ANNUAL REPORT

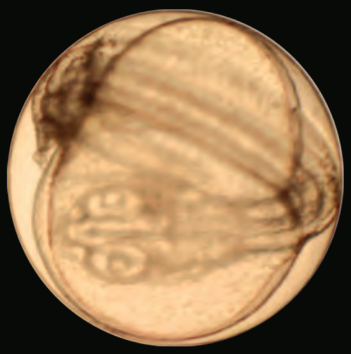
2015-16

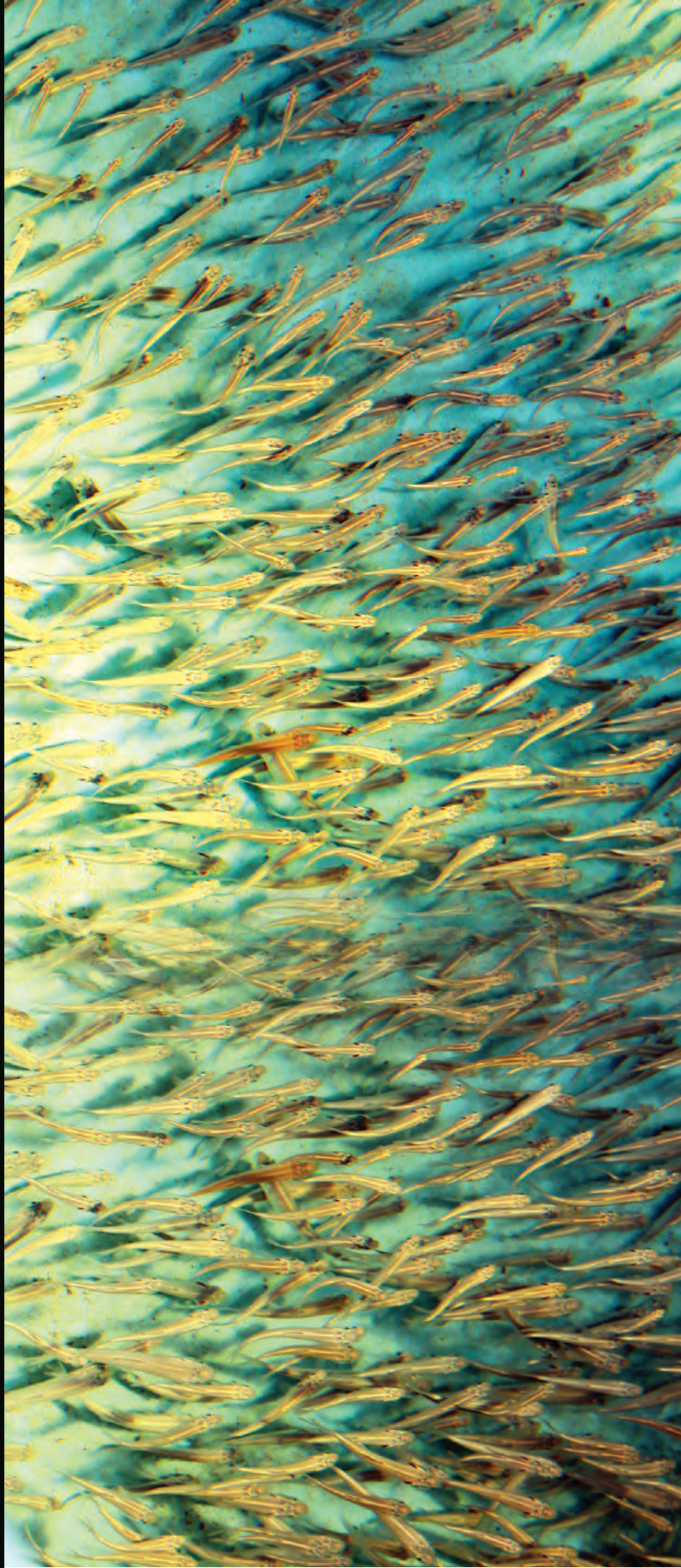
भाकृअनुप
ICAR

CIBA

भाकृअनुप - केन्द्रीय खारा जलजीव पालन अनुसंधान संस्थान

ICAR - CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE





Cover photo, front:

Left pane, top **:** Milkfish egg with developing embryo on 20th hour of post fertilization

Left pane, bottom **:** A milkfish larvae hatching out from the egg after complete development

Right pane **:** Shoal of milkfish fingerlings produced under captive conditions, in Muttukadu experimental finfish hatchery

वार्षिक प्रतिवेदन

ANNUAL REPORT

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भा.कृ.अनु.प.–केन्द्रीय खारा जलजीव पालन अनुसंधान संस्थान
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Annual Report 2015-16

Preface

Captive breeding and seed production of milk fish (*Chanos chanos*) for the first time in the country...

The year 2015-16 is behind us, and when look back, this has been an eventful year for CIBA, with significant success stories, useful and meaningful research outcomes, achievements and events which brought CIBA right in front of the stake holders and their aspirations. As a research and development organization, our main purpose is to have research programmes based on the need of stake holders including the farming community, to provide technology backstopping. Authentic and quality research output from CIBA, will serve as a catalyst in the growth of brackishwater aquaculture development, increasing the visibility of CIBA in India and overseas. The brackishwater ecosystem being a dynamic sector, our efforts have always been challenging and we have to accept this task in taking the sector forward. This annual report provides the progress of our research findings, and it is a snap shot of our effort towards the goal of sustainable coastal aquaculture. I am pleased to share our story of research progress, during the period of April 2015-March 2016.

As I have already mentioned, due to the dynamic nature of the brackishwater sector, on many occasions CIBA had to confront several burning issues, where we were able to prioritise our efforts to address the immediate requirements of the sector. Mahatma Gandhi gave India the slogan "from swadeshi to swaraj", which means "be indigenous in order to self-rule". CIBA has imbibed this concept in fixing the knowledge gaps in brackishwater aquaculture, in the areas of biology and biotechnology, and has come out with technologies and products relevant to the sector. Captive breeding and seed production of herbivorous milkfish (Chanos chanos), for the first time in the country has added one more species to brackishwater aquaculture. Modern brackishwater aquaculture has been dominated by penaeid shrimp culture since its inception in the late 1980s, and it continues to be the economic engine and backbone of the sector, as a commodity earning foreign exchange for the country. While considering the requirement of fishmeal based feed for shrimp rearing, aquaculture of shrimp has often been criticized for, 'shifting the fish from plate to place'. To have a balanced approach in the sector, species at the lower trophic levels, which have minimum ecological foot

prints, need to be promoted. At this context, the success in captive breeding of milkfish achieved by the institute is particularly important in achieving the goal of increased fish production.

In aquatic animal health, we have characterized Enterocyotozoon hepatopenaei (EHP), the emerging protozoan parasite that causes widespread crop loss in shrimp production systems. We also developed DNA based diagnostics for this parasite, and organised a national consultation followed by an advisory for the benefit of the sector, demonstrating CIBA's expertise and capacity in the field of aquatic animal health. Further our surveillance on diseases incidences confirms the disease free status of the country with reference to the EMS/AHPND. In the scenario of the shrimp feed industry, CIBA has developed, tested and commercialised a cost-effective formulated feed for vannamei, the 'Vannamei $^{plus'}$ and the technology provided a Desi alternative for the shrimp farmers. This step exemplifies our shift from the traditional research management scenario to innovation management, where we conceptualize our research results in the social context. Another highlight in the research accomplishment of the institute is the initiation of full genome sequencing of the Indian white shrimp Penaeus indicus, and complete sequencing of mitochondrial genome. This study helps us to obtain an in-depth understanding in population genetic analysis and genetic improvement program of this species of priority.

Our research efforts on diversified aquaculture and species have continued, with focus on grey mullet Mugil cephalus, and catfish Mystus gulio. We also focus on alternative aquaculture systems such as integrated multi-trophic aquaculture systems (IMTA), family farming and organic farming. Further, we have taken sincere efforts to bridge the relationship between the stakeholders and farmers, and the results are visible in the form of partnership agreement and MOU signed on a public private partnership (PPP) mode. Also CIBA has developed close working relationship between the state government and other government agencies working for the development of brackishwater aquaculture in the country by sharing the strength and weaknesses, which provided a new synergy. This is reflected in the funding support from Maharashtra Government for the IMTA demonstration project, MOU between the Fisheries University and Matsyafed of Kerala Government and close association with RGCA-MPEDA, NFDB etc.

When issues such as climate change is looming over, posing challenges in our task of increasing food production for an ever increasing population which is expected to reach 1.6 billion mark by 2050, farming in the brackishwater is one sector the potential of which is still remains unutilized, in area and volume. As brackishwater does not compete with human need for drinking and agriculture, the scope of the utilization potential is really high, where the possibility of doubling the present level of brackishwater aquaculture production to one million mark in another 2-3 years is an achievable proposition. In this endeavour, CIBA will be playing its proactive role as an R&D institution.

In short, the year 2015-16 has been a year filled with activities and some of the achievements are truly remarkable. This annual report is a show case of encouraging science carried out by CIBA. The achievements given in the preface are just highlights and I invite readers to go through the detailed report. All these research performances and achievements would not have been possible without the professional support provided by former DG, Dr S. Ayyappan, and present DG, Dr Trilochan Mohapatra. We thank Dr J. K. Jena, DDG (Fisheries) for his keen enthusiasm and timely help. Finally I thank all my colleagues for their whole-hearted support and commitment for all outcomes and achievements of ICAR-CIBA.

Dr K K Vijayan
Director

कार्यकारी सारांश

खाराजलीय उत्पादन प्रणाली अनुसंधान

जब भारतीय आबादी बढ़ रही है और वर्ष 2050 तक 1.7 बिलियन आबादी होने का आकलन है, तो पर्याप्त आहार उत्पादन और पोषण सुरक्षा सुनिश्चित करने हेतु जलीय कृषि सहित खेती के सभी क्षेत्रों में आहार उत्पादन बढ़ाना प्राथमिकता है। भारत के प्रमुख खाद्य उत्पादन क्षेत्रों में से एक 0.4 मिलियन टन उत्पादन वाली खाराजलीय कृषि को खाराजलीय संसाधनों के दोहन और जलीय कृषि के माध्यम से खाद्य उत्पादन की वृद्धि में योगदान देने हेतु एक महत्वपूर्ण भूमिका निभानी होगी। अतः केन्द्रीय खारा जलजीव पालन अनुसंधान संस्थान ने अपनी अनुसंधान एवं विकास गतिविधियों की प्राथमिकता विविधिकरण, सततता और सामाजिक प्रासंगिकता की ओर किया।

मिल्कफिश प्रजनन में सफलता

मांसभोजी प्रजाति सीबास (लेटस कैलकैरीफर) की हैचरी और पालन प्रौद्योगिकी के सफल विकास के बाद सीबा ने शाकभोजी प्रजातियों (मिल्कफिश चनोस चनोस) के प्रजनन का प्रयास किया। तत्पश्चात लंबे समय से अपेक्षित मिल्कफिश के प्रजनन में भारत ने पहली बार जून, 2015 में सफलता प्राप्त की। मत्स्यपालन प्रभाग के वैज्ञानिकों ने पीयूष (एलएचआरएच) और जननांग (17.α.मिथाइल–टेस्टोस्टेरॉन) हार्मोनों में फेरबदल कर मिल्कफिश के प्रेरित प्रजनन प्रोटोकोल का मानकीकरण किया। मुत्तुकाडु पखमीन अनुसंधान एवं विकास हैचरी में रखरखाव की गई प्रजननीय परिपक्व मिल्कफिश से कई निषेचन घटनाएं दर्ज की गईं। चालू वर्ष में लगभग 75% निषेचन दर से 0.3 मिलियन जीरों का उत्पादन किया गया। प्रथम हैचरी साइकिल से उत्पादित मिल्कफिश की अंगुलिकाओं को पश्चिम बंगाल, आंध्रप्रदेश, तमिलनाडु, केरल और गुजरात के किसानों में वितरित किया गया।

सीबास की पायलट स्केल प्रयोगात्मक हैचरी से बड़े पैमाने पर उत्पादन

सीबा के मुत्तुकाडु स्थित प्रयोगात्मक हैचरी में सीबास लार्वा उत्पादन में वर्षभर के प्रजनन से सर्वाधिक 0.6 मिलियन लार्वा दर्ज किया गया।

स्थानीय रूप से मूल्यवान छोटी मछली मेस्टस गुलियो के प्रजनन का विकास एवं पालन

सीबा के काकद्वीप अनुसंधान केन्द्र के अनुसंधान दल ने एंडोक्राइन और न्यूरोएंडोक्राइन हार्मोन श्रृंखला के उपयोग से हार्मोनों में फेरबदल कर इस प्रजाति की प्रजनन प्रौद्योगिकी का विकास किया। हैचरी उत्पादन के 4 साइकलों में कुल 0.2 मिलियन पोनों का उत्पादन किया और इन्हें प्रक्षेत्र स्तर पर उत्पादन क्षमता के मूल्यांकन हेतु किसानों में वितरित किया गया।

ग्रे मल्लेट मुगिल सेफालस का बंद प्रजनन

निम्न पोषी संरचनाओं में प्रजाति की पालन प्रौद्योगिकी के विकास के लिए निर्धारित प्राथमिकता के अनुसरण में एम. सेफालस के बंद प्रजनन कार्य में तेजी लाई गई। विभिन्न भौगोलिक पारिस्थितिकियों से प्राप्त प्रजनक मछलियों के जननद्रव्य का गुणचित्रण कर संस्थान के प्रयोगात्मक हैचरी में रखरखाव किया जा रहा है। हार्मोनल थेरेपी द्वारा प्रजनन परिपक्वता एवं नर मछलियों की युग्मक गुणता को अनुकूल बनाया गया। साइलास्टिक कैप्सूल के माध्यम से हार्मोन की डिलवरी को मानक बनाया गया। हार्मोनों में हस्तक्षेप से पूरे प्रजनन काल में नर मछलियां प्रजननीय रहे। मादा मछलियों में एलएचआरएच हार्मोन फेरबदल से अंडाणुओं का व्यास 280 µm से 590 µm तक वृद्धि हुई जिससे सकारात्मक प्रजनन प्रतिक्रिया सूचित होती है।

पर्ल स्पॉट यूट्रोप्लस सुराटेनसिस के निरंतर बीज उत्पादन प्रौद्योगिकी का विकास और पैरेन्टल केयर में फेरबदल

निषेचन के तुरन्त बाद पोनों को जनक मछलियों से दूर कर पैरेन्टल केयर में फेरबदल करने पर ई. सुराटेनसिस के बीज उत्पादन में उल्लेखनीय वृद्धि देखी गयी। पैरेन्टल केयर अवधि को कम करने और लवणता में फेरबदल करने पर एक टन क्षमता वाले मॉडीलार टैंक से 215 दिनों के परीक्षण में पर्ल स्पॉट के प्रत्येक प्रजनन में औसत लार्वा उत्पादन दर 750 से 990/30–45 दिनों के साइकल में दर्ज किया गया।

केरल के मत्स्य पालकों के समक्ष कम आयतन के पिंजरों में सीबास पालन का निरूपण

सीबास के पोनों (औसत शारीरिक भार : 8 ग्रा.) को तैरते पिंजरों में 10 माह तक फिश बायकैच के आहार से संवर्धन किया गया। पालन अवधि के अंत में 18.8 कि.ग्रा./घनमीटर की उत्पादकता दर से 475 कि.ग्रा. मत्स्य उत्पादन प्राप्त हुआ जिससे 9000 रूपए/माह का शुद्ध आय हुआ, जहां बाजार मूल्य 350 रूपए/कि.ग्रा. और उत्पादन लागत लागत 120 रूपए/ कि.ग्रा. रहा है।

बहु–पौष्टिकता वाले क्षेत्र में समेकित जलीय कृषि अधिक लाभप्रद और सतत उत्पादन प्रणाली

संस्थान के काकद्वीप अनुसंधान केन्द्र में ग्रे मुल्लेट मुगिल सेफालस, गोल्डस्पॉट मुल्लेट लिजा पार्सिया तथा टाइगर झींगा पीनियस मोनोडॉन मछलियों को क्रमशः 2000, 8000 तथा 30000/हे., ज्वारनदमुखी सीपों को 1600/हे. की दर से संग्रहित करने के पश्चात समुद्री खरपतवार 200 कि.ग्रा. बायोमास/हे. डालकर समेकित जलीय कृषि प्रारम्भ किया गया। सामान्य तालाबों (1434 कि.ग्रा./हे.; मुल्लेट्स 772 और झींगा 662 कि.ग्रा./हे.) की अपेक्षा बहु–पौष्टिकता वाले क्षेत्र में समेकित जलीय कृषि के अंतर्गत बहुपालन पद्धति (सीपों और समुद्री खरपतवार के बिना) में उल्लेखनीय उत्पादकता (पी<0.05) 1707 कि.ग्रा./हे. (मुल्लेट्स–926 और झींगा–781 कि.ग्रा/हे.) तथा बेहतर जल गुणवत्ता प्राचल देखे गए।

प्रक्षेत्र में नर्सरी संवर्धन से मत्स्य पालन तालाबों में पीनियस वन्नामेय की उत्तरजीविता में सुधार

पी. वन्नामेय के उत्पादन चक्र में नर्सरी चरण को सम्मिलित करना प्रक्षेत्र उत्पादन को अनुकूलतम बनाने की दिशा में एक महत्वपूर्ण प्रबंधन रणनीति है। नर्सरी संवर्धन की दक्षता के मूल्यांकन हेतु किए गए परीक्षणों से सूचित हुआ है कि नर्सरी संवर्धित बीज (24–28 दिन) संग्रहण वाले प्रक्षेत्रों में उच्च उत्तरजीविता दर (87.5%±5.00), कम फसल अवधि (106±16.33), निम्न एफसीआर (127±0.10), उच्च उत्पादन (5.9 टन/हे.±1.73) तथा कम लागत देखा। सीधे संग्रहण (0.901±0.062) करने की तुलना में नर्सरी संग्रहण प्रक्षेत्रों की तकनीकी दक्षता अधिक (0.945±0.009) पायी गयी।

पीनियस वन्नामेय के उच्च स्वास्थ्य लार्वा उत्पादन के लिए बायोफ्लॉक आधारित लार्वा संवर्धन

मत्स्य पालन तालाबों में स्वस्थ लार्वा उत्पादन के लिए बायोफ्लॉक आधारित प्रणाली द्वारा पीनियस वन्नामेय के नर्सरी संवर्धन का विकास किया गया। विभिन्न प्रयोगशाला एवं प्रक्षेत्र आधारित प्रयोगों के माध्यम से बायोफ्लॉक उत्पन्न करने हेतु प्रोटोकोल का विकास किया गया। बायोफ्लॉक आधारित संवर्धन प्रणाली (10^7 सीएफयू/मि.ली.) में परंपरागत गैर–बायोफ्लॉक प्रणाली की अपेक्षा सवंर्धित पोस्ट लार्वा (पीएल3) में उच्च वृद्धि दर और उत्तरजीविता दर देखी गई। बायोफ्लॉक के बिना सवंर्धित झींगों की तुलना में विभिन्न प्रतिरोधी जीन (प्रोफेनोलॉक्सिडेस (पीपीओ), क्रस्टीन, रास, एल्फा 2एम, मास, एसपी तथा एंटीवायरल जींस) में एमआरएनए (mRNA) ट्रांस्क्रिप्ट लेवल काफी विनियमित (~1.3 से 2.5 गुणा परिवर्तन) पाया गया जिससे बायोफ्लॉक प्रेरित प्रतिरोधिता वृद्धि सूचित होती है।

पेनॉइड झींगो की तीन प्रजातियों (पी. इंडिकस, पी. मोनोडॉन तथा पी. वन्नामेय) में तुलनात्मक वृद्धि एवं उत्पादन

सीबा के काकद्वीप अनुसंधान केन्द्र में पी. इंडिकस, पी. मोनोडॉन तथा पी. वन्नामेय पर किया गया मूल्यांकन अध्ययन से स्पष्ट हुआ है कि 118 दिनों के पालन में क्रमशः 17.93±1.26 ग्रा., 24.84±0.87 ग्रा तथा 16.36±0.69 ग्रा. वृद्धि हुई। रोचक तथ्य है कि एक ही प्रकार की पर्यावरण स्थितियों में 80 दिनों की पालन अवधि तक पी. मोनोडॉन और पी.. वन्नामेय की अपेक्षा पी. इंडिकस की वृद्धि दर अधिक पाई गई।

कीचड़ केकड़ा स्काइला सेर्राटा का नर्सरी उत्पादन

कीचड़ केकड़ों के बीज उत्पादन और पालन, तरूण अवस्थाओं ($सी_4$–$सी_5$) में नर्सरी उत्पादन के निष्पादन का विभिन्न भीतरी तथा प्रक्षेत्र प्रयोगों के माध्यम से तार्किक एवं आर्थिक अनुकूलन का मूल्यांकन किया गया। प्रक्षेत्र प्रयोगों में समग्र उत्तरजीविता दर 56.5 ± 5.3%; 40-71%; एन=5, जबकि भीतरी प्रयोग में उत्तरजीविता दर निम्न स्तर का 12.8% पाया गया। भीतरी टैंकों में 22 दिनों के संवर्धन में उत्तरजीविता दर ~ 50% तक प्राप्त हुई जिससे सूचित होता है कि भीतरी टैंकों में बेहतर उत्तरजीविता दर के साथ 20 दिनों तक संवर्धन किया जा सकता है।

पीनियस मोनोडॉन में रिप्रॉडक्टिव मैच्युरेशन पाथवे के हार्मोनल कंट्रोल मैकानिज्म का चित्रण

दो मुख्य प्रजननीय हार्मोन तथा प्रजननीय एवं प्रजननीय संबंधी ऊतकों (अंडाशय, हेपाटापैन्क्रियास एवं आइस्टॉल्क गैंगलिया) में प्रोटीन (GIH तथा Vg mRNA ट्रांस्क्रिप्ट्स लेवल) के Vg mRNA ट्रांस्क्रिप्ट्स लेवल के उपयोग से पी. मोनोडॉन के रिपॉडक्टिव मैच्युरेशन पाथवे की नियंत्रण व्यवस्था का गुणवर्णन किया गया। झींगों के अपरिपक्व तथा परिपक्तव अंडाशय के आइस्टॉल्क में GIH mRNA की उच्चतम अभिव्यक्ति हुई। त्वरित विटेल्लोजेनिक अवस्था के दौरान अंडाशय में Vg mRNA स्तर उच्चतम रहा और इसके बाद Vg स्तर कम पाया गया और परिपक्व अवस्था में न्यूनतम स्तर देखा गया जबकि हेपाटोपैन्क्रियास में उच्चतम Vg ट्रांस्क्रिप्ट अभिव्यक्ति अंडाशय की विटेल्लोजेनिक अवस्था से पूर्व पाई गई।

पीनियस इंडिकस के पालतूकरण के लिए प्रजनकों की प्रजननीय क्षमता

भारतीय सफेद झींगा पी. इंडिकस के पालतूकरण और चयनित प्रजनन के लिए तीन विभिन्न भौगोलिक क्षेत्रों (चेन्नई, उड़ीसा और कन्याकुमारी) के प्रजनकों की प्रजननीय क्षमता का मूल्यांकन किया गया। डब्ल्यूएसएसवी से मुक्त 7285 प्रजनको का उपयोग किया गया और 12 लार्वा संवर्धन साइकलों से 6.5 लाख पोस्ट–लार्वा का उत्पादन किया गया। चेन्नई प्रजनकों की प्रजननीय क्षमता बेहतर पाई गई। इससे आगे मानसून से पूर्व और मानसून के पश्चात प्रजनकों की प्रजननीय क्षमता का मूल्यांकन किया गया। मानसून अवधि के दौरान डब्ल्यूएसएसवी का प्रकोप कम (5.9-7.7%) पाया गया और इसके विपरीत मानसून के पश्चात प्रजनकों में डब्ल्यूएसएसवी का प्रकोप अधिक (43-45%) देखा गया, वन्य क्षेत्र में डब्ल्यूएसएसवी का उच्च प्रकोप से सूचित होता है कि पेनोइड झींगो की वन्य सम्पदा पर रोगाणुओं का दबाव है तथा पालतूकरण के लिए स्वच्छ मत्स्य सम्पदा के विकास की आवश्यकता है।

पुलिकेट और मुत्तुकाडु खाराजलीय लैगूनों का चित्रण

जलीय कृषि से संबंधित महत्वपूर्ण जैविक एवं अजैविक घटकों के साथ खाराजलीय संसाधनों के चित्रण की दिशा के पहले चरण में दो महत्वपूर्ण खाराजलीय लैगूनों पुलिकेट एवं मुत्तुकाडु का भौगोलिक सूचना प्रणाली प्लेटफॉर्म पर चित्रण किया गया तथा और जमीनी सच्चाई संबंधी आंकड़ों का सर्वेक्षण किया गया। डिजीटल एवं हार्डकॉपी के रूप में उत्पन्न डाटा का उपयोग खाराजलीय कृषि के विकास में उपयोग किया जा सकता है।

पोषण एवं खाद्य प्रौद्योगिकी

वन्नामेयप्लस : पीनियस वन्नामेय के लिए कम लागत वाला आहार

सीबा ने झींगा पालन के लिए लागत प्रभावी नए आहार का विकास कर प्रक्षेत्र में परीक्षण किया और इस आहार को ''वन्नामेय$^{प्लस}$'' नाम दिया जिससे भारतीय झींगा पालन क्षेत्र को लाभ हो सके। 54 रुपए प्रति किलो मूल्य वाले इस आहार का गुजरात, पश्चिम बंगाल और आंध्र प्रदेश के व्यावसायिक प्रक्षेत्रों में बृहत रूप में परीक्षण किया गया। 'वनामय$^{प्लस}$' के उपयोग से किए गए प्रयोगात्मक परीक्षणों से पर्याप्त प्रमाण प्राप्त हुए हैं कि झींगा उत्पादन लागत को 91 रुपए प्रति किलोग्राम झींगा तक कम किया जा सकता है।

कार्यात्मक खाद्य पदार्थ के रूप में मोरिंगा (सहजन : मोरिंगा ओलेयफेरा) लीफ मील

मोरिंगा लीफ मील 1% सम्मिलित करने पर प्रयोगशाला परीक्षणों में झींगों के औसत दैनिक भार में 148% की वृद्धि देखी गई। यद्यपि, आंकड़ों का प्रयोगशाला एवं प्रक्षेत्र परीक्षणों में आगे मूल्यांकन करने की आवश्यकता है।

झींगा एवं सीबास मछलियों के लिए सीबा का लार्वा आहार (श्रिम्प लार्वीप्लस और सीबास लार्वीप्लस)

व्यावसायिक हैचरियों में परीक्षित आहार में झींगा और सीबास लार्वा में क्रमशः पोस्ट लार्वा 13 (पीएल 13) अवस्था तक 73.6%

औसत उत्तरजीविता तथा निषेचन के 25 दिनों तक 86% उत्तरजीविता देखी गई। लार्वा आहार आयातित होने के कारण इस देशी कार्यात्मक आहार को आयात के विकल्प के रूप में विकसित किया जा सकता है।

फिशमील के विकल्प के रूप में पादप उप–उत्पाद

झींगा मछलियों की वृद्धि से समझौता किये बिना झींगा आहार में मूंगफली और सूरजमुखी की खली को फिशमील के विकल्प के तौर पर प्रोटीन स्रोत के रूप में क्रमशः 7.5% तथा 5% सम्मिलित किया जा सकता है। मुगिल सेफालस तथा पी. मोनोडॉन के आहार परीक्षणों से सूचित होता है कि दोनों प्रजातियों में फिशमील के स्थान पर ड्राई डिस्टिलर ग्रेन का 10% तक उपयोग किया जा सकता है।

प्राकृतिक आहार से झींगों की आहारीय प्रोटीन आवश्यकता में कमी

भारतीय एवं पैस्फिक सफेद झींगो के बाहरी सूक्ष्म जगत अध्ययन से सूचित हुआ है कि प्राकृतिक आहार की मौजूदगी से वृद्धि दर एवं उत्पादकता में समझौता किए बिना आहार के प्रोटीन स्तर को 25% तक कम किया जा सकता है, जिससे उत्पादन लागत में बचत की संभावना है।

खाराजलीय पखमीन मछलियों के लिए कार्यात्मक प्रजनक आहार

प्रयोगों से सूचित हुआ है कि अधिकतम निषेचन के लिए गोल्ड स्पॉट मुल्लेट प्रजनक मछलियों के आहार में न्यूनतम 30% प्रोटीन और 9% लिपिड की आवश्यकता होती है। पर्ल स्पॉट आहार (इट्रोब्रूड$^{प्लस}$) जिसका पिछले वर्ष वन्य वयस्कों में अच्छा निष्पादन रहा है, इसकी पुनरावृत्ति बारंबार प्रजनन (औसतन 4 बार/वर्ष) और बंद स्थितियों में उच्च पोना उपज से एफ2 पीढ़ी की वयस्क मछलियां प्राप्त हुईं जिससे इसकी पौष्टिकता प्रमाणित होती है।

तालाब में सवंर्धित गोल्ड स्पॉट मुल्लेट में जैविक रूप से महत्वपूर्ण फैटी एसिड्स का निम्न स्तर

वन्य एवं सवंर्धित वयस्क गोल्ड स्पॉट मुल्लेट (लिजा पार्सिया) के ऊतक विशेष फैटी एसिड्स प्रोफाइलिंग में देखा गया है कि वन्य प्रजातियों की तुलना में सवंर्धित नमूनों के मांसपेशी ऊतकों में सी16:0 तथा सी18:2ω-6 फैटी एसिड्स में क्रमशः 3.4 तथा 23 गुणा अधिकता पाई गई। तालाबों में संवर्धित मछली में महत्वपूर्ण फैटी एसिड्स सी20:4ω-6 तथा सी22:6ω-3 में काफी कमी (50 से 20% तक) देखी गई जो पुनरूत्पादन और लार्वा विकास में मुख्य भूमिका निभाते हैं।

मुत्तुकाडु पश्चजल में सूक्ष्म शैवाल विविधता और फैटी एसिड प्रोफाइलिंग

मुत्तुकाडु पश्चजल (चेन्नई, तमिलनाडु) से 12 सूक्ष्म शैवालों का पृथककरण कर इन्हें परिशुद्ध किया गया जिनमें क्लोरेल्ला प्रजाति आइसोक्राइसिस और चेटोसेरास भी सम्मिलित हैं। मानसून से पूर्व साइनोफाइसे (52.96%) और बेसिललारियोफाइसे (39. 68%) की बहुलता थी जब कि मानसून अवधि के पश्चात बेसिललारियोफाइसे (66.89%) की बहुलता देखी गई। फैटी एसिड के प्रोफाइलिंग में देखा गया है कि कुल फैटी एसिडों में 7.88% ईपीए तथा 4.31% डीएचए मौजूद है। सूक्ष्मशैवालों के मिश्रण नन्नोक्लोरापसिस प्रजाति और आइसोक्राइसिस प्रजाति 1:3 अनुपात व्यावसायिक समृद्धि उत्पादों से बेहतर है और केकड़ों के लार्वा संवर्धन हेतु रोटीफर्स की समृद्धि में उपयोगी है।

झींगा में बायोमास बायोफ्लॉक की उत्पादकता एवं गुणवत्ता पर प्रभाव

बायोफ्लॉक उत्पादकता को अधिकतम करने संबंधी प्रयोगों में देखा गया है कि यद्यपि सी:एन अनुपात 20 ब्राउन बायोफ्लॉक उत्पादन में अधिकतम प्रोटीन को प्रेरित करता प्रतीत होता है, परंतु उत्पादकता और गुणवत्ता एकल सी:एन अनुपात की अपेक्षा पशु बायोमास की मौजूदगी एवं अनुपस्थिति से अधिक प्रभावित होता है।

आनुवंशिकी एवं जैवप्रौद्योगिकी

भारतीय सफेद झींगा पी. इंडिकस के माइटोकोंड्रियल जिनोम की व्याख्या

पहली बार पी. इंडिकस के माइटोकोंड्रियल जिनोम की संपूर्ण व्याख्या की गई। अनुक्रमित पी. इंडिकस झींगा प्रजातियों में सभी प्रोटीन कोडिंग जींस के आधार पर किए गए फाइलोजेनेटिक विश्लेषण से स्पष्ट हुआ है कि बनाना श्रिम्प और रेड टेल श्रिम्प के बीच निकट संबंध है और पेनोएड झींगों का वर्गीकरण स्पष्ट हुआ है।

अन्य क्षेत्रों की अपेक्षा मुंबई की भारतीय सफेद झींगा की भिन्नता

पी. इंडिकस झींगों की समष्टि संरचना के चित्रण के लिए दो एमटीडीएनए जींस(mtDNA), साइटोक्रोम बी तथा 16एस आरआरएनए (16S rRNA) के आंशिक भागों का उपयोग किया गया। अध्ययन की गई संपदाओं में देखा गया है कि दोनों एमटीडीएनए (mtDNA) जींस से स्पष्ट है कि मुंबई की सम्पदा पुरी, चेन्नई, कन्याकुमारी और क्यूलोन सम्पदा से भिन्न हैं जिससे उपमहाद्वीप में भारतीय सफेद झींगों में आनुवंशिक विविधता सूचित होती है।

झींगों के डब्ल्यूएसएसवी संक्रमण पर डी–अर्गीनाइन और डी–ओर्नीथइन मेटाबोलिक पाथवेस पर सक्रिय

स्वस्थ तथा व्हाइट स्पॉट सिड्रोम वायरस से संक्रमित पी.मानोडॉन के हेपाटोपांक्रियास से ट्रांसक्रिपटोम निकाल कर विश्लेषण किया गया। परिणामों से सूचित हुआ है कि डब्ल्यूएसएसवी संक्रमण के दौरान झींगों की मृत्यु का कारण डी–अर्गीनाइन और डी–ओर्नीथइन मेटाबोलिक फंक्शनल पाथवेस की सक्रियता हो सकता है।

झींगों के विटेल्लोजेनेसिस में सेरोटोनिन की नियामक भूमिका

आइस्टाल्क निकाली गयी मादा मछली को सेरोटोनिन देने पर पुनरूत्पादन संबंधी जींस की अभिव्यक्ति में उल्लेखनीय वृद्धि हुई। डिम्भग्रन्थि जीन अभिव्यक्ति से ज्ञात होता है कि पेनोयड झींगों में विटेल्लोजेनेसिस और पोस्ट–विटेल्लोजेनिक मेयोटिक रिसम्पशन के अप्रत्यक्ष उत्प्रेरण एवं परिपक्वता में दोहरी नियामक भूमिका निभाता है। इससे आगे कृत्रिम परिवेश में किए परीक्षणों में प्री–विटेल्लोजेनिक डिम्भग्रन्थि ऊतकों में सेराटोनिन देने पर विटेल्लोजेनेसिस में अप्रत्यक्ष उत्प्रेरक भूमिका की पुष्टि हुई है। यह सूचना जलजीव पालन में पेनोयड झींगों के लिए परिपक्व आहार बनाने में उपयोगी हो सकता है।

जलीय जीव स्वास्थ्य

खारा जलीय जीवों के रोग हेतु सीबा में नेशनल रैफर्रल लैबोरेट्री की विदेशी जलीय रोगाणुओं के निदान एवं रोकथाम में महत्वपूण f भूमिका

सीबा में खारा जलजीव रोगों के लिए स्थापित नेशनल रैफर्रल लैबोरेट्री में नए उभरते एक्यूट हेपाटोपेन्क्रियाटिक नेक्रोसिस रोग तथा एंटेरोसाइटोजून हेपाटापेनाय सहित ओआईई में सूचीबद्ध जलजीव रोगाणुओं के निदान की क्षमता है और इससे जलजीव स्वास्थ्य

क्षेत्र के विभिन्न पहलुओं का समाधान हुआ है। सीबा में स्थापित यह प्रयोगशाला विभिन्न अभिकरणों, जैसे एनिमल क्वारनटाइन एंड सर्टिफिकेशन सर्विसेस, दक्षिणी क्षेत्र, चेन्नई, एक्वाटिक क्वारनटाइन फैस्लिटी, राजीव गांधी सेंटर फॉर एक्वाकल्चर को आयातित जलजीव पालन निवेश जैसे आर्टेमिया सिस्ट, विदेशी एवं विशिष्ट रोगाणुमुक्त पी. वन्नामेय प्रजनकों एवं पीएलएस आदि की जांच में महत्वपूर्ण सेवाएं दे रही है। क्रम रहित जांच के दौरान एक्वाटिक क्वारनटाइन फैस्लिटी से आयातित विशिष्ट रोगाणुमुक्त पी. वन्नामेय झींगों में आईएसएचएनवी संदूषण पाया गया जिन्हें नष्ट कर दिया गया। आयातित वन्नामेय में विशिष्ट रोगाणुमुक्तता का स्तर बनाए रखने हेतु उचित पद्धतियों को अपनाया गया।

भारतीय झींगा प्रक्षेत्र सीमापार रोगों से मुक्त

वर्ष 2015–16 के दौरान तटीय झींगा प्रक्षेत्रों की वर्षभर निगरानी से स्पष्ट हुआ है कि भारतीय झींगा जलजीव पालन सीमापार रोगों जैसे, येल्लो हेड डिसीज, तौरा सिंड्रोम तथा संक्रामक मायवनक्रोसिस, एक्यूट हेपाटोपेन्क्रियाटिक नेक्रोसिस रोग से मुक्त है।

एंटेरोसाइटोजून हेपाटोपेनाय (ईएचपी)

भारतीय झींगा पालन में ईएचपी दूसरा महत्वपूर्ण रोग है। भारत में पहली बार इस परजीवी का गुणवर्णन आकृति एवं आणि वक स्तर पर किया गया। सीबा के रोग निगरानी कार्यक्रम के अंतर्गत 43.39: प्रक्षेत्रों में परजीवीय संक्रमण पाया गया। ईएचपी से प्रभावित प्रक्षेत्रों में 34.7: मामलों में छोटे कद तक वृद्धि, 39.13: मामलों में व्हाइट फेसेस सिंड्रोम तथा 21.7: मामलों में व्हाइट मस्लस सिंड्रोम देखा गया।

ईएचपी प्रबंधन पर राष्ट्रीय चर्चा

''भारतीय खारा जलीयजीव पालन में एंटेरोसाइटोजून हेपाटोपेनाय संक्रमण के प्रबंधन'' विषय पर दिनांक 19 जनवरी, 2016 को एक दिवसीय राष्ट्रीय चर्चा का आयोजन किया गया। खारा जलीय जलजीव पालन क्षेत्र के पणधारी (स्टेकहोल्डर) वैज्ञानिक अनुसंधान संस्थान, विश्वविद्यालय, झींगा हैचरी परिचालक, झींगा पालक, मत्स्य आहार निर्माता, एक्वाकल्चर प्रोफेशनल सोसायटी के सदस्य, भारतीय समुद्री उत्पाद निर्यात संघ, कृषि मंत्रालय, पशुपालन डेरी एवं मात्स्यिकी विभाग, कोस्टल एक्वाकल्चर अथॉर्टी, मैरिन प्रॉडक्टस एक्सपोर्ट डेवलेपमेंट अथॉर्टी, राजीव गांधी सेंटर फॉर एक्वाकल्चर तथा राज्य सरकार के अधिकारियों ने चर्चा बैठक में भाग लिया। पणधारियों, केन्द्र तथा राज्य सरकारों एवं सरकारी अभिकरणों के उपयोग के लिए झींगा प्रक्षेत्रों में ईएचपी प्रबंधन हेतु एक एडवाइजरी जारी किया गया।

झींगा पालन में सफेद धब्बा रोग निरंतर एक प्रमुख समस्या

आंध्र प्रदेश, तमिलनाडु, गुजरात तथा पश्चिम बंगाल तटीय राज्यों के 141 झींगा प्रक्षेत्रों में सक्रिय रोग निगरानी से स्पष्ट हुआ है कि सफेद धब्बा रोग चिंता का प्रमुख कारण है जिससे 37.5: प्रक्षेत्रों में झींगों की मृत्यु हो जाती है और भारतीय झींगा पालन में डब्ल्यूएसएसवी के नियंत्रण हेतु नियमित निगरानी की आवश्यकता प्रतीत होती है।

संवर्धित वन्नामेय झींगों में संक्रामक हाइपोडर्मल तथा हेमाटोपोएटिक नेक्रोसिस (आईआईएचएन)

अप्रैल 2015 से मार्च 2016 के दौरान 138 प्रक्षेत्रों के अध्ययन में देखा गया है कि 5: प्रक्षेत्रों में आईएचएचएनवी संक्रमण है और अधिकांश प्रक्षेत्रों में संवर्धित झींगों की वृद्धि में धीमी गति की समस्या है। विशिष्ट रोगाणुमुक्त झींगों के उपयोग के बावजूद इस रोगाणु की मौजूदगी में वृद्धि होना चिन्ताजनक विषय है और इसके लिए आगे अन्वेषणों की आवश्यकता है।

अवरूद्ध विकास, व्हाइट फेसिस सिंड्रोम तथा रनिंग मोर्टालिटि सिंड्रोम से अत्यधिक रूगण्ता :

रोग लक्षण जैसे व्हाइट फेसिस सिंड्रोम (डब्ल्यूएफएस), अवरूद्ध विकास, रनिंग मोर्टालिटी सिंड्रोम (आरएमएस), व्हाइट मसल सिंड्रोम (डब्ल्यूएमएस) तथा लूज शेल सिंड्रोम (एलएसएस) वन्नामेय प्रक्षेत्रों में गंभीर समस्या बन गई है। इन लक्षणों से प्रक्षेत्रों में बड़े पैमाने पर रूगण्ता और मार्त्यता होती है। वर्ष 2015–16 के दौरान प्रक्षेत्रों में अधिकतम अवरूद्ध विकास/वृद्धि में रूकावट 30.8: तक, आरएमएस 20:, डब्ल्यूएफएस 20. 8: तथा व्हाइट मसल सिंड्रोम 12.5: दर्ज की गई।

व्हाइट फेसिस सिंड्रोम (डब्ल्यूएफएस) की सूक्ष्मजीवीय विविधता से झींगा तालाब प्रभावित

जलजीव पालन परितंत्रों में सूक्ष्मजीवों की प्रमुख भूमिका होती है। स्वस्थ एवं डब्ल्यूएफएस प्रभावित झींगा तालाबों में एनजीएस प्रौद्योगिकी के उपयोग से बैक्टीरियाई 16एस आरडीएनए (1ẟ तक्छ।) के वी3 और वी6 क्षेत्र में सूक्ष्मजीवीय विविधता परीक्षण किया गया। स्वस्थ एवं संक्रमित तालाबों में स्यूडोआल्टरमोनाडेसे कुल के बैक्टीरियाई की प्रचुरता थी जबकि स्वस्थ तालाबों में फ्लैवोबैक्टीरियासे, साइनेकोकोकासे, रोडोबैक्टेरासे, पिस्किरिककेटसियासे, मारनिसेल्लासे की बहुलता पाई गई। इसके विपरीत व्हाइट फेसिस सिंड्रोम से प्रभावित तालाबों में बेनोकोकासे, स्पेरोचेकासे, विक्टीवल्लासे, हलनएरोबियासे, मोगिबैक्टेरासे, काल्डिकोप्रोबैक्टेरासे, यूजीबयासे, जोनसियासे कुल की बैक्टीरिया पाई गई। इस सूचना के विवेचनात्मक परीक्षण से रोग प्रक्रिया में सूक्ष्मजीवों की भूमिका विशेषकर जलजीव पालन संबंधी रोगों जैसे, डब्ल्यूएफएस और आरएमएस स्पष्ट होती है।

पी. वन्नामेय हैचरियों में जोया प्सिंड्रोम चिंता का विषय

जोया सिंड्रोम प्रकोप के संदर्भ में संक्रामक कारकों, पोषक घटकों तथा प्रबंधन पद्ध तियों की भूमिका का अध्ययन किया गया। वायरल रोगाणु नहीं पाए गए परंतु हिस्टोपैथोलॉजीकल अध्ययन से सूचित हुआ है कि प्रणालीगत असमानताएं, पेरीट्रोपिक मेम्बरेन का विघटन, मध्य एवं पश्च भाग के आंतड़ियों में इपिथिलियल सेल का विच्छेदन एवं विशल्कन देखा गया। आगे इटियोलॉजी या पोषणिक, आनुवंशिक कारकों का अध्ययन आवश्यक है ताकि सिंड्रोम को समझा जा सके।

डब्ल्यूएसएसवी आणविक निदान

डब्ल्यूएसएसवी डीएनए के छोटे से छोटे भाग 1 एफजी (फेम्टो ग्राम) को भी पहचान कर सकने वाले एक संवेदनशील नैदानिक उपकरण लूप मिडीएटेड आइसोथर्मल एम्प्लीकेशन (एलएएमपी) का विकास किया गया है। इलेक्टोफोरेसिस चरण को टालने और निदान को उपयोगकर्ता मैत्रीपूर्ण बनाने हेतु इंडीकेटर डाइस जैसे एसवाईबीआर गोल्ड और हाइड्रोक्सीनैपथोल ब्लू के उपयोग से एलएएमपी के विजुअल डिटेक्शन मेथड विकसित किया गया।

एनजीएस के उपयोग से वैब्रियो हारवेयी जेनोम का अनुक्रमण

झींगा हैचरियों और झींगा पालन तालाबों में वैब्रियो हारवेयी एक उल्लेखनीय रोगाण J है। विस्तृत अनुसंधान होते हुए भी वी.

हारवेयी की विषाक्तता का स्पष्ट ज्ञान का अभाव है। विषाक्त कारकों के चित्रण हेतु विषैले जीवाणु आइसोलेट वीएच102 का इल्लुमिना प्लॉटफार्म के उपयोग से नेक्सट जेनरेशन सीकवेंसिंग किया गया। वीएच102 में कुल जीसी परिमाण 45.69: पाया गया। कुल 59 मिलियन रीड्स बनाए गए जिनकी औसत लम्बाई 101 बीपी है। प्राथमिक जेनोम विश्लेषण से ज्ञात हुआ है कि वीएच102 जेनोम में 4800 से अधिक जींस हैं।

झींगों के लिए नवीन प्रोबायोटिक्स

विविध कार्यात्मक गुणों वाले नवीन प्रोबायोटिक सूक्ष्मजीवों की खोज जारी रखी गयी। उनकी प्रतिरोधी गतिविधियां एंजाइम उत्पादन, पीएच और लवणता की प्रति सहिष्णुता के आधार पर चार बैक्टीरियायी आइसोलेट्स बैसीलस सबटिलिस, बी. पुमिलिस तथा बी. एमिलोलिकुफेसियन्स को उम्मीदवार प्रोबयोन्ट के रूप में चयन किया और बड़े पैमाने पर उत्पादन हेतु प्रोटोकॉल को अनुकूल बनाया गया। पुटेटिव प्रोबायोटिक्स के फार्मूलेशन्स तैयार किया गया और बैक्टीरियायी कोशिकाओं की व्यावहारिकता के संदर्भ में फार्मूलेशन्स की स्थिरता का परीक्षण किया गया। हैचरी परिवेश में उत्पादन का अपस्केलिंग और परीक्षण कार्य चल रहा है।

झींगों में सफेद धब्बा रोग का प्रोफिलैक्सिस और रोगोपचार

सफेद धब्बा रोग के लिए प्रोफिलैक्सिस और रोगोपचार प्रयास जारी रखे गए। डब्ल्यूएसएसवी चुनौती से 24 घंटे पूर्व वीपी जीन28 में डीएसआरएनए (केत्छ।) दिया गया और यह झींगों को संरक्षण देने में प्रभावी पाया गया। दूसरी ओर झींगों को होस्ट डिफेंस जींस के लिए डीएसआरएनए (केत्छ।) रैब 7, रेलिश और अपाप्टोसिस निरोधी देने पर प्रतिरक्षा जींस जैसे क्रस्टिन, पेनेयडिन, मैंगानीज–सूपर अक्साइड डिसम्यूटेज का विनियमन कम हो गया और ट्यूमर प्रोटीन नियंत्रित हुआ, जब कि प्रभावी रोगनिरोधकों का विकास अभी बाकी है। मानव उपचार में प्रयोग की जाने वाली वायरसरोधी दवा एसीक्लोविर प्रभावहीन पाया गया चाहे सुई के रूप में या आहार के द्वारा दी गई हो।

पीनियस वन्नामेय में आक्सीटेट्रासाईक्लिन की जैवसुरक्षा

जलीय तलछटों में मौजूदगी और पी. वन्नामेय के लिए आक्सीटेट्रासाईक्लिन (ओटीसी) की जैवसुरक्षा का अध्ययन किया गया। अध्ययनों से ज्ञात हुआ है कि जलीय तलछटों में ओटीसी अवशेषों की मौजूदगी का संबंध मृदा के प्रकार और जलीय लवणता से है। झींगों के लिए सिफारिश खुराक का चार गुना ओटीसी भी सुरक्षात्मक है।

जलजीव पालन परितंत्र

पश्च जल (बैकवाटर) क्षेत्र में ग्रीन हाउस गैस (जीएचजी) उत्सर्जन

विभिन्न तटीय परितंत्रों नामतः पिचावरम मैंग्रोव, मुत्तुकाडु पश्च जल तथा मामल्लापुरम के निकट बकिंघम कैनल, में गीन हाउस गैसों के उत्सर्जन का अध्ययन किया गया। मुत्तुकाडु पश्च जल की तुलना में अर्ध–गहन झींगा जलजीव पालन वाले क्षेत्र बकिंघम कैनल और पिचावरम मैंग्रोव पर गीन हाउस गैसों का प्रभाव कम पाया गया। मुत्तुकाडु पश्च जल से ग्रीन हाउस गैसों का अधिक उत्सर्जन औद्योगिक और मलजल प्रवाह के कारण हो सकता है। मैंग्रोव परितंत्र में तलछट कुल कार्बन 28.34 मैग्नीशियम प्रति हे. है जो अन्य दो परितंत्रों से तीन गुना अधिक है।

अपचयोपचय क्षमता झ .200 उट वाले तलछटों में सल्फेट की कमी और उच्च मिथेन उत्सर्जन

जलजीव पालन तालाबों में एनोक्सिक सेडीमेंट्स की प्रक्रिया में सल्फेट की कमी प्रमुख है जिस दौरान विषाक्त हाइड्रोजन सल्फाइड उत्पन्न होता है और यह प्रक्रिया पीएच और लवणता से प्रभावित होती है। सल्फेट की अधिकतम कमी पीएच 8 और पीएच 6 में देखी गई है। अधिकतम सल्फेट कमी और लवणता के सभी स्तरों में सल्फाइड का उत्पादन तीव्र गति में देखा गया। मेथानोजेनेसिस पर अपचयोपचय क्षमता से सूचित तालाब की अवस्थिति का प्रभाव और सल्फाइड फार्मेशन यह दर्शाता है कि 30 पीपीटी लवणता स्तर में .200 उट पर सल्फेट की अधिकतम कमी और निम्न लवणीय पर्यावरण (5 पीपीटी) में .200 उट पर उच्च मिथेन स्तर।

जलजीव पालन परितंत्र की गुणवत्ता में सेडीमेंट–वाटर इंटरफेस (एसडब्ल्यूआई) की महत्वपूर्ण भूमिका

झींगा तालाबों में लवणता के विभिन्न स्तरों तथा भिन्न भिन्न संग्रहण घनत्वों के अंतर्गत एसडब्ल्यूआई का अध्ययन किया गया। तालाब के जल की लवणता का प्रभाव नाइट्रेट, नाइट्राइट, फास्फेट, क्षारीयता और जल के कठोरपन पर होता है। उच्च संग्रहण घनत्व के अंतर्गत एसडब्ल्यूआई में जैविक कार्बन, टोटल अमोनिया नाइट्रोजन (टीएएन), नाइट्राइट एन तथा टोटल बैक्टीरियल काउंट अधिक पाई गई। उच्च पीएच दर और टीएएन झींगों की प्रतिरक्षात्मक गुणों तथा मिनरल प्रोफाइल और जल गुणवत्ता को प्रभावित किया है।

कार्बन प्रच्छादन हेतु जलजीव पालन तालाब के गाद से बायोचार

अधिशोषक सामग्री के उपयोग से जलजीव पालन प्रक्षेत्र से निस्सारित जल में पोषक तत्वों की मौजूदगी को कम करने का प्रयास किया गया है। विभिन्न स्तर की लवणीयता वाले निस्सारित जल में फास्फोरस को कम करने में सिंथासाइज्ड अल्यूमिनम पिल्लरड् बेंटोनाइट प्रभावी पाया गया, यद्यपि बढ़ती लबणता से इसकी अधिशोषण क्षमता घटती गई। कार्बन प्रच्छादन के उपाय के रूप में जैविक तत्वों से समृद्ध जलजीव पालन तालाब के गाद से बायोचार तैयार कर इसे आयरन आक्साइड लेप से मैग्नीटाइज किया गया और इससे बायोचार की फास्फोरस अधिशोषण क्षमता में वृद्धि हुई।

उत्पादों से घुलित आक्सीजन निर्मोचन को एनए–ईडीटीए (छं.म्क्ज।) द्वारा गति प्रदान करना

घुलित आक्सीजन निर्मोचन करने वाले उत्पादों नामतः कैलशियम पेरोक्साइड, सोडियम परकार्बोनेट तथा सोडियम पर्बोरेट की क्षमता में वृद्धि करने का प्रयास में देखा गया है कि इन उत्पादों की स्थिरता में वृद्धि करने में एनए–ईडीटीए लवण प्रभावी है। घुलित आक्सीजन रिलीज में तेजी लाने हेतु प्रेरक के रूप में टेट्रा एसिटल इथीलेन डयामाइन उपयोगी पाया गया।

खनिज निर्गमन दक्षता में व्यावसायिक खनिज उत्पादों की भिन्नता

तमिलनाडु के तांजावूर तथा आंध्र प्रदेश के भीमावरम और गुडीवाड़ा प्रक्षेत्रों में निम्न लवणता/मीठाजल परितंत्रों में पी. वन्नामेयपालन तथा पालन के साथ–साथ पालन जल में खनिजों के प्रोफाइलों का मूल्यांकन किया गया। थांजावुर के प्रक्षेत्रों में अन्य दो क्षेत्रों की अपेक्षा बेहतर निष्पादन देखा गया। इन प्रक्षेत्रों के स्रोत जल में खनिजों के प्रोफाइल में प्रमुख आयाम, जैसे सोडियम, पोटाशियम, कैल्सियम और मैगनिसियम की सांद्रणता में काफी भिन्नता देखी गई तथा समुद्री जल की तुलना में आयोनिक अनुपात में उल्लेखनीय अंतर देखा

गया। चार व्यावसायिक खनिज उत्पादों के मूल्यांकन में विभिन्न लवणता स्तर वाले जल में खनिज निर्गमन क्षमता में असमानता देखी गई।

व्यावसायिक किट की अपेक्षा सीबा द्वारा विकसित सीबीएके जल गुणवत्ता किट बेहतर

तालाब क्षेत्र मे जल प्राचलों के मापन के लिए पोर्टेबल एवं संवेदनशील जल विश्लेषण किट/सेंसर आवश्यक है। सीबा में पूर्व में विकसित डीओ किट में एक अभिक्रमक अस्थिर पाया गया और स्टेबलाइजर जोड़कर संशोधन करने पर इसकी स्थिरता आठ माह से अधिक हो गई। कार्बोनेट, बाईकार्बोनेट तथा कुल क्षारियता किट (सीबा–सीबीएके) विकसित किया गया जो व्यावसायिक किटों से बेहतर पायी गई।

केकड़ा पालन के पर्यावरणीय प्रभाव मूल्यांकन संबंधी अध्ययन में पर्यावरण पर कोई प्रतिकूल प्रभाव नहीं

खारा जलजीव पालन में निरंतरता के लिए पर्यावरणीय प्रभाव मूल्यांकन तथा निगरानी कार्यक्रमों की आवश्यकता है। पर्यावरणीय प्रभाव मूल्यांकन के लिए केकड़ा पालन के पांच पेन तथा वहन क्षमता मूल्यांकन के लिए महाराष्ट्र में सिंधुदुर्ग जिले के तटीय तालुकाओं मालवन, दावगढ़ तथा वेनगुरला के तीन संकरी खाड़ियों अचारा, नारिंगरे तथा मांडवी से पर्यावरणीय तथा सामाजिक–आर्थिक प्राचल संबंधी प्राथमिक एवं गौण आंकड़ों से सूचित हुआ है कि केकड़ा पालन से पर्यावरण पर कोई नकारात्मक प्रभाव नहीं है। इसी प्रकार के एक और अध्ययन में मुत्तुकाडु पश्चजल में वर्षभर के मौसमीय परिवर्तनों से संबंधित डाटाबेस के परीक्षण से सूचित हुआ है कि सीबा के मुत्तुकाडु प्रयोगात्मक स्टेशन की गतिविधियों से पश्चजल गुणवत्ता पर कोई प्रतिकूल प्रभाव नहीं है।

समाज विज्ञान

नेल्लूर में नवंबर–दिसंबर 2015 के दौरान अतिवृष्टि के कारण 2000 करोड़ रुपए की क्षति

झींगा जलजीव पालन पर जलवायु परिवर्तन तथा चरम जलवायुवीय घटनाओं के प्रभाव को प्रलेखित किया गया। आंध्र प्रदेश के नेल्लूर जिले में नवंबर–दिसंबर 2015 के दौरान अतिवृष्टि के परिणामस्वरूप 12000 एकड़ झींगा पालन तालाब जलमग्न हो गए, अवसंरचना एवं मशीनरी क्षतिग्रस्त तथा मौजूद मत्स्य संपदा नष्ट हो गई जिससे कुल क्षति लगभग 2000 करोड़ रुपयों की हुई।

कृषि में युवाओं को आकृषित करना एवं बनाए रखना (आर्या)

चेन्नई के आस–पास के ग्रामीण एवं शहरी क्षेत्रों के विद्यालयों में आर्या कार्यक्रम क्रियान्वित किया गया। 'ओपन डे'के अवसर पर खेत प्रशिक्षण, सीबा अनुसंधान व्यवस्थाओं का दौरा स्कूल के छात्रों के लिए आयोजित किया गया और खाराजल जीवपालन संबंधी साहित्य का वितरण किया गया। विश्वविद्यालय तथा महाविद्यालय के छात्रों में खारा जलजीव पालन के प्रति जागृति उत्पन्न की गई। मत्स्य पालन, झींगा पालन, मत्स्य आहार की तैयारी तथा कीचड़ केकड़ा पालन के विषयों से युवा काफी प्रभावित हुए। मत्स्य एवं झींगा पालन को अपने कैरियर के रूप में अपनाने हेतु युवा उत्साहित हुए।

मेरा गांव मेरा गौरव (एमजीएमजी) कार्यक्रम का प्रारंभ

मेरा गांव मेरा गौरव कार्यक्रम के अंतर्गत युवा मछुवारों द्वारा खुले जल क्षेत्र में हापाओं में एशियन सीबास नर्सरी संवर्धन से सूचित हुआ है कि बेरोजगार युवाओं के लिए यह हस्तक्षेप एक व्यवहार्य आजीविका विकल्प हो सकता है।

पश्चिमी तटीय राज्यों में गुणवत्तायुक्त बीज तथा तकनीकी सहायता की आवश्यकता

अंतर्राज्यीय जलजीव पालन विकास के विश्लेषण से ज्ञात हुआ है कि पश्चिमी तटीय राज्यों को गुणवत्तायुक्त बीज एवं प्रौद्योगिकी सहायता के संदर्भ में अतिरिक्त सहायता की आवश्यकता है ताकि पी. वन्नामेय से लाभ उठा सकें।

कीचड़ केकड़ा तथा एशियन सीबास पालन से अनुपूरक राजस्व उत्पत्ति हेतु सामुदायिक एवं पारिवारिक प्रतिभागिता

जनजातीय उप–योजना के अंतर्गत आईसीएआर–सीबा की सहायता से तमिलनाडु में तिरवल्लूर जिले के कुल्लाथुमेडु जनजातीय गांव इरूलार स्थित सामुदायिक तालाब में कीचड़ केकड़ा (स्काइला सराटा) तथा एशियन सीबास (लेटेस एलकैरिफर) के बहुप्रजातीय पालन संबंधी निरूपणों की सफल गाथाओं को प्रलेखित किया गया। इस हस्तक्षेप से यह प्रमाणित होता है कि आम जल निकायों में खारा जलजीव पालन प्रौद्योगिकियों को अपनाते हुए सामुदायिक एवं पारिवारिक प्रतिभागिता से अनुपूरक राजस्व उत्पत्ति एक व्यवहार्य मॉडल है।

''फोन इन प्रोग्राम'' के माध्यम से प्रौद्योगिकी का प्रसार

प्रतिभागियों की आवश्यकताओं तथा प्रश्नों के लिए ऑडियो कॉन्फ्रेंसिंग फेसीलिटी के माध्यम तथा एम. एस. स्वामिनाथन रिसर्च फाउंडेशन के सहयोग से फोन इन प्रोग्राम का आयोजन किया गया। ''सीबास पालन एवं इसके प्रक्षेत्र प्रबंधन पद्धतियां'' विषय पर तमिलनाडु और पुदुचेरी के विभिन्न भागों के 117 मत्स्य पालकों द्वारा उठाए गए 120 प्रश्नों को प्रलेखित किया गया। इस अध्ययन से प्रतिभागियों की धारणाएं, उनकी ताकत और कमजोरियां, अवसरों तथा पीआईपी की आशंकाएं तथा सीबास पालन एवं प्रबंधन सूचनाओं के अभाव संबंधी समस्याओं का भी विश्लेषण हुआ है। अध्ययन से ज्ञात हुआ है कि 72 प्रतिशत प्रतिभागियों में इस कार्यक्रम के प्रति अनुकूल धारणाएं हैं।

आईसीटी की सहायता से फज्जी डिसीजन सपोर्ट सिस्टम का विकास

आईसीटी सहायता प्राप्त सशक्तीकरण मूल्यांकन उपाय का विकास किया गया जिसके पांच घटक हैं नामतः सामाजिक, राजनीतिक, मनोवैज्ञानिक, तकनीकी व आर्थिकी। विभिन्न आईसीटी परियोजनाओं के प्रतिभागियों के अनुभवों के विश्लेषण हेतु परीक्षण किया गया। परिणामों से स्पष्ट हुआ है कि राजनीतिक सशक्तिकरण को छोड़कर शेष सभी घटक आईसीटी परियोजनाओं के उपयोगकर्ताओं में दृष्टिगोचर है। आईसीटी की सहायता से फज्जी डिसीजन सपोर्ट सिस्टम का विकास कर भारत में आन्ध्र प्रदेश राज्य के पश्चिमी गोदावरी और पूर्वी गोदावरी जिलों में 'एक्वा चौपाल' मॉडल में परीक्षण किया गया ताकि ई–मार्केटिंग सिस्टम के परिणामस्वारूप जलजीव पालन के विपण न में सेवा गुणवत्त परिवर्तन का मूल्यांकन किया जा सके। मूल्यांकन रेखांकित होता है कि एनालाइटिकल हैआर्की मेथड (64:) आफ वेयट्स की तुलना में फज्जी सिस्टम को अधिकतम प्राथमिकता (71:) प्राप्त है। इससे ज्ञात होता है कि फज्जी सिस्टम जलजीव पालन में ई–मार्केटिंग सिस्टम के मूल्यंकन के लिए उपयुक्त है।

संस्थान के अनुसंधान परियोजनाओं के डिजीटाइलैजेशन हेतु सीबा प्रो बेस

संस्थान के प्रारम्भ से अनुसंधान परियोजना प्रस्तावों को डिजीटाइज करने हेतु सीबाप्रोबेस नामक वेब–आधारित रिपोजिटरी का विकास किया गया। संस्थान के सभी अनुसंधान परियोजना प्रस्तावों को डिजीटाइज कर सिस्टम में अपलोड किया गया। ओपेन सोर्स जियोसर्वर के उपयोग से जियोपोर्टल के विकास का प्रयास किया गया। ड्रूपल कंटेंट मैनेजमेंट सिस्टम के उपयोग से संस्थान के वेबपेज की पुनर्रचना की गई। चालू वर्ष में संस्थान के प्रकाशनों के लिए डिजीटल रिपोजिटरी निमार्ण कार्य प्ररम्भ किया गया।

जलजीव पालकों और राज्य सरकार के अधिकारियों के लिए प्रशिक्षण कार्यक्रमों का आयोजन

केन्द्रीय खारा जलजीव पालन संस्थान ने खारा जलजीव पालन क्षेत्र के पणधारियों जैसे मत्स्य पालक, आहार निर्माता, प्रक्षेत्र तकनीशियन, मात्स्यिकी स्नातक तथा केन्द्रीय एवं राज्य सरकारों के अधिकारियों के लिए 16 प्रशिक्षण कार्यक्रमों का आयोजन किया। इन कार्यक्रमों में 250 प्रतिभागियों ने भाग लिया। खारा जलजीव पालन पद्धतियों के विभिन्न पहलुओं जैसे हैचरी परिचालन, मत्स्य बीज उत्पादन, केकड़ा, झींगा और सीबास पालन पर प्रशिक्षण दिया गया। प्रशिक्षण के दौरान प्रशिक्षणार्थियों को नैदानिक और स्वास्थ्य प्रबंधन, जैवप्रौद्योगिकी, आहार उत्पादन और जल व मृदा विश्लेषण संबंधी पहलुओं पर हैंड्स ऑन ट्रेनिंग उपलब्ध कराया गया। वर्ष 2015–16 के दौरान भा.कृ.अनुप. के संस्थानों में नवनियुक्त 6 एआरएस वैज्ञानिकों को प्रोफेशनल एटैचमेंट ट्रेनिंग के अंतर्गत प्रशिक्षण दिया गया। विशेष रूप से पश्चिम बंगाल और ओडिशा की आवश्यकताओं की पूर्ति के लिए पांच प्रशिक्षण कार्यक्रमों का आयोजन किया गया जिनमें 57 प्रशिक्षण ार्थियों ने भाग लिया। भारत और ओमान सल्तनत के बीच कृषि अनुसंधान क्षेत्र में सहयोग के अंतर्गत ओमान सल्तनत के दो वैज्ञानिकों को खारा जलजीव पालन में प्रशिक्षण दिया गया।

संस्थान के वैज्ञानिक, तकनीकी, प्रशासनिक एवं सहायक कर्मचारियों को प्रशिक्षण

संस्थान के 11 वैज्ञानिक, 2 तकनीकी, 1 प्रशासनिक तथा 1 सहायक कर्मचारी ने कार्य दक्षता में वृद्धि हेतु अपने कार्य क्षेत्र में प्रशिक्षण प्राप्त किया।

केकड़ा पालन के पर्यावरणीय प्रभाव मूल्यांकन संबंधी अध्ययन में पर्यावरण पर कोई प्रतिकूल प्रभाव नहीं

खारा जलजीव पालन में निरंतरता के लिए पर्यावरणीय प्रभाव मूल्यांकन तथा निगरानी कार्यक्रमों की आवश्यकता है। पर्यावरणीय प्रभाव मूल्यांकन के लिए केकड़ा पालन के पांच पेन तथा वहन क्षमता मूल्यांकन के लिए महाराष्ट्र में सिंधुदुर्ग जिले के तटीय तालुकाओं मालवन, दावगढ़ तथा वेनगुरला के तीन संकरी खाड़ियों अचारा, नारिंगरे तथा मांडवी से पर्यावरणीय तथा सामाजिक–आर्थिक प्राचल संबंधी प्राथमिक एवं गौण आंकड़ों से सूचित हुआ है कि केकड़ा पालन से पर्यावरण पर कोई नकारात्मक प्रभाव नहीं है। इसी प्रकार के एक और अध्ययन में मुत्तुकाडु पश्चजल में वर्षभर के मौसमीय परिवर्तनों से संबंधित डाटाबेस के परीक्षण से सूचित हुआ है कि सीबा के मुत्तुकाडु प्रयोगात्मक स्टेशन की गतिविधियों से पश्चजल गुणवत्ता पर कोई प्रतिकूल प्रभाव नहीं है।

समाज विज्ञान

नेल्लूर में नवंबर–दिसंबर 2015 के दौरान अतिवृष्टि के कारण 2000 करोड़ रुपए की क्षति

झींगा जलजीव पालन पर जलवायु परिवर्तन तथा चरम जलवायुवीय घटनाओं के प्रभाव को प्रलेखित किया गया। आंध्र प्रदेश के नेल्लूर जिले में नवंबर–दिसंबर 2015 के दौरान अतिवृष्टि के परिणामस्वरूप 12000 एकड़ झींगा पालन तालाब जलमग्न हो गए, अवसंरचना एवं मशीनरी क्षतिग्रस्त तथा मौजूद मत्स्य संपदा नष्ट हो गई जिससे कुल क्षति लगभग 2000 करोड़ रुपयों की हुई।

कृषि में युवाओं को आकृषित करना एवं बनाए रखना (आर्या)

चेन्नई के आस–पास के ग्रामीण एवं शहरी क्षेत्रों के विद्यालयों में आर्या कार्यक्रम क्रियान्वित किया गया। 'ओपन डे'के अवसर पर खेत प्रशिक्षण, सीबा अनुसंधान व्यवस्थाओं का दौरा स्कूल के छात्रों के लिए आयोजित किया गया और खाराजल जीवपालन संबंधी साहित्य का वितरण किया गया। विश्वविद्यालय तथा महाविद्यालय के छात्रों में खारा जलजीव पालन के प्रति जागृति उत्पन्न की गई। मत्स्य पालन, झींगा पालन, मत्स्य आहार की तैयारी तथा कीचड़ केकड़ा पालन के विषयों से युवा काफी प्रभावित हुए। मत्स्य एवं झींगा पालन को अपने कैरियर के रूप में अपनाने हेतु युवा उत्साहित हुए।

मेरा गांव मेरा गौरव (एमजीएमजी) कार्यक्रम का प्रारंभ

मेरा गांव मेरा गौरव कार्यक्रम के अंतर्गत युवा मछुवारों द्वारा खुले जल क्षेत्र में हापाओं में एशियन सीबास नर्सरी संवर्धन से सूचित हुआ है कि बेरोजगार युवाओं के लिए यह हस्तक्षेप एक व्यवहार्य आजीविका विकल्प हो सकता है।

पश्चिमी तटीय राज्यों में गुणवत्तायुक्त बीज तथा तकनीकी सहायता की आवश्यकता

अंतर्राज्यीय जलजीव पालन विकास के विश्लेषण से ज्ञात हुआ है कि पश्चिमी तटीय राज्यों को गुणवत्तायुक्त बीज एवं प्रौद्योगिकी सहायता के संदर्भ में अतिरिक्त सहायता की आवश्यकता है ताकि पी. वन्नामेय से लाभ उठा सकें।

कीचड़ केकड़ा तथा एशियन सीबास पालन से अनुपूरक राजस्व उत्पत्ति हेतु सामुदायिक एवं पारिवारिक प्रतिभागिता

जनजातीय उप–योजना के अंतर्गत आईसीएआर–सीबा की सहायता से तमिलनाडु में तिरवल्लूर जिले के कुल्लाथुमेडु जनजातीय गांव इरूलार स्थित सामुदायिक तालाब में कीचड़ केकड़ा (स्काइला सराटा) तथा एशियन सीबास (लेटेस एलकैरिफर) के बहुप्रजातीय पालन संबंधी निरूपणों की सफल गाथाओं को प्रलेखित किया गया। इस हस्तक्षेप से यह प्रमाणित होता है कि आम जल निकायों में खारा जलजीव पालन प्रौद्योगिकियों को अपनाते हुए सामुदायिक एवं पारिवारिक प्रतिभागिता से अनुपूरक राजस्व उत्पत्ति एक व्यवहार्य मॉडल है।

''फोन इन प्रोग्राम'' के माध्यम से प्रौद्योगिकी का प्रसार

प्रतिभागियों की आवश्यकताओं तथा प्रश्नों के लिए ऑडियो कॉन्फ्रेंसिंग फेसीलिटी के माध्यम तथा एम. एस. स्वामिनाथन रिसर्च फाउंडेशन के सहयोग से फोन इन प्रोग्राम का आयोजन किया गया। ''सीबास पालन एवं इसके प्रक्षेत्र प्रबंधन पद्धतियां'' विषय पर तमिलनाडु और पुदुचेरी के विभिन्न भागों के 117 मत्स्य पालकों द्वारा उठाए गए 120 प्रश्नों को प्रलेखित किया गया। इस अध्ययन से प्रतिभागियों की धारणाएं, उनकी ताकत और कमजोरियां, अवसरों तथा पीआईपी की आशंकाएं तथा सीबास पालन एवं प्रबंधन सूचनाओं के अभाव संबंधी समस्याओं का भी विश्लेषण हुआ है। अध्ययन से ज्ञात हुआ है कि 72 प्रतिशत प्रतिभागियों में इस कार्यक्रम के प्रति अनुकूल धारणाएं हैं।

आईसीटी की सहायता से फज्जी डिसीजन सपोर्ट सिस्टम का विकास

आईसीटी सहायता प्राप्त सशक्तीकरण मूल्यांकन उपाय का विकास किया गया जिसके पांच घटक हैं नामतः सामाजिक, राजनीतिक, मनोवैज्ञानिक, तकनीकी व आर्थिकी। विभिन्न आईसीटी परियोजनाओं के प्रतिभागियों के अनुभवों के विश्लेषण हेतु परीक्षण किया गया। परिणामों से स्पष्ट हुआ है कि राजनीतिक सशक्तिकरण को छोड़कर शेष सभी घटक आईसीटी परियोजनाओं के उपयोगकर्ताओं में दृष्टिगोचर है। आईसीटी की सहायता से फज्जी डिसीजन सपोर्ट सिस्टम का विकास कर भारत में आन्ध्र प्रदेश राज्य के पश्चिमी गोदावरी और पूर्वी गोदावरी जिलों में 'एक्वा चौपाल' मॉडल में परीक्षण किया गया ताकि ई–मार्केटिंग सिस्टम के परिणामस्वारूप जलजीव पालन के विपण न में सेवा गुणवत्त परिवर्तन का मूल्यांकन किया जा सके। मूल्यांकन रेखांकित होता है कि एनालाइटिकल हैआर्की मेथड (64:) आफ वेयट्स की तुलना में फज्जी सिस्टम को अधिकतम प्राथमिकता (71:) प्राप्त है। इससे ज्ञात होता है कि फज्जी सिस्टम जलजीव पालन में ई–मार्केटिंग सिस्टम के मूल्यंकन के लिए उपयुक्त है।

संस्थान के अनुसंधान परियोजनाओं के डिजीटाइलैजेशन हेतु सीबा प्रो बेस

संस्थान के प्रारम्भ से अनुसंधान परियोजना प्रस्तावों को डिजीटाइज करने हेतु सीबाप्रोबेस नामक वेब–आधारित रिपोजिटरी का विकास किया गया। संस्थान के सभी अनुसंधान परियोजना प्रस्तावों को डिजीटाइज कर सिस्टम में अपलोड किया गया। ओपेन सोर्स जियोसर्वर के उपयोग से जियोपोर्टल के विकास का प्रयास किया गया। ड्रूपल कंटेंट मैनेजमेंट सिस्टम के उपयोग से संस्थान के वेबपेज की पुनर्रचना की गई। चालू वर्ष में संस्थान के प्रकाशनों के लिए डिजीटल रिपोजिटरी निमार्ण कार्य प्ररम्भ किया गया।

जलजीव पालकों और राज्य सरकार के अधि ाकारियों के लिए प्रशिक्षण कार्यक्रमों का आयोजन

केन्द्रीय खारा जलजीव पालन संस्थान ने खारा जलजीव पालन क्षेत्र के पणधारियों जैसे मत्स्य पालक, आहार निर्माता, प्रक्षेत्र तकनीशियन, मात्स्यिकी स्नातक तथा केन्द्रीय एवं राज्य सरकारों के अधिकारियों के लिए 16 प्रशिक्षण कार्यक्रमों का आयोजन किया। इन कार्यक्रमों में 250 प्रतिभागियों ने भाग लिया। खारा जलजीव पालन पद्धतियों के विभिन्न पहलुओं जैसे हैचरी परिचालन, मत्स्य बीज उत्पादन, केकड़ा, झींगा और सीबास पालन पर प्रशिक्षण दिया गया। प्रशिक्षण के दौरान प्रशिक्षणार्थियों को नैदानिक और स्वास्थ्य प्रबंधन, जैवप्रौद्योगिकी, आहार उत्पादन और जल व मृदा विश्लेषण संबंधी पहलुओं पर हैंड्स ऑन ट्रेनिंग उपलब्ध कराया गया। वर्ष 2015–16 के दौरान भा.कृ.अनुप. के संस्थानों में नवनियुक्त 6 एआरएस वैज्ञानिकों को प्रोफेशनल एटैचमेंट ट्रेनिंग के अंतर्गत प्रशिक्षण दिया गया। विशेष रूप से पश्चिम बंगाल और ओडिशा की आवश्यकताओं की पूर्ति के लिए पांच प्रशिक्षण कार्यक्रमों का आयोजन किया गया जिनमें 57 प्रशिक्षण ार्थियों ने भाग लिया। भारत और ओमान सल्तनत के बीच कृषि अनुसंधान क्षेत्र में सहयोग के अंतर्गत ओमान सल्तनत के दो वैज्ञानिकों को खारा जलजीव पालन में प्रशिक्षण दिया गया।

संस्थान के वैज्ञानिक, तकनीकी, प्रशासनिक एवं सहायक कर्मचारियों को प्रशिक्षण

संस्थान के 11 वैज्ञानिक, 2 तकनीकी, 1 प्रशासनिक तथा 1 सहायक कर्मचारी ने कार्य दक्षता में वृद्धि हेतु अपने कार्य क्षेत्र में प्रशिक्षण प्राप्त किया। ★★★

Executive Summary

When the Indian population has been increasing and is projected to touch the 1.7 billion mark in 2050, in order to produce sufficient food and to ensure nutritional security, efforts in increasing food production from all the farming sectors, including aquaculture has been the priority. Brackishwater aquaculture sector being one of the major food production sectors in India, with a production of about 0.4 million tonnes, it needs to play a significant role in contributing towards increased food production, exploiting the brackishwater resources and aquaculture options. CIBA, therefore, has prioritized R&D with focus on diversification, sustainability and social relevance.

Breakthrough in milkfish breeding:

After having successfully developed hatchery and farming technology for the carnivorous candidate species, seabass *(Lates calcarifer)*, CIBA initiated efforts to breed the herbivorous candidate species, milk fish *(Chanos chanos)* placed at a lower trophic level. Subsequently, the long awaited breeding of milkfish was successfully achieved in India for the first time in June 2015. Scientists of the Fish Culture Division standardized an induced breeding protocol tailor-made to milkfish. Multiple spawning events were recorded from the reproductively mature milkfish broodstock maintained at Muttukadu finfish R&D hatchery facility. During the current year, about 0.3 million spawns with a hatching rate of about 75% was produced. Milkfish fingerlings produced from the first hatchery cycle have been distributed to farmers of West Bengal, Andhra Pradesh, Tamil Nadu, Kerala and Gujarat.

Pilot scale experimental hatchery of seabass recorded a milestone production:

The seabass larval production at the experimental hatchery of CIBA, Muttukadu recorded an all-time high of 0.6 million larvae with year round breeding.

Development of breeding technology and farming of small regionally-valued fish, Mystus gulio:

The research group at Kakdwip Research Centre of CIBA has successfully developed the breeding technology of this species by hormonal manipulation using a series of endocrine and neuroendocrine hormones. A total of 200,000 fry were produced from 4 hatchery production cycles and fry were distributed to the farmers for further evaluation of production potential at the farm level.

Captive breeding of grey mullet, Mugil cephalus:

Following the priority set towards the development of farming technology for species at the lower trophic level, research efforts were geared towards the intensification of captive breeding of *M. cephalus*. Germplasm of the broodstock obtained from different geographical locations were characterized and are being maintained at the experimental hatchery of the institute. Reproductive maturation and gamete quality of males were optimized by hormonal therapy. The delivery of hormone through silastic capsule was standardized. By the hormonal intervention, males became reproductive throughout breeding season. Hormonal manipulation in females using LHRHa enhanced oocyte diameter from 280 µm to 590 µm, indicating a positive breeding response.

Manipulation of parental care and development of continuous seed production technology of pearlspot, Etroplus suratensis:

Manipulation of parental care by weaning of fry from parental fishes immediately after spawning improved seed production of *E.suratensis* significantly. In a 215-day trial carried out in modular 1 ton tanks, by curtailing parental care and with salinity manipulations , an average larval production per spawning of pearlspot in the range of 750 to 990/per 30-45 day cycle could be achieved.

Low volume cage culture for seabass demonstrated to farmers of Kerala.

Seabass fry (average body weight: 8 g) were reared in floating cages (24 m^3) for 10 months and were fed with fish bycatch. At the end of the culture period the fish production was 475 kg with a productivity

of 18.8 kg/m^3, realising a net income of Rs. 9000/month, with a market value of Rs. 350/kg and cost of production of Rs 120/kg.

Integrated multi-trophic aquaculture:

A more productive and sustainable production system: Integrated multi-trophic aquaculture (IMTA) was undertaken at the Kakdwip Research Centre of CIBA using a combination of grey mullet, *Mugil cephalus*, goldspot mullet, *Liza parsia* and tiger shrimp, *P. monodon* stocked @2000, 8000 and 30000 nos./ha, respectively, estuarine oyster, *Crassostrea cuttackensis* @ 1600 nos./ha and seaweed, *Enteromorpha spp.* @ 200 kg biomass/ha. IMTA vis a vis polyculture (without oyster and seaweed) was significantly more productive ($P<0.05$), with 1707 kg/ha (mullets-926 and shrimp-781 kg/ha) and better water quality parameters, compared to the control ponds (1434 kg/ha; mullets-772 and shrimp-662 kg/ha), after 150 days of culture.

Farm based nursery rearing improves survival of Penaeus vannamei in grow-out ponds:

Inclusion of nursery phase in the production cycle of *P. vannamei* is found to be a significant management strategy to optimize the farm production performance. Experiments carried out to evaluate the efficiency of nursery rearing indicated that farms stocked with nursery reared seeds (24-28 days) showed higher survival (87.5% ± 5.00), less cropping period (106 ± 16.33), low FCR (1.27± 0.10), higher production (5.9 t/ha ± 1.73) and lower cost of production. Further, the technical efficiency of nursery stocked farms was higher (0.945 ± 0.009) compared with those with direct stocking (0.901 ± 0.062).

Biofloc-based larval rearing for high-health larval production of Penaeus vannamei

A bio-floc based system was developed for nursery rearing of *Penaeus vannamei* to produce healthy postarvae for grow-out culture. Protocols were developed to generate biofloc through different lab and field based experiments. Post larvae (PL3) reared in biofloc (10^7 CFU/ml) based rearing system showed significantly higher growth and survival than in conventional non-biofloc system. Furthermore, the mRNA transcript levels of different immune genes (Pro Phenoloxidase (PPO), Crustin, Ras, Alpha 2M, Mas, SP and antiviral genes) were found to be significantly upregulated (~1.3 to 2.5 fold changes) compared to that of shrimp grown without biofloc, indicating that biofloc improves immunity.

Comparative growth and production of three species of penaeid shrimps (P. indicus, P. monodon and P. vannamei)

An evaluation study conducted at KRC of CIBA, with *P. indicus*, *P. monodon* and *P. vannamei* revealed growth with body weights of 17.93±1.26g, 24.84±0.87g and 16.36±0.69 g, respectively in 118 days. Interestingly, growth rate of *P. indicus* was higher than that of *P. monodon* and *P. vannamei* for the first 80 days, under the same environmental conditions.

Nursery production of mud crab Scylla serrata:

In order to evaluate the logistic and economic optimization of seed production and grow out culture, nursery production performance of early juvenile stages (C_4-C_5) of mud crab was assessed through several indoor and field experiments. The overall survival rate in the outdoor experiment was 56.5 ± 5.3%; 40-71%; N=5, whereas indoor survival was as low as 12.8%. After 22 days of rearing in the indoor tanks survival -increased to ~ 50%, indicating that it is possible to rear the animals in indoor tanks for about 20 days with reasonable increase in survival rate.

Hormonal control mechanism of reproductive maturation pathway of Penaeus monodon characterized:

The control mechanism of reproductive maturation pathway in *P. monodon* was characterized using mRNA transcript levels of amajor reproductive hormone and protein (GIH and Vg) in the reproductive and reproduction-associated tissues (e.g. ovary, hepatopancreas and eyestalk ganglia). GIH mRNA was expressed at highest levels in the eyestalks of shrimps with immature and ripe ovaries. In the ovary, Vg mRNA level was highest in the early vitellogenic phase, and thereafter showed a decrease, reaching a minimum at the ripe stage, whereas in the hepatopancreas highest Vg transcript expression was found in the pre-vitellogenic ovary stage.

Reproductive performance of broodstocks for the domestication of Penaeus indicus:

As a preliminary step for the domestication and selective breeding of Indian white shrimp *Penaeus indicus*, hatchery and reproductive performance of broodstocks from three different geographical areas (Chennai, Orissa and Kanyakumari) was evaluated. A total of 728 broodstocks free from WSSV were used and a total of 6.5 lakhs of post larvae were produced from 12 larval rearing cycles. The performance of Chennai stock was found to be significantly better. Further, reproductive performance of pre-monsoon

and post-monsoon broodstock was also evaluated. Incidence of WSSV was found to be low during pre-monsoon period (5.9-7.7%), conversely the incidence of WSSV in post-monsoon stock was high (43-45%). Higher WSSV prevalence in the wild indicates the pathogen pressure in the wild stock of peneaid shrimp, and the need to develop a clean stock for domestication.

Pulicat and Muttukadu brackishwater lagoons mapped:

As a first step in the direction of mapping the brackishwater resources for important biotic and abiotic factors relevant to aquaculture, two important brackishwater lagoons, Pulicat and Muttukadu, were mapped on the GIS platform and further surveyed for ground truth data. The data generated in digital and hardcopy format would have potential use in the promotion of brackishwater aquaculture operations.

Nutrition and Feed Technology Vannamei^{Plus}:

Cost effective formulated feed for Penaeus vannamei: CIBA developed and field-tested a new cost effective grow-out shrimp feed and branded it as "Vannamei^{Plus}", for the benefit of the Indian shrimp farming sector. The feed costing Rs 54 per kg, has been extensively tried in commercial farms in Gujarat, West Bengal, and Andhra Pradesh. Experimental trials using 'Vannamei^{Plus}' have provided enough evidence that shrimp production costs could be reduced to Rs 91 per kg of shrimp by using this feed.

Moringa (drumstick; Moringa oleifera) leaf meal as functional feed ingredient.

At 1% inclusion level, moringa leaf meal showed a 148% increase in the average daily weight gain of shrimp in laboratory trials. However, the data need further evaluation in lab and field trials.

CIBA's larval feeds for shrimp and seabass (Shrimp Larvi^{Plus} and Seabass Larvi^{Plus}).

The larval feeds tested in commercial hatcheries showed an average survival of 73.6% up to post-larvae 13 (PL13), and 86% survival 25 dayspost-hatch in shrimp and seabass larvae, respectively. Since larval feeds currently being used have to be imported, these indigenous functional feeds could be developed as import substitutes.

Plant by-products as substitutes for fishmeal:

Oilcakes of groundnut and sunflower could be included in shrimp diets at levels up to 7.5% and 5%, respectively in place of fishmeal as protein source without compromising growth. Feeding trials in *Mugil cephalus* and *P. monodon* indicated that dried distiller's grain (DDG) could replace fishmeal by up to 10% in both the species.

Natural feeds can reduce dietary protein requirement of shrimp:

Outdoor microcosm studies with Indian and Pacific white shrimp have indicated that in the presence of natural diets, protein levels in feeds could be reduced up to 25% without compromising the growth and productivity and there appears to be a scope for savings in production cost.

Functional broodstock feeds for brackishwater finfishes:

Experiments indicated that a minimum of 30% protein and 9 % lipid was essential in broodstock diets for gold spot mullet in order to achieve maximum fecundity. Pearlspot broodstock diet (EtroBrood^{plus}), which yielded good results with wild adults last year, was also able to produce similar repeated spawning (average 4 times/annum) and higher fry yield (1679±452) with captive raised F2 generation *Etrolplus* adults, proving its wholesomeness.

Pond reared gold spot mullet are low in biologically important fatty acids:

Tissue specific fatty acid profiling of wild and farmed adult gold spot mullet (*Liza parsia*) showed 3.4 and 23 fold higher C16:0 and C18:2ω-6 fatty acids, respectively in muscle tissue of farmed samples compared to its wild counterparts. The most important fatty acids like C20:4ω-6 and C22:6ω-3, which play major role in reproduction and larval development are significantly lower (50 to 20% lower) in pond reared fish.

Microalgal diversity and fatty acid profiling in Muttukadu backwaters.

Twelve microalgae, including *Chlorella* sp, *Isochrysis* and *Chaetoceros* were isolated and purified from Muttukadu backwaters (Chennai, Tamil Nadu). Cyanophyceae (52.96%) and Bacillariophyceae (39.68%) were dominant in the pre-monsoon season, whereas Bacillariophyceae (66.89%) dominated in the post-monsoon season. Fatty acid profiling showed that *Isochrysis* contained 7.88% EPA and 4.31% DHA. A mixture of microalgae, *Nannochloropsis* sp and *Isochrysis* sp in 1:3 ratio was superior to commercial enrichment products and served as alternates in enriching rotifers for crab larval rearing.

Shrimp biomass influences productivity and quality of biofloc:

Experiments on optimization of biofloc productivity found that, although a C:N ratio of 20 appears

to be optimum for inducing the high protein containing brown biofloc production, productivity and quality of bioflocare more influenced by presence and absence of animal biomass, rather than by C:N ratio alone.

Mitochondrial genome of Indian white shrimp P. indicus deciphered:

Whole mitochondrial genome of *P. indicus* has been deciphered for the first time. Phylogenetic analysis based on all protein coding genes among the shrimp species, including the sequenced *P. indicus* revealed a close relationship between banana shrimp and red-tail shrimp, and unravelled the classification among penaeid shrimps.

Mumbai stock of Indian white shrimp is divergent from those from other regions:

Partial fragments of two mtDNA genes, cytochrome b and 16S rRNA were used to delineate the population structure among the stocks of *P. indicus*. Among the stocks studied, both the mtDNA genes reveal that Mumbai stock is divergent from Puri, Chennai, Kanyakumari and Quilon stocks indicating genetic diversity in Indian white shrimp along the subcontinent.

D-Arginine and D-ornithine metabolic pathways activate upon WSSV infection in shrimp:

The transcriptome from hepatopancreas of healthy and white spot syndrome virus (WSSV) infected *P. monodon* was generated and analyzed. The results indicated that the mortality during WSSV infection could be due to activation of D-Arginine and D-ornithine metabolic functional pathways.

Serotonin plays a regulatory role in vitellogenesis in shrimp:

Administration of serotonin to unilaterally eyestalk ablated females significantly increased the expression of genes related to reproduction. Ovarian gene expressions suggested a possible dual regulatory role of serotonin on both vitellogenesis and indirect stimulation of post-vitellogenic meiotic resumption and oocyte maturation in penaeid shrimps. Further, in vitro trials testing the effect of addition of serotonin on previtellogenic ovarian tissues confirmed its indirect stimulatory role in vitellogenesis. This observation would be of use in the development of a maturation feed for penaied shrimps used in aquaculture.

National Referral Laboratory for Brackishwater Aquatic Animal Diseases (NRLD) at CIBA-playing a crucial role in diagnosis and prevention of exotic aquatic pathogens:

As a National referral laboratory for brackishwater aquatic animal diseases (NRLD), CIBA with its capacity for diagnosing all OIE listed aquatic animal pathogens including emerging pathogens such as Acute Hepatopancreatic Necrosis Disease (AHPND) and Enterocytozoon hepatopenaei (EHP), has addressed several issues in the aquatic animal health sector. The NRLD of CIBA has been providing valuable services to various agencies such as Animal Quarantine and Certification Services, Southern Region (AQCS-SR), Chennai, Aquatic Quarantine Facility (AQF), Rajiv Gandhi Centre for Aquaculture (RGCA), for screening live imported aquaculture organisms such as Artemia cyst, exotic and specific pathogen free (SPF) *P. vannamei* brooders and PLs etc. During the routine random screening of the imported SPF brooders from AQF, SPF shrimp contaminated with IHHNV have been detected and destroyed. Proper procedures have been put in place to upkeep the SPF status of the imported vannamei shrimp.

Indian shrimp farms are free from Trans-boundary diseases: Active surveillance throughout the year across coastal shrimp farms revealed that Indian shrimp aquaculture was free from Trans-boundary diseases such as yellow head disease (YHD), Taura syndrome (TS) and infectious myonecrosis (IMN), and acute hepatopancreatic necrosis disease (AHPND) during 2015-16.

Enterocytozoon hepatopenaei (EHP):

EHP is the second most important disease in Indian shrimp farming. The parasite has been characterized at morphological and molecular levels for the first time in India. Under the CIBA's disease surveillance program, 43.39% of farms showed positive results for the parasite infestation. Of the farms affected with EHP, 34.7% cases were associated with stunted growth, 39.13% with white faeces syndrome (WFS) and 21.7% cases with white muscle syndrome (WMS).

National Consultation on management of EHP:

A one-day national consultation on "Managing Enterocytozoon hepatopenaei (EHP) infections in brackishwater aquaculture in India" was organised on 19th January 2016. Stakeholders from the brackishwater aquaculture sector, representing scientific research institutions, universities, shrimp hatchery operators, shrimp farmers, feed manufacturers, members of Society of Aquaculture Professionals (SAP), Seafood Exporters Association of India (SEAI), officials from the Ministry

of Agriculture, Department of Animal Husbandry Dairying and Fisheries, Coastal Aquaculture Authority, Marine Products Export Development Authority (MPEDA), Rajiv Gandhi Centre for Aquaculture (RGCA) and State Government officials participated in the consultation meeting. An advisory on management of EHP in shrimp farms was brought out for the use of stakeholders, Central and State Governments and other government agencies.

White spot disease continues to be the major concern to shrimp farming:

Active disease surveillance in 141 shrimp farms covering coastal states such as Andhra Pradesh, Tamil Nadu, Gujarat and West Bengal revealed that white spot disease (WSD) remained the major cause of mortalities with 37.5% of the farms suffering mortalities, indicating the need of continued vigilance on the control of WSSV in Indian shrimp farming.

Infectious hypodermal and haematopoietic necrosis (IHHN) in farmed vannamei shrimps:

The IHHNV infection was prevalent in 5% of the 138 farms investigated during April 2015 to March 2016, and majority of them were associated with growth retardation of farmed shrimp. Increased occurrence of this pathogen despite use of SPF stocks is interesting and requires further investigation.

Stunted growth, white faeces syndrome (WFS) and running mortality syndrome (RMS) cause considerable morbidity:

Disease syndromes such as white faeces syndrome (WFS), stunted growth, running mortality syndrome (RMS), white muscle syndrome (WMS) and loose shell syndrome (LSS) have become a serious cause of concern in vannamei farms. These syndromes together cause considerable morbidity and mortality in farms. During 2015-16, stunted growth / growth retardation was recorded in as many as 30.8% of the farms, RMS in 20 %, WFS in 20.8% of the farms and white muscle syndrome in 12.5% of the farms investigated.

Microbial diversity of white faeces (WFS) affected shrimp ponds:

Microbes play a pivotal role in the aquaculture ecosystem. The microbial diversity was examined in healthy and WFS affected shrimp ponds using NGS technology, targeting V3 and V6 regions of bacterial 16S rDNA. Bacteria of the famaily Pseudoaltermonadaacea were found to be dominant in both the healthy and diseased ponds. Whereas bacteria of Flavobacteriaceae were found to be predominant in the healthy ponds. Conversely, the families of Deinococcaceae, Jonesiacea, Vicivallaceae were only found in the disease affected ponds. Critical examination of this information could provide a clue on the role of microbes in the disease process, especially with regard to aquaculture system related diseases such as WFS and RMS.

Zoea II syndrome a matter of concern in P. vannamei hatcheries:

Role of infectious agents, nutritional factors and management practices on the outcome in terms of occurrence of zoea syndrome was investigated. While no viral pathogens could be detected, histopathological studies indicated systemic abnormalities, disintegration of peritrophic membrane, desquamation and detachment of epithelial cells in to the lumen in the middle and posterior intestine. Further etiology if any, or nutritional and genetic factors need to be investigated, to understand the syndrome.

WSSV molecular Diagnostics:

Loop mediated isothermal amplification (LAMP), a highly sensitive diagnostic tool, which can detect as low as 1 fg (femto gram) of WSSV DNA has been developed. A visual detection method of LAMP was developed using indicator dyes such as SYBR Gold and hydroxynaphthol blue to avoid the electrophoresis step, and to make the diagnostics more user friendly.

Vibrio harveyi genome sequenced using NGS:

Vibrio harveyi is a significant pathogen in shrimp hatcheries and grow out ponds. Despite extensive research, a clear understanding on the virulence mechanism of *V. harveyi* is lacking. To characterise the novel virulence factors, a virulent bacterial isolate VH102 was subjected to next generation sequencing (NGS) using Illumina platform. The overall GC content within the VH102 genome was 45.69%. A total number of 59 million reads, with an average read length of 101 bp was generated. Preliminary genome analysis revealed that the VH102 genome contained more than 4800 genes.

Novel Probiotics for shrimp:

The search for novel probiotic microbes possessing diverse functional properties was continued. Based on their antagonistic activity, enzyme production and tolerance to pH and salinity, three bacterial isolates, *Bacillus subtilis*, *B. pumilis* and *B. amyloliqufaciens* were selected as candidate probionts, and mass production protocols were optimized. Formulations of

putative probiotics were prepared and stability of the formulations in terms of viability of bacterial cells was examined. Up-scaling production and testing under hatchery conditions is underway.

Prophylaxis and therapy of white spot disease of shrimp:

Efforts to seek prophylaxis and therapy of WSD were continued. dsRNA for VP28 gene was administered @ 1µg/g 24 hours prior to challenge with WSSV, and was found to be effective in providing protection to shrimp. On the other hand, administration of dsRNA for host defence genes, Rab7, Relish and inhibitor of apoptosis (IAP) to shrimp significantly down regulated immune genes such as crustin, penaeidin, manganese-super oxide dismutase (Mn-SOD) and translationally controlled tumor protein. Acyclovir, an antiviral drug used in human medicine, was found to be ineffective in prevention/control of WSD, when it was applied either through injection or through feed. Effective therapeutic approaches are therefore yet to be developed.

Biosafety of oxytetracycline in Penaeus vannamei

Persistence in aquatic sediments and biosafety of oxytetracycline (OTC) for *P. vannamei* were examined. Studies indicated that soil type and water salinity had bearing on the persistence of OTC residues in the aquatic sediments. OTC was found to be safe to shrimp even at 4X advocated dose.

Green House gas (GHG) emission higher at backwaters:

GHG emission from different coastal ecosystems viz. Pichavaram mangrove, Muttukadu backwater and Buckingham canal near Mamallapuram were studied. Buckingham canal and Pichavaram mangrove ecosystems with semi-intensive shrimp aquaculture had less impact on GHG emission compared to Muttukadu backwater. Higher GHG emission at Muttukadu backwater could be attributed to pollution from industries, sewage inflow etc. Mangrove ecosystem had the highest sediment total carbon of 28.34 Mg ha^{-1}, which was three times higher than that of the other two systems.

Sulfate reduction and methane emission high in sediments with redox potential of > -200 mV:

Sulfate reduction in aquaculture ponds is one of the key processes in anoxic sediments during which toxic hydrogen sulfide is produced and this process is influenced by pH and salinity. Highest sulfate reduction was observed in pH 8 and pH 6. Production of sulfide was observed to be very rapid in all salinities and highest sulfate reduction. Effect of pond deteriorating condition as indicated by redox potential on methanogenesis and sulphide formation showed that sulfate reduction was maximum at -200 mV in 30 ppt salinity, whereas high methane levels were observed in -200 mV in low saline (5 ppt) environment.

Sediment-water interface (SWI) plays an important role in the quality of aquaculture environment:

SWI was characterised in shrimp ponds with various salinities and stocking densities. Salinity of pond water had marked influence on the nitrate, nitrite, phosphate, alkalinity and hardness in water. Organic carbon, total ammonia nitrogen (TAN), nitrite N and total bacterial count were high at SWI in ponds with high stocking densities. High pH and TAN influenced immunological parameters in shrimp and also the mineral profile and water quality.

Biochar from aquaculture pond sludge for carbon sequestration:

Efforts were made to decrease the nutrient load in discharge waters of aqua farms using adsorbent materials. The synthesised aluminum pillared bentonite was effective in reducing the phosphorus load from discharge waters of different salinities; however, its sorption capacity decreased with the increasing salinity. As a measure of carbon sequestration, biochar prepared from the organic rich aquaculture pond sludge was magnetised by coating with iron oxide and this was found to enhance the phosphorus sorption capacity of biochar.

Na-EDTA accelerates dissolved oxygen release from products:

Efforts on enhancing the efficiency of dissolved oxygen (DO) releasing products viz., calcium peroxide, sodium percarbonate and sodium perborate showed that Na-EDTA salt was effective in enhancing the stability of these products. Addition of tetra acetyl ethylene diamine as activator was found to increase the rate of DO release.

Commercial mineral products vary in mineral releasing efficiency:

The performance of *P. vannamei* culture in low saline/freshwater systems was evaluated in farms at Thanjavur in TN, Bhimavaram and Gudivada in AP vis a vis mineral profiles of culture water. Farms in Thanjavur showed better performance compared to the other two areas. Mineral profile in source waters in these farms showed wide variations in the concentration of major ions such as sodium, potassium, calcium and magnesium, and the ionic ratios deviated significantly

compared to seawater. Evaluation of four commercial mineral products showed non-uniformity in the mineral releasing efficiency in different saline waters.

CIBA-CBAK water quality kit performs better than the commercial kits:

Portable and sensitive water analysis kits/sensors are essential for the measurement of water parameters on the pond site. One of the reagents of the DO kit developed earlier at CIBA was unstable, and a modification with the addition of a stabiliser improved its stability for more than eight months. A carbonate, bicarbonate and total alkalinity kit (CIBA-CBAK) was developed at CIBA and was found to be superior to the commercial kits.

Environmental impact assessment (EIA) of crab farming study indicated no adverse impact on the environment:

Environmental impact assessment (EIA) and monitoring programmes are necessary for sustainability of brackishwater aquaculture. Primary and secondary data on environmental and socio-economic parameters collected pertaining to five crab culture pens and three ponds for EIA, and three creeks Achara, Naringre and Mandavi for carrying out capacity assessment in Malvan, Davgad and Vengurla coastal taluks of Sindhudurg District, Maharashtra indicated no negative impact of crab farming on the environment. In another such study, examination of the database on seasonal variation in Muttukkadu backwaters throughout the year indicated no negative impact of activities at Muttukadu Experimental Station of CIBA on the backwater quality.

Deluge during November–December 2015 in Nellore causes loss to the tune of Rs.2000 crores:

Impact of climate change and extreme climatic events on shrimp aquaculture was documented. As a consequence of the deluge during November–December 2015 in Nellore District, AP, about 12000 acres of shrimp culture ponds were inundated, infrastructure and machinery was damaged and standing stock was lost, amounting to a total loss of about Rs.2000 crores.

Attracting and Retaining Youth in Agriculture ARYA:

The ARYA programme was implemented in schools in and around Chennai from both rural and urban areas. Field trainings and visit to CIBA research facilities were organized for the school children on 'Open Day' and literature on brackishwater aquaculture was distributed. Awareness was created on brackishwater aquaculture among the students from universities and colleges. The youth were introduced to subjects such as fish farming, shrimp farming, manufacturing of feeds and mud crab farming, which made them enthused about taking up fish and shrimp farming as their career.

Mera Gaon Mera Gaurav (MGMG) programme launched:

Under the MGMG programme, nursery rearing of Asian seabass carried out in hapas by the fisher youth in an open water system indicated that this intervention seems to be a viable alternative livelihood for the unemployed youth.

Quality seed and technology support required in the west coast states:

An inter-state analysis of aquaculture development revealed that the west coast states needed additional attention in terms of quality seed and technology support to reap the benefits of *P. vannamei* introduction.

Community and family participation in supplementary revenue generation with mud crab and Asian seabass farming:

Success stories were documented from the polyculture demonstration of mud crab (*Scylla serrata*) and the Asian seabass (*Lates calcarifer*) in a community pond located in the Irular tribal village, Kulathumedu, Tiruvallur district of Tamil Nadu, supported by ICAR-CIBA under the Tribal Sub Plan. This intervention proved to be a viable model of supplementary revenue generation portraying the community and family participation in adoption of brackishwater aquaculture technologies in common water bodies.

Technology dissemination through "Phone in Programme" (PiP):

was conducted in collaboration with the M. S. Swaminathan Research Foundation, based on the needs and queries of participants via audio conferencing facility. Over 120 queries raised by 117 fish farmers from different parts of Tamil Nadu and Puducherry were documented on the subject of "Seabass Culture and its Farm Management Practices". This study also analysed the perception of the participants, strengths, weakness, opportunities and threats towards PiP, and the problems specific to information gaps in seabass culture and management. The findings revealed that 72% of the participants showed highly favourable perception towards this programme.

ICT aided Fuzzy decision support system developed:

ICT aided empowerment assessment tool comprising of five factors viz., social, political, psychological, technical and economic was developed and tested for analysing the various ICT project participants' experiences. The results revealed that except for political empowerment, all other factors are visible among the users of ICT projects. ICT aided Fuzzy decision support system was developed and tested with 'aqua choupal' model in West Godavari and East Godavari districts, Andhra Pradesh, India, to assess the change in service quality in aquaculture marketing as a result of the e-marketing system. The evaluation highlighted that fuzzy system receives higher priority (71%) compared with analytical hierarchy method (64%) of weights. This shows that Fuzzy system is suitable for evaluating the e-marketing system in aquaculture.

CIBAproBASE for digitalising the institute research projects:

In an attempt to digitalise the institute research project proposals right from their inception stage, a web-based repository called CIBAproBASE has been developed. All the Research Project Proposals of the institute have been digitised and uploaded into the system. Attempts were also made to develop a geoportal using open source Geoserver. The institute webpage has been redesigned using Drupal content management system. Development of a digital repository of the institute publications has also been undertaken in the current year.

Training Programmes conducted for Aquafarmers and State Government officials:

Central Institute of Brackishwater Aquaculture organised sixteen training programs for stakeholders of the brackishwater aquaculture sectors such as farmers, feed operators, field technicians, fisheries graduates, state and central government officials. These were attended by more than 250 participants. The trainings were organised on various aspects of brackishwater culture practices such as hatchery operation, fish seed production, crab, shrimp and seabass culture. A full hands-on training was provided to trainees on the aspects of diagnostics and health management, biotechnology, feed production, and soil and water quality analysis. During 2015-16, CIBA also imparted training to six newly joined ARS scientists from sister ICAR institutes under their professional attachment training programme. To especially cater to the needs of West Bengal and Orissa, CIBA Kakdwip Research Centre organised five training programs which was well attended by 57 trainees. Under the co-operation between India & Sultanate of Oman in the field of agriculture research,training in brackishwater aquaculture was imparted to two scientists from Sultanate of Oman.

CIBA Scientific, Technical, Administrative and Support staff underwent Training:

During 2015-16, 11 scientific, 2 technical, 1 administrative and 1 support staff from CIBA attended training in their respective areas to further improve their work efficiency★★★

Introduction

Aquaculture or aquatic agriculture has emerged as the only choice in the increase of fish production to meet the growing demand for food and protein due to increasing per capita consumption and stagnated wild fish catch. Brackishwater aquaculture is a rapidly growing enterprising agribusiness in coastal areas of India, contributing to employment generation, poverty alleviation, community development and food security and to the export. In brackishwater farming, footprint of fish production on potable water is zero, therefore much of the expansion in aquaculture is expected to occur in these environments. Also in the climate change scenario of sea level rise, the inundated area could be utilized for brackishwater aquaculture. Brackishwater ecosystems are diverse and productive with unique group of biological diversity. Out of total 3.9 million hectares of estimated estuarine area, 1.2 million hectares of coastal saline lands have been identified to be potentially suitable for brackish water farming. In addition, about 9 million hectares of salt–affected lands were assessed in the hot semi-arid and arid eco-region of northern plains and central high lands in the states of Haryana, Rajasthan, Uttar Pradesh, Maharashtra and Gujarat with surface and sub-soil saline water. Suitable areas from these regions needs to be graphed evaluated and tried for aquaculture purpose, and it will add to the existing potential.

Despite several challenges like natural disasters, disease outbreaks, volatile export market, increasing production cost, shrimp farming continues to be the major farmed species in brackishwater in quantity and value. Farming of finfishes such as seabass, milkfish and pearlspot gained a notable impetus and given options in farming and imparted confidence to the coastal farmers. Recent CIBA's achievement in breeding the milkfish for the first time in India in captivity has given a considerable hope to the farmers due to the herbivorous nature and cost effective production. Standardisation of breeding protocols for fishes such as pearlspot and long whiskered catfish under captive conditions attracted many stakeholders for monoculture as well as in Integrated Multitrophic Aquaculture (IMTA) models. It is believed that long expected grey mullet breeding in India will add more to it. Brackishwater aquaria is an emerging element within the fishkeeping hobby. Indian brackishwater systems are treasure of popular ornamental fishes such as chromides, mono angel, scats, puffers, gobies, flatfish, tiger perch, glassy perch let and gar. CIBA has standardised the breeding and larval rearing of important ornamental fishes such as mono angel and scats, and continue working on other species.

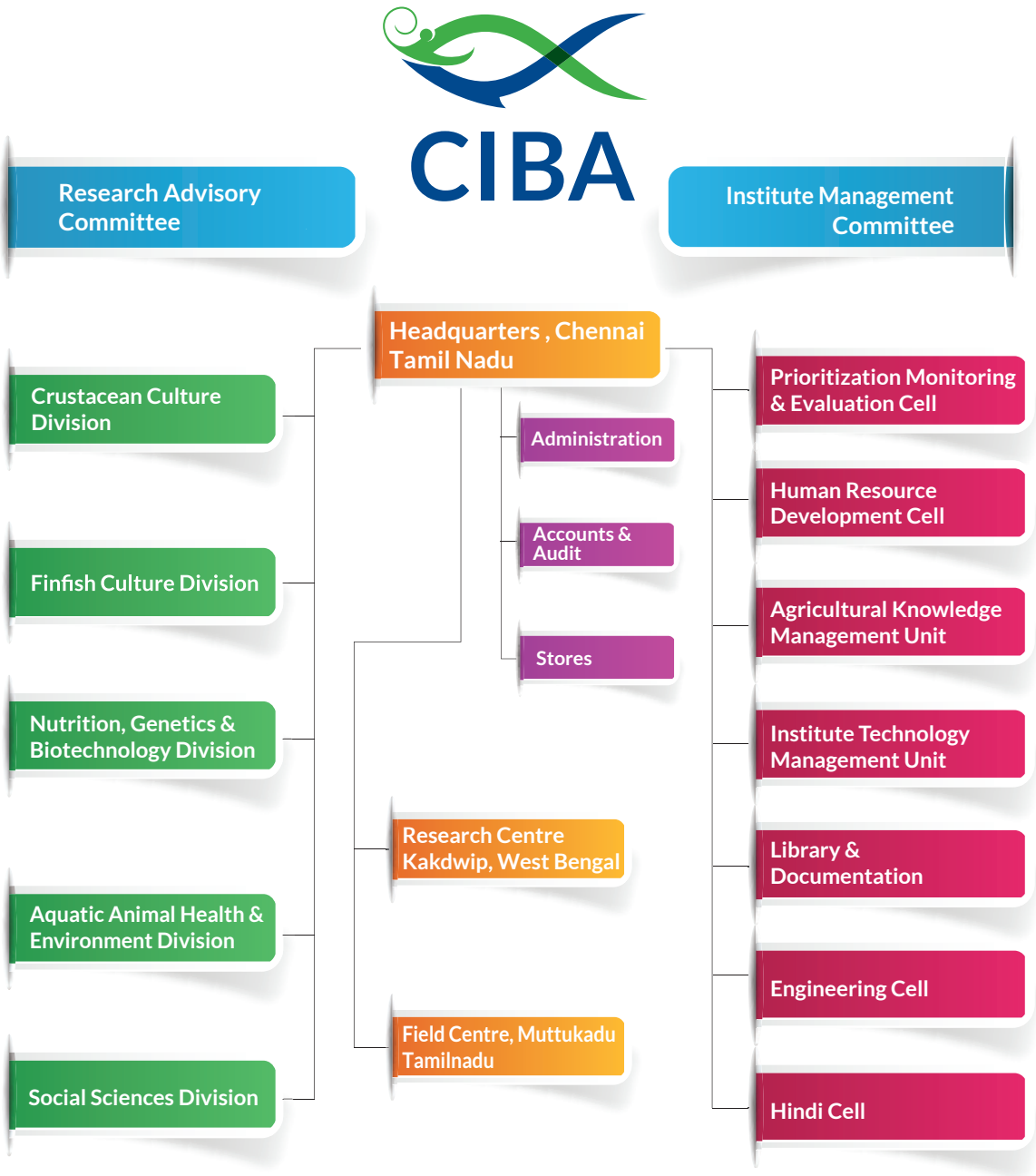
ICAR-CIBA as a nodal research and development agency to develop the brackishwater aquaculture in this country, not only developing technology for producing seeds of candidate species, but also engaged in issues related to environment, cost effective feed production, farm and hatchery construction, disease diagnosis, monitoring and advocating remedies and social research etc. After playing crucial role in the introduction of exotic *P. vannamei* to Indian shrimp farming, CIBA understand the risk of complete dependence of the sector entirely on imported broodstock. As futuristic alternate strategy, CIBA has identified native Indian white shrimp, *P. indicus* as candidate species for research

initiatives in the direction of stock improvement through selective breeding. CIBA envisaging to take up a selective breeding program on consortium mode with public private partnership mode as flagship program for the sector. Besides production oriented research, CIBA also undertake research to preserve the valuable natural resources like land, water and energy, to have more sustainable, eco- friendly and socio-economically viable brackishwater aquaculture in this country.

CIBA being headquartered in Chennai, has a field station at Muttukadu, about 30 km south of Chennai and a Research Centre at Kakdwip in West Bengal. The research programs of the Institute are diverse in nature, which were carried out under 11 in-house and 22 externally funded projects during 2015-16. The institute has prioritized research programs to fit in to the scope of its preconceived 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 repository of information on brackishwater fishery resources with a systematic database.
- Human Resource Development, capacity building and skill development through training, education and extension.

Organisation Chart



Financial Statement: 2015-16

(₹ in lakhs)

Sub-Head	BE	RE	Actual Expenditure
PLAN			
Travelling Expenses	35.00	15.00	14.99
HRD	11.00	12.00	12
Contingency	336.00	376.50	376.5
Works	207.00	250.00	250
Equipment	80.00	80.00	80
Information Technology	30.00	25.00	25
Vehicles & Vessels	0.00	0.00	0
Miscellaneous expenses	6.00	6.50	6.49
Library	20.00	20.00	20
Furniture & Fixtures	35.00	15.00	14.97
TSP	20.00	58.00	57.95
Total	**780.00**	**858.00**	**857.9**
NON-PLAN			
Equipment	2.00	3.50	3.50
Vehicles & Vessels	0.00	0.00	0.00
Furniture & Fixtures	1.00	1.50	1.50
Establishment	1280.00	1369.40	1330.03
O.T.A	0.20	0.20	0.00
Travelling Allowance	8.00	9.00	9.00
Research & Operational	17.00	20.38	20.38
Administrative Expenses	172.50	619.60	619.59
Miscellaneous	2.30	2.76	2.76
Sub Total	**1483.00**	**2026.34**	**1986.76**
Pension	900.00	1052.00	1051.36
Loans & Advances	7.00	6.93	6.93
Total	**2390.00**	**3085.27**	**3045.05**

Revenue Generation: 2015-16

Year	Revenue Receipts (in lakhs)
2015-16	**92.61**

Official Language Implementation Programme

Official Language Implementation Committee meetings were held on 05.10.2015, 05.01.2016 and 24.03.2016 during the year 2015-16. Usage of Hindi in official correspondences, bilingual use of Hindi and English in files, publications in Hindi were reviewed in these meetings. Hindi week was celebrated at the Headquarters during between 14th and 19thSeptember, 2015. Competitions in Hindi Noting and Drafting, Hindi Geet/Kavita path (Poem Recital), Hindi Prasnothari were held on 15th, 16th and 18thSeptember, 2015 respectively. Hindi Day (Diwas) was held on 19thSeptember, 2015. Hindi week celebrations were held at KRC of CIBA, Kakdwip also. Prizes were distributed to the winners of the Hindi Noting and Drafting, Hindi Geet / Kavita Path, Hindi Prasnothari competitions by the Director. A guest lecture on "Official Language Implementation" was delivered by Shri. R. Gyanasekar, Deputy Director, Census Operations during the event. The Hindi Day celebrations were co-ordinated by Dr. M. S. Shekhar, Principal Scientist & Member-Secretary, OLIC. Cash Awards have been handed over to three prize winners of CIBA from Special Cash Incentive Scheme for the year 2014-15.

Shri. R. Gyanasekar, Deputy Director, Census operations releasing the Hindi magazine on brackishwater aquaculture (Jal Tarang)

Staff Position

Category	Sanctioned	Filled	Vacant
RMP/Director	1	1	Nil
HOD/Principal Scientist	5	3	2
Senior Scientist	10	7	3
Scientist	52	42	10
Total	68	53	15
T-4	1	1	0
T-3	14	11	3
T-1	16	12	4
Total	**31**	**24**	7
Administrative Officer	1	1	0
Finance & Accounts officer	1	0	1
Deputy Director (OL)	1	0	1
Asst. Administrative Officer	3	3	0
Junior Accounts Officer	1	1	0
Private Secretary	1	1	0
Personal Assistant	2	2	0
Stenographer Grade – III	1	2*	*1 excess
Assistants	7	5	2
Upper Division Clerk	3	3	0
Lower Division Clerk	5	4	1
Total	**26**	**22***	5
Skilled Support Staff	55	27	28

***The details of sanctioned, filled and vacant position as on 31.03.2016**

On-going research projects

Crustacean Culture Division

Sl. No.	Project Title	Funding	Project Team
	Institute Funded Projects		
1	Technology up gradation and refinement for sustainable development of diversified systems and species of penaeid shrimp	ICAR-CIBA	PI: Dr. C. Gopal Co-PIs: Dr. K.V. Rajendran, Dr. M. Jayanthi, Dr. C.P. Balasubramanian, Dr. A. Panigrahi, Dr. P. Nila Rekha, Dr. S. Kannappan, Dr. P. Shyne Anand, Ms. L. Christina, Dr.M. Muralidhar, Dr. T.K. Ghoshal, Dr. D.D. Vimala, Dr. M. Kumaran, Dr.R.Saraswathi, Dr. K. Ambasankar, Dr. J. Syama Dayal, Dr. Sanjoy Das, Shri K.P. Sandeep, Dr. S. Sivagnanam, Shri S. Rajamanickam
2	Issues in biology, reproduction, larval rearing of candidate crustacean species for brackishwater aquaculture	ICAR-CIBA	PI: Dr. C.P. Balasubramanian Co-PIs: Dr. C. Gopal, Dr. K.V. Rajendran, Dr. M. Jayanthi, Dr. A. Panigrahi, Dr.S. Kannappan, Dr. P. Nila Rekha, Dr. P. Shyne Anand
3	Demonstration of improved culture technologies in shellfish and finfish aquaculture and TSP programmes in Gujarat	ICAR-CIBA	PI: Dr. C. Gopal Co-PIs: Dr. M. Kailasam, Dr. M.Muralidhar, Dr. P.K. Patil, Dr. P.Mahalakshmi, Shri Aritra Bera
	Externally Funded Projects		
4	Technology refinement of nutrient dense nursery rearing of grow-out of L. vannamei in periphyton and biofloc based systems	National Fisheries Development Board	PI: Dr. A. Panigrahi Co-PIs: Dr. C. Gopal, Dr J. Syama Dayal, Dr R.Saraswathy, Dr Shyne Anand

5	Upgradation of breeding and culture technology of Indian white shrimp *Fenneropenaeus indicus* through stock evaluation and culture demonstration	National Fisheries Development Board	PI: Dr. A. Panigrahi Co-PIs: Dr. G. Gopikrishna, Dr. C. Gopal, Dr. S. Kannappan, Dr. Kumaraguru Vasagam, Dr. P. Mahalakshmi, Dr. K.Vinaya Kumar, Dr. Shyne Anand, Ms. L. Christina
6	Development of integrated multitrophic aquaculture systems in Sindhudurg District, Maharashtra	Ministry of Environment and Forest, Govt. of India	PI: Dr C.P. Balasubramanian *Co-PIs:* Dr. K.K. Vijayan, Dr. A. Panigrahi, Dr. K. P. Kumaraguru Vasagam, Dr. Krishna Sukumaran, Dr. P. Kumararaja
7	Seaweeds for bioremediation in recirculatory aquaculture system	Department of Science and Technology, Govt. of India	PI: Dr. P. Nila Rekha Co-PIs: Dr. K. Ambasankar, Dr. Akashaya Panigraghi, Dr. Kumaraguru

Finfish Culture Division

Sl. No.	Project Title	Funding	Project Team
	Institute Funded Projects		
1	Evaluation of reproductive biology, breeding, larval biology and seed production of candidate finfish species for brackishwater aquaculture development	ICAR-CIBA	PI: Dr. M. Kailasam *Co-PIs:* Dr.M. Makesh, Dr. Satyanarayana Sethi, Dr. Krishna Sukumaran, Dr.G. Biswas, Dr. Premkumar, Shri Aritra Bera, Ms. Babita Mandal, Smt.M.U. Rekha, Dr. K. Ambasankar, Dr. Sherly Tomy, Dr. P. Kumararaja, Shri. K.P. Sandeep, Dr. T.K. Ghoshal, Shri R. Subburaj
2	Development and refinement of finfish culture technologies for sustainable brackishwater aquaculture development	ICAR-CIBA	PI: Dr. M. Makesh *Co-PIs:* Dr. M. Kailasam, Dr. Satyanarayana Sethi, Dr.Krishnan Sukumaran, Dr. G. Biswas, Dr. Prem Kumar, Shri Aritra Bera, Ms. Babita Mandal, Smt. M.U. Rekha, Dr. K. Ambasankar, Dr. P. Kumararaja, Dr. T.K. Ghoshal, Shri R. Subburaj

Aquatic Animal Health and Environment Division

Sl. No.	Project Title	Funding	Project Team
	Institute Funded Projects		
1	Invertebrate and finfish diseases in brackishwater aquaculture and development of prophylactic and therapeutic strategies	ICAR-CIBA	PI: Dr. S.V. Alavandi Co-PIs: Dr.K.K. Vijayan, Shri Joseph Sahaya Rajan, Shri T. Sathish Kumar, Smt. Vidya Rajendran, Dr. T. Bhuvaneswari, Dr. P. Ezhil Praveena, Dr. S. K. Otta, Dr. Satheesha Avunje, Dr.P.K.Patil, Dr.K.P.Jithendran, Dr. M. Poornima, Dr. Sanjoy Das
2	Development of water and soil health card for environmental management for brackishwater aquaculture systems	ICAR-CIBA	PI: Dr. M. Muralidhar Co-PIs: Dr.R.Saraswathy, Dr. N. Lalitha, Dr. P. Kumararaja
	Externally Funded Projects		
3	Defense genes of tiger shrimp (*Penaeus monodon*) with respect to bacteria (*Vibrio harveyi*) and white spot syndrome virus (WSSV) infection	National Fund for Basic, Strategic and Frontier Application Research in Agriculture (NFBSFARA), ICAR	PI: Dr. Subhendu Kumar Otta Co-PIs: Dr. K.P. Jithendran, Dr. T. Bhuvaneswari
4	Identification of etiology of monodon slow growth syndrome (MSGS) of black tiger shrimp in India and development of rapid diagnostic tools	Department of Biotechnology (DBT), Govt. of India	PI: Dr. M. Poornima Co-PIs: Dr.S.V.Alavandi, Dr. P. Mahalakshmi
5	Development of white spot syndrome virus free shrimp brooders for seed production: using indigeneous shrimp, *Penaeus indicus* as a model (Collaborating centre: C. Abdul Hakeem College, Vellore)	Department of Biotechnology (DBT), Govt. of India	PI: Dr. Subhendu Kumar Otta *Co-PIs:* Dr. A. Panigrahi, Dr. P. Ezhil Praveena
6	National surveillance programme for aquatic animal diseases (Lead centre: NBFGR (ICAR), Lucknow)	National Fisheries Development Board	PI: Dr.S.V. Alavandi *Co-PIs:* Dr. K.K. Vijayan, Dr. K.P. Jithendran, Dr. M. Poornima, Dr. Sanjoy Das, Dr. P. Ezhil Praveena, Dr.T. Bhuvaneswari, Smt. Vidya Rajendran, Shri T. Sathish Kumar
7	All India Network Project on Fish Health	Indian Council of Agricultural Research (ICAR)	National Coordinator: Dr.K.K. Vijayan PI: Dr.P.K. Patil *Co-PIs:* Dr.S.V. Alavandi, Dr.K.P. Jithendran, Dr.S.K. Otta, Dr. Sanjoy Das, Dr. T. Bhuvaneswari, Dr. Satheesha Avunje, Dr. M. Makesh, Dr. M. Muralidhar, Dr.R. Saraswati, Dr. N. Lalitha, Dr. P. Kumara Raja, Dr. B. Sivamani, Dr. T. Ravisankar, Shri J. Ashok Kumar

8	Consortia Research Platform on Vaccines and Diagnostics (Fisheries Sector)	Indian Council of Agricultural Research (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
	b. Development of vaccine for betanoda virus infecting seabass, *Lates calcarifer*		PI: Dr. (Smt.) M. Poornima Co-PIs: Dr. P.K. Patil, Dr.M. Makesh, Dr.K.P. Jithendran
	c. Biocontrol of vibrios in shrimp hatcheries using bacteriophages		PI: Dr.S.V. Alavandi Co-PIs: Dr. Satheesha Avunje, Smt. Vidya Rajendran
	d. Development of probiotics and immunostimulants for shrimp		PI: Dr. P.K. Patil Co-PIs: Dr. K.K. Vijayan, Dr. S.V. Alavandi, Dr. Satheesha Avunje Dr. T. Bhuvaneswari
	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. Sathish Kumar, Smt. Vidya Rajendran
9	National Initiatives on Climate Resilient Agriculture (NICRA) – Impact of climate change on aquaculture and mitigation options for minimizing green house gases from aquaculture sector (Lead Centre: Central Research Institute for Dryland Agriculture, Hyderabad)	Indian Council of Agricultural Research (ICAR)	PI: Dr.M.Muralidhar *Co-PIs:* Dr.M.Jayanthi, Dr.J.Syama Dayal, Dr. A.Panigrahi, Dr.M.Kumaran, Dr. R.Saraswathy, Shri J.Ashok Kumar, Dr. N.Lalitha, Dr.K. Vinay Kumar, Shri P. Kumararaja and Dr.A.Nagavel
10	Environmental impact assessment of of mangrove crab (*Scylla serrata*) farming in the coastal villages of Sindhudurg District, Maharastra and carrying capacity assessment of creeks for crab farming	UNDP-GEF funded through Mangrove Cell, Maharashtra	PI: Dr.M.Muralidhar *Co-PIs:* Dr.C.P.Balasubramanian, Dr.M.Jayanthi, Dr.P.Kumararaja, Dr.A.Nagavel

Nutrition, Genetics and Biotechnology Division

Sl. No.	Project Title	Funding	Project Team
	Institute Funded Projects		
1	Biotechnological interventions and application of bioinformatics tools for improvement of brackishwater fish and shellfish	ICAR-CIBA	PI: Dr.G.Gopikrishna *Co-PIs:* Dr.K.K. Vijayan, Dr. M.S. Shekhar, Dr.Sherly Tomy, Dr.K.Vinaya Kumar, Dr. B.Sivamani, Shri Aritra Bera, Dr. (Smt.) Krishna Sukumaran, Ms. Babita Mandal, Smt. Vidya Rajendran, Shri K.P. Sandeep, Dr. M. Makesh, Dr. C.P. Balasubramanian, Dr. K.V. Rajendran, Dr. M. Kailasam, Dr. Satyanarayana Sethi, Smt. M.U. Rekha
2	Newer feed resources and feed additives for development and improvement of shrimp and fish feeds	ICAR-CIBA	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, Dr.(Smt.) Shyne Anand, Ms. Babita Mandal
	Externally Funded Projects		
3	Outreach activity on fish feed	Indian Council of Agricultural Research (ICAR)	PI: Dr.K. Ambasankar *Co-PIs:* Dr.J. Syama Dayal, Dr. T.K. Ghoshal, Dr. Debasis De, Dr. K.P. Kumaraguru Vasagam, Dr.(Smt.) P. Nila Rekha
4	Outreach activity on nutrient profiling and evaluation of fish as a dietary component (Lead Centre: CIFRI, Barrackpore)	Indian Council of Agricultural Research (ICAR)	PI: Dr.J.Syama Dayal
5	Outreach activity on fish genetic stocks (Lead Centre: NBFGR, Lucknow)	Indian Council of Agricultural Research (ICAR)	PI: Dr.G.Gopikrishna *Co-PIs:* Dr. M.S. Shekhar, Dr. C.P. Balasubramanian, Dr.K.Vinaya Kumar, Dr.B. Sivamani, Dr. Krishna Sukumaran
6	Assessment of productivity and variation in nutritional characteristics of bio-floc a sustainable feed for farmed aquatic animals	Department of Science and Technology, Govt. of India	PI: Dr. K.P. Kumaraguru Vasagam *Co-PIs:* Dr. K. Ambasankar, Dr. J. Syama Dayal
7	Molecular mechanisms of gonad inhibiting hormone action on the control of egg maturation in the penaeid shrimp	Department of Biotechnology, Govt. of India	PI: Dr. Sherly Tomy *Co-PIs:* Dr. S.K. Otta, Dr. C.P. Balasubramanian and Prof. T. Subramoniam
8	Whole genome sequencing of Indian white shrimp *Penaeus indicus*	Indian Council of Agricultural Research (ICAR)	PI: Dr. M.S.Shekhar *Co-PIs:* Dr. G. Gopikrishna, Dr. K. Vinaya Kumar, Shri J. Ashok Kumar, Dr. C. P. Balasubramanian, Dr. S.K. Otta, Dr. M. Makesh, Dr. Santhosh J. Eapen

Social Sciences Division

Sl. No.	Project Title	Funding	Project Team
	Institute Funded Project		
1	Research and development interventions for sustainable brackishwater aquaculture	ICAR-CIBA	PI: Dr.V.S.Chandrasekaran *Co-PIs:* Dr.T.Ravisankar, Dr.B.Shanthi, Dr.D.Deboral Vimala, Dr.M.Kumaran, Dr. P.Mahalakshmi, Shri J. Ashok Kumar
	Externally Funded Project		
2	Network project on agricultural bioinformatics and computational biology	ICAR	PI: Shri J. Ashok Kumar *Co-PIs:* Dr. S.V. Alavandi, Dr. K. Vinaya Kumar, Dr. B. Sivamani, Dr. Satheesha Avunje, Dr. Monendra Grover

Kakdwip Research Centre

Sl. No.	Project Title	Funding	Project Team
	Institute Funded Project		
1	Development of economically viable and sustainable brackishwater aquaculture practices with special reference to Sundarban Mangrove biosphere and Chilka, Odisha	ICAR-CIBA	PI: Dr.T.K. Ghoshal *Co-PIs:* Dr. T.K. Ghoshal, Dr. Debasis De, Dr. Sanjoy Das, Dr. G. Biswas, Dr. Prem Kumar, Ms. L. Christina
	Externally Funded Project		
2	Stock characterization, captive breeding, seed production and culture of hilsa (*Tenualosa ilisha*)	National Fund for Basic, Strategic and Frontier Application Research in Agriculture (NFBSFARA), ICAR	PI: Dr. Debasis De *Co-PIs:* Dr. P.S. Shyne Anand

Others

Sl. No.	Project Title	Funding	Project Team
	Externally Funded Projects		
1	Agri-Business Incubation centre (ABI) at CIBA, Chennai	XIIth plan scheme 'National Agricultural Innovation Fund' (NAIF)	PI: Dr. T. Ravisankar *Co-PIs:* Dr.P.K.Patil
2	Intellectual property Management and Transfer/ Commercialization of Agricultural Technology Scheme (Up-scaling of existing components i.e. Intellectual property Right (IPR)	XIIth plan scheme 'National Agricultural Innovation Fund' (NAIF)	PI: Dr. T. Ravisankar *Co-PIs:* Dr.P.K.Patil

Research Highlights

Brackishwater production system research

Nurserry rearing of seabass in hapas at Garraladdibba village, Krishna dist. Andhra Pradesh

Brackishwater Production System Research

Brackishwater aquaculture production system has been one of the most vibrant and dynamic food production system both nationally and globally. Brackishwater ecosystem is a subset of coastal ecosystem, and has been exploiting for fisheries and aquaculture since time immemorial., Scientific brackishwater aquaculture, however, started recently. This new production system undergoes rapid changes since its inception in response to disease issues, shifts in species preference, environmental impacts etc. Institute research addresses these issues and formulated projects in this direction.

Low volume cage culture of Asian seabass- a promising livelihood model

Diversification of aquaculture systems is fundamental to provide access to a larger number of farmers to support their livelihood through aquaculture. Aqua farmers have access to different kinds of water resources. Cage culture of finfish is a potential opportunity for fishermen or farmers with access to open waters to adopt aquaculture as a livelihood option. Cage culture was initiated with farmers' participation at Chalakudy Puzha (Trissur, Kerala). Floating low volume cages (2.0 X 2.0 X 2.0 m) were stocked with 800 no of seabass fingerlings per cage, initial wt- 8- 10 g. Fish were fed trash fish at 5% per day, cost- ₹ 30 per kg. Animals were graded into three compartments after 3 months when seabass reached ~100g. After culture duration of 10 months, seabass reached a final weight of 500g- 1.5 kg with a production of 475 kg and a survival of 81%. The productivity from the cage system was 19.8 kg/m^3, and the cost of production from the cage system was ₹ 220/kg. The revenue generated was 1.9 lakh from the cage culture activity and the net profit gained by the farmers was ₹85,000/- . The results demonstrate the low volume cage culture models are ideal for livelihood generation for small farmers with access to open water resources.

The first haul of Asian seabass after 10 months of cage culture with farmers participation at Trissur, Kerala

Finfish polyculture: Farmers'participatory approach and novel initiative at fish marketing

A total of 600 milkfish seed, average weight of 1.53 g and 500 pearlspot, 0.82 g body weight were stocked in a 700 m^2 earthen pond. Fishes were fed with formulated feed prepared by CIBA at 3–4% on daily basis. Periodical manuring with cow dung was done throughout the culture period. After 264 days of culture. A total production of 222.80 kg constituting of 196.5 kg of milkfish and 26.3 kg of pearlspot were harvested with an estimated productivity of 3.2 t/ha. The average size of harvested milkfish and pearlspot was 340 g and114 g respectively. In a novel initiative at marketing, the harvested milkfish and pearlspot were marketed at Paravoor fish market, Ernakulam through open auction at Rs. 200/kg and Rs. 380/kg, respectively. The fish were transported by rail in chilled condition in ice boxes and taken to Paravor fish market and marketed via auction on weight basis. The entire quantity of fish 145 kg milkfish and 6 kg pearlspot taken to the market was absorbed in a short duration of 30 minutes. In case, the entire quantity could not be absorbed, the option to market in the neighbouring market was kept open. Milkfish fetched an average price of Rs 200- 220 per kg and pearlspot fetched an average price of Rs 380 per kg. Auction charges were 10% of the total cost, thus a total amount of Rs 28,338.00 was generated from the auction. This model can be adopted by fish farmers to market fish species with a regional preference(eg. milkfish and pearlspot) to get a good price for their produce.

Species diversification among the rural youth of Garraladdibba village, Krishna dist. Andhra Pradesh

Satellite nursery rearing technology to produce stockable sized fry/ fingerlings from larvae of Asian seabass *L. calcarifer* is being promoted among the farmers in different states to act as bridges between hatchery and grow-out ponds. In this context, efforts were made to impart the seabass nursery rearing technology among the farmers in Andhra Pradesh, Tamil Nadu, Odisha, West Bengal, Karnataka, Kerala, Maharashtra and Gujarat. After successful demonstrations, many success stories on Asian seabass farming were observed from the farmers following the CIBA technology. The farmers who have obtained the seabass seed from CIBA have been successfully practicing seabass nursery rearing in their farms by adopting the technology developed by the CIBA.

Rural youth involved in satellite seabass nursery rearing at Garraladdibba village, Krishna dist. Andhra Pradesh

Adoption of seabass nursery rearing by the village youth has turned the Garraladdibba village, Krishna district, Andhra Pradesh into a hub of seabass nursery rearing. Nursery rearing of seabass is the main livelihood option for many fisher folk in the village. About 700 people live in this village and almost 300 farmers has been practicing seabass nursery rearing and pre-grow out culture in about 400 acres. The farmers initiated seabass nursery rearing in this village way back during 2008 with small area of 50 acres using seabass seed provided by ICAR-CIBA as well as wild seeds. The seabass farming area has now increased to 400 acres. Farmers use wild zooplankton as feed for the juveniles. The Institute aims to increase the seabass nursery rearing years for augmenting seabass production and supporting brackishwater species diversification area to 1000 acres in the forthcoming years.

Optimizing the stocking density of Asian seabass during hapa based nursery rearing in ponds

Survival and growth of juveniles of Asian seabass in nursery rearing system largely depends on the stocking density, quality of feed and feed management. Therefore, in order to evaluate the effect of stocking density on nursery rearing performance of Asian seabass fry an experiment was carried out at three densities (250, 500 and 750 nos./m3) in KRC pond production system. Further, a semi-moist feed prepared from locally available ingredients (CP- 38%) was also evaluated in this trial. Feed was provided @ 20-12% of fish biomass daily (in two rations) in dough form in a feed tray submerged in the water column of each net cage. After 60 days, fingerlings were harvested. Although, a significantly higher ($p<0.05$) survival of 71% was achieved at the lowest density rearing compared to 53% in 500 no./m3 and 45% in 750 nos./m3, the best growth (364 mm/ 492 mg) of fingerlings was observed at 500 no./m3 density compared to that of the lowest (335 mm/ 392 mg) and the highest density (263 mm/ 203 mg) rearing. Therefore, stocking density of 500 nos./m3 may be suggested in net cage rearing of seabass fry using semi-moist feed. From this trial, a total of 2200 seabass fingerlings were supplied to a progressive farmer for grow-out culture demonstration.

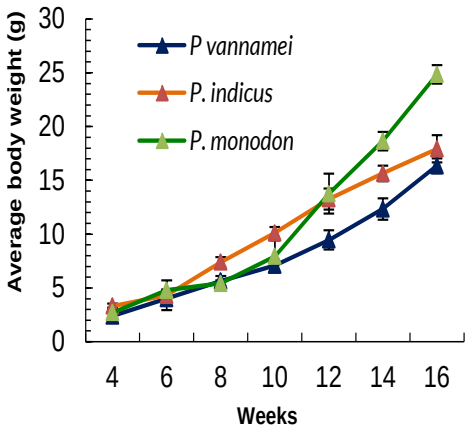
Distribution of hapa raised Asian seabass fingerlings to farmer for grow-out culture by CIFRI director, Dr. V. R. Suresh

Hapa based nursery rearing by cage farmers- a step towards attaining self-sufficiency in seabass fingerling production for stocking in cages

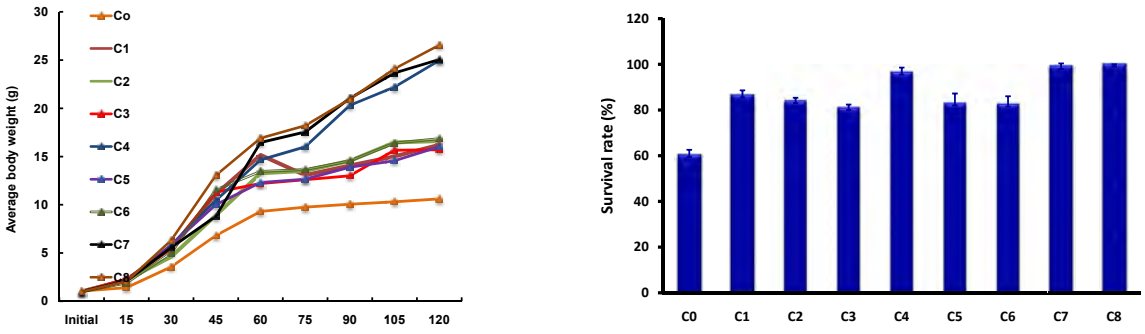
One of the fundamental requirements for successful cage culture of seabass is the availability of stockable size fingerlings. Recognizing this, ICAR-CIBA has signed MoU with the farmers Mr. Sukumaran and Mr. Radhakrishnan of Tatwamasi Self Help Group at Chalakudy, Trissur, Kerala to demonstrate nursery rearing and low volume cage culture of Asian seabass *L. calcarifer* under seabass satellite seed rearing programme. The farmers were trained on seabass nursery rearing to produce seabass seed from fry to fingerling stockable in net hapas erected in ponds. This nursery rearing technology adopted by the farmers helped to bridge the gap between the hatchery supply of fry and the requirement of 5-10 g size seeds which is suitable for stocking in the cage system. This initiative on the part of farmers to produce seabass fingerlings from hatchery produced fry to stock in their cages is commendable. Adoption of this model by other farmers interested in seabass cage culture will help the farmers achieve self-sufficiency with respect to production of stockable sized seabass for cages

Comparative growth performance of *P. vannamei*, *P. indicus* and *P. monodon*

Domestication and genetic improvement of native penaeid stock is one of the high priority areas o f Indian brackishwater sector. Growth and culture performance of native Indian white shrimp was evaluated in comparison with the non native P vannamei. The growth performance of *P. monodon*, the species which was the most widely cultured during yesteryears, was also evaluated to provide a comparative aquaculture performance profile. Experiment was carried out in the experimental ponds at the KRC. *P. indicus* and *P. monodon* attained 17.93 ± 1.26 g and 24.84 ± 0.87g respectively in 118 days whereas *P. vannamei* attained 16.36±0.69 g in 112 days rearing. *P. indicus* and *P. vannamei* were found to have similar growth; however survival was lower in *P. indicus*. Biofloc technology, a technique to improve water quality through the addition of carbon sources in shrimp culture system, has been widely acknowledged. Effect of various carbon sources, for example: maida, atta, gram, ragi rice, corn, molasses and multigrain atta on growth performances, survival, water quality, microbial dynamics and cost effectiveness, of P. vannamei culture was evaluated. The experimental trial was conducted for 120 days, and *P. vannamei* juveniles (ABW: 1g) with a stocking density of 60 no/ m^2. At the end of the trial, growth performance and survival were significantly higher in biofloc ponds (15.6 to 26.6 g; 90-100%) compared to non biofloc ponds (BW: 13.7 g; survival: 70.5%). Further, best performance in terms of growth and survival was observed in ponds provided with molasses and multigrain atta. The study, thus, indicate that multigrain atta performs similar to molasses and regions where the availability of molasses are constrained due to the legal issues, multi grain atta could be an economical alternative.



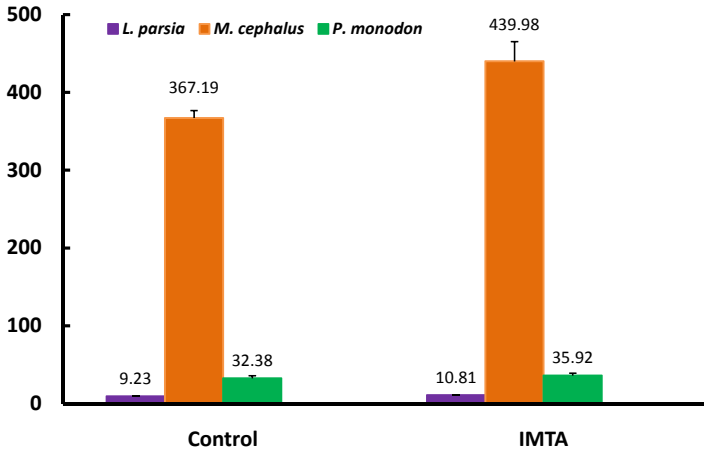
Comparative growth performance of *P. vannamei*, *P. indicus* and *P. monodon*



Effect of various carbon sources on growth and survival of *P. vannamei*

IMTA system- a viable in option for livelihood in coastal waters of Sundarban

Integrated multi-trophic aquaculture (IMTA) is a farming practice which combines cultivation of fed aquaculture species (e.g., finfish/shrimp) with organic extractive aquaculture species (e.g., bivalves) and inorganic extractive aquaculture species (e.g., seaweed/ seagrass) in the appropriate proportions to create balanced systems for environmental sustainability, economic stability and social acceptability. In order to develop an IMTA model as a viable aquaculture option in coastal waters of the Sundarban, a 150-day on-station experiment was



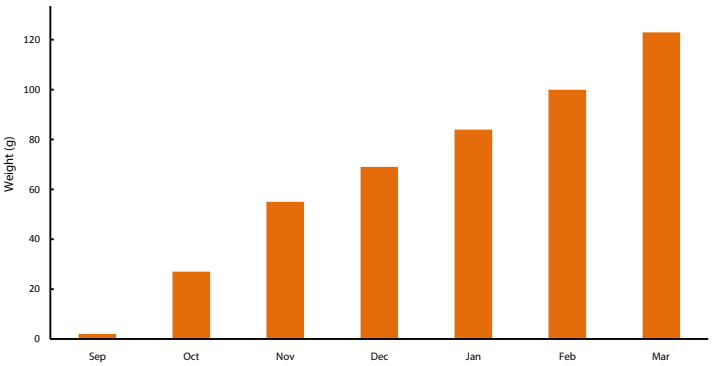
Harvest weight of mullet and tiger shrimp in IMTA pond

conducted in brackishwater ponds at KRC of CIBA. Six ponds (0.06 ha each) were randomly assigned into two groups: treatment (T) and control (C) with three replicates. Treatment groups were stocked with grey mullet (*Mugil cephalus*), goldspot mullet (*Liza parsia*) and tiger shrimp (*Penaeus monodon*) at densities of 2000, 8000 and 30000 no/ha, respectivel. Backwater oyster (*Crassostrea cuttackensis*) and sea weed Eneromorpha spp were stocked at the rate of 1600 no./ha , 200 kg biomass/ha respectively. Control ponds were stocked with the same density of fishes and shrimp as that of Treatment ponds, but devoid of oyster and seaweed. After 150 days of culture, fishes and shrimp were harvested. Mullets and tiger shrimp attained a significantly higher growth ($P<0.05$) in IMTA system compared to that of control ponds. A significantly higher production ($P<0.05$) of 1707 kg/ha (Mullets- 926 and shrimp- 781 kg/ha) with better water quality was obtained in IMTA system compared to that of control ponds (1434 kg/ha; mullets- 772 and shrimp- 662 kg/ha). This preliminary trial indicates the potential of IMTA in brackishwaters, and further experiments will be conducted for refining the species combination and assessing economic viability of the IMTA model.

Harvested grey mullet and tiger shrimp from IMTA pond at Kakdwip, West Bengal

IMTA – A milkfish-paddy integration model

In another model of IMTA, an integrated milk fish paddy culture was developed in the low saline areas (7-10 ppt) where temperature drops up to 12^{0}C during winter months (Sept-March). Black gram and ladies finger were cultivated as highland sporadic cultivation in pond bank for household consumption. These vegetables needed no irrigation and were cultivated purely on rainwater. Farmer had share in paddy cultivation near the pond. Total productivity of kharif rice was 3000-3500 kg/ ha. Paddy was cultivated using freshwater bore well water whereas milkfish (BW, 2g) was cultured in 300 m^2 pond fed with saline tide fed irrigation canals for six months (September- March) on pellet feed. A total 65 Kg of milkfish was harvested in 6 months period with average productivity of 3.25 t/ha. The market price of milkfish was Rs. 180/kg amounting to gross income of Rs. 11,700/-and a net profit of Rs 8700. Milkfish contributed an approximate equal share in the total income of Rs. 17,700 from the integrated culture.



Average body weight of milkfish

Harvest of milkfish in paddy-fish integrated culture, Kakdwip, West Bengal

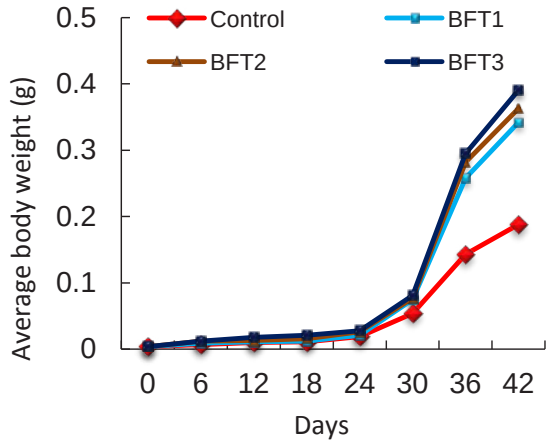
IMTA in Sindhudurg District, Maharashtra

The overall objective of this project is to demonstrate farmers of Maharashtra the potential benefits of IMTA over mono-specific culture. This study also compares the growth of shrimp in monoculture and in IMTA system, and ecological characteristics of both systems. Two models of IMTA were developed: pond based IMTA and open-water based IMTA. In pond based system, shrimp (*Penaeus indicus*), finfish (*Etroplus suratensis/Chanos chanos/ Lates calcarifer*) and bivalves (*Crassostea madrasensis*) were stocked in the IMTA system and monoculture system was stocked with *P. indicus* alone. Pond based system was replicated in two sites. Open-water based model was carried out in natural estuarine ecosystem, and a total of 1000 white shrimp *(P. indicus)* seeds, 300 pearlspot *(Etroplus suratensis)* , 200 milk fish *(Chanos chanos)* and 200 seabass, *(Lates calcarifer)* seeds were reared in the net hapas with functional feed developed by CIBA for the IMTA. After having reared for three and half months in the net hapas 200 *P. indicus*, 252 Etroplus and 20 milk fishes were transferred to the round cages. In all the systems *Crassostrea madrasensis* was stocked as an extractive organic crop. IMTA system provides several advantages to farmers. This low intensive culture gives additional income for the secondary crops such as *E. suratensis*, *C. chanos* and *Crassostrea madrasensis*. The estimated production from IMTA culture is: shrimp 1500 kg/ha, *E. suratensis*, 1000 kg/ha, milkfish 2000 kg/ha and oyster 500 kg/ha. As it is low intensive and utilizing all the niches of ecosystem, effluent from this system and chances of nutrient build up and associated problems are estimated to be low.

IMTA system in Sindhudurg, Maharashtra

Biofloc technology (BFT) for shrimp nursery

A number of studies, both lab based and pond based, conducted in farmers pond revealed the advantages of BPT system. Protocol for nursery rearing of shrimp larvae (P. vannamei) with biofloc based system was developed to produce healthy post larvae for the grow-out culture. In lab based experiment, P. vannamei reared in biofloc based nursery system in 500 L FRP tank at stocking density 6000 number post larvae per tank for 28 days. The biofloc level with 107 CFU/ml was maintained through three approaches differing in their generation 1) biofloc lyophilized powder (BFT-1) 2) fermented biofloc product (BFT-2) and 3) Recycled matured water (BFT-3) and compared with that of the conventional nursery rearing without biofloc treatment (Co). The production performance, water quality and microbial characteristics were analyzed during the nursery periods. All the biofloc grown shrimps were found to have significantly higher growth and survival when compared to that of control.



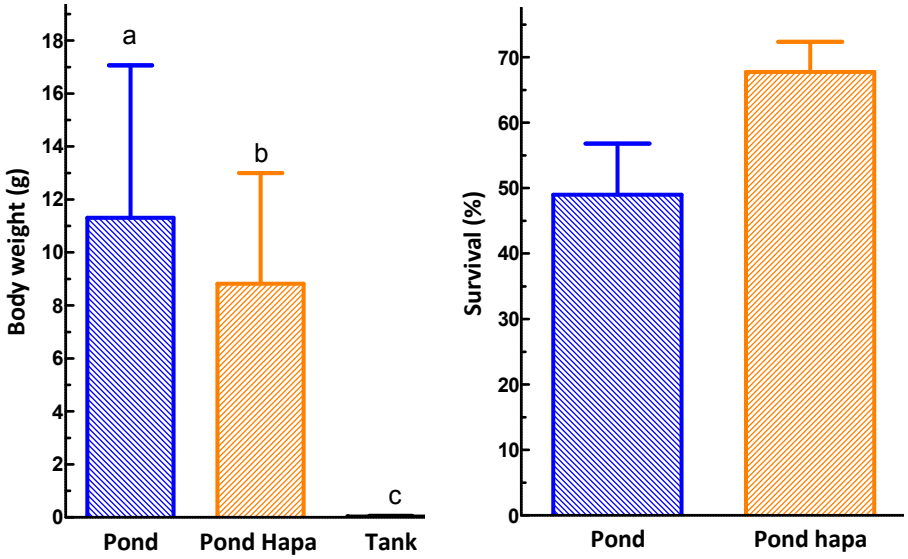
Average body weight of *Penaeus vannamei* during 42 - day nursery rearing experiment

The mRNA transcript levels of different immune genes of the biofloc nursery grown L. vannamei were studied through q PCR and genes involved in the defense mechanism like Pro Phenoloxidase (PPO), Crustin, Ras, Alpha 2M, Mas, SP and antiviral genes were found to be significantly upregulated with 1.3 to 2.5 fold changes compared to that of the conventionally grown non biofloc groups of shrimps. Challenge trials conducted at the end of Nursery rearing under bio-floc: The improved protective response of shrimps reared in biofloc compared to the control. Challenge trial against bacterial pathogen *Vibrio parahemolyticus*.

Biofloc based experiment for nursery production conducted at commercial grow out production system (Gangapattinam, Nellore district, Andhra Pradesh) suggested significant positive correlation with size and volume of the biofloc maintained during the nursery phase. Post larvae were stocked at a stocking density of 5000 no/m^2, and reared for 28 days. Sugar was used to manipulate the C: N ratio in nursery ponds.

Mud crab nursery production performance of *Scylla serrata*, early juveniles C4-C5 instars

The major aim of this study was to determine the timing of cessation of hatchery phase of mud crab *Scylla serrata*, and to determine optimum stage for field nursery production. The results of previous studies show the possibility of using megalopa stage in the field nursery production system. In order to evaluate the logistic and economic optimization of hatchery and nursery phase, nursery production performance of early juvenile stages (C4-C5) were evaluated through several indoor and field experiments during the current investigation period. During this study , the mud crab at C4- C5(0.01-.04 g) were reared in three rearing systems: in door tanks earthen pond without hapa, and hapa erected in the earthen ponds. The concrete indoor tank used for the study had a capacity of 6 m^2. Hapa net of 2 m^2 (2 m long X 1 m wide X 1 m deep) were suspened in the earthen pond of 100 m^2 area. The stocking densities were: 150/m^2 for tanks and hapa and all the ponds were stoked at the rate of 10 no/m^2. The crabs were fed with smashed trash fish and clam meat in excess throughout the study period. The study was carried out for 57- 66 days in outdoor experimental systems whereas in door tank experiment was terminated within 25 days due to high cannibalism. The overall survival rate in the out-door experiment was (56.5 ± 5.3%; 40-71%; N=5), whereas in door survival was as low as 12.8%. After 22 days rearing in the in-door tanks survival was up to ~ 50% indicating that it is possible to rear the animals in indoor tanks about 20 days with reasonable survival.

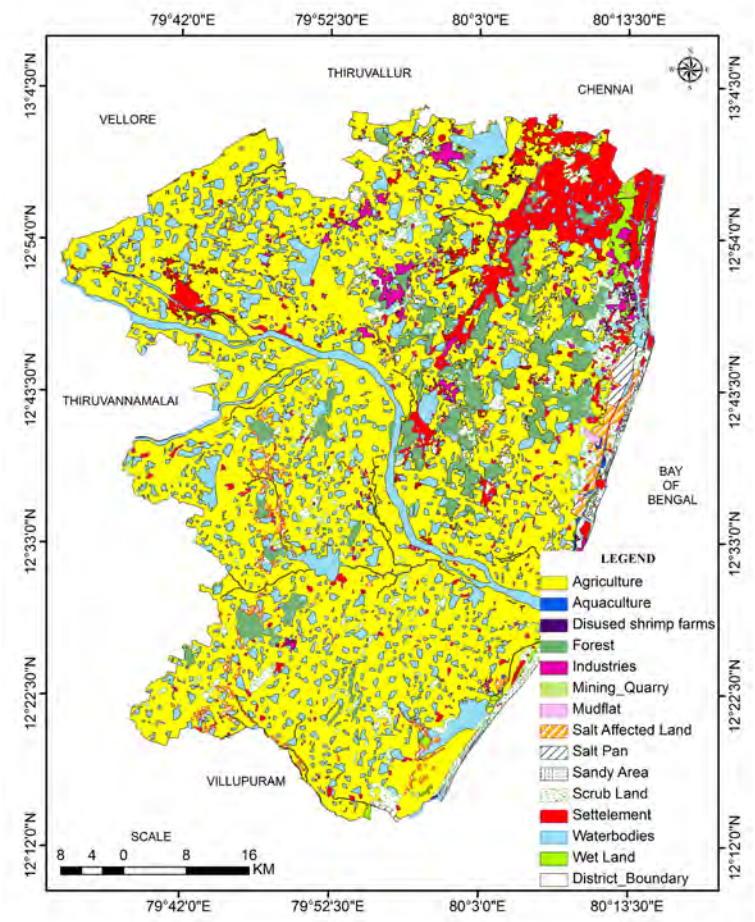


Growth and survival of mud crab, *Scylla serrata* juveniles in different rearing systems

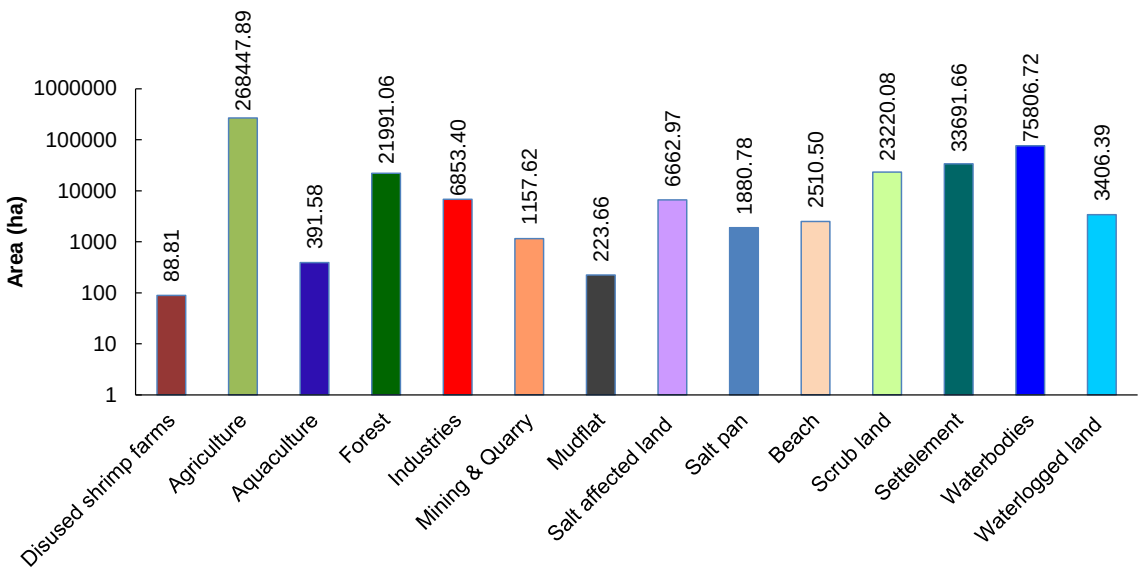
In the out-door experiment survival in the pond hapa was higher (67.7% ± 3.25%) whereas in the ponds without hapas survival was 49 ± 4.5%. However the survival rate between two systems was not significant (P> 0.05). After one month, growth in the ponds was significantly higher with an average growth of 11.31 ± 0.60 g than pond hapa (8.8 ± 0.66 g) and tanks (0.03 ± .004 g). Length weight analysis of mud crabs in the pond hapa, pond and tank are given in theThe regression equation for crabs in ponds (b= 2.84), pond hapa (b=2.87) and tank(b=2.97) were found to be negatively allometric with b value below 3.

Assessment of brackishwater resources (Kanchipuram, Tamil Nadu)

Mapping of suitable resources available for brackishwater aquaculture is the essential requisite for sustainable development of aquaculture. Kanchipuram District is a coastal district of Tamil Nadu yet to be optimally utilized for brackishwater aquaculture. Land and water resources of this district were mapped through visual interpretation and thereafter ground truth verification. Polygons were classified as agriculture, aquaculture, forest, mining and Quarry, water bodies, disused shrimp farms, lake, salt affected, mud flat, beach, salt pan, scrub land, settlement, water logged area using visual interpretation keys based on colour, tone, texture, pattern, size, shape and its associated features. The accuracy of the classification was assessed using error matrix and Khat coefficient. The district has 9 taluks and 14 blocks with total extent of 446333 ha. The major land use classes were agriculture and water bodies, and the present aquaculture area was 392 ha. The suitable classes available for brackishwater aquaculture development were scrub land (23220 ha), water logged land (3406 ha), mudflat (224 ha) without restricting the distance from water source and provision of buffer zones. Soil texture map from soil survey land use, water source and drainage from topographic map were delineated, and the land available in mud flat, scrub and water logged land beyond 200 m but within 3 km of high tideline was delineated. The buffer of 100 m was given to prevent the impact of aquaculture on nearby resources as per CAA regulations. Multi criteria analysis was performed to identify the suitable lands available for brackishwater aquaculture. Based on MCDSS, the suitable land available for future aquaculture development under different classes is 3548 ha.



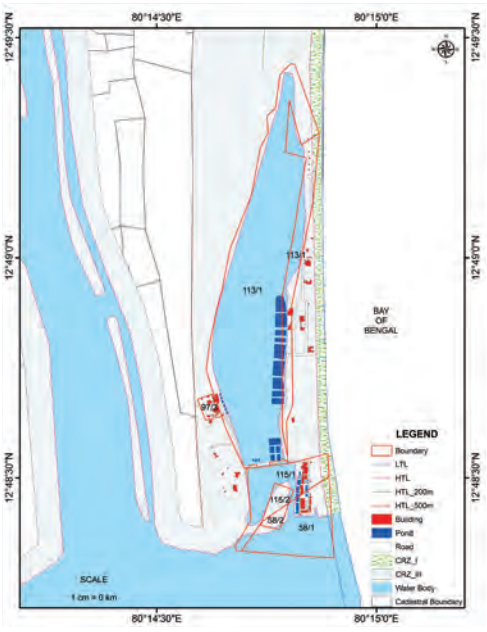
Land use classification of Kancheepuram district, Tamil Nadu from Land sat 2015



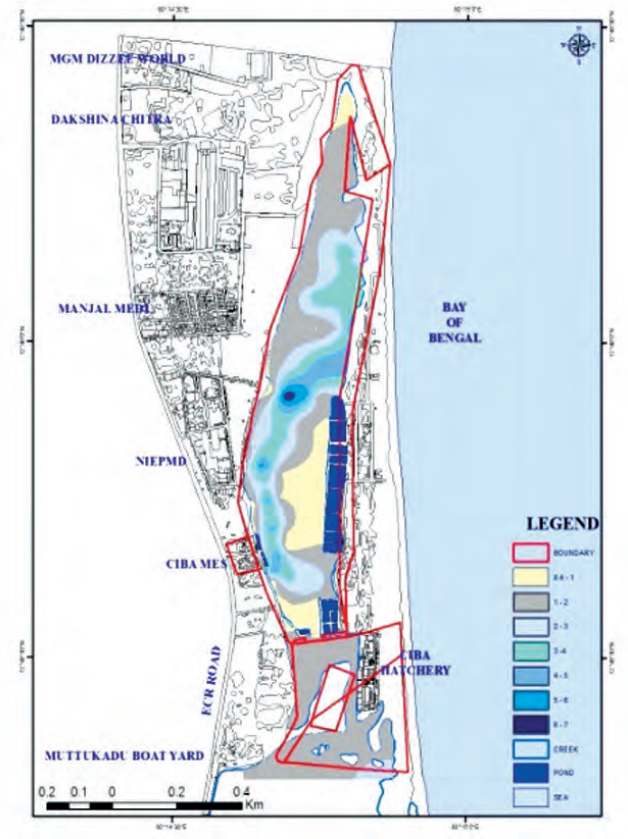
Extant of land and water resources of Kancheepuram district, Tamil Nadu

Mapping of Muttukadu lagoon

Muttukadu lagoon is a complex shallow estuarine network that opens to the Bay of Bengal, and spread over almost 216 acres along the east coast of Kanchipurm Distrit (Tamil Nadu). CIBA experimental station at Muttukadu has 121.86 acres of land and water resources to carry out brackishwater aquaculture research and development. Satellite data and GIS were used to map the resource details such as high tide line, water spread areas of lagoon, CRZs, built up areas of hatcheries and buildings. The total area of 121.86 acre of MES comprises 99.04 ha of water body, 20.57 acre of CRZ III and 2.25 acre of CRZ I. The depth of the lagoon was measured with the interval of 5 m transect in March 2016. The water depth varies from 0.12 to 2.13 m, and about 75.5 acre water spread area has water level below 1 m. This area could be utilized for the pen culture. The remaining 12.56 and 4.91 acres have the water depth of 0.3 to 1.2 m and 1.2 to 1.8 m respectively. More than two meter water depth was recorded only in 0.2 acre area. The water quality characteristics such as pH, salinity, TAN, Nitrite, Nitrate, Phosphate, Carbonate, Bicarbonate, Total Alkalinity, Calcium, Magnesium and turbidity at different seasons were monitored. The pH ranged from 8.7 to 8.8 in the months of July to September compared to 7.9 to 8.2 in Jan – March. The salinity varies from 5 to 7 ppt in Oct to December compared to 27-29 ppt in the summer months Feb-May. High values of TAN was observed in the months of April to July 0.7 to 1.34 ppm compared to 0.1-0.3 during Jan – march. This study would help to delineate the suitable areas in the lagoon for experimental aquaculture of the Institute as well as farmer participatory research initiative to help the development of the local fisher community.



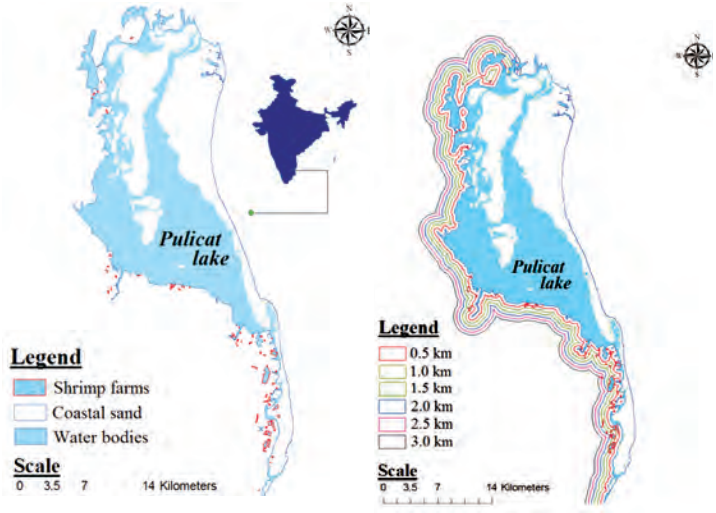
Map of Muttukadu lagoon drawn with the help of satellite data and GIS



Muttukadu lagoon CRZ and, depth wise distribution and infrastructure

Mapping of Pulicat lake

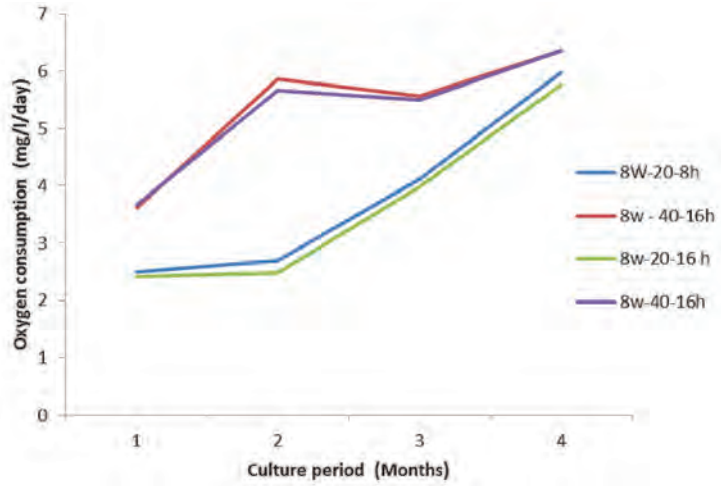
Mapping of brackishwater resources in and around Pulicat lake (Thiruvallaur district, Tamil Nadu) using GIS and Remote sensing showed that approximately 590 ha area with 8 clusters in the district is covered by shrimp farming. Twenty four micro watershed covering the shrimp farms have been delineated and various thematic maps , for example: drainage , geology, lithology and soil resources, have been prepared .The decadal growth of aquaculture between 2005 and 2015 were analyzed using satellite data, and revealed that 35% increase in culture area was observed in comparison with 2005.



Map showing shrimp farming areas in Pulicat area

Aeration requirements in shrimp ponds

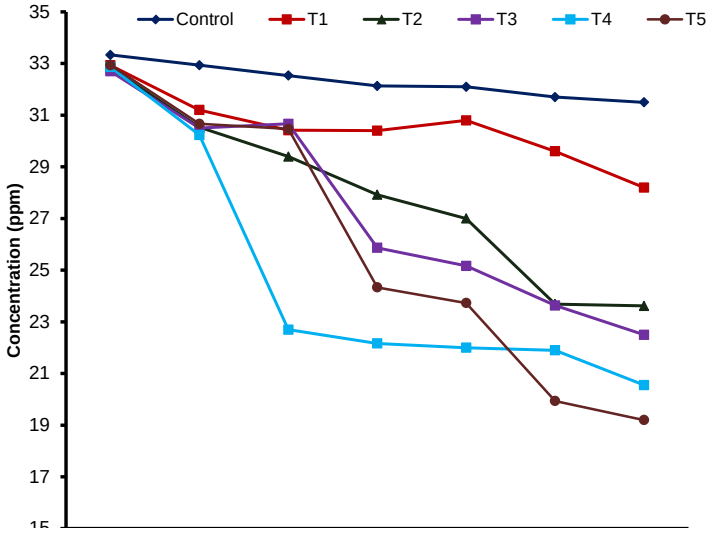
Optimization of aeration requirements in the P. vannamei grow out system is essential to economize the production cost as well as long term sustainability of production system. Aeration requirements in the grow out production system with different stocking density (20/m^2 and 40/m^2) with two different type of aerators (eight and sixteen paddle wheels) were evaluated. In shrimp farms, sediment respiration rate (SR) and water column respiration rate (WR) were determined through the column method. All respiration data were used to characterize temporal requirement of mechanical aeration (HP/ha) 1) in shrimp ponds. Total oxygen demand (OD) was calculated using maximum shrimp respiration measured, and the SR and WR obtained in the column method, as shown in the following equation (Oxygen demand = AR + WR + Sh. R; TOD = OD *Vx1/1000) where TOD is the total oxygen demand (kg h-1); V the volume of the pond (m3); and 10-3 is the conversion factor.



The oxygen transfer rate was adjusted to the mean temperature of the experimental units : OTRT = OTR20 x 1:024 T -20 where OTRT is the oxygen transfer rate at pond temperature (kg h-1) and T is the pond temperature (^{0}C). After these calculations, aerations required by pond hectare (HP/ ha) for every week of the production cycle can be determined using the equation: Number of aerators = TOD / OTRT . Comparing SR and WR, sediment respiration rates, higher aeration is required in the last month of culture. For the calculation higher values of water respiration of 7.01(mg/l/day and soil respiration of 6.98 mg/l/day was taken. T h e shrimp respiration rates in all four months of growth ranged from 1.31-1.43 mg/l/shrimp, 1.76 – 1.86 mg/l /shrimp, 2.39- 2.43 mg/l /shrimp, 3.13-3.45 mg/l/ shrimp while the weight ranged from 3.5-4.2 g, 6.16-7.16 g, 13.92-14.19 g and 16.26-18.08 g respectively for the four months of culture period. Considering highest values of shrimp, soil and water respiration, mean energy required per kg of production was worked out to be 3.63 Kwhr/kg .

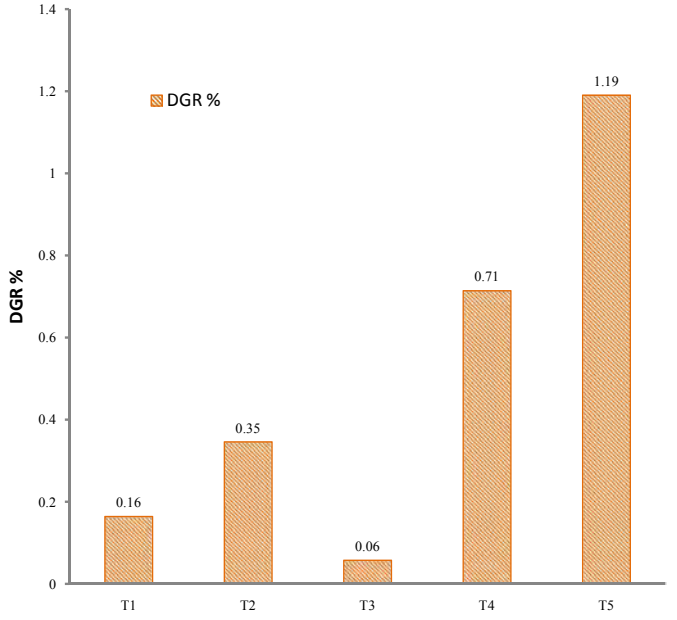
Nutrient sequestration of seaweed

Integrating non-fed aquaculture crops such as seaweed with mono culture of shrimp has been found to be an effective method to mitigate the negative effect of coastal aquaculture. Therefore, a detailed study has been carried out to evaluate the bioremediation of potential of Gracilaria spp. Pilot experiments using Gracilaria spp from Pulicat and Muttukadu brackishwater system indicate that both stock has different sequestration capacity. Therefore, two outdoor experiments using both stocks were carried out. First experimental trial was carried out using Pulicat stock with five different sea weed stocking levels (T1-0.5g/l, T2-1g/l, T-1.5g/l, T4 – 2.0g/l and T5- 2.5g/L and control 0g/L). Ammonia (35 ppm) was maintained by addition of ammonium chloride, and it was it was observed that the total ammonia nitrogen (TAN) was reduced in all treatment when compared to control. Further, it was found that the treatment provided with 2.5 g/L (T5) provided maximum reduction from 33 to 15 ppm after 96 h.



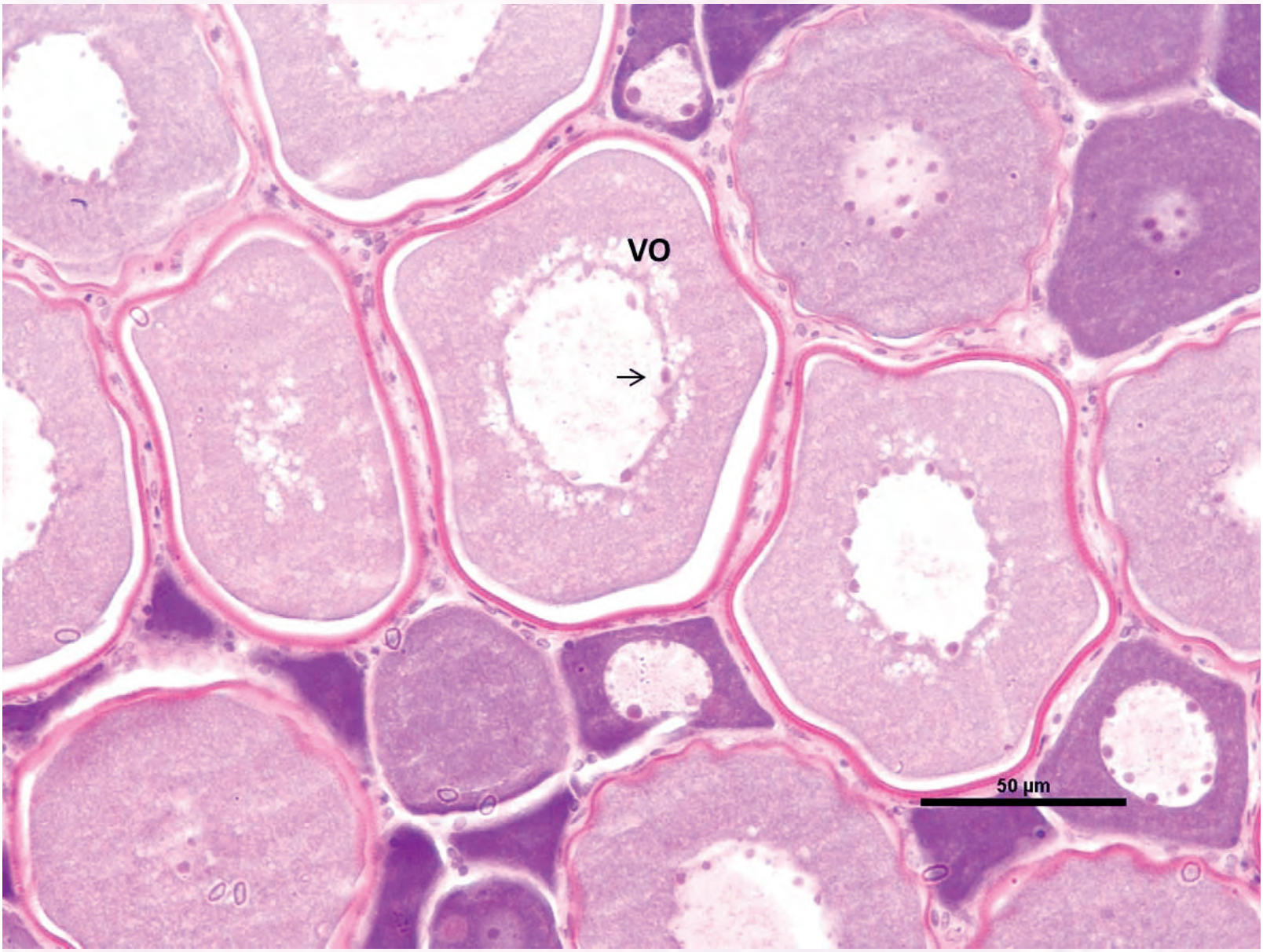
Ammonia-N removal percentage within a day

Second trial was conducted with the Gracillaria sp from Muttukadu lagoon. In this trial, the effect of addition of limiting nutrients, nitrogen and phosphorous, at the atomic ratio of (N:P) 30:1 micromoles were studied. The experiment was conducted at three different phases on the basis of three different dosages of nutrients. I phase is with the dosage of 60:.2, II Phase with 150: 5 and III Phase with 300: 10. The initial intensity of seaweed was at 3gm/lit. Temperature, pH, dissolve oxygen, salinity and ammonia, nitrite, nitrate and phosphate were recorded at initial time and every 4 days interval at 14:00 hrs throughout the entire study period. The NH4-N concentration was totally reduced to nil during all the phases within 4 days, and same was observed in the II and III phase also. However, the growth rate was higher in first phase (5.2-6.1%) in all treatment groups. However, growth was found to be reduced in second and third phase.



Average daily growth rate at different stocking density of seaweed

Reproduction, breeding and larval rearing

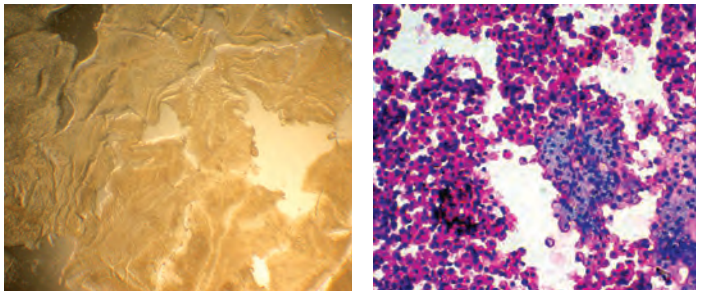


Developing ovary section of *Mugil Cephalus*

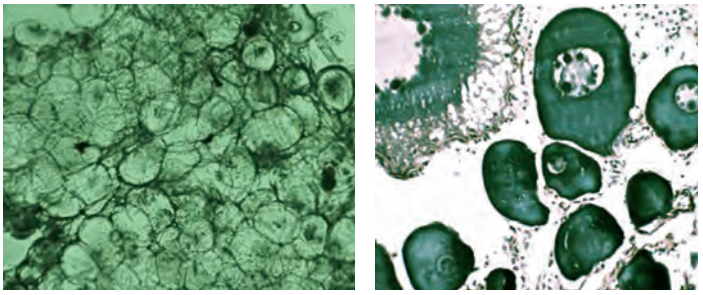
Reproduction breeding and larval rearing

Induced breeding of Milkfish (*Chanos chanos*) in captivity - CIBA's success story

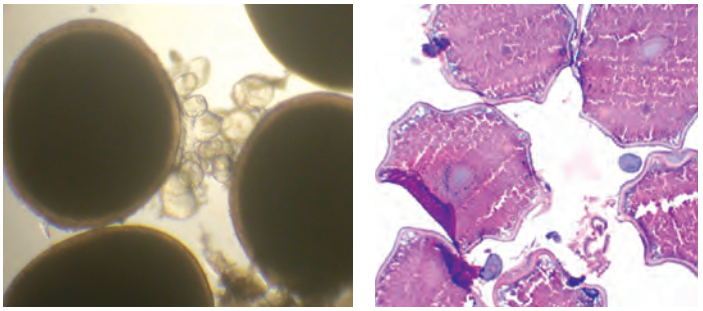
CIBA has successfully bred and raised milkfish *C. chanos* for the first time in the country through its entire life cycle after years of focused research. Milk fish, a largely herbivores species at the lower trophic level has been a delicacy in India and in many Asian countries. Although a lucrative market exists for this species in India, it has been cultured in brackishwater ponds at lower scale. Aquaculture of this species is greatly hampered due to the constraints in the hatchery production. This success, hopefully, pave the way for more wide spread aquaculture of this important brackishwater species. Currently ICAR-CIBA has achieved 15-20 % larval survival. A total of 10000 fry (30-day old) were produced and distributed to farmers for culture demonstration at different coastal states. Further, 7000 fingerlings were produced at private hatchery using the fertilized eggs of milkfish provided by the Institute. Milkfish grow-out feed developed by the Institute provides encouraging results for adoption of milkfish culture among entrepreneurs and farmers.



Initial adipose tissue (< 90) µm



Primary oocyte stage (275-350) µm

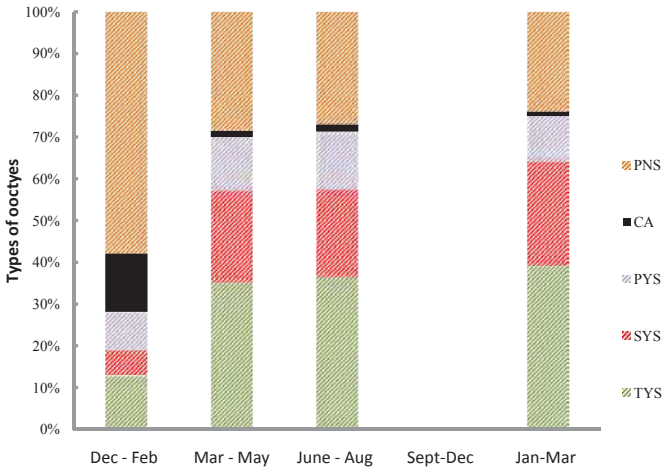


Mature oocytes (650 – 680) µm

Gross and histological examination of biopsy tissues from milkfish ovary

Induced maturation and breeding of milkfish in captivity

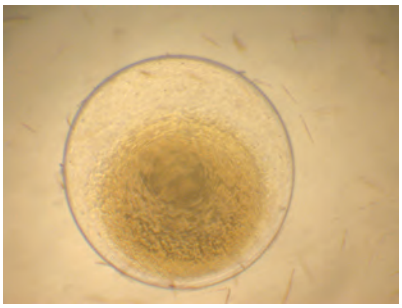
Hormonal manipulation was employed for induced maturation and spawning of milk fish. Significantly higher spawning performance, with 0.1 million eggs per spawning and a total of 0.67 million eggs, was observed when two hormones were used in combination. Fertilization (75%) and hatching rate (71%) were also found to be higher in combination treatment compared to single hormonal use (Fertilization rate: 18.8%; hatching rate 41%).

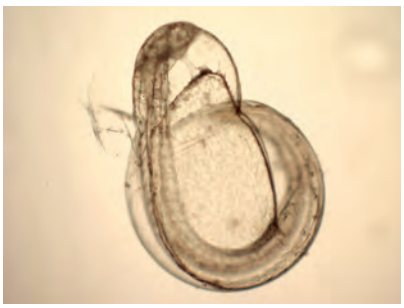


Oocyte maturation in milk fish during hormonal manipulation

Embryonic development of milkfish and optimization of different parameters for improving milkfish larval rearing

Staging of early embryonic ontogeny and larval phases is of critical importance in understanding the biology of the species and its environmental preferences. Therefore, the embryonic stages and early larval phases of milk fish has been traced and described. The size of fertilized egg was 1.2-1.3 mm and the incubation period was 22-24 h depending on temperature and salinity. A salinity, 32 -35 ppt is ideal for incubation with mild flow-through. Newly hatched larval size was recorded to be 3.24 mm. Optimization of different parameters for improving the milkfish larval rearing was carried out. A larval survival of 12-15 % was obtained using indoor FRP tank (blue or yellow background) based system. The algal species Chlorella salina was added to all the LRTs to maintain green water (0.4-0.5 million cells/ml). Third day onward rotifer maintained at 20-30 no ml-1. From the 12th day density of Artemia nauplii was provided at 3-4 no ml-1, and artificial feed (200-300 µm) was supplied for weaning from 20 day onwards. Milkfish reached the mean size - 32 mm by 30 dph in 27-30 ppt.

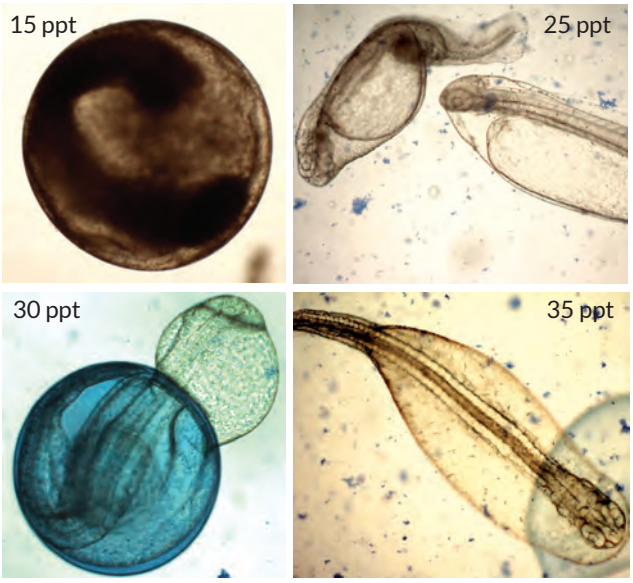




Embryonic development of milkfish

Effect of salinity and transportation on hatching of milkfish eggs

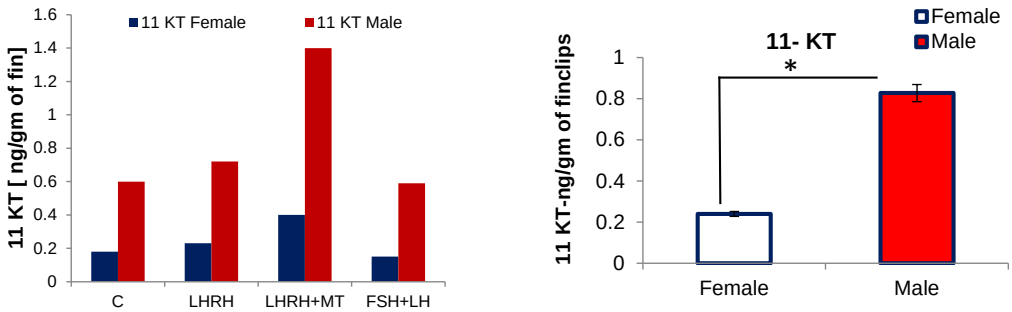
It is well documented that salinity plays a major role in the hatching of marine finfish eggs. Standardization of the optimal salinity range is essential to realize optimal hatching percentage. Highest ($p < 0.05$) hatching percentage 84 % was observed at 35 ppt followed by 30 ppt and 25 ppt. It is recommended to use water in the salinity range of 32-35 ppt during incubation to avoid embryonic arrest. . Salinity below 25 ppt leads to complete arrest of embryonic development with 0% hatching rate. As a proactive step towards promotion of satellite larval rearing centers of milkfish among private entrepreneurs, standardization of long and short distance transportation of fertilized eggs of milkfish is a critical. This will allow producers to procure eggs and newly hatched larvae directly from the nodal breeding center as an alternative to establishment of capital intensive finfish broodstock holding facility and hatchery systems. These satellite rearing systems will serve as a link between the hatchery and the nursery or grow-out production systems. To study the effect of transportation, fertilized eggs were stocked at two different densities; 5000 no/5 l (T1) and 7500 no/5 l (T2) under oxygen packing. These were placed inside an insulated card board box and transported for 15 h. The eggs were found to hatch during the transportation period. A hatching rate of 85% and 78% was recorded in T1 and T2 respectively. When eggs were transported at similar packing densities for 24 h, hatching rate of 0% was recorded. Hence, for long distance transportation a water temperature between 22-25 °C and transport duration of 10-12 h seems preferable.



Embryonic development of milk fish at different salinites

Identifying sex in milk fish: pectoral fin based sex identification

Sex differentiation in milkfish on the basis of morphology or external features is extremely difficult. Identification of fish on the basis of sex is important for assessing breeding response and tracking parental lineage. Pectoral fins of many finfishes show sexual dimorphism. Pectoral fins are also reported to secrete some sex-steroids particularly 11-Keto-Testosterone (11-KT) in males. Pectoral fin of sexually mature fish contains 11 KT and this level significantly differs within sex. Induced maturation in 3 year old milkfish sub-adults was attempted with hormone pellets containing carp pituitary, LHRH and LHRH + 17-α- MT. Control pellet contained only cholesterol. Fishes were kept



Pectoral fin 11 KT levels in milk fish treated with different hormone doses and mean 11 KT levels in male and female

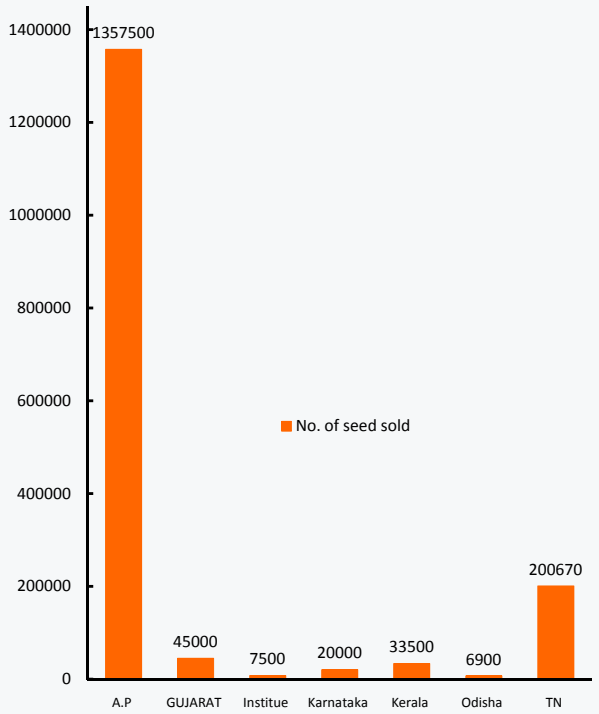
in four RAS system (capacity, 8t) with 300 % daily water exchange. Sex steroid, 11 KT was estimated from pectoral fin from each treatment and values differed significantly ($p < 0.05$) within the treatments. LHRH+MT treatment showed highest intra-treatment variation (0.40 ng/g and 1.40 ng/gm). If value of 11 KT shows above the threshold level (0.24 ng/g), the sex of the animal would be male as 11 KT is an androgenic hormone. In this study, average male 11 KT was estimated to be 0.827 ng/g in the pectoral fin extract. This study indicates that sex steroid in the pectoral fin is a marker for identification of sex in milk fish.

Seed production of Asian seabass

A predominance of natural over induced spawning in captivity and outdoor broodstock holding systems: CIBA's journey with Asian seabass seed production started since its first induced breeding success through hormonal therapy in late nineties. During this year, a total of 62 spawning of Asian seabass were recorded in the finfish hatchery MES-CIBA, of which 55 were natural and 7 were induced. This may be a reflective of the effect of gradual domestication of the broodstock to the captive conditions. The natural spawning was observed not only in indoor RAS system (10 t) with better environmental controls but also in outdoor RCC tank (100 t) systems. This year witnessed 4 natural spawning in outdoor tanks in the July and this extended up to September, despite the drop in salinity up to 10 ppt. Mature oocytes were observed in fish maintained in open broodstock tanksThe spawning was initiated in the month of March after implantation of hormone pellet, both male and female fish @100µg/kg body weight in February. Mature oocytes were recorded after one month and these fish were bred by hormonal induction. During 2015-16, a total of 11.6 million eggs were produced (20,000- 5,00,000 lakhs per spawning). Natural spawning had higher fertilization rate (70-95%) than induced spawning (0-80%).

Seabass seed production and sales at finfish hatchery touches a new milestone

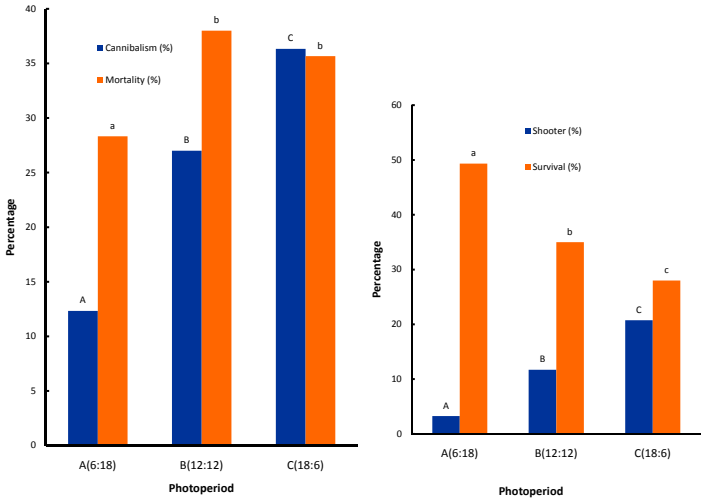
Since the establishment of finfish hatchery in the 1997, the year 2015-16 has witnessed the highest seed sales , 1.67 million with a revenue generation of ₹1.3 million. A total of 40 farmers were supplied with seabass seed. The percentage of seeds were procured by farmers mainly from Andhra Pradesh (80%), Tamil Nadu (15%), and from other states like Kerala, Karnataka, Maharastra and Odisha (5%). For seabass seed rearing in a satellite production mode, demonstrations were undertaken at Kodungallur, Kerala, Baber, Kendrapara, Odisha, Bailor, Murudeswara and Karnataka.



Supply of Asian seabass seed to farmers of different states

Effects of photoperiod, light spectra and dietary estradiol supplementation on cannibalism in Asian seabass larvae

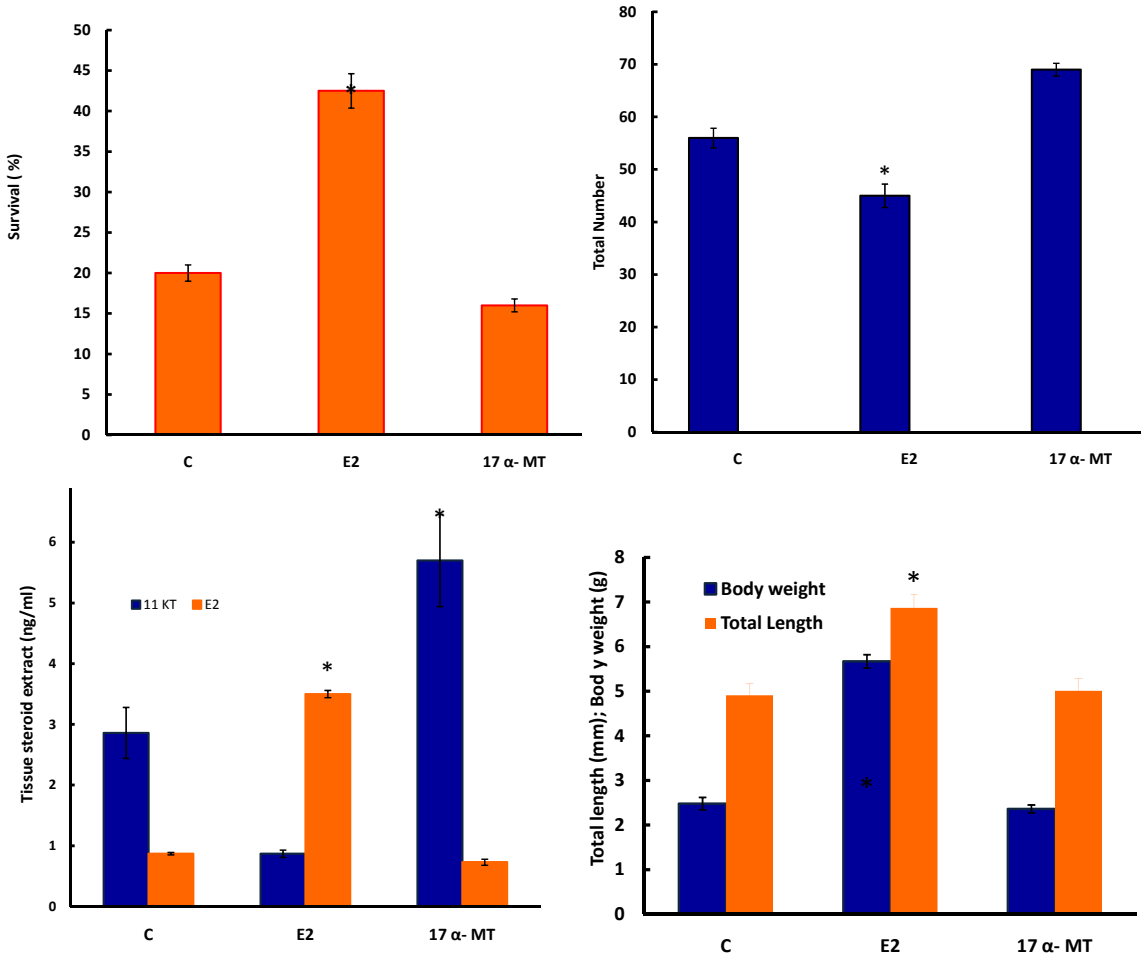
Coeval (same aged) cannibalism is a major challenge during larval rearing of Asian seabass. Cannibalism is a consequence of size heterogeneity and results in the emergence of shooters. In the previous study, it was found that continuous hours of darkness can reduce the emergence of shooters; leading to larval survival up to 45% whereas blue spectra was found to be helpful to reduce natural mortality up to 28%. As a continuation to the study, trials of different photoperiods of blue spectrum: A (6:18), B (12:12) and C (18:6) were conducted to reduce cannibalism and natural mortality for improving the overall larval survival percentage. One hundred and fifty numbers of 25 day old weaned seabass were reared in 100 L tanks with the different photoperiods for 30 days. Photoperiod was maintained using a photoperiod timer fitted to an 12 W LED blue light. Tanks were covered with black cloth to maintain the desired spectra. It was found that survival (%) has increased up to 49.33 ± 0.66% by providing 6:18 photoperiod of blue spectra. The percentage of shooters were also significantly reduced, 3.26± 0.67%. Mortality was due to natural reasons and cannibalism was found to be 28.33± 1.66% and 12.33± 1.0% respectively, which was significantly ($p<0.05$) lower among all other photoperiod groups. Lowest size heterogeneity and less aggressive behavior were also observed in this photoperiod.



Effect of different photoperiod on mortality, cannibalism, shooter emergence and survival (%) of Asian Seabass larvae

Estradiol enriched feed supported improved growth and reduced cannibalism in Asian seabass larvae

Changes in sex-steroid levels during early life stages of Asian Seabass (*L. calcarifer*), a protandrous hermaphrodite, has definite effects on the behavior of the fish. Levels of steroid hormones are associated with shooter emergence and cannibalism during the larval rearing of seabass. A study was taken up to evaluate the effect of feeding Artemia nauplii enriched with estradiol followed by estradiol coated granulated larval feed to seabass larva to achieve cannibalism reduction. Nine days post hatch (9 dph) seabass larve were divided into three groups each in triplicate and stocked in 500 L FRP tanks @ 3 no/L. Artemia nauplii were enriched with estradiol (E2) or 17-α Methyl Testosterone (17-α MT) solution for 3 hours. The estradiol group was fed daily with E2 enriched Artemia nauplii at dose of 50 mg of E2/kg-larval biomass and testosterone group was fed daily with 50 mg of 17- α MT / kg-larval biomass to observe the effect of induced feminization and masculinization on cannibalism. The control group was fed with Artemia nauplii without hormone enrichment. After 25 dph the hormones were administered through granulated larval feed till 90 dph. Estradiol (E2), 11-Keto Testosterone (11-KT), Testosterone (T) and 17α-Hydroxy Progesterone (17 HP) were assayed through ELISA (Cayman Chemicals Inc.). Sex steroids were extracted from gonadal ridge of seabass larvae and whole Artemia nauplii and assayed. Grading was done twice weekly in all groups to separate shooters to study cumulative survival and shooter emergence. Significant level of feminization in protandrous seabass was evident through higher ($p < 0.05$) estradiol level (3.5 ng/ml of tissue steroid extract) in E2 group compared to



Survival, shooter emergence, growth, hormonal level in Asian seabass juveniles after E2 and 17 α – MT treatment

control and 17 MT. Sex-steroid equilibrium was altered by application of estradiol through feed, and resulted in better survival, higher growth rate. Testosterone (T) and progesterone (17-HP) level did not vary significantly ($p > 0.05$) in all the experimental groups. Further this approach could be used to develop female seabass as broodstock as the natural conversion to female is reported only after 3- 4 years

Captive broodstock development of red snapper, *Lutjanus argentimaculatus*

A new initiative of ICAR-CIBA towards finfish species diversification: Red snapper, *L. argentimaculatus* is a species of high economic significance considering its global value both as a food and game fish. As an initiative towards captive broodstock development, fish were brought from the brackishwater pond of Kerala and Tamil Nadu. The fish were transported from site of collection to fish hatchery, MES, CIBA and are being maintained in RCC tank (capacity, 100 t) and earthen ponds (450 m^2) respectively. Biopsy of captive broodfish, avg. body wt. >2.0 kg showed the fish were in immature stage. Examination of female fish (avg. wt. 4.29- 6.2 kg) sourced from commercial landings showed gonad weight, GSI, oocyte diameter to range between 202-255g; 4.11- 4.7; 426 to 464 µm respectively indicated that the fish in these size ranges to be in the final stages of maturity.

Seed production of Cobia *Rachycentron canadum* from pond based captive broodstock

ICAR- CIBA developed a pond based captive broodstock and induced breeding technology of Cobia Rachycentron canadum. As a part of this program, a total of 28 fishes of cobia are being maintained in 300 m^2 earthen pond in the size range, 7.0-25 kg. The fishes were fed with trash fish (tilapia and sardines) @ 3% body weight daily. Regular examinations of broodfish were done to assess the maturity stage. A set of broodfish females, approximately-20 kg, mean oocytes diameter-650 µm and two oozing males size range, 7.0- 7.5 kg were selected from the pond and transferred to 100 t capacity cement. Both female and male fish administered with HCG hormone @ 500 IU/kg body weight were observed to spawn after 40 h post injection and a total of 2.2 lakh eggs were collected from the spawning tank. Fertilization rate and hatching rate were estimated to be 56% and 65% respectively. The newly hatched cobia larvae were stocked in the larval rearing tanks and the larval rearing carried out.

Assessment of gonadal maturity of cobia

Broodstock development and induced captive maturation of grey mullet, *Mugil cephalus*

Grey mullet, *Mugil cephalus* has has been identified as a candidate finfish for brackishwater farming, and plays major role in the roadmap to sustainable brackishwater aquaculture in India as it occupies at the lower trophic levels of the food chain and is a favoured food fish among the consumers. A major thrust has been, therefore, placed on developing protocols for captive maturation and induced breeding of the species. A key foundation-stone for captive breeding is the availability of the broodstock. To develop quality broodstock grey mullet from three different sources: marine, brackishwater lake and pond reared stock, were obtained from east and west

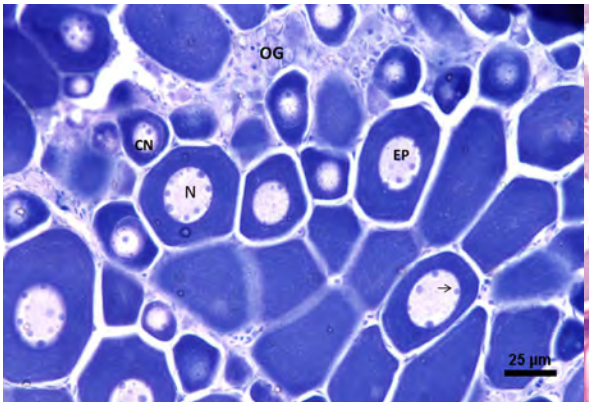
coast. Short (3h) and long distance (18 h) live transportation of grey mullet brooders (400- 1600 g) were standardized with 100 and 98% survival. Considering the significance placed on the role of natural food organisms for the grey mullet maturation, pond based broodstock holding system was developed. Arachidonic acid, vitamin E and astaxanthin , proven nutrients for enhancing fish maturity, were fortified in the broodstock feed. All fish above 500 g in RCC tanks were tagged using PIT tags to establish identity and sex. For enhancing reproductive maturation, efforts were made to standardize the hormonal therapy using sex steroid and hormones of central nervous system An oocyte growth rate based on Y= 7.7692x+280.38, of 7.75 µm per day was worked out from females implanted at early stage III, 280 µm oocyte diameter which progressed to ripe stage 590 µm. Based on the percentage of mature male and females above 1 kg, the season began in September and peaked in November, maturity, 30%, thereafter a decline was observed in the percentage maturity and incidentally coincided with the sharp drop in salinity to 10 ppt observed in first week of December. For a better understanding of the broodstock maturity, the different stages were identified based on the size and appearance of oocytes corroborated with histological studies

Macroscopic and histological characteristics of the maturity stages of the ovary of *Mugil cephalus*

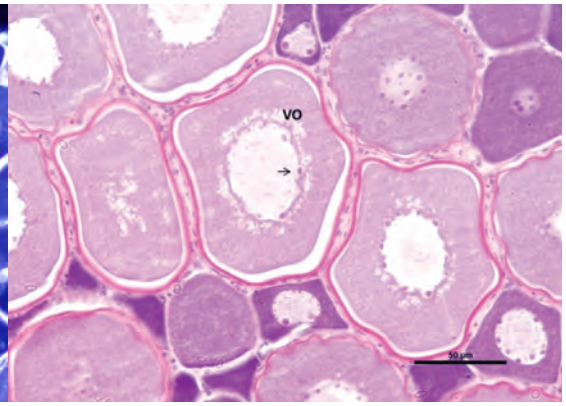
Wild specimens of grey mullet obtained during May 2015 -March 2016 and were analyzed for reproductive biological characteristics of fish. For describing the maturity stages, macroscopic observations of the gonads were recorded based on shape, size, colour, and percentage occupation in the abdominal cavity, degree of oocyte visualization and histology of the different maturity stages conducted. A five point scale was used to describe the maturity stages of ovary

Sexually matured *M. cephalus* (grey mullet) female

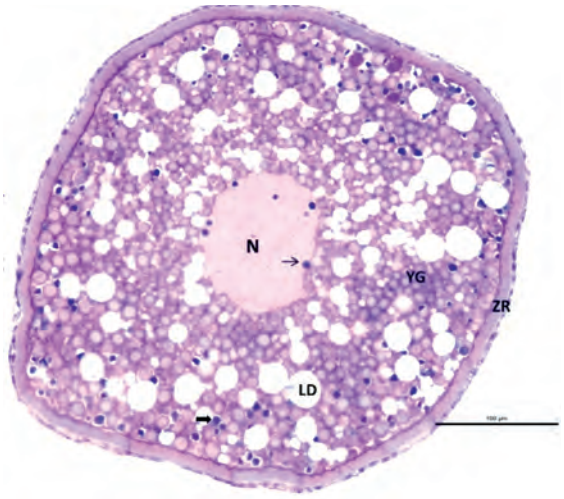
Ripen ovary of grey mullet



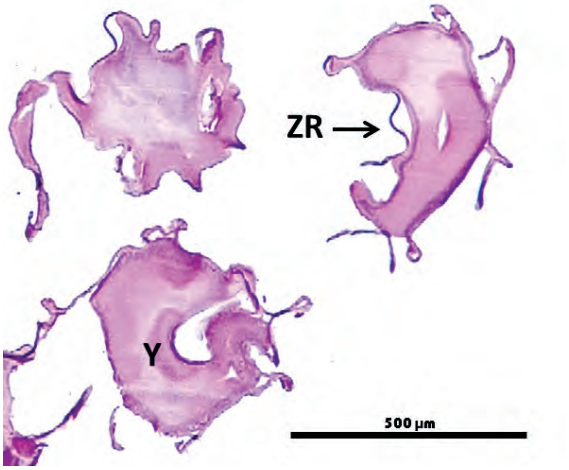
Immature ovary



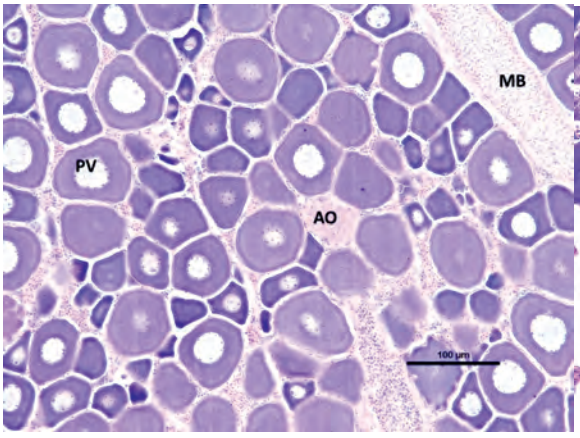
Developing ovary



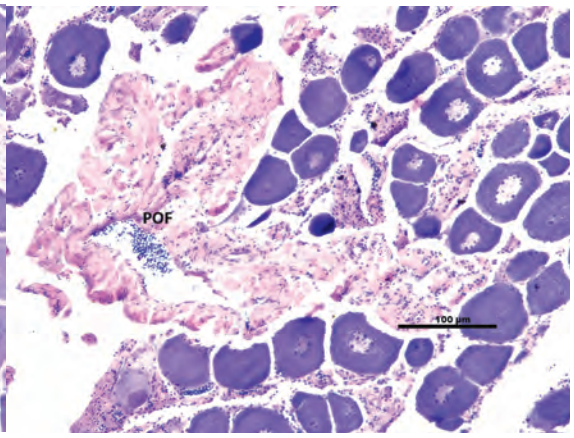
Mature oocyte



Residual ripe oocytes in spent ovary



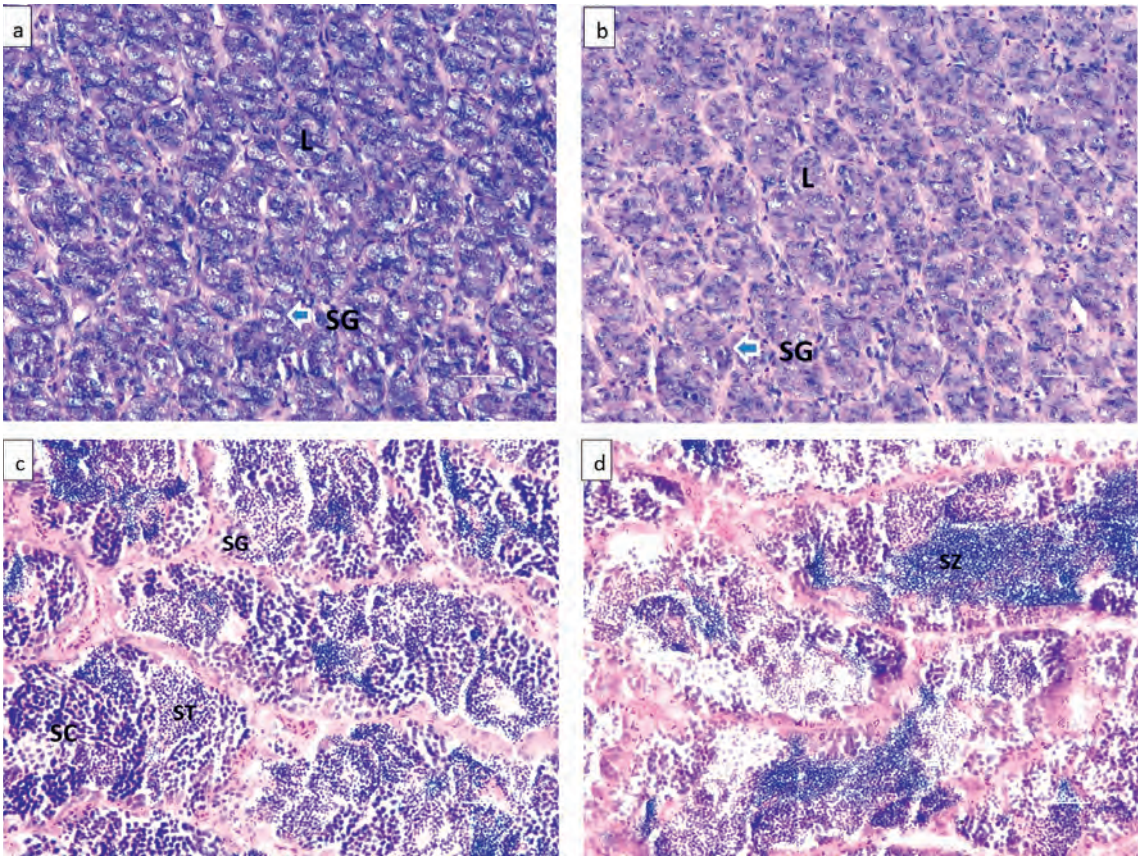
Ovary at spent recovery stage



Post ovulatory follicle (POF) inside a spent ovary

Histology of testis of *Mugil cephalus*

Macroscopic examinations revealed that *Mugil cephalushas* a pair of filiform testes located in the covered by a tunica albuginea, hundreds of smooth muscle cells and blood vessels. The seminal tubules are composed of cysts, which are defined by cytoplasmic projections of sertoli cells. Each cyst contains cells at the same stage of differentiation, forming a clone.



Histological sections of *Mugil cephalus* testis in different maturity stages.a and b denotes the immature testis containing primary and secondary spermatogonia (SG), lumina of seminal lobules (L). c) Early maturing testis contains cysts of spermatogonia (SG), spermatocytes (SC) and spermatids (ST) d) late maturing, with spermatozoa (SZ). (Bar = 25µm)

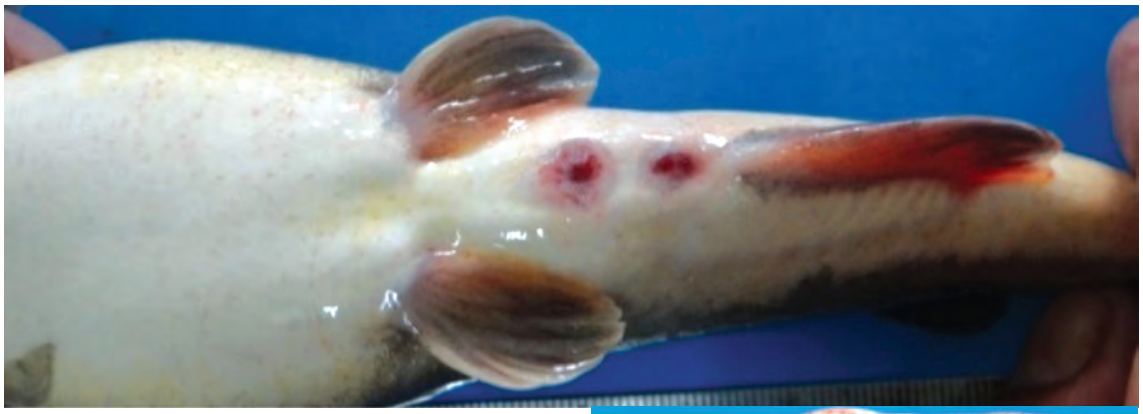
Successful captive breeding and seed production of brackishwater catfish *Mystus gulio*, a mile stone in brackishwater finfish species diversification

Mystus gulio a, native catfish of family Bagridae, locally known as "NunaTengra", is a highly cherished and valued fish in West Bengal and Orissa. For studying the reproductive biology of the fish, different size groups of male and female specimens were collected during spawning season, May-August. Sexual dimorphism was found to be distinct; male was characterized by a muscular papilla with dark red tip, this was absent in females. Females were generally observed to be larger than that the males. Minimum size at maturity ranged from 20 to 25 g. Ova diameter distribution showed a single peak, indicating that the fish is a single spawner. Spawning season of *M. gulio* in West Bengal estuaries ranges from March to November. Fecundity of the animals ranged between 10000 and 35000.

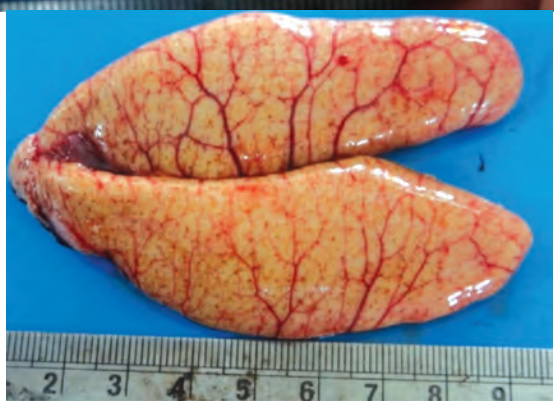
Brackishwater catfish, *Mystus gulio (adult)*

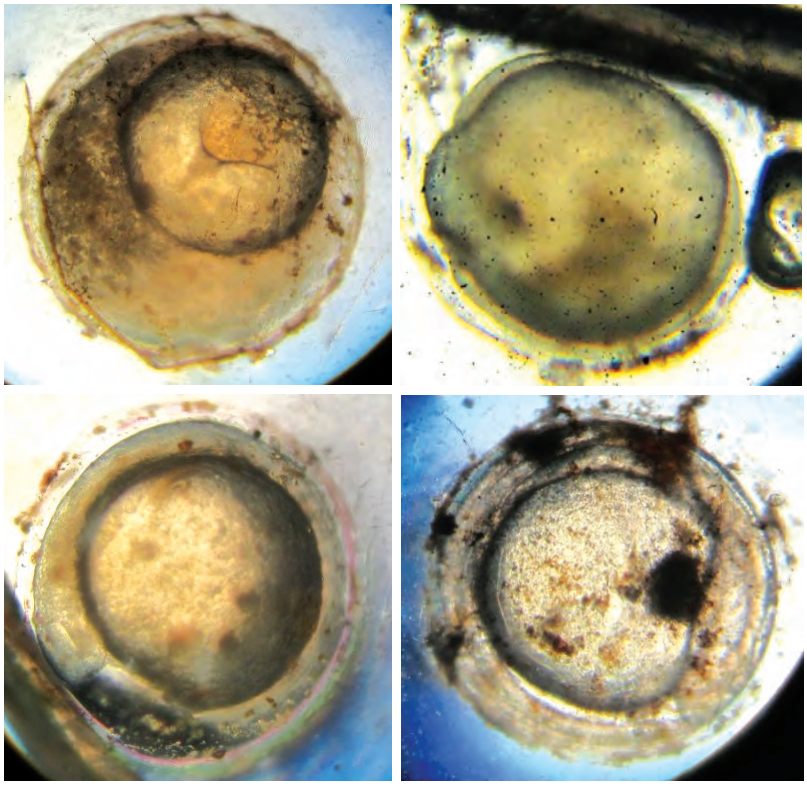
Sub-adult brood stocks of *M. gulio* were collected from wild and induced to attain oocyte maturation under captive condition through dietary manipulation and LHRHa hormone pellet implantation. Oocytes from mature females were circular in shape with clear periphery having average diameter of 450 µm. As males of the fish do not ooze milt on applying gentle pressure on abdomen, maturity was assessed by presence of protruded genital papilla with white body and pink tip. Fishes were induced to spawn and breed through intramuscular injection of different hormonal treatment (pituitary gland extract (PGE) @ 30-50 mg per female (70 g), hCG @ 0.5 IU/gm, LHRHa @0.25 µg/g for female). The males were injected with half the dose of the respective hormones. Among the hormones tested, optimum spawning and fertilization was noticed in LHRHa injected group. Fishes were observed to spawn after 4-6 h of injection. Fertilized eggs were transparent, demersal, round and sticky in nature. Incubation period was recorded to be 12-16 h. On an average 1.5 lakhs eggs are spawned by a single female. The diameter of the fertilized eggs were egg ranged from 750-1000 µm. Hatching rate varied from 60-70%. Size range of newly hatched larva, total length was 2.25- 2.8 mm. The yolk sac was observed without oil globule. Complete yolk sac absorption was observed 3 days post hatch, however larvae was observed to commence exogenous feeding before completion of yolk sac utilization, by the second day. Larvae were fed with Artemia nauplii from second day onwards and continued up to seventh day. Gradual weaning to pulverize pelleted feed was done for the next for 7 days and after 15 days feeding was exclusively done with artificial feed. Mortality was highest during the first 6 days of nursery rearing. In 35 days of rearing, the fish attain an average size; avg. wt., 1.0 g; TL, 48 mm. Following the standardized protocols, a total of 4 breeding trails were conducted and 5 lakh spawns were produced. Fertilization and hatching percentage were 80 and 90 % respectively. Average percentage survival of nursery reared fry was 30 %.

Mature male with prominent muscular genital papilla and multi lobed testis

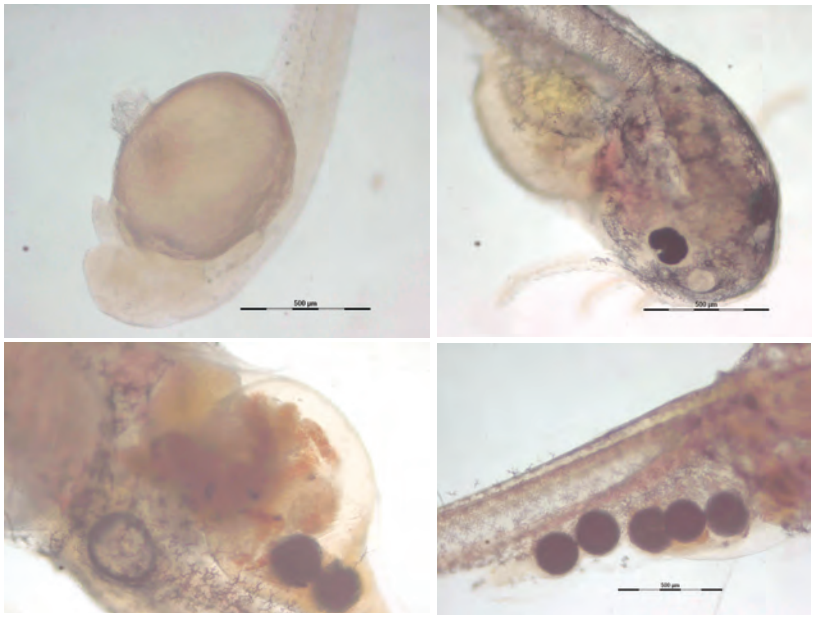


Mature female with round gonopore and ripen ovary





Embryonic development of *M. gulio*



Newly hatched larvae (2.25 mm in total length) with round yolk sac, ii) two days old larvae with exhausting yolk sac without oil globule and pigmentation on body, iii) yolk sac with food particle in stomach, iv) completely exhausted yolk sac with food particles in stomach v) *M. gulio* larvae mouth length (617 µ) and width (90µ), and artemia nauplii measurement (10X)

Mystus gulio, an important farmed fish in West Bengal

A survey was conducted among fish farmers and fish entrepreneurs involved in marketing of *M. gulio* in an around the Sunderban delta, West Bengal. During the survey, it was observed that polyculture of *M. gulio* is being carried out in brackishwater and freshwater pondsalong with other brackishwater species; seabass, mullet, gold spot mullet and shrimp. No standard stocking density or stocking ratio was followed and this was subject to the availability of wild seed. Generally wild seed of *M. gulio* are collected during monsoon months (May to June) from the brackishwater areas or at times from seed suppliers in Bangladesh at relatively higher prices (Rs. 0.5-1 /unit). Few farmers have observed the breeding of the fish in brackishwater pond during monsoon months (June –July).Slight reduction in salinity due to heavy rain was found to trigger this fish to spawn in brackishwater pond. In most of the cases, multiple harvesting was done and at the end. Complete dewatering was adopted to collect all the *M. gulio* from the pond bottom after 8-10 months of culture period. The fish attained a size of 70-80 g in six months of culture period. The fishhas very high market demand; and is sold at prices ranging from Rs. 150 to 450 /kg depending on its size. Smaller size (25-30 g), medium size (50-70 g) and larger size (100 g and above) are sold at Rs. 150, 350 and 450/ kg by the wholesaler to the retailer who in turns sells it after an addition of Rs. 30 to 50 per kg of fish

Marketing of *Mystus gulio* at fish markets in Namkhana, Kakdwip and Nischintpur fish market, West Bengal

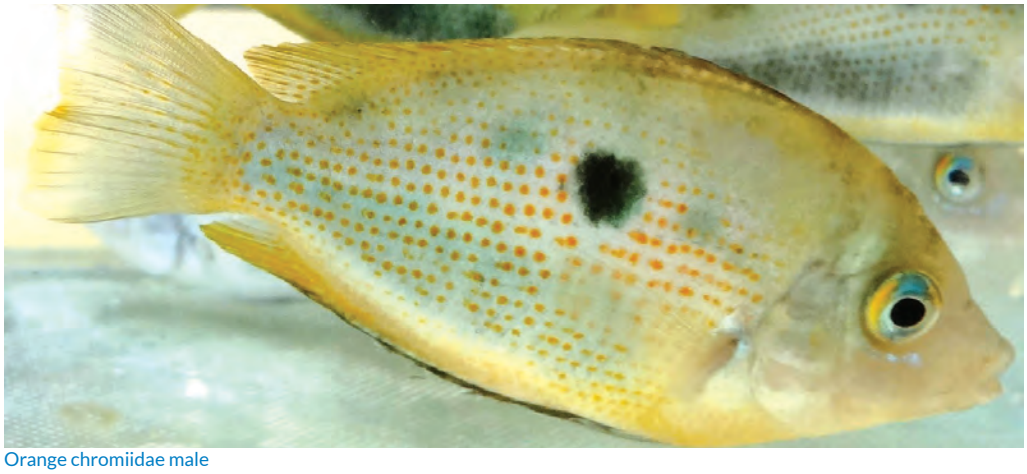
Breeding of gold spot mullet, *Liza parsia*

Gold spot mullets are regionally important species having high consumer demand and high value in West Bengal and Orissa. Considering the market demand, effort has been made to develop the aquaculture of this species in KRC of CIBA. As a first step, experiments were carried out develop breeding technology of this species. Trials were carried out using broodstock developed in the pond as well as wild caught brooders. Broodstock raised in the ponds were provide LHRHa implantation at monthly interval for four months. At the end of the trial, early oozing males and females with developed ovary was found suggesting that LHRHa could be a candidate hormone for the induced maturation of *L. parsia*. In the trial using wild broodstock, animals were provided with hCG implantation. Out of ten animals one animal spawned although eggs were unfertilized.

Liza parsia female

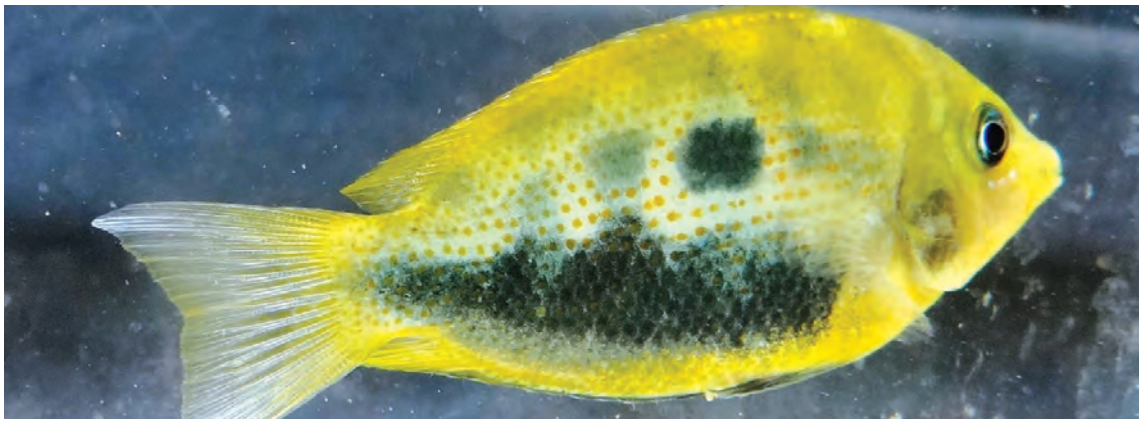
Breeding and seed production of orange chromide, *Etroplus maculatus* in backyard -A livelihood option for rural coastal community

Considering the significance of ornamental fish production as a livelihood option in rural areas, development of adoptable seed production technologies of brackishwater ornamental species has been given a major thrust at ICAR-CIBA. The ornamental fish, orange chromide, *Etroplus maculatus* possesses attractive colour patterns, an elongated oval shaped body, yellow to bright



Orange chromiidae male

colouration, with three short transverse bars in mid-section of the body. The current market price for the fish ranges from Rs.10-15 per fish. Breeding and juvenile production of *E. maculatus* have been developed under controlled conditions in FRP tank with the aim of developing a homestead hatchery unit. In each tank, two pairs of orange chromide (BW: 7.0-11.0 g) of male and female were stocked. The water quality characteristics were: salinity (5-10 ppt), temperature (25-28oC), pH 7.5-8.2) and dissolved oxygen(6-8 mg/L) Spawning was achieved after 10-12 days of stocking in the broodstock tank. Wrigglers (3 days post hatch) of 250-300 numbers were collected from each tank. Repeated spawning could be observed between 10-15 days after wigglers collection. Average fecundity was 292±109.38 and inter-spawning interval was 12 ± 2.13 days. Rotifers and C. salina were supplied together as feed up to 15 dph followed by Artemia nauplii up to 25dph, thereafter the fishes were weaned to formulated artificial feeds. The juvenile attained mean length of 45.0 ± 5.4 mm and mean body weight of 2.2 ± 0.43 g at 75 dph. The present experiment demonstrated the scope to develop breeding model of *E. maculatus* as livelihood options for small scale farmers and Self-Help-Groups. A business module has been developed and a monthly income of Rs.4000-5000/- could be generated through nursery rearing of orange chromide in backyard systems.

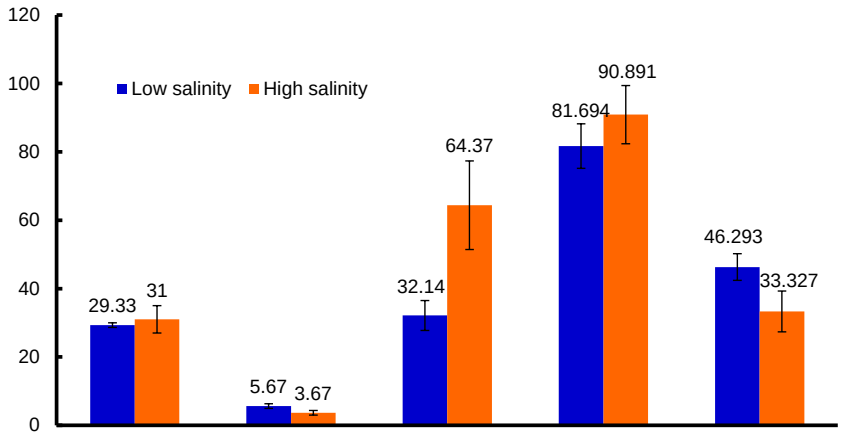


Orange chromiidae female

Juveniles of orange chromide produced under tank conditions

Optimization of the seed production of pearlspot by curtailing parental care and salinity manipulation

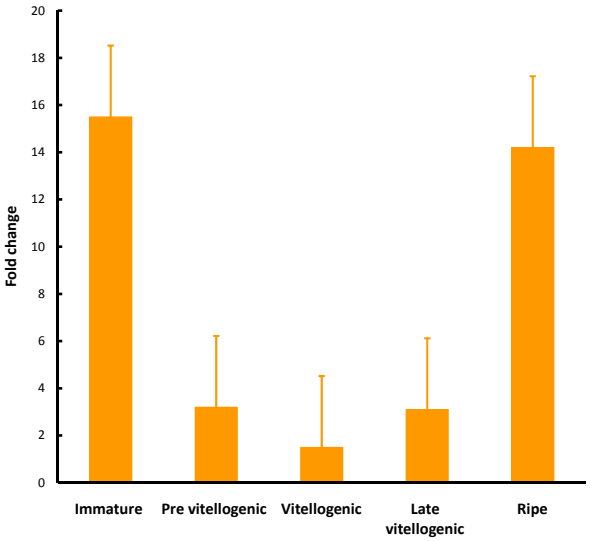
The captive breeding of pearlspot was optimized in modular tank (1t) system by curtailing parental care and salinity manipulations. A 216 day breedign trial was conducted in RAS based modular tank models (capacity- 1t). Experiment was carried out at salinity regimes: low (4-8 ppt) and high (26-30 ppt), and the larvae were weaned at early phase of spawning. The mean breeding frequency, the inter-spawning interval and average larval production per spawning of pearlspot at low and high salinity were 5.66±0.66 and 3.67±0.67; 32.14±4.38 days and 64.37±12.95 days, 816.94±64.58 and 908.91±84.86 respectively. Significantly ($p<0.05$) lower inter-spawning interval was recorded at lower salinity. The results demonstrate that the modular tank systems are suitable for captive breeding of pearlspot as they facilitate easier larval separation and management. Further, the curtailing of parental care following larval separation can optimize the breeding frequency and larval production of pearlspot in captivity. The reproductive performance in terms of higher breeding frequency, lower inter-spawning interval and higher total larval production per pair of fish was recorded at low salinity relative to high salinity. Experimental trials on egg hatching rates without parental care gave hatching rates above 95%, this result may support future biotechnological intervention for developing specific ornamental traits.



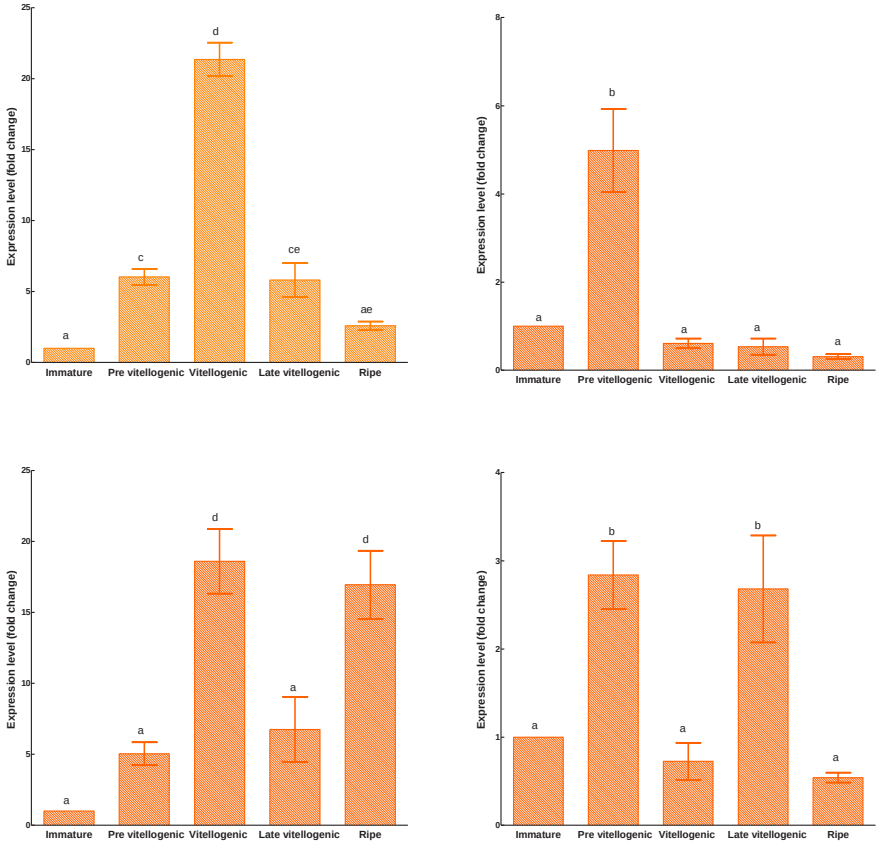
Interval to first breeding, breeding frequency, inter-spawning interval, larval production per spawning and total larval production of pearlspot *Etroplus suratensis* in a small tank system following larval separation at low and high salinity during 216 days

Expression of vitellogenin (Vg) and Gonad Inhibiting hormone (GIH) mRNA expression during reproductive cycle of wild *Penaeus monodon* broodstock

In order to understand the control mechanism of reproductive maturation of *P. monodon*, GIH and Vg mRNA transcript levels in reproductive and reproductive associated tissues (e. g. ovary , hepatopancreas and eyestalk ganglia) were quantified by real time Polymerase Chain Reaction assay (RT-PCR). For Vg mRNA analysis tissues of both naturally reproducing and endocrinologically induced (eyestalk ablated) females were used. GIH mRNA was expressed at highest level in the eyestalks of shrimps at



Expression profile of Gonad inhibiting hormone gene in the eyestalk ganglia of wild females of *Penaeus monodon*

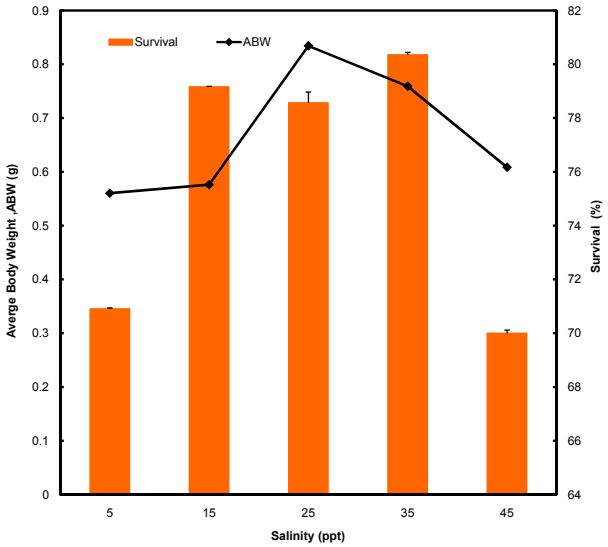


Vg mRNA expression levels in ovary (a &b) and hepataopancreas (c&d) during different ovarian vitellogenic phases. Figures b and d are eyestalk ablated females and figures a and C are intact females. Note two peaks in the ovary and hepatopancreas of the eyestalk ablated females

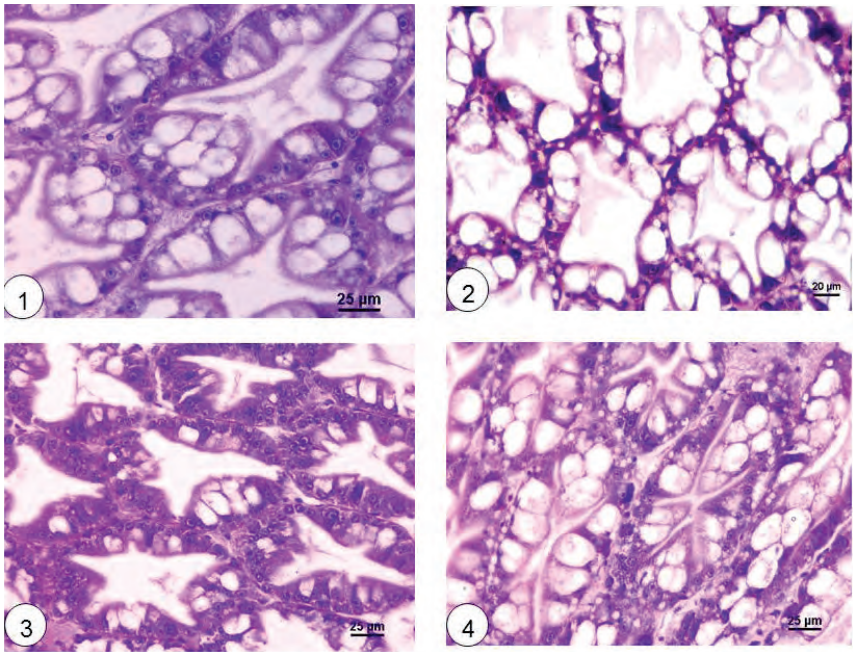
the immature and ripe ovary, and there was a sharp decline in the pre vitellogenic through late vitellogenic stages. Vitellogenin gene expression level in the ovarian tissue during the naturally reproductive cycle of wild broodstock showed marked variation at each ovarian stage. Vg mRNA level was highest in early vitellgoenic phase, and there after Vg level found to be less and showed minimum at the ripe stage. On the contrary in the hepatopancreas highest Vg transcript expression was found in the previtellgoenic ovary. In the endocrinologically induced shrimps (eyestalk ablated) highest Vg transcript levelsl were found both in the early vitllgoenic ovary and ripe ovary. Similarly in the eyestalk ablated shrimps, Vg mRNA levels were higher in pre vitellogenic ovary and late viellogenic ovary. The highest level of GIH mRNA in the ripe ovary indicates that the animal undergoes a reproductive rest after the spawning. Further in the endocrinologically induced females ripe ovary showed a high level of Vg mRNA contrastingly intact ripe ovary comprises low level of Vg mRNA indicating a continuous reproduction after the removal of eyestalk.

Effect of salinity on growth performance and physiological changes in hepatopancrease of *P. indicus* juveniles

The hepatopancreas, analogous to liver of higher organisms, is the major vital organ involved in diverse metabolic activity in crustaceans. Digestive enzymes and histological analysis of the hepatopancreas helps to understand physiological adaptation of Indian white shrimps related to ambient salinity that indirectly regulate growth at lower salinities of shrimps. A-30 day experiment was carried out to assess the effect of different salinities (5, 15, 25, 35 and 45‰) in the hepatopancreas and digestive enzyme in *P. indicus* juveniles(<0.3 g). Highest final body weight was recorded at 25‰ (0.83±0.4) followed by 35‰ (0.78±0.08) and lowest body weight was recorded in lower salinity (5‰),0.56±0.03g. Similarly, higher and lower salinity group recorded comparatively lower survival (70%) compared to other groups. However, shrimps reared at lower (5‰) and higher (45‰) recorded higher activities of digestive enzymes like amylase, protease and chymotrypsin levels compared to shrimps reared at 15-25‰ salinities, indicates that extra food energy need to be derived to compensate the energy loss for osmoregulation when ambient salinity is different from the optimum salinity requirement. Furthermore, histology of hepatopancreas tubules at lower and higher salinity had higher number and enlarged size of B cells, main cite for synthesis of digestive enzymes. This indicate that high rate of synthesis and release of digestive enzymes in hepatopancreas tubules for supply of energy for better osmoregulation of shrimp at high or low salinity to adapt to environmental stress. Furthermore, the number of R cells in the hepatopancreas tubules



Influence of salinity on growth and survival of *Penaeus indicus*



Hepatopancrease (H&E) of shrimps reared in different salinities

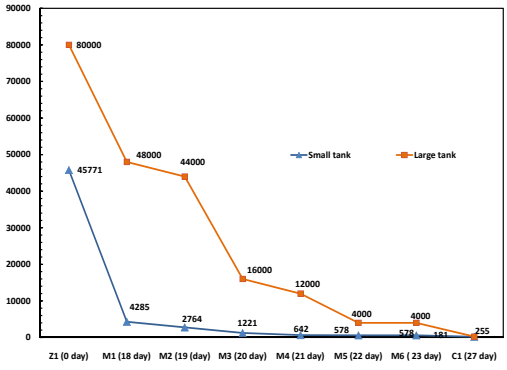
differed between salinity treatments with maximum R cells recorded in 15‰ ppt salinity while higher and lower salinity had lowest R cells. As R cell is considered the main site for nutrient reserve, decrease of R cell number at low salinity might be due to the enhanced energy demand for osmoregulation. High energy expenditure was noticed at high and low salinity to cope up with the environmental stress through various functional adaptations. Thus study suggests that *P. indicus* have the ability to adapt low or high salinity

Optimization of density and anesthetic for *P. indicus*, PL for long distance transportation (24h)

Transportation mortality is the major problem associated with long distance dispatch of post larvae, particularly highly cannibalistic post larvae of *P. indicus*. Although many anesthetises are used in aquaculture, only few of them are cleared for aquaculture use. Clove oil, distilled product of the clove tree, (a topical anaesthetic cleared for use in human medicine) has recently been suggested as anaesthetics in aquaculture. An experiment was carried out to determine the optimum dose of clove oil for transportation of *P. indicus* PL for a period of 24 h. Significantly highest survival was obtained at a dose of 30 µg/L. Further, two 24-h simulated transportation experiment was carried to find out the optimum density and anesthetic for ideal transportation experiment of shrimp PL. Post larvae (PL12) were stocked at 1000, 1500, 2000 and 3000 nos. per PE transportation bag (3.5 L).The water quality characteristics were maintained at optimum levels, for example: Temperature(20-22OC), salinity (28-30 ‰) , DO (8 ppm) , total ammnona nitrogen (0.1 ppm). Further, Artemia nauplii ~9 nos/ml were maintained at tanks. After 24 hr simulated transportation experiment, lowest density, 1000 nos/bag provided highest survival (67±1.7%) followed by 1500 nos/bag (61±6%). To study the role of anesthetic in shrimp, two anesthetic clove oil (30µl/L) and phenoxy ethanol (100µl/L) and simulated transportation carried out for 24h. The highest survival was noticed using clove oil (60±5%) while no significant differences were noticed among phenoxy ethanol (54± 4%) and control (50±3%). Study revealed that using low dose of anesthetic and optimum density of prey (20 artemia Nauplius / ml) with Post larvae density 1000-1500 nos/bag can be used for transportation. Further research about the ideal stage of PL and optimum temperature for PL transportation is needed

Optimization of mud crab larval rearing protocol

In order to develop a commercially viable hatchery production protocol for mud crab *S. serrata*, a total of six hatchery runs were carried out. Two runs (run 4 and 5) were carried out to evaluate the timing of introduction of Artemia and cessation of Rotifer in the feeding regime of mud crab larvae. In the first hatchery run the larvae were fed Rotifer (12-15 no/ml) throughout the hatchery run from Z1 to Megalopa stage and Artemia (1 no/ml) were introduced in the late Z3 stage onwards. Experiments were carried out in large FRP tank (5000 capacity) and small FRP (500 L capacity). Besides this variables such as effect of antibiotic (oxy tetracycline) effect of substratum, effect of tank color

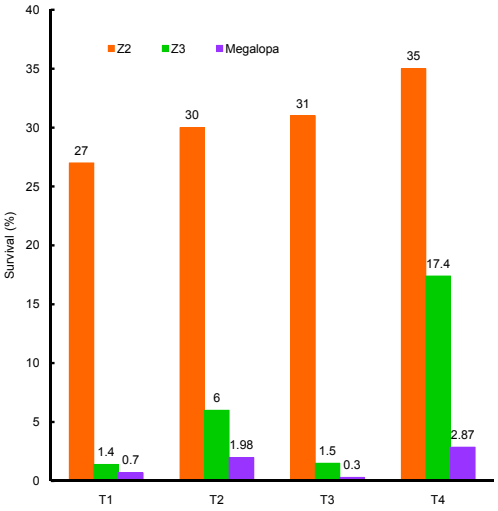


Survival of megalopa of *Scylla serrata* in large tank and small tank

were evaluated for the hatchery production. The experiments were carried out in large container (5000 L) and small container (500 L), up to megalopa stage the percentage of survival in the large tank was as high as 60%. Further when Rotifer was removed from Z3 onwards the success rate was found to be high. It was also found that the success rate of hatchery run was high when black tanks were used instead of off-white tanks

Effect of microencapsulated feed on larval rearing of *Scylla serrata*

Inconsistency in production of rotifer and variation in quality of micro algae are major challenges in mud crab hatchery production. A study was carried out to evaluate the effect of microencapsulated feed in combination with live feed, vitamin C and Cholesterol. Mud crab zoea were reared at a stocking density of 75 no/m^2 with different combination of feeds (Control: Live feed alone; T2: Live feed + formulated feed + Cholesterol; T 3: Live feed + formulated feed + vitamin C; T4: Live feed + formulated feed + Cholesterol + vitamin C) . At the end of the experiment, significantly higher proportion of megalopa was obtained in the group provided with live feed supplemented with cholesterol and vitamin C (2.87% in T4 treatment compared to 0.7% in control treatment).



Effect of different feeding schedule on larval survival of *Scylla serrata*

Density improvement of rotifer *(Brachionus plicatilis)* through use of pure dissolved oxygen in place of traditional aeration in rotifer culture tanks

Small body size, motility and high reproduction rate makes rotifer an ideal live food for hatcheries engaged in finfish/shell fish larval production. Reproductive rate of rotifer varies according to presence of food, dissolved oxygen and other water quality parameters and these maybe utilized to optimize the density of the rotifer population. The effect of dissolved oxygen was assessed in two different culture tanks (700 l). Rotifer (Brachionus plicatilis) were inoculated at the density of 50 no./ml with Chlorella salina (cell density 1.2 X 107 cells/ml) feeding. In tank A pure oxygen (DO 6.0 ± 0.1 ppm) was provided and in tank B vigorous aeration (DO 5.4 ± 0.3 ppm) was provided. Water level was increased gradually every day to provide adequate space for growing population and to reduce the ammonia levels. Daily water quality parameters were analysed. On 7th day rotifer population density was reached 1206 ± 28 no/ml in tank A as compared to 1044 ± 18 no/ml in tank B indicating that use of pure oxygen as compared to the use of aeration can support rotifer population at significantly higher densities.

Artemia biomass production in outdoor tank based batch system

Live or frozen Artemia biomass forms an excellent feed for the nursery production phase of most aquacultured species. Additionally it has also been regarded as a high valued maturation diet in the shrimp broodstock rearing. Further, the use of Artemia as a delivery system for dietary enrichment and hormone therapy has been well established. A study was carried out to optimize Artemia biomass production using hypersaline (100-150‰), brine from salt pans. Experiment was carried out in batch system at different density in different feed combination at diluted brine (40‰). The first experiment was carried out using four different type of feed: microalgae (Chaetoceros sp. 1), Rice flour (T2), Rice bran (T3) and mixed diet (combination of algae, rice bran and rice flour at equal proportion T4). Artemia instar 1 was stocked at a density, 1000 no/L in all the experimental tanks. Highest total ammonia nitrogen (TAN) was recorded in mixed diet Proximate composition of harvested biomass indicated a highest level in the mixed diet, conversely fatty acid profile was found to be higher in treatment group with algae alone. At the end of the experiment, highest biomass of 2.5±0.7kg/m3/ 2 week (1.8-3.2 kg/m3) was recorded in rice flour and mixed diet fed groups indicating combination of carbohydrate sources with microalgae could yield better production and flexibility in culture compared to microalgae based system. In order to evaluate the optimum stocking density of Artemia, for biomass production, a two week experiment was carried out at three different stocking density (500, 1000, 2000 and 3000 no/L

with mixed feed combination (Chaetoceros, rice bran and rice flour at 1:1:1). After 15-day experiment, highest survival (53±3) and biomass (3.29±0.5 kg/m3) was obtained at the stocking density of 500 no/L. Further, at lower density more than 90% of population attained maturation and riding couple formation. Economic analysis indicated a Benefit cost ratio, 5.1 and cost of production per kg (60/-) at 500 no/L

Polychaete biomass production under controlled conditions

Marine polychaetes have been well known as a maturation diet in penaeid shrimp hatchery across the world. It has been well recognized as indispensable component of penaeid broodstock nutrition. Recent biosecurity concerns on the wild broodstock, and reportedly diminishing natural stock, reinforce the importance of development of techniques for culture of polychaetes. Large Marphysa graveli, marine polychaete found in the Muttukadu lake (Tamil Nadu), which is commonly used in the shrimp hatchery were bred in a modified culture system. A total of 40 adult animals were reared in 300 L tanks in three replicates for 168 days, and at the end of the experiment a total of 1267 (10 to 50 mm long) juveniles were produced with an average of 422 individuals per tank.

Harvested polychaete biomass

Nutrition and feed management

CIBA's pilot scale feed mill at Muttukadu housing ring die pellet mill and twin screw extruder

Nutrition and feed management

In aquaculture, feed and its management continues to be a major recurring cost, which often ranges from 50 to 60 % of the total cost of production, and stands out be key factor in determining the profitability of the crop. Similarly, in feed manufacturing, fishmeal remains to be prime ingredient, which determines the cost of feed. Last year fishmeal price has increased sharply due to poor production related to El Niño weather system and increasing demand for aquafeed. Not only fishmeal, but also other ingredients showed a steep increase in price due to unexpected drought in most of the regions in India. Even in this challenging business environment, India's aqua feed sector was more vibrant with current production around 1.3 million metric tons of feed and it is expected to touch 6 to 7 million metric tons in 2020. Our dependency on overseas companies for the hatchery feeds for broodstock and larvae still continues and it creates a pressure on the hatcheries in producing quality seeds for cheaper price. 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, feed management options considering natural feeds etc.

CIBA's cost effective shrimp feed for *P. vannamei*: Vannamei^{Plus}

Major share of Indian shrimp feed business still under the monopoly of the multinational corporate companies, which is characterised by unbearable hike in feed price. CIBA's Focussed research on nutrient requirements, scientific feed formulation, database on locally available ingredients led to a cost effective shrimp feed (Vannamei^{plus}) using locally available ingredient and indigenous feed manufacturing technology. This cost effective Vannamei^{Plus} has been tested in a farmer's pond in Andhra Pradesh and Gujarat states. Vannamei^{Plus} has good attractability and palatability as revealed by the farmers. While the cost of the commercial feed available to the farmer was about ₹ 78/kg, the cost of Vannamei^{Plus} was only ₹ 54 per kg (inclusive of cost of ingredients + processing and transportation cost). At the end of 117 days of culture shrimps fed Vannamei^{Plus} have attained an average final body weight of 27.1 g and shrimps fed control feed have attained the final body weight of about 24.6g. The average FCR was 1.69 and 1.79 in shrimp fed Vannamei^{Plus} and control feed respectively. We demonstrated that, while feed cost to produce 1 kg of shrimp can be restricted to ₹91 by using "vannamei^{Plus}, it can go up to ₹ 140 with commercial feeds.

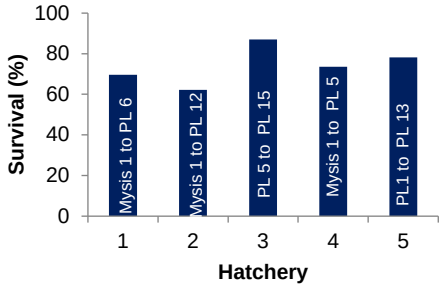
Pacific White shrimp, *P. vannamei* produced using Vannamei^{plus}

Moringa leaf meal as a functional growth-promoting additive in *P. vannamei*

Moringa oleifera Lam (Moringaceae) is a highly valued plant with an extraordinary range of functional properties, including growth promotion, antimicrobial and antioxidant effects in fish and animal nutrition. An experiment was conducted to evaluate the growth promoting effect of moringa leaf meal (MLM) in the diet of pacific white shrimp *P. vannamei*. MLM was incorporated in the standard CIBA's Vannamei^{plus} formulation at 0, 0.5, 1.0 and 1.5%. After 45 days of feeding trial, shrimps fed 1% MLM had significant difference in the growth performance. The average daily weight gain (ADG; mg/day) has increased from 124.37 in the control feed (0%) to 165.52, 184.30 and 169.48 respectively in 0.5, 1 and 1.5% MLM inclusion levels. There was no significant difference in survival among the experimental diets, which ranged between 91.11% and 95.56%. FCR showed a significance improvement as the level of MLM inclusion increased from 0 to 1.5%. Overall, MLM has the potential to be used as functional feed additive for improving the shrimp growth.

CIBA's shrimp larval feed: Shrimp Larvi^{Plus}

Larval feeds are specialty feeds, which is one of the vital elements for a successful hatchery operation. At present 100% of the larval feeds used in Indian shrimp hatcheries are imported, and are very expensive. Visualizing the demand for the larval feeds, CIBA has developed feeds for different larval stages. Micro-bound and micro-particulate feeds of different particle sizes (300 to 800 micron) were prepared to contain 55% crude protein and 12% lipid, using premium ingredients enriched with EPA and DHA. The feeds were evaluated in commercial hatcheries, which have signed agreement with CIBA under public private partnership (PPP) mode.



Survival of PL fed Shrimp Larvi^{Plus} in different shrimp hatcheries

Feedback from the hatchery operators witnessed that Shrimp Larvi^{plus} has good palatability and attract ability. In addition, water quality of the larval rearing tanks also were stable and well maintained while using this feeds, which could be attributed to the good water stability factor of the feeds. Survival of PL was > 60% after 12 days of age. For the first time in this country CIBA has developed, an indigenous shrimp larval feed which could be a cost effective replacement for imported feeds. Further technology refinement is in progress for developing feeds for shrimp early larval stages.

Micro particulate larval feeds

CIBA's seabass larval feed: Seabass Larvi*Plus*

Seabass larvae are highly cannibalistic in the absence of suitable feeds, therefore apt feed and proper weaning are key elements in viable hatchery production of seabass seeds. In this setting, CIBA developed micro bound larval feeds for seabass using extrusion cooking. Feeds were formulated to contain 55% crude protein and 15% lipid, using premium ingredients of high digestibility and nutritive value. The larval feeds were tested in Auro maritech hatchery facility. The results revealed that the feed have better attractability and palatability in seabass larvae of different stages with respective particle sizes. The survival of the seabass fry from 25 DPH to 45 DPH ranged from 72-86%. Feasibility analysis for scaling up of the technology is in progress with participation of Auro maritech hatchery for large-scale production of seabass larval feeds.

CIBA's crab fattening feed: Scylla*plus-F*

Both farming and fattening of crab still mostly depend on conventional unsustainable feeds such as trash fish, bivalve meat and other meaty foods, and sourcing of these foods is always a constrain. On a trial basis, CIBA developed crab fattening feed, Scylla*Plus-F* using indigenous ingredients to contain 35% protein and 5.6% fat. Feed was processed as 6 mm sinking pellets and tested in soft crabs reared in small sea cages installed by a farmer at Atiramapattinam, Pudukkottai, Tamil Nadu. Feed was offered at 5% of the body weight and in a specially designed feeding trays which were placed inside the cages. Regular monitoring of the crab behaviour and the feeding trays evidenced that feeds had been very well accepted by the crabs, and the crabs could be hardened within 15-19 days. It has been decided to have many such trials using the CIBA feed and feeding methods in different places.

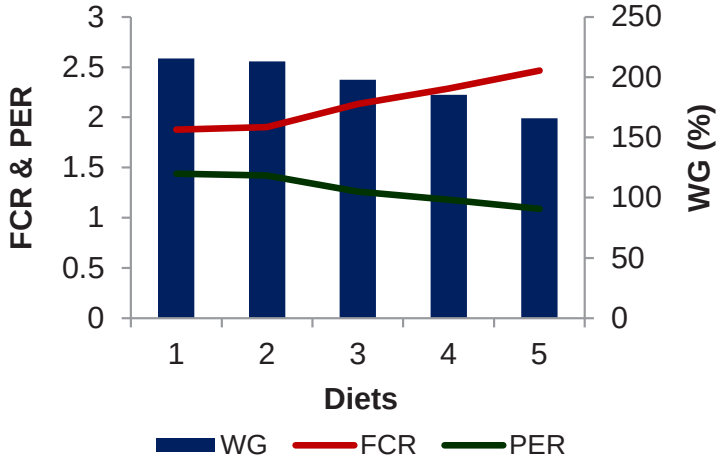
Harvested crabs from cages

Nutrient utilization of sunflower and groundnut oil cakes in shrimp *Penaeus indicus*

Sustainable shrimp aquaculture needs significant reduction in fishmeal usage in compounded feeds to address the environmental concerns and reduction of cost of shrimp production. Many choices of alternates of fishmeal are emerging, and oil cake such as sunflower oil cake and groundnut oil cake are locally available agriculture by-products. In order to optimize the inclusion of sunflower cake and ground nut oil cake in *P. indicus* feed, ten test feeds having 0, 2.5, 5.0, 7.5 and 10% levels of each cake were tested in *P. indicus* juveniles two separate 45 day feeding trial. The weight gain percentage was significantly ($P < 0.05$) lower in shrimp fed 7.5% and above sunflower cake containing diets. FCR increased from 1.88 to 2.6 in shrimp fed diets with 0 to 10% sunflower cake. The apparent crude protein digestibility is 82.73% and 68.36%, respectively in 0% sunflower cake feed and 10% sunflower cake fed shrimp. The incorporation of

Growth performance of *P. indicus* fed sunflower cake at varying levels

Diets	FCR	Survival (%)	PER	ACPD (%)
SF 0	1.88d ±0.02	93.33 ±3.85	1.40a ±0.01	82.73a ±1.92
SF 2.5	2.13c ±0.07	86.65 ±6.66	1.23b ±0.04	83.13a ±1.93
SF 5	2.23bc ±0.08	86.68 ±3.85	1.18bc ±0.04	83.69a ±2.48
SF 7.5	2.39ab ±0.03	91.11 ±5.88	1.10cd ±0.01	75.19ab ±1.38
SF 10	2.60a ±0.04	84.44 ±8.01	1.01d ±0.02	68.36b ±2.0

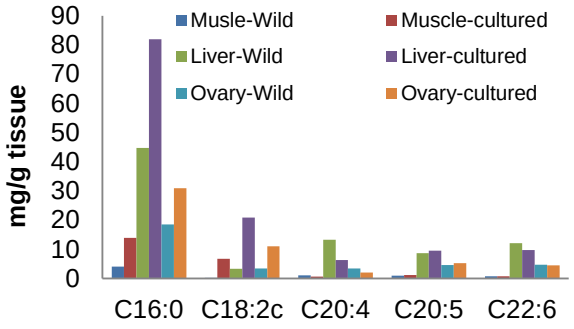


Growth performance of *Penaeus indicus* fed groundnut cake at varying levels

GNC above 7.5% resulted in reduction of weight gain percentage. Protein efficiency ratio and FCR were also significantly (P<0.05) affected in shrimp fed above 5% GNC. Based on the results it is suggested that sunflower cake can be included in shrimp feeds up to 5%. In order to increase its digestibility and incorporation level, the both oil cakes were fermented with *Aspergillus niger*. The digestibility trial results indicated that with fermentation the protein digestibility was significantly (P<0.05) improved.

Comparative study of fatty acids in the muscle, liver and ovary of wild and cultured mature gold spot mullet, *Liza parsia*

Generally, the reproductive performance of pond-reared fishes is much lower than the wild collected brood fishes due to deficiency or imbalances in nutrients of the pond reared fish, especially the essential fatty acids (DHA, EPA, and ARA). The fatty acids of yolk plays major role in the embryogenesis and yolk-sac larval development by involving in the modulation of neural and endocrine functions. To authenticate this, present study has been taken with a primary aim to compare the contents of fatty acids of different tissues of wild-caught and pond reared mature goldspot mullet, *Liza parsia*. Different parts like muscle, liver and ovaries of mature brood fishes from culture ponds and from wild were collected and analysed for fatty acid composition. The most significant differences in the fatty acid profiles of the two groups were observed in liver and muscle. The cultured fish contained significantly higher levels of C16:0 and C18:2ω-6 in all three parts compared to the sample of wild fishes (3.4 and 23 fold increase in muscle, respectively). The most important fatty acids like C20:4ω-6 and C22:6ω-3, which plays major role in reproduction, embryogenesis and

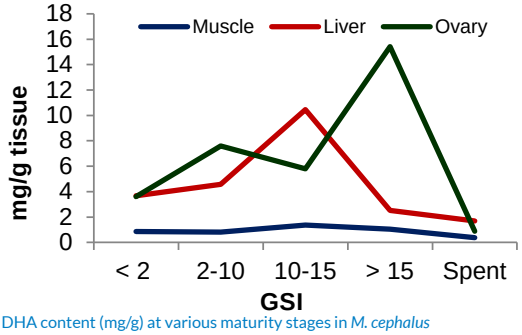


Major fatty acids (mg/g) in different tissues of mature *Liza parsia* from wild and culture conditions

larval development are conspicuously lower in pond reared fish liver and ovary (50 to 20% lower). The mobilization and accumulation of fatty acids differed significantly at different stages of maturity. These results suggest that the lipid composition of the formulated diet fed to the cultured fish differed greatly from that of the diet consumed by the wild fish in which hypothetically contains the desirable lipids for reproductive performance.

Fatty acid mobilization in wild Grey mullet, *Mugil cephalus*, at different stages of maturation

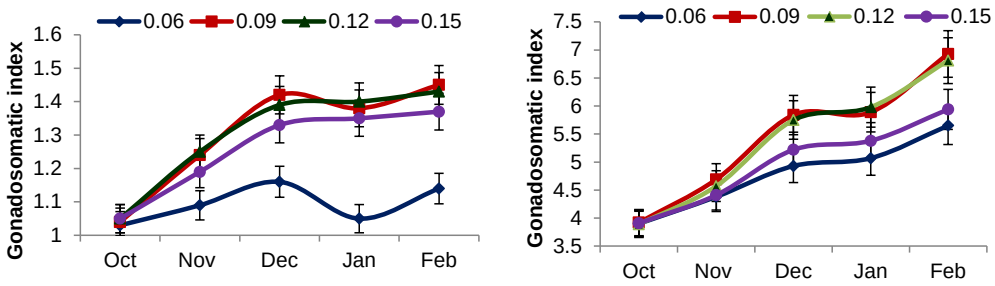
The formation of an egg is a unique, complex process involving various nutrients and hormones in different species of fish. Understanding the mechanism underlying the processes can be studied by analysing the composition of different tissues at various stages of maturity, and that information will be useful for captive breeding of selected species. In the present study, fatty acid composition tissues of wild grey mullet at different stages of the reproductive cycle was studied. The results of the present study showed that gonadal maturation was associated with fatty acid accumulation and the accumulation is not uniform for all the fatty acids. The findings suggest that during maturation (up to 15 GSI) most of the fatty acids are simultaneously increasing in all three tissues indicating the essentiality of dietary up take of these fatty acids. Whereas the fatty acids like DHA, EPA and ARA were selectively accumulated in the ovary (2 to 3 folds) with simultaneous reduction in the liver and muscle signifying their role in the reproductive function in *M. cephalus* during advanced maturation stage. The fatty acids like palmitic acid was increased in liver with maturity indicative their catabolic role during spawning and reduced in spent fish from 40 mg/g to 5 mg/g.



DHA content (mg/g) at various maturity stages in *M. cephalus*

Broodstock feed for gold spot mullet, *Liza parsia*

Gold spot mullet is a small size high value mullet species, which is amenable for induced breeding under captive conditions. It is expected that, their maximum reproductive potentials can be realized through dietary interventions for the broodstock. Four isoproteic(30%) feeds with varying dietary lipid levels such as, 6%, 9%, 12% and 15% lipid were fed to parsia brood stock maintained in pond enclosures (100 m^2) in triplicate, for 120 days. Significantly higher gonadosomatic index (GSI) was observed in both male



GSI of male and female *Liza parsia* fed broodstock feed

and female fishes fed 9% and 12 % lipid levels. GSI values attained peak during January and February month in both the treatments, which indicates this as a suitable season inducing them for spawning. Based on the constructive values on fecundity (49075±664) and ova diameter (0.55±0.07mm) with the fishes fed higher lipid level, it have been concluded that 30% protein and 9 % lipid is required in broodstock diet for gold spot mullet, *L. parsia*.

Formulated feed for pond rearing of long-whiskerscatfish, *Mystus gulio*

Long-whiskerscatfish is a medium sized tasty food fish with good market potential West Bengal. An attempt was made to grow this food fish in ponds using hatchery produced seeds and low cost compounded feed produced with locally available feed ingredients. Feed was scientifically formulated to contain 30% protein and 6% lipid. *M. gulio* fry of 0.85 g were used in ponds at two different densities (1 and 2/m^2). After seven months of culture, body weight of 58±3.3 and 56.8 ± 3.1 g achieved in1 and 2/m^2 stocking density, respectively. The results of this pond trial demonstrated the technical feasibility of farming of this high value catfish up to table size in a period of seven months by using formulated feeds. Further studies will be taken up to optimize the economic feasibility of farming this species in brackishwater.

Pond reared *M. gulio*

Protein requirement for Hilsa fry

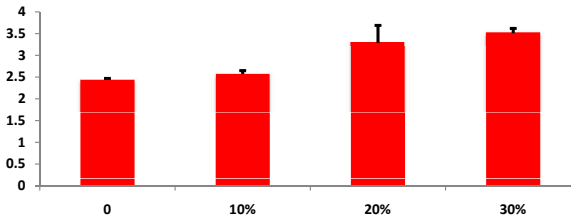
Protein is the costliest nutrient in fish feeds, and determines the feed price. Hilsa shad is a high value fish, which has region specific markets in India. We determined the protein requirement for hilsa fry (3.65±0.02g) under captive rearing conditions in nutrition lab at KRC. Formulated floating feed (500 micron) with different level of protein (30, 35, 40, 45 %) were prepared to determine the protein requirement in hilsa fry in a six weeks trial in RAS system with clear water. Growth performances indicated that 35% protein could be optimum in yielding better FCR and growth.

Dried distillers grain (DDGS) as sustainable alternate for dietary fishmeal in aqua feeds

DDGS is a by-product of alcohol manufacturing process with the nutrients largely comprise of essential proteins that are in favour with aquafeed. DDGS production in India is growing due to increasing ethanol production for fuel, therefore it is apt to evaluate DDGS as a feed ingredient in fish and shrimp feeds.

Formulated feed to contain DDGS for grey mullet, *Mugil cepahalus*

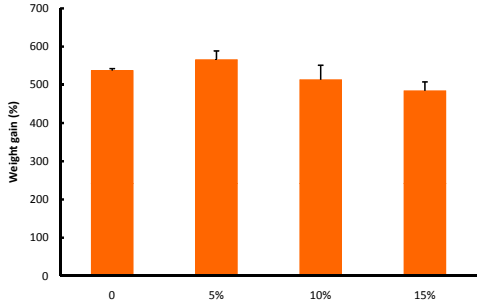
Isoproteinous (CP-27%) and isolipidic (EE-9%) feeds prepared to contain four different levelsof DDGS, i.e., 0, 10, 20 & 30 % replacing different protein source were tested in yard trial with grey mullet fry (Av. Body wt. 0.193 g).After 10 weeks, average daily gain and percent weight gain of fish fed 10% DDGS was comparable (P>0.05) with reference control. Feed conversion ratio(FCR) and Protein efficiency ratio (PER) were not affected up to 10% DDGS inclusion. Therefore, it has been inferredthatDDGSis having potential to replace 30% of fishmeal and can be positively incorporated up to 10% level in diet of Mugil cephalus without compromising the growth of fish.



Growth of *M.cephalus* fed different level of DDG

Formulated feed with DDGS fortiger shrimp *P.monodon*

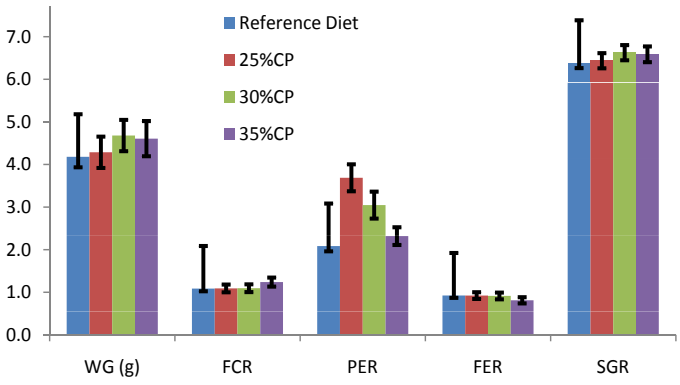
Considering the nutritional requirement and feeding biology of the tiger shrimp, high protein iso-proteic (CP-40 %) and isolipidic (EE-8 %) experimental feedwere prepared with four levels of DDGS inclusion (i.e., 0, 5, 10 & 15 %). After 6 weeks, average daily gain and percent weight gain were similar in all the groups of shrimps fed feed with or without DDGS. No significant difference in FCR was observed up to 10% DDGS, above which FCR was significantly higher (P<0.05). Therefore it has been inferred thatDDGScan beincorporated up to 10 % level in diet of *P. monodon* without any negative impact on shrimp performance



FCR in monodon fed different level of DDG

Growth performance of Indian white shrimp *Peaneus indicus* fed differential dietary protein in the presence of natural feeds

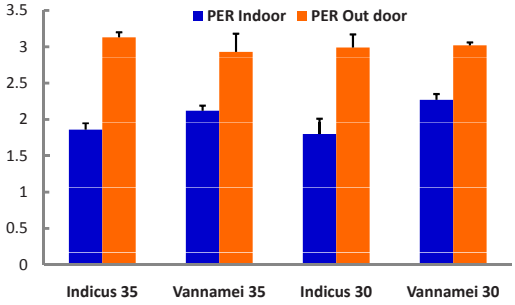
Protein is the most critical and a costliest nutrient in shrimp feed, and it requirement varies in relation, amino acid profile of the ingredient, digestibility, and external factors like the presence of natural feed organisms in the rearing system. An experiment was conducted to estimate effect of various natural feeds on growth performance of juvenile Indian white shrimp by feeding three different protein levels (25, 30 and 35% CP), using specially designed outdoor microcosm tanks containing biofloc and micro algae. A dietary protein level of 25% in the presence of natural feeds with Indian white shrimp in outdoor microcosm tanks yielded a significantly better FCR (1.09) and PER (3.69) compared to their higher levels. In addition, there was no significant difference in any of the growth performance indicators of the shrimp except "protein efficiency". It clearly shows that 25% protein level could be cost effective in the presence of good natural feed production in the rearing system.



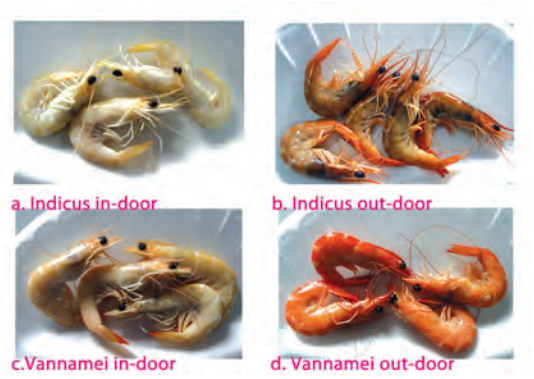
Growth of *P. indicus* fed differential dietary protein

Growth of white shrimps in the presence and absence of natural feeds

In shrimp farming about 50 to 60% of the operational expenditure is invested for feed. By understanding the natural feed availability in the rearing system and considering the potential of shrimps to utilize various natural feeds for their growth, there is a huge scope for reducing the cost of production. A feeding trial was conducted to elucidate the contribution of natural feeds for the growth of juvenile penaeid shrimps (vannamei and indicus) fed two different dietary protein levels (30 and 35%) in the absence and presence of natural feeds. There was a significant difference in the weight gain of the shrimps fed same level of dietary protein, and gown indoor and outdoor. Overall outdoor systems with natural feed got a maximum weight gain (vannamei: 8.59 vs 7.71; indicus: 5.26 vs 3.16) indicating a significant contribution of nutrients from the natural feeds. This clearly indicates that, there is ample chance for cost savings in feed and feed management by considering the natural feeds in the rearing system.



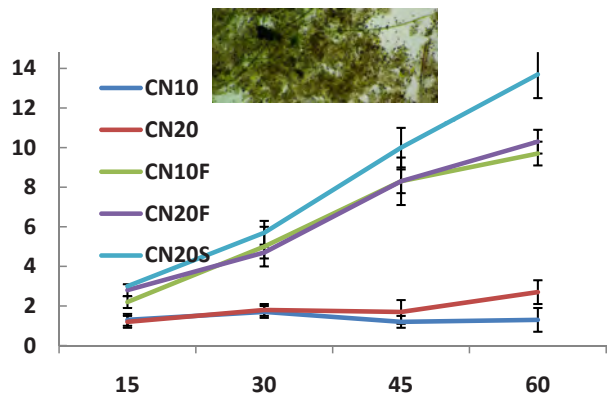
Variations in protein efficiency ratios in shrimp reared indoor and out door



Accumulation of pigments in the final carcass evidences the consumption of natural feeds

Productivity and nutritional characters of biofloc as a protein source and potential fishmeal replacement

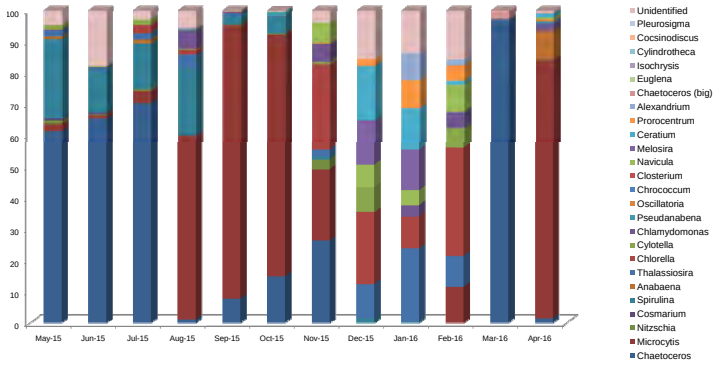
Other than use of biofloc in in situ feeding,the new concept is to harvest the biofloc in continuous manner and dry themto produce biofloc meal. This meal can be a functional feed ingredient in aquafeeds. In this backdrop, we attempt to study the productivity, and nutritional composition of harvested biofloc in relation to C: N ratios. Self-circulating out-door microcosm tanks were used for producing biofloccs. Biofloccs were produced against various C:N ratios and with presence of fish and shrimp. Radial flow settlers in combination with filter meshes were used for harvesting the biofloc from the water. Our observations indicated that, the presence of shrimp and high C:N 20 synergistically contributed to more protein containing biofloc production, rather than by any of the factors independently. Presence of shrimp yielded more biofloc production compared to fish. Matured brown biofloc dominated by bacterial biomass had higher protein compared to the green biofloc which is formed by more of micro algal cells. Average protein content of the dried biofloc meal was 33%, with ash content >20% irrespective of C:N ratio or presence and absence of fish or shrimp in the system.



Productivity of biofloc in varying C:N ratio

Diversity of micro algae in Muttukadu backwaters

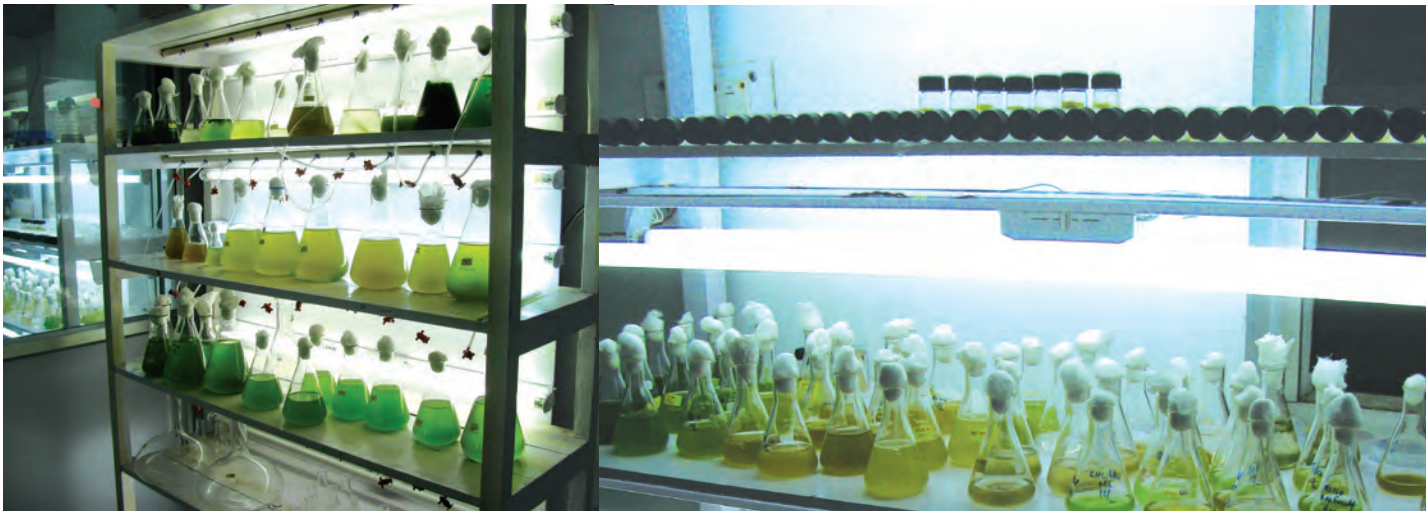
Microalgae have been exploited for human and animal nutrition, cosmetics and for high value nutraceutical molecules. In aquaculture, microalgae are critical link in the larval rearing and nutrition for a brief period, either for direct consumption or indirectly as food for the live feeds. Regular monthly samplings were carried out for estimation of micro algal biodiversity and dynamics of the Muttukadu backwater adjacent to MES, and analysed. During the one year diversity study, 24 genera of microalgal groups belonging Bacillariophyceae (10 genera), Cyanophyceae (6 genera), Chlorophyceae (5 genera) and Dinophyceae (3 genera) were recorded. The following algae were isolated: Isochrysis (2 strains), Thalassiosriasp, Chaetocerossp, Chlorella sp, Naviculasp, Nitzschiasp, Psedanabenaspand 2 unidentified species.The average distribution of microalgal groups in pre-monsoon season showed the dominance of Cyanophyceae (52.96%) & Bacillariophyceae (39.68%) and in post monsoon season showed the dominance of Bacillariophyceae (66.89%). Presence of Dinoflagellates (3 species) after flood and associated mass fish (Tilapia) mortalities observed in post monsoon season.



Monthly percentage distribution of microalgae in Muttukadu backwaters

Microalgal isolates of aquaculture importance, their growth and nutrient profiles

Isolation of individual species of micro algae isolate from natural open water is important step in exploiting the benefits of making them as useful resource in aquaculture. Isolation of microalgae was conducted by serial dilution, agar plating and micromanipulation techniques. Twelve pure isolates have been developed from Muttukadu backwaters, and the growth kinetics were studied. Independently, Thalassiosira, Chaetoceros, Isochrysis and Nitzschia were mass cultured in 500 L outdoor tanks to produce biomass for further bioprospecting. Growth studyshowed a faster growth in Chlorella (like), Isochrysis and Chaetocerossp. Profiling of Isochrysissp (MS 007) biomass showed high percentage of EPA (7.88 % of total fatty acids) and DHA (4.31% of total fatty acids).



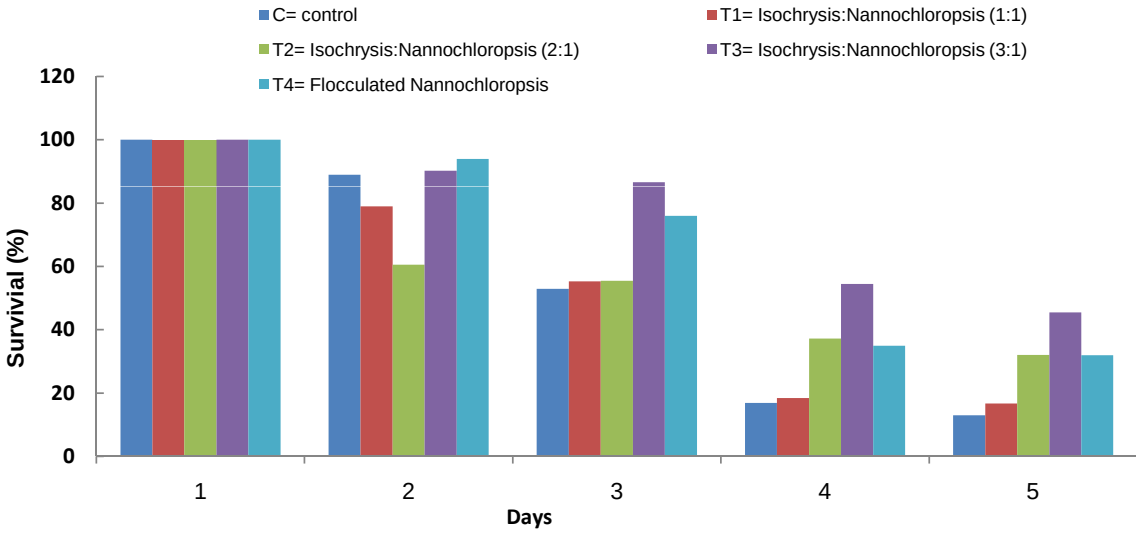
Microalgae isolation chamber and stocks of microalgae strains isolated from Muttukadu backwaters

Flocculation efficiency of alkalis in harvesting of microalgae

One of the bottlenecks in the harvest of micro algae for commercialization of microalgae based industrial processes is the high-energy input for the recovery of microalgal biomass. The difficulty in microalgae biomass harvesting is mainly due to the highly dilute culture with a cell density of lower than 1.0 gL-1 as well as the small size of microalgal cells (2–20 micron). High cost involved in harvesting process accounts for about more than 30 % of the total production cost. The flocculation is a technique used in the harvesting of microalgae. The presence of alkalis will initiate the formation of flocs in the culture. Here different alkalis for the efficiency in flocculation the microalgae (Chlorella vulgaris) were compared. NaOH showed highest flocculation efficiency in shortest time.

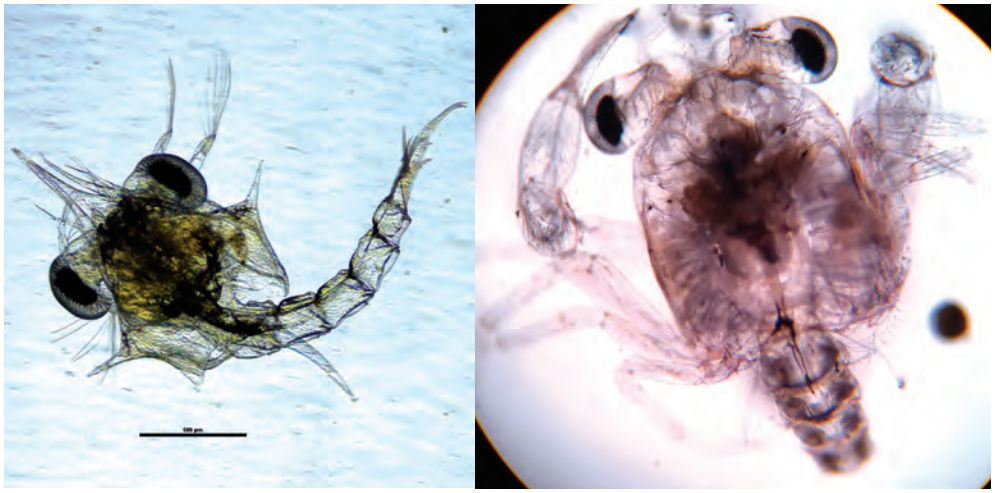
Mixed micro algae for rotifer enrichment in mud crab larval rearing

Dietary EPA and DHA are critical in crab larval metamorphosis. Rotifer raised on chlorella is the recognized live feed in first feeding of crab zoea, and enrichment with commercial media is always preferred to achieve the required EPA and DHA. It is not only expensive, but there is also no improvement in the larval survival. In this backdrop, as alternate strategy, larval rearing experiments were conducted with crab zoea1 using rotifers enriched with individual microalgae (*Nannochloropsis*, *Isochrysis* and *Dunaliella*), and their mixtures. Commercial enrichment medium (Selco from INVE Aquaculture) was used as positive control. Rotifer grown on chlorella alone served as negative control. The results of the experiment showed a higher survival (>40) on day 5 in larvae fed



Survival of mud crab larvae fed enriched rotifer

Isochrysis: *Nannochloropsis* mixture in ratio of 3:1. Interestingly, a fast zoeal conversion from stage 1 to 2 was observed in other Isochrysis: Nannochloropsis mixture ratio 2:1 also. Here it has been evidenced that larval feeding strategies using mixed cultures of Isochrysis: Nannochloropsis could be used as suitable low cost enrichment media for rotifer in effective crab larval rearing.



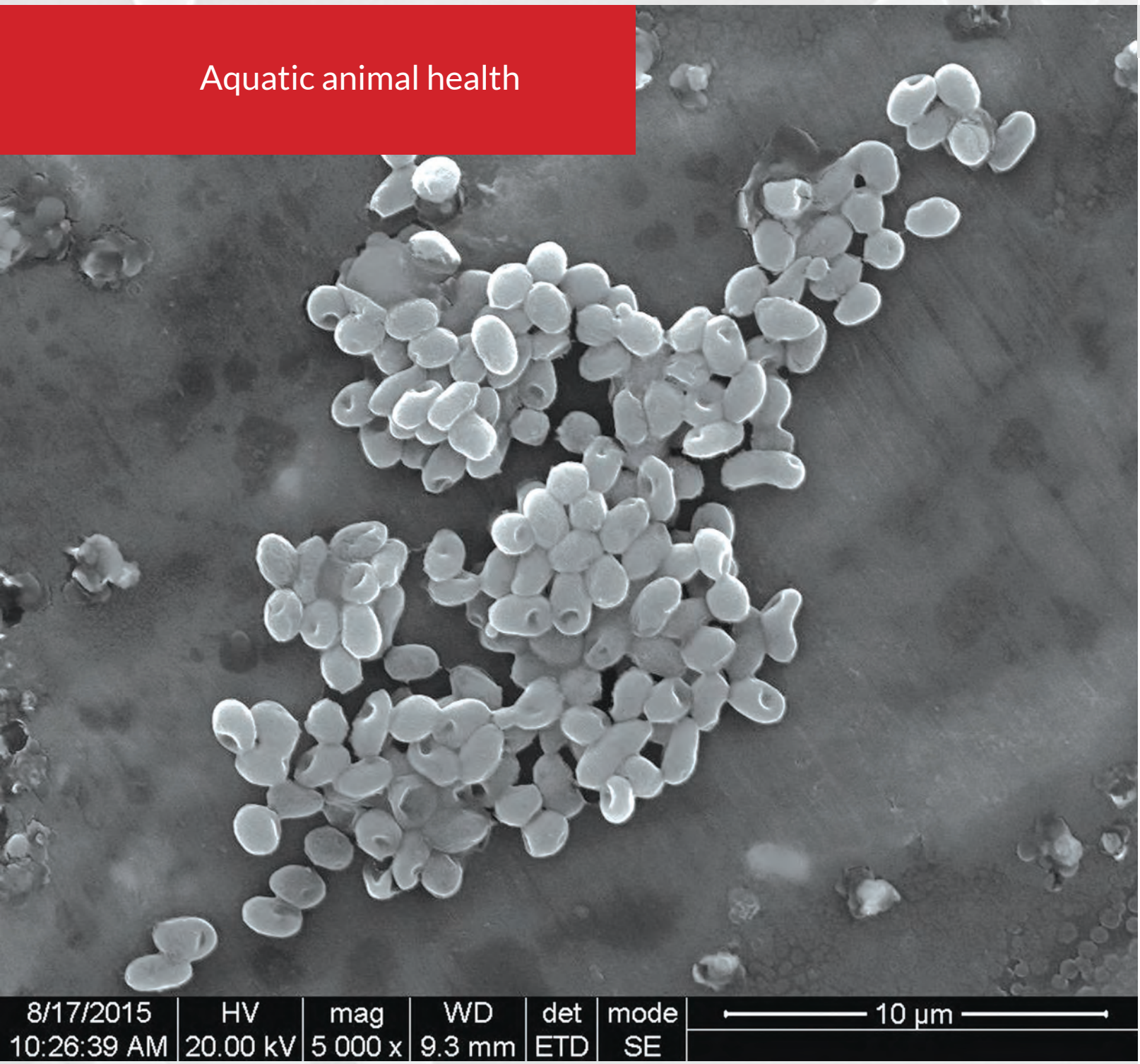
Mud crab larvae Zoea 3 and Megalopa

Compounded nursery feeds for crab

In crab seed production, after passing the dramatic larval rearing phase, nursery rearing is vital to keep maintaining the survival and achieving faster growth. A suitable feed is the key in issues related to inconsistent supply and fluctuating price of fresh feeds. Considering this, a compounded dry pellet feed was developed and tested with one-month-old crab juvenile by feeding marmurized pellet feed of 800 micron particle size with 53 % crude protein.

Though the final average body weight of juvenile crabs fed formulated feed was 33% less, the survival was almost intact in the juveniles fed formulated feed compared to the conventional feeds. Another interesting observation was the juveniles fed formulated feed were uniform in size compared to those fed clam meat. By getting equal opportunity to access the feed, crab juveniles fed formulated feed grown uniformly, and in turn aided in avoiding cannibalism of smaller ones by larger ones.

Aquatic animal health



Scanning electron micrograph of microsporidian parasite *Enterocytozoon hepatopenaei* (EHP) of shrimp

Enterocytozooan hepatopenaei emerging concern for shrimp farming in India

Active disease surveillance was carried out in 141 shrimp farms covering coastal states such as, Andhra Pradesh, Tamil Nadu, Gujarat and West Bengal. White spot disease (WSD) remained the major cause of mortalities with 37.5% of the farms suffering mortalities. Additionally, a new microsporidian parasite, Enterocytozoon hepatopenaei (EHP) has emerged as a new challenge to Indian shrimp farming. EHP was detected in 26.7% of the farms in in the maritime states, particularly Andhra Pradesh (AP) and Tamil Nadu (TN).

Infectious hypodermal and haematopoietic necrosis (IHHN) was prevalent in 5% of the farms, and monodon baculovirus (MBV) in 13.3%. None of the other trans-boundary diseases such as YHV, IMNV and TSV were detected during the period.

Occurrence of viral, bacterial and fungal diseases in shrimp aquaculture in India

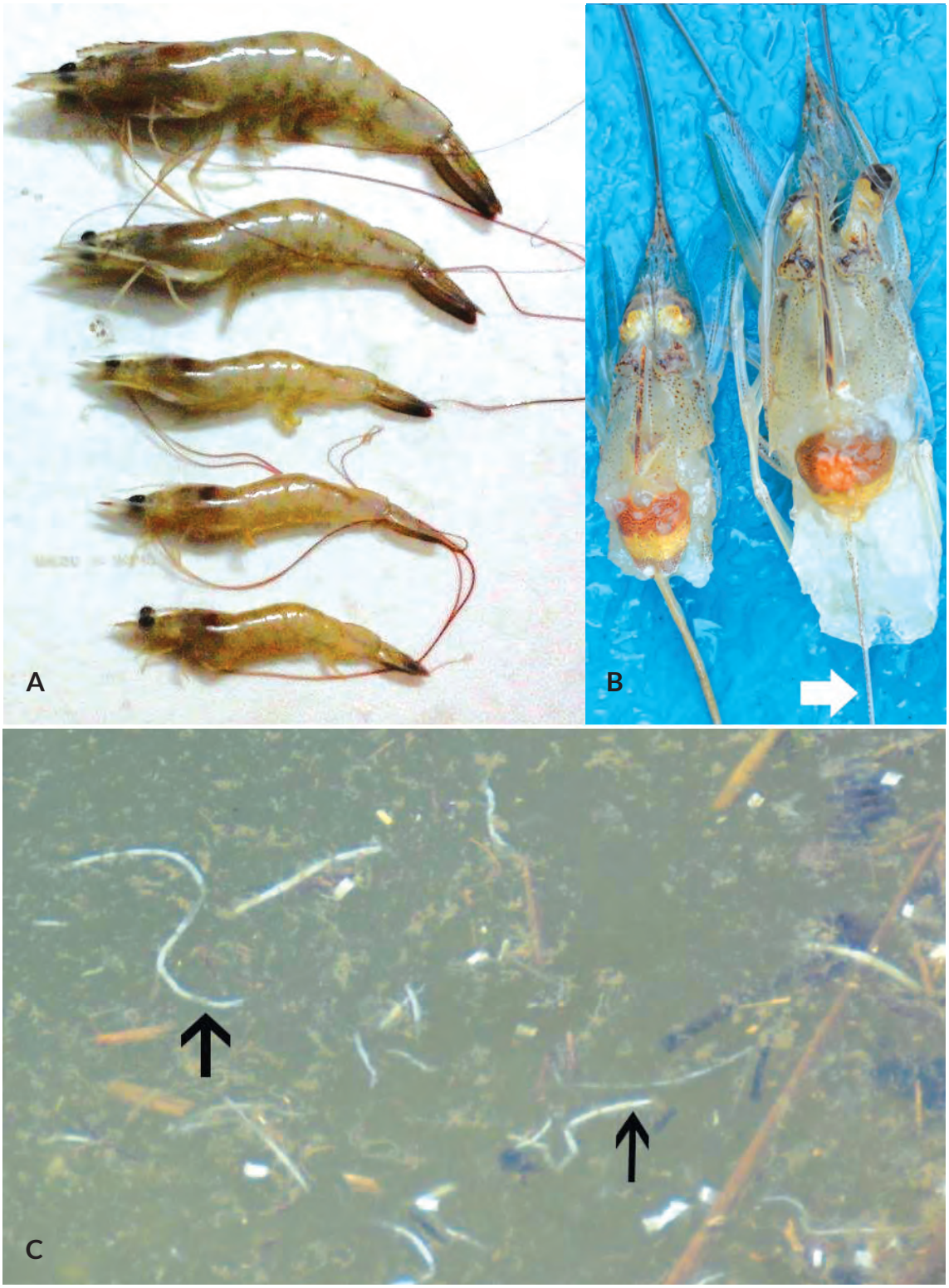
DNA Viruses						RNA viruses			Bacteria	Fungi	
WSSV		IHHNV	MBV	HPV	YHV	IMNV	TSV	PvNV	AHPND	EHP	
I step	II step									I step	II step
9/141	53/141	11/141	16/141	0/141	0/141	0/141	0/141	0/120	0/141	04/60	16/60
6.3%	37.5%	7.8%	11.3%	0	0	0	0	0	0	6.66%	26.7%

WSSV: White Spot Syndrome Virus, IHHNV: Infectious Hypodermal and Haematopoietic Necrosis Virus, MBV: Monodon Baculovirus, HPV: Hepatopancreatic Parvo Virus, YHV: Yellow Head Virus, IMNV: Infectious Myonecrosis Virus, TSV: Taura Syndrome Virus, PvNv: *Peneaus vannamei Nodavirus*, AHPND: Acute Hepatopancreatic Necrosis Disease, EHP: *Enterocytozoon hepatopenaei*

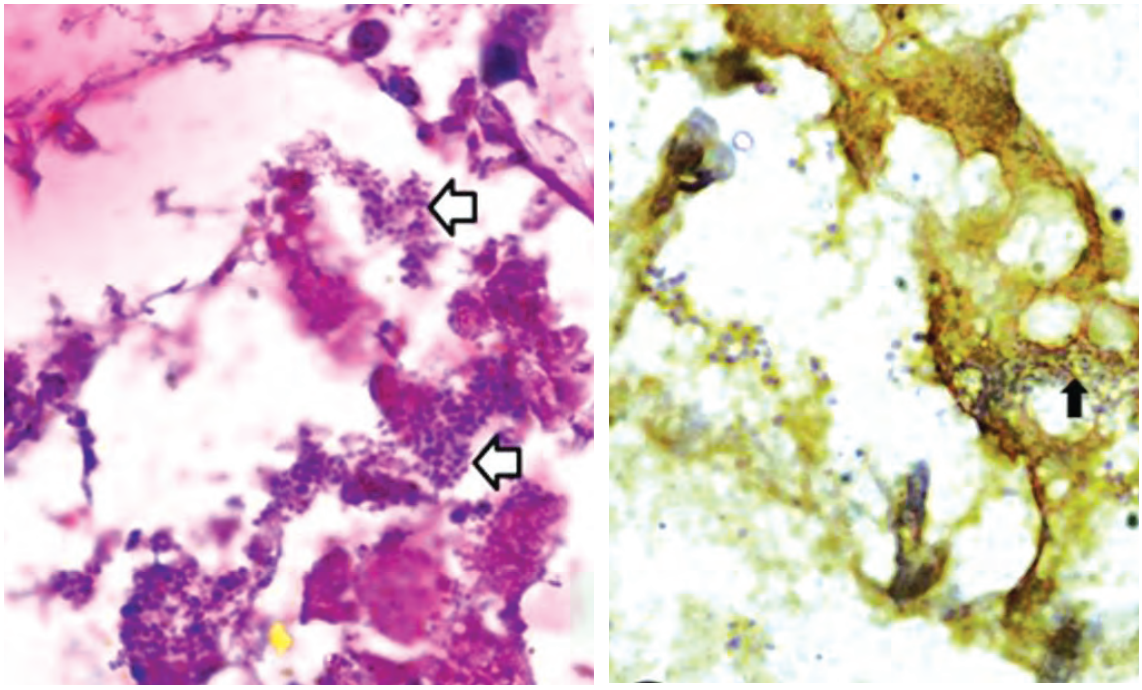
Of the farms affected with EHP, 50% of the cases were associated with stunted growth, 43.7% with white faeces syndrome (WFS) and 10% with WSD. Post-larvae of *P. vannamei* screened from a few hatcheries were found to be PCR negative for EHP. *In situ* hybridisation using EHP-specific DIG-labelled probe showed positive signals in infected hepatopancreatic tissue . Although EHP could be detected from slow-growing as well as WFS-affected animals, the present study could not conclusively elucidate the association of EHP with these clinical signs through experimental infection trials.

Association of *Enterocytozoon hepatopenaei* (EHP) with other syndromes, stunted growth and white faeces syndrome

EHP	Co-infection with WSSV	Incidences associated with						Bacteria
		Normal	Stunted growth	WFS	WMS	LSS	RMS	
16 /60	6/16	5 /16	8/16	7/16	3/16	3/16	2/16	*Vibrio parahemolyticus*: 4 *V. proteolyticus*: 3 *V. alginolyticus*: 3
(26.7%)	(10%)	(37.5%)	(50%)	(43.7)				



Farm-level observations: retarded growth after 90 days of culture (A), white / empty gut and discolouration of hepatopancreas (B) and floating white faeces in the pond water (C).



Histological sections of hepatopancreas of *P. vannamei infected with Enterocytozoonhepatopenaei.* Tubule epithelium showing presumptive developmental stages of EHP.

A significant observation made in the present study is that a high prevalence of EHP (96.4%) has been detected in the animals collected from pond which experienced WFS, compared to 39.7% prevalence observed in the animals collected from ponds without WFS. When the PCR results were analysed by classifying the animals according to the body weight into normal and slow growing groups, it has been found that slow growing animals had low prevalence (58.5%) of EHP compared to normal animals which showed a prevalence of 80.8%. On the contrary first step PCR revealed that 14.6% of the slow growing animals were EHP positive while EHP could be detected only in 5.5% of the normally growing animals

Stunted growth, white faeces syndrome and running mortality syndrome cause considerable morbidity

Disease syndromes such as white faeces syndrome(WFS), stunted growth, running mortality syndrome (RMS), white muscle syndrome (WMS) and loose shell syndrome (LSS) have become a serious cause of concern in vannamei farms. These syndromes together cause considerable morbidity and mortality, and primarily are due to poor farm management.During 2016, stunted growth /growth retardation was recorded in as high as 30.7% of the farms, RMS in 20 %, WFS in 20.6% of the farms and white muscle syndrome in 11% of the farms investigated. Five per cent of the 141 farms investigated were affected with IHHNV during April 2015 to March 2016 and majority of them were associated with growth retardation of farmed shrimp. Increased occurrence of this pathogen despite use of SPF stocks is interesting and requires further investigation.Out of 29 farms affected with WFS, seven farm samples had WSSV infection, four with MBV and nine had EHP. *Vibrio parahemolyticus* found predominant in three farms, *V. proteolyticus* in seven, *V. alginolyticus* intwo of WFS affected farms. Out of 28 farms affected with RMS, 18 farms had WSSV infection, six farms had MBV and one farm had IHHNV infection. WMS affected shrimp were also tested for Penaeus vannameinoda virus (PvNV) and infectious myonecrosis (IMNV), however, all the samples tested were negative. Five WMS farm samples had EHP infection. *V. parahemolyticus*, *V. proteolyticus*, *V. alginolyticus*, *V. coralliilyticus* were found to be predominant in the WMS affected shrimp. In histological sections, cogulative necrosis and hemocytic infiltration was observed in the hepatopancreas of affected shrimp but no viral inclusions were observed.

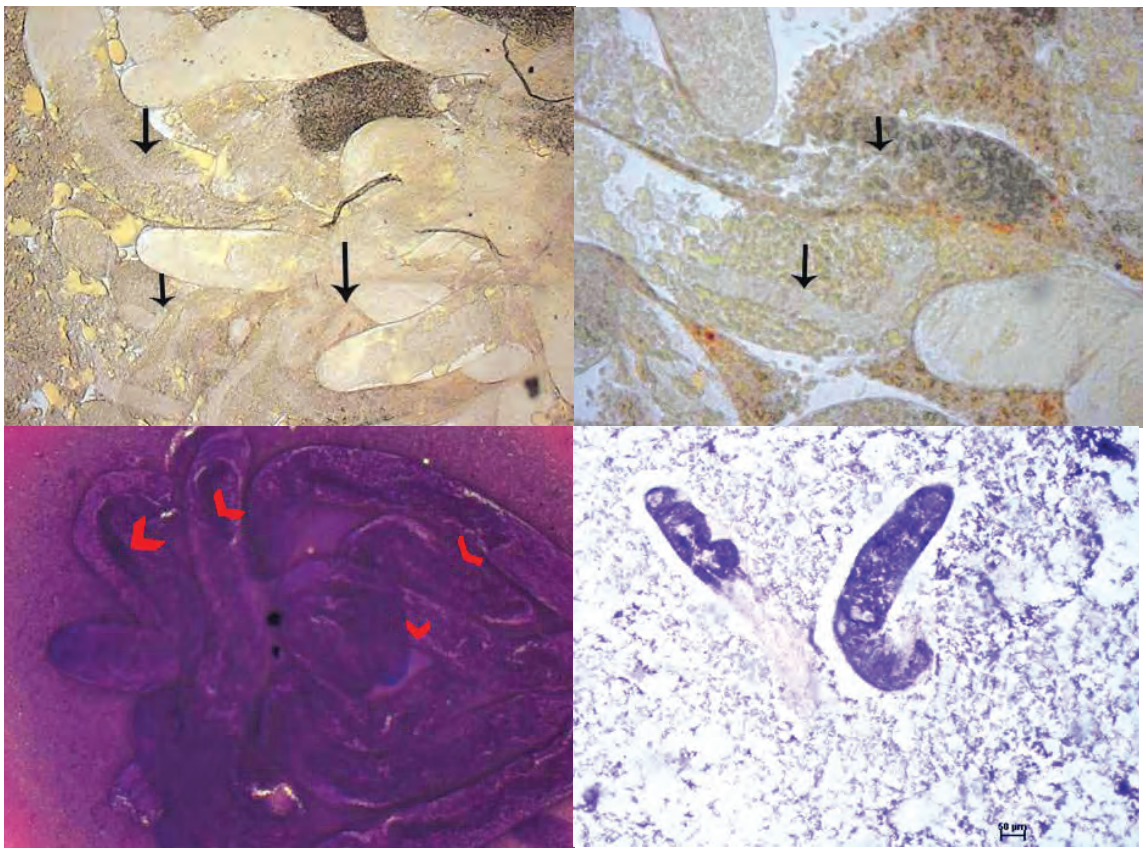
Occurrence of stunted growth, white faeces syndrome and running mortality syndrome in shrimp farming in India

Size variation	WFS	WMS	CMS (RMS)	LSS
43/141	29/141	16/141	28/141	14/141
(30.7%)	(20.56%)	(11.34%)	(19.85%)	(9.9%)

WFS: White Faeces Syndrome; WMS: White Muscle Syndrome; CMS: Chronic Mortality Syndrome; LSS: Loose Shell Syndrome

White faeces syndrome (WFS) in farmed *P. vannamei*

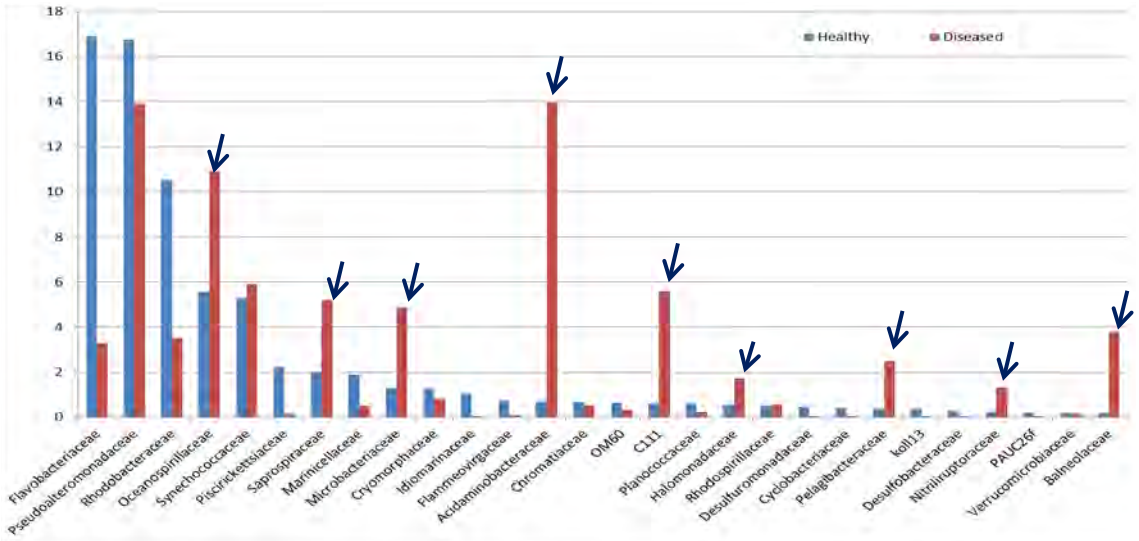
White faeces syndrome (WFS) in farmed *P. vannamei* White faeces syndrome (WFS) in cultured *P. vannamei* is widely prevalentin *P. vannamei* shrimp farms. The disease is usually noticed after about 50-60 DOC and is believed to affect shrimp survival and retarded growth in affected ponds. The aetiology of WFS is still not clear. While reports from other studies in Southeast Asian countries and the present study of CIBA suggest association of WFS with microsporidian (EHP),while the role of other microbes needs to be investigated.



4A&B: Squash preparation of WFS affected animals hepatopancreatic tubules showing ATM (Aggreagated transformed microvilli like structures). C: ATM like structures stained with Giemsa stain. D: ATM like structures stained with Hematoxylin stain.

Microbial diversity of shrimp ponds affected with white faeces syndrome

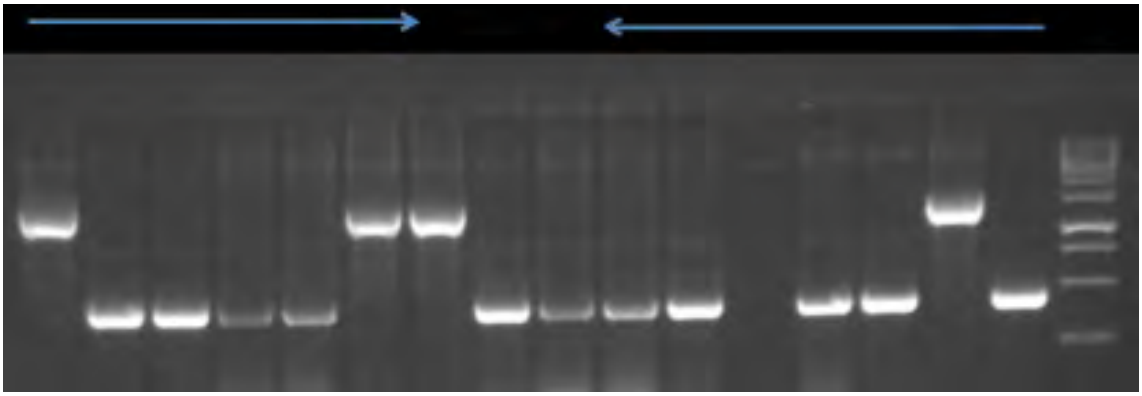
The microbial diversity in healthy and WFS affected shrimp ponds was analysed using next generation sequencing (NGS) of 16S V3-V4 regions using Illumina platform-Miseq platform. A 100L water sample from each of the WFS affected and normal ponds was concentrated using tangential flow filtration system (TFF), DNA was extracted and subjected to 16S-r DNA metagenomic sequencing. A total of 10 million paired end reads per sample was obtained and are being subjected to bioinformatics analysis.Results throw light on the diversity of bacteria associated with WFS and their possible role in the disease. While bacteria of the family Pseudoaltermonadaceae were found to be dominant in both the healthy and diseased ponds, bacteria of Flavobacteriaceae, Synechococcaceae, Rhodobacteraceae, Piscirickettsiaceae, Marinicellaceae were found predominant only in the healthy pond.It was notable that the bacteria of the family viz. Deinococcaceae, Sphaerochaetaceae, Victivallaceae, Halanaerobiaceae, Mogibacteriaceae, Caldicoprobacteraceae, Euzebyaceae, Jonesiaceae were found only in diseased pond. Also members of the family Acidaminobacteraceae, Oceanospirillaceae, Saprospiraceae, Microbacteriaceae, Halomonadaceae, Desulfuromonadaceae, Pelagibacteraceae, Nitriliruptoraceae were found to be dominant in the WFS affected pond.



Bacterial diversity at family level of healthy and WFS affected shrimp ponds based on V3 region of 16S rRNA

Viral metagenomic analysis of WFS affected *Penaeus vannamei*

In this part of the study, the possible viral aetiology of WFS affected P. vannamei was investigated using viral metagenomic studies. The WFS affected shrimp were individually screened for the presence of known DNA and RNA viruses such as WSSV, MBV, IHHNV, YHV, TSV, and IMNV. The viral particles were purified from various tissues such as hepatopancreas, stomach, gill and pleopod, and were pooled separately. The viral DNA was extracted from this purified viral preparation and subjected to mitochondrial and 16s ribosomal DNA PCR to detect the contamination of host and bacterial DNA. The viral DNA from stomach was contaminated with the host DNA. The viral DNA from hepatopancreas and gill and pleopod were subjected to WGA. However, there was no amplification with WGS of the purified viral DNA samples. Alternatively, RAPD-PCR was used and the products were cloned using TA cloning kit. The clones were screened using M13 primers and the products of approximately 400 and 2500 bp length were sequenced. Sequence analysis of RAPD-PCR amplicons revealed that all the sequences were not homologous to any sequence in the GenBank database.



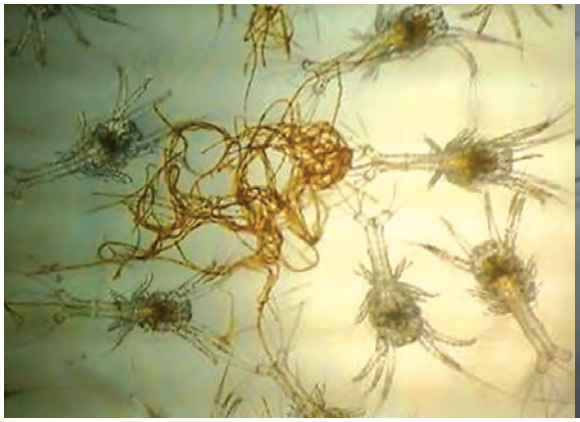
Clones from DNA viral fractions from hepatopancreas of shrimp affected with WFS affected *Penaeus vannamei*

Stunted growth in farmed *Penaeus vannamei*

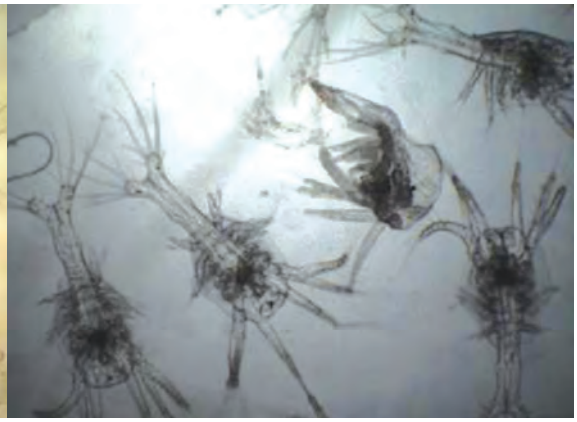
Growth retardation / stunted growth in farmed shrimp has become an emerging serious disease in shrimp aquaculture due to reduced survival and growth in affected ponds. The aetiology of stunted growth is still not clear. Viral metagenomic analysis was carried out to identify the possible viral aetiologic agent if any. Growth retarded shrimp were screened individually for the presence of known DNA and RNA viruses such as white spot syndrome virus (WSSV), monodon baculovirus (MBV), infectious hypodermal and haematopoietic necrosis virus (IHHNV), yellow head virus (YHV), Taura syndrome virus and infectious myonecrosis virus (IMNV). Shrimp free from all pathogens were used for viral metagenomics study. The viral particles were purified from hepatopancreas and gill and pleopod were pooled separately. The viral DNA was extracted from this purified viral preparation. The viral DNA was subjected to mitochondrial and 16s ribosomal DNA PCR to detect the contamination of host and bacterial DNA. The viral DNA was subjected to whole genome amplification (WGA). However WGA did not amplify the viral DNA. As an alternative approach, randomly amplified polymorphic DNA PCR (RAPD-PCR) was carried out to examine presence of viral sequences in the viral DNA preparation. Amplification was observed with two sets of RAPD primers. These PCR products were cloned using TA cloning kit. The clones were screened with M13 primers and the products indicating viral DNA inserts of approximately 400 and 1400 bp length were sequenced. These sequences were similar to the Bacteriophage S-PM2 and *Escherichia coli ACN001.*

Zoea II syndrome in shrimp *(P. vannamei)* hatcheries

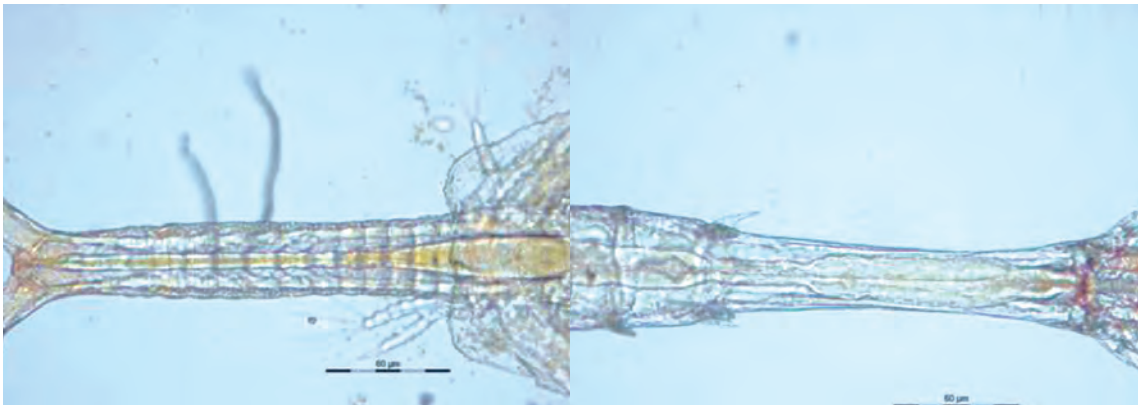
During the recent years, mass mortalities at zoea II stage has been widely experienced in the *P. vannamei* hatcheries. Zoea II syndrome has been reported since 1993 in Latin American countries. In affected hatcheries, the molting process is delayed and mass mortality occurs at zoea II stage. Investigation was carried out at CIBA in16 hatcheries in east coast of India mainly from Tamil Nadu and Andhra Pradesh to understand the role of infectious agents, nutritional factors and management practices on the outcome in terms of occurrence of zoea syndrome. While no viral pathogens could be detected, systemic abnormalities such as anorexia, arrested peristaltic movement of gut, inflammation like disruptions in intestinal epithelium and empty gut with no fecal strands were observed in the affectedzoea. Histology revealed low to moderate necrosis, sloughing of hepatopancreatic tubule epithelial cells and disintegration of peritrophic



Healthy zoea with long fecal strands and full gut



Un healthy zoea with no fecal strands and empty gut



Normal Zoea with fullgut and accumulation of fecal strand, B – Infected zoea with empty gut and absence of fecal strand, C – Normal zoea with full gut with no abnormalities, D – Infected zoea showing empty gut with inflammation like disruptions in intestinal epithelium.

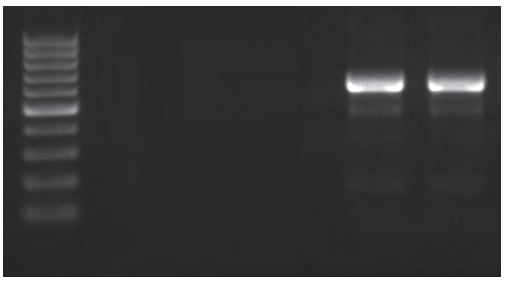
membrane, hypertrophied cells, vacuolization, sloughing/ desquamation and detachment of epithelial cell in to the lumen in middle and posterior intestine in some cases. From the zoea II syndrome affected larvae, *V. alginolyticus* predominantly recovered. The study could not prove involvement of pathogenic vibrios in the zoea II syndrome in the shrimp hatcheries.

Irido virus was detected in farmed seabass

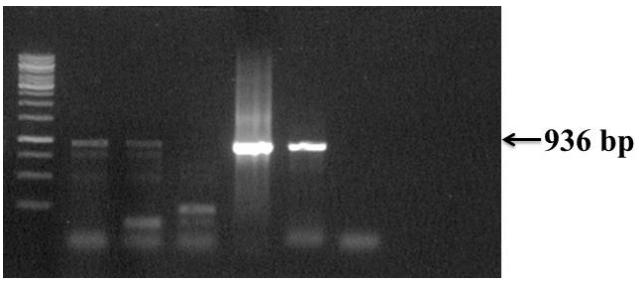
Irido virus was detected in samples from farmed seabass in Krishna district in Andhra Pradesh. Dual viral infection with noda and irido virus leading to severe mortalities of Tilapia at Ecopark, Chennai was also recorded. Surveillance of parasitic infections in aquaculture revealed mongenean (*Gyrodactylus sp*) in *Etroplus suratensis*; mixed infections of *Lernaea* sp., *Vorticella* sp. and *Gyrodactylus* sp. in Poeciliaspenops while in shrimp farms at Kovalam, Mahabalipuram and Nagapattinam revealed black gill diseases associated with Zoothamnium sp. infestations.

Seabass cage culture

Extensive skin erosion in diseased tilapia fish affected with dual viral infection



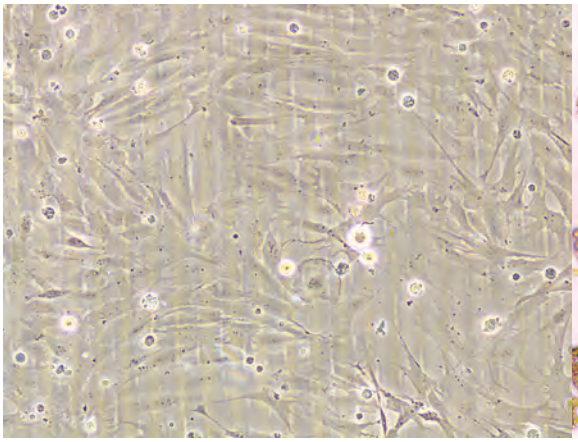
Detection of viral nervous necrosis virus (VNN) by protocols of Dalla Valle et al. (2000)



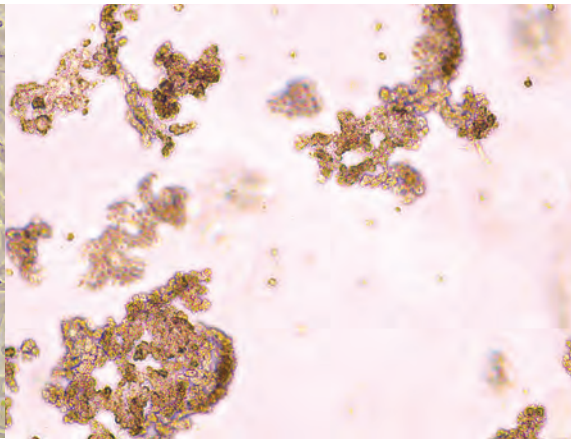
Detection of iridovirus by protocols of Jeong et al. (2006)

Adaptation and multiplication of VNN in cell cultures

The viral inoculum was prepared from homogenised tissue suspension from previously confirmed VNN positive seabass samples that was clarified by centrifugation and treated with antibiotics and passed through 0.22µ filters. The primary cultures were inoculated with the virus suspension (100µl) and incubated for half an hour. Cell culture medium (L-15) was added and further incubated at 27°C for 7-10 daysand observed for CPE. After three blind passages, cytopathic effect (CPE) was observed as rounding and sloughing of monolayer within 10 days. The cell culture supernatant was tested by rt-PCR and confirmed as VNN. Further, the virus will be adapted in seabass spleen cell line to develop VNN vaccine



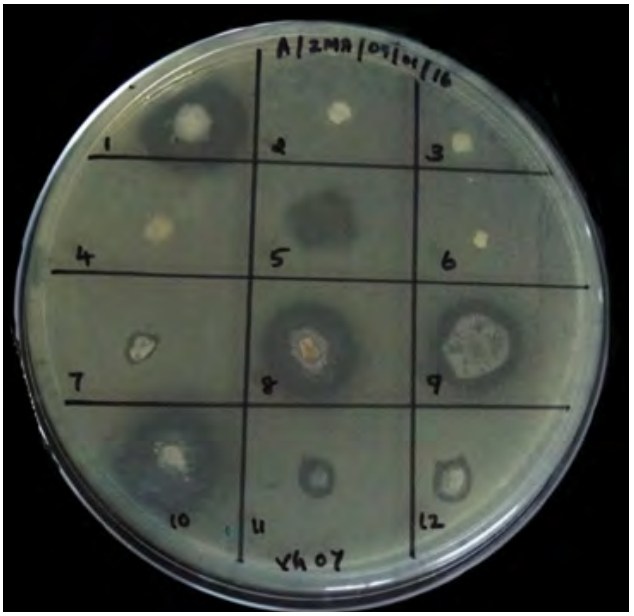
Primary brain culture from milk fish culture (10x)



CPE in VNN infected primary brain – control (10x)

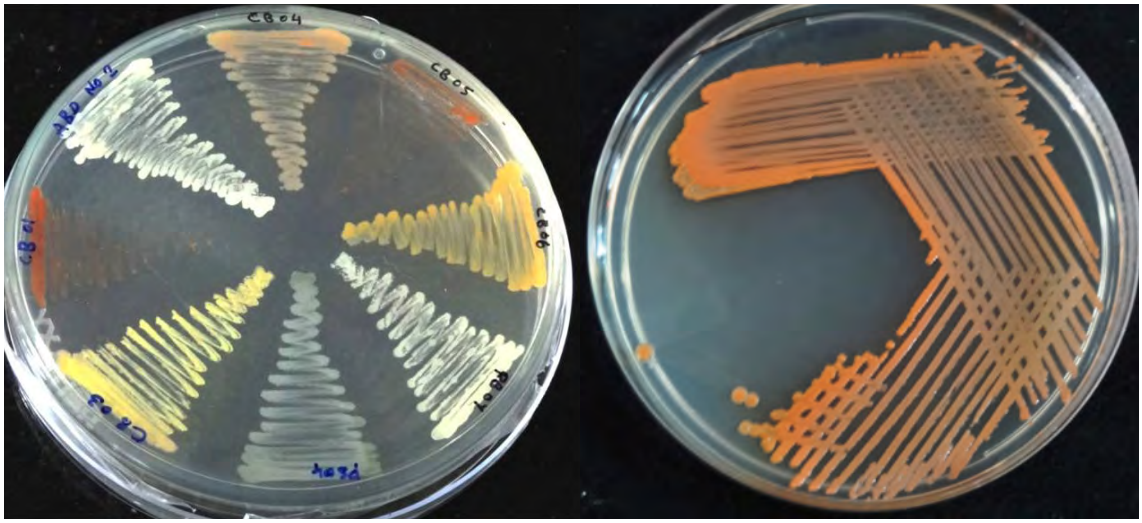
Development of probiotics

The search for novel probiotic microbes possessing diverse functional properties with an objective of finding an alternative therapeutic in shrimp aquaculture was taken up. A total of 314 bacterial isolates were examined from diverse environments in different regions of Tamil Nadu, Andhra Pradesh and West Bengal including the sampling locations such as lakes, ponds, creeks and mangrove. All the isolates were screened for antagonistic activity against strains of pathogenic *V. harveyi* and *V. parahaemolyticus*. Based on their antagonistic activity, enzyme production, tolerance to pH and salinity, three bacterial isolates, *Bacillus subtilis*, *B. pumilis* and *B. amyloliqufaciens* were selected for mass production.



Screening of putative probionts for antagonism against *Vibriospp*

Four different media were optimized for mass production to reach viable count (2×109 CFU/ml) in a benchtop fermenter. Formulations of probiotics were prepared by mixing bacterial cells with combinations of dextrin, carboxymethyl cellulose, starch and trehalose at different concentrations. Stability of the formulation in terms of viability of bacterial cells is being examined periodically.



Chromogenic bacterial isolates from brackishwater environments *Micrococcus* spp. *Exiguobacterium* spp. and *Bacillus* spp.

Up-scaling production, formulation and testing under hatchery conditions would be taken up in the current year.

A water probiotic developed from the consortia of ammonia oxidizing bacteria and nitrite oxidizing bacteria have been standardized for bulk production and confirmed their activity both in liquid and solid formulation during the room temperature storage trials. The product is presently under farm level testing in Gujarat, Tamil Nadu and Andhra Pradesh.

Prophylaxis and therapy of white spot disease of shrimp

Prevention and control of white spot disease in shrimp farming has been a serious challenge since its emergence in the nineties. One of the human antiviral drugs, Acyclovir, used against a number of dsDNA viruses, was examined for its ability to prevent / control of WSSV infection in shrimp. The drug was found to be ineffective when it was administered either through injection or through feed. In another approach, three of the plants, Emilia sanchifolia, Tridaxprocumbens and Kapphphycusalvarezii, with known antiviral effect against human and animal viruses were tested for prevention / control of WSSV infection in shrimp. Aqueous extract of these plants either through injection or feed or in different dosages did not provide any protection to shrimp against WSSV.

RNAi mediated prophylaxis therapy of white spot syndrome virus (WSSV)

Efforts were made to use RNA interference technology to prevent WSSV infections in shrimp. dsRNA for host genes defense genes, Rab7, Relish and IAP administered to shrimp significantly knocked down of the respective genes within 48 hours. All the shrimp administered with dsRNA (against Rab7, Relish or IAP) showed significant down regulation of other immune genes such as Crustin, Penaeidin, MnSOD and translationally controlled tumor protein (TCTP) compared to the control. Knock down of IAP gene brought mortality within 48-72 hours and more than 90% hemocytes from these animals exhibited apoptosis. On the other hand, administration of WSSV Vp28 dsRNA failed to inactivate WSSV virions even when the shrimp had very low levels of infection (viral copy numbers).

The gene expression analysis of the four apoptosis related genes (translationally controlled tumor protein (TCTP), inhibitor of apoptosis protein (IAP), ubiquitin conjugated enzyme E2 and caspase) was carried out in shrimp P. vannamei. This study aimed to decipher their functional role and understanding the molecular mechanisms by which they interact and involve in the apoptosis network that occur in shrimp (*P. monodon*) in response to WSSV infection. The down-regulation of TCTP and caspase genes indicates the role of WSSV induced apoptosis resulting in mortality of infected shrimp.

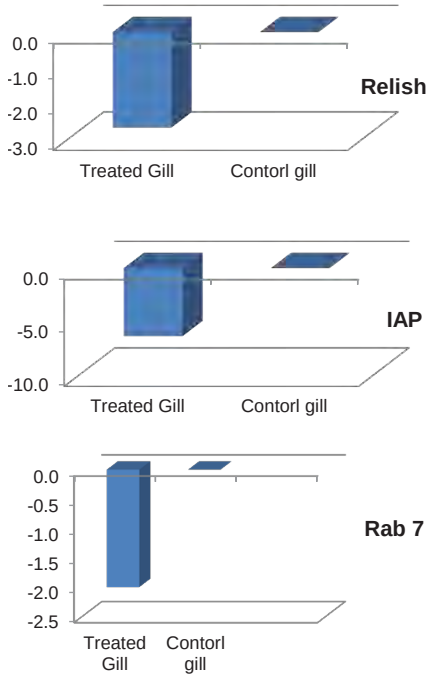
Two of the virulent genes of WSSV (VP15 and VP28) were targeted for dsRNA construction. Based on the available sequence, primers were designed and dsRNA was constructed for VP28 gene of WSSV during the period. The efficacy was tested by injection of this dsRNA at different dosages. A dosage of 1µg/gm of shrimp was found to be effective to provide protection upon challenge. Similarly, a time period of 24 hours prior to challenge was found to be effective in providing protection.

Initially, Carbon Quantom Dot (CQD) nanoparticle conjugation with VP28 dsRNA of WSSV was tried. Based on the available protocol, nanoparticle was generated from Poly Ethylene Glycol (PEG) and Poly Ethylene Amine (PEI) through microwave heating. This was conjugated to dsRNA and purified. Initial verification on efficacy was tried through injection. However, this conjugated dsRNA was not able to provide protection upon challenge. Further verification on conjugation status will be carried out through TEM and zeta potential measurement.

As a second approach, chitosan nanoparticle conjugation to VP28 dsRNA was carried out. This conjugated dsRNA after purification was mixed with feed and supplied to shrimps at 1µg/gm of body weight for through day feeding. After 48 hours, shrimps were challenged with WSSV. Nanoparticle conjugated dsRNA treated shrimps showed 46% survival compared to mass mortality in control group. Further standardization in dosages and period of treatment will be carried out in future.

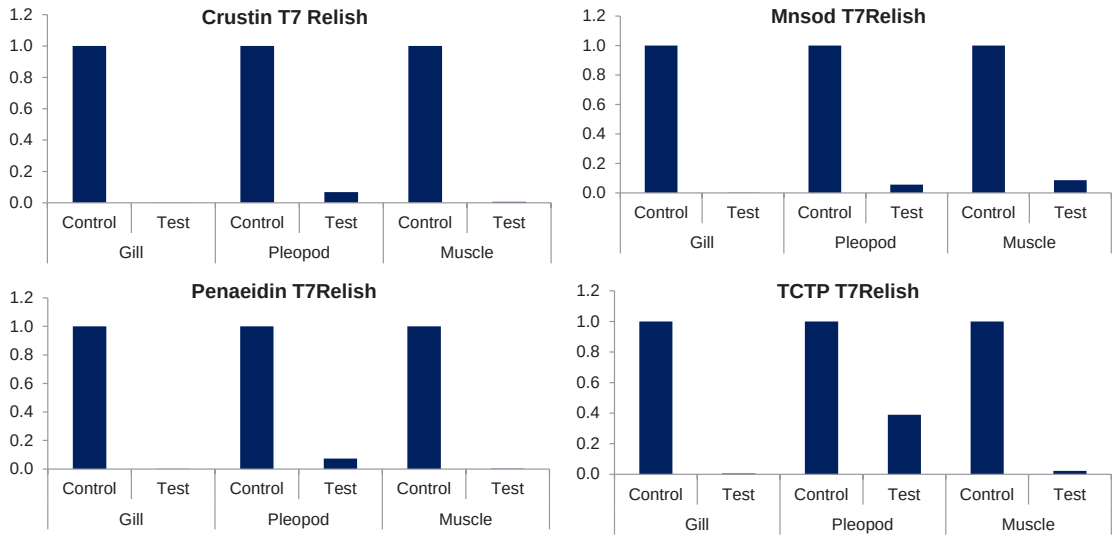
Host defense gene response against white spot virus infection in tiger shrimp *(Penaeus monodon)*

The RNAi response is crucial in controlling virus replication and limiting virus induced pathology and inherently provides specific antiviral response. Also implicated in antiviral responses, various signalling pathways lead to the activation of transcription factors and the subsequent expression of antimicrobial peptides. RNA interference (RNAi) is the mechanism mediated by small RNAs. The shrimp innate immune system is triggered by the recognition of the invading microbes by the molecules called pattern recognition proteins (PRPs). The PRPs recognize and bind to the microbes and activate various immune responses. For viral pathogens, the shrimp specific PRPs could respond to the ssRNA and dsRNA from viruses in order to initiate the RNAi pathways. In the present study, shrimps were separately treated with dsRNA of three important defense genes such as the small GTP-binding protein Rab7, nuclear factor NF-κB transcription factor or relish and inhibitor of apoptosis (IAP). Significant knock down of these genes was observed after 24-48 hours of dsRNA injection.



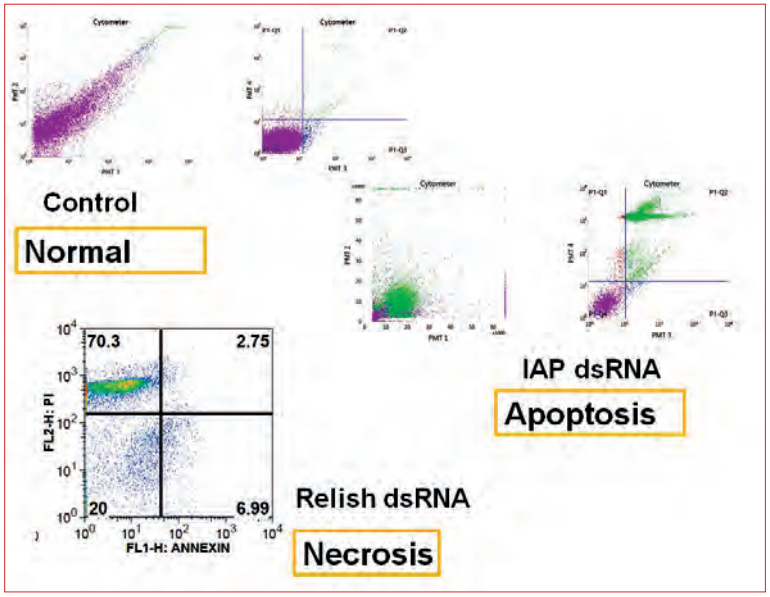
Defense gene silencing by ds RNA

Tissues from knockdown animals were further subjected to real time PCR analysis for the expression of other defense genes. The immune genes, crustin, penaeidin, MnSOD (Manganese superoxide dismutase) and translationally controlled tumour protein(TCTP) were significantly down regulated in shrimp treated with dsRNA targeting Rab7, relish and IAP, indicating a definitive correlation between these defense genes. All the shrimp treated with dsRNA targeting Rab7, relish and IAP were further challenged with WSSV and hemocytes collected from the animals were subjected to double staining by propidium iodide (PI) and Annexin V by flow cytometry in order to understand the haematological changes.



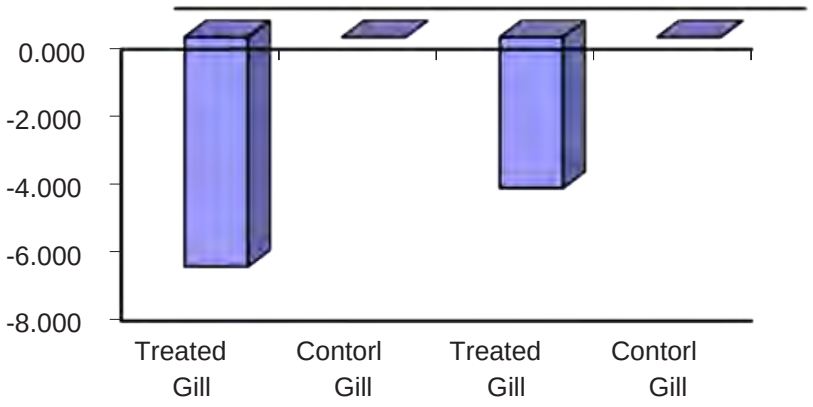
Expression of immune genes in defense gene knock down animals

IAP knocked down shrimp showed automatic apoptosis of hemocytes within 24-48 hours and showed 100% mortality. Shrimp treated with dsRNA targeting relish showed necrosis of hemocytes within 48 hours of WSSV challenge, indicating the importance of these defense genes in providing protection to shrimps. In conclusion, all the three host defense genes were found to have individual important role for protection of host against pathogens. It was also found that the genes depend on each other for expression indicating their link with each other in host defense system.



Rab7 as a host gene in shrimp is presumed to be a receptor for WSSV. Knock down of this gene appears to provide protection against WSSV challenge. Therefore, improving the delivery method may be helpful for protection against WSSV. dsRNA targeting Rab7 was synthesised and conjugated with chitosan nanoparticles. Purified conjugated dsRNA was mixed with feed, air dried and coated with egg white and fed to shrimp to administer 1µg dsRNA g-1 d-1. After 48 hours, knock down effect of Rab 7 was tested by real time PCR. About 40-60% knock down

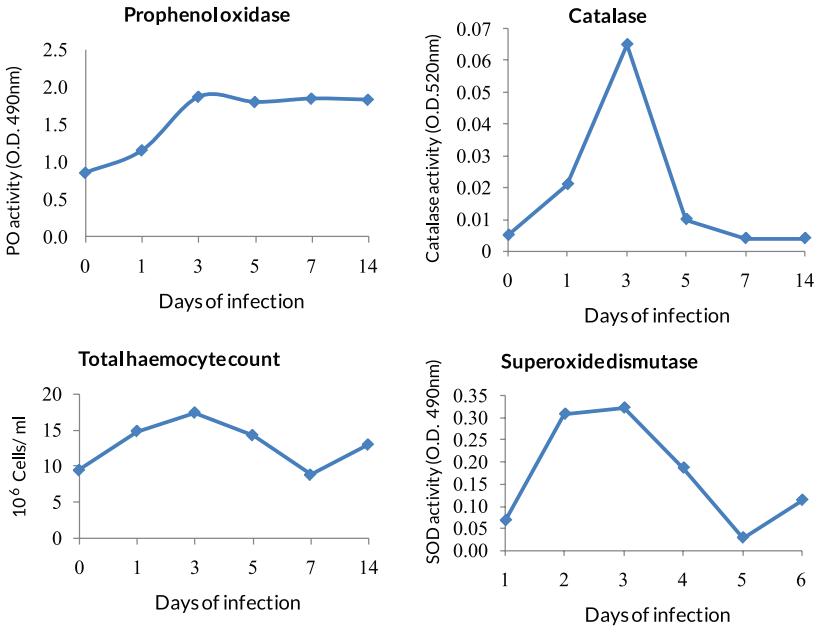
of Rab 7 was observed in the gill tissue of shrimp indicating the effectiveness of oral fed dsRNA. The experiments indicated that oral delivery of dsRNA will be effective in knockdown of the receptor protein of WSSV and thereby provide protection against WSSV infection.



silencing in shrimp fed with diet containing Rab 7 dsRNA conjugated with chitosan nanopariciles

Immune response of *P. vannamei* in response to IHHNV infection

IHHNV infection in *P. vannamei* is typically a chronic disease, and causes growth retardation or runt deformity syndrome (RDS). *P. vannamei* of 6-8g were acclimatized for a week at 28^{0}C, 30ppt salinity. Shrimp were infected with IHHNV through oral route by feeding infected tissue @ 5% of shrimp biomass once. Shrimp were routinely provided with standard pellet feed. Haemolymph was collected from the shrimps at periodic intervals up to 14 days of infection. The total haemocyte count was found to be increasing from day 1 of infection and it reached a peak on day 3 of infection.

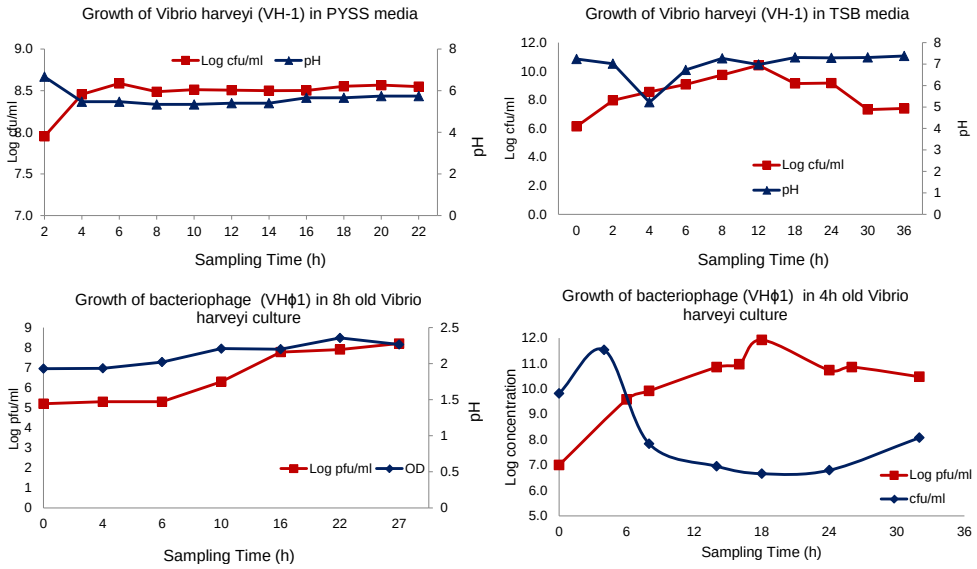


Immune response of *P. vannamei* upon challenge with IHHNV

Biocontrol of vibrios in shrimp hatcheries using bacteriophages

Vibriosis, predominantly caused by *V. harveyi* is one of the most important diseases in shrimp hatcheries. Development of bacteriophage therapy may provide a biocontrol a means for control of vibriosis and reduce application of antibiotics in the hatcheries. Protocols for production of high titre lysates were evaluated with different media such as peptone yeast extract with synthetic sea salt (PYSS) with different peptone concentrations and tryptone soya broth (TSB) with synthetic sea salt and 30% sea water. TSB with sea water yielded 109 cfu ml-1 of *V. harveyi* at 30°C at pH 7.5 with 300 rpm

Time of inoculation of bacteriophages to *V. harveyi* host culture and multiplicity of infection (MOI) of bacteriophages was optimized. Bacteriophage lysate was inoculated to the *V. harveyi* culture at different culture period, with an MOI of 0.01. Optimum time for inoculation of bacteriophages to 4 h old culture of *V. harveyi* yielded increases phage yields in terms of plaque forming units (pfu). It was observed that inoculating bacteriophages with 0.01 MOI to a 4hr old *V. harveyi* culture with 109cfuml-1 could yield 8 x 1011pfuml-1 in 24h. As the bacteriophage growth increased 4h post inoculation, the count of host Vibrio declined to reach the lowest 106 cfuml-1 at 18h post phage inoculation. At the same time, phage concentration peaked to 8x1011pfu ml-1.



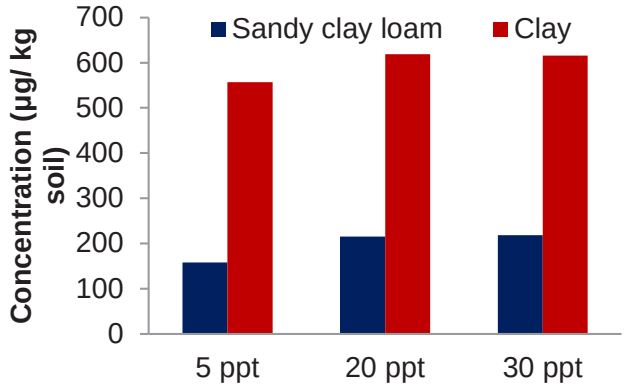
Growth of *V. harveyi* and bacteriophage

Inputs used in Indian aquaculture

In aquaculture, a number of inputs are being used without adequate scientific validation. Information on these inputs was collected from aqua shops in major aquaculture production states of India. These inputs could be classified as probiotics, antibiotics, mineral mixtures, vitamin and amino acids, binders, non-specific antimicrobial agents, antiparasitic and antiprotozoal drugs, disinfectants, binders, minerals, nonspecific antimicrobial agents, oxygen enhancers, pH stabilizers, plantkton growth enhancers, vitamins and amino acids, immunostimulants and hormones. Among the inputs, highest percentage of products were probiotics (21.9%) followed by disinfectants (14.28%) and least number of products were found for enhancing the plankton growth (1.67%). Though the antibiotic residues in aquaculture products was considered as menace, surprisingly only 3.81% of the products contained antibiotics among the aquaculture inputs traded in India and that too meant for use in fresh water fish culture.

Evaluation of residual effect of Oxytetracycline (OTC) in sediment and water

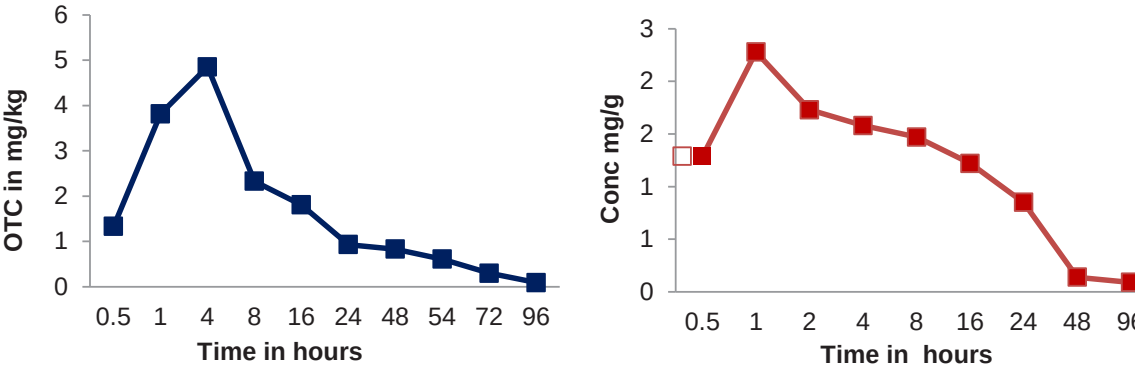
Application of antibiotics in aquaculture has shown to adversely impact the environment. As per the FDA, only oxytetracycline (OTC) is approved for use in aquaculture. A study was undertaken to understand the role of soil texture and water salinity on the OTC residue in culture environments. The study was conducted in two soil types (sandy clay loam and clay) and different salinities. *P. vannamei* shrimp juveniles were administered OTC @ 4.5g kg-1 feed for 14 days. Analysis of soil and water samples revealed that OTC persisted longer in clay soil compared to sandy clay loam soil. Analysis of mineral content in the soil samples suggest that calcium and magnesium might play a role in adsorption of OTC. Similarly the OTC residue was directly proportional to salinityof water.



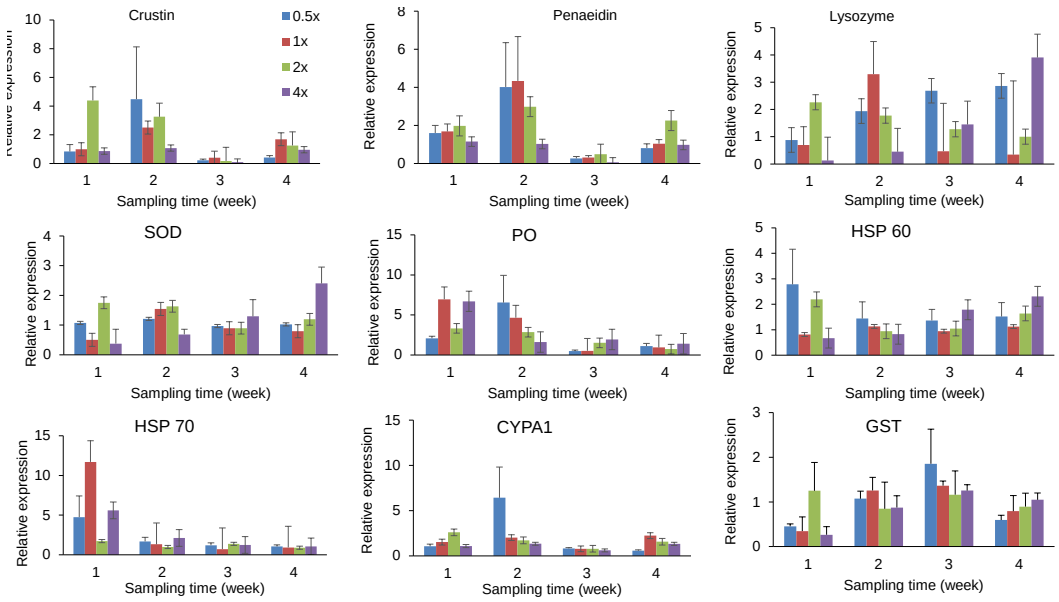
Oxytetracycline residue in sandy and clayey sedimentsafter its use @ 4.5g kg-1 feed fed to *P. vannamei* juvenilesfor 14 days

Evaluating the biosafety of oxytetracycline (OTC) in juvenile shrimp *P. vannamei*

A study was undertaken to validate the withdrawal period of OTC. Biosafety studies were conducted by administration of OTC @ 0.5x, 1x, 2x and 4x dose for 14 days. The drug was found to be safe to juvenile shrimp at four times the recommended dose of 4.5 g kg-1 feed. It was observed that OTC had little effect on growth, survival, histopathological, immune (crustin, penaeidin, prophenoloxidase, lysozyme and superoxide dismutase), stress response (heat shock protein 70, HSP 60) and antibiotic metabolism (CYPA1 and glutathione-S-transferase) gene expression and gut microbial profile. The withdrawal periods were shown to be 72 h and 96 h following 7 and 14 days of drug regime. Results of the study suggest that OTC can be safely be used at the USFDA recommended concentration of 4.5g kg-1 per day for 14 days and the drug residue reaching the below maximum permissible limit of 0.1 µg g-1 96 h post feeding regimen.



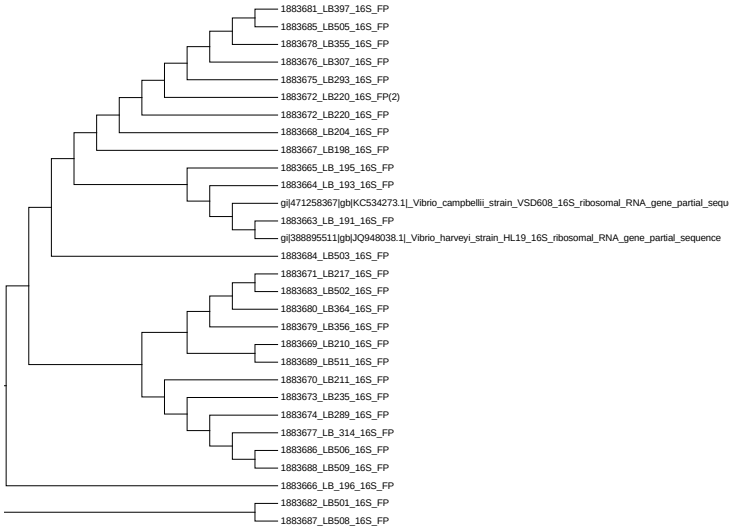
Withdrawl of oxytetracycline in P. vannamei



Gene expression of *P vannamei* fed with oxytetracycline

Virulence of vibrios

Vibrio species are ubiquitous organisms in coastal and marine ecosystems and are often associated with disease in shrimp and finfish. However, differentiating virulent and non-virulent strains is a challenge. Efforts are underway to achieve this objective of differentiating the pathogenic strains so that diagnostic tools could be developed to put in place biosecurity measures. Luminescent bacteria recovered from disease outbreaks in hatcheries were identified to Vibrio clade by 16s rDNA and sequencing. A neighbor joining tree was constructed with 16s rDNA sequence of isolates and reference strains of *V. harveyi* and V. campbelliusing mega 6 software. However, 16Sr DNA sequencing could not differentiate virulent strains.



Neighbour joining tree constructed using the 16SrDNA sequences of lumniscent Vibrios using mega 6 software with reference strains of Vibrio harveyi and Vibrio campbelli

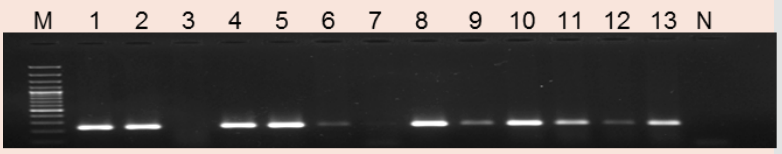
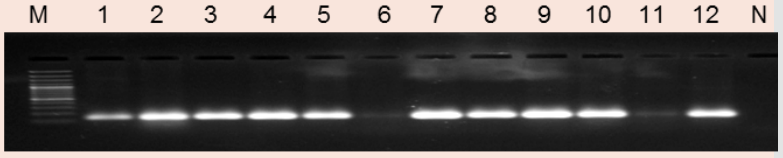
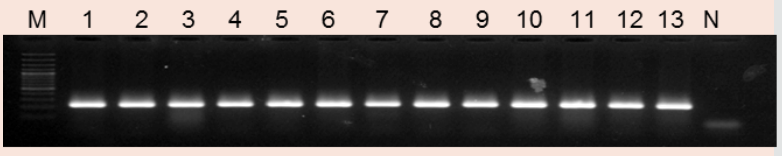
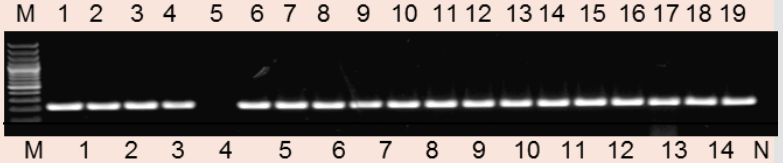
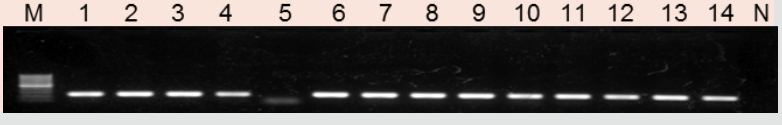
In order to understand the virulence, luminescent vibrio isolates were screened for five putative virulence genes viz., haemolysin (Vhh), chitinase (ChiA), metalloprotease (Vhmp), toxR and Serine protease characteristic feature of Vibrio clade. All 27 isolates screened were positive for ToxR and serine protease genes (Table)

An immersion challenge study was conducted to determine the pathogenicity of Vibrio isolates with 15 luminescent vibrio isolates based on their disease history. PL 8 stages of P. vannamei post larvae procured from local hatcheries were challenged with 106cfu mL-1 of bacteria. Bacterial dose was standardized in PL-8 stage and survival rate was recorded and percentage mortality was calculated.

Application of genomics for understanding the virulence of *Vibrio harveyi*

To characterise the novel virulence factors, one virulent isolate VH102 was subjected to next generation sequencing (NGS) using Illumina platform. The overall GC content within VH102 genome was 45.69%. A total number of 59 million reads, with an average read length of 101 bp was generated. Genome mapping was done using the Burrows Wheeler Aligner algorithm taking *V. harveyi* ZJ0603 as reference strain. The preliminary genome analysis revealed that the VH102 genome contained more than 4800 genes. Identifying virulence genes of *V. harveyi* using bioinformatics is underway.

Presence of putative virulence genes in luminescent *Vibrio* isolates

Target gene	% age of isolates positive	Gel images showing the of presence of virulence genes in *V. harveyi* isolates
Chitinase	95%	
ToxR	100%	
Serine protease	100%	
Metallo-protease	96%	
Vhh	88.8%	

In silico genomic analysis within the pathogenicity island regions of the AHPND *Vibrio parahaemolyticus* strains did not reveal unique genes

Vibrio parahaemolyticus is a gram-negative ubiquitous marine bacterium sometimes associated with disease incidences in brackishwater aquaculture. Certain strains are also of public health importance. Since 2010, a strain of this species has been reported to be associated with the devastating disease termed as acute hepatopancreatic necrosis disease (AHPND), earlier called as early mortality syndrome (EMS) in the Southeast Asian countries. A special focus has been given in investigating the role of these bacteria in the mortalities of farmed shrimp in Indian aquaculture. *V. parahaemolyticus* isolates from shrimp farms in Tamil Nadu, Kerala and West Bengal were examined for various virulence factors such as haemolysin genes thermostable direct hemolysin (tdh), thermostable direct hemolysin-related hemolysin (trh) and thermolabilehemolysin (tlh) and found negative. These bacteria were also examined for the putative type III secretion system apparatus proteins vscS2, vopB2 and vscP and were found negative. All the isolates were also found negative for AHPND using AP3 protocols and Pockit Kit (from Gene Reach Technologies, Taiwan).

An in silico genomic analysis of the *V. parahemolyticus* strains causing AHPND was carried out to identify the unique genes within the pathogenicity island regions. Four hundred eighty seven putative pathogenic genes were obtained from the pathogenicity islands though integrated method by island viewer (http://www.pathogenomics.sfu.ca/islandviewer2). Whole genomes of three isolates causing AHPND and four other isolates (including one Indian isolate) were screened for pathogenic genes. The results did not indicate major differences in terms of presence/absence of pathogenic genes between isolates recovered from AHPND in shrimp and other isolates. However few proteins related to DNA recombination and transcriptional regulation were observed only in isolates obtained from AHPND cases. Interestingly a protein similar to a component of Type III secretion system was observed only in the Indian isolate. In addition, few hypothetical proteins were found only in the Indian isolate which requires further investigation

MLST based phylogenetic analysis for differentiating shrimp pathogenic *Vibrio parahaemolyticus*

Genomic variations were analysed within the 181 *V. parahaemolyticus* isolates based on the clusters built with housekeeping genes derived from multi locus sequence typing (MLST). Genomes of *V. parahaemolyticus* were downloaded from NCBI and the housekeeping genes were extracted using online MLST tool (https://cge.cbs.dtu.dk/services/MLST/). Seven housekeeping genes namely dnaE, dtdS, gyrB, pntA, pyrC, recA, tnaA were present in all the genomes. Multiple sequence alignment was performed for each one of the seven genes and poorly aligned sequences/unaligned portions at start and terminal positions of the gene sequences were trimmed using Bioedit. Further, these seven genes of were concatenated to make single string of 3682 nucleotides and were used for phylogenetic analysis using MEGA 6.0. Phylogenetic trees were generated using neighborhood joining, maximum likelihood and UPGMA. Two closely related clades, one having two isolates from shrimp ponds of Malaysia and the other having two isolates recovered from AHPND affected ponds were found to be distinct from all other isolates. Twenty five single nucleotide polymorphisms (SNPs) unique to these isolates having relevance to understanding AHPND in shrimps were observed and are being studied further to establish their significance. MLST based phylogeny appears to be a suitable approach to differentiate AHPND isolates of *V. parahaemolyticus* from other isolates.

National Referral Laboratory for Brackishwater Aquatic Animal Diseases (NRL-BAAD)serves aquaculture sector in India

As a National referral laboratory for brackishwater aquatic animal diseases (NRL-BAAD), CIBA laboratory capacity in diagnosing all OIE listed aquatic animal pathogens including emerging pathogens such as AHPND and EHP. The NRL-BAAD of CIBA has been providing valuable services to various agencies such as Animal Quarantine and Certification Services, Southern Region (AQCS-SR), Chennai, Aquatic Quarantine Facility (AQF), Rajiv Gandhi Centre for Aquaculture (RGCA), for screening imported Artemia cyst samples and P. vannamei brooders under quarantine.

Protocols used for the screening of shrimp pathogens in the National Referral Laboratory for Brackishwater Aquatic Animal Diseases (NRL-BAAD) of CIBA

S.No.	Shrimp and Fish Pathogens	Reference
1.	White Spot Syndrome Virus (WSSV)	OIE, 2014; Kimura et al, 1996
2.	Infectious Hypodermal and Haematopoietic Necrosis Virus (IHHNV)	OIE, 2014
3	Monodon baculovirus	OIE, 2014
4	Hepatopancreatic Parvo virus (HPV)	OIE, 2014
5.	Yellow Head Virus (YHV)	OIE, 2014
6.	Taura Syndrome Virus (TSV)	OIE, 2014
7.	Infectious Myonecrosis Virus (IMNV)	OIE, 2014
8.	Acute Hepatopancreatic Necrotic Disease (AHPND)	Sirikharin et. al, 2014
9.	NecrotisingHepatopancreatitis Bacteria (NHPB)	IQ 2000 kit (Gene Reach)
10.	Enterocytozoonhepatopenaei(EHP)	Tangprasittipap et al. (2013)
11.	Viral Nervous Necrosis (VNN)	OIE, 2014
12.	Iridovirus	Jeong et al., 2006

NRL-BAAD confirms IHHNV in imported SPF shrimp broodstock under quarantine

During the routine random screening of the imported SPF brooders from AQF, SPF shrimp contaminated with IHHNV have been detected and was referred to CIBA for confirmation. Samples were collected from the imported stock and tested for WSSV, IHHNV, IMNV, TSV, YHV/GAV and NHPB using nested PCR using IQ 2000 detection systems. Considering the special reference to IHHNV, two protocols described under the OIE manual were used for the detection of IHHNV. Two primer sets, 392F/R and 389F/R, are the most suitable for detecting all the known genetic variants of IHHNV including IHHNV-related sequences called types 3A and 3B, which are inserted into the genome of certain geographic stocks of *P. monodon* from the western Indo-Pacific, East Africa, Australia and India. Primer set 309F/R amplifies only a segment from IHHNV types 1 and 2 (the infectious forms of IHHNV), but not types 3A and 3B, which are non-infectious and part of the *P. monodon* genome. The samples of DNA and the pleopods of shrimp received from AQF, Chennai were

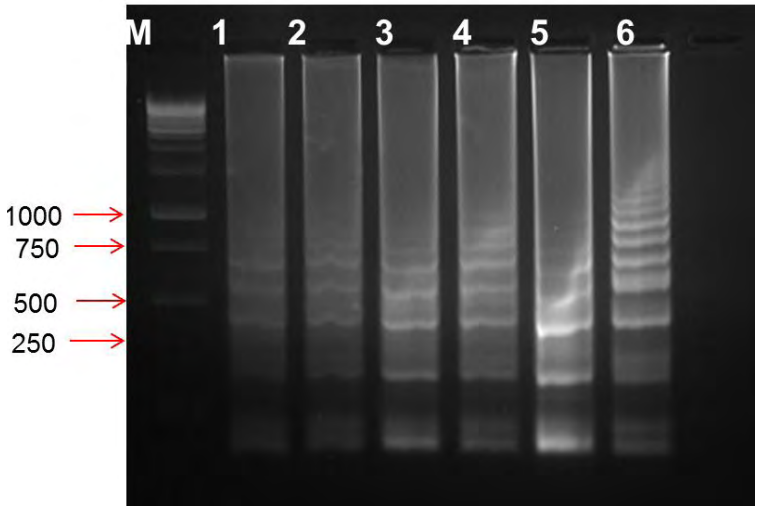
positive for IHHNV indicating that the shrimp under quarantine were infected. The NRL-BAAD of CIBA confirmed the presence of IHHNV in imported SPF P. vannamei shrimp broodstock using OIE (2015) recommended protocols. A detailed report was submitted to the Coastal Aquaculture Authority (CAA) about the findings and guidelines were provided to the AQF with regard to disposal of infected material.

Since April 2015, a number of imported Artemia cyst, fishmeal and re-imported shrimp samples were screened for the OIE listed shrimp and fish pathogens in the NRLBAAD, CIBA for the Animal Quarantine and Certification Cervices, Southern region (AQCS-SR) Chennai. At the Ministry's request, 12 samples from Broodstock Multiplication Centre were also screened for the OIE listed shrimp pathogens. The samples were subjected to screening of OIE listed shrimp pathogens using standard protocols. None of the samples tested were positive for any of the OIE listed pathogens. Imported P. vannamei brooders under quarantine at AQF, RGCA before releasing for hatchery operations were screened for Acute Hepatopancreatic Necrosis Disease (AHPND) and EHP. Over200 samples of shrimp faecal matter from brooders were tested by polymerase chain reactions (PCR) as per standard protocols (AHPND by AP3 and AP-4 methods, Sirikharin et. al, 2014 and EHP by Tangprasittpapet al., 2013). None of the samples found positive for AHPND and EHP by PCR.

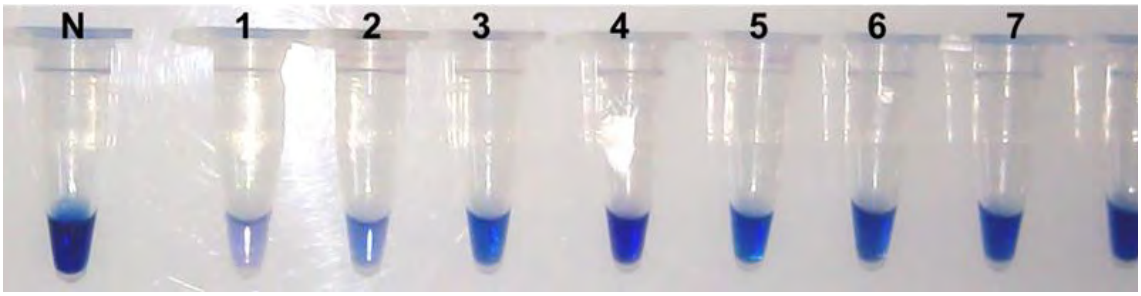
AAHED provided services to the Department of Animal Husbandry, Dairying and Fisheries (DADF), Ministry of Agriculture and Farmers'Welfare (MoAFW), Govt. of India on various policy related matters; Costal Aquaculture Authority (CAA) for inspection of SPF hatcheries and farms

Development of Diagnostics: A highly sensitive WSSV diagnostic test evaluated

Early and rapid diagnosis of white spot disease (WSD) plays a very critical role in the prevention of this devastating disease either in the shrimp hatcheries or grow-out farms. A number of molecular diagnostic techniques are being currently used in aquaculture. Evaluation of various diagnostic techniques such as OIE nested PCR protocol (2015), PCR protocol of Kimura et al (1996), Nunan et al (2011), real time quantitative PCR (qPCR), commercial diagnostic kits from Gene Reach Technologies (IQ 2000 and POCKIT) presently being used in the diagnosis of WSSV revealed that loop mediated isothermal amplification (LAMP) test was highly sensitive. LAMP assay was performed as per the protocols of Kono et al (2004) and evaluated for sensitivity with other tools. The assay was found to detect as low as 7 WSSV viral copy numbers equivalent to 0.1 femto gram of WSSV DNA as detected by real time quantitative PCR (qPCR) using SYBR green and TaqMan chemistries. Use of indicator dyes such as SYBR Gold and hydroxynaphthol blue (HNB) were found to be helpful in direct visualization of LAMP reaction with the naked-eye without having to carry out agarose gel electrophoresis. In conclusion, among the diagnostic tools evaluated, LAMP assay was rapid, sensitive and cost effective than other protocols for the detection of WSSV, and that pH indicator dyes such as SYBR Gold or HNB could be used to detect LAMP amplicons instead of conventional agarose gel electrophoresis and carcinogenic stains such as ethedium bromide.



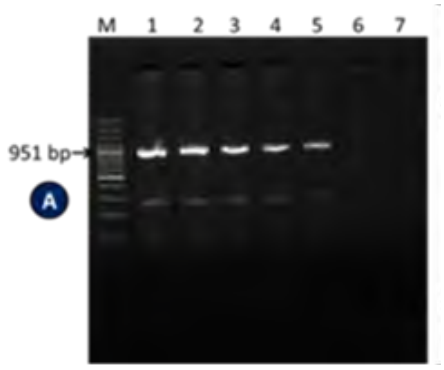
Detection of different concentrations of WSSV-DNA using LAMP protocol. Lane M: 1 kb marker; Lane 1: 0.1fg; Lane 2: 1 fg; Lane 3: 10 fg; Lane 4: 100 fg; Lane 5: 1 pg; Lane 6: 10 pg; Lane N: Negative control



Detection of different concentrations of WSSV DNA based on pH changes during WSSV LAMP reaction using hydroxynaphthol blue (N: negative control; 1-8: 0.1 fg to 1 ng WSSV DNA)

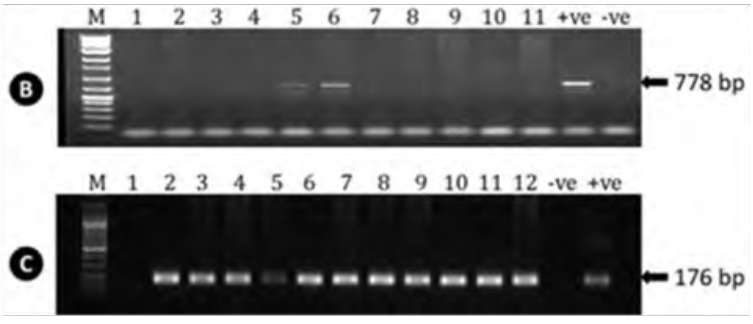
Development of diagnostics for EHP

Specific detection of EHP can be done using DNA based molecular diagnostic tools such as PCR, real time PCR, in situ hybridization (ISH) and loop mediated isothermal amplification (LAMP) methods. The AAHED lab of CIBA has been testing shrimp samples using PCR protocols of Tourtip et al. (2009),Tangprasittipap et al. (2013) and Tang et al. (2015).

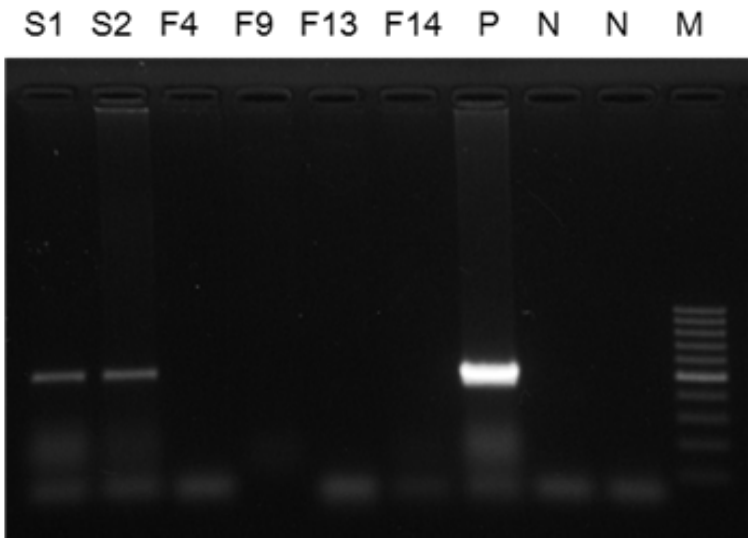


Detection of EHP by PCR using protocol of Tourtip et al(2009) showing 951 bp amplicon;

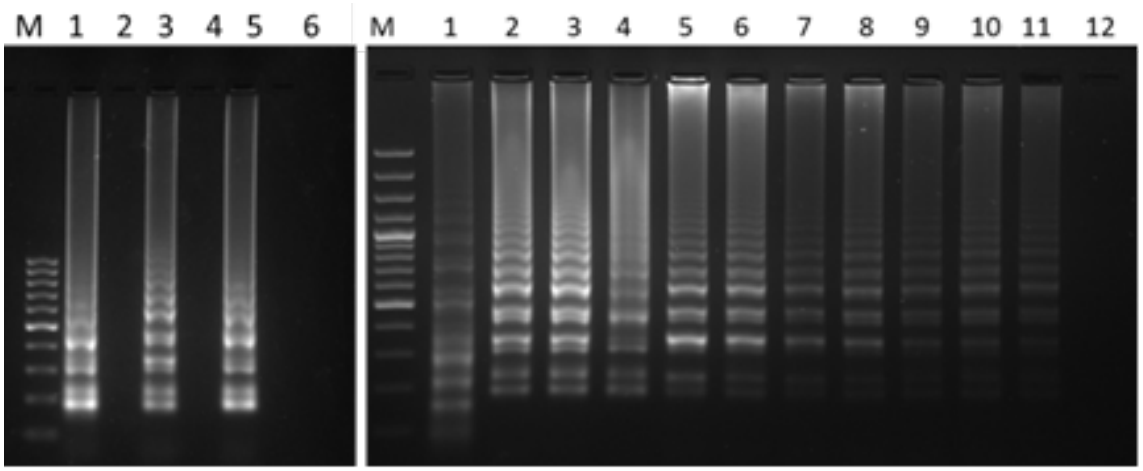
In order to diagnose EHP with rapid sensitivity and specificity, loop mediated isothermal amplification (LAMP) protocol was developed. In this protocol LAMP primers (two outer primers and two inner primers) were designed based on the published sequence of 18s small subunit rRNA gene of EHP (Tang et al 2015) using the software Primer explorer version 4. Target sequence of EHP was amplified at constant temperature of 63°C for 60 min after optimization by testing with different annealing temperatures. The sensitivity of this LAMP protocol for the detection of EHP was found to be 20 copies.



First step (upper panel) and nested PCR (Lower panel) for EHP using Protocol of Tingprasittipap et al., 2013 showing 778 and 176 bp products



Detection of EHP by PCR using protocol ofTang, et al. (2015): S1 and S2: infected hepatopancreas, F4,F9, F13 and F14: shrimp faecalsamples, P: Positive control, N: Negative control, M: 100bp Marker

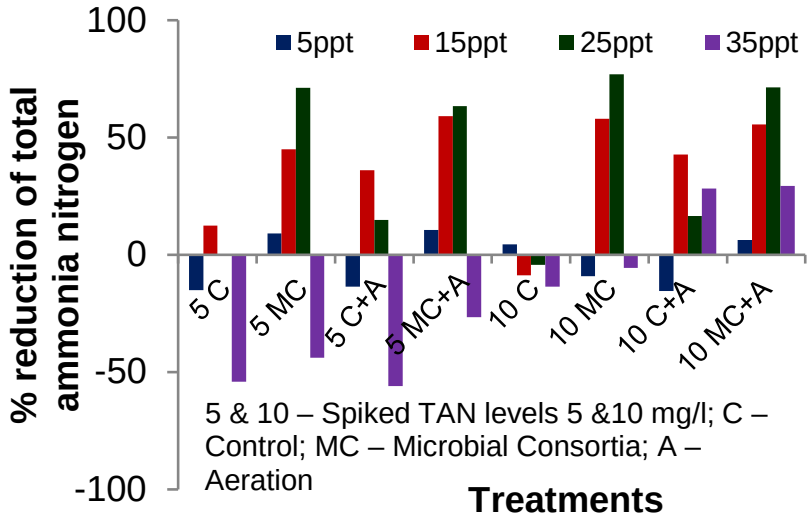


Agarose gel electrophoresis of LAMP amplicons of *Enterocytozoonhepatopenaei* (EHP) at different annealing temperatures andthat of EHP plasmid with serially diluted copy numbers.

Aquaculture environment and climate change

Soil sample collection from crab culture pond

Bioremediation of nitrogenous metabolites by AOB and NOB consortia at varying salinity

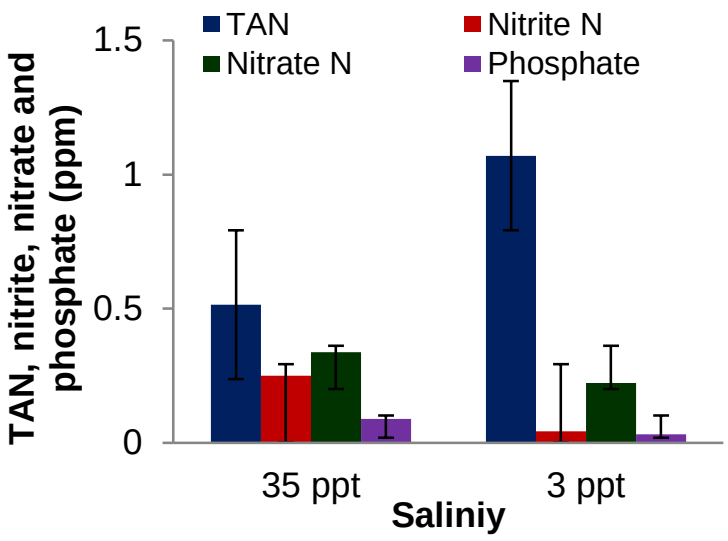


Effect of AOB and NOB consortia on TAN

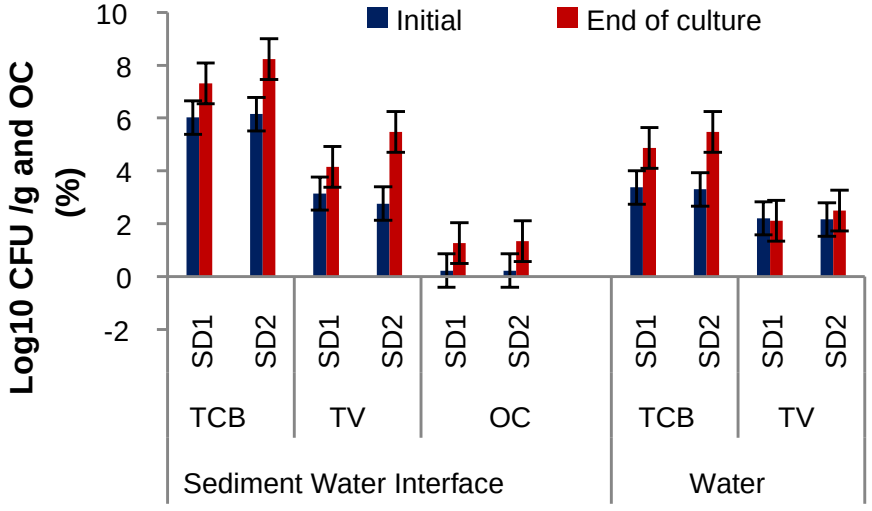
Nitrogenous metabolites built up in pond environment are toxic to shrimp at very low concentrations causing high mortality and economic loss. Bioremediation potential of ammonia oxidizing (AOB) and nitrite oxidizing (NOB) bacterial consortia at a concentration of 105 cells/ ml was evaluated at an interval of 0, 24, 48, 72 and 96 hours in 5, 15, 25 and 35 ppt salinity waters spiked with 5 and 10 mg/l total ammonia nitrogen (TAN) under controlled conditions with and without aeration. Higher per cent reduction of TAN was observed in 25 (63 – 77%) and 15 ppt (45 – 58 %) as compared to 5 (6 – 11%) and 35 ppt (29%) and the reduction was on higher magnitude in 10 mg/l TAN spiked treatments.Aeration improved the efficacy of consortia in the removal of nitrogenous metabolites. Bacteria consortia with aeration at both 5 and 10 mg/l concentration of TAN spiking showed 9 - 32% and 31 - 32 % per cent reduction of NO2 - N in 5 and 25 ppt salinity, respectively compared to without aeration. The consortia was combined with denitrifying bacteria to prevent the excess formation of nitrite and nitrate.

Characteristics of sediment-water interface in shrimp culture ponds in two salinities and stocking densities

Sediment-water interface (SWI) is the most significant indicator of culture ponds environment. In order to characterize the SWI of shrimp farming systems during culture period, water and soil samples were collected at different intervals from surface and SWI by sub-surface water and soil core samplers, respectively from *P. vannamei* ponds at two salinities (3 and 35 ppt) and *P. indicus* ponds with two stocking densities (16 and 32 nos. per sq.m). Organic carbon content (0.27 %) and total bacterial count (8.16 x 108cfu/ml) in sediment and concentration of TAN (0.51 ppm) and nitrite N (0.25 ppm) in water were high at SWI of P. vannamei ponds. There was no difference in water and soil pH at SWI between the ponds with two salinities, whereas nitrate, phosphate, nitrite, alkalinity and hardness in water were significantly influenced by salinity. At the end of *P. indicus* culture period, the total cultivable bacteria (TCB) and total Vibrio (TV) were high at SWI and high stocking density (8.22 and 5.48 log10cfu/g) compared to the values in water and low stocking density (4.86 and 2.12, log10 cfu/ml). The organic carbon (OC) at SWI was 1.27 and 1.33 per cent in 16 and 32 per sq.m stocking density ponds, respectively. It is recommend to collect the samples from SWI to understand the pond condition at any point of time during culture period as the values of indicative parameters were high.



Nutrients and metabolites concentration at SWI in *P. vannamei* ponds varying in salinity



Microbial and organic carbon load at SWI and surface water in *P. indicus* ponds varying in stocking density

Evaluation of *P. vannamei* culture in performance in low saline/ freshwater systems

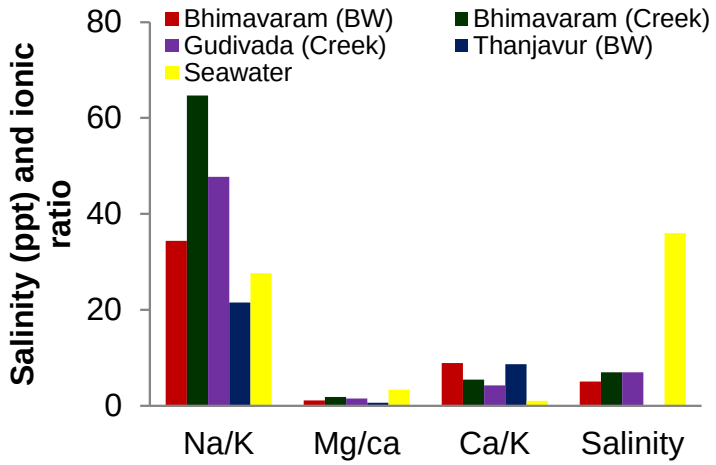
P. vannamei is being cultured in very low saline waters by the farmers in Andhra Pradesh and Tamil Nadu on a large scale. In order to assess the performance of vannamei in low saline waters, culture farms were monitored at Thanjavur in TN and, Bhimavaram and Gudivada in AP. The culture at Thanjavur is almost at 0 ppt, and ranged from 1 to 8 ppt at other two areas in AP. Though salt was added by the farmers to increase the water salinity, still it remained at 0 to 1 ppt in the ponds at Thanjavur.

Water and soil parameters during culture period were in optimum range at all the places. Farms in Thanjavur showed better performance compared to other two areas. Since the discharge water from the Thanjavur farms was more or less freshwater and enriched with nutrients nitrogen and phosphorus, the demand for discharge water from shrimp farms for irrigating paddy crops is increasing.

The source waters for the farms are creek and bore well. Mineral profile in source waters showed wide variation in the concentration of major ions sodium, potassium, calcium and magnesium and the ionic ratios were deviated to a large extent in comparison with the typical sea water. Overall Na/K and Ca/K ratios were higher and the Mg/Ca ratios were lower than the seawater and it is recommended to apply Mg for maintaining the ionic balance.

DETAILS OF *P. vannamei* CULTURE IN LOW SALINE AREAS

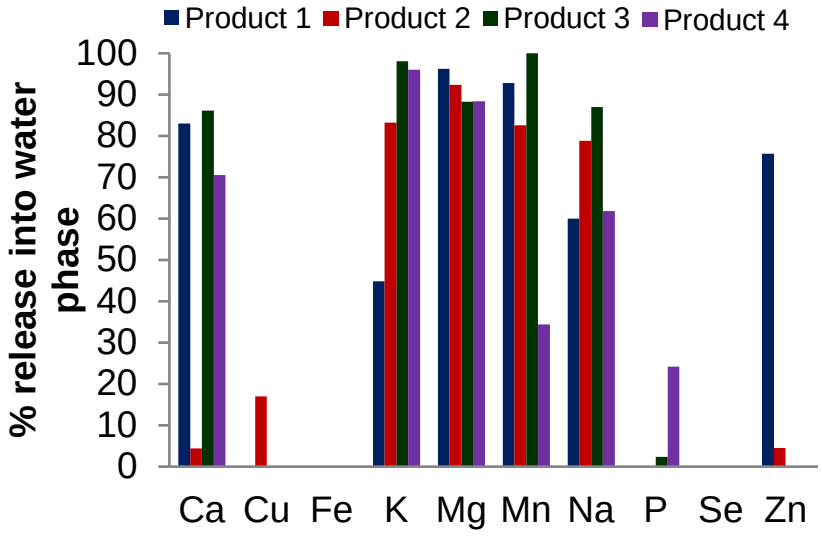
Parameter		Thanjavur (TN)	Bhimavaram (AP)	Gudivada (AP)
Salinity (ppt)	Stocking time	0 to 1	2 to 4	3 to 4
	Culture period	0 to 1	1 to 5	3 to 8
Salt added	Stocking time	500 kg	Salt is added when bore water is not available.	Nil
	Culture period	150 to 250 kg salt at 10 days intervals. Min. mix. addition	After stocking, no salt is added. Mineral mixtures addition.	Mineral mixtures addition
Stocking density nos./m^2)		40 to 50	30 to 40	30 to 40
Survival (%)		80 to 85 %	50 to 60 %	50 to 60%
FCR		1:1to1:1.7	1:1.7	1:1.5to1:1.7
Production (t/ha)		5.8 to 6.2	4 to 5	4.4 to 5.1



Ionic ratios of source waters in low saline farming areas in comparison with seawater of 35 ppt

Evaluation of efficiency of commercial mineral products

The mineral supplementation has been a major concern as information on actual quantity of minerals required is not available. There are no studies on percentage of minerals released from commercial products into the water phase. An experiment was conducted by dissolving four commercial mineral products in waters of varying salinity from 0 to 30 ppt. A steady increase in the minerals concentration was observed for all four products with the increase in water salinity. However, the increase in the availability was not uniform for all the minerals. The releasing efficiency of each mineral in all saline waters was varied with each product. In product 1, low pH (3.94) was observed at 0 ppt and slowly increased with the increase in salinity and reached neutral pH (6.99) at 30 ppt, whereas other three products showed almost neutral pH at all salinities. The

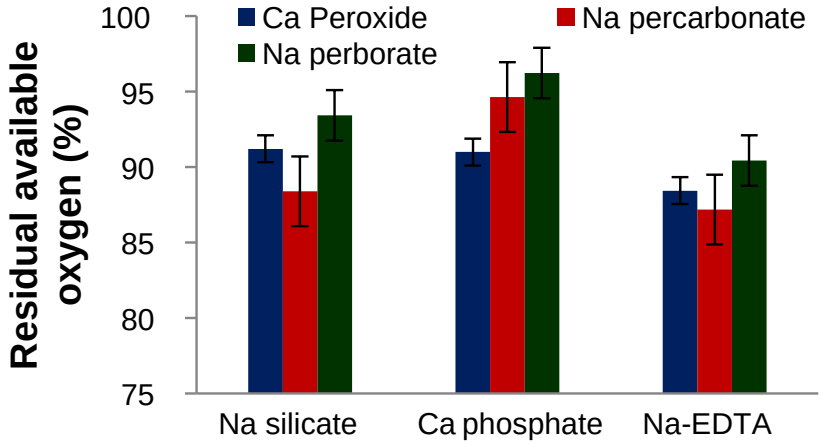


Minerals release into water from commercial mineral products

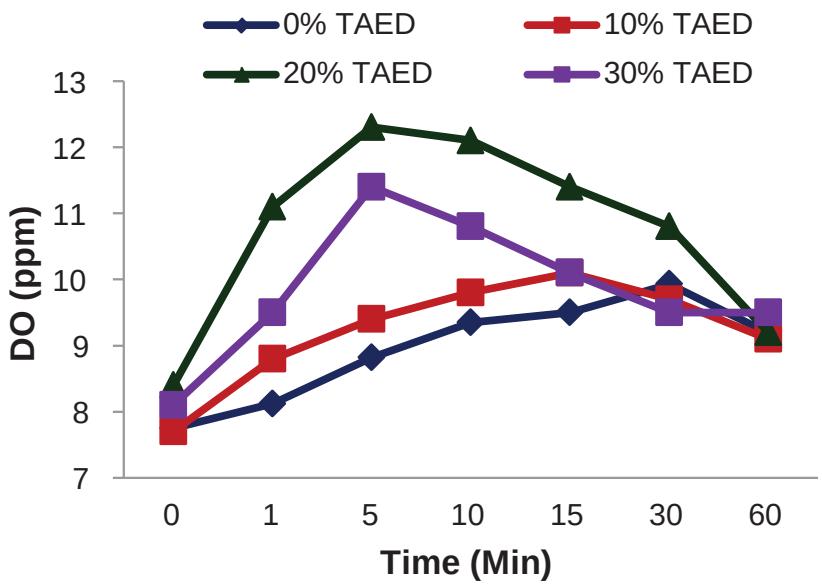
variation of mineral composition and pH among the products is due to the nature of ingredients present in the product and their availability after dissolving in the saline waters. Eventhough some of the minerals (Cu, P, Zn, Se and Fe) are present in the products, as shown in the label, availability of such minerals was not observed with all the products. The releasing efficiency of few minerals into water was less (K -44.8%, and Na - 60% in Product 1; Ca - 4.43%, Cu - 17% and Zn - 4.51% in Product 2; Mn - 34.4%, Na - 61.8% and P - 24.2% in Product 4) compared to the actual values in the product. Based on releasing efficiency of minerals and their availability in different saline waters, Product 1 is best suitable for supplementation of Ca, Mg and Mn, Product 2 is for K, Mg, Mn and Na, Product 3 is for Ca, K, Mg, Mn and Na and, Product 4 is for K and Mg. These findings are useful for mineral supplementation calculations in shrimp culture ponds and selection of product as mineral source based on releasing efficiency of minerals in varying salinity waters.

Enhancing the efficiency of dissolved oxygen releasing products

Even though mechanical aerators are commonly used for better aeration, dissolved oxygen (DO) releasing compounds are to be applied in shrimp culture ponds under emergency situation of low DO levels. In order to enhance the efficiency of DO releasing products, calcium peroxide (CP), sodium percarbonate (SPC) and sodium perborate (SPB) were coated with the stabilizers sodium silicate, calcium phosphate and Na-EDTA. All the tested materials were found to be effective in improving the stability of the oxygen releasing active components. SPC released maximum oxygen (11.7 ppm) followed by CP (10.6 ppm) and least by SPB (7.2 ppm) due to its low solubility in water. EDTA salt was effective in enhancing the stability by maintaining 93.8, 92.5 and 90.2% of residual available oxygen in SPB, CP and SPC, respectively followed by sodium silicate and least by calcium phosphate. As the solubility of SPB in water is low, an activator Tetra acetyl ethylene diamine (TAED) was added @10, 20 and 30% w/w of SPB to fasten the oxygen release. Addition of 20% TAED + SPB @ 2g/10 l in 20 ppt saline water was found to be effective in faster as well as higher amount of DO release from SPB. DO release was maximum at 5 minutes after application in case of 20 (12.3 ppm) and 30% (11.4 ppm) TAED addition, whereas maximum release of oxygen with 10% TAED was 10.1 ppm after 15 minutes of application.



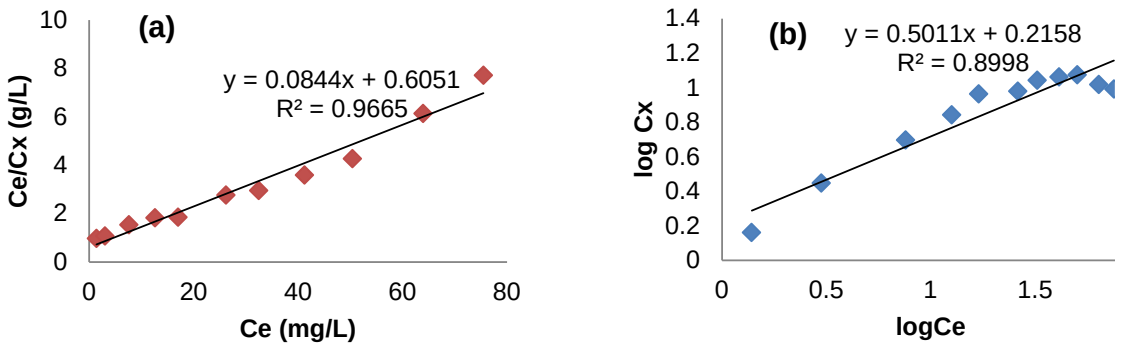
Effect of stabilizers TAED on increasing the efficiency of active components of DO products



Effect of activator TAED on increasing the efficiency of active components of DO products

Phosphorus removal from shrimp farm effluent

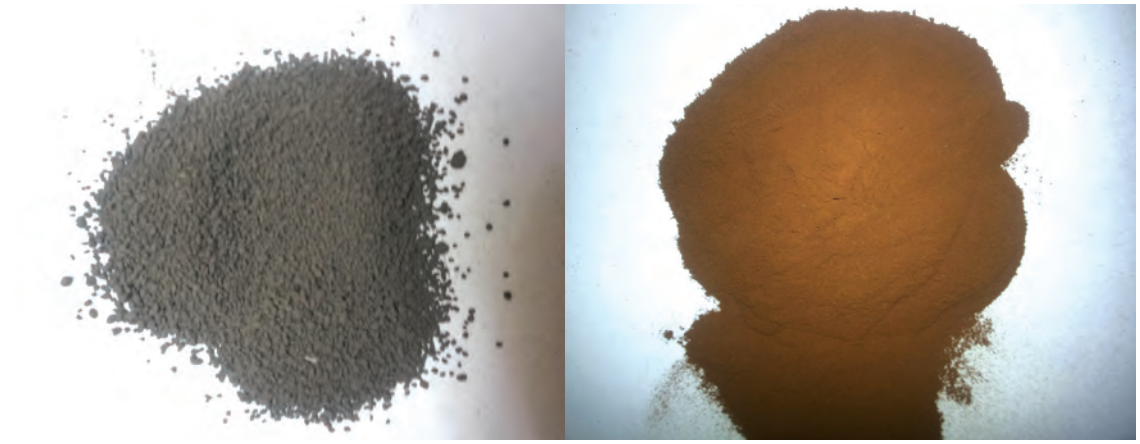
In order to reduce the nutrient load from aquaculture discharge water, pillared bentonite clay was tested as adsorbent for phosphorous. Clay minerals are naturally abundant small size particles with large surface area and functional groups. The sorption properties of bentonite clay mineral was enhanced by aluminum pillaring process which increases surface area as well as the incorporation of ion having greater affinity towards phosphorus. The synthesised aluminum pillared bentonite was assessed for its phosphorous removal capacity from the shrimp farms wastewater varying in salinity. The sorption capacity decreased with the increasing salinity from 11.85 mg P / g at 0 ppt to 5.01 mg P/ g 30 ppt.



Phosphorous sorption by aluminum pillared bentonite indicated by Langmuir (a) and (b) Freundlich isotherm

Enhancement of sorption capacity of biochar through magnetisation

As a measure of carbon sequestration, the labile carbon of the organic rich aquaculture pond sludge was converted to biochar (non-labile carbon) by the process of slow pyrolysis, which was found to be effective in the removal of phosphorus from wastewater. In order to increase the efficiency of P adsorption by biochar, the synthesised biochar prepared from aquaculture pond sediment was magnetised by coating with iron oxide. Magnetic materials used for wastewater treatment can be recovered from the system by their magnetic properties. Both the biochar and magnetic biochar were evaluated for their phosphorous adsorption capacity. Magnetisation enhanced the phosphorus sorption capacity of biochar from 28.9 mg P/g to 37.5 mg P/g.The magnetic biochar with the improved phosphorous sorption potential can be utilized as adsorbent material for wastewater treatment.

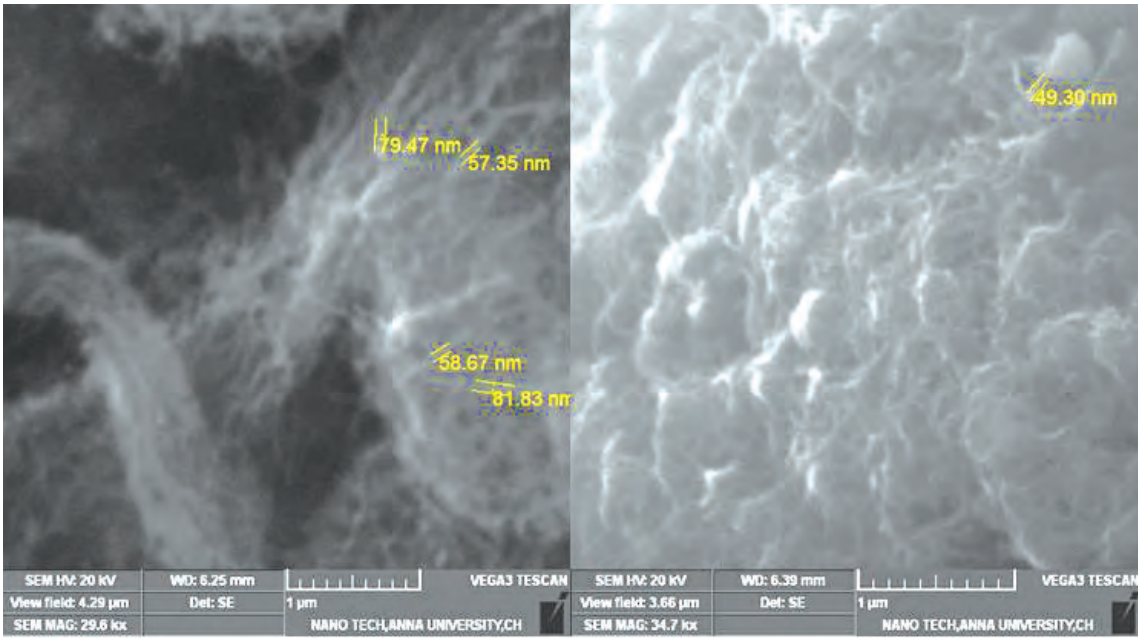


Biochar

Magnetised biochar

Effect of environmental stressors on shrimp immunological parameters, mineral profile and water quality

A single environmental stressor may not be responsible for retarded growth or mortality of shrimp and it is essential to study at what level of toxicity shrimp can tolerate combinations of critical environmental parameters and their adverse effect on cellular components of shrimp immune system. Microcosm of combinations of two stressors viz., pH (6, 8 and 10) and total ammonia nitrogen (TAN) (1, 3, 6 and 9 ppm) were created in 100 L FRP tanks. Yard experiment was conducted in triplicate for three weeks with 8 shrimps (P. vannamei) per 100 l FRP tank. On 3rd, 7th, 14th& 21st day of experiment, hemolymph collected from shrimp were analysed for immunological parameters, Phenoloxidase (PO), Superoxide Dismutase (SOD) & Total Heamocyte Count (THC), mineral profile (Ca, K, Na, Mg, Mn, Cu, Fe, and Zn) and water samples for quality parameters. In treatment tanks of pH10TAN6 and pH10TAN9 all animals died within 24 hours. Shrimps in pH8TAN9 & pH10TAN3 showed lowest survival low concentration of minerals compared to control. At low pH, nitrite-N concentration was low (pH6<pH8<pH10) in all the concentrations of TAN. At high pH, unionised ammonia increased with increase in TAN concentration (pH10TAN1< pH10TAN3< pH10TAN6< pH10TAN9), whereas at pH 6 & 8, this trend was not observed. THC, PO & SOD activity was high in control followed by pH8TAN1, pH6TAN1 and pH8TAN3, and lowest in pH8TAN9 treatments. The findings inferred that it is necessary to understand the effect of multiple combinations of environmental and weather stressors on pond environment and shrimp growth.



SEM image - Unfunctionalized and OH-functionalized MWCNT

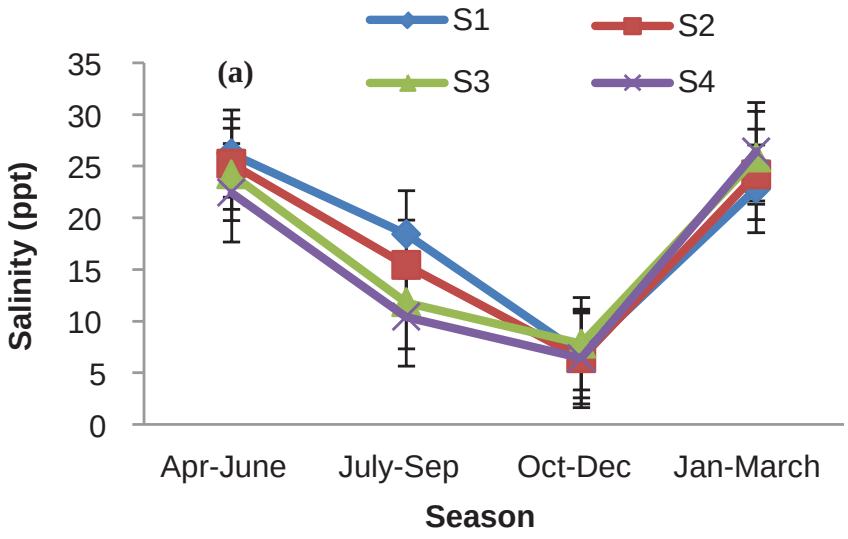
Refinement and development of water analysis kits

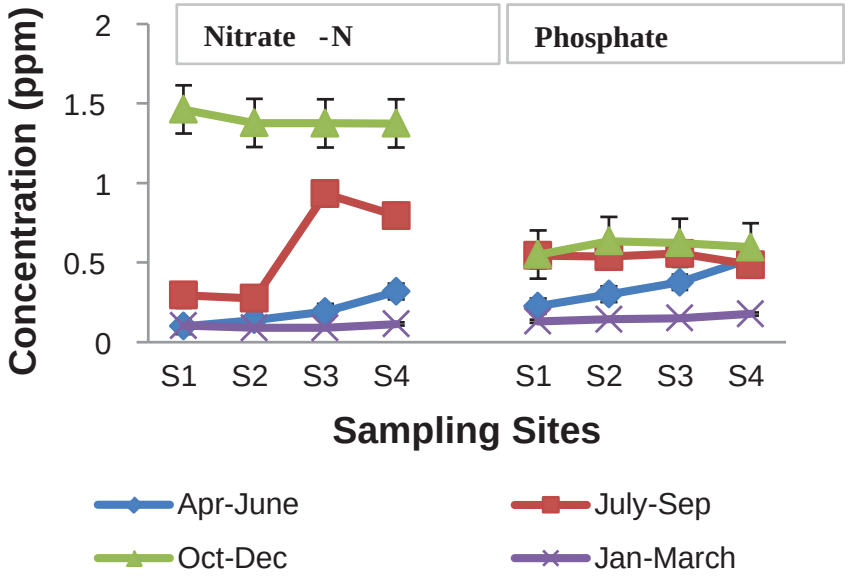
One of the reagents, starch solution in the dissolved oxygen (DO) kit commercialised by the Institute and also in most of the commercial DO kits had a problem of stability and turns into brown colour, when stored at room temperature within 15 days to one month. Modifications were made for this reagent with the addition of various stabilisers and one stabiliser showed no signs of deterioration of the reagent at room temperature and it was stable for more than eight months.

Carbonate, bicarbonate and total alkalinity Kit (CIBA-CBAK) was prepared and its precision and accuracy were checked with the actual titration method and compared with three commercially available kits. Out of commercial kits, only one kit was performed well in comparison with actual titration method. The values with CIBA-CBAK kit were very close to the actual titration method, better than the commercial kits and the per cent accuracy was 95 ± 5.

Seasonal variation of water quality characteristics in Muttukkadu backwater

In order to study the seasonal variation in Muttukkadu backwaters, samples collected monthly from the sites near crab (S1), crustacean (S2) and fish hatcheries (S3) and nearer to sea (S4) were analysed for basic physico-chemical parameters. There was a significant variation in water quality parameters between the seasons. The salinity reached to a maximum of 26 ppt (S1) during April-June followed by 25 ppt during January –March of (S4). The salinity levels were lowest (6-8 ppt) during October-December. Similar trend of seasonal variation was observed with pH also. Nitrate N and phosphate concentration were found to be maximum during October- December and lowest during January-March across the sites. The water parameters were found to be below the maximum permissible level of State Pollution Control Board across the sites throughout the year indicating the negative impact of activities at Muttukadu Experimental Station of CIBA on the backwaters quality.

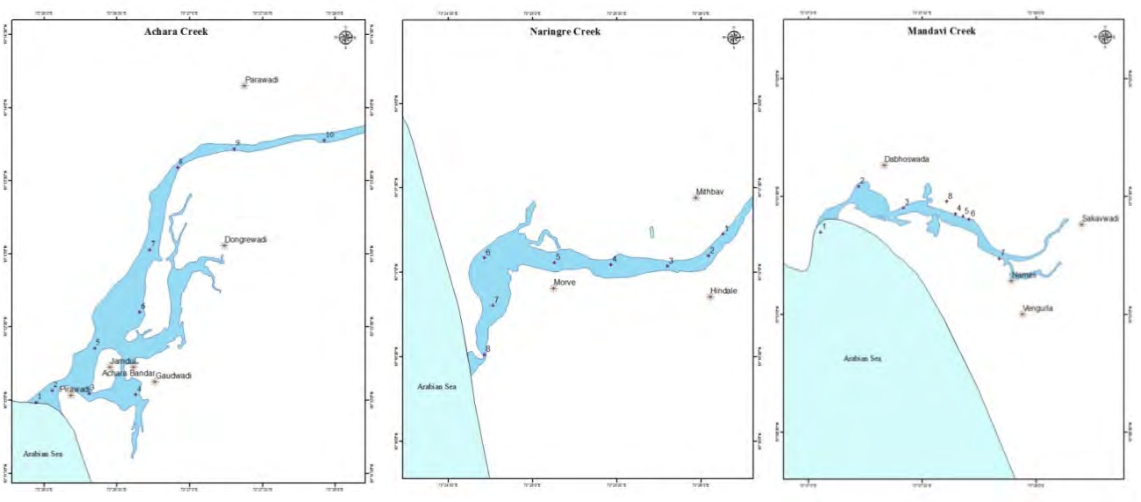




Water quality parameters A) Salinity B) Nitrate-N and Phosphate variationinMuttukkadu backwater during different season

Environmental impact assessment (EIA) and carrying capacity estimation of creeks for mangrove crab farming

EIA of crab farming was initiated in Malvan, Davgad and Vengurla coastal taluks of Sindhudurg District, Maharashtra. Baseline data on environmental and socio-economic parameters was collected pertaining to five crab culture pens and three ponds. In order to estimate the carrying capacity assessment of creeks for crab farming, three creeks Achara, Naringre and Mandavi representing one for each taluk were selected. Environmental monitoring programme (EMP) has been implemented to compare the environmental parameters data during culture period and post-culture with the pre-culture data to assess the impacts of crab farming on the environment. The water and soil samples collected from the fixed sampling points on each creek and crab pens/ ponds, were in optimum range, though slightly, low water pH (6.6) and high soil organic carbon content (0.87 and 1.14%) were observed in few pen sites. Data on environmental parameters from the first two samplings indicated no significant difference between water parameters of pond inlet, outlet and at different points in the creeks during the of culture period indicating no negative impact of crab farming on the environment.



Sampling stations on creeks in Sindhudurg District, Maharashtra for carrying capacity study

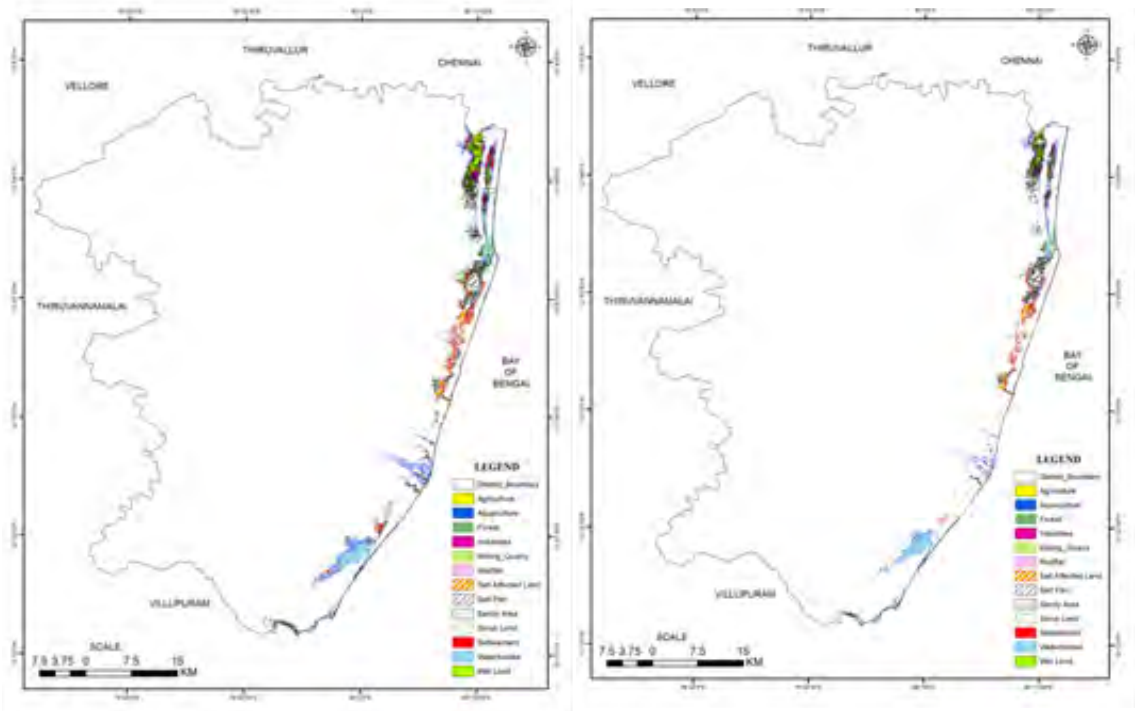
Impact of flood, extreme climatic event on shrimp aquaculture

The damage to aquaculture due to flood as a consequence of very heavy rainfall duringNovember–December 2015,under the influence of deep depression in the southwest Bay of Bengal, which has been attributed to the El Niño phenomenon was assessed in Nellore District of Andhra Pradesh. About 12000 acres of brackishwater ponds in 14 mandals and freshwater ponds in four mandals of the district were damaged and inundated. All the vannamei shrimp ponds situated on either sides of the Kandaleru creek were washed away. Infrastructure (Storage structures and temporary buildings) and machinery (aerators and motors) were damaged and washed away, and standing stock was lost out amounting to a total loss of 2000 crores. Siltation on the ponds bottom was observed upto 15-20 cm depth.

Loss to A) Infrastructure, B) Aerators, and C) Stock in shrimp farms due to flood in Nellore District, AP

Predicted impact of storm surge and sea level rise on inundation of coastal resources

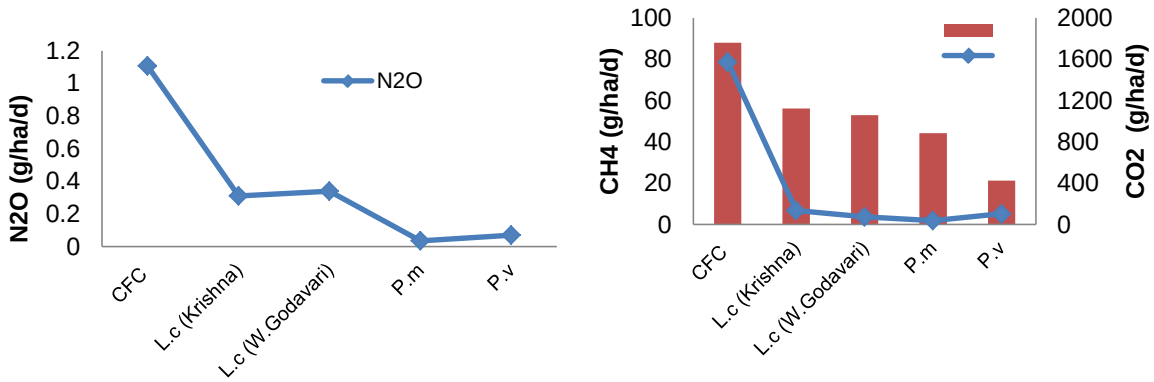
GIS and RS tools were used to predict the future impact of sea level rise (SLR) on land use classes in in Kancheepuram District, Tamil Nadu. The predications indicated that agriculture and aquaculture area of 67 and 39 ha and 273 and 110 ha will be inundated with 0.5 and 1 m SLR, respectively. Though a little area under aquaculture will be under inundation, a large area will be available for brackishwater aquaculture from the inundation of other land use categories.



Inundation of land use categories with 0.5 and 1 m SLR in Kancheepuram

Greenhouse gases emission from shrimp and fish culture ponds

Greenhouse gases (GHGs) emission were estimated monthly from culture ponds of *P. monodon* (12 nos./m^2)) in Nagapattinam District, Tamil Nadu, P. vannamei (35 nos./m^2) and freshwater composite fish culture (CFC) of Catla, Rohu and Sheelavathi in Krishna District, and Asian Seabass (*L. calcarifer*) in Krishna and W. Godavari Districts, Andhra Pradesh. Average emission of all GHGs in g/ha/day were high in CFC and finfish culture ponds (CH4 –3.62 to 7.86; CO2 – 1056 to 1758; N2O – 0.31 to 1.11) compared to shrimp culture ponds (CH4 – 1.88 to 5.14; CO2 – 423 to 883; N2O – 0.07 to 0.35). GHGs emission in terms of CO2 eq. emission in Kg/ha ranged from 78 to 190, 118 to 224 and 155 to 245 in the nursery (upto 300 g), grow out 1 (upto 1 kg) and grow out 2 (upto 3 kg) of *L. calcarifer* culture ponds, respectively. High GHGs emission in grow-out ponds of Seabass compared to nursery ponds indicated the influence of biomass size on GHGs emission. GHGs emission from different aquaculture systems in terms of CO2 eq. emission in Kg/kg production was 0.096 from CFC, 0.022 to 0.03 from Asian seabass, 0.04 from *P. monodon* and 0.042 from P. vannamei culture ponds. The emissions were high during the summer season compared to winter. The emissions significantly reduced during rainfall conditions and aquaculture ponds act as sink during rainy days and low temperature conditions.

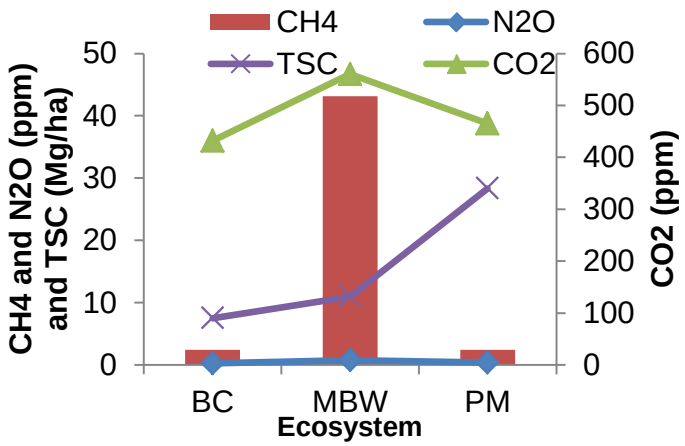


GHGs emission from aquaculture systems (CFC – Composite fish culture; L.c – *Lates calcarifer*; P.m – *Penaeus monodon*; P.v-*Penaeus vannamei*

Comparison of GHGs emission and sediment carbon status from different coastal water ecosystems

Greenhouse gases emission was estimated monthly for six months in open coastal water bodies of three different ecosystems viz. Pichavaram mangrove (PM) near Chidambaram, Muttukadu backwater (MBW) near Muttukadu Boat house (MBH) and Buckingham Canal (BC) near Mamallapuram. The major anthropogenic activities prevailed in each ecosystem were shrimp aquaculture, boating, agriculture, deforestation, fishing etc. In PM, continuous release of sewage, industrial effluents, urban run-off, boating, etc. in MBW and shrimp aquaculture in BC.

Collection of GHGs at A.Pichavaram Mangrove; B. Buckingham Canal and C. Muttukadu Back Water

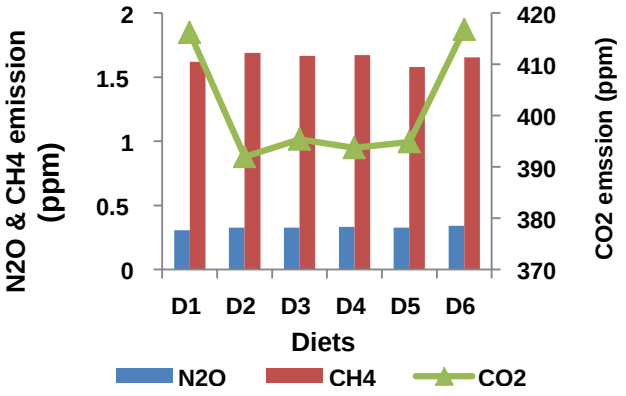


GHGs emission and sediment carbon content of three coastal water ecosystems

Emission of all the three GHGs was found highest in MBW followed by PM and BC. The average N2O and CH4 emission were found to be highest in MBW (0.76 ppm and 43.16 ppm, respectively) followed by PM and BC. The mean nitrous oxide emission to the atmosphere from MB is about 1.8 and 2.71 times higher than that of BC and PW while methane and CO2 emissions from MB were about 18 and 1.2 times higher than other study areas. PM has three times higher carbon sequestration potential than the other two study areas. Total sediment carbon (TSC) (Mg ha^{-1}) of each ecosystem was determined from the values of total carbon per cent, bulk density and specific depth of the sediment. Mangrove ecosystem has the highest sediment total carbon of 28.34 Mg ha^{-1}, which was 3 times higher than other two systems. The findings inferred that coastal water ecosystem with semi-intensive shrimp aquaculture has less impact on GHG emission compared to the ecosystem with pollution load from industries, sewage inflow etc.

Effect of fish meal replacement in the diets of *P. vannamei* on GHGs emission

Six different types of feed were formulated by replacing fish meal (FM) with plant protein sources (D1 - FM 25%; D2- FM 20%; D3 – FM 15%; D4 – FM 10%; D5- FM 5%; D6 – FM 0%). Yard experiment was conducted for 12 days to study the effect of diets on GHGs emission in 100 L FRP tankswith P. vannamei (Av. body weight 12 g) @ 6 nos. / tank and fed at 5% of their body weight. GHGs concentration was estimated once in 3 days interval throughout the experiment. GHGs samples exhibited same trend in emission with respect to CH4& N2O in all the samplings. CO2 concentration was maximum in tanks fed with D1 & D6, while N2O concentration was least in D1 and maximum in D6 throughout the experiment.

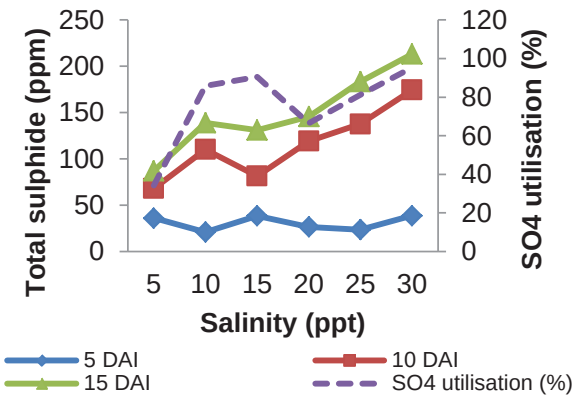


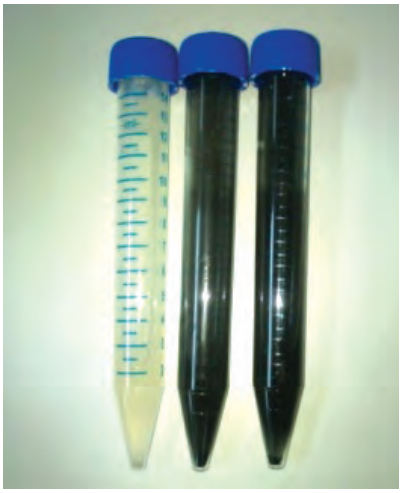
GHGs emission in *P. vannamei* tanks fed with fish meal replacement diets

Factors influencing the sulfate reduction and abundance of Sulfate reducing bacteria (SRB) in shrimp culture ponds

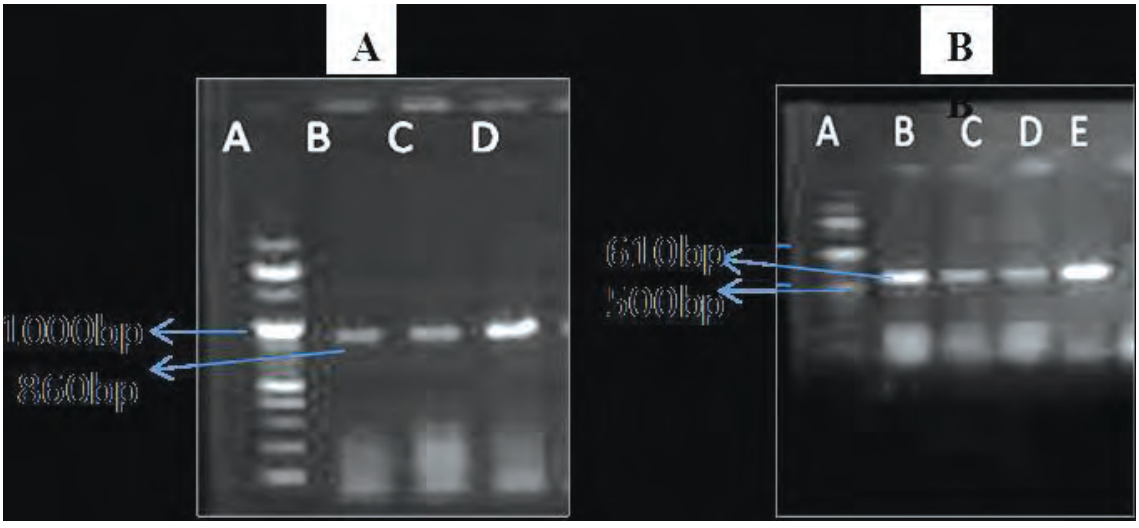
Sulfate reduction in aquaculture ponds is one of the key processes in anoxic sediments during which toxic hydrogen sulfide is produced and a number of factors influence the rate of sulfate reduction. Batch experiments were conducted with the sediment samples collected from P. vannamei culture ponds to study influence of pH (4 to 9) and salinity (5 to 30 ppt) in a buffered medium under anoxic conditions for a period of fifteen days. Total sulfide and sulphate levels were measured once in three days to study the utilization of sulphate during sulfide production. The highest sulfate reduction was recorded in pH 8 (72.4 ppm) followed by pH 6 (60.8 ppm) on 6th day and decreased thereafter.

In case of salinity, the production of sulfide was observed to be very rapid in all salinities and highest sulfate reduction was recorded in 30 ppt on 15th day. Sulfate utilization trend was similar to sulfide production in both pH and salinity batch experiments. In order to study the diversity of SRB in batch experiments, primer sets targeting six suprageneric groups were selected for amplification. Different groups are responsible for sulphate reduction at different pH and





Positive enrichment indicates black coloration



Gel pictures showing amplification of A) *Desulfococcus and B) Desulfovibrio*

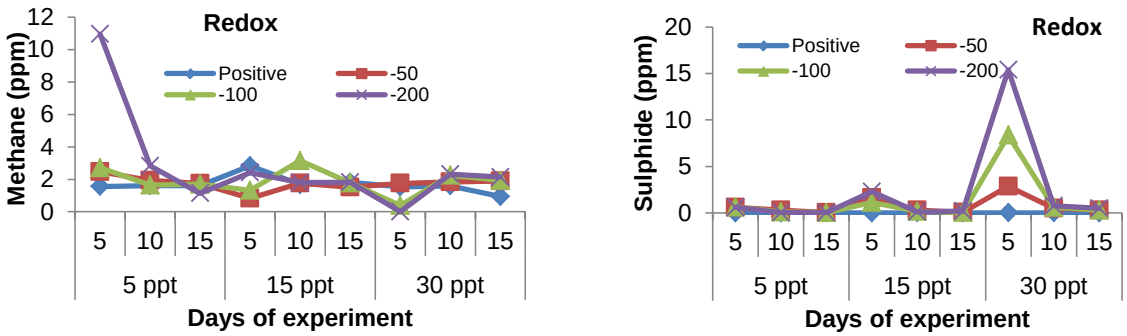
Diversity of sulphate reducing bacteria in pH and salinity batch experiments

SRB Group	pH						Salinity (ppt)					
	4	5	6	7	8	9	5	10	15	20	25	30
Desulfotomaculum(Gr-1)	×	×	×	×	×	×	✓	×	✓	×	×	×
Desulfobulbus(Gr-2)	×	✓	✓	✓	✓	×	×	×	×	×	×	×
Desulfobacterium(Gr-3)	×	×	×	×	×	×	✓	×	✓	×	×	×
Desulfobacter(Gr-4)	✓	×	✓	×	✓	×	✓	×	✓	×	✓	×
Desulfococcus, Desulfonema, Desulfosarcina(Gr-5)	×	×	×	×	×	×	✓	✓	✓	✓	✓	✓
Desulfovibrio, Desulfomicrobium(Gr-6)	×	×	×	×	×	×	✓	✓	✓	✓	✓	✓

×– Absent; ✓- Presence

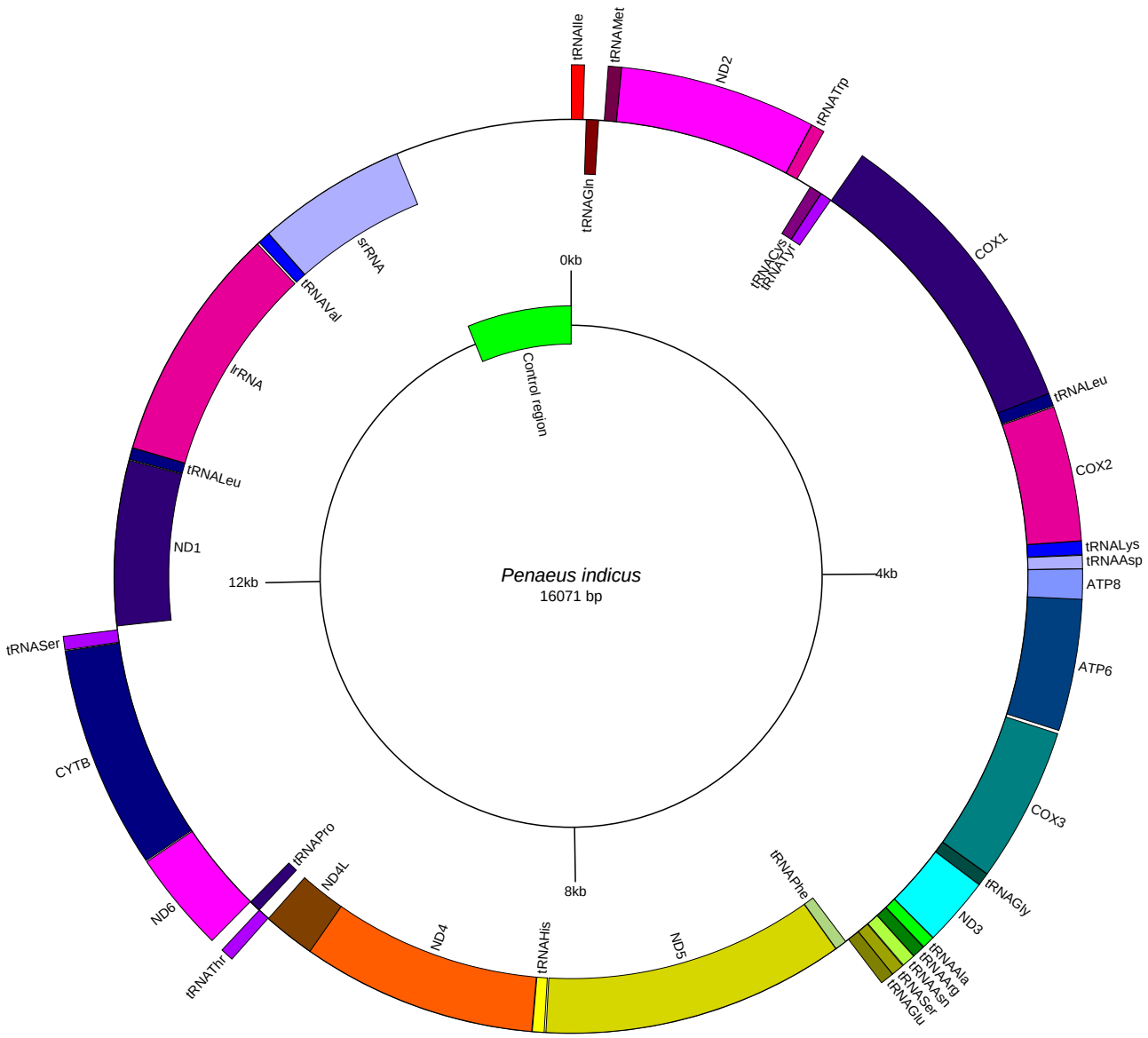
Methanogenesis and sulphide formation in aquaculture ponds

Sulfate reduction in aquaculture ponds is one of the key processes in anoxic sediments during which toxic hydrogen sulfide is produced and a number of factors influence the rate of sulfate reduction. Batch experiments were conducted with the sediment samples collected from P. vannamei culture ponds to study influence of pH (4 to 9) and salinity (5 to 30 ppt) in a buffered medium under anoxic conditions for a period of fifteen days. Total sulfide and sulphate levels were measured once in three days to study the utilization of sulphate during sulfide production. The highest sulfate reduction was recorded in pH 8 (72.4 ppm) followed by pH 6 (60.8 ppm) on 6th day and decreased thereafter.



Methane and suphide production in microcosms of varying salinity maintained at different redox potentials

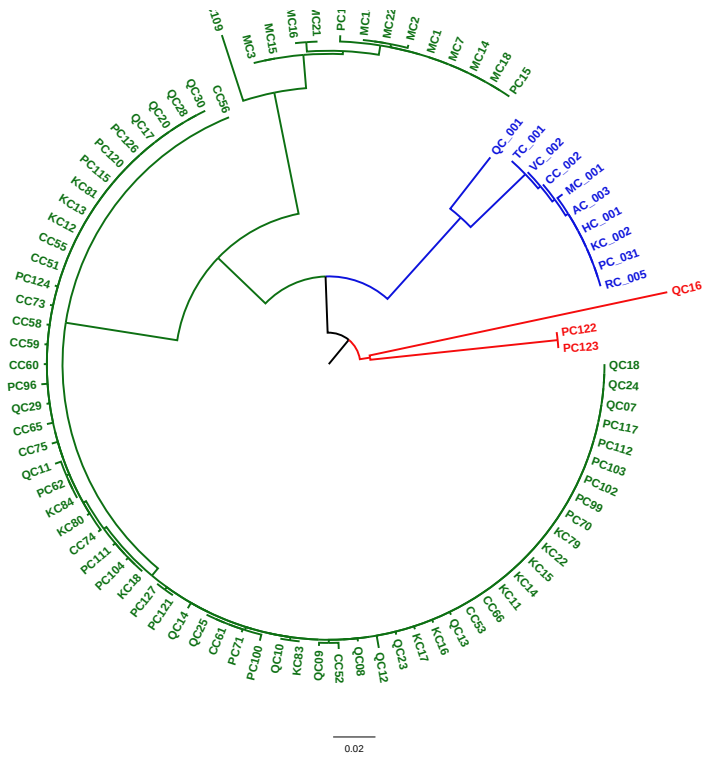
Genetics and biotechnology



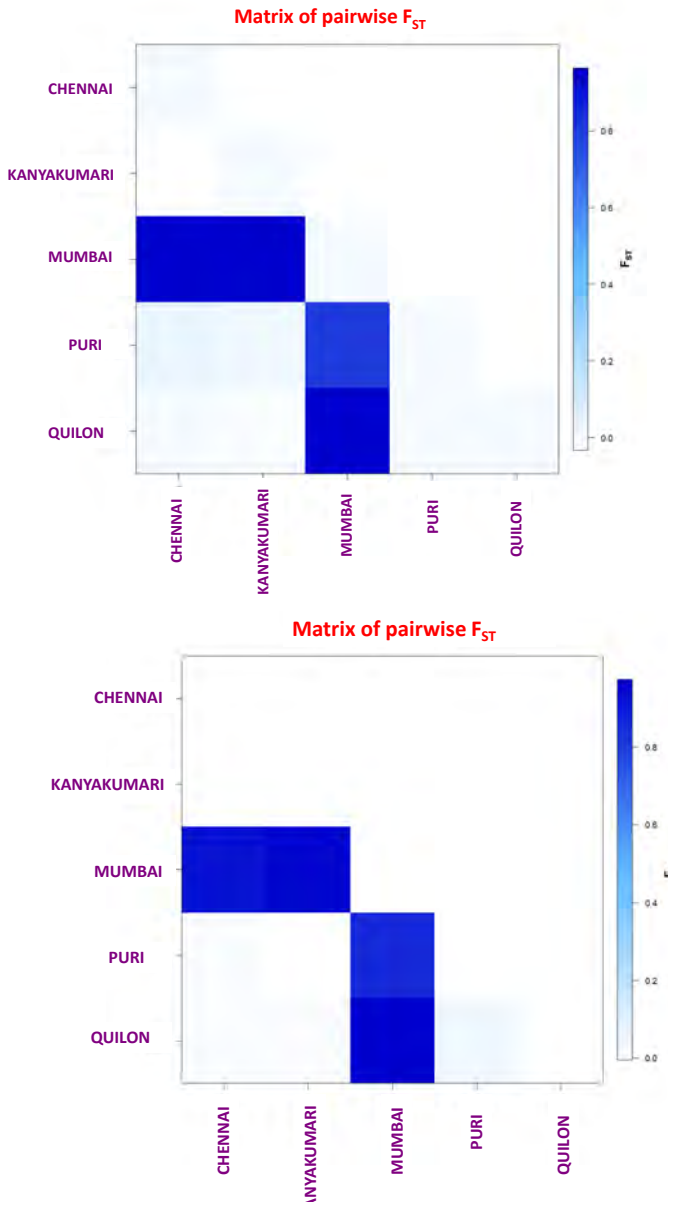
Full mitogenome of *P. indicus*

Population genetics of Indian white shrimp stocks

Majority of the farmed shrimp production in India is contributed by non-native P. vannamei, owing to the availability of specific-pathogen free and genetically improved broodstock. Although vannamei aquaculture performed well during the initial few years, shrimp farmers experience severe constraints due to new disease out breaks, unstable export market, genetic depression and increasing production cost. Therefore a strong necessity for alternate species is felt by shrimp farmers/ entrepreneurs to have a genetically improved native species to overcome the dependence on imported broodstock. The Indian White Shrimp, *P. indicus* having comparable growth potential as P. vannamei in grow out production system has been identified as the species of choice for establishing genetically improved population in India, which was also endorsed by stakeholders. Knowledge of the population structure across the natural range of distribution is critical to the establishment of base population for carrying out genetic improvement program in any aquatic species. Therefore, to comprehend the genetic divergence among the stocks of the species, specimens of *P. indicus* were collected from the natural habitat along the Indian coast for carrying out population genetic analysis based on mitochondrial DNA genes and microsatellite markers. Specimens were collected from Chennai, Kanyakumari, Mumbai, Puri and Quilon have been collected, presered and the total DNA extracted from these specimens and preserved for subsequent studies. A partial fragment of 710 bp in bar-coding gene, Cytochrome c oxidase I (CO I) was amplified using the primers after Folmer et al., (1994) and sequenced for 80 specimens (Chennai: 14, Kanyakumari: 14, Mumbai: 11, Puri: 23 and Quilon: 18). This stretch of sequence of CO I was used for confirmation of species as two other white shrimps existing along Indian coast have almost identical taxonomical features. A consensus sequence of 689 bp of these 80 specimens along with 10 tiger shrimp sequences as outgroup were analysed by maximum likelihood method under general time reversible model with 500 bootstrap replicates. All the tiger shrimp specimens clustered as a separate clade (blue) as depicted in the dendrogram. Three of the study specimens also formed a separate clade (red) and hence removed from further analysis.



The dendrogram of Indian white shrimp and tiger shrimp specimens based on CO I gene following maximum likelihood analysis



The pair-wise FST values among the stocks of IWS based on cytochrome b gene (top) and 16S rRNA gene (bottom)

Partial fragments of two mtDNA genes, cytochrome b and 16S rRNA were amplified using the primers given by Merritt et al. (1998) and Bouchon et al. (1994) respectively in species-confirmed specimens of IWS and sequenced. A consensus fragment of 370 bp and 501 bp for cytochrome b and 16S rRNA genes respectively was considered for haplotype-based population genetic analysis in Arlequin software. For cytochrome b gene, out of 50 sequences (Chennai: 12, Kanyakumari: 11, Mumbai: 9, Puri: 8 & Quilon: 10) considered for analysis, 27 haplotypes were observed. About 77 % of total variation in the population was attributed to the differences among the stocks. For 16S rRNA gene, out of 56 sequences (Chennai: 11, Kanyakumari: 10, Mumbai: 9, Puri: 11 & Quilon: 15) considered for analysis, 11 haplotypes were observed. About 78 % of total variation in the population was attributed to the differences among the stocks. The analysis based on both the mtDNA genes did point out that the Mumbai stock is significantly divergent from rest of the stocks. The analysis would be repeated after including sequences of specimens from other stocks of IWS in West and Eastern coasts of India to obtain a consolidated population genetic structure.

Phylogenetic analysis of the penaeid shrimps

Mitochondrial DNA genes were explored to study the phylogenetic relationships among the penaeid shrimps. The relationships indicate which species are more related and the order in which speciation events have evolved. This will also help to extrapolate possible production and reproduction behaviour of less-studied species which is more close to well-studied species. Full mitogenome sequence is available at NCBI and downloaded for penaeid shrimps like *P. monodon* (NC_002184), *F. chinensis* (NC_009679), *F. merguiensis* (NC_026884), *F. penicillatus* (NC_026885), *L. vannamei* (NC_009626), *L. stylirostris* (NC_012060), *F. californiensis* (NC_012738), *M. japonicus* (NC_007010) and *M. ensis* (NC_026834).

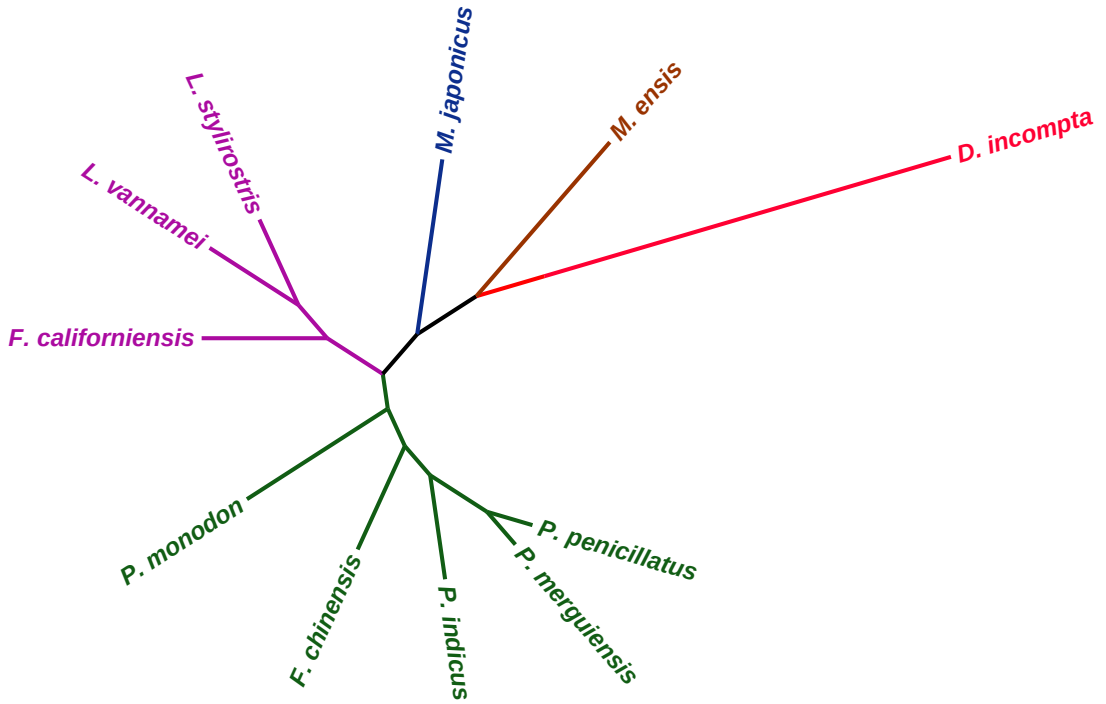
Complete mitochondrial genome of *P. indicus*

Full mitogenome of *P. indicus* is not available so far and has been deciphered for the first time using an approach that enriches methylated DNA. The Illumina paired-end sequencing on NextSeq instrument generated 12,26,040 reads which were assembled in to a single contig of 16,071 bp.The mitogenome of *P. indicus* has the same 13 protein-coding genes like other penaeid shrimps. If we separate the whole mitogenome of IWS into 1 Kb windows, then the window spanning from 14,001 bp to 15,000 bp has got higher AT distribution (76.5 %).

The 13 protein-coding nucleotide sequences of 10 penaeid shrimp mitogenomes (including *P. indicus*) as well as that of Drosophila incompta (KM275233.1, outgroup) were extracted using DOGMA tool. Individual gene sequences of all species were aligned separately and then concatenated to generate a consensus sequence of 11,237 bp (see chapter splitter) A phylogenetic tree was constructed using maximum likelihood method with 500 bootstrap replicates.

Dendrogram depicting the phylogenetic relationship among the penaeid shrimps

The phylogeny indicated similarities among the American shrimps which clustered together in a clade. Further, our study advances in clarifying the phylogenetic relationship among genus *Penaeus*, which has been controversial for last few decades since Perez *Farfante* and kensely (1997), split the genus in to six subgenera. Re classification of Perez *Farfante* and Kensely (1997) is mainly based on the difference in the genitalia of *Litopenaeus* and other Penaeus.Our complete mitochondrial genome analysis indicate that the difference in genitalia may not have genetic basis as *Farfantepenaeuscalifornien*sis, another closed thelycum species, grouped with open thelycum, *Litopeneus* group. Therefore, our complete mitochondrial genome analysis confirms the monophyly of genus *Penaeus*. Our present study refute the classification provided by Perezfarfante and Kensely, and reaffirm the single genus classification. As we used complete mitochondrial genome

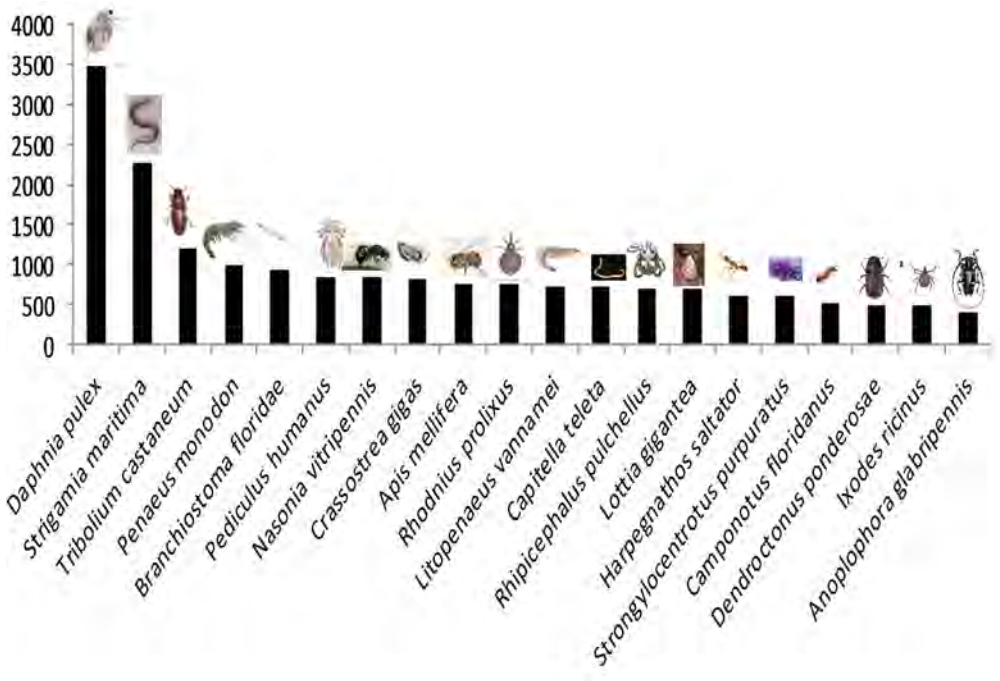


Phylogenetic tree depicting the relationship among the penaeid shrimps

for phylogenetic analysis, hence the analysis of phylogeny is more confirmatory in nature. In our previous annual report (CIBA annual report, 2014-15) we have provided a new scheme of classification for genus Penaeus, and our present study confirm our hypothesis.Among the white shrimps present along the Indian coast, banana shrimp and red-tail shrimp were observed to be more closely related as sister-groups and the Indian white shrimp has recently diverged from them

Molecular insights into the host response against WSSV infection by transcriptomic approach

The transcriptome from hepatopancreas of healthy and white spot syndrome virus (WSSV) infected black tiger shrimp *Penaeus monodon* was generated. The species distribution based on unigenes similarity from transcriptome of *P. monodon* is shown. The WSSV infected shrimp transcriptome revealed the activation of D-arginine and D-ornithine metabolic functional pathway. The current study indicates that stimulation of the identified pathway might be responsible for accumulation of ammonia and reactive oxygen species (ROS) such as hydrogen peroxide occur in WSSV infected shrimp



Distribution of top 20 species based on BLASTX similarity of *P. monodon*

Bioprospecting and characterization of bioactive compounds from marine sources

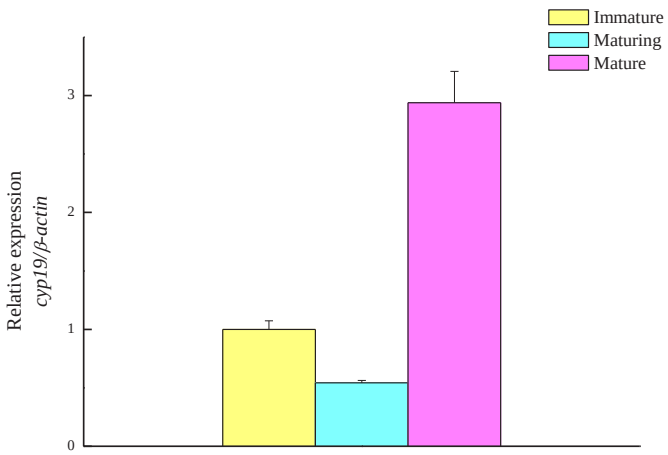
Bioprospecting is an effort to find out novel molecules from saline sources such as,oyster *(Crassostrea madrasensis)*, green mussel *(Pernaviridis)* and shoreline purslane *(Sesuviumportulacastrum)* have been initiated. The crude extracts are being analysed for active compounds. The samples will be characterized for bioactive compounds in collaboration with IIT, Madras as a collaborative initiative.

Amplification of kisspeptin complete coding sequence from Asian seabass

Induced breeding is an important tool for farmers to profitably breed and reproduce species that do not naturally reproduce in captivity, and to manipulate the timing of reproduction to suit production cycles. Various synthetic hormones like ovatide, ovaprim, wova-FH, ovopel, HCG and LHRH are used in induced breeding of fishes. Kisspeptins are group of peptides recently identified to stimulate GnRH release and are required for puberty and maintenance of normal reproductive function. Therefore, to understand their biological activities as well to develop an alternate synthetic hormone for Asian Seabass, the complete coding sequence of kisspeptin has been cloned in a plasmid vector.

Understanding the molecular and biochemical basis of maturation in wild mullet

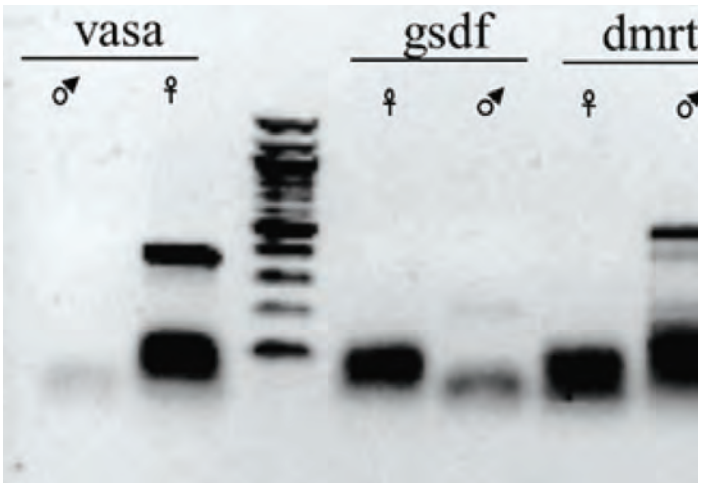
Understanding the molecular and biochemical basis of maturation in wild mullet: Grey mullets are prime candidate brackishwater species for which the complete seed production protocol of the species remains to be standardised in our country. Sex steroid hormones play important roles in teleost reproduction. The steroid hormone, estrogen regulates vitellogenesis in females. To gain a further understanding on the molecular basis of maturation in grey meullets, the differential expression of aromatase (cyp19a), the key enzyme catalyzing the synthesis of estrogen from androgen, in grey mullet (Mugilcephalus) at different stages of maturation was studied. Results showed a 2.5-fold higher expression of aromatase (cyp19a) in the ripe ovaries of grey mullets compared to the immature stage, suggesting its use as a biomarker in studying the maturation of grey mullet under captivity.



Quantitative RT-PCR of cyp19a in the ovaries of M. cephalus at different stages of maturation

Sex determination in red snapper *Lutjanus argentim aculatus*

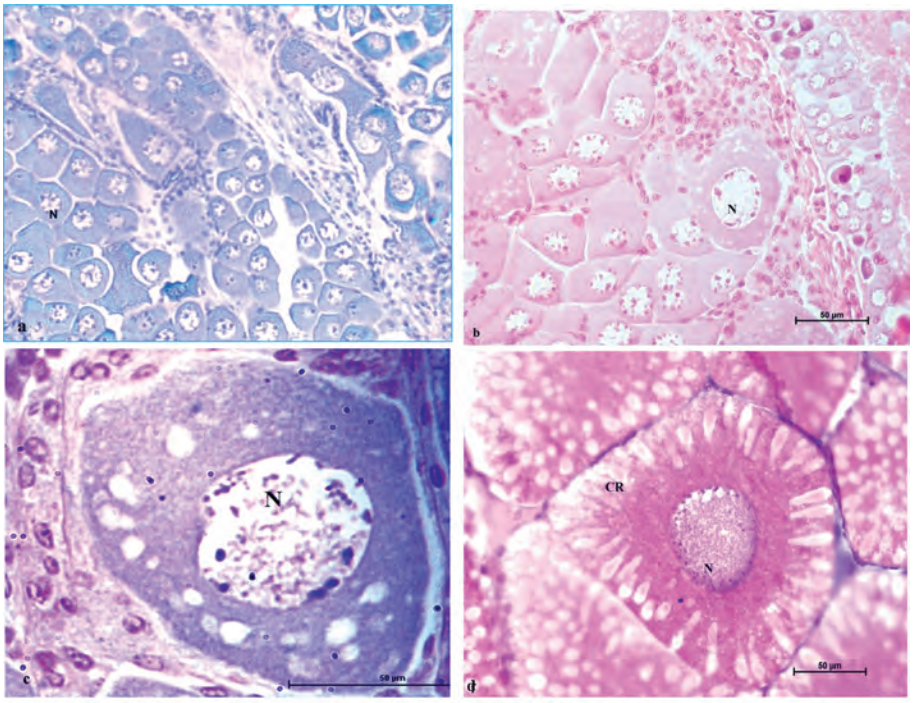
Differentiating sexes is difficult in Mangrove red snapper,Lutjanusargentimaculatusdue to the absence of sex specific external distinguishing features. Hence, expression of dmrt1, a reported male sex determining gene in some teleosts was studied in wild caught male and female red snappers. The results indicated a strong band of ~ 500bp in males. Expression of germ cell marker gene vasa was observed to be stronger in ovaries while that of gsdfwas comparatively stronger in testis. This could be evaluated to use as a tool to identify the sex of mangrove red snapper in captive breeding and domestication programs.



Gene amplification in *L. argentimaculatus*

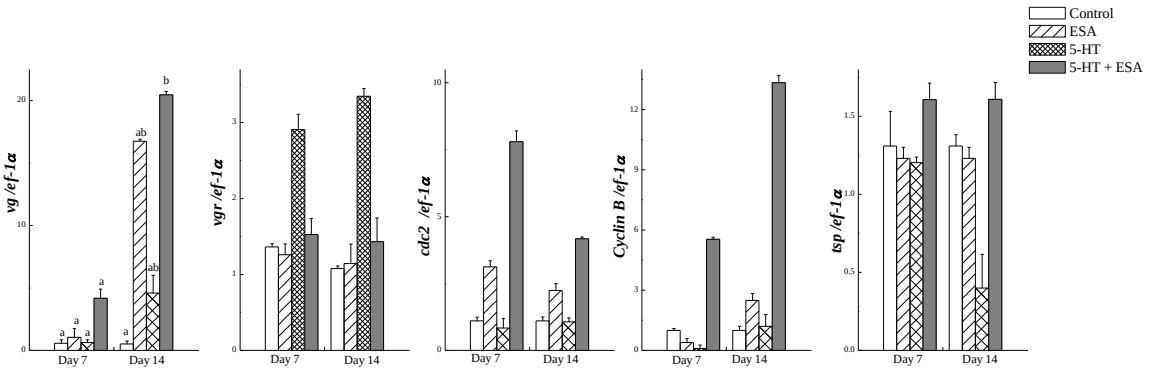
Serotonin induced ovarian maturation in *Penaeus indicus*

Serotonin (5-hydroxytrptamine, 5-HT) is known to stimulate ovarian maturation in penaeids. To evaluate the effect on the network of genes regulating ovarian maturation, serotonin was injected intramuscularly to intact and unilaterally eyestalk ablated females @ 50 µg/g body weight and the differential expression of ovarian genes involved in vitellogenesis [vitellogenin (vg), vitellogenin receptor (vgr)] and meiotic maturation [cyclin-dependent kinase 2 (cdc2), cyclin



Histological sections of ovarian tissues collected from *Penaeus indicus* on Day 14

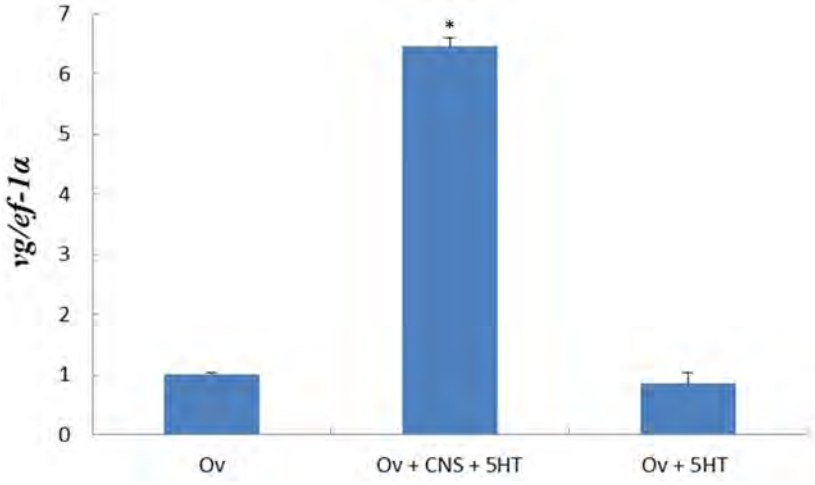
B and thrombospondin (tsp)] was examined. Significant increase in the expression of genes was observed in ablated females treated with serotonin which is known to act synergistically with other stimulatory hormones during eyestalk ablation to instigate ovarian maturation. This suggests a possible dual regulatory role of serotonin on both vitellogenesis and indirect stimulation of post-vitellogenic meiotic resumption and oocyte maturation in penaeid shrimps. Further the results could be used to make a strategy for inducing maturation and spawning of shrimp.



Real-time PCR analysis of (a) vg, (b) vgr, (c) cdc2, (d) cyclin B and (e) tsp transcripts in ovaries of *Penaeus indicus* subjected to induce maturation on Day 7 and Day 14. Each value represents means ± SEM (n = 10 shrimp). Different letters indicate significant differences (P < 0.05) according to the one-way ANOVA followed by Duncan's multiple range test

In vitro effect of serotonin treatment on vitellogenin (vg) mRNA expression in *Penaeus indicus*

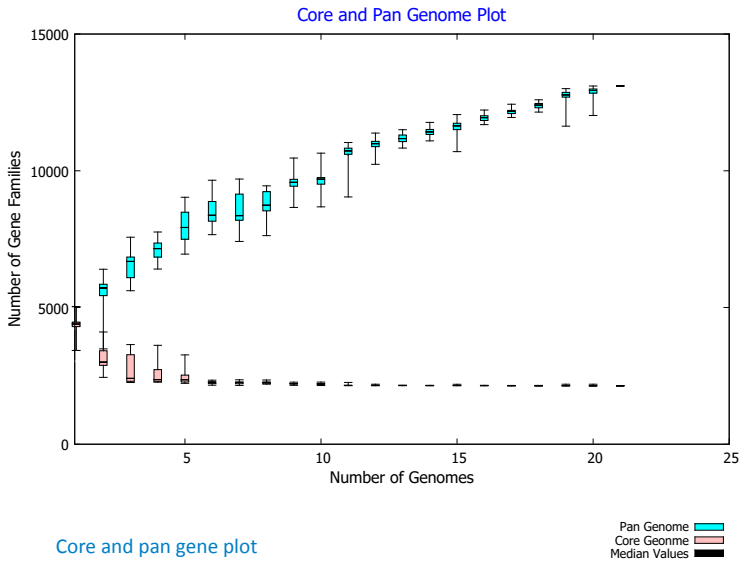
To verify the hypothesis that serotonin exerts an indirect stimulatory action on vitellogenesis, previtellogenic ovarian tissues dissected from *P. indicus* were incubated in a 24-well plate filled with 1.5 ml culture medium, either alone or co-cultured with nervous tissue, to which serotonin (50µg/ml) was added and incubated at 16^{0}C with gentle shaking on an orbital shaker (100 rpm) for 16 hrs. Control groups were treated with equal volumes of crustacean saline. A significant increase in vg expression levels was observed in ovary and nervous tissue co-cultured group treated with serotonin, confirming the indirect stimulatory role of serotonin in vitellogenesis.



Relative expression of vg transcripts following treatment with serotonin tissue; .Ov-ovarian tissue; Ov+CNS+5HT: Ovarian tissue co-cultured with nervous tissue and treated with serotonin; Ov+ 5HT: Ovarian tissue treated with serotonin

Pan-genome analysis of *Vibrio* sp.

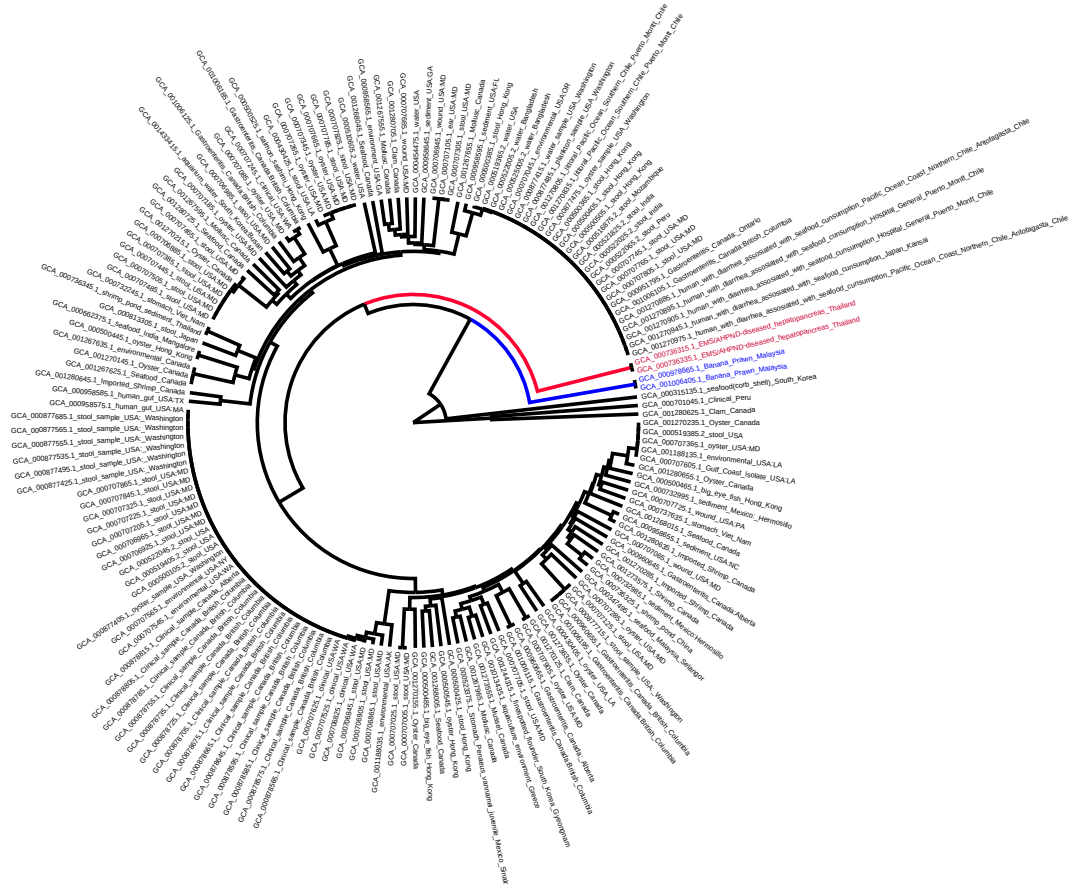
In order to profile the core and accessory genes present in Vibrio species, a pan-genome analysis was carried out. Complete whole genomes of Vibrio sp., important to brackishwateraquaculture, such as *Vibrio alginolyticus*, *Vibrio anguillarum*, *Vibrio campbellii*, *Vibrio parahaemolyticus* and *Vibrio vulnificus* were used in this study. Analysis was done using BPGA (Bacterial Pan Genome Analysis pipeline), and there are2138 core genes and 13106 pan-genes found in the five Vibro species comprising 21 genomes.



Core and pan gene plot

MLST based phylogenetic analysis for differentiating shrimp pathogenic *Vibrio parahaemolyticus*

Differentiation of acute hepatopancreatic necrotic disease (AHPND) isolates of *Vibrio parahaemolyticus* is of particular importance in the management of AHPND. In order to study phylogenetic relations, MLST based phylogenetic analysis was carried out. One hundred eighty one genomes of *V. parahaemolyticus* with known habitat were downloaded from NCBI. Housekeeping genes from these genomes were extracted using online MLST tool (https://cge.cbs.dtu.dk/services/MLST/) and were subjected to phylogenetic analysis. Two closely related clades, isolates from shrimp ponds of Malaysia and isolates recovered from AHPND affected ponds were found to be distinct from all other isolates. MLST based phylogeny appears to be a suitable approach to differentiate AHPND isolates of V. parahaemolyticus from other isolates.



MLST based phylogenetic tree of *Vibrio parahaemolyticus* (Red clade represent EMS isolates and blue clade represent Banana shrimp of Malaysia)

Whole genome sequencing of *Vibrio harveyi* and *Pseudomonas aeruginosa*

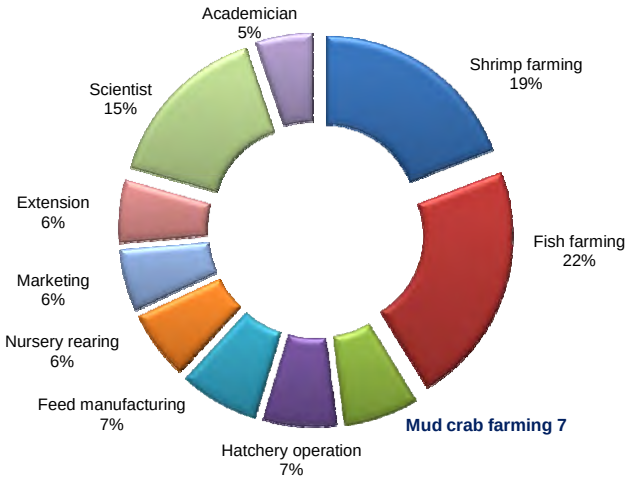
Whole genome sequencing of two bacterial species:*Vibrio harveyi* and *Pseudomonas aeruginosa* has been carried out. Reads were assembled using A5 miseqgeonomeasseblypipeline Comparative analysis of assembled Pseudomonas aeruginosa was conducted with reference genome PA-01 against 18 clinical isolates.

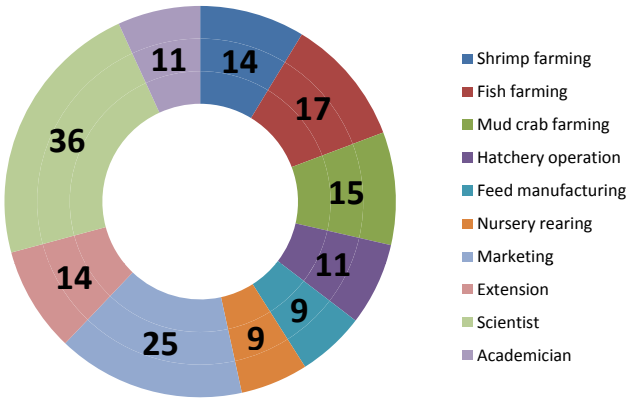
Social science and development

Brackishwater aquaculture with rural youth participation, Thiruvalluvar district, Tamil Nadu

Awareness and entrepreneurship motivation of youth on brackishwater aquaculture

A sample of 341 and 72 students from colleges and schools respectively were given exposure in different aspects of brackishwater aquaculture. The students from universities and colleges were impressed in the subject matter of shrimp farming > fish farming > feed formulations/ manufacturing > mud crab farming in order. Their career aspiration ranked top in fish farming followed by shrimp farming and to serve as scientist predominantly in order. The students from schools were impressed in the subject matter of shrimp farming > fish farming > mud crab farming > biotechnological research, in order. Their career aspiration ranked top to serve as scientist followed by marketing, fish farming, mainly in order.





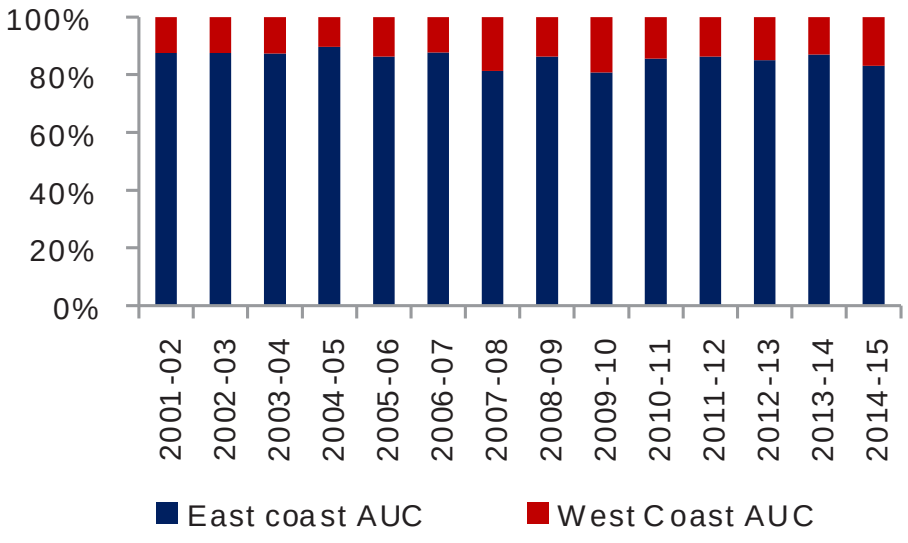
Economic trend analysis for seafood consumption and brackishwater shrimp production

Trends in domestic fish Consumption

An analysis of the fish consumption patterns of rural and urban populations in coastal states and union territories (UTs) in India, and how these have changed over time was carried out. The analysis is based on unit record data on fish consumption obtained from National Sample Surveys conducted in 1983 and 2009-10. Distributional aspects of fish consumption both within and across coastal States/UTs, and over time are assessed. The results suggest that despite an increase in fish production over time, people living close to the coast in almost all states and UTs report a decline in consumption. Average monthly per capita quantity of fish consumption for the rural population has fallen among all States and UT's, except in Kerala and West Bengal, where it has risen. Fish consumption in rural areas has fallen while urban areas increased marginally. Kerala and Goa are the top two and Gujarat has the lowest in per capita consumption. In addition to Kerala and West Bengal, average monthly per capita quantity of fish consumption among the urban population has also increased marginally in Tamil Nadu and it remained the same in Odisha over-time.

Trends in growth of brackishwater aquaculture

West Bengal, Orissa, Andhra Pradesh, Pondicherry UT and Tamil Nadu have 55.97 per cent of potential area of brackishwater areas and west coast states viz., Gujarat, Maharashtra, Goa, Karnataka and Kerala have 46.97 per cent. In spite of an equal share in potential aquaculture area, east coast alone contributes for about 83.15 per cent of shrimp and only 16.85 per cent is contributedby west coast to the nation's total shrimp production. The poor development of aquaculture in West Coast is attributed to the lack feed and seed production facilities in the west coast, and high cost of these major inputs which needs to be obtained from east coast.



Trends in Estimated Production of shrimp in India

Role of fisherwomen in marketing the catch from brackishwater lakes

Though the contribution of wild catch from brackishwater resources to the total fish catch is negligible, it is a livelihood for the fisher folks in the small coastal villages. A study conducted among 30 coastal families at Annamalaicherry, Tirupalaivanam, Tiruvallur district Tamil Nadu showed that majority of the women participated and took major decisions on marketing of shrimps and fish catch. Women alone participated actively in collecting, auctioning and/or purchase, packing, transportion and sales of fish to nearby towns. Their work started at 8.00 am and ended at 5.00 pm. Men supported women only a part in logistics.

Aquaculture as an alternative livelihood for hunting was demonstrated for Irular tribal families as a part of the CIBA-TSP initiative. Thousand five hundred wild caught milk fish fingerlings were stocked in pond of 0.1 ha size, in Senjiammannagar, Tirupalaivanam in Tiruvallur District of Tamil Nadu.Milk fishes were fed CIBA's low cost fish feed @ 2 to 5 % of the standing biomass twice a day in equal rations. After three months, 200 numbers of milkfish of 50 to 100 g were harvested and sold @ Rs.10/- per fish and a amount of Rs. 2000/- was realized as interim profit.

Beneficiaries in the community pond, Pulicat, Tamil Nadu

Fish sampling by the farming community in Pulicat, Tamil Nadu

Mobile telephony/e-Extension/mass media programmes for sustainable brackishwater aquaculture

A sample of 84 farmers in East Godavari district of Andhra Pradeshwas contacted to collect primary data. Their information needs were centered on six specific topics. They depended mainly on interpersonal relationships in meeting for their information needs. The role of mass media and printed materials as sources of information was found to be very low. Lack of timely access, low level of education and language barrier were the constraints that these farmers faced while getting the necessary information. The needs are different according to the state of the farmers can be divided into six groups.

Majority of the farmers were not having access to some of the aquaculture information. Therefore ICT based aquaculture information support system would be of great help for the shrimp farmers.

S.No	Specific Information	No. of farmers (n=84)	Information required by farming community on mobile
1	Field acquisition	52 (61.90%)	Farmers are required to know different forms of schemes, subsidies
2	Aquaculture inputs	61 (72.61%)	Quality seeds, feeds, other inputs and weather conditions
3	Technology	49 (58.33%)	Farmer should be fed with information about innovative technology in their farming
4	Credit	38 (45.23%)	Farmers need information about credit facilities and terms of loans
5	Marketing	73 (86.90%)	Day to day market trend on price of shrimps

Demonstration of polyculture of milkfish with pearlspot

Demonstration of brackishwater finfish polyculture (milkfish and pearlspot)was carried out in the farmer's pond. A total of 600 nos of milkfish seed in the size range of 2-3g and 500 nos of pearlspot seed in the size of 4-5g were stocked in 700m2earthern ponds. Fishes were fed formulated feed prepared by CIBA @ 3-4% daily. Periodical manuring with cow dung was done. After 7 months of time, 220 kg of fishes (200kg of milkfish and 20 kg of pearlspot) was harvested with the productivity of 3.3 tone/ha The harvested milkfish and pearlspot were sold in Kerala market @ Rs.200/kg and Rs.380/ kg respectively.The average size

Fish sampling by the youths in low saline ponds, Thiruvalluvar district, Tamil Nadu

of harvested milkfish and pearlspot was 340g and114.g respectively.CIBA has organised a harvest mela on 24th July 2015 and it was witnessed by around 100 participants consists of farmers,scientists,technical personnel and officials of state department, Tamil Nadu.

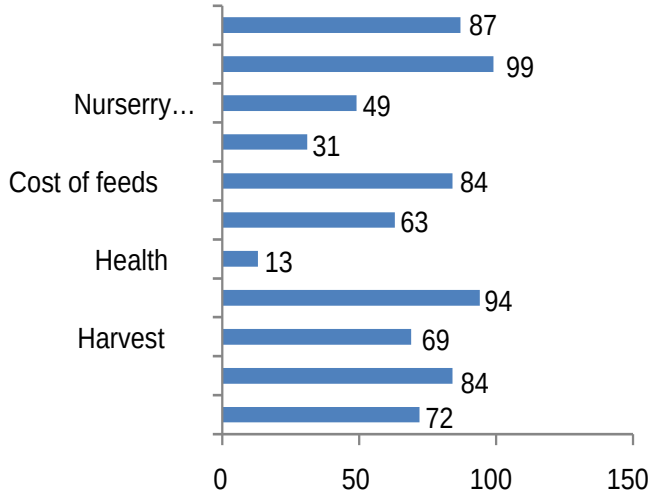
Fish harvest mela in low saline ponds, Thiruvalluvar district, Tamil Nadu

Phone in programme" (PiP) :

"Phone-in" is a live program where listeners are invited to air their comments by telephone in specific topic of interest. This kind of programs are gaining popularity agriculture, and same has been attempted by in

STRENGHTS	WEAKNESS
1. Convenient access through mobile phones. 2. Time & cost saving. 3. New attitude regarding the role of fish culture. 4. The increasing information technology. 5. Access with experts. 6. Message delivered is based on information need.	1. Oriented towards accessible farmers. 2. Irregular programs 3. Language barrier 4. Focused on a single subject. 5. Limited reach 6. Clarification of doubts. 7. Lack of literacy
OPPORTUNITIES	**THREATS**
1. Changes in farmers' preference towards culture. 2. Access with experts. 3. Collaboration between research institutes and community groups. 4. Fish farmers are innovative to new ideas	1. Production risk. 2. Marketing risk. 3. Discouraging face to face contact. 4. Poor contact with extension officials

brackishwater aquaculture sector as first of its kind. The program was conductedusing the audio conferencing facility of M.S.Swaminathan Research Foundation (MSSRF), Chennai. Frequency distribution analysis of the participants based on the pre-defined categories of the queries has been carried out. Around 121 queries raised by 117 fish farmers were documented on the subject of "Seabassfarming' and its Farm Management Practices" with the help line number of MSSRF and via SMS to the CIBA mobile number. Total farmers targeted were 201 of which about 91.54% participated in this live PiP interaction from different parts of the districts of Tamil Nadu and Puducherry, Union territory. About 11.94 % could not participate in the PiP because of the poor signal and pre occupied works. The findings revealed that about 72% of the participants showed highly favourable perception towards conduct of this programme since the information shared during the interaction was satisfying and able to solve the problems. SWOT analysis of the programmes was undertaken and the results are presented in the matrix.



Information gaps in Asian Seabass farming

Experts responding to the farmers questions in "phone in programme"

Comparative assessment of production parameters of shrimp farms with on-farm nursery and direct stocking

A sample of 84 farmers in East Godavari district of Andhra Pradeshwas contacted to collect primary data. Their information needs were centered on six specific topics. They depended mainly on interpersonal relationships in meeting for their information needs. The role of mass media and printed materials as sources of information was found to be very low. Lack of timely access, low level of education and language barrier were the constraints that these farmers faced while getting the necessary information. The needs are different according to the state of the farmers can be divided into six groups.

Majority of the farmers were not having access to some of the aquaculture information. Therefore ICT based aquaculture information support system would be of great help for the shrimp farmers.

Comparison of parameters in farms using farm level nursery and direct stocking

S.No	Production parameters	With nursery (n=6)	Direct stocking (n=6)
1	Stocking density (PL/m^2)	45 ± 5.00	38 ± 13.96
2	Survival (%)	87.5 ± 5.00	67.5 ± 11.12
3	DoC (No.of days)	81 ± 16.33	122 ± 20.41
4	Average body weight (in g)	20.5 ± 3.32	23.61 ± 5.05
5	FCR	1.27± 0.10	1.42 ± 0.20
6	Production (Tonnes/ha)	5.9 ± 1.73	4.90 ± 2.72
7	Labour (man days /crop/ha)	217.5 ± 28.72	283 ± 48.49
8	Fuel/Electricity charges (Rs/crop/ha)	60000 ± 16329	99571 ± 42768
9	Farm Technical Efficiency	0.945 ± 0.009	0.901 ± 0.062

Lined pond for rearing shrimp in East Godavari district of Andhra Pradesh

Comparison of shrimp productivity in earthen and lined ponds

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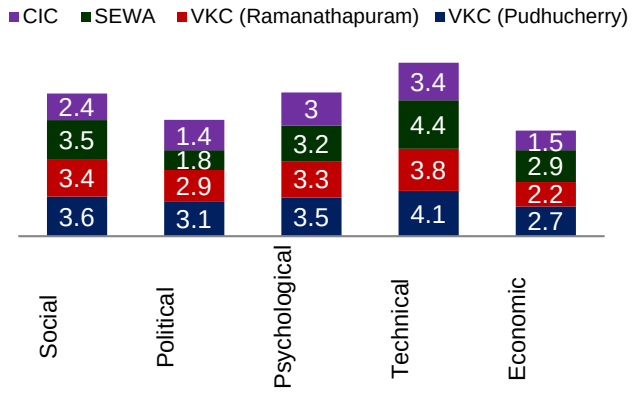
Comparitive efficency of shrimp productivity in earthen and lined ponds

S. No	Variables	Lined ponds (n=14)	Earthen ponds (n=14)
1	Stocking density (PL/m^2)	66.66 ± 12.34	38 ± 13.96
2	Survival (%)	87.66 ± 12.93	82 ± 11.12
3	DoC (No.of days)	136.4 ± 22.0	112 ± 20.41
4	ABW (in g)	29.33 ± 2.71	25.61 ± 5.05
5	FCR	1.32 ± 0.87	1.42 ± 0.20
6	Production (t/ha/crop)	9.73 ± 1.33	5.90 ± 2.72
7	No. of crops	3	2
8	Efficiency	Relatively high	Relatively low

Empowerment assessment tool for evaluating ICT projects in aquaculture

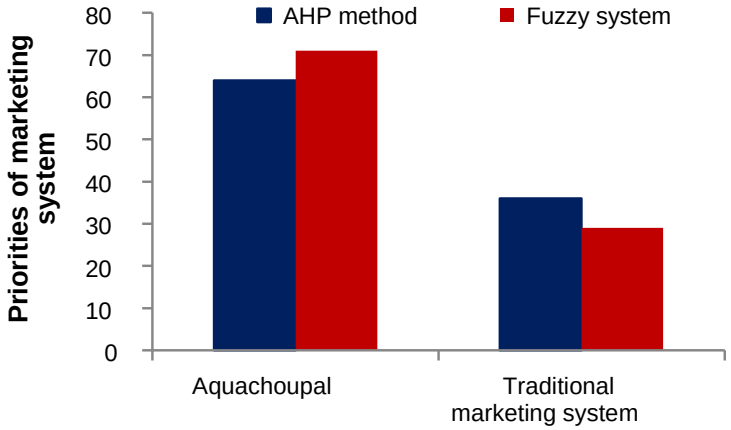
Empowerment assessment tool comprises of five factors viz., social, political, psychological, technical and economicwas developed based on the literature, interviews and group meetings with users and operators of ICT projects for evaluating the ICT projects in aquaculture. The tool was tested for analysing the various ICT projects participants' experiences such as VKC of MSSRF, Tamil Nadu (22 nos.), Self Employed Women's Association, Gujarat (22 nos.) and Community Information Centre, Odisha (22 nos.) in these forms of empowerment and the use of ICTs in aquaculture. The results revealed that except political empowerment all other factors are visible among the users of ICT projects . The average scores of technical and economic empowerment of all the projects show that, projects have not only produced many ICT literates but have also enabled them to get alternative livelihood options in aquaculture/fisheries through trainings they got at the centres. The study also revealed that the tool is useful for analyzing the users of ICT project experiences in these forms of empowerment.



Average empowerment scores for different ICT projects

Fuzzy decision support system for evaluating e-marketing in aquaculture

Fuzzy decision support system was developed to assess the change in service quality in aquaculture marketing as a result of e-marketing system in the form of aquachoupal model in West Godavari and East Godavari district, Andhra Pradesh, India. Evaluating, e-marketing induced service quality changes, the two candidate alternatives are service quality under the aquachoupal model and traditional marketing system in aquaculture. The opinions of 88 shrimp farmers on service quality dimensions have been investigated by means of a survey questionnaire. The aquachoupal model scores over the traditional system of marketing because of its transparency in operations and functions. The aquachoupal model receives the highest priority 71% and traditional system receives 29% of weights. For evaluating the results of fuzzy system, it was compared with the Analytical Hierarchy Process (AHP) based method developed by Mahalakshmi et al., (2011). The results highlighted that fuzzy system receives the

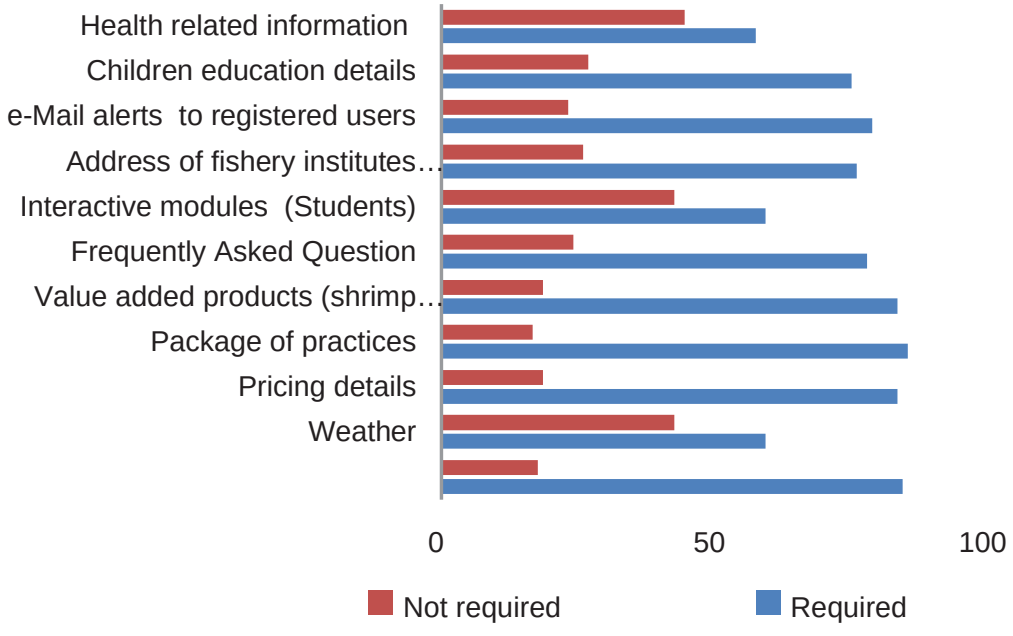


Priorities of marketing systems using fuzzy logic and AHP method

highest priority (71%) compared with hierarchy method (64%) of weights. The result also shows that the execution time of fuzzy system is very low (11 seconds) compared to AHP method (23 seconds). This shows that fuzzy system is suitable for evaluating the change in service quality e-marketing system in aquaculture. The result also shows that there has been significant improvement in service quality in aquaculture because of e-marketing.

Needs assessment for development of e-knowledge center in brackishwater aquaculture

An information needs assessment of 110 stakeholders viz.,users of ICT projects of Village Knowledge Centre of MSSRF, Tamil Nadu and Aquachoupal, Andhra Pradesh (50 nos); aqua/tribal farmers of Gujarat (50 nos.) and students (10 nos.)were conducted for the development of e-Knowledge center in brackishwater aquaculture. More than 90% of respondents required aquaculture and fisheries information, package of practices, marketing information and value added products. Almost 80% of the respondents are expressed that the requirement of addresses of various fisheries and aquaculture departments and universities, information on subsidies for fishermen, aqua farmers and women, education related information especially for courses offered in aquaculture and fisheries. In addition some of the respondents (60%) are required weather and health related information.Based on the information needs of stakeholders the contents such as information on monodon, vannamei, banana shrimp; milkfish, pearlspot, seabass, mud crab, applications of minerals, probiotics usage, soil and water suitability and management, success stories, area and production, policies and fisheries institutions were collected and processed for the development of e-knowledge center in brackishwater aquaculture.



Needs assessment of stakeholders for e-Knowledge centre

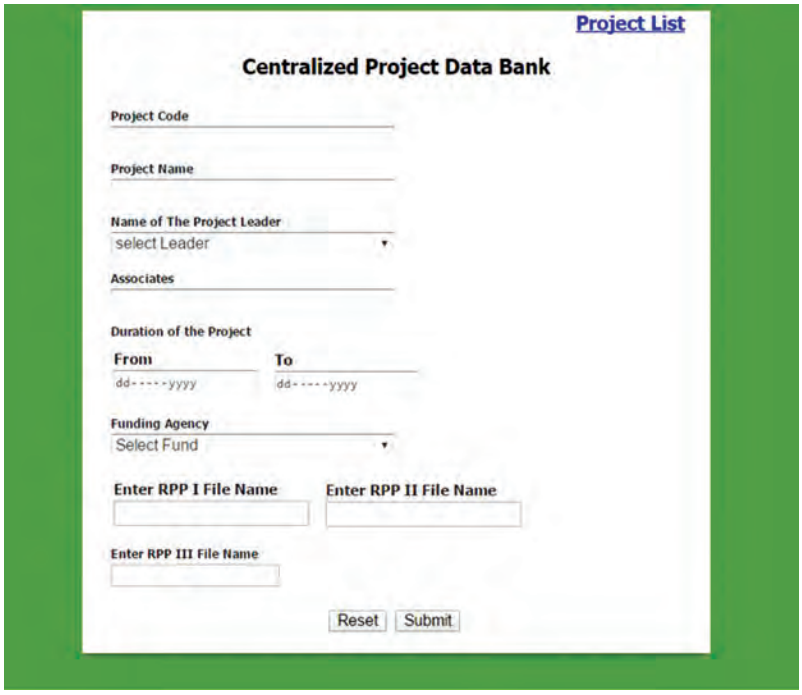
Evaluating the suitability of sites for demonstrating the brackishwater aquaculture technologies in Adyar creek and estuary

Under Mera Gaon Mera Gaurav programme, three fishermen villages viz Srinivasapuram, Mullikuppam and Mullimanagar located near Adyar creek and estuary has been selected for demonstrating the brackishwater aquaculture technologies in cages for their alternative livelihoods activities in aquaculture. For evaluating the suitability of sites, soil and water samples were collected in and around Adyar creek and estuary at monthly intervals and were analyzed for important parameters. Similarly to understand the influence of high tide and low tide, particular site located near fish market, Srinivasapuram, was selected and depth and other parameters were analysed at weekly intervals. Results showed that pH, salinity, nutrients, metabolites, total alkalinity and hardness were within desirable limit and will be suitable for brackishwater aquaculture.

Digitalization approaches of brackishwater aquaculture research

CIBAproBASE

Web-based retrieval system (CIBAproBASE) for institute project information has been developed using MySQL database and PHP scripting language. RPPs of CIBAS projects since the inception of the institute have been digitized and uploaded to the system. System has data admin and search modules for adding/ updating data and searching the records respectively. This portal of institute project data has been published in the intranet server.



Snapshot of CIBAproBASE

Geodatabase

Web-interface for geoportal on brackishwater aquaculture database has been designed using Openlayers. This system has the ability to plot various data layers on the map. Data collections for the Brackishwater information system is collected and stored in the database as a continuous proccess.

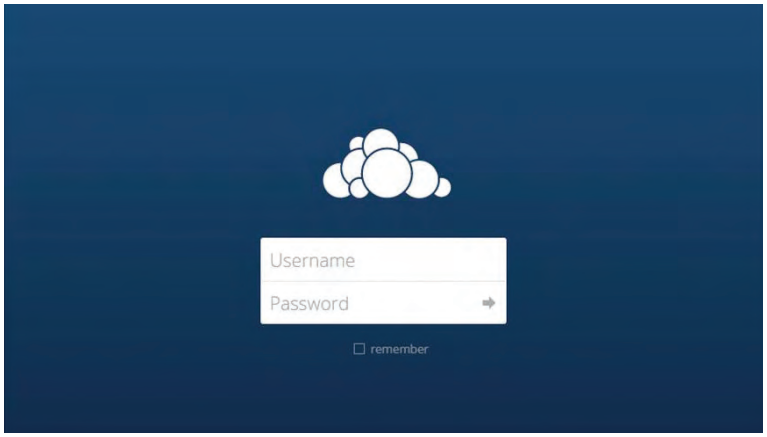
Digital repository

Online Digital repository system for CIBA has been developed using 'eprints' software version 3.3. The software has been installed and configured on institute's library documentation server, which was loaded with Ubuntu Linux. Institute publications and publication so the scientist of CIBA are being uploaded.

Snapshot of digital repository 'eprints@CIBA'

CIBA Cloud

Cloud space has been created for users of CIBA using own-cloud application. This application has been loaded on bioinformatics server of the institute. All the users of CIBA can now store, share the data through cibacloud by login into http://14.139.181.168/cibacloud/index.php



Snapshots of "CIBA cloud"

Human Resource Development (HRD) - trainings, capacity building and skill development

Trainings attended by individuals

National

Dr. J. Syama Dayal attended training on "Right to information Act, 2005 for Central Public Information Officers" ISTM, New Delhi, during 27-28 Apr 2015.

Ms. M. Mathuramuthu Bala, UDC attended a training programme on Database management using MS-Access at Anna Institute of Management, Chennai from 15-17th July, 2015.

Dr. S. Sivagnanam, Asst. Chief Technical Officer attended a training programme on Competence Enhancement Training for Technical Officers of ICAR at ICAR-NAARM, Hyderabad from 19-28th August, 2015.

Dr. M.Muralidhar, Dr.J.Syama Dayal, Dr.P.K.Patil, Dr.K.Vinaya Kumar attended One day interactive FDIS/ISO 9001:2015 Awareness Training Course" organized by the Intertek India Private Limited to be held on 28th August 2015 at Chennai

Dr. P. S. Shyne Anand and Dr. Krishna Sukumaran, Scientists, attended a training programme on Developing Winning Research Proposals in Agricultural Research at ICAR-NAARM, Hyderabad from 25-29th August, 2015.

Dr. Prasanna Kumar Patil, Senior Scientist attended a training course on Business Planning for developing new Agro-technology Enterprises at ICAR-CTCRI, Trivandrum from 2-11th September, 2015.

Smt. V. Usharani, AAO attended a training programme on Reservation in Services (RIS) for Scheduled Castes, Scheduled Tribes and OBCs at ISTM, New Delhi from 5-7th October, 2015.

Dr. B. Sivamani, Scientist attended a training programme on Fish Genomic and Proteomic Data Analysis with High Throughput Computing at ICAR-NBFGR, Lucknow from 19-24th November, 2015.

Dr. M. Makesh, Senior Scientist attended a training workshop on Competency Development for HRD Nodal Officers of ICAR at ICAR-NAARM, Hyderabad from 10-12th February, 2016.

Dr.M.Muralidhr, J.Ashok Kumar and Dr.P.Kumararaja attended Training on Simapro LCA software during 11-12 February, 2016 at Chennai.

Dr. K. Ambasankar, Principal Scientist attended a training programme on Science Governance & Management at Administrative Staff College of India, Hyderabad from 29th February-4th March, 2016.

Shri D. Raja Babu, Assistant Chief Technical Officer attended a training programme on Competence Enhancement Training Programme for Technical Officers of ICAR at ICAR-NAARM, Hyderabad from 1-10th March 2016.

Training Programs Organized

The technologies/knowledge-base developed by the Institute were extended during the year to progressive fish farmers, private entrepreneurs, officials of state and centre through the following short-term training programmes.

Headquarters

Sl. No.	Training Programme	Duration	No. of participants
1	Generation and Analysis of Truss Morphometric Data for Aquaculture species	18-19th May 2015	16
2	Fish Hatchery operation	1-7th July 2015	3
3	Integrated Fish/Shrimp - Crab Culture	20-30th July 2015	16
4	Under the co-operation between India & Sultanate of Oman in the field of Agriculture Research: Training in Brackishwater aquaculture imparted to two Scientists from Sultanate of Oman	10-18th August, 2015 at CIBA, Chennai	2
5	Brackishwater fish seed production	22-31st August 2015	5
6	Genetics and Biotechnology: Tools and their Application in Aquaculture	14-19th December 2015	4
7	Soil and water Health cards distribution to brackishwater aqua farmers	19th December, 2015	140
8	Hands on training on Feed analysis and quality control	5-8th January 2016	1
9	Advanced training in aquaculture nutrition and feed processing	20-29th January 2016	4
10	Hands-on Training on Water and Soil analysis	1-5th February 2016	1
11	Hands-on training programme on Nursery rearing of seabass for the village youth	2-5th March, 2016	15
12	Hands-on training programme on "Aquatic Animal Health Management in Brackishwater Aquaculture"	30th November-December 2015	10
Kakdwip Research Centre			
13	Training on Sustainable Brackishwater Aquaculture Practices	21-25th July, 2015	10
14	Field Experience Training of M.F.Sc. (Aquaculture) students from ICAR-CIFE, Mumbai	30 August–5 September 2015	2
15	Training on Diagnosis, prevention and control of brackishwater finfish and shellfish diseases	31st August-5th September, 2015	7
16	Training on Scientific shrimp (*L. vannamei*) farming	5-9th October, 2015	8
17	On-farm Training of B.F.Sc. 4th year students from Faculty of Fishery Sciences, WBUAFS, Kolkata	24–30 November 2015	30

Professional Attachment Training for newly recruited Scientists of ARS

Sl. No.	Name of the Scientist	Parent Institute	Field	Date
1	Shri J. Praveenraj, Scientist	CIARI, Port Blair	Fish Health	11.05.2015 to 10.08.2015
2	Shri T. Sivaramakrishnan, Scientist	CIARI, Port Blair	Fish Nutrition	11.05.2015 to 10.08.2015
3	Ms. Saloni Shivam, Scientist	CMFRI, Kochi	Fish Health	01.06.2015 to 29.08.2015
4	Shri M. Rajkumar, Scientist	CMFRI, Kochi	Fisheries Resource Management	01.06.2015 to 29.08.2015
5	Shri Chandra Bhushan Kumar, Scientist	MBFGR, Lucknow	Fish Health	25.05.2015 to 24.08.2015
6	Ms. Thangjam Nirupada Chanu, Scientist	CIFRI, Kolkata	Fisheries Resource Management	15.06.2015 to 15.09.2015

Participants of the Hands-on training programme on "Aquatic Animal Health Management in Brackishwater Aquaculture", 30th November 2015

Workshops/Seminars/Meetings

New Logo of CIBA, launched

Considering the important role of CIBA, as an R&D institution under ICAR, Government of India, in the development of brackishwater aquaculture in the country, and the increasing role played by CIBA, with its new initiatives in the area of public-private-partnership, for better visibility and identity a new logo was conceived and designed. Muthukaruppan, President, Society for the Aquaculture Professionals, released the new logo on 20-06-2015, and congratulated CIBA for its new brand building efforts, which is essential for the visibility of the institute. He also expressed his happiness, in the initiatives of CIBA, in bringing the Brackishwater aquaculture industry closer with the institute activities, and promised the full support of the industry in this direction.

Towards a Better Identity

CIBA

भाकृअनुप – केन्द्रीय खारा जलजीव पालन अनुसंधान संस्थान

ICAR - CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE

CIBA's New logo: The logo of an institution serves as a window to its identity and purpose

Stakeholder meet on Breakthrough achieved in Milkfish Breeding

A stakeholder meet was organized on 10th July 2015 at Muttukadu Experimental Station after the historic event of milkfish breeding by ICAR-Central Institute of Brackishwater Aquaculture. The meeting was presided by Dr.Madan Mohan, ADG, ICAR and Dr.Sakthivel, Aquaculture Foundation of India Farmers and aquaculture professinals from various parts of the country attended this event.

Dignitaries on the diace during the stake holder meet on breakthrough achieved in Milkfish Breeding

Milkfish juveniles produced at finfish hatchery in Muttukadu Experimental Station of CIBA

Low volume cage farming (LVCF) of Asian Seabass (Latescalcarifer) on partnership farming mode (PFM) at Trissur, Kerala

One of the fundamental requirements for successful cage culture of seabass is the availability of stockable size fingerlings of 5g to 50g size. Recognizing this, ICAR-CIBA signed MoU with the farmers Mr. Sukumaran and Mr. Radhakrishnan of Tatwamasi Self Help Group at Chalakudy, Trissur, Kerala to demonstrate nursery rearing and low volume cage culture of Asian seabass, *L. calcarifer* under seabass satellite seed rearing programme. The farmers were trained on seabass nursery rearing to produce seabass seed from 15 day old fry to stockable fingerlings, using net hapas. For popularizing the LVCF technology in the locality, a harvest festival and farmers meet was conducted on 24th December 2015. The Chief whip, Governemnt of Kerala, Advocate Shri. Thomas Unniyadan inaugurated the harvest festival and farmers meet. Dr. K. K. Vijayan, Director, CIBA spoke about the scope of brackishwaterLVCF for ensuring alternate livelihood options and nutritional security of the local communities. The function was presided by the Municipal Chairman, Kodungaloor Municipality, Shri. C.C. VipinChandran who sought long term co-operation with CIBA for popularizing brackishwater cage culture in the region. Father Johnson Panketh of KITS and other dignitaries were also present. The dignitaries distributed seeds of Asian seabass to the selected farmers. The meeting was attended by more than 100 farmers and over 80 school children.

Municipal Chairman, Kodungaloor Municipality distributing seeds of Asian seabass to a farmer of Trissur, Kerala

An entrepreneur from Trissur, Kerala, shares his farming experience

Soil and Water Health Cards Distributed to Brackishwater Aquaculture Farmers

In a major step towards achieving sustainable aquaculture of shrimp and finfish farming in brackishwaters, CIBA has begun the process of issuing Soil and Water Health Cards (SWHC) for the first time in the countryin fisheries sector.SWHCs were issued to shrimp farmers hailing from state of Tamil Nadu during the farmers'meetorganisedon the occasion of Celebration of International Year of Soils2015 on 19th December, 2015 at Mahabalipuram. Emphasizing the importance of soil and water health card CIBA, Director Dr. KK Vijayan said that long term sustainability in aquaculture depends on the maintenance of soil health and water quality and advised the farmers to stock ponds at optimum densities and follow better management practices (BMP) to preserve the soil and water quality. Dr.P. Ravichandran Member Secretary, Coastal Aquaculture Authority said that primarily it is the responsibility of the farmers to keep the soil and water quality within the optimum levels. About 140 stakeholders representing farmers, consultants and TN State Fisheries Department Officials participated in the workshop.

CIBA Scientists displaying Soil and Water Health Cards in presence of Dr.K.K.Vijayan, Director CIBA and Dr.P.Ravichandran, Member Secretary, CAA

Brackishwater Aqua-Farmers' Meet to promote indigenous shrimp species in Sunderbans

CIBA has been making efforts to promote of native candidate species of shrimp, such as tiger shrimp *Penaeus monodon* and Indian white shrimp *P. indicus* among the farming communities in the Sundarbanarea. Shrimp harvesting was arranged as a part of the Meet on 3rd December, 2015.The Meet was attended by more than 250 participants including brackishwater farmers, stakeholders and entrepreneurs from South 24 Parganas, North 24 Parganas and PurbaMedinipur Districts, West Bengal. Farmers witnessed successful farming and harvest of the Indian white shrimp, *P. indicus*, tiger shrimp, *P. monodon*. An exhibition was also organised by displaying various on-going activities of the Centre for the benefit of the farmers. As a part of pilot scale demonstration and propagation of sustainable finfish farming techniques, theKRC- hatchery produced fish seeds of brackishwater catfish *Mystus gulio* and hatchery produced and nursery reared Asian seabass (*L. calcarifer*) fingerlings were distributed to farmers for grow-out culture, with technical assistance from CIBA.

Dr. V.R. Suresh, Director, ICAR-

Dignitaries of Brackishwater Aqua-Farmers Meet to promote indigenous shrimp species in Sunderbans

Central Inland Fisheries Research Institute, Barrackpore, Kolkata inaugurated the Aquafarmers Meet. Dr. AnupHalder, Project Officer, Sundarban Development Board, Govt. of West Bengal, Dr. SankhaChakraborty, Assistant Director of Fisheries (Brackishwater), South 24 Parganas, West Bengal and Dr. N.J. Maitra, Programme Coordinator, Ramkrishna Ashram KrishiVigyan Kendra (RAKVK), Nimpith, South 24 Parganas, West Bengal graced the occasion as special guests.

Brackishwater Aqua-Farmers' Meet in Sunderbans

All India Network Project on Fish Health Launched

The long awaited All India Network Project on Fish Health was launched at CIBA (ICAR), Chennai on June 20, 2015. The Member Secretary of the Coastal Aquaculture Authority (CAA), Dr. P. Ravichandran was the chief guest of the function. Representing the brackishwater aquaculture sector, Mr. Muthukaruppan, President, Society of Aquaculture Professionals, Mr. Balasubramanian, General Secretary, Prawn Farmers' Federation of India and Dr. Panda, in-charge, MPEDA-RGCA Aquatic Quarantine Facility, joined the occasion. The meeting was represented by 10 partnering institutions including seven ICAR fisheries research institutes, CIFE, the Deemed to be Fisheries University in and two universities, West Bengal and Gujarat, along with the scientists, and staff and research students of CIBA (ICAR). Dr. Vijayan, Director CIBA, and he accentuated the importance of collective action by the different working groups for surmounting the challenges faced by the aqua-farmers and the aquaculture industry. Economic losses faced by the farmers especially with respect to disease, the associated slow growth, the crop-losses faced by the farmers, due to disease related crop loses; rational use of aquaculture inputs in the backdrop

Dr. P. Ravichandran, Member Secretary, CAA, felicitating the gatherings during the launch of the All India Network Project on Fish Health

of the problems of rejection of the Indian seafood exports, and the need for developing a National level certification program for the aquaculture in India. Dr. P. Ravichandran expressed his happiness on the faith shown by the stakeholders on CIBA's R&D efforts, and technologies. Dr. Ravichandran threw light on the reports of emergence of newer diseases like white feces disease, white patch disease, parasites like EHP, and called for research efforts from CIBA, partnering with farmers, to provide a scientific basis on these emerging syndromes, getting christened under different names.

Mr. V. Balasubramanian, General Secretary, PFFI speaking during the launch of the All India Network Project on Fish Health.

CIBA Foundation Day celebrated as "Open Day" for school children

CIBA Foundation Day was celebrated commemorating the genesis of Central Institute of Brackishwater Aquaculture as "Open Day" on 6thApril 2015 at Experimental Station of CIBA, Muttukadu. Awareness was created among the school children about the environmentally safe and socially acceptable and sustainable aquaculture and its benefits for nutritional food security.About 400 school children (8thstandard and above grades) from 10 schools in and around Muttukadu and Chennai city visited the campus in Muttukadu. They were given exposure to various facilities and research activities of the institute, viz., shrimp/fish seed production in the hatcheries, aqua-feed production, different aquacultured organisms, such as shrimps, fishes and crabs, and many other aspects related to brackishwater aquaculture. Students released about 1 lakh

Director, Dr. K.K. Vijayan hand overing fish seeds to a entrepreneur on the event of "Open day"

shrimp and fish larvae in the nearby sea as a demonstration of sea ranching programme to replenish the natural population. The programme was attended by Mr. Murugan, Panchayat president, Karikattukuppam, Muttukadu, Mr. Eraniyappan fish farmer and hatchery owner and Mr. Nithyananthan sports-fisheryentrepreneur. They shared their experience and views on the importance of fisheries particularly brackishwater aquaculture as a means of income generation and to take up as an enterprise with the participating school children. This programme was conducted as a part of ARYA (Attracting and Retaining Youth in Agriculture) initiative of THE HINDU and the Indian Council of Agricultural Research.

NICRA project review

Directors of CIBA and CRIDA, PI and Co-PIs from CRIDA and CIBA during NICRA Project Review meeting

Review of NICRA project was doneat CIBAon 27th April, 2015. Dr.Srinivasarao, Director, National Coordinator of NICRA,by the Nodal Institute, Central Research Institute for Dryland Agriculture (CRIDA) Dr.M.Mahaeswari, National PI and Dr.S.Srinivasarao, PI of strategic research component from CRIDA visited the research facilities of CIBA at MES of CIBA and Head Quarters. Dr.K.K.Vijayan, Director, CIBA gave the introductory remarks about the project and the expectations in the scenario of future climate change. Dr.M.Muralidhar, PI Dr.M.Jayanthi, Dr.M.Kumaran and Dr.A.Panigrahi Co-PIS of CIBA presented the progress of work under NICRA Project. Dr.Ch.Srinivasarao and Dr.M.Mahaeswari reviewed the progress of project and Dr.S.Srinivasarao reviewed the status of budget and expenditure.

ICAR - Industry Day celebrations held on 16th July 2015

On the Indian Council of Agricultural Research (ICAR)'s 86th foundation day, Industry Day was celebrated at CIBA on 16thJuly, 2015. Dr.K.K.Vijayan, Director, CIBA welcomed the Chief Guest and in his opening remarks highlighted the importance of celebrating the Industry day that is to ultimately help farmers to meet their requirements. Dr.Subhendu Chakrabarti, Senior Principal Scientist- Business Process Division, Central Leather Research Institute (CLRI), Chennai, the chief guest of the programme, pointed out the importance of Intellectual Property Rights (IPR) in the knowledge economy and importance of being aware of happenings in IP protection domain. In his address, he spoke on acquisition of patents, copyrights, advantages of patenting, non-patentable subject matters, patentable inventions, provisional and complete specifications of patent applications, patent drafting, PCT (Patent Cooperation Treaty) applications and International Searching Authority (ISA). Dr. Subhendu Chakrabarti distributed the cash prizes for best interactions.

Dr. Subhendu Chakrabarti, Central Leather Research Institute (CLRI), Chennai addressing the gatherings and issuing prizes to participants who had best interacted on ICAR - Industry Day celebrations

Aquaculture Sub-committee of Bureau of Indian Standards held at CIBA on 16-17 July 2015

First meeting of Aquaculture Sub-committee (FAD 12:1) and Tenth meeting of Fish, Fisheries and Aquaculture Sectional Committee, FAD 12 of Bureau of Indian Standards were held at CIBA, on 16-17July 2015.Dr. B. Meenakumari, Former DDG (Fisheries), ICAR (Chairperson, FAD 12) and Dr.Bhawana,. In her address, Dr.Meenakumari, emphasized the need for development of standards for aquaculture produce and management practices, as quality standards are crucial for Indian aquaculture produce to meet the requirements at global markets. Dr. K. K. Vijayan, Director, CIBA, in his special address, showed concerns about the upcoming private certification bodies at domestic and international level, and the confusion created by the multiplicity of these bodies. Further he recommended that CIBA along with other government agencies, such as CAA, MPEDA, CIFT, CMFRI, CIBA etc., and BIS should involve in developing standards and certification relevant to India and that can be flagged at the international level.

Director of CIBA along with Dr. B. Meenakumari, Former DDG, ICAR Chairperson and Dr. Bhawana during Aquaculture Sub-committee of Bureau of Indian Standards

Dr.Balasubramanian explained the process of transformation of Best Management Practices (BMP) to standards, which is important for all the stakeholders and Government as well. The decision and recommendation of sub-committee were endorsed in tenth meeting of FAD 12, which was conducted on July 17, 2015 and chaired by Dr. B. Meenakumari. The roadmap for bringing up the standards were further discussed and finalized. Dr.Bhawana, Scientist 'B', Food and Agriculture Deptt, BIS thanked the chairperson and participants.

Dignitaries and participants of the ICAR Organizes Workshop on "Sustainable growth of Agriculture in the East Coast Region"

ICAR Organizes Workshop on sustainable growth of Agriculture in the East Coast Region

In line with policy initiatives from the Prime Minister's Office, ICAR organized a one day interactive workshop for developing a road map for identifying the issues and providing effective technological support to the Farmers in 'East Coast Plains and Hills Regions' of Tamilnadu, Andhra Pradesh and Odisha, at ICAR-Central Institute of Brackishwater Aquaculture, Chennai on 29th October 2015. The workshop lead by a team from ICAR comprising Dr. A.K. Singh, Deputy Director General (Agricultural Extension & Fisheries), Dr.S.D.Singh, Assistant Director General (Inland Fisheries), Dr K.K. Vijayan, Director, CIBA and Dr.Sreenath Dixit, Director, ATARI, Bengaluru, with experts from the field of Agriculture, Animal Husbandry and Fisheries, from ICAR Institutions and State Govt. Agriculture, Animal Husbandry and Fisheries Universities. Dr. K.K. Vijayan, Director, CIBA and Nodal Officer of the workshop, in his presentation, highlighted the status and major issues confronting livestock and fisheries sectors in this zone comprising Tamil Nadu, Puducherry, Andhra Pradesh and Odisha. He highlighted the importance of sustainable mode of farming, integrating the three important production sectors, viz., the Agriculture, Animal husbandry and Fisheries. Further, he suggested adopting novel farming models such as integrated multitrophic farming systems, family farming, etc, to achieve increased production and nutritional safety.

Dr.Sreenath Dixit, Director, ATARI, Bengaluru, Co-Nodal Officer of the workshop suggested farmers to adopt integrated farming system approach to spread out the production risks in case of climatic adversities, in the emerging scenario of climate changes. He also elaborated on initiatives being undertaken by ATARI and KVKs for implementation of ICAR new schemes, like 'Mera Gaon, Mera Gaurav' and 'Attracting and Retaining Youth in Agriculture' (ARYA).

Progressive farmers from various districts of the Zone participated in the workshop and put forth their specific problems and issues which needed attention and solution. Recurrent droughts and water availability, limited availability of quality seeds of suitable crop and animal varieties, limited labour availability for farming and need of mechanisation, loss of crops by wild animals and need of location specific integrated farming systems were some of major issues deliberated upon.

Mera Gaon Mera Gaurav Programmes

ICAR –CIBA, Chennai adopted three fishermen villages viz., Srinivasapuram, Mullikuppam and Mullimanagar located near CIBA headquarters in Chennai. This village cluster has about 4500 people in 2000 households. These villages were severely affected by the flash floods during 2nd to 5th December 2015. Issues such as dengue fever, diarrhoea, fungal skin infections and athlete foot were impending health hazards. ICAR- CIBA along with doctors from Sri JayendraSaraswathi Ayurveda College and Hospital (SJSACH), Nazarathpet, Chennai, conducted a cleanliness campaign and medical camp in the villages on 10-12-2015. Dr.RamdasMaganti, Principal, SJSACH deputed a medical team lead by Dr. P. A. Sudhir, Professor, Dr.UshaPatil, Reader and Dr. Anita Patel, Reader along with a group of medical students of BAMS course of SJSACH for the camp. Dr.K.K.Vijayan, Director, ICAR-CIBA, Chennai briefed the assembly about the work of ICAR and CIBA and highlighted the importance of cleanliness in the villages to avoid infections and diseases. He also assured the villagers all possible support from ICAR- CIBA for upkeep of surroundings and health of the villagers. Bleaching power, Sodium hypo chlorite liquid, garbage bins were distributed to the villagers. Needy were geiven free Ayurvedic medicines. The meeting was attended by about 400 villagers along with their panchayat leaders and office bearers, women self help group

Director of CIBA along with medical doctors and CIBA scientists in medical camp at Srinivasapuram, Chennai

Director of CIBA along with scientists and Srinivasapuram village in medical camp

Flood Relief Measures in Tribal and Coastal Villages

Under Tribal Sub Plan and village adoption "Mera Gaon Mera Gaurav" programme, ICRA-CIBA Chennai has adopted two coastal villages, one for each programme viz., Senjiamman Nagar and Thonirevu, respectively, near Pulicat Lake in Tiruvallur district of Tamil Nadu. The villages were heavily flooded and the flood waters entered tribal houses upto 5- 6 ft during the torrential rains and subsequent flooding from 2nd to 5th December 2015, causing loss of household and other articles. ICAR - CIBA distributed

CIBA scientist team along with the people of Thonirevu village, Tiruvallur district of Tamil Nadu distributing the flood reliefs

CIBA scientist team along with the people of Senjiamman Nagar village, Tiruvallur district of Tamil Nadu distributing the flood reliefs

flood relief material like toiletry items, bed sheet, mats, bleaching powder, groceries, food items and old clothes to the victims of the villages. Dr. B. Shanthi and Dr. V.S. Chandrasekaran, Nodal Scientists of the TSP and MGMG programme coordinated this event.

CIBA has beenalso working with Karikattukuppam village (Kanchipuram district, Tamil Nadu) near Experimental Station of CIBAat Muttukkadu, 30 km south of CIBA head quarters Chennai. This is a coastal village with 310 families with a total population of 1200, mainly engaged in fishing as their major livelihood activity. The unprecedented deluge during the first week of December 2015 in Chennai resulted in sewage stagnation and garbage pileup in this village, resulting in mosquitoes menace.

CIBA with the assistance of medical professionals from Sri JayendraSaraswathi Ayurveda College and Hospital (SJSACH), Nazarathpet, Chennai, conducted a cleanliness campaign and health camp in the village on 17-12-2015.

CIBA scientist team along with doctors from Sri JayendraSaraswathi Ayurveda College and Hospital (SJSACH) and the people of Karikattukuppam village, Kancheepuram district of Tamil Nadu, in Medical camp after flash flood in Chennai

Dr.RamdasMaganti, Principal, SJSACH deputed a medical team lead by Dr.A.A.N. Udaya Kumar and Dr.K.P.Roshini, with a group of medical students for the camp. Dr (Mrs) D. DeboralVimala, Principal scientist highlighted the importance of the cleanliness in the village to avoid infectious diseases and briefed about the various brackishwater activities under "Mera Gaon Mera Gaurav" in the village. Dr.M.Kailasam, Principal Scientist & Officer-in-Charge, Muttukkadu Experimental station briefed about the various ongoing research activities which has direct impact in the livelihood improvement of the fisherfolk in the village. The medical team explained various steps and safety precautions to be taken to keep the village premises clean and healthy. Free medical checkupwas held and medicines were distributed to the villagers.

Doctors from Sri JayendraSaraswathi Ayurveda College and Hospital (SJSACH) in Medical camp at Karikattukuppam village, Kancheepuram district of Tamil Nadu

Distribution of study materials to the flood affected schools of Chennai suburb

Considering this unprecedented flood situation and damages during December 2015, the ICAR-CIBA family members including DG, ICAR Dr S. Ayyappan volunteered to help the schools and students by providing study materials. After the survey of the flood affected schools, and the requirement, the three schools, viz., Panchayat Union Middle School, and Govt. Higher Secondary school inSemmencherry,and Govt. High School, at Kovalamwere identified as the worst affected based on the extent of damage. After interaction with the teachers and students, based on their requirements, school bags, two computers, examination pads, writing pads, A4 paperreams, examination paperreams were supplied by CIBAon 5th January 2016 at the school premises. The damaged drinking water RO plant was also repaired. Scientists of ICAR- CIBA interacted with students and explained the research activities. This activity was organised and coordinated by Dr.K. Ambasankar, Dr. M. Kumaran, Dr. AkshayaPanigrahi, Dr. M. Jayanthi and Dr. M. Muralidhar under the guidance of Dr. K.K. Vijayan, Director, CIBA.

CIBA scientist team distributing school bags and stationeries to the students Govt. High School, at Kovalam, Tamil Nadu after flash flood in Chennai.

Veterinary health camp conducted at Vennangupattu, Kancheepuram district

As part of the Mera Gaon Mera Gaurav programme a one day veterinary health campaign was organised in collaboration with the Department of Animal Husbandry, Govt. of Tamil Nadu, Kancheepuram district on 29th December 2015, to diagnose and treat diseases of livestock at Vennagupattu village in Kancheepuram district. The camp was organised at two places in the village and well received by the villagers. About 200 farm and pet animals, viz., cattle, goats, poultry and dogs were screened and treated during the campaign. Cattle and goats were vaccinated with Black Quarter vaccines. Besides this, deworming drugs, mineral mixture supplements, vitamin supplements, antibiotics, antiseptics and disinfectants were distributed to the farmers. Farmers and villagers expressed that the camp was very useful and felt that their need was well addressed by ICAR-CIBA. Dr. Ramesh, Veterinary Surgeon, from the Department of Animal Husbandry, Govt. of Tamil Nadu and Mr. Prabahar Livestock Inspector, Kadapakkam Village conducted the veterinary camp. The Chairman of the Kadapakkam Municipality inaugurated the camp in the presence of village councillors and the villagers. Dr. M. Kumaran, Principal Scientist, Dr. P. K. Kumaraguruvasagam, Senior Scientist, Dr.VinaykumarKatneni and Dr. P. Ezhil Praveena scientists of CIBA coordinated the programme.

Activities during the Veterinary Health Camp at Vennangupattu, Kancheepuram district

National Consultation on the Management of the emerging pathogen, *Enterocytozoon hepatopenaei (EHP)*

The *Enterocytozoon hepatopenaei* (EHP) disease outbreaks have been widely reported in Asian countries like China, Indonesia, Malaysia, Vietnam and Thailand. The parasite was identified last year from Indian shrimp farms. On a follow-up study conducted by CIBA and MPEDA-RGCA, after the shrimp farmers widely reported stunted growth, which caused concern as EHP affected the size, market value and crop failure of farmed shrimp. The major farming areas affected where the state such as Andhra Pradesh where intensive *Penaeus vannamei* farming were taken up. The study by scientists from Aquatic Animal Health and Environment Division of CIBA and RGCA aquatic animal health laboratory in the year 2015 indicated the emergence of the parasite with widespread occurrence in Indian shrimp farming systems. This issue was discussed at the day-long workshop to draw the strategies for the control of EHP problem in India.

A one day national consultation was held on "Managing *Enterocytozoon hepatopenaei* (EHP) infections in brackishwater aquaculture in India" on 19th January 2016 at CIBA Chennai. Stakeholders from the brackishwater aquaculture sector, representing scientific research institutions, universities, shrimp hatchery operators, shrimp farmers, feed manufacturers, members of Society of Aquaculture Professionals (SAP), Seafood Exporters Association of India (SEAI), officials from the Ministry of Agriculture, Department of Animal Husbandry Dairying and Fisheries, Coastal Aquaculture Authority, Marine Products Export Development Authority (MPEDA), Rajiv Gandhi Centre for Aquaculture (RGCA) and state Govt. officials participated the consultation.

Dr. K.K. Vijayan, Director of CIBA emphasised that resolving such issues would be easy when all the stakeholders work together for the future of aquaculture sector in the country. He urged that prevention is better than cure and BMPs are important in management of diseases such as EHP and running mortality syndrome (RMS), which appear to be largely due to bad management of the aquaculture ecosystem.

Dr. (Mrs.) Beela Rajesh, IAS, Commissioner of fisheries, Tamil Nadu, while inaugurating the national consultation said, EHP is an important disease as it causes slow growth and reduced production. She advocated to investigate the zoonotic importance of the pathogen and also emphasised the need to transfer the scientific information in the vernacular language for the benefit of the farming community. Mr. Elias Sait, Secretary General, SEAI, said that after introduction of Pacific white shrimp in 2009, the shrimp farming growth was phenomenal and India is biggest exporter of shrimp in international market. EHP is a challenge, and shrimp farming has to face

such challenges, considering the nature of live aquatic animal production systems.

Dr. P. Ravichandran, Member Secretary, Coastal aquaculture authority (CAA) said, the capacity of Indian stakeholders in diagnostics was perfect, but despite great amount of work on white spot disease controlling it was still a challenge and continued to be a major challenge to the sector. He stressed that shrimp farmers must adopt biosecurity measures and better management practices (BMPs) if they have to avoid diseases such as EHP and RMS. He mentioned that since EHP is endemic in South East Asian countries, EHP and EMS need to be included in screening of imported SPF shrimp. Mr. Santhana Krishnan CEO, Maritech representing SAP, appraised that this consultation was a timely intervention and the the advisory would help farmers to manage the disease. In the technical session two presentations by Dr.Sanil, Scientist, CMFRI and Dr. Rajendran, Principal Scientist & Head, ICAR-CIFE covered the topics on basic biology of microsporidia and the status of EHP in farmed shrimp in India.

Mr. Elias Sait, Secretary General, SEAI and Dr. (Mrs.) Beela Rajesh, IAS, Commissioner of fisheries, Tamil Nadu addressing the gatherings in National Consultation on managing Enterocytozoon hepatopenaei (EHP)

Deputy Director General (Fisheries) at CIBA

Dr. J.K. Jena, DDG (Fy), ICAR, made his maiden visit to CIBA headquarters Muttukadu Experimental Station (MES) on February 27, 2016. DDG Fy addressed staff and scientist at CIBA and also visited laboratories, Pilot scale feed mill and hatchery facilities.He motivated the scientists to have a boarder vision for research and urged them to give their best efforts. In his address DDG emphasized that all the staff to get involve in institute activities irrespective of the cadre, and advised to know dos and don'ts in the system. He urged the staff to cooperate and help each other in accomplishing their works, and emphasized the importance of giving their best to the cause of the institute. He advised scientists to visit the farmers often, and to understand their requirements and to learn real field situation. He appealed scientists to approach research work with passion and to work even beyond regular office hours as research cannot be confined to ten to five mode of working. He further highlighted the need of timely publishing the results in quality journals, and mentioned that published research is the only reflection of fruitful research work, and research would remain incomplete unless it is published.

Dr. J.K. Jena, DDG (Fy), ICAR, address the staffs of CIBA during his maiden visit to CIBA

National Workshop on Marketing Stategies for Newly Cultured Fishes in India

CIBA Director along with dignitaries of meet on National Workshop on Marketing Strategies for Newly Cultured Fishes in India

Aquaculture in India at the moment is witnessing increased interest in the farming of consumer-oriented indigenous finfishes such as seabass, cobia, milkfish and grey mullet and exotic Nile Tilapia and catfish (*Pangasius* sp), resulting in the overall increased production in the country. When the bulk quantity of fish are produced, understanding the market and proper planning for marketing is need of the hour. Marketing strategies vary depending on the species, size and volume of fish and regional demands. In this backdrop, a National Workshop on "Marketing Stategies for Newly Cultured Fishes in India" was organised jointly by The Fisheries Technocrats Forum (FTF), and ICAR-Central Institute of Brackishwater Aquaculture (CIBA), at CIBA, Chennai. The deliberations focused on the current status of seed production, grow-out culture and production trends of seabass, cobia, milkfish, grey mullet, Nile Tilapia and Vietnamese catfish; problems in marketing of these newly cultured fishes and strategies for enhanced production of these species of fish and their marketing so as to ensure higher economic returns for fish culturists.

During the inaugural function, Dr. A.R. Thirunavukkarasu, Chairman, FTF welcomed the gathering, while Dr. K.K. Vijayan, Director, CIBA gave the presidential address. The felicitations were offered by Dr. V. Sugunan, Former ADG-ICAR and presently Senior Consultant, NFDB and Dr. S. Santhanakrishnan, M/s Marine Technologies, Chennai. Dr. P. Ravichandran, Member-Secretary, Coastal Aquaculture Authority (CAA) inaugurated the workshop. Dr. M. Kumaran, Principal Scientist, CIBA proposed a vote of thanks. A total of 123 personnel including the special invitees from Andhra Pradesh and Karnataka, scientific / technical staff of CIBA and CMFRI, the members of FTF, state fisheries officials, private entrepreneurs and college teaching staff / students participated in the event.

'Start-up India' in Aquaculture: Brackishwater Start up Initiative and Launching of Agricultural Business Incubator

"Brackishwater start-up initiative" under Start up India campaign of Government of India was organised at ICAR-CIBA, Chennai on 17th March 2016, along with a one-day workshop familiarizing the start-up entrepreneurs on the initiatives taken up by the institute highlighting different technologies developed by CIBA. Agricultural Business Incubator (ABI) funded by National Agricultural Innovation Fund of Indian Council of Agricultural Research (ICAR) was also formally launched during the programme. Current and prospective entrepreneurs of brackishwater aquaculture sector from different parts of India participated in this whole day event to acquire knowledge about this less exploited emerging sector.

Mr. S. Panikkassery, Director, Micro Small and medium Enterprises Development Institute (MSME-DI) inaugurated the programme. In his inaugural address, he mentioned that more than 95% of entrepreneurs were from micro sector and starting of business required more of motivation than education. He suggested that CIBA would be able to hand-hold and help the new entrepreneurs to be successful, and promised all support from MSME. The guest of honour, Head of Federation of Indian Chambers of Commerce and Industry Tamil Nadu State Council (FICCI), Mr. Ruban Hobday highlighted the need to reduce the gap between institutes, industry and the commercialization. He assured that FICCI will keep its option open for aquaculture as they have for agricultural business. Dr.M. Sakthivel, President, Aquaculture Foundation of India, provided an overview about the opportunities in the aquaculture sector. Dr. K. K. Vijayan Director ICAR-CIBA

Head of Federation of Indian Chambers of Commerce and Industry Tamil Nadu State Council (FICCI), Mr. Ruban Hobday giving a prudential address in the meeting on "Brackishwater start-up initiative" under Start up India campaign of Government of India

delivered the presidential address pointed out the importance of close association between science and entrepreneurship. Dr. Kavitha CEO, Fibsol, Chennai, Dr. V. Shanta Chandra Professor, Biotechnology, IIT, Madras and M/S Erukava, Hyderabad shared their experiences in developing industrial applications. Dr.K.Suresh from National Fisheries Development Board, Hyderabad and Mr.Karuppan Chetty, Agri Business Incubator-International Crops Research Institute for the Semi-Arid Tropics (ABI-ICRISAT), Hyderabad shared the details of support to start-ups from their institutions.

ICAR-IARI Innovative Farmers Award 2016 awarded to Irular Tribal Woman trained by ICAR-CIBA, on alternate livelihood in Brackishwater Aquaculture

Smt. M. Usha receiving award from Shri. Radha Mohan Singh, Hon'ble Union Minister for Agriculture and Farmers Welfare.

An Irular tribal woman brackishwater aquafarmer Smt. M. Usha, nominated by ICAR- CIBA, Chennai received the award "IARI Innovative Farmers Award 2016. Shri. Radha Mohan Singh, Hon'ble Union Minister for Agriