudden changes, the salinity of the water was reduced from 25 ppt to 20, 15, 10, 5 and 1 ppt in the yard experiment and the water and hemolymph were collected at 5 and 24 hours. Under the salinity variation of 25 to 5 ppt, water osmolality varied from 78-475 and 130-542 mOsmol/kg at 5 and 24 h respectively, whereas serum osmolality varied within a short range of 510-687 mOsmol/kg at 5 h and further narrowed and stabilized (639-665 mOsmol/kg) at 24 h. Shrimp survival was 95 % upto 5 ppt, only 20% in 1 ppt at 5 h and 0% at 24 h. Although *P.vannamei* is able to adapt quickly to changes in salinity due to its osmoregulatory capacity, it is unable to withstand the drastic change in salinity from 25 to 1 ppt. However, *P.vannamei* survived well even in < 1 ppt stable salinity in field and yard studies.



Influence of drastic water salinity on osmolality of serum and water at 5hs and 24hrs

EFFECT OF CLAY POLYMER ADSORBENT ON NITROGEN METABOLITES CONCENTRATION IN P.VANNAMEI CULTURE

In shrimp farming to overcome the problem of nitrogen metabolites viz., total ammonia nitrogen (TAN), and nitrite nitrogen (NO_2-N), application of adsorbents like zeolites, probiotics and water

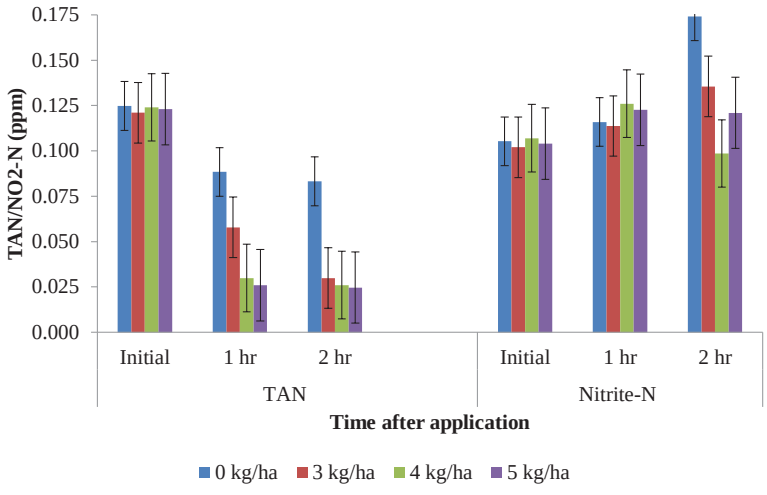


Effect of clay polymer based adsorbent on percent reduction in TAN and Nitrite-N in P.vannamei rearing tanks at different stocking density

exchange, is the common practice. Clay-polymer based adsorbent was synthesized and evaluated for its effectiveness in the management of these metabolites. *P. vannamei* were stocked at two stocking densities (60 and 90 no/m^2) in100 L FRP tanks at 28 ppt salinity. The adsorbent was added at weekly interval @ 2.5g/ 100 l. The percent reduction of TAN was 88.3 and 78.9 during the first week and it reduced to 45.1 and 43.2 in the fourth week at lower and higher stocking density, respectively. Similarly, the NO_2-N level was reduced by 88.2 and 78.1, 18 and 10.5 percent during the first and fourth week at lower and higher stocking density, respectively. The efficiency of the adsorbent can be enhanced by raising the dose and frequency of application. The result indicates the use of synthesized adsorbent as an amendment for nitrogen metabolites management in shrimp culture.

EFFECT OF OXYGEN RELEASING COMPOUND ON WATER QUALITY DURING SHRIMP CULTURE

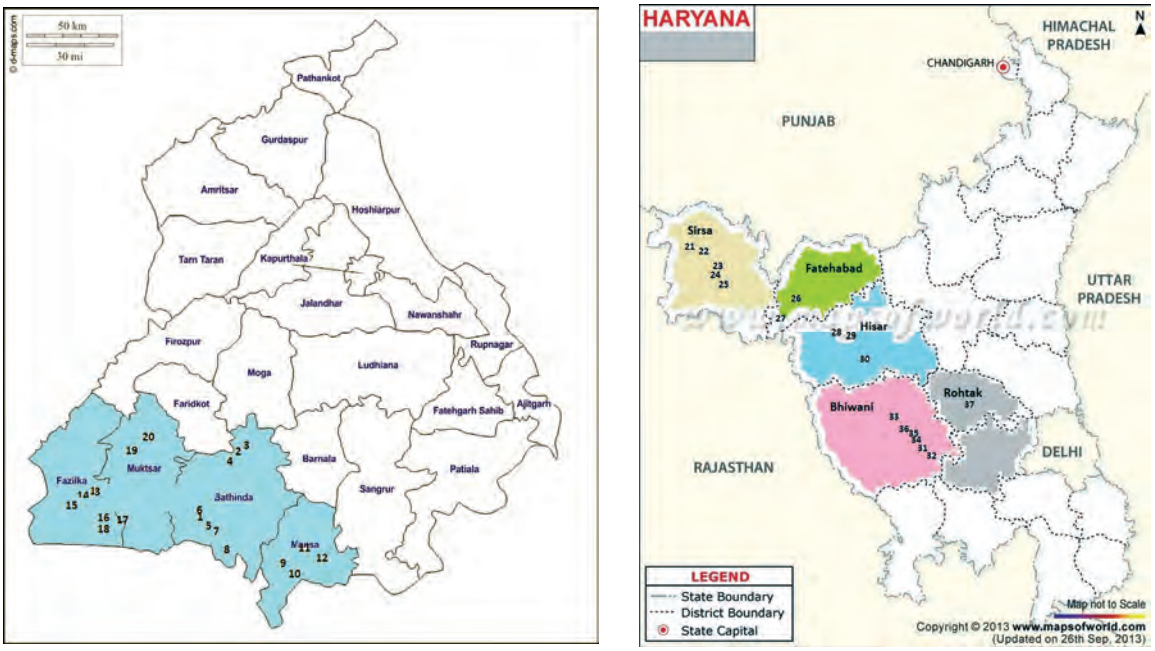
To study the effect of developed oxygen releasing compound (ORC) on water quality, 3, 4 and 5 kg ORC was applied per ha and water quality parameters were monitored at different time intervals. ORC enhanced the dissolved oxygen level to 7.5, 9.2 and 12.1 ppm from initial value of 4.8 ppm at 3, 4 and 5 kg/ha, respectively. Apart from enhancing the dissolved oxygen levels, total ammonia nitrogen reduced to 0.025 ppm after 2 h of ORC application from the initial value of 0.125 ppm. Higher dose (5 kg/ha) of ORC resulted in the plankton crash. Based on the DO levels and other water quality parameters, the optimum dose was found to be 3 kg/ha.



Effect of oxygen releasing compound on nitrogen metabolites concentration

ASSESSMENT OF SUITABLE SITES FOR INLAND SALINE AQUACULTURE IN PUNJAB AND HARYANA

In India, salt-affected soils are spread over 6.74 m ha and likely to increase to 16.2 m ha by 2050 (ICAR-CSSRI, 2019). Salt-affected soils concentrated in North western parts of India comprising Punjab, Haryana, Rajasthan and Gujarat. To assess the degraded land for inland saline aquaculture, soil (34) and water (33) samples were collected from selected districts of Punjab and Haryana. The salinity, pH, hardness and alkalinity ranged from 2-20 ppt, 7.2 to 8.3, 540-6570 ppm and 126-601 ppm respectively. The no. of samples with in the optimum range for critical water parameters indicated that 95, 52 and 37 per cent inland saline waters were deficient in potassium, magnesium and calcium that warranted for mineral supplementation.



Sampling locations in Punjab and Haryana

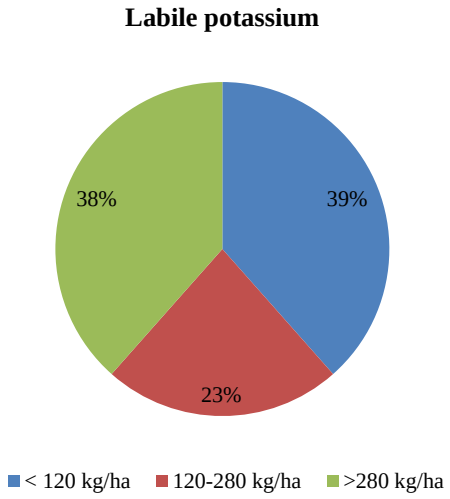
Mineral profile and chemical properties of inland saline waters

Sl.No	Water Parameter	Range	Samples in optimum value (%)
1	pH	7.16-8.27	100
2	Salinity (ppt)	2-20	70
3	Total Alkalinity (ppm CaCO3)	126-601	88
4	Total Hardness (ppm CaCO3)	540-6570	79
5	Calcium (ppm)	72-1080	63
6	Magnesium (ppm)	88-1181	48
7	Potassium (ppm)	2.1-46.3	5

POTASSIUM SUPPLYING CAPACITY OF INLAND SALINE SOILS

Inland saline waters are deficient in potassium and rich in calcium, and results in imbalanced ionic ratios. To rectify the skewed ratio, minerals should be applied externally. As soils could also be a source of potassium, potassium supplying capacity of inland saline soils of Rajasthan was evaluated by quantification of potassium fractions viz., water-soluble, exchangeable, non-exchangeable and total. The water-soluble, exchangeable, non-exchangeable

and total potassium varied between 15 to 223, 27 to 814, 78-911 and 305 to 2275 kg/ha. Among the studied soils, 39% are low, 23% are medium and 38% are high in potassium fertility status based on labile K content. The soils from Jaitpura, Ajitpura, Jogni and Kishangarh were rich in labile potassium and could contribute to balance the skewed ionic ratio.



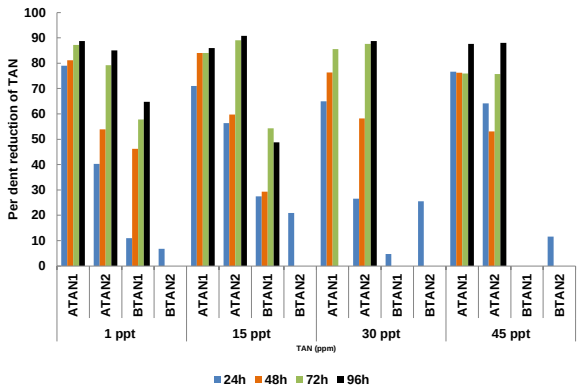
Potassium fertility status of inland saline soils of Rajasthan

MYCOTIC BIOREMEDIATION OF TOTAL AMMONIA NITROGEN IN VARYING WATER SALINITY

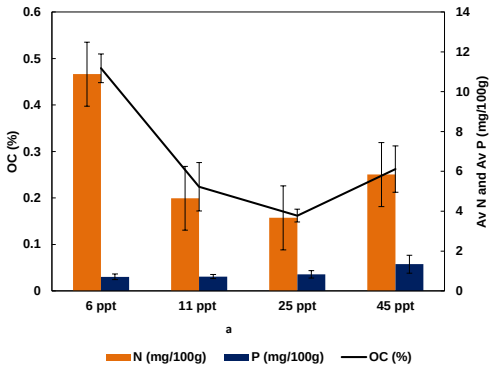
In vitro studies were conducted using the *Pleurotus erygnii* [A] and *Pleurotus ostreatus* [B] for remediating the nitrogenous metabolites. Both the species were applied @ fungal load of 10^4 CFU ml^{-1} in different salinity waters (1, 15, 30 and 45 ppt) spiked with total ammonia nitrogen concentration of 1 and 2 mg l^{-1}. Water samples were analyzed for TAN at periodic intervals 0, 24, 48, 72 and 96 h. TAN showed a reduction of more than 80% in 1, 15 and 30 ppt and less than 80% in 45 ppt within 72 h with *P. erygnii*. It was found that the *P. erygnii* has more potential to remediate total ammonia nitrogen in varying water salinities.

CARBON DYNAMICS IN RELATION TO OTHER NUTRIENTS IN SHRIMP CULTURE PONDS

The variations in carbon concentration along with other nutrients like nitrogen and phosphorus in pond sediment of *P.vannamei* culture ponds varying in water salinity were studied. The shrimp culture ponds of varying salinity (6, 11, 25 and 45 ppt) were chosen in Elavur Village, Tiruvallur Distrct, Tamil Nadu within a perimeter of 5-10 km and carbon, nitrogen and phosphorus concentrations in the sediment during the culture period were determined. The average organic carbon content (0.48 %) in the sediments of low saline areas was found to be higher than that of high saline areas and decreases with increasing salinity, except at 45 ppt (0.26 %). Available nitrogen content varied from 3.6 to 10.8 mg/ 100 g and observed to follow the same trend as that of organic carbon. The available phosphorus content (0.7 to 1.3 mg/100 g) was observed to follow a reverse trend, an increase in concentration with increasing salinity. To further comprehend the changes in soil organic matter, water-soluble carbon (WSC) pool was studied. The WSC (mg/kg) was found to increase with salinity: WSC_{45} (2.5)> WSC_{25} (2.2)> WSC_{11} (2.1)> WSC_{6} (1.4).



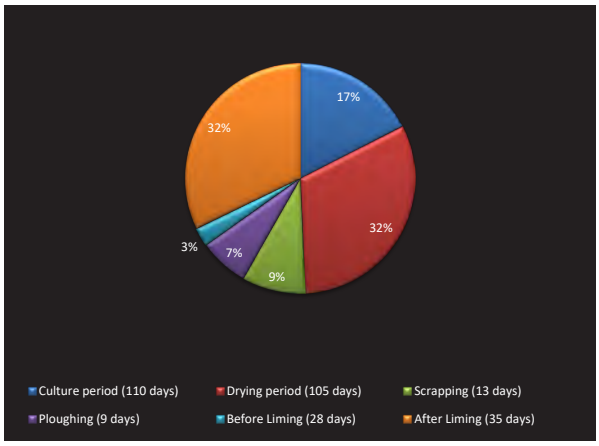
Effect of Pleurotus sps.on TAN in different salinities

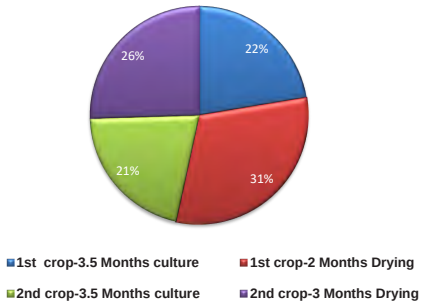


Carbon, nitrogen and phosphorus content in pond sediment (average of 3 samples) under varying salinities

CONTRIBUTION OF CULTURE PRACTICES FOR GREENHOUSE GASES EMISSION IN SHRIMP FARMS

Studies were conducted in shrimp farms with single crop and two crops per year to assess the contribution of culture, fallow period and drying practices on GHGs emission. In the shrimp farms with single crop culture period of 110 days, the CO2 equivalent emission varied from 110-134 kg/ha. After harvest during the drying period, emission rate increased seven times (755 kg/ha) on the 3rd day of harvest compared to culture period and decreased gradually during fallow period. After scrapping and ploughing, GHGs emission increased thrice (360 kg/ha) and twice (282 kg/ha) compared to culture period. The highest CO_2 equivalent emission was recorded after liming, 13 times more (1304 kg/ha) compared to culture period. Single crop culture period of 110 days, drying period of 105 days, scrapping period of 13 days, and ploughing period of 9 days contributes 17%, 32%, 9 and 7% of total GHGs emission. In two crops per year, during the 1st crop, the CO_2 equivalent was 90 kg/ha on DOC 5 and increased gradually to 520 kg/ha on 90 DOC. After harvest emission increased 1.7 times (900 kg/ha) compared to culture period and decreased gradually to 216 kg/ha after 55 days of drying. During the second crop, CO_2 emission was 493 kg/ha on 90 DOC. During drying period, after one week of harvest, emission was 2.25 times more (1111 kg/ha) and decreased gradually to 113 kg/ha on the 80th day after harvest. The first crop culture period of 3.5 months, drying period of 2 months after 1st crop, second crop culture period of 3.5 months and drying period of 3 months after second crop in a year contribute to 22, 31 21 and 26 per cent of total CO_2 emission equivalent.

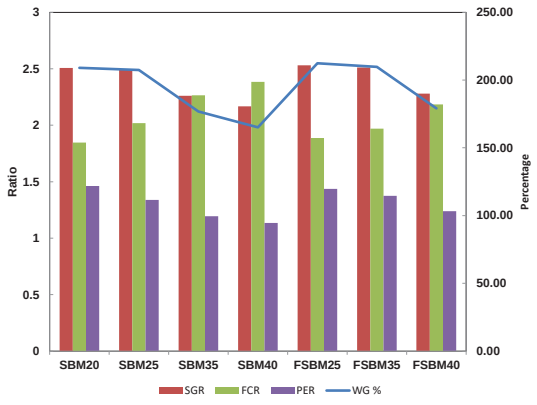


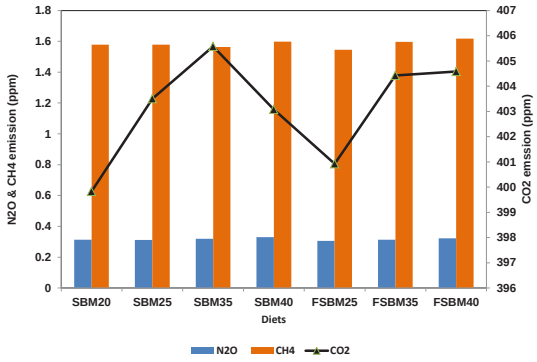


Contribution of culture practices on GHGs emission from shrimp farms A. Single crop per year B. Two crops per year

EFFECT OF SOLID STATE FERMENTATION OF SOYBEAN MEAL ON GREENHOUSE GASSES EMISSION IN P. VANNAMEI

The development of alternatives to fish meal should not compromise the production performance and also should not increase the emission of greenhouse





Effect of varying levels of unfermented and fermented soybean meal in the diets of P. vannamei on A. Growth and nutrient utilization and B. Greenhouse gases emission

gasses (GHGs) into the environment. In the present study, soybean meal was subjected to solid state fermentation using *Aspergillus niger*. Seven experimental practical shrimp diets were prepared by incorporating various levels of raw and fermented soybean meal viz., 20% raw soybean as control, and six treatments 25, 35 and 40% of raw and fermented soybean meal. These diets were fed to the juveniles of *P. vannamei* (3.88 ±0.062 g) for evaluation of growth and nutrient utilization in 500 L FRP tanks with three replications for each diet. After 45 days of growth trail, six shrimp from each replicate tank were transferred to 100 LFRP tank specifically designed for measuring the GHGs emission. The GHGs were measured once in three days for 12 days. Increase of raw soybean meal beyond 25% and fermented soybean meal beyond 35% has reduced the growth performance and nutrient utilization efficiencies. Among the three greenhouse gasses, nitrous oxide (N_2O) emission was significantly ($P<0.05$) different with dietary treatments. The fermented soybean meal inclusion has significantly ($P<0.05$) reduced the emission of N_2O at 40% soybean meal inclusion level. This may be due to the lower apparent dry matter and crude protein digestibility values of raw soybean meal (78.46 and 89.46%) compared to fermented soybean meal (91.71 and 95.49%), respectively. CO_2 and CH_4 emissions were not influenced by the dietary treatments.

SOCIAL SCIENCE AND DEVELOPMENT

DATABASE MANAGEMENT ON INDIAN BRACKISHWATER AQUACULTURE : AQUASTAT INDIA 2018

ICAR-CIBA created a statistical compilation, the first comprehensive database on the world and Indian brackishwater aquaculture scenario. Aquastat consists of an updated database on aquaculture resources, production, trade, and consumption from 1991 to 2017. It also attempted to include economic loss due to important diseases, doubling of farmers income, and review for World, India, and States. This work is significant as ICAR-CIBA has been mandated to act as a repository of the database on brackish water aquaculture. The technical information provided in "Aquastat India 2018" would be useful for all fishermen, researchers, and other stakeholders.

This compilation is unique in nature, and technical information provided in "Aquastat India 2018" would be useful for all fishermen, researchers, and other stakeholders.



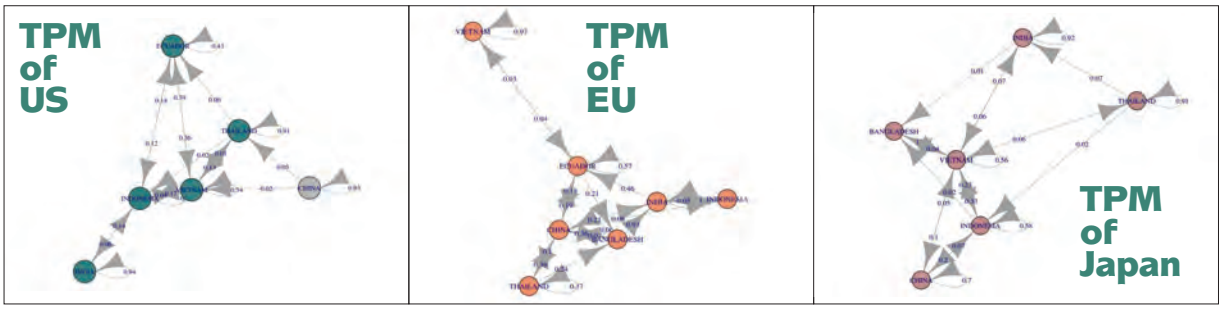
Aquastat India 2018

INDIAN SHRIMP EXPORT PERFORMANCE FROM 2002-18

Methodology on Transition Probability Matrix using LINGO (Version 10) Package for shrimp exports was created to convert the data into a Linear Programming (LP), and Transitional probability matrix (TPM) values were estimated. The TPM indicated that India retained its share of 94%, and lost 6% to Indonesia in the US shrimp market. However, India gained 14 percentage of Indonesian share in the US shrimp market during the same period. China, and Thail, and retained their share of 93%, and 91% respectively, from 2002 to 17. Indonesia, Ecuador, and Vietnam lost their share of 30, 58, and 66 % to the other countries.

THE DIRECTION OF SHRIMP TRADE FROM THE US, EU, AND JAPAN: METHODOLOGY ON MARKOV CHAIN ANALYSIS: TRANSITIONAL PROBABILITY MATRIX (TPM) BY R SOFTWARE

Over the period, India in US shrimp market gained an almost complete share of Indonesia, and Bangladesh



TPM of shrimp imports

The trend of shrimp exports, and rejections from 2002-18

Country	Compound Growth Rate of exports/rejection						RCA		Instability index	
	2002-2010		2011-18		2002-18				2002-18	
	Exports	Rejections	Exports	Rejections	Exports	Rejections	2002-2010	2011-18	Exports	Rejections
US	-10.26	-23	25.59	2.71	13.84*	-1.1*	2.7	3.2	4.3	10.8
EU	6.52	-3.61	5.73	14.9	5.16*	-4.03*		4.74	6.6	11.6
Japan	-1.47	1.06$	2.71	-9.27	2.57*	23.8**	4.1	4.7	1.8	31.1

Note: Data for rejection: Japan (2006-17)*, Indicate significance at 1% , and 5% respectively**

shrimp market in the EU, and managed to retain half of its exports over the period (2012 to 17). Ecuador gained maximum Indian share (47%) of the EU market. Vietnam was able to maintain 97% of its quota, whereas Ecuador, Thail, and China retained 57, 37, and 6% of their shares, respectively. India kept 92% of its share of the Japanese shrimp market, losing marginally to Vietnam (7%), and Bangladesh (1%) throughout 2002-17. Thail, and China retained their share of 91 and 70% respectively, while Indonesia and Vietnam retained half of their share in the Japanese shrimp market during the same period.

Compound Growth Rate of rejections of Indian shrimp exports to the US declined sharply by 23% in 2002-10, while it became -0.27 in 2011-17, overall period, the rejection rate remained at -2.42%. It may be seen along with the growth rate of exports by -10.26%, 26.40%, and 12.57% for the periods respectively. Similarly, Indian shrimp exports to EU grew from 4.55% (2007-10) to 18.36% (2011-17) while the rate of rejections increased from -3.61% to 3.34% in terms of CAGR during the same period. Indian exports to Japan grew marginally by 2.46% with higher rejections CAGR of 28.10%. However, during the first half of the study period, Indian shrimp exports to Japan declined by 1.47%, and rejections grew by 1.06% while in the second half of the period of study, exports grew by 2.56%, and rejections declined by 9.27%.

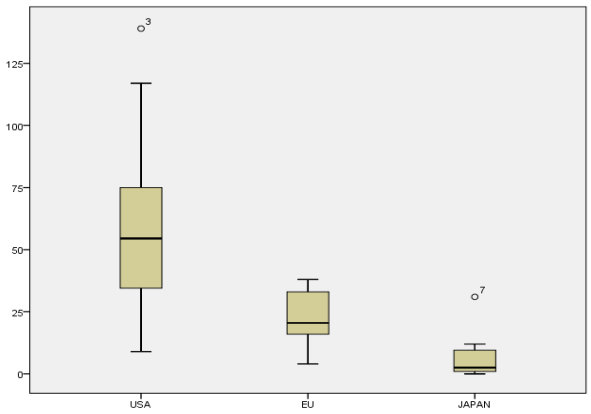
Analysis of instability in Indian shrimp exports, and rejections during the study period revealed higher variations in rejection by Japan while exports stayed relatively stable (2.48%). Exports to the US, and EU, and their denials remained steady at 6.90%, and 7.48% for exports, and 11.89%, and 12.14% for rejections respectively.

DATABASE MANAGEMENT ON SHRIMP EXPORT REJECTION BY THE US, EU, AND JAPAN FROM 2002 TO 2018

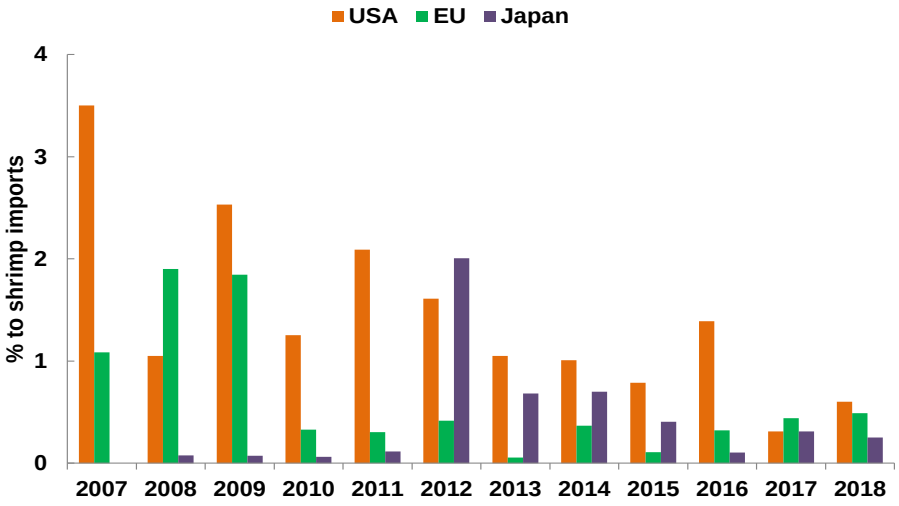
The export rejection database collated from trade portals of India, USA, EU, and Japan on shrimp products for the year 2002-2018, revealed Indian shrimp export rejections by the US, EU, and Japan were 83, 20, and five respectively. Box plot analysis of Indian shrimp export rejections to US, EU, and Japan showed that higher quantum of rejections was from upper quartile for the US while rejection distribution for EU and Japan situated at lower quartile.

INDIAN SHRIMP EXPORTS REJECTION SHARE IN TOTAL EXPORTS FROM 2007 TO 2018

In the USA, the rejection percent was 3.5 in 2007 and consistently reduced to 0.6 in 2018, which showed affirmative compliance of Indian shrimp exports. The share was very high during 2004 (6.1%). In EU, the rejection share was 1.08% in 2007 and significantly reduced to 0.49 during 2018 whereas, in Japan, the percentage was very high in 2012 (2%), and afterward it had decreased to 0.25 during 2018.



Box plot analysis of Indian shrimp export rejections



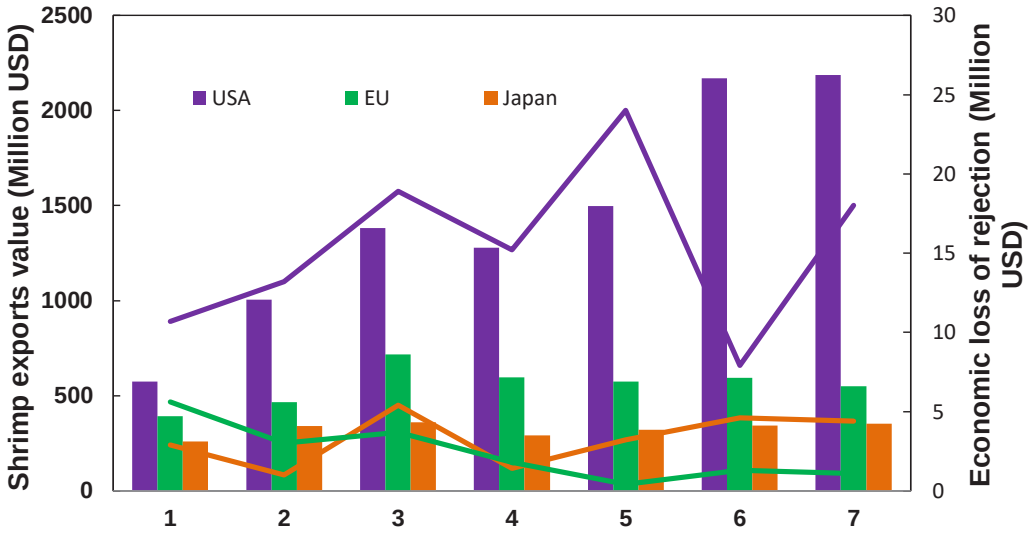
Indian shsrimp experot rejections

THE ECONOMIC LOSS OF INDIAN SHRIMP EXPORT REJECTION BY US, EU, AND JAPAN

Estimated financial loss due to shrimp export rejection by the US was between Rs.7.5 crores to Rs.158 crores. Value of shrimp exports to the USA was 363 million $ US in 2002, and significantly increased to 2186 million USD during 2018 whereas the economic loss was 11 million $ US in 2012 and rose to 24 million USD in 2016, and during 2018, which had significantly decreased to 18 million USD, and showed an improvement in compliance performance and adoption of Better Management Practices (BMP) by the shrimp processors.

ECONOMIC LOSS OF INDIAN SHRIMP EXPORT REJECTION

The European Union has more stringent food safety standards. In the EU, the value of Indian shrimp exports was 305 million $ the US and increased to 550 million $ US, and economic loss also significantly rose from 2.9 in 2012 to 4.4 million $ US in 2018. In Japan, the value of shrimp exports has been increased sharply from 258 million USD to 353 million USD from 2012 to 2018 whereas the economic loss had decreased from 5.61 million USD to 1.1 million $ US except during 2012 when the loss was 3.7 million USD. Japan has been traditionally importing Jumbo tiger

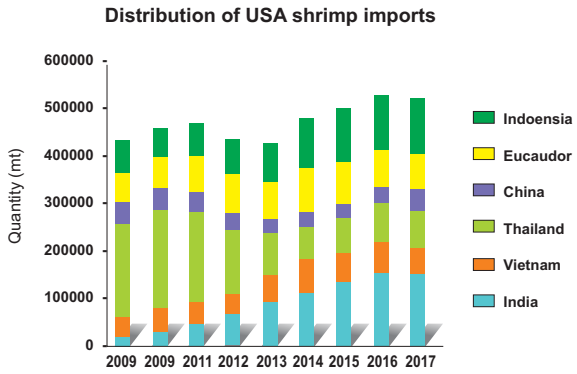


Indian shrimp export and economic rejection

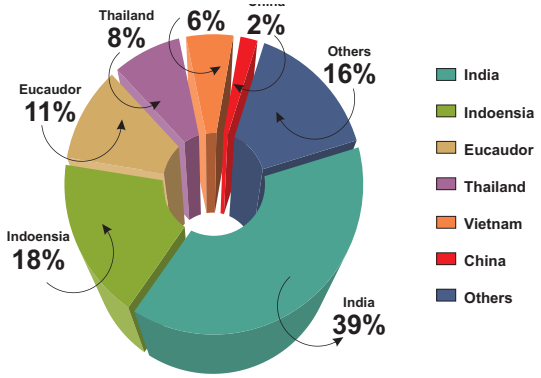
shrimps for making ethnic dishes like tempura, and shush. There were incidents of rejections of shrimp imports from India during 2012-2014 for the presence of anti-oxidants.

PANEL DATA REGRESSION: GRAVITY MODEL APPROACH ON US SHRIMP IMPORTS FROM INDIA, AND OTHER EXPORTERS

Panel data methodology for US shrimp imports from India, and other major exporters used and based on the results of the Hausman test, and Breuch Pagan Lagrangian multiplier test, the random effects model, adopted. LM test clearly showed that there is a significant difference among various regions, and panel effect between different shrimp exporting countries to the US.



US shrimp import quantities from 2009 to 2017



Top shrimp exproters to USA by value in 2016

Top shrimp exporters to US

ECONOMIC ANALYSIS OF BRACKISHWATER AQUACULTURE TECHNOLOGIES IN INDIA

An analysis of cage culture of pearl spot was carried out in a single cage of 4x4x3 m undertaken by KVK Alleppey, with the technological backstopping of CIBA Chennai, and KVK Ernakulam. The results indicated that the survival rate was 80% for 1000 fingerlings, the yield was 200 kg. Out of the total cost of Rs.37000, Rs. 10000 (25%) was incurred for feed, and Rs.8000 (21.6%) for the labor. Seed cost accounted for only 5.4 %. The gross return was Rs.80000, and the net profit was Rs.43000/crop, and the realized BCR was 2.16.





Pearl spot farming in brackishwater resources of Alleppey district in Kerala

ECONOMICS OF RE-CIRCULATORY AQUACULTURE SYSTEM

To study the economy of Recirculatory Aquaculture System (RAS) practiced at farmer's level, a survey sheet was prepared, and data were collected to do the economic analysis of existing RAS. Modification of RAS design could be done to reduce the cost of production, optimize the production volume for economic viability (Break-even analysis) of RAS.

RAS designed to study the reproductive performance of penaeid shrimps in comparison with flow-through the system. Preliminary trials of water quality analysis of shrimp maturation in flow-through system revealed that the Total Ammonia Nitrogen (TAN) was above the recommended limit (1 ppm) in all the tanks with 100% water exchange per day at a stocking density of 2 shrimps/m2. To overcome the disadvantages of the flowthrough, a new RAS system is designed, and modified to improve water quality, subsidize water usage, preserve pheromones, and also ensure biosecurity in shrimp maturation. The shrimp broodstock RAS is designed based on the capacity, biomass, water flow rates, biofilter sizing, oxygen delivery, etc. The estimated capacity was to stock five shrimps/m2. Broodstock RAS is modified as follows: Tank bottom is raised to 40 cm – to accelerate gravity flow, central drainage with slope- easy sludge removal, two-step swirl separation- removal of settleable solids (large, and fine solids), and bio ball filter aeration piping design- made adequate to provide fluidization of bio-balls. A further modification is possible to improve the capacity of RAS by replacing the media. The biomass and animal stocking density was calculated based on the carrying capacity of the RAS concerning the solids removal rate of mechanical filter, TAN removal rate of biofilter, Oxygen addition rate, etc. The flow rate required to maintain the optimum concentration of TAN, TSS (Total Suspended Solids), and DO (Dissolved Oxygen) in the RAS, and sizing of biofilter was calculated using the spreadsheet.

To summarize, RAS is designed to grow shrimp from its post-larvae stage to maturity. The system is proposed to have the capacity to grow 500 PL/m3. The study is being conducted to optimize the stocking density, and system carrying capacity, and analyze the water quality, and efficiency of the system.

TECHNO-ECONOMIC VIABILITY OF THREE-TIER CAGE FARMING OF ASIAN SEABASS FISH IN OPEN BRACKISHWATER BODIES

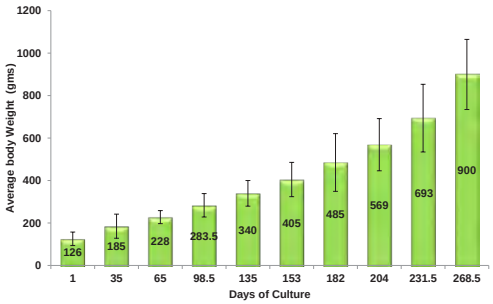
Fingerling size fish (8-10g) is the stockable size in pre-grow out cages, and generally small size fry will not survive in running waters. Although fingerlings can be purchased from the nurseries operated by farmers, the cost is extremely high, and it is economically unfeasible. Therefore nursery rearing to raise fish fry to fingerling size is the better option, and a critical phase to get the fingerling stock for the cages. The group carried out four cycles of nursery rearing to raise fingerlings, and the weekly growth rates of fish fry stocked in hapas are given in the Table. The average survival in the four cycles was 40%, and the mean growth rate in eight weeks duration was 7.3 cm (7-8 g). It was noted that nursery rearing in hapas in open waters did not give better survival when the water current was more than 10 cm/sec. Therefore it is suggested that nursery rearing unit need to be set up in a pond based system.

Rearing of fish fingerlings (7-8g) to a juvenile size (900-100g) was taken up in pre-grow out cages for 90-105 days. The average growth of fingerlings in pre-grow-out, and mean body weights were measured in fortnightly intervals, and the results are presented in the Table. The average daily growth was found to be one gram in pre-grow out stage, and at the end of 100 days, the fingerlings were grown to juvenile fishes with an average size of 126 g.

Average body weight, and length of fish in pre-grow out phase

Day of Culture	ABW (g)	Mean length (cm)
1	4.9±1.6	6.9±0.84
15	13.6±1.9	9.8±1.20
30	28.0±2.9	11.9±1.54
45	40.6±4.1	13.2±1.28
60	52.7±6.5	14.3±2.96
75	75.4±6.8	15.8±3.18
90	101.6±17.3	17.9±3.48
100	126.0±37.2	19.6±3.89

In the grow-out phase, the fish juveniles of 100-150 g size were transferred from pre-grow out cage into a larger grow out cage for rearing them to an adult size of around one kg. At 270 days of culture, the mean body weight of the fish was 900g. It was observed



Mean growth rate of Asian Seabass in grow out phase

Growth rate, and weekly survival in nursery rearing

Nursery cycles	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Mean± SD
Initial Length (mm)	2.5	2	3	4	2.9±0.8539
Final Length (cm)	6.5	6.8	7.5	8.5	7.3±0.8884
The average survival in %					
Week 1	80.0	74.0	73.0	85.0	78.0±5.5976
Week 2	63.0	69.0	69.0	72.0	68.3±3.7749
Week 3	58.0	55.0	58.0	66.0	59.3±4.7170
Week 4	54.0	50.0	55.0	57.0	54.0±2.9439
Week 5	49.0	46.0	51.0	52.0	49.5±2.6458
Week 6	45.0	42.0	49.0	46.0	45.5±2.8868
Week 7	42.0	39.0	48.0	42.0	42.8±3.7749
Week 8	39.0	36.0	46.0	40.0	40.3±4.1932

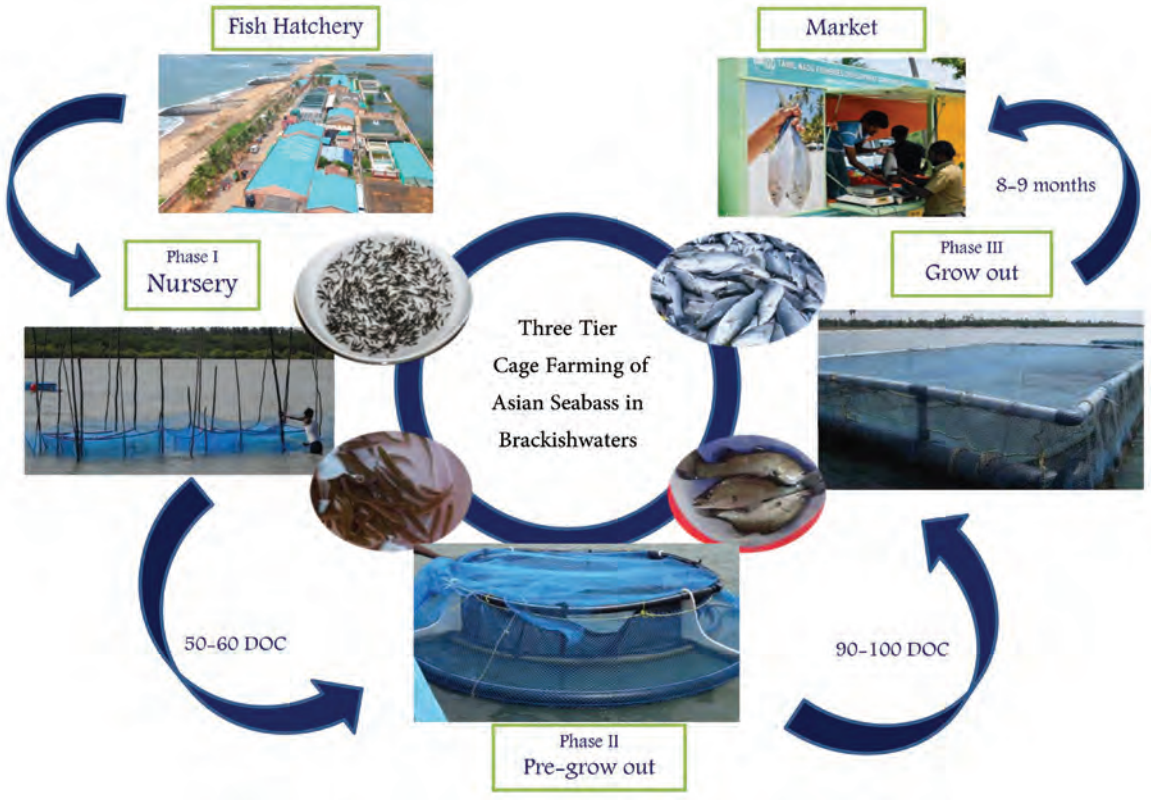
that the cages acted as fish aggregating devices, and fishers had good catch around the cage farming site. As the water quality was good in moving waters, and fishes were in the ideal rearing environment, the quality and taste of the fish was very good and fetched a premium price in the market. The Fisher group was linked with the Tamil Nadu Fisheries Development Corporation (TNFDC) the marketing arm of the Department of Fisheries, Govt. of Tamil Nadu, and they bought the fish at the cage site. Due to this market linkage, the Fisher group received a better price for their produce.

MEAN GROWTH RATE OF FISH IN GROW OUT PHASE

The seabass fish were sold @ Rs.380-400/kg at the cage site itself. The fishers obtained a monthly income of Rs.8000, Rs.4900, and Rs.8500 respectively in nursery rearing, pre-grow out, and the grow-out farming. This shows that cage farming has provided them an alternative livelihood, and doubled their income. With proper management of cage erected at an ideal location in brackishwater can yield production of 20-25kg/m3 with various species of fishes. Since all the three phases require hardly two man hours per day to manage the system, the fishers could take up cage farming as an additional occupation. With proper planning, four cycles of nursery rearing, and two cycles of pre-grow out culture can be taken up in a year. Nursery rearing can provide eight months of employment in a year for four people. Two persons in the group can take care of pre-grow out farming, and an average one member can spend one hour in the morning, and one hour in the evening for feeding the fishes. All together for the 90 days of duration, 180 hours of manpower was required for one cycle of three months. Two cycles can be done in a year. Four fisher youth of the team can take up grow out farming. On average, one member can spend one hour in the morning, and one hour in the evening for feeding the fishes. All together for 300 days totally 600 man hours of manpower they need to spend for one total cycle. With the installation of one more grows out the cage in the site, two full cycles of the three-tier system could be taken up in a year.

The group members may subdivide among themselves to take up the nursery, pre-grow out, and grow out phases as this segmentation might provide interim

Three tier system of cage farming with forward and backward linkages



returns to them, and they need not wait for the cycle to complete. In the subsequent culture, they could inter-change their portions among themselves. Since the water bodies are common property resources group of fishers of their families could jointly take up this system of farming. Nursery rearing can be taken up by fisher womenfolk as it requires smooth handling, and grading once in 4-5 days to avoid sibling cannibalism. For effective adoption of aquaculture technologies by the poor, and new entrants in the developing countries, the use of participatory rather than technology-driven approaches are highly convincing (Edwards, 2000). The fisheries departments of the states should promote cage aquaculture in suitable locations by developing suitable schemes with an inbuilt subsidy to establish cage infrastructure. Location-specific cage designs using locally available materials could minimize the investment.

POLYCULTURE OF MILKFISH, PEARL SPOT, AND MUD CRAB FARMING AT SADARASKUPPAM BACK WATERS, KANCHEEPURAM DISTRICT, TAMIL NADU

Polyculture of milkfish, pearlspot, and mud crabs was conducted in the open water system pen structure (size of 150 m2) among five tribal families (10 nos.) of Sadraskuppam, Kancheepuram district, Tamil Nadu. A total of 100 milkfish (avg. wt 49 g), 750 pearl spot (3 to 15 cm) size, and 125 mud crab (18. 5 kg; 95 to 250 g) were stocked in pen. After 60 DOC, due to obstruction at the bar mouth of Sadraskuppam backwater area followed by less water exchange to the pen structure, heavy mortality of mud crab was noticed. Mud crabs were harvested with 30 % of survival range from (225 to 685 g) size, and fish culture is in progress.







Harvested Mud crab at Sadaraskuppam backwaters, Kancheepuram district, Tamil Nadu



Culture of milkfish, and pearl spot at Sadaraskuppam backwaters, Kancheepuram district, Tamil Nadu

INSTALLATION OF FISH WASTE PROCESSING UNIT, AND DEMONSTRATION FOR PREPARING PLANTONPLUS, AND HORTI*PLUS*

ICAR-CIBA, Chennai has adopted fishermen villages viz., Srinivasapuram, Nambikkai Nagar, Mullikuppam, and Mullimanagar located near CIBA Headquarters in Chennai. This village cluster has about 4500 persons in 2000 households. Their main occupation is fishing, and selling of fish in the lighthouse fish market, which is located nearby these villages. In this fish market, fish waste is not properly disposed or recycled. Mostly fish trimming wastages are dumped nearby seashore. In this backdrop, "Fish Waste Processing Unit" was established for recycling of fish waste to high value-added products in the Nambikkai Nagar, Pattinapakkam, Chennai, Tamil Nadu based on the need, and interest shown by the Nambikkai Fish Farmers Group, Nambikkai Nagar, Pattinapakkam. After installation ICAR- CIBA staff has given a demonstration about the protocol for recycling of fish waste to value-added products to Nambikkai Fish Farmers Group, Nambikkai Nagar, Pattinapakkam, Chennai during February, and March 2019. Impact of this initiative, the group has produced 520 Kg of Plantonplus, and 65 Kg of Hortiplus during March 2019 , and received Rs. 16120/-. The group is processing the fish waste continually and producing Plantonplus, and Hortiplus as an alternative livelihoods activity. This initiative is not only cleaning, and hygienic disposal of fish market waste which is abundantly available in the village cluster but also will help to produce wealth from waste as a concept of the circular economy. This user-friendly technology will help in improving the environment in addition to enhancing their livelihood.



Fish Waste Processing Unit at Nambikkai Nagar, Pattinapakkam, Chennai









Protocol for recycling of fish waste to Plankton^{plus}, and Horti^{plus}, Nambikkai Fish

ORNAMENTAL FISH FARMING FOR PROFITABLE INCOME GENERATION, AND COMMUNITY DEVELOPMENT AMONG COASTAL FAMILIES OF KOVALUM VILLAGE, KANCHEEPURAM DISTRICT. TN.

Homestead backyard pearl spot seed rearing unit as a livelihood support activity was established for the clam collecting coastal families at Kundrakadu village, Kovalum, Kancheepuram district. TN. Pearlspot (Etroplus suratensis) 2000 Nos, with the average size of 1.0 cm to 2.0 cm was stocked in 4 concrete tanks @ 500 nos – each (in a hatchery shed of 200 sq.ft (20x10ft.). After 52 days of culture, the fish attained the average size of 0.6g in size ranging from 2.5 cm to 3.13 cm, with the survival rate of 93.3%. A total of 1865 nos. of pearlspot was harvested from all the tanks indicating the successful nursery phase rearing. These beneficiaries earned Rs. 8000-12,000/- approx. per trial or month. These beneficiaries saved their profit money earned from this intervention by opening a joint bank savings account.







Homestead backyard pearl spot seed rearing unit







Pearl spot seeds for stocking being received by beneficiaries from Shri. Chhabilendra Roul, Special Secretary, DARE, Govt. of India & Secretary, ICAR in the presence of Dr. K.K.Vijayan, Director -CIBA

MILK FISH FARMING WAS DEMONSTRATED IN VACANT SHRIMP PONDS FOR COASTAL SHRIMP FARMER'S FAMILY AT TIRUVALLUR DISTRICT, TAMIL NADU.

Two tier Milkfish (chanos chanos) farming in brackishwater pen culture system was demonstrated as fish farming in an open water pen erected in the brackishwater body among the tribal families under Tribal Sub Plan. 0.5g milkfish fry stocked in the nursery pond @2 nos/m2 attained an average body weight of 12 g with a survival rate of 70% in 43 days. Subsequently, these 12g size milkfish fingerlings were transferred to a pen culture enclosure erected in Pulicat lake area and stocked @ 2.5 nos/m2 in a 400 m2 pen system. After 55 days of grow out culture, the fish attained an average body weight of 125g - 180g with a survival rate of 70%.







HARVEST MELA OF MILKFISH IN KANAVANTHURAI VILLAGE OF TIRUVALLUR DISTRICT

A harvest mela was conducted on 23rd October 2018, at Kanavanthurai village A production of 60 kg milkfish was harvested. Bank accounts were opened , and the tribal beneficiaries deposited Rs.25,000/- the profit earned from this intervention in their bank account — officials from CPCL Company, local villages heads, bank manager & Govt. School children participated in this program. The present demonstration showed that milkfish farming in open water systems is technically feasible, economically viable, environmentally sustainable in providing livelihood to the tribal families, other communities with access to water bodies.



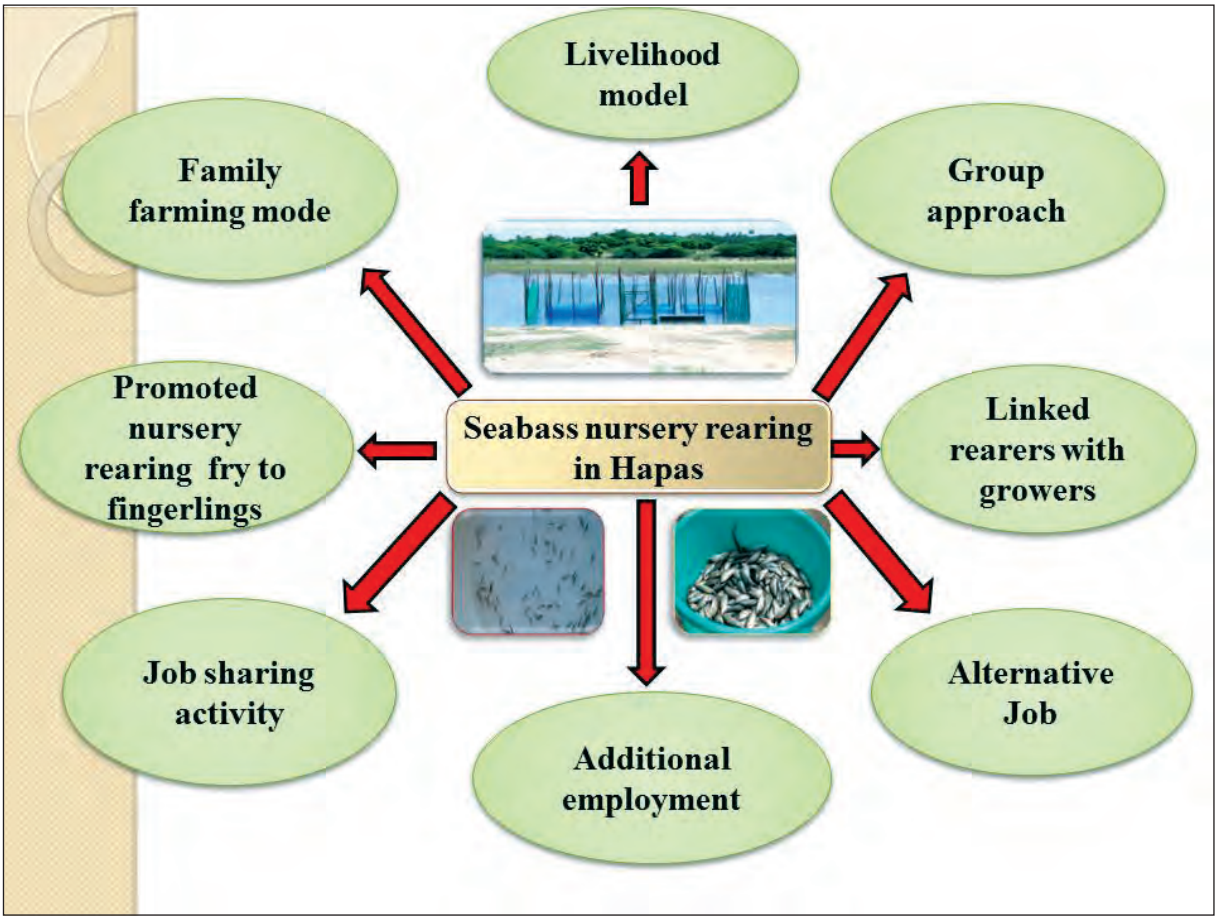


Pearlspot integrated with crab farming (in tide fed ponds) was demonstrated among Irular tribal families of Kulathumedu village, Tiruvallur District. TN. (in tide fed ponds)

TECHNOLOGY TRANSFER MECHANISMS FOR IMPROVING THE LIVELIHOOD SECURITY OF COASTAL FAMILIES.

Hatchery produced seabass fish fry of size 1.8-2.0 cm was stocked @ 500 no. Per hapa , and four trials were conducted in Koovathur village of Kancheepuram district in Tamilnadu. CIBA seabass nursery Plus with 45% CP, and 12% lipid was used as feed. Feeding was done twice a day at 08.00hrs, and 16.00hrs. Grading of the fry and cleaning of the net was carried out once in 4-5 days. The nursery rearing was continued for 60 days. The total realized production was 2500, 2520, 2523, and 2850 fingerlings out of 5000 fries stocked in each trial. At the end of nursery rearing, an average total length size of 6.8, 7.1, 7.0 & 8.4 cm was harvested — survival of 50-57% in open waters.

The net income from four cycles was Rs 1,14,000/-, and each member got an average income of Rs.7000 /- per head/ per cycle. It was an additional income, job-sharing employment which could be taken up throughout the year as a livelihood activity. Regular supply, and uniform size of fry, site specification, calendar of operation, standardization of transport mode, stocking density depending on the availability of feed, feeding frequency, and demand based marketing were the suggestions given by the farmers regarding technology refinement.

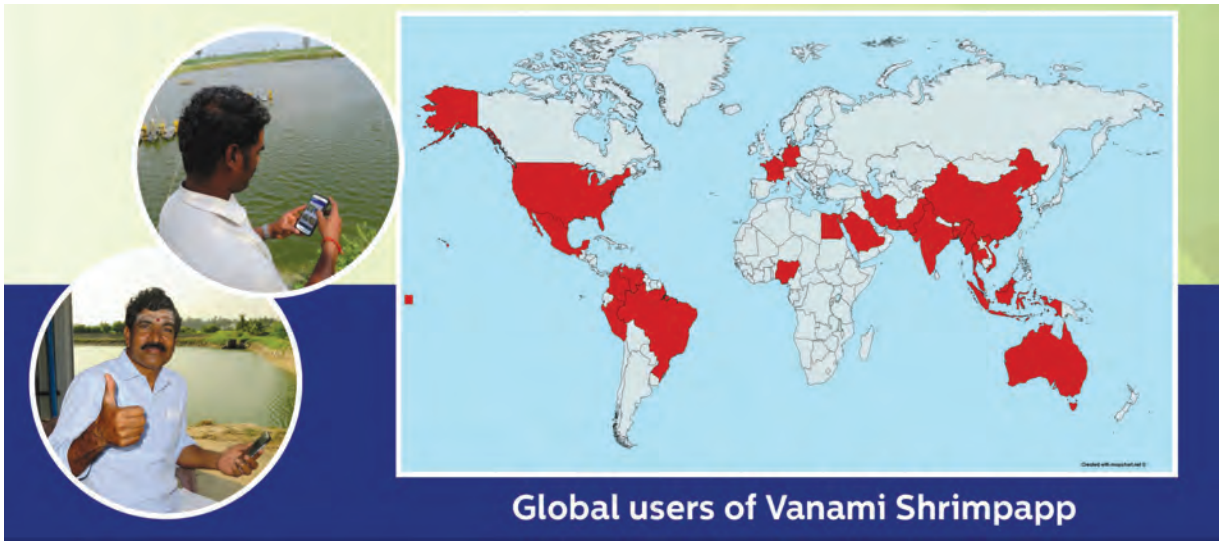


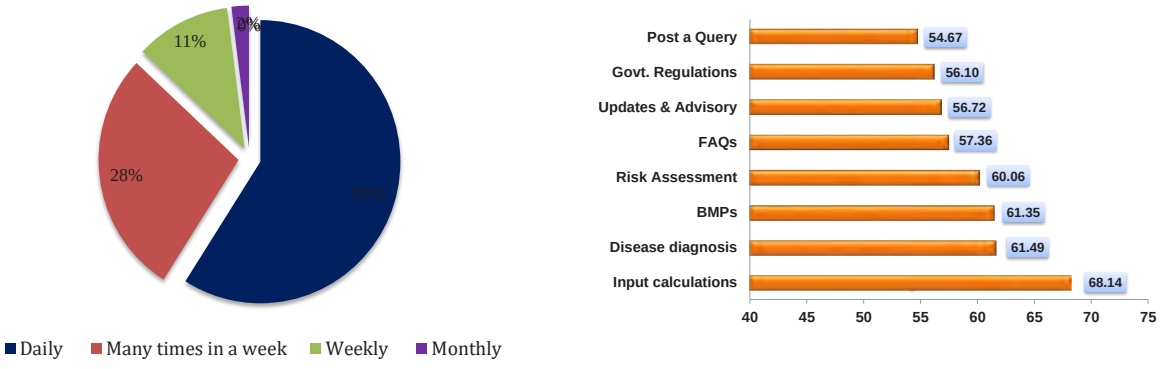
Farmers feedback on nursery rearing of seabass in hapas in open brackishwater sources

EFFECTIVENESS OF MOBILE APP IN TECHNOLOGY DISSEMINATION ON SHRIMP FARMING

ICAR-CIBA launched a mobile application Vanami Shrimpapp in 2017 a platform to disseminate technical knowledge to the aqua farmers, and extension workers. The app has been regularly updated with new information as per the field requirements, and extensively consulted across the countries. As on date, it has more than 15300 downloads across the worldwide with 4.5/5.0 rating. India is the major user with 80% of downloads. A study was undertaken with 180 vanami shrimpapp users to assess its effectiveness in terms of the usefulness of its modules to the end users. It was noted that 85% of the respondents conveyed that it was a reliable source of information, and a farmer can decide on his farm using this app.

Similarly, 87% of them opined that it was a notable contribution by the institute to the sector. Majority of the app users referred to the app every day (59%), and 28% consulted on alternate days (28%). The users ranked input calculations; disease diagnosis, BMPs, and risk assessment were the most used modules. Based on the suggestions, the app was updated with additional modules, and in vernacular languages viz. Tamil, Telugu, Bengali, and Hindi, and renamed as CIBA Shrimpapp , and launched during the National Brackishwater Aquaculture Farmers Conclave-2019 on 22 January 2019 at CIBA campus.





Usability of mobile app



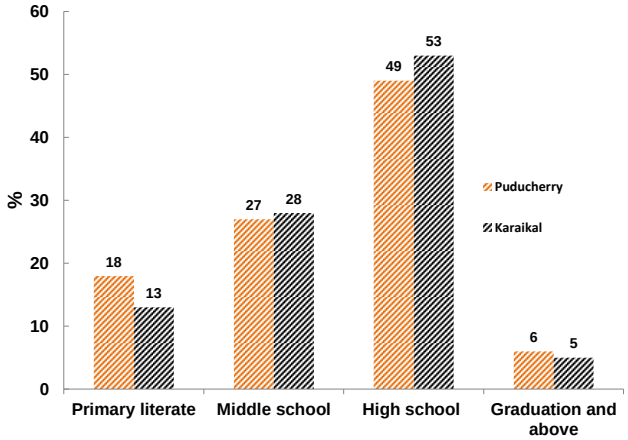
CIBA Shrimpapp launch

CAGE AQUACULTURE IN BRACKISHWATER OF PUDUCHERRY, AND KARAIKAL REGIONS OF PUDUCHERRY UNION TERRITORY

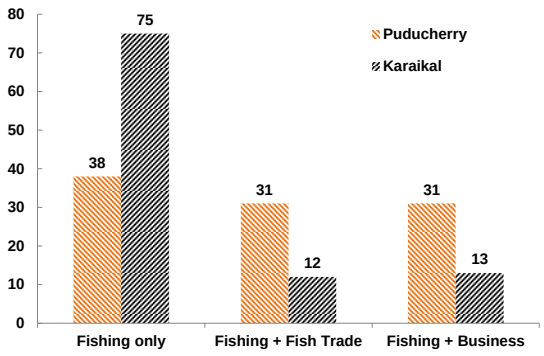
A feasibility study on Socio-economic status of coastal fishers Puducherry, and Karaikal region revealed the following:

Majority of the fisher families in Puducherry (69%) , and Karaikal (60%) were of a nuclear type, and the family sizes were also small with four members or less (66% , and 60%). However, about 30-40% of fisher families still live as joint families as this important in case of fishing avocation is concerned, and it shows that the family relationships were intact, and they help mutually one another during the needed situations. Almost half of the respondents in Puducherry (49%), and Karaikal (53%) were educated up to high school.

It is interesting to note that the majority of Puducherry (64%), and 37% of Karaikal fisher families had more than one source of income mainly through fish marketing. However, the majority of the fishers of Karaikal (63%) mostly depend on fishing for their livelihood, and they may be receptive to any fisheries development programs. This is explicitly indicated by the occupation status of the respondents wherein 75% of the Karaikal fishers were full-time fishers , and fishing was their only occupation.



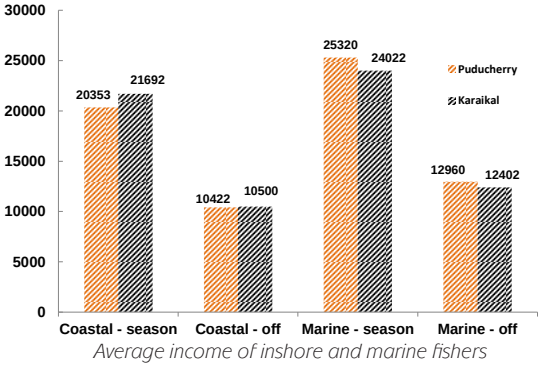
Education status of the fishers



Occupational status of fisherfolk

In terms of contact with the Fisheries Department, which is the nodal agency for their welfare, the majority of Karaikal respondents (65%) had contacted the Department officials for one or the other purpose. However, in case of Puducherry, one-third of respondents had monthly to occasional (28-33%) contacts with Fisheries Departments, and one-third of them (37%) had contacted the officials of the Fisheries Department. This may be because the Karaikal fishers were mostly dependent on fisheries for their livelihood, and they need to contact with fisheries department for getting advisories, and information about the scheme, etc.

The average monthly income realized by the coastal fishers was Rs.20,353-Rs.21692 while the marine fishers could realize Rs.24, 022 –Rs.25,320 during the fishing seasons. However, during the off-seasons, their monthly income was respectively Rs.10, 422-10,500, and Rs.12,402 -12,960 for the estuarine, and marine fishers. During the off season, their monthly income was reduced by 50% but their effort on fishing was the same.



Average income of inshore and marine fishers

THE LIVELIHOOD ASSESSMENT OF COASTAL FISHERS PUDUCHERRY, AND KARAIKAL REGIONS:

The livelihood assessment has indicated that the average livelihood score of coastal fishers was 70%. The mean livelihood score of Puducherry fishers was 67.50 %, and the fishers of Karaikal region had an average livelihood score of 72.50% However, about 40% of the Puducherry, and Karaikal fishers were in the category of below the average livelihood score. These results indicated the respondents needed support in the form of assets, capacities, and activities to improve their livelihood status. The statistical analysis carried out showed that there is a significant difference in the livelihood scores of Puducherry, and Karaikal fishers and both the samples are not belonging to the same set of the population ($p \leq 0.01$). Further, the analysis shows that Karaikal fishers (mean rank 87.80) had an edge in terms of their livelihood levels than their Puducherry (mean rank 62.55) counterparts.

ASSESSMENT OF WATERBODIES FOR THEIR SUITABILITY FOR AQUACULTURE

Assessment of waterbodies considering the physical, chemical, and environmental conditions using geospatial analyses has indicated that Malattaru estuary, a portion of Chunnambar river in Puducherry , and Arasalaru creek in Karaikal regions were identified as relatively suitable for taking up culture-based fisheries. However, tourism and recreation were found to hamper the fisheries and initiating culture based alternative livelihood for the fishers in Puducherry.



Collecting onsite water quality parameters



Collecting soil samples

DEVELOPMENT OF DECISION-MAKING TOOL FOR AQUACULTURE DEVELOPMENT AT ADYAR CREEK, AND ESTUARY

Web-based Adyar Creek and Estuary Information System based on Decision Making Tool was developed for the development of aquaculture in the water bodies. The system permits end users to fast, and easy access to large amounts of analyzed data which are collected in different sample locations, and details of culture practices which are suitable for the different sample locations for the development of brackishwater aquaculture. It has been developed using MySQL database management system, and PHP scripting language. In this tool, an information system was designed into different modules namely, about Adyar creek, and estuary, System needs, and objectives, Sample location, Water parameters, Soil parameters, phytoplankton, zooplankton, and culture practices. The season wise, location-wise, month-wise, year-wise, salinity-wise, phytoplankton class/genus-wise, and/or zooplankton group-wise information is used for deciding to develop the aquaculture activities in the water bodies. Although illustrations are based on the six sample locations, the system is general and can act as a model to elaborate for the entire Adyar creek water bodies.



Front page of a decision-making tool for aquaculture development at Adyar creek, and estuary

DEVELOPMENT, AND EVALUATION OF THE EFFECTIVENESS OF WEB-BASED KNOWLEDGE CENTRE IN BRACKISHWATER AQUACULTURE

Web-based Knowledge Centre in brackishwater aquaculture was developed using Drupal content management software (CMS) based on the ADDIE model of Instructional System Design (ISD), including Analysis, Design, Development, Implementation, and Evaluation. This system is built-up with PHP, and MySQL for the design of pages, and database, respectively. The effectiveness of the centre was evaluated using a structured questionnaire consists of six categories such as related to contents; presentation of modules; interactivity, visual design, and accessibility; user friendliness; module applicability; and general assessment of the unit. For the pilot study, the questionnaire was distributed to twenty-five randomly selected users of Village Knowledge Centers (VKCs), MSSRF, Chennai, and their responses were analyzed for checking its reliability by Alpha-Cronbach test.



FLOW DIAGRAM OF WEB-BASED KNOWLEDGE CENTRE INSTRUCTIONAL SYSTEM DESIGN

The results showed that the questionnaire was reliable since the alpha score produced was over 0.7 for each category of the questionnaire. After the pilot study, this tested evaluation questionnaire was used for evaluating the effectiveness of the centre by recording the responses of 30 sample ICT users, VKC, MSSRF, Chennai. A five-point rated scale was used where a respondent was asked to indicate their response to their statements on the centre. The possible scores were 1 for strongly disagree, 2 for disagree, 3 for undecided, 4 for agree, and 5 for strongly agree. The average score was obtained by adding the multiplication of frequencies with the respective weights and dividing them with a total number of respondents. The evaluation results revealed that the items related to contents produced, visual design, accessibility, and presentation style had good responses. Future provides a knowledge base which goes beyond the traditional approach of storing and retrieving of information of various aspects of brackishwater aquaculture as racks of hard copies or in removable media storages. This also safeguards the valuable information gathered on shrimp, crab, finfish, and policies over some time.

Reliability, and evaluated results for web-based knowledge centre

Criteria	Reliably result (Alpha value (α))	Evaluated results (Average score)
Contents of the centre	0.85	4.1
Presentation, and Interactivity of the centre	0.78	3.3
Visual design, and accessibility of the centre	0.81	4.4
User friendliness, and motivation of the centre	0.73	3.3
Module applicability	0.82	2.9
General assessment	0.84	3.6





HUMAN RESOURCE DEVELOPMENT (HRD)

TRAINING, CAPACITY BUILDING AND SKILL DEVELOPMENT

TRAINING ATTENDED BY INDIVIDUALS

International

Dr. Aritra Bera, Scientist, attended the International Training Courseon Fish Culture Development at Egyptian International Centre for Agriculture (EICA) & World Fish at Arab Republic of Egypt during 01.10.18 – 15.12.2018



National

Dr. Debasis De, Principal Scientist attended the Training Programme on "Empanelled members in the evaluation committee under NPOP" organized by APEDA, New Delhi during 21-23 May 2018

Dr. M. Muralidhar, Principal Scientist attended the National Dialogue on "Artificial Intelligence and IoT applications in Agriculture" organized by ICAR – NAARM, Hyderabad during 1-2 June 2018

Dr. R. Geetha, Scientist attended the Training programme on "Advanced statistical methods and computational software for fisheries research and management" organized by Extension, Information & Statistics Division, ICAR-CIFT, Kochi during 17-26 July 2018

Dr. R. Ananda Raja attended the "Two Days Regional Workshop cum Training Programme for Nominees of CPCSEA" at Conference Hall, Madras Veterinary College, Vepery, Chennai- 600 007, Tamil Naduduring 19-20 July, 2018

Dr. Debasis De, Principal Scientist attended the Training programme on "Research Excellence in Organizations" organized by Administrative Staff College of India, Hyderabad during 8-10 August 2018

Shri T. Sivaramakrishnan, Scientist attended the Training Course on "LC-Ms based Proteomics" organized by CSIR – CCMB, Hyderabad during 3-13 October 2018

Dr. P. Kumararaja, Scientist attended the Training programme on "Winter School Climate Change impacts and resilience options for Indian marine Fisheries" organized by ICAR-CMFRI, Cochin during 8-29 Nov. 2018

Shri T. Sathish Kumar, Scientist attended the Workshop on "Basic course in Bio-Statistics for medical professionals and non-medical researchers" during 10-14 December, 2018 at NIE, Chennai

Dr. Krishna Sukumaran, Senior Scientist attended the "Training of Master Trainers" organized by Agricultural Skill Council of India during 7-9 January, 2019

Dr. T. Ravi Sankar, Principal Scientist attended the Incubator Manager Training Programme organized by American Corner, St. Francis College for Women, Uma Nagar, Begumpet, Hyderabad during 28-29 January 2019

Dr. J. Raymond Jani Angel, Scientist attended the Training Programme on "Bioinformatics for metagenome data analysis (NGSDAT 2019) Organized by ICAR- Indian Institute of Species Research, Kozhikode, at Keraladuring 19-22 March 2019

Dr. T.N. Vinay, Scientist attended the Training Programme on "Bioinformatics for metagenome data analysis (NGSDAT 2019) Organized by ICAR-Indian Institute of Species Research, Kozhikode, at Keraladuring 19-22 March 2019

Technical Staff

Dr. Sivagnanam, CTO attended the Training of Trainers programmes under Skill Training Programme organized by ATARI Kanpur during 17-19 December 2019

Shri S. Rajamanickam, ACTO attended the Training of Trainers programmes under Skill Training Programme organized by ATARI Kanpur during 17-19 December 2019

Dr. Joseph Sahayarajan, ACTO attended the Training Course on "Molecular Cloning & Protein Expression" organized byCSIR – CCMB at Hyderabad during 19 June to 13 July 2018

Dr. A. Nagavel, ACTO attended the Training Programme for Technical Personnel on "Experimental data analysis" organized by IASRI, New Delhi during 27 August 1 Sept 2018

Shri S. Prabhu, Technical Assistant attended theTraining programme on Green Buildings organized by IGBC, Chennai during 14-15th February 2019

Administrative Staff

Shri S. Pari, AAO (C&B) attended the Training programme on PFMS & FMS organized by ICAR-NAARM, Hyderabad during 10-12th September 2018

Shri A. Sekar, Assistant attended the Training programme on PFMS & FMS organized by ICAR-NAARM, Hyderabad during 10-12th September 2018

Supporting Staff

Shri V. Kishor Kumar, SSSattended the Training programme on PFMS & FMS organized by ICAR-NAARM, Hyderabad during 10-12th September 2018.

TRAININGS PROGRAMMES ORGANIZED

Headquarters

Sl. No	Name of the Training /FGD	Duration	No. of participants
1	Training Course on "Skill Enhancement in the marine sector (SEMS) for Sustainable Export Opportunities"	7-11 May, 2018	16
2	Training course on "Sustainable crustacean farming in brackish water systems"	14-19 May, 2018	9
3	Skill Development Training programme on "Recent Advances in Soil and Water Management in Brackishwater Aquaculture"	25 - 30 June 2018	20
4	Customized training on Identification, isolation and pure culture of microalgae from sea and brackishwater	11-13 July 2018	
5	NFDB Sponsored Training Progamme on "Seed Production and farming of brackishwater finfish species"	30 July – 3 August 2018	
6	Training Programme on "Hatchery production and farming of milkfish and mullets"	16-20 August 2018	10
7	Customized Training Programme on "Water and Soil Treatment Applications in Aquaculture"	27-28 August, 2018	7
8	Hands-on training on "Aquaculture Genomics and Bioinformatics"	27 August to 1 September, 2018	11
9	NFDB sponsored training on Recent advances in farming of pacific white shrimp	10-14 September, 2018	8
10	Training Programme on Seed Production and culture of Brackishwater Finfishes	18-22 September 2018	2

Sl. No	Name of the Training /FGD	Duration	No. of participants
11	Hands-on Training on "Waste to wealth: Recycling of fish and domestic waste to value added products" at Srinivasapuram, Pattinapakkam, Chennai, Tamil Nadu	28 September 2018	70
12	Hands-on training to women self-help group on recycling of fish waste to value added products at Muttukadu Experimental Station, Muttukadu, Tamil Nadu	1 October 2018	14
13	Customized training on Aqua feed Processing and Quality Control	30 Oct.- 3 Nov. 2018	4
14	Training cum demonstration on "Waste to Wealth" by recycling of fish waste to value added products at Nambikkai Nagar, Pattinapakkam	22 December, 2018	30
15	Customized training on aqua feed processing and quality control	1-5 February 2019	2
16	Advanced Training in Aquaculture Nutrition and Feed Technology	19-28 February 2019	12
17	Hands on Training on Nursery rearing of Seabass (Lates calcarifer)	25-27 February 2019	6
18	Hands-on Training on "Waste to wealth: Recycling of fish waste to value added products" at Nambikkai Nagar, Pattinapakkam, Chennai, Tamil Nadu	4-7 March 2019	12
19	National Workshop-cum-Training Programme on "Biofloc Technology for Nursery and Grow-out shrimp aquaculture"	12-16 March 2019	20

Kakdwip Research Centre

Sl. No	Name of the Training /FGD	Duration	No. of participants
1	Training programme on "Seed production and farming technology of brackishwater catfish, Mystus gulio"	2-7 July 2018	25
2	Training Programme on "Advances in Brackishwater Aquaculture"	23-28 July 2018	13
3	Training Programme (Training of Trainer) on "Advances in brackishwater aquaculture practices"	20-24 August 2018	11
4	Training programme on "Brackishwater fish, shrimp and crab culture with feed formulation and feed management "	10-15 September 2018	15
5	Training-cum-awareness programme on integrated farming of Fish and Livestock for the livelihood improvement of tribal people of Sundarban region, organized at Mundapara, Manmathapur, South 24 Parganas.	9 October 2018	50
6	Need based training for IFB Technical Staff on Advances in Brackishwater Aquaculture Practices	26-28 December 2019	19
7	Skill development training for Shrimp farmers	5-29 March 2019	20
8	Hands-on training on "Aquaculture Genomics and Bioinformatics"	27 August to 1 September, 2018	11
9	NFDB sponsored training on Recent advances in farming of pacific white shrimp	10-14 September, 2018	8

Navsari Gujarat Research Centre

Sl. No	Name of the Training /FGD	Duration	No. of participants
1	Training Programme on "Seabass Nursery and Pre Grow out Rearing in happas as a livelihood activity" to Nursery Self-help group beneficiaries (No.s) of Nivati and Redi Villages, Taluka-Vengurla District- Sindhudurg, Maharashtra	17 May, 2018	48
2	Training Programme on "Brackishwater finfish cage culture models as livelihood opportunities for rural folks"		80

AWARDS AND RECOGNIZATIONS

ICAR NATIONAL TEAM AWARD FOR NUTRITION AND FEED BIOTECHNOLOGY WON BY CIBA SCIENTISTS

ICAR-CIBA Nutrition team was awarded with Nanaji Deshmukh ICAR Award for outstanding interdisciplinary team research in Agriculture and allied sciences 2015-16 in the category of Animal and Fisheries Sciences. The nutrition team comprising of Dr. K. Ambasankar, Dr. J. Syama Dayal, Dr. K.P. Kumaraguru Vasagam, Late Shri. S. Stanline, Dr. P. Nila Rekha, Dr. Debasis De, Shri. Sandeep, K.P., Dr. T.K. Ghoshal and Dr. K.K. Vijayan. The team leader, Dr. K. Ambasankar, Principal Scientist received the award from Dr. T. Mohapatra, Hon'ble secretary DARE and Director General ICAR, on the occasion of Pusa Krishi Vigyan Mela organized at ICAR- IARI New Delhi on 5th March 2019. The Award carries a citation and cash prize of INR 5 Lakhs.







Dr.M.Kumaran, Principal Scientist, Social Sciences Division, ICAR-CIBA has been conferred with Swami Sahajanand Saraswati Outstanding Extension Scientist Award-2017 (Individual category)of the ICAR on 16th July, 2018 for his outstanding and impactful contribution in the field of Brackishwater Aquaculture Extension Research, Capacity enhancement and Technology Transfer through innovative approaches.

ICAR-CIBA received Certificate of Appreciation from DG, ICAR on 4th December 2018 for proactively implementing ICAR-Research Data Management Guidelines and uploading more than 700 publications in KRISHI portal.

Dr. R.Ananda Raja and team got the best oral presentation award for the paper entitled "Fatty liver syndrome in pearlspot, Etroplus suratensis" in the



भारतीय कृषि अनुसंधान परिषद
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
भा.कृ.अनु.प. में ज्ञान संवर्धन के लिए अनुसंधान आंकड़ों का कोष
ICAR Research Data Repository for Knowledge Management
CERTIFICATE OF APPRECIATION
प्रशंसा पत्र

यह प्रशंसा पत्र भा.कृ.अनु.प. - केन्द्रीय खारा जल जीवपालन अनुसंधान संस्थान, चेन्नई को भा.कृ.अनु.प. अनुसंधात्मक आंकड़ों के प्रबंधन दिशानिर्देशों के सक्रिय क्रियान्वयन एवं कृषि पोर्टल में कृषि पोर्टल में 700 से अधिक प्रकाशन अपलोड करने के लिए प्रदान किया जाता है।

This certificate of appreciation is awarded to ICAR- Central Institute of Brackishwater Aquaculture, Chennai for proactively implementing ICAR Research Data Management Guidelines and uploading more than 700 Publications in KRISHI Portal.

(नरेन्द्र सिंह राठौर)
उपमहानिदेशक (कृषि शिक्षा)
(Narendra Singh Rathore)
DDG (Agricultural Education)

(के. अलगुसुन्दरम)
उपमहानिदेशक (प्राकृतिक संसाधन प्रबंधन)
(K. Alagusundaram)
DDG (Natural Resource Management)

दिनांक : 04 दिसम्बर 2018
Date: 04 December 2018

"Fourth National Agricultural Science Tamil Research Conference" organized by Agricultural Scientific Tamil Society, New Delhi at The Directorate of Research, TNFU Campus, OMR, Vaniyanchavadi, Chennai during 10-20 November, 2018

Dr.M.Kailasam, Principal Scientist received best Scientist Award for the year 2017-18 by ICAR-CIBA &SCAFI in the CIBA Foundation cum Annual Day held on 29th December 2018

Dr. Shyne Anand, Scientist received best Scientist Award for the year 2017-18 by ICAR-CIBA &SCAFI in the CIBA Foundation cum Annual Day held on 29th December 2018

Dr.Joseph Sahaya Rajan, Asst. Chief Technical Officer received best Technical Award for the year 2017-18 by ICAR-CIBA &SCAFI in the CIBA Foundation cum Annual Day held on 29th December 2018

Late Mr. Stanline, Technical Officer received best Technical Award posthumously for the year 2017-18 by ICAR-CIBA &SCAFI in the CIBA Foundation cum Annual Day held on 29th December 2018

Mrs. Mary Desouza, Assistant received best Administrative Award for the year 2017-18 by ICAR-CIBA &SCAFI in the CIBA Foundation cum Annual Day held on 29th December 2018

Mr. Pichandi & Mr, Jeevanandam received best

Supporting Staff Award for the year 2017-18 by ICAR-CIBA &SCAFI in the CIBA Foundation cum Annual Day held on 29 December 2018

Dr. G. Biswas, Senior Scientist received the Best Oral Presentation Award (First Place) for the paper entitled "System Diversification in Brackishwater Aquaculture of India: Research Support on Fish Culture Options for Sundarban Producers" presented in the International Congress on Engineering and Life Science (ICELIS 2018) held during April 26-29, 2018 at Kastamonu, Turkey.

Dr. K.P. Jithendran, Principal Scientist received Springer Nature–Indian Virological Society Award for the best paper published in Virus Disease on Aquatic Virology during Virocon-2018, PGIMER, Chandigarh, India during 10-14 November 2018

Shri T. Sathish Kumar, Scientist awarded with best oral presentation in the Fourth National Agricultural science Tamil research conference" Nov 19-20, 2018 at TNJFU, Chennai for the oral presentation on "Rapid and specific loop mediated isothermal amplification detection of Enterocytozoon hepatopenaei (EHP)" in Tamil.

Dr. M.S. Shekhar, Principal Scientist received the Best poster award for for the paper entitled "Understanding the course of infection: determining gene expression changes with time in Penaeus vannamei infected with white spot syndrome virus" in the World Brackishwater Aquaculture Conference (BRAQCON, 2019) during 23-25 January, 2019 organized by ICAR-CIBA & SCAFIat ICAR-CIBA, Chennai

Dr. M. Makesh,Principal Scientist received theBest Oral Presentation Award for the paper entitled "Development of Inactivated oral NNV Vaccine for Asian Seabass, Lates calcarifer"

Dr.S.N.Sethi, Principal Scientist received theBest Poster Presentation Award in the field of Brackishwater/Marine Biodiversity and Conservation in World Brackishwater Aquaculture Conference (BRAQCON, 2019) during 23-25 January, 2019 organized by ICAR-CIBA & SCAFI at ICAR-CIBA, Chennai

Dr. Krishna Sukumaran, Senior Scientistreceived theBest Poster Presentation Award for the poster entitled "Growth and reproductive parameters of two geographical groups of grey mullet Mugil cephalus" in World Brackishwater Aquaculture Conference (BRAQCON, 2019) during 23-25 January, 2019 organized by ICAR-CIBA & SCAFI at ICAR-CIBA, Chennai

Dr. K.Vinaya Kumar, Senior Scientist received the Best Oral Presentation Award for the paper entitled "The applications of genomics and proteomics in Aquaculture, Fisheries and Marine biology (omicsAFM 2018)" at the National Symposium on ', Sathyabama Institute of Science and Technology, Chennai, 20th and 21st of June 2018.

Dr. K. Vinaya Kumar, Senior Scientist received the Best Poster Presentation Award in the International conference on World Brackishwater Aquaculture Conference (BRAQCON 2019) held during 23-25 January 2019 organized by ICAR-CIBA & SCAFI at ICAR-CIBA, Chennai.

Dr. Prem Kumar, Scientist received the Best Poster Presentation Award for paper entitled "Larval development, rearing and digestive tract ontogeny of Indian shad, Tenulosa ilisha" in the International conference on World Brackishwater Aquaculture Conference (BRAQCON 2019) held during 23-25 January 2019 organized by ICAR-CIBA & SCAFI at ICAR-CIBA, Chennai.

Shri Jose Antony, Scientist received the Best Poster Presentation Award for paper entitled "….."in the International conference on World Brackishwater Aquaculture Conference (BRAQCON 2019) held during 23-25 January 2019 organized by ICAR-CIBA & SCAFI at ICAR-CIBA, Chennai.

PhD obtained



Shri S Sivakumar, was awarded PhD degreree by University of Madras, for his doctoral thesis, "Development of Cell culture system from crustacean and insect cell lines and adaptation of white spot syndrome virus (WSSV). The research work was carried out under the supervision of Dr N. Kalaimani, Retired Principal Scientist, ICAR-CIBA.

LINKAGES AND COLLABORATIONS

The institute maintained linkages with the following national and international organizations

National ICAR Institutes

- Central Institute of Fisheries Education, Mumbai
- Central Institute of Freshwater Aquaculture, Bhubaneswar
- Central Marine Fisheries Research Institute, Cochin
- Central Agricultural Research Institute, Port Blair
- Central Inland Fisheries Research Institute, Barrackpore
- Central Institute of Fisheries Technology, Cochin
- Central Research Institute for Dryland Agriculture, Hyderabad
- Directorate of Seed Research, Mau
- Directorate of Research on Women in Agriculture, Bhubaneswar
- National Academy for Agricultural Research Management, Hyderabad
- National Bureau of Agriculturally Important Microorganisms, Mau
- National Bureau of Fish Genetic Resources, Lucknow

Other Institutes / SAUs / State Agriculture Departments

- Agricultural & Processed Food Products Export Development Authority, New Delhi
- Center for Advanced Studies in Marine Biology, Annamalai University, Parangipettai
- Coastal Aquaculture Authority, Chennai
- College of Fisheries, University of Agricultural Sciences, Mangalore
- College of Fisheries, Sri Venkateswara Veterinary University, Muthukur
- Dept. of Horticulture, Govt. of Tamil Nadu, Chennai.
- Dept. of Animal Husbandry, Govt. of Tamil Nadu, Chennai.
- Department of Animal Husbandry, Dairying and Fisheries, New Delhi
- Department of Biotechnology, New Delhi
- Fisheries College and Research Institute, Tamil Nadu Veterinary and Animal Sciences University, Thoothukudi
- Indian Institute of Tecnology, Chennai
- Mangrove Cell, Government of Maharashtra, Mumbai
- Ministry of Science and Technology, New Delhi
- Ministry of Water Resources, New Delhi
- Marine Products Export Development Authority, Cochin
- Navsari Agricultural University, Navsari, Gujarat
- National Fisheries Development Board (NFDB), Hyderabad
- National Institute of Ocean technology, Chennai
- Sundarban Development Board, Govt. of West Bengal
- Tamil Nadu Veterinary and Animal Sciences University, Chennai
- Tamil Nadu Agricultural University, Coimbatore
- University of Madras, Chennai
- West Bengal University of Animal and Fisheries Sciences, Kolkata

State Fisheries Departments/BFDAs

The Institute has well established linkages with State Fisheries Depts. /BFDAs mainly for transfer of technology programmes.

CONSULTANCIES, TECHNOLOGY DEVELOPMENT AND TRANSFER

INSTITUTE TECHNOLOGY MANAGEMENT AND AGRI BUSINESS INCUBATION UNIT (ITMU) & (ABI)

Institute Technology Management Unit and Agri Business Incubator have been functioning with ICAR-National Agricultural Innovation Fund at ICAR-CIBA. The Performance has been consistently good and CIBA is generating revenue of Rs.25 lakhs and above every year from commercialization of various technologies developed by ICAR-CIBA. In total CIBA has signed 112 MoUs and Rs.168 crores of revenue have been generated. In addition, CIBA also made partnership with various national and state level institutions, farmers and other stakeholders of the brackishwater sector for backstopping sustainable brackishwater aquaculture in the country.

MOUS SIGNED IN 2018-19

A total number of Twenty one MoUs have been signed during April 2018 to March 2019. A total amount of Rs.24.00 Lakhs (Rupees Twenty Four lakhs) was generated as one time license fee. Revenue share and royalty of 3 to 10% is expected to be received by the institute in the event of good crops in this year. Two patents have been granted and one patent application has been filed.

TECHNOLOGIES TRANSFERRED /COMMERCILAIZED

STRATEGIC ALLIANCE WITH 'THE WATERBASE LTD' IN THE PROMOTION OF BRACKISHWATER AQUACULTURE IN THE COUNTRY



The Waterbase Ltd, one of the pioneering Indian company that manufactures high-quality shrimp feed signed a Memorandum of Understanding (MoU) on 10th April 2018, for a collaborative programme of eco-friendly shrimp feed technology. The collaboration programme will cover technical collaboration and partnership in the development of ecofriendly shrimp feed, the Vanami Ecoplus

PARTNERSHIP WITH CORPORATE SOCIAL RESPONSIBILITY (CSR) INITIATIVES OF KCT



The KCT group signed a memorandum of understanding (MoU) at Thapar House in Delhi on 10thApril 2018, as a knowledge partner. This collaborative effort is targeted to benefit aqua farmers in Nellore region for their needs with regard to testing and diagnostic services related to soil & water quality of aquaculture ponds, seed quality, DNA-based screening of disease causing microbial pathogens and feed quality.

FIRST SHRIMP FEED MILL DR ATTAR AQUA FEED, HARYANA IN NORTHERN INDIA



The KCT group signed a memorandum of understanding (MoU) at Thapar House in Delhi on 10thApril 2018, as a knowledge partner. This collaborative effort is targeted to benefit aqua farmers in Nellore region for their needs with regard to testing and diagnostic services related to soil & water quality of aquaculture ponds, seed quality, DNA-based screening of disease causing microbial pathogens and feed quality.

TECHNOLOGY TRANSFER OF INDIGENOUS SHRIMP FEED



Vanami Plus' feed technology was transferred to Pranita Marines, Andhra Pradesh on 14th August 2018. The company envisaged to produce shrimp feed with the CIBA's technical guidance. The feed will meet the demand of aquaculture farmers in and around Bhimavaram which is expected to benefit the shrimp farmers, and to increase the profitability.

TECHNICAL PARTNERSHIP WITH MINISTRY OF EARTH SCIENCES (ESSO)-NIOT IN THE PROMOTION OF AQUACULTURE IN THE COUNTRY



Technical partnership with Ministry of Earth Sciences (ESSO)-NIOT in the promotion of aquaculture in the countrywas initiated on 25thSeptember, 2018 through an MoU. The MOU will help to contribute towards the roadmap conceived by the MoES 'Farming the Oceans for the Future' to promote India's blue economy. Partnership of NIOT with its blend of engineering expertise in finfish cages and CIBA with its proven technologies in hatchery, farming and feed biotechnology for candidate finfish species such as Seabass, would help in expanding the finfish cage culture operation, in the depths from 5 m to 100m.

TECHNOLOGY TRANSFER OF SEABASS FISH HATCHERY TECHNOLOGY



Hatchery technology developed for the production of seabass seed and nursery rearing technology for the fingerlings, has been transferred to a young entrepreneur, Mr. Nishanth Reddy from Nellore, Andhra Pradesh through an MOU on 30thOctober 2018, at CIBA Headquarters, in the presence of Dr. J K Jena, DDG (Fy. Science), ICAR, New Delhi.

TRANSFER OF FORMULATED FISH AND SHRIMP FEED TECHNOLOGY TO PROMOTE BRACKISHWATER AQUACULTURE DEVELOPMENT IN THE WEST COAST OF INDIA



Strategic alliance was made with Aditi Enterprise, Porbandar, Gujarat by transferring Shrimp and Seabass Feed Processing Technologies to spread its feed biotechnology footprints in the West coast of the country. The feed will cater to the need of aquaculture farmers of West coast of the country, particularly the small and marginal farmers, who cannot afford the high cost feed. The proposed concept of 'factory to farm' promoted by CIBA would help the farmer to source the feed directly from the feed mill, enabling the farmers to save the usual marketing cost also.

TRANSFER OF "CMH MINERAL, AMMONIA, NITRITE & DO TECHNOLOGY



Maintenance of water quality parameters in optimum level is critical for successful aquaculture operations. It is essential to monitor pH, dissolved oxygen (DO) and the toxic metabolites like, ammonia and nitrite which are critical for the survival of aquatic animals. Different kits have been developed for detection of these parameters in hatcheries and grow-out farms will help in taking up immediate measures for preventing the economic loss. These kits was transferred the New Bio Science Company, Mysore on the 24thday of January, 2019 by signing MoU.

TRANSFER OF "CIBAMOX"- WATER PROBIOTIC TECHNOLOGY



ICAR-CIBA has developed a water probiotic "CIBAMOX" which has the innovative combination of ammonia oxidizing bacteria, nitrite oxidizing bacteria and denitrifying bacteria. The technology is being transferred to Rallis India Limited, (Tata Enterprise), Mumbai for up-scaling and commercial production. In this regard, CIBA signed the MoU on 15thFebruary 2019.

TECHNOLOGY TRANSFER ON FISH FEED PROCESSING AND PRODUCTION



Institute has developed fish feed processing and production technology and transferred the fish feed technology for commercial production to various clients. The technology was licensed to Sanvika Feeds, Ernakulam, Kerala on 16thday of March 2019 by signing a MoU.

COLLABORATIVE PROGRAMMEWITH AQUACULTURE DEVELOPMENT COOPERATIVE SOCIETY (ADCOS), PAYYANUR, KERALA- FOR CAPACITY DEVELOPMENT AND TRANSFER OF LOCATION SPECIFIC BRACKISHWATER AQUACULTURE TECHNOLOGIES

Aquaculture Development Cooperative Society (ADCOS), Payyanur, Kerala inked a MoU on the 25thMarch, 2019 to train the aqua farmers of the ADCOS and dissemination of CIBA technologies suitable for the agro-climatic situation of the west coast. Under the agreement CIBA will partner with the farmers group to provide technical guidance for the adoption of brackishwater technologies suitable for the region.

EVALUATING THE UTILITY OF KRILL MEAL IN SHRIMP DIET



M/S. Aker Biomarine private Limited, Mumbai made an alliance to harness the nutritional potency of Krill meal in shrimp and fish feeds on 28thMarch 2019. Aker Biomarine is a Oslo based Norwegian fishing and biotech company providing krill meal and value added products through a fully regulated and sustainable value chain, from the Antarctic region. As the major supplier of krill to the salmon farming industry, the nutritional superiority of the krill meal in salmon feeds has been proven. Aker Biomarine India Private Limited, Mumbai is a subsidiary of Norwegian company taking up the operations in India and wanted to promote krill mill as a functional component in shrimp and fish feeds with, which would benefit the Indian feed Industry and aquaculture sector.

PARTNERSHIP WITH FARMERS

BIOFLOC BASED SHRIMP NURSERY TECHNOLOGY DEMONSTRATED BY ICAR-CIBA



Frontline Demonstrations on Biofloc based Nursery rearing Technology for Pacific white shrimp Penaeus vannameihave been conducting in different parts of the country with support from the Department of Biotechnology, Govt. of India. The genesis of this demonstration was initiated with the MOU signed with one progressive farmer (Dandapat Aquatics) on 10th July, 2018 in presence of Hon'ble Member of Parliament Mr Rabindra Jena.

TECHNICAL SUPPORT AND PARTNERSHIP FARMING FOR ADOPTION OF PERIPHTYON BASED MILKFISH GROW-OUT CULTURE MODEL



MoUswere signed for technical support and Partnership farming for Adoption of Periphtyon based milkfish Grow-out culture Modelwith Sri. Animesh Das and Sri Krishnendu Gayan, Shibgobindapur - South 24 Parganas, Pin-743371, West Bengal on 28th June 2018

GOVERNMENT DEPARTMENT SUSTAINABLE DEVELOPMENT OF BRACKISHWATER AQUACULTURE



Memorandum of understanding was signed for the sustainable development of brackishwater aquaculture between Govt. of Gujarat and CIBA for the Brackishwater Aquaculture Development in the state on 5th September 2018. The MoU is for the development, refinement and transfer of technologies by CIBA in brackishwater aquaculture for the state of Gujarat and refine localized brackishwater aquaculture solutions on a partnership mode for farmers and entrepreneurs in Gujarat.

MEETING ORGANIZED

ICAR FOUNDATION DAY AS 'AQUACULTURE STARTUP DAY' TO PROMOTE INNOVATIONS AND ENTREPRENEURSHIP IN INDIAN AQUACULTURE SECTOR



Startup initiatives are common in sectors other than aquaculture, and hence an aquaculture startup day has been organized on the occasion of 90thICAR-foundation at CIBA on 16th July 2018, to infuse innovations and attract entrepreneurship in aquafarming. A Brainstorming workshop on "Startup India programme on aquaculture sector" brought the outgoing students from Fisheries Colleges of Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu together on the startup platform at CIBA. About 70 participants including officials from State Fisheries Departments, Development Agencies like NFDB, MPEDA, MSME, CII, FICCI, Investors, Startups, Professors and students from State Fisheries Universities attended the workshop and participated in the panel discussions.

START-UP MEET 2019



As a part of the conference a Start-Up Meet was organized on 24thJanuary 2019, chaired by Dr Sanjeev Saxena, ADG IPTM, ICAR, New Delhi, in which about 70 participants including scientists, business entrepreneurs, Start-Up entrepreneurs, prospective Start-Up personnel, Senior officials from NABARD, Patent Office, State Department officials from Tamil Nadu, Andhra Pradesh and Odisha, Oriental Insurance, faculty students from fisheries college have participated in the group-discussion meet on opportunities, problems and prospects of the Start-Ups in aquaculture sector



AGRI START-UP CONCLAVE



Young entrepreneurs of ICAR-CIBA at Agri Start-up conclave on 16 &17thOctober 2018 at NASC complex, New Delhi

REVENUE GENERATED DURING 2018-19

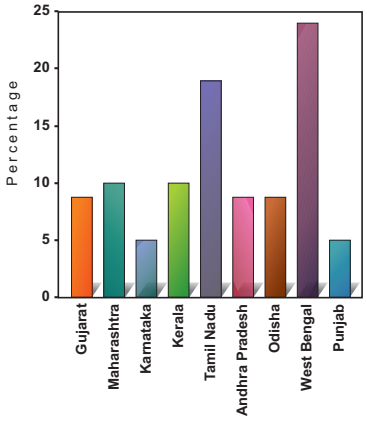
The Revenue earned from different types of activities and revenue from onetime payment and royalty/revenue share obtained in the total revenue generated.

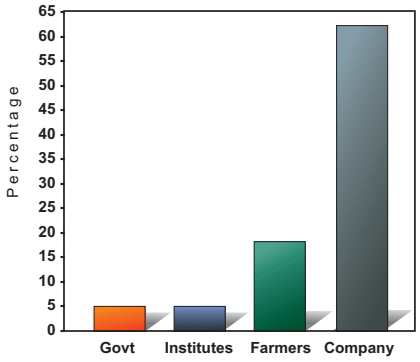
REVENUE GENERATED

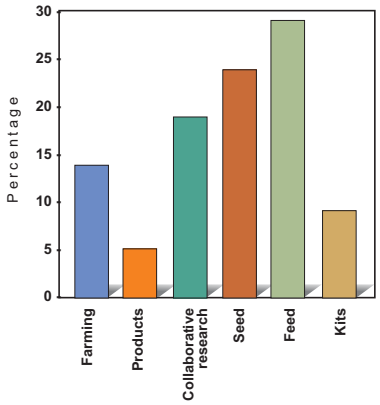
Client Name	Revenue Generated
The Water Base Ltd, Chennai 600 008.	2,36,000
Dr.Attar Aqua Feed, Haryana.	1,10,000
Mr.Suryakumar Boriah-CEO, Hitide Seafarms, Tamil Nadu	50,000
Shri. Anjan Kumar Dandapat, M/s. Laxmi Narayan Feeds, Odisha	88,500
Sri Krishnendu Gayan, West Bengal.	20,000
Sri. Esukapalli Nagaraju, M/s. Pranita Marines, AP	1,18,000
Sri Aniruddha Das, West Bengal	20,000
Shri. Nishanth Reddy, AP.	2,36,000
Shri. Keshav Odedara, M/s.Aditi Enterprises, Gujarat.	7,08,000
Mrs.B.Aarthi, New Bio Science Company, Mysore.	2,50,000
Dr. R. Singaravel, Coastra Biosolutions Pvt. Ltd.,Chennai.	1,47,500
Rallis India Limited, Mumbai.	2,36,000
Shri Alok Kumar Choudhury, Sri Jagannath Foods&Aquaculture Odisha	1,50,000
Oriental Insurance	27,000
Total	**23,97,000 (inclusive of tax)**

CIBA'S MOU WITH DIFFERENT STAKEHOLDERS

Nature of organizations which signed MoU with ICAR-CIBA







RESEARCH & ADMINISTRATIVE MEETINGS

RESEARCH ADVISORY COMMITTEE (RAC)

The Research Advisory Committee of CIBA was constituted by ICAR (Councils order F.No.18-3/2016-ASR-I dated 06.12.2016) for a period of three years with effect from 01.01.2017:

Chairman	**Dr. K. Gopakumar**
Members	Dr. V.V.Sugunan Dr. K.M.Shankar Dr. G.Gopakumar Dr. S.N. Mohanty Dr. Aparna Dixit Dr Pravin Puthra Dr.K.K.Vijayan
Member Secretary	Dr. Subhendu Kumar Otta

The 24th meeting of the Research Advisory Committee (RAC) of CIBA was held on 2nd March 2019 at CIBA Headquarters, Chennai.



INSTITUTE RESEARCH COUNCIL (IRC)

The Institute Research Council (IRC) of CIBA has been constituted as follows:

Chairman	**Dr. K.K.Vijayan, Director**
Members	Assistant Director General (M.Fy.), ICAR, New Delhi Dr. C. P. Balasubramanian Dr. S.V. Alavandi Dr. G.Gopikrishna Dr. M. Kailasam Dr. C.V.Sairam Dr. M. Muralidhar Dr. K. Ambasankar Principal Investigators of all the projects
Member Secretary	Dr. Subhendu Kumar Otta

The 35th IRC Meeting was held on 26-27th April 2018 and the progress of research work was reviewed.

INSTITUTE MANAGEMENT COMMITTEE (IMC)

The Institute Management Committee has been constituted as follows:

Chairman	**Dr. K.K.Vijayan**
Members	Dr. Pravin Puthra, ADG (M.Fy.), ICAR Dr. Sudhansu Sekhar Mishra, Principal Scientist, ICAR- CIFA, Bhubaneswar Dr. V.R. Suresh, Principal Scientist, ICAR-CIFRI, Barrackpore, West Bengal Dr. Vindhya Mahendra, Principal Scientist, ICAR-NBFGR, Lucknow Dr. Shekarnath Ojha, Principal Scientist, ICAR-CIFE, Mumbai Commissioner of Fisheries, Govt. of Tamil Nadu, Chennai Commissioner of Fisheries, Govt. of Gujarat, Gandhi Nagar The Dean, FCRI, TANUVAS, Thoothukudi
Member Secretary	Dr. T. Ravisankar, Principal Scientist & Head of Office
Co-opted Members	Dr. S. K.Otta, Principal Scientist, OIC, PME Cell Dr. M. Jayanthi, Principal Scientist & OIC Engg. Cell Shri R.K.Babu, Finance & Accounts Officer Shri. R. Kandamani, AAO (Stores) Smt. V. Usharani, AAO (Estt.) Shri S. Pari, AAO & DDO Shri. P. Srikanth, Junior Accounts Officer
Non-Official Members	Sh. S. Satish Kumar, Farmers' Representative Sh. R.P. Venkatachalam, Farmers' Representative

The 50th IMC meeting held on 3rd September, 2018

INSTITUTE JOINT STAFF COUNCIL (IJSC)

The Institute Management Committee has been constituted as follows:



The composition of the Institute Joint Staff Council (reconstituted by CIBA for a period of three years w.e.f 29.03.2016 to 28.03.2019 vide Office Order F.No.13-1/2012-Admn. Dated 02.04.2016) is as follows:

Official Side	
Chairman	**Dr. K.K.Vijayan**
Members	Dr. T. Ravisankar, P.S. Dr. K.Ambasankar, P.S. Dr. C.P.Balasubramanian, P.S. Dr. R.Saraswathy, P.S. Dr. M.Kumaran, P.S. Shri R.K.Babu, Finance & Accounts Officer Smt. V. Usharani, AAO (Estt.)
Staff Side	
Secretary	Shri A.Manoharan, Assistant
Members	Shri N.Jagan Mohan Raj, Sr. Technical Asst Shri K.Paranthaman, Technical Asst. Smt. E.Mary Desouza, UDC Shri M.Sakthivel, Skilled Support Staff Shri C.Raghu, Skilled Support Staff

GRIEVANCE COMMITTEE

The composition of the Institute Grievance Committee (reconstituted by CIBA vide Office Order F.No.48-16/2010-Admn. Dated 06.06.2016) is as follows:

Chairman	**Dr. K.K.Vijayan**
Elected Members	
Scientific Member	Dr. J. Shyam Dayal, P.S & Dr. Nila Rekha, P.S
Technical Member	Dr. A. Nagavel, Senior Technical Officer
Administrative Member	Mrs. Usha Rani, A.A.O
	Shri P. Srikanth, J.A.O
	Shri. A. Manoharan, Assistant
Staff Member	Shri. M. Pichandi, Skilled Support Staff

WOMEN COMPLAINT COMMITTEE

Women Complaint Committee has been constituted as follows:

Chairman	**Dr. R. Saraswathy, Principal Scientist**
Member	Dr. Prasanna Kumar Patil, Principal Scientist Dr. P.Nila Rekha, Principal Scientist Shri N.Jagan Mohan Raj, Sr. Technical Asst Smt. E. Mary Desouza,

External Member Dr. A. Sumathi, Asst. Prof. & Head-in-Charge, Dept. of Biomedical Sciences , Sri Ramachandra Medical College, Porur, Chennai

WOMEN CELL

Women Cell has been constituted as follows:

Chairman	**Dr. D.Deboral Vimala, Principal Scientist**
Member	Dr. R.Saraswathy, Principal Scientist Smt. B.Amudavalli Smt. K.Subhashini, PA Smt. M.Mathuramuthubala
Member Secretary	Shri R. Kandamani, AAO

SERVICES AND ASSIGNMENTS

SERVICES IN COMMITTEES

Dr.K.K.Vijayan, Director

• Executive Committee and Governing Body, Rajiv Gandhi Centre for Aquaculture (MPEDA), Mayiladuthurai.

• ICAR Regional Committee No.VIII

• Executive Committee member - National Centre for Sustainable Aquaculture (NaCSA)

• Coastal Aquaculture Authority

• Scientific Advisory Committee, Krishi Vigyan Kendra, Tiruvallur.

• Scientific Advisory Committee for Dr.Perumal Krishi Vigyan Kendra

• State Level Committee on Animal Genetic Resources (SLCAnGR), constituted by Department of Animal Husbandry & Veterinary Services, Government of Tamil Nadu, Chennai.

• Board of Management of Tamil Nadu Fisheries University, Nagapattinam.

• Board of Management of Tamil Nadu Veterinary and Animal Sciences University, Chennai.

• Academic Council of Central Institute of Fisheries Education, Mumbai.

• Board of Management of Central Institute of Fisheries Education, Mumbai.

• National Committee on Introduction of Exotic Aquatic Organisms into Indian waters, constituted by the Ministry of Agriculture & Farmers Welfare, DAHDF, Govt. of India, New Delhi.

• Advisory Committee on Hilsa Conservation and Research

• Governing Body of State Fisheries Resource Management Society (FIRMA), Thiruvananthapuram.

• Advisory Board for Fisheries Sector Development, constituted by Special Chief Secretary (Planning), Planning Department, Govt. of Andhra Pradesh.

• Society of Coastal Aquaculture and Fisheries

• Society for Fisheries Technologists

• Marine Biological Association of India

• Project Monitoring Committee for monitoring the project works related to setting up of the Specific Pathogen Free Shrimp Seed Multiplication Centre at Mulapolam Village, Sompeta Mandal of Srikakulam District in Andhra Pradesh under the chairmanship of Chief Executive, National Fisheries Development Board, constituted by the Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Govt. of India, New Delhi.

• Technical Committee to examine as to whether the concepts and designs provided by MHKL for setting up Multiplication Centre for SPF P.monodon could be used for any alternative species of shrimp, constituted by the Department of Animal Husbandry Dairying and Fisheries, Ministry of Agriculture, Govt. of India.

• Member of Faculty in the Board of Studies of Cochin University of Science and Technology (CUSAT), Kochi.

• Selection Committee - Tamilnadu Scientist Award (TANSA) constituted by Tamil Nadu State Council for Science and Technology.

• High Power Society "Society for Promotion of Shrimp Farming in Punjab", headed by Additional Chief Secretary, Government of Punjab, Department of Animal Husbandry, Fisheries & Dairy Development, constituted by Department of Fisheries, Punjab.

• Selection Committee for the selection of the University Officers of the Tamil Nadu Dr J Jayalalitha Fisheries University, Nagapattinam.

• State-wise Coordination Committees for doubling Farmer's income by March, 2022, constituted by Secretary, DARE & Director General, ICAR, New Delhi.

• Kerala State Council for Science Technology and Environment, Thiruvananthapuram.

• Expert committee to study on Vembanad, Astamudi and Sasthamkotta lakes, constituted by Office of the Director of Fisheries, Govt. of Kerala, Thiruvananthapuram.

• Steering Committee for the Asian Pacific Aquaculture 2019 (APA 2019) event to be held on 18-21 June 2019 in Chennai.

• Sub-Committee to work out modalities for engaging Consultants in Coastal Aquaculture Authority.

Scientists

• Acted as External examiner to evaluate the Ph.D. thesis at CIFE and at Madras University - Dr. K.

Ambasankar

• Acted as Expert member in the discipline of Fish Nutrition in the departmental selection committee for promotion of ARS scientist At CIFE, Mumbai - Dr. K. Ambasankar

• Member of Entrepreneurship Development and Innovation Institute (EDII), Chennai, constituted by Govt. of Tamil Nadu - Dr. K. Ambasankar

• Member of the Steering committee of the TN fisheries Department on 03.10.2018 - Dr. K. Ambasankar

• Participated as a Chief Guest in the inaugural Function of one year Diploma Programme in Industrial Aquaculture Technology on 27.10.2018 - Dr. K. Ambasankar

• Acted as Member of the Abstract and Poster Management committee for the XIV Agriculture Science Congress, New Delhi during 20-23 February, 2019 - Dr. K. Ambasankar

• Acted as observer in the ICAR's 23rd AIEEA – 2018-19 on 22-23rd June, 2018 at Mullai Infotech, 3/148, SBI building, 1st floor, Mount Poonamalle High Road, Ramapuram, Chennai – Dr. R. Ananda Raja

• Member Secretary in the Institutional Animal Ethics Committee (IAEC) – Dr. R. Ananda Raja

• Member in the Institutional Biosafety Committee (IBSC), Annual Physical Verification Committee, Library Advisory Committee, and job training for security guards for fire safety – Dr. R. Ananda Raja

• Acted as an expert with Coastal Aquaculture Authority (CAA) to inspect the hatchery located at Prakasam, Guntur and Krishna districts of Andhra Pradesh on 4th and 5th October, 2018– Dr. R. Ananda Raja

• Observer in ARS/NET Exam- 2018 during 9-10 April, 2018 held at Chennai Centre – Dr. Debasis De

• Observer for the Renewal audit of Karnataka State Organic Certification Agency (KSOCA), Bengaluru under National Programme for Organic Production (NPOP) held during 9 -11 July, 2018 - Dr. Debasis De

• Member, ICAR Regional Committee No. II. - Dr. T.K. Ghoshal

• Member, Scientific Advisory Committee of Ramkrisahna Ashram Krishi Vigyan Kendra, Nimpith ¬ Dr. T.K. Ghoshal

• Member, Scientific Advisory Committee of Sasya Shyamala Krishi Vigyan Kendra, Narendrapur - Dr. T.K. Ghoshal

• Acted as Expert Member in the assessment committee for staff of Ramakrishna Ashram Krishi Vigyan Kendra, Nimpith on 21.04.2018 and 27.07.2018 - Dr. T.K. Ghoshal

• Acted as External Examiner for evaluation of answer sheet and viva- voce of PG and Ph.D. students of Animal Nutrition of NDRI on 30.10.18 at NDRI-ERS, Kalyani - Dr. T.K. Ghoshal

• Acted as Member of Assessment Committee for scientist under CAS at ICAR-NINFET, Kolkata on 22.03.19 - Dr. T.K. Ghoshal

• Acted as an Organizing Committee Member for the International Congress on Engineering and Life Science (ICELIS 2018) held during 26-29 April 2018 at Kastamonu, Turkey - Dr. Gouranga Biswas

• Acted as a Member (Outside expert) in the Selection Committee Meeting for selection of JRF under a DBT funded project held on 4 August 2018 at ICAR-CIFA, Kalyani Field Centre, Kalyani, West Bengal - Dr. Gouranga Biswas

• Reviewer for Journal of Indian Society of Coastal Agricultural Research - Dr. T.K. Ghoshal

• Editorial Board Member for Menba Journal of Fisheries Faculty, Kastamonu University, Turkey - Dr. Gouranga Biswas

• Editorial Board Member for Marine Science and Technology Bulletin, Turkey ¬- Dr. Gouranga Biswas

• Associate Editor, Journal of Fisheries and Life Sciences, Mangaluru, India - Dr. Gouranga Biswas

• Reviewer for various international journals, such as Aquaculture, Aquaculture Research and Fish Physiology and Biochemistry - Dr. Gouranga Biswas

• Acted as member in the State level monitoring committee for Tilapia aquaculture, at Department of Fisheries, Govt. of Tamil Nadu for approving Tilapia farms for the farmers of Tamil Nadu after screening the documents on 21.3.2019 – Dr. M.Kailasam

• Nodal person - State-of-the-art Community

Development Centre for Learning, Livelihood & Research (CDC-LLR) Laboratories in Nellore, Bhimavaram and Surat by KCT with CIBA as technical partner - Dr. M. Muralidhar

• Expert member of Committee constituted by Coastal Aquaculture Authority to suggest suitable recommendations for amending the CAA Rules, 2015 and guidelines issued there under to facilitate implementing them at field level - Dr. M. Muralidhar

• Expert Member of Technical and Inspection Committee for regulating establishment and operation of SPF shrimp broodstock multiplication Centres in the coastal areas, Depart of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Family Welfare, Government of India - Dr. M. Muralidhar

• Expert member for Inspection of hatcheries applied for permission to import brood stock of SPF L.vannamei and its seed production - Dr. M. Muralidhar

• Expert Panel member to develop strategies for holistic development of marine and island fisheries of Andaman & Nicobar Islands - Dr. M. Muralidhar

• Expert member for interviewing the candidates for the post of "Subject Matter Specialist, Agricultural Extension" at RASS KVK, Tirupati, Andhra Pradesh on 18th August 2018 - Dr.P.Mahalakhsmi

• Expert member for conducting "Departmental Promotion Committee meeting for Technical Staff" at ICAR-NRC for Banana, Tiruchirappalli on 16 October 2018 - Dr.P.Mahalakhsmi

• Jury member for holding "Smart India Hackathon (SHS) 2019: software" at Sri Sivasubramaniya Nadar College of Engineering, Chennai, Tamil Nadu during 2-3 March 2019 - Dr.P.Mahalakhsmi

• Member, Doctoral Committee for a research scholar in School of Information Technology, VIT University, Vellore - Dr.P.Mahalakhsmi

• Reviewer for various international journals, such as Review of research papers from Aquaculture, aquaculture research and Indian Journal of Fisheries - Dr. Prem Kumar

• Programme Committee member in International Conference of Virology on Global Viral Epidemics: A Challenging Threat, Chandigarh, India – Dr. M.Poornima

• Doctoral Committee Member in Sathyabhama University, Chennai – Dr. M.Poornima

• External expert to set question papers for master degree examinations Madras Veterinary college, TANUVAS, Chennai – Dr. M.Poornima

• External examiner for comprehensive viva voce examination, VELs University, Chennai – Dr. M.Poornima

• Lead Invited Speaker for the Krishi Sammridhi Mela 2018 at CODISSIA Trade Complex, Coimbatore during 24-26th August 2018 – Dr. C V Sairam

• Observer for ICAR AIEEA-2018 (UG/PG/SRF) held on 22-23 June, 2018 – Dr. Sherly Tomy

• Doctoral committee member in Presidency College, Chennai - Dr. Sherly Tomy

• Nodal officer, Data Management of ICAR-CIBA - R. Saraswathy

• Acted as Co-chairman of session entitled 'Role of Muscle Food Safety and Human Health' of the 8th Conference of Indian Meat Science Association and International Symposium on Technological Innovation in Muscle Food Processing for Nutritional Security, Quality and Safety during 22-24 November 2018 at West Bengal University of Animal and Fishery Sciences, Kolkata - Dr. Sanjoy Das

• Acted as Evaluation Committee Member under National programme for organic production (NPOP) Committee member with APEDA – Shri T. Sathish Kumar

• Served as Assessment panel expert member for approving cold storage with EIA - Shri T. Sathish Kumar

• Served as Inspection committee member for inspecting hatcheries with CAA- Shri T. Sathish Kumar

• Member in IMC of CIFA, Bhubaneswar – Dr. S.K.Otta

• Examiner to conduct PhD viva, TNFU, 27th November 2018 - Dr. S.K.Otta

• Member of 'Technical and Inspection Committee' constituted by the DAHD&F, Ministry of Agriculture and Farmers' Welfare for the purpose.

ATTRACTING AND RETAINING YOUTH IN AGRICULTURE (ARYA): AN INITIATIVE TO ATTRACT YOUTH TO BRACKISHWATER AQUACULTURE

Farming in land and water is the noble occupation and farmers consider it as their way of life. In India, we have a self sufficient and self reliant food production system. However, most farmers do not want their next generation to be in agriculture, as income from agriculture is not sufficient, and quality of life is not that appreciative. Minds of youth are creative and socially networked and they are capable of handling risk factors such as climate changes using various technologies. At this context, Govt. of India initiated a new scheme ARYA and it is launched by ICAR.

More than 450 school / college students from 20 educational institutions visited CIBA HQ and MES Muttukadu and learned about brackishwater aquaculture technologies. In Government School at Pakkam village, in Tiruvallur district of Tamil Nadu, an ornamental fish unit was established under CPCL project. The unit is being maintained by high school children under the guidance of their teachers. The National Science Day was organized at Corporation School Mylapore, in which importance of science and brackishwater aquaculture farming in Indian agriculture were inculcated among the school children









MERA GAON MERA GAURAV

Under the flagship programme of the Honourable Prime Minister of India, Mera Gaon and Mera Gaurav (MGMG), ICAR-CIBA organised 65 visits by a team of scientists, 28 meetings and 8 training programmes; Under the patronage of the MGMG programme,33 demonstrations were conducted,812 mobile advisories have been extended, 10 literature were distributed, in addition to the completion of 31 campaigns. The total number of activities conducted were 221 and 3428 fish/shrimp farmers benefitted out of it. These activities were taken up to hasten lab to land programmes and to create awareness among farmers about the organisations and the programmes related to the farming sector.

TECHNOLOGICAL INTERVENTIONS

• ICAR-CIBA's technological interventions such as three-tier system of cage aquaculture and nursery rearing of Seabass (Lates calcarifer) in open brackishwaters,family farming initiatives,homestead backyard Pearl spot larval rearing techniques, demonstration of "Waste to Wealth: Recycling of Fish and Domestic Waste"were demonstrated to the coastal families of MGMG villages for livelihood support and the security of communities and for doubling their income.

LESSONS LEARNT

• The lessons learnt out of the technological interventions were the development and successful implementation of appropriate policy guidelines for optimal utilization of open brackishwaters involving coastal fishers, technical empowerment of coastal communities in pen and cage culture of milkfish and mud crab, skill development of fisherwomen in the recycling of fish and domestic waste,providing opportunities to improve the livelihood of coastal women and their families and provision of alternative and additional income during the lean period.

LINKAGESDEVELOPED

• The fishers were linked with the Tamil Nadu Fisheries Development Corporation, CRRT, Department of Fisheries, Govt. of Tamil Nadu, and private fish farmers for procurement and marketing of seabass fingerlings as well as research institutes such as ICAR-CIBA and Kolathur ornamental hub, Chennai, for marketing.



Hand-on training on Waste to wealth: recycling of fish waste to value added products at MES of CIBA, Tamil Nadu



Demonstration of recycling of fish waste to value added products at Nambikkai Nagar, Srinivaspuram, Chennai, Tamil Nadu



Inauguration of Fish waste Processing Unit at Nambikkai Nager, Srinivaspuram, Chennai, Tamil Nadu



Homestead backyard Pearl spot hatchery Unit



Farmers feedback on nursery rearing of seabass in hapas in open brackishwater sources

SWACHH BHARAT MISSION

The Swachh Bharat or Clean India Mission was conceived by the Hon'ble Prime Minister, Sri Narendra Modi to motivate and galvanise Indian citizens from all walks of life to achieve by 2019 Mahatma Gandhi's dream of a clean India. In response to the noble call, Swachh Bharat Mission, the following Swachhta Hi Seva and Swachhta Pakhwada programmes were conducted at ICAR-CIBA, Chennai and Kakdwip Research Centre (KRC) of CIBA, Kakdwip, West Bangal, and Navsari Gujarat Research Center (NGRC) of CIBA, Navsari, Gujarat with due gravity and purposefulness during 15th September to 1st October 2018 and December 16-31 2018 respectively.

• Awareness campaign among the school children and villagers about the importance of hygiene and health aspects with displaying of sentences related with cleanliness and hygiene and importance of reducingopen defecation and water management to thechildren at Panchayat Union Primary School, Keelarkollaivillage, Kanchipuram District, Tamil Nadu, on 20th September 2018.



DISPLAYING OF CLEANLINESS AND HYGIENE RELATED SENTENCES AT PANCHAYAT UNION PRIMARY SCHOOL RALLIES, TAMIL NADU, ICAR-CIBA, CHENNAI

• Swachhta Hi Seva 2018 programme at Kannavanduraivillage, Tiruvallurdistrict, Tamil Nadu, on 21st September 2018 to create awareness on cleanliness, hygiene and sanitation among the villagers and removal of waste from the village and coastline premises.



CLEANING OF VILLAGE ROADS - - DAKSHIN LAKSHMINARAYANPUR, SOUTH 24 PARGANAS, WEST BENGAL - ICAR-CIBA, CHENNAI

• Swachhta workshop on "Waste to Wealth" by recycling of fish and domestic waste under Swachhata pakhwada programme on 28th September, 2018 at Srinivasapuram, Mullikuppam, Mullimanagar fishermen villages cluster located near CIBA headquarters in Chennai.



HAND ON TRAINING ON COMPOSTING OF DOMESTIC WASTE IN THREE STEPS - SRINIVASAPURAM, ADYAR CREEK AND ESTUARY, TAMIL NADU – ICAR-CIBA, CHENNAI

• Awareness programme on cleanliness, usage of toilet, health aspects hygiene and sanitation among the villagers and removal of waste from the village premises at Karathittu village, Kancheepuram district, Tamil Nadu on 29th September 2018.



CLEANING AND COLLECTING OF WASTES - KAKDWIP BUDDHAPUR ROAD, WEST BENGAL

• Awareness on cleanliness, hygiene and sanitation among the villagers; door to door meeting and removal of waste from the households activities on 18th December 2018 at Keelarkollai village, Kancheepuram district, Tamil Nadu.



SCHOOL COMPETITION, AADARSH BUNIYADI PRATHAMIK SHALA, MATWAD, NAVSARI, GUJARAT

DISTINGUISHED VISITORS

HEADQUARTERS, CIBA, CHENNAI

Sl. No	Details of visitors	Date of visit
1	Dr. K.K. Ramachandran, Scientist and Head, Central Geomatics Lab, Group Head atmospheric process group, Ministry of Earth Science, Government of India	20.04.2018
2	Dr. George Chamberlain Managing Director, Kona Bay & President - Global Aquaculture Alliance	01.05.2018
3	Dr. M.R.Ramesh Kumar, Chief Scientist, Physical Oceanography Division, CSIR – National Institute of Oceanography- Goa	15.05.2018
4	Dr.E.Vivekanandan, National Consultant, Bay of Bengal Programme	05.06.2018
5	Dr. R. Venkatesan, Scientist G & Head and Ocean Observation systems, National Institute of Ocean Technology, Pallikaranai, Chennai	08.06.2018
6	Mr Rabindra Jena, Hon'ble Member of Parliament	10.07.2018
7	Dr.G.S.Sameeran, IAS, Director of Fisheries, Government of Tamil Nadu	30.07.2018
8	Dr.K.Narayana Gowda, Former Vice-Chancellor, UAS, Bangalore & Chairman, ARYA Programme of ICAR	29.08.2017
9	Dr.Vipin Chandra, Joint Secretary, MoES, at NIOT campus, Chennai.	25.09.2018
10	Dr. Madhavan Rajeevan, Secretary, Ministry of Earth Sciences(MoES)	25.09.2018
11	Dr. M.A. Atmanand, the Director of NIOT, Chennai	25.09.2018
12	Mr. Harnath Singh Yadav, Member of Parliament (Rajya Sabha)	04.10.2018
13	Shri Pradeep Tamta, Member of Parliament (Rajya Sabha)	04.10.2018
14	Shri Prataprao Ganpatrao Jadhav, Member of Parliament (Lok Sabha)	04.10.2018
15	Dr. Sunil Baliram Gaikwad, Member of Parliament (Lok Sabha)	04.10.2018
16	Dr. Prasanna Kumar Patasani, Member of Parliament (Lok Sabha) and Convenor of the second sub-committee of Parliament on Official Language	04.10.2018
17	Dr. Malathi, Adjunct Professor, Department of Plant Pathology, TNAU, Coimbatore	30.10.2018
18	Dr. K.S. Palaniswami, Former Director (Research), TANUVAS	30.10.2018
19	Dr. Aniket Sanyal, Co-ordinator, CRP on Vaccines & Diagnostics	30.10.2018
20	Dr. Ashok Kumar, ADG (AH), ICAR	30.10.2018
21	Dr. J K Jena, DDG (Fy. Science), ICAR, New Delhi	30.10.2018
22	Mr. Nishanth Reddy, Nellore, Andhra Pradesh	30.10.2018
23	Prof. (Dr) Mohan Joseph Modayil, Former ASRB Chairman, Ex-Director CMFRI	15.11.2018
24	Joint Secretary, Department of Animal Husbandry, Dairying & Fisheries, New Delhi	10.12.2018
25	Dr. M. A. Atmanand, Director, National Institute of Ocean Technology (NIOT), Chennai	29.12.2018
26	Shri.N.Vasudevan, Additional Principal Conservator of Forest, Mangrove Foundation, Govt. of Maharashtra	22.01.2019
27	Dr.M.S. Swaminathan, The doyen of Indian Agricultural Research and Education	22.01.2019
28	Thiru.D.Jayakumar, Hon'ble Minister for Fisheries, Personnel and Administrative Reforms, Govt. of Tamil Nadu	22.01.2019
29	Dr.K.Gopal, IAS, Principal Secretary, Animal Husbandry, Dairying & Fisheries, Govt. of Tamil Nadu,	22.01.2019

30	Dr.B.Meenakumari, Chairperson, National Biodiversity Authority (NBA), Chennai	22.01.2019
31	Dr.J.K.Jena, Deputy Director General (Fisheries) and Animal Sciences, ICAR, New Delhi	23.01.2019
32	Dr.S.K.Saxena, Director, Export Inspection Council, GOI	23.01.2019
33	Dr.Trilochan Mohapatra, Secretary, DARE & DG, ICAR, New Delhi	23.01.2019
34	Dr. S.D.Tripathi, Former Director Central Institute of Freshwater Aquaculture and Central Institute of Fisheries Education	25.01.2019
35	Dr.Modadugu Vijay Gupta, World Food Prize Laurate	25.01.2019
36	Prof. Chris Hauton, University of South Hampton, UK	25.01.2019
37	Mr. Mathew Jose, CEO, Paperman Foundation, Chennai	13.02.2019
38	Shri.N K Uppal, Vice President (Corporate Growth Projects), Rallis India limited	15.02.2019
39	Mr. Atul Barman, Director, Aker Bio marine India Private Limited, Mumbai	28.03.2019
40	Dr. A. K. Munirajan, Professor & Head, Department of Genetics, University of Madras, Chennai	12.03.2019
41	Shri. T. Purushothaman, President, Aquaculture Development Cooperative Society (ADCOS), Payyanur, Kerala	25.03.2019

KAKDWIP RESEARCH CENTRE, KAKDWIP

Sl. No	Details of visitors	Date of visit
1	Dr. J.K. Jena, DDG (Fisheries & Animal Science), ICAR	10.05.2018
2	Dr. S.S. Mishra, Director, ICAR-CIFA	12.06.2018



NAVSARI GUJARAT RESEARCH CENTRE, GUJARAT

Sl. No	Details of visitors	Date of visit
1	Dr. J.K. Jena, Deputy Director General (Fisheries), ICAR	07.06.2018
2	Shri. R.C. Patel, Member of Legislative Assembly, Navsari	07.06.2018
3	Dr. C.J. Dangaria, Vice Chancellor, NAU	07.06.2018
4	Dr.C.Gopal, Member Secretary, Coastal Aquaculture Authority, Govt. of India, Chennai	07.06.2018
5	Dr. Pravin Puthra, Assistant Director General (Fisheries), ICAR	07.06.2018
6	Dr. N.H. Kelawala, Dean, Veterinary College	07.06.2018
7	Shri. Mohammed Shahid (IAS), Commissioner of Fisheries, Department of Fisheries, Gujarat	05.09.2018
8	Shri. R. C. Faldu, Hon'ble Cabinet Minister for Agriculture, Rural Development, Fisheries, Animal Husbandry and Transport, Government of Gujarat.	05.09.2018

PERSONNEL

PERSONNEL AS ON 31.03.2019

Sl.No.	NAME	DESIGNATION	
1	Dr.K.K.Vijayan	Director	
2	Dr.G.Gopikrishna	Principal Scientist, HOD , NGBD	Retired on 30.11.2018
3	Dr. S.V.Alavandi	Principal Scientist, HOD , AAHED	
4	Dr.K. P. Jithendran	Principal Scientist	
5	Dr.C.V.Sairam	Principal Scientist	
6	Dr.T. Ravisankar	Principal Scientist	
7	Dr.M. Muralidhar	Principal Scientist	
8	Dr. (Smt) M. Jayanthi	Principal Scientist	
9	Dr. (Smt) B. Shanthi	Principal Scientist	
10	Dr. C. P. Balasubramanian	Principal Scientist	
11	Dr.M. Kailasam	Principal Scientist	
12	Dr. (Smt) D. Deboral Vimala	Principal Scientist	
13	Dr. M. Shashi Shekhar	Principal Scientist	
14	Dr. (Smt) P. Nila Rekha	Principal Scientist	
15	Dr.K. Ambasankar	Principal Scientist	
16	Dr.J. Syama Dayal	Principal Scientist	
17	Dr. Akshya Panigrahi	Principal Scientist	
18	Dr.M. Kumaran	Principal Scientist	
19	Dr. S. Kannappan	Principal Scientist	
20	Dr. (Smt) M.Poornima	Principal Scientist	
21	Dr. (Smt) R. Saraswathy	Principal Scientist	
22	Dr. M.Makesh	Principal Scientist	
23	Dr. (Smt) Sherly Tomy	Principal Scientist	
24	Dr.Debasis De	Principal Scientist	
25	Dr. Prasanna Kumar Patil	Principal Scientist	
26	Dr.Subhendu Kumar Otta	Principal Scientist	
27	Dr. (Smt) P. Mahalakshmi	Principal scientist	
28	Dr. Satyanarayan Sethi	Principal Scientist	Promoted on 15.05.2017
29	Dr.K.P.Kumaraguru vasagam	Principal Scientist	Promoted on 26.03.2018
30	Shri. Ashok Kumar Jangam	Scientist	
31	Dr. Vinaya Kumar Katneni	Scientist	Promoted On 12.06.2016
32	Dr. R. Ananda Raja	Scientist	Promoted on 08.01.2017
33	Dr.(Smt) Krishna Sukumaran	Scientist	Promoted on 07.01.2017
34	Dr.(Smt)P. Ezhil Praveena	Scientist	Promoted on 07.01.2017
35	Dr. Sujeet Kumar	Scientist	
36	Dr. (Smt).Shyne Anand	Scientist	
37	Dr. (Smt) N. Lalitha	Scientist	
38	Dr. (Smt) T. Bhuvaneswari	Scientist	
39	Dr. P. Kumararaja	Scientist	
40	Dr.B.Sivamani	Scientist	
41	Dr. (Smt) Vidya Rajendran	Scientist	

Sl.No.	NAME	DESIGNATION
42	Dr. Satheesha Avunje	Scientist
43	Shri. K.P.Sandeep	Scientist
44	Ms. Babita	Scientist
45	Dr. Aritra Bera	Scientist
46	Shri. T.Sathish Kumar	Scientist
47	Smt.M.U.Rekha	Scientist
48	Dr.N.S.Sudheer	Scientist
49	Dr. Suvana Sukumaran	Scientist
50	Dr.(Smt)Neethu.K.C.	Scientist
51	Shri.R. Aravind	Scientist
52	Shri.Dani Thomas	Scientist
53	Shri.Biju.I.F.	Scientist
54	Ms. Misha Soman	Scientist
55	Smt.Mary Lini	Scientist
56	Dr.J.Raymond Jani Angel	Scientist
57	Shri.T.Sivaramakrishnan	Scientist
58	Dr.Vinay Tharabenahalli Nagaraju	Scientist
59	Dr.(Smt)R.Geetha	Scientist

TECHNICAL

Sl.No.	NAME	DESIGNATION	
1	Shri R. Elankovan	Chief Tech. Officer	
2	Dr. S. Sivagnanam	Chief Tech. Officer	Promoted on 14.02.2017
3	Shri D. Raja Babu	Chief Tech. Officer	Promoted on 13.03.2017
4	Shri M. Shenbagakumar	Chief Tech. Officer	Promoted on 07.07.2018
5	Shri R. Puthiavan	Assistant Chief Tech. Officer	
6	Smt. K. Jacquline	Assistant Chief Tech. Officer	
7	Shri Joseph Sahayarajan	Assistant Chief Tech. Officer	Promoted on 08.12.2015
8	Shri S. Rajamanickam	Assistant Chief Tech. Officer	Promoted on 28.10.2015
9	Shri S. Nagarajan	Assistant Chief Tech. Officer	Promoted on 03.01.2017
10	Dr. A. Nagavel	Assistant Chief Tech. Officer	Promoted on 02.08.2017
11	Shri R. Subburaj	Assistant Chief Tech. Officer	Promoted on 27.08.2017
12	Shri N. Ramesh	Tech. Officer	
13	Shri S. Saminathan	Tech. Officer	
14	Shri N. Jagan Mohan Raj	Tech. Officer	
15	Shri D. M. Ramesh Babu	Tech. Officer	Promoted on 24.07.2017
16	Shri G. Thiagarajan	Tech. Officer	Promoted on 04.08.2017
17	Shri K. Paranthaman	Senior Tech. Asst.	
18	Shri K. Karaian	Senior Tech. Asst.	Promoted on 10.09.2017
19	Shri. S.Prabhu	Technical Asst.	Joined on 14.09.2018
20	Shri. K.V. Delli Rao	Senior Technician	

ADMINISTRATION

Sl.No.	NAME	DESIGNATION	
1	Shri.K.V.S.Satyanarayana	Administrative Officer	Retired on 31.10.2018
2	Shri.Babu.R.K.	Finance & Accounts Officer	Joined on 23.05.2018
3	Shri R. Kandamani	Asst. Admn. Officer	
4	Smt. V. Usharani	Asst. Admn. Officer	
5	Shri S. Pari	Asst. Admn. Officer	
6	Shri P. Srikanth	Junior Accounts Officer	
7	Smt. S. Nalini	Private Secretary	Promoted on 08.05.2018
8	Shri. K.G. Gopala Krishna Murthy	Personal Assistant	
9	Smt. K. Subhashini	Personal Assistant	Promoted on 06.12.2018
10	Shri A. Manoharan	Assistant	
11	Smt. E. Amudhavalli	Assistant	
12	Shri A. Sekar	Assistant	
13	Smt. E. Mary Desouza	Assistant	
14	Shri. Raghavendra.K	Assistant	
15	Smt. K. Hemalatha	Stenographer, Grade – III	
16	Smt. R. Vetrichelvi	UDC	
17	Smt. M. Mathuramuthu Bala	UDC	
18	Smt. B. Prasanna Devi	UDC	Promoted on 27.10.2018
19	Shri.B.Palanivelmurugan	UDC	Transfer to CMFRI, Mandapam on 31.10.2018
20	Shri. R. Kumerasen	LDC	
21	Shri A. Paul peter	LDC	

SKILLED SUPPORT STAFF

Sl.No.	NAME	DESIGNATION	
1	Shri V. Jeevanantham	Skilled Support Staff	
2	Shri K. Nithyanandam	Skilled Support Staff	
3	Shri V. M. Dhanapal	Skilled Support Staff	
4	Shri V. Kumar	Skilled Support Staff	
5	Shri E. Manoharan	Skilled Support Staff	
6	Shri C. Saravanan	Skilled Support Staff	
7	Shri.S.Kuppan	Skilled Support Staff	VRS on 03.04.2018
8	Shri M. Pichandi	Skilled Support Staff	
9	Shri S. Selvababu	Skilled Support Staff	
10	Shri D. Senthil Kumaran	Skilled Support Staff	
11	Shri C. Ragu	Skilled Support Staff	
12	Shri P.G. Samuvel	Skilled Support Staff	
13	Shri M. Sakthivel	Skilled Support Staff	
14	Shri R. Mathivanan	Skilled Support Staff	
15	Shri R. Indra Kumar	Skilled Support Staff	
16	Shri G. Dayalan	Skilled Support Staff	
17	Shri Kanaka Prasad	Skilled Support Staff	
18	Smt. S. Premavathy	Skilled Support Staff	
19	Shri. J. Murugan	Skilled Support Staff	
20	Shri.V.Kishorkumar	Skilled Support Staff	

NAVSARI RESEARCH CENTRE OF CIBA, GUJARAT
NGRC SCIENTISTS

Sl.No.	NAME	DESIGNATION	
1	Shri.K.V.S.Satyanarayana	Administrative Officer	Retired on 31.10.2018
2	Shri.Babu.R.K.	Finance & Accounts Officer	Joined on 23.05.2018
3	Shri R. Kandamani	Asst. Admn. Officer	
4	Smt. V. Usharani	Asst. Admn. Officer	
5	Shri S. Pari	Asst. Admn. Officer	
6	Shri P. Srikanth	Junior Accounts Officer	
7	Smt. S. Nalini	Private Secretary	Promoted on 08.05.2018
8	Shri. K.G. Gopala Krishna Murthy	Personal Assistant	
9	Smt. K. Subhashini	Personal Assistant	Promoted on 06.12.2018
10	Shri A. Manoharan	Assistant	
11	Smt. E. Amudhavalli	Assistant	
12	Shri A. Sekar	Assistant	
13	Smt. E. Mary Desouza	Assistant	
14	Shri. Raghavendra.K	Assistant	
15	Smt. K. Hemalatha	Stenographer, Grade – III	
16	Smt. R. Vetrichelvi	UDC	
17	Smt. M. Mathuramuthu Bala	UDC	
18	Smt. B. Prasanna Devi	UDC	Promoted on 27.10.2018
19	Shri.B.Palanivelmurugan	UDC	Transfer to CMFRI, Mandapam on 31.10.2018
20	Shri. R. Kumerasen	LDC	
21	Shri A. Paul peter	LDC	

NAVSARI RESEARCH CENTRE OF CIBA, GUJARAT
NGRC SCIENTISTS

Sl.No.	NAME	DESIGNATION	
1	Shri.Pankaj Amrut Patil	Scientist	Transferred on 24.07.2018
2	Shri.Tanveer Hussain	Scientist	Transferred on 20.09.2018
3	Shri.Jose Antony	Scientist	Transferred on 17.09.2018

KRC Staff
SCIENTISTS

Sl.No.	NAME	DESIGNATION	
1	Dr.T.K.Ghosal	Principal Scientist	
2	Dr.Sanjoy Das	Principal Scientist	
3	Dr.Gouranga.Biswas	Scientist	Promotedo on 08.01.2017
4	Dr. Prem Kumar	Scientist	
5	Ms.Christina Lalramchhani	Scientist	
6	Ms. Leesa Priyadarsani		Scientist

TECHNICAL

Sl.No.	NAME	DESIGNATION	
1	Shri.P.S.Samanta	Tech. Officer	Retired on 30.09.2018
2	Smt. Chhanda Mazumder	Senior Tech. Asst.	

ADMINISTRATION

Sl.No.	NAME	DESIGNATION
1	Shri. S.K Bindu	Assistant

Sl.No.	NAME	DESIGNATION	
1	Shri.N.N.Jana	Skilled Support Staff	Retired on 28.02.2019
2	Shri K.P.Naskar	Skilled Support Staff	
3	Smt L.R. Bhuiya	Skilled Support Staff	
4	Shri U.K. Santra	Skilled Support Staff	
5	Shri P.C. Das	Skilled Support Staff	
6	Shri.Sanjoy Some	Skilled Support Staff	

REDEPLOYED STAFF FROM PURI RESEARCH CENTER of CIBA TO CIFA, BHUBANESHWAR

Sl.No.	NAME	DESIGNATION
1	Shri.P.C.Mohanty	Technical Assistant
2	Shri.Premanadha Bisoi	Skilled Support Staff

INFRASTRUCTURE DEVELOPMENT

INFRASTRUCTURE DEVELOPMENT

1. Construction of laboratory building at CIBA Head Quarters, Chennai
2. Replacement of floor tiles in 1st & 2nd floor corridor at Main Lab cum Admin building of CIBA Head Quarters, Chennai
3. Pavement blocks for car parking in back side of the main building at CIBA Head Quarters, Chennai
4. Renovation of storm water trench including earth filling at CIBA Head Quarters, Chennai
5. Construction of sewage collecting tank at CIBA Head Quarters, Chennai
6. Construction of atrium space at CIBA Head Quarters, Chennai
7. Providing gate in southern side of the compound wall at CIBA Head Quarters, Chennai
8. Providing Non- Essential panel including cabling for connecting the existing two generators and two transformers at CIBA Head Quarters, Chennai
9. Re-routing the existing wet raiser system at CIBA Head Quarters, Chennai
10. Supply & installation of Electrical Distribution panel board near Trainees hostel at CIBA Head Quarters, Chennai
11. Supply and fixing of exterior aluminium composite panel in the sit out area in the first floor at CIBA Head Quarters, Chennai
12. Fabrication and supply of glass water fountain at CIBA Head Quarters, Chennai
13. Renovation of internal road in CIBA Head Quarters, Chennai
14. Supplying and fixing LED light in the roof of court yard at CIBA Head Quarters, Chennai
15. Construction of Central drainage pond at Muttukadu Experimental Station, Muttukadu
16. Construction of 5000 litres RCC tanks in place of FRP tanks with pipe line for water and aerator at Muttukadu Experimental Station, Muttukadu
17. Construction of first floor over the existing wet laboratory building at KRC of CIBA, Kakdwip
18. Construction of Trainees Hostel under Tribal Sub-plan completed at KRC of CIBA, Kakdwip
19. Construction of Electrical Sub-station building completed and new transformer with enhanced load (200 KVA) installed at KRC of CIBA, Kakdwip
20. Barbed wire fencing at C-sector farm completed at KRC of CIBA, Kakdwip
21. Executed the work Re-excavation of inlet canal at Sector-B at KRC of CIBA, Kakdwip












LIBRARY AND DOCUMENTATION



A. LIBRARY HOLDINGS

CIBA Library procured 45 new books including official language books during the period 2018-19 and currently holds 2,776 books, subscriptions for fourinternational and national journals at the headquarters, Chennai and Kakdwip Research Centre in West Bengal. The details of Library holdings as on March 31, 2019 are provided in the diagram below.

B.LIBRARY AND E-RESOURCE CENTRE

The CIBA library has been upgraded as Library and e-Resource Centre with six workstations having the facility to access e-books, online journals, Institute publications and scientists publications for ease of use by scientists and scholars. This facility is now open to students, scholars and other researchers from Universities, Colleges and other academic Institutes. The timing of the facility also has been extended till 6 p.m. to enable students to use it effectively.

C. DIGITAL REPOSITORY

Under the digitalization initiative, all institute publications and individual scientist's publications have been digitized and uploaded in the KRISHI Portal. It will be further uploaded in the E-prints open sources software) and linked to the international databases to enhance visibility of CIBA research achievements across the globe.

D. ONLINE ACCESS TO THE CIBA SUBSCRIBED &CERA JOURNALS AND DOCUMENT DELIVERY SERVICES:

CIBA has access to e-books and journals published by Springer, John Wiley and Elsevier through ICAR- CeRA resource sharing platform. For the ease of use, the library has listed all the full content accessible online journals along with their access links in CIBA web portal. The library section supplied photocopies of journal articles requested from various ICAR institutes, scientists and research scholars under CeRA-Document Delivery Request (DDR).

E. EXCHANGE SERVICES

CIBA library maintained exchange relationship with various national and international organizations working on fisheries and aquaculture on mutual interest. The library maintained free mailing of institute's annual report and other Institute publications to various research organizations, universities and other agencies to provide updates on the institute research and development programmes.

F. INFORMATION SERVICES TO THE STAKEHOLDERS

CIBA library acted as a reference library by providing access to the reference books & journals available in the library to the scientific personnel of other research organizations, academia, university/ college students, research scholars, stakeholders and other related visitors. The library provided photocopying service to users on nominal payment basis.

G. UTILIZATION OF FUNDS

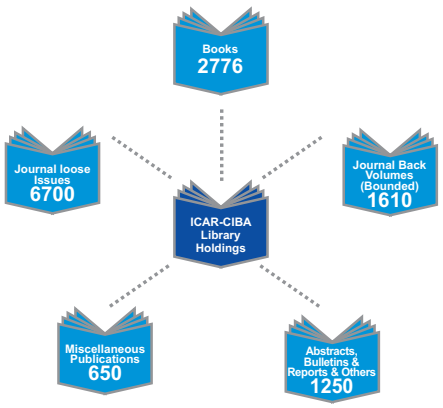
The funds available to the tune of Rs. 10.00 lakhs were effectively utilized towards the procurement of new books. Journals, Anti-plagiarism and Grammarly software for the library users, Scientists & Staff of Headquarters and KRC library of CIBA.

H. ISBN NUMBERS

CIBAhasobtained 50 ISBNs for five years from the Ministry of Human Resources Development for its publications. Fifteen books have been allotted ISBN numbers as of March 2019.

I. KRISHI PORTAL

ICAR-CIBA has uploaded more than 700 of its publications consisting of research papers and Institute publications in the ICAR-KRISHI Portal. The Institute was felicitated with a Certificate of Appreciation for proactively implementing ICAR-Research Data Management Guidelines and uploading the publications.



CIBA – Overview of Library Holdings

PUBLICATION, PARTICIPATION IN CONFERENCES, MEETINGS, WORKSHOPS, SYMPOSIA

Institute Publication List

Annual Report 2017-18
Training Calendar 2018-19 (http://krishi.icar.gov.in/jspui/handle/123456789/20307)
Jal Tarang Vol. 4 (Hindi magazine) (http://krishi.icar.gov.in/jspui/handle/123456789/20311)

CIBA Extension Series

- Information and communication technology for brackishwater aquaculture technology. ICAR-CIBA Extension Series No. 61. (http://krishi.icar.gov.in/jspui/handle/123456789/20216)
- Demonstration of brackishwater finfish farming in Gujarat - CIBA initiatives. ICAR-CIBA Extension Series No. 62. (http://krishi.icar.gov.in/jspui/handle/123456789/20215)
- Application of minerals in shrimp culture systems. ICAR-CIBA Extension Series No. 63. (http://krishi.icar.gov.in/jspui/handle/123456789/20217)
- Community and family farming initiatives for tribal and aqua farmers of Gujarat. ICAR-CIBA Extension Series No. 64. (http://krishi.icar.gov.in/jspui/handle/123456789/20218)
- Advisories on Infectious myonecrosis (IMN)(http://krishi.icar.gov.in/jspui/handle/123456789/20316)
- Hepatopancreatic microsporidiosis (HPM) (http://krishi.icar.gov.in/jspui/handle/123456789/20314)
- White spot disease (WSD) (http://krishi.icar.gov.in/jspui/handle/123456789/20317)
- Acute hepatopancreatic necrosis disease (AHPND) (http://krishi.icar.gov.in/jspui/handle/123456789/20315)
- Aquastat India 2018. ICAR-CIBA. Extension Series No.66.(http://krishi.icar.gov.in/jspui/handle/123456789/20293)

CIBA Technology Series

- Poly plus – a cost effective feed for brackishwater polyculture. CIBA Technology Series, 15.(KRISHI: Technology Repository)
- Metagenomics studies: an aquaculture perspective. CIBA e-publication series 2019 – No. 30. (http://krishi.icar.gov.in/jspui/handle/123456789/20252)

CIBA Training Manuals

- Recent advances in soil and water management in brackishwater aquaculture – a training manual. CIBA-TM Series-2018, No. 8. (http://krishi.icar.gov.in/jspui/handle/123456789/20211)
- Training manual on seed production and farming technology of brackishwater catfish, Mystus gulio. CIBA- TM Series 2018 No. 11.(http://krishi.icar.gov.in/jspui/handle/123456789/20308)
- Hands on training on aquaculture genomics and bioinformatics. CIBA-TM Series-2018-No. 12. (http://krishi.icar.gov.in/jspui/handle/123456789/20256)
- Training manual on seed production and farming of brackishwater finfishes (http://krishi.icar.gov.in/jspui/handle/123456789/20299)
- Water and soil treatment application in aquaculture - a training manual. CIBA- TM Series 2018, No. 13.(http://krishi.icar.gov.in/jspui/handle/123456789/20212)
- Training manual on recent advances in farming of Pacific white shrimp, Penaeus vannamei. CIBA- TM Series, 2018, No. 14.
- Training manual on hatchery production and farming of milkfish and mullets. (http://krishi.icar.gov.in/jspui/handle/123456789/20306)

Books by CIBA

- Fostering aquaculture Start-Ups: 2019(http://krishi.icar.gov.in/jspui/handle/123456789/20290)
- A Guide to milkfish (Chanos chanos) aquaculture. ISBN: 978-81-932937-5-1 (http://krishi.icar.gov.in/jspui/handle/123456789/20213)
- Family farming model in brackishwater aquaculture for livelihood support of communities living around Adyar Creek and Estuary. ISBN 978 - 81 - 932937 -9- 9. (http://krishi.icar.gov.in/jspui/handle/123456789/20214)
- Innovative approaches and success stories of brackishwater aquaculture farmers, Farmers Conclave. BRAQCON World Brackishwater Aquaculture Conference 22-25, January, 2019 (http://krishi.icar.gov.in/jspui/handle/123456789/20197)
- Souvenir book, BRAQCON World Brackishwater Aquaculture Conference 22-25, January, 2019.(http://krishi.icar.gov.in/jspui/handle/123456789/20289)
- Book of abstracts Braqcon 2019, BRAQCON World Brackishwater Aquaculture Conference 22-25, January, 2019 (http://krishi.icar.gov.in/jspui/handle/123456789/20295)

Peer Reviewed Journals

1. Alavandi, S.V., Muralidhar, M, Dayal, J.S., Rajan, J.S., Praveena, P.E., Bhuvaneswari, T, Saraswathy, R., Chitra, V., Vijayan, K.K., Otta, S.K., 2019. Investigation on the infectious nature of running mortality syndrome (RMS) of farmed Pacific white leg shrimp, Penaeus vannamei in shrimp farms of India. Aquaculture, 500, 278-289.(https://krishi.icar.gov.in/jspui/handle/123456789/11324)
2. Ali, S.S.R., Ambasankar, K., Praveena, P.E., Nandakumar, S., Musthafa, M.S., 2018. Effect of dietary prebiotic inulin on histology, immuno-hematological and biochemical parameters of Asian seabass (Lates calcarifer). Aquac. Res., 49, 2732–2740. (http://krishi.icar.gov.in/jspui/handle/123456789/10632)
3. Anand, P.S. S., Balasubramanian, C. P., Lalramchhani, C., Kumar, S., Biswas, G., De, D., Ghohsal, T. K., Vijayan, K. K., 2019. Substrate based black tiger shrimp, Penaeus monodon culture: Stocking density, aeration and their effect on growth performance, water quality and periphyton development. Aquaculture, 507, 411-418. (http://krishi.icar.gov.in/jspui/handle/123456789/20205)
4. Anand, P.S. S., Balasubramanian, C.P., Lalramchhani, C., Panigrahi, A., Gopal, C., Ghoshal, T.K., Vijayan, K.K., 2018. Comparison of mudcrab- based brackishwater polyculture systems with different finfish species combinations in Sundarban, India. Aquac. Res., 49(9), 2965-2976.(http://krishi.icar.gov.in/jspui/handle/123456789/20204)
5. Antony, J., Balasubramanian, C. P., Balamurugan, J., Sandeep, K. P., Biju, I. F., Vijayan, K. K., 2019. Optimization of nursery rearing for megalopa of giant tiger crab Scylla serrata (Forskaal, 1775). Indian J. Fish., 66(1), 43-50. (http://krishi.icar.gov.in/jspui/handle/123456789/20202)
6. Bedekar, M. K., Soman, P., Kole, S., Anand, D., Tripathi, G., Makesh, M., Rajendran, K.V., 2018. Evaluation of interferon gamma (IFN-γ) of Labeo rohita as an immunomodulator: in vitro expression model. Aquacult. Int., https://doi.org/10.1007/s10499-018-0292-9(http://krishi.icar.gov.in/jspui/handle/123456789/20286)
7. De, D., Ghoshal, T.K., Biswas, G., Mukherjee, S., Kumar, S., Anand, P.S.S., Raja, R.A., Vijayan, K.K., 2018. Evaluation of growth performance in Mugil cephalus L. juveniles fed diets incorporated with fermented plant feedstuffs replacing fishmeal or diets supplemented with fish gut bacteria. J. Food. Process. Technol., 9(4), 728. (http://krishi.icar.gov.in/jspui/

handle/123456789/20193)

8. De, D., Raja, R.A., Ghoshal, T.K., Mukherjee, S., Vijayan, K.K., 2018. Evaluation of growth, feed utilization efficiency and immune parameters in tiger shrimp (Penaeus monodon) fed diets supplemented with or diet fermented with gut bacterium Bacillus sp. DDKRC1. isolated from gut of Asian seabass (Lates calcarifer). Aquac. Res., 49, 2147-2155. (http://krishi.icar.gov.in:8080/jspui/handle/123456789/9660)

9. Duvvuru, J.A., Arjun, R., Sethi, S.N., Kasthuri, R., 2018. Inhibition and recovery of aquatic macrophyte Lemna gibba exposed to a combination pesticide. Indian J. Natur. Sci., Vol.8 (46), Feb. 2018. (http://krishi.icar.gov.in/jspui/handle/123456789/20291)

10. Gora, A.H., Ambasankar, K., Sandeep, K. P., Rehman, S., Agarwal, D., Ahmad, I., Ramachandran, K., 2019. Effect of dietary supplementation of crude microalgal extracts on growth performance, survival and disease resistance of Lates calcarifer (Bloch, 1790) larvae. Indian J. Fish., 66(1), 64-72. (http://krishi.icar.gov.in/jspui/handle/123456789/20194)

11. Jannathulla, R., Ambasankar, K., Dayal, J.S., Rajamohmed, M.K., Sravanthi, O., Rajesh, B., 2019. Studies on functional properties and chemical composition of commercial shrimp feeds used in Andhra Pradesh, India. Int. J. Fish. Aquat. Stud., 7(2), 84-89. (http://krishi.icar.gov.in/jspui/handle/123456789/20195)

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14. Jannathulla, R., Dayal, J.S., Vasanthakumar, D., Ambasankar, K., Muralidhar, M., 2018. Effect of fungal fermentation on apparent digestibility coefficient for dry matter, crude protein and amino acids of various plant protein sources in Penaeus vannamei.Aquacult. Nutr., 24 (4): 1318-1329 doi.org/10.1111/anu.12699. (http://krishi.icar.gov.in:8080/jspui/handle/123456789/10740)

15. Jaseera, K.V., Kaladharan, P., Vijayan, K.K., Sandhya, S.V., Antony, M.L., Pradeep, M.A., 2018. Isolation and phylogenetic identification of heterotrophic thraustochytrids from mangrove habitats along the southwest coast of India and prospecting their PUFA accumulation. J. Appl. Phycol.,(http://krishi.icar.gov.in/jspui/handle/123456789/20313)

16. Jayanthi, M., Thirumurthy, S., Muralidhar, M., Ravichandran, P., 2018. Impact of shrimp aquaculture development on important ecosystems in India. Global Environ. Chang., 52, 10-21. (http://krishi.icar.gov.in/jspui/handle/123456789/20198)

17. Jayanthi, M., Thirumurthy, S., Nagaraj, G., Muralidhar, M., Ravichandran, P., 2018. Spatial and temporal changes in mangrove cover across the protected and unprotected forests of India. Estuar. Coast. Shelf Sci., 213, 81-91. (http://krishi.icar.gov.in/jspui/handle/123456789/20199)

18. Kannappan, S., Sivakumar, K., Sethi, S.N., 2018. Protective effect of mangrove (Rhizophora apiculata) leaves extract in shrimp (Penaeus monodon) larvae against bio-luminescent disease-causing Vibrio harveyi bacteria. Spanish J. Agri. Res., 16 (1), e0501. (http://krishi.icar.gov.in:8080/jspui/handle/123456789/12308)

19. Khan, H.I., Madhubabu, E.P., Jannathulla,

R., Ambasankar, K., Dayal, J.S., 2018. Effect of partial replacement of marine protein and oil sources in the presence of lysolecithin in Tiger shrimp, Penaeus monodon Fabricus, 1978. Indian J. Fish., 65 (2), 100-107. DOI: 10.21077/ijf.2018.65.2.74154-12. (http://krishi.icar.gov.in/jspui/handle/123456789/20196)

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21. Kumar, K.V., Shekhar, M.S., Otta, S.K., Karthic, K., Kumar, J.A., Gopikrishna, G., Vijayan, K.K., 2018. First report of a complete genome sequence of white spot syndrome virus from India. Genome Announc. 6(8), e00055-18. (http://krishi.icar.gov.in:8080/jspui/handle/123456789/13634)

22. Kumar, P., Biswas, G., Ghoshal, T.K., Kailasam, M., Lalramchhani, C., Vijayan, K.K., 2018. Current knowledge on the biology, captive breeding and aquaculture of the brackishwater catfish, Mystus gulio (Hamilton, 1822): A review. Aquaculture, 499, 243-250. (http://krishi.icar.gov.in/jspui/handle/123456789/20281)

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24. Kumar, S., Mashooq, M., Gandham, R.K., AlavandiS.V., Viswas, K.N., 2018. Characterization of quorum sensing system in Clostridium chauvoei.Anaerobe, 52, 92-99.(http://krishi.icar.gov.in/jspui/handle/123456789/20186)

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Popular Articles

1. Kumar, T.S., Rajan, J.J.S., Makesh, M., Alavandi, S.V., Vijayan, K. K., 2018. Rapid and specific loop mediated isothermal amplification detection of Enterocytozoon hepatopenaei (EHP) (in Tamil). Fourth National Agricultural Science Tamil Research Conference.

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PARTICIPATION IN CONFERENCES, MEETINGS, WORKSHOPS AND SYMPOSIA

Director

1. Workshop on 'Brackishwater Fish Farming', an initiative for the development of brackishwater aquaculture, organized by Anthoor Municipality at Kannur on 5 April 2018
2. Review Meeting of ICAR Regional Committee No.VIII at Sugarcane Breeding Institute, Coimbatore on 17th April 2018
3. 61st Foundation Day of Central Institute of Fisheries Technology, Kochi on 28th April 2018
4. Review Meeting of the Directors of Fisheries Institutes of ICAR and DADF Institutes to discuss regarding Skill Development Programmes, organized by National Fisheries Development Board (NFDB) at Hyderabad on 2May 2018.
5. Inauguration of the first customized shrimp feed mill at Bhiwani, Haryana and Farmers Meet-cum-MOU signing ceremony with Dr.Attar Aqua Feed at Bhiwani, Harayana, under the ARYA initiative in connection with Vanamiplus feed technology transfer on 15 May 2018.
6. Inauguration of the Navsari-Gujarat Research Centre of CIBA at Navsari Agricultural University Campus, Navsari on 7 June 2018.
7. Inter-session Meeting of the Consultative Committee of the Ministry of Agriculture and Farmers Welfare, held on 2 July 2018 at Hotel Hyatt Rameshwaram
8. 90th Foundation Day of Indian Council of Agricultural Research (ICAR) at A.P.Shinde Hall, NASC Complex, Pusa , New Delhi held on 16 July 2018
9. National conference "PONSHRIMP 2018" Organized by Tamil Nadu Dr. MGR Fisheries College and Research Institute, Ponneri , TNFU on 25 July 2018 - Dr. K. Ambasankar
10. Brainstorming Workshop on "Fisheries and aquaculture development in Malabar Region", organized by Kerala University of Fisheries and Ocean Studies (KUFOS) at KUFOS, Payyanur, Kerala on 3 August 2018.
11. Consultancy Evaluation Committee of National Biodiversity Authority (NBA) at NBA, Chennai on 14 August 2018.
12. Assessment Committee Meeting for the promotion from Senior Scientist to Principal Scientist, under the Revised Career Advancement Scheme at ASRB, New Delhi on 30 August 2018
13. Inauguration of the Community Development Centre for Learning, Livelihood and Research under the CSR initiative, by KCT Group, at Bhimavaram on 12 September 2018
14. 58th Executive Committee Meeting and 24th Annual General Body Meetings of RGCA, 12th Annual General Body Meeting of NaCSA and 32nd AGM of OSSPARC organized by MPEDA at Kochi on 5 October 2018
15. Inauguration of the Aquaculture Development Cooperative Society (ADCOS) at Payyanur on 11 October 2018
16. Curtain Raiser Programme of the 80th Anniversary Celebrations, School of Marine Sciences, Cochin University of Science and Technology (CUSAT), Kochi on 2 November 2018.
17. Meeting of the Fisheries Minister of South India, at Central Marine Fisheries Research Institute, Kochi on 10-11 November 2018.
18. Fourteenth Meeting of the Project Screening Committee constituted under the Guidelines for establishment of operation of SPF Shrimp Broodstock Multiplication Centre (BMC), at Krishi Bhavan, New Delhi held on 16 November 2018.

19. 61st Meeting of the Coastal Aquaculture Authority organized by CAA at Chennai on 10December 2018

20. Fifteenth Meeting of the Project Screening Committee constituted under the Guidelines for establishment and operation of SPF Shrimp Broodstock Multiplication Centre (BMC), at Krishi Bhavan, New Delhi held on 17December 2018

21. Selection Committee Meeting for appointment of Dean (Fisheries) and Associate Professor (Aquaculture) for Kerala University of Fisheries and Ocean Studies, at KUFOS, Kochi held on 22 December 2018

22. DST-INSPIRE Internship Science Programme, hosted by Central University of Kerala, Periye, Kasargod on 26 December 2018

23. Director's Conference of ICAR Institutes held at A.P.Shinde Symposium Hall, NASC Complex, New Delhi during 31 January – 1 February 2019

24. Meeting of the Directors of Fisheries Institutes at SMD (Fisheries), ICAR, New Delhi on 2 February 2019

25. Selection Committee Meeting for the Selection of "Senior Administrative Officer" and Sixty Second meeting of the Coastal Aquaculture Authority at CAA, Chennai on 14 February 2019

26. Stakeholders Meeting to discuss various issues of shrimp aquaculture sector held at GRT Radison Blue Hotel, Chennai on 14 February 2019

27. Expert Consultation on biosecurity measures in shrimp aquaculture organized by Kerala University of Fisheries and Ocean Studies (KUFOS) in association with ReAct Asia Pacific, at Kochi on 8 March 2019

Scientists

1. Brainstorming session on Fish reproduction Biotechnology: current and Future prospects during 6-7 April 2018 at Visva-Bharati, Santiniketan, West Bengal- Dr. Premkumar

2. International Congress on Engineering and Life Science (ICELIS 2018) during 26-29 April 2018 at Kastamonu, Turkey - Dr. Gouranga Biswas

3. Syllabus Review Meet for updating postgraduate and doctoral syllabi of disciplines offered by the University, ICAR-CIFE, Mumbai on May 19-20, 2018 – Dr. M. S. Shekhar

4. Interface Meeting with developmental Departments in Tamil Nadu organized by ICAR-CRIDA, Hyderabad along with Department of Agriculture, Govt. of Tamil Nadu on 25 May 2018 at Chennai – Dr. M. Muralidhar, Dr. R. Saraswathy

5. National dialogue on Application of Artificial intelligence and Internet of Things (IoTs) in Agriculture organized by NAARM during 1-2, June 2018 at Hyderabad - Dr. M. Muralidhar

6. 16th Aquaculture Expo organized by Aqua Tech at Bhimavaram during 16-17 June, 2019 - Dr. M. Muralidhar

7. Seminar on Climate Change and Sustainable Development Jointly organized by MSSRF and Center for Environment Education on 26 June, 2018 at Chennai - Dr. M. Muralidhar

8. National Symposium on the Application of Genomics and Proteomics in Aquaculture, Fisheries and Marine Biology (omics AFM 2018) at Centre for Ocean Research, Sathyabama Institute of Science and Technology, organized by Centre for Ocean Research Col. Dr. Jeppiaar Research Park, Sathyabama Institute of Science and Technology, June 20-21, 2018, Chennai - Dr. M. S. Shekhar, Dr. K. Vinaya Kumar

9. Regional Committee meeting for Zone-II during June 21-14 2018 at ICAR-CIFA, Bhubaneswar - Dr. T.K. Ghoshal

10. Brainstorming Workshop on Start-up India Programme for Aquaculture Sector on the occasion of ICAR Industry Day Celebration organized by CIBA on 16 July 2018 at Chennai - Dr. M. Muralidhar, Dr. B. Sivamani

11. One day workshop on ranking of ICAR institutes at NAARM, Hyderabad, 20 July 2018 – Dr. S. K. Otta

12. Meeting with delegation of Minister of State for Universities, Science, Research and Innovation UK on Poverty alleviation through prevention and future control of the two major socio-economically important pathogens in Asian aquaculture IIT, Chennai on 27 July 2018 - Dr. M. S. Shekhar
13. Launching programme of Network Project on "Ornamental fish breeding and Culture"(NPOFBC) held at CMFRI, Kochi on 28 July 2018 - Dr. Krishna Sukumaran
14. 6th Annual NICRA Workshop organized by CRIDA, Hyderabad during 7-8, August 2018 at New Delhi- Dr. M. Muralidhar
15. International consultation on water: Augmentation of supply and management of demand during 7-9 August 2018 at MSSRF, Chennai in partnership with various national and international agencies. – Dr. R. Saraswathy, Dr. P. Kumararaja, Dr. S. Suvana
16. Workshop on Carrying capacity assessment of water bodies organized by Fisheries Department on 11 Sept, 2018 at Bhimavaram, Andhra Pradesh - Dr. M. Muralidhar
17. Meeting of Inauguration of state-of-the-art Community Development Centre for Learning, Livelihood & Research (CDC-LLR) Laboratory in Bhimavaram by KCT on 12Sept, 2018. - Dr. M. Muralidhar
18. Aquaculture Seminar for "RAS and Krill as a feed ingredient" organized by Innovation Norway at Trident hotel, Chennai on 19 September 2018 – Dr. Krishna Sukumaran
19. Workshop "Norwegian Technology for land based RAS and Krill; an important ingredient for fish & shrimp feed" organized by Norwegian Embassy at Hotel Trident, Chennai on 19 September, 2018 - Dr. K. Ambasankar
20. Parliamentary Committee on Official language, October 3-5, 2018, Chennai - Dr. M. S. Shekhar
21. 4th India International Science Festival (IISF-2018) during 5-8 October, 2018 at Lucknow" – Shri T. Sathish Kumar
22. First Steering committee meeting of Tamil Nadu Irrigated Agriculture Modernization Project at Directorate of Fisheries, Chennai on 10 October, 2018 - Dr. K. Ambasankar
23. 13th Annual convention of Central Information Commission, New Delhi, held on 12 October 2018 – Dr.S.K.Otta
24. Workshop on knowledge management in Marine Fisheries conducted by BOBP, Chennai on 12 October 2018 – Dr. C. P. Balasubramanian
25. Workshop on "Knowledge Management in Marine Fisheries Sector" Organized by BOBP-IGO at Hotel Raintree, Chennai on 12 October, 2018 - Dr. Debasis De
26. Annual Review meeting 2017-2018 of Consortium Research Platform on Vaccines and Diagnostics held at ICAR-CIBA, Chennai during 30-31 October, 2018 – Dr. K.P.Jithendran, Dr. R. Ananda Raja
27. Workshop on "Framing guidelines for culture of P.vannamei outside the jurisdiction of CAA " on 8 Nov, 2018 at DOF, Chennai – Dr. R. Saraswathy
28. "FourthNational Agricultural Science Tamil Research Conference" organized by Agricultural Scientific Tamil Society, New Delhi at the Directorate of Research, TNFU Campus, OMR, Vaniyanchavadi, Chennai during 10-20 November 2018 – Dr.R.Ananda Raja
29. Meeting with Hon'ble Union Minister of Agriculture on 16 November 2018 in Kolkata - Dr. T.K. Ghoshal
30. Seminar on "Ion Chromatography Uses" during 16 November 2018 at Chennai organized by Metrohm India Ltd, Chennai - Dr. S. Suvana
31. Fourth National Agricultural Science Tamil Research conference during 19-20th November 2018 at TNJFU, Chennai – Shri T. Sathish Kumar
32. Eighth Conference of Indian Meat Science Association and International Symposium on Technological Innovation in Muscle Food Processing for Nutritional Security, Quality and Safety during 22-24 November 2018 at West Bengal University of Animal and Fishery Sciences, Kolkata - Dr. Sanjoy Das

33. Conference on Revisiting Agricultural Research and Monitoring system for developing innovations during 24-25 November 2018 at ICAR-CIWA, Bhubaneswar – Dr.Premkumar

34. Workshop of nodal officers of ICAR Research Data Repository for Knowledge Management during 4-5, December, 2018 at ICAR, New Delhi – Dr. R. Saraswathy

35. Dissemination workshop by National Biodiversity Authority at India Habitat Centre, New Delhi held on 5 December 2018 – Dr. S.K.Otta

36. Scientist's interaction meet of ICAR-CIBA, Chennai and IISER, Thiruvananthapuram conducted by ICAR-CIBA, 13 December 2019, Chennai - Dr. M. S. Shekhar, Dr. Sherly Tomy, Dr. B. Sivamani, Ms. Misha Somen

37. Town Official Language Implementation Committee (TOLIC) meeting during 18 December, 2018 at NIOT, Chennai - Dr. S. Suvana

38. World Disaster Management Congress organized by IIT, Mumbai during 29 January – 1 February – Dr. R. Saraswathy

39. Meeting with the Secretary and Director of Department of Industrial Policy and Promotion (DIPP) for transfer of surplus salt pan land ICAR-CIBA on 4 January 2019 - Dr. S. Kannappan

40. Golden Jubilee International Salinity Conference on "Resilient Agriculture in Saline Environments under Changing Climate: Challenges and Opportunities" during 7-9 February 2019 at ICAR-CSSRI, Karnal - Dr. P. Kumararaja

41. National Workshop - Aquaculture as a Livelihood Option for Tribal Farmers of India during 18-19 February 2019 at ICAR-CIFA, Bhubaneswar - Dr. T.K. Ghoshal

42. Expert Committee Meeting of Hilsa Project Phase-II at NASC complex, New Delhi on 14 February, 2019 - Dr. Debasis De

43. Fourth HLMC meeting on Aquazonation organized by Fisheries Departmrnt at Secretariat, Velagapudi, Amaravati, Andhra Pradesh on 21 February, 2019 - Dr. M. Muralidhar

44. "Interactive meeting-cum-workshop of Scientists in IT/Computer Application" with Secretary DARE & DG ICAR scheduled for 6 March 2019 at NASC Complex, New Delhi – Dr. P. Mahalakshmi

45. Brain storming session on Metagenomics applications in brackishwater aquaculture under the Network Project for Agricultural Bioinformatics and Computational Biology (CABin) during 8 March, 2019 at ICAR-CIBA, Chennai - Dr. M. Muralidhar, - Dr. M.S.Shekhar, Dr. N. Lalitha, Dr.R.Ananda Raja

46. Technical and Inspection Committee on Establishment of Shrimp Broodstock Multiplication Centres for Penaeus monodon and P. vannamei by Government of Andhra Pradesh Submitted to the Ministry of Agriculture and Farmers' Welfare on 12 March, 2019 – Dr. C. P. Balasubramanian

47. National Workshop on Brackishwater Aquaculture Resource Mapping for Sustainable Development during 14-15, March 2019 at ICAR-CIBA, Chennai – Dr. M. Muralidhar, Dr. R. Saraswathy, Dr. P. Kumararaja, Dr. Gouranga Biswas, Dr. Prem Kumar, Dr.R.Ananda Raja

48. Seminar on Climate Change, Demographic Pressures and Global Sustainability organized by MSSRF on 19 March 2019 at Chennai - Dr. M. Muralidhar

49. Meeting on Revival of domestication of tiger shrimp Penaeus monodon project (DTSP) in Andaman and Nicobar islands organized by Department of Commerce through joint venture with AQUALIMA-UNIMA, Madagascar on 28 March, 2019 – Dr. C. P. Balasubramanian



BRAQCON 2019

Glimpses from Braqcon 2019

























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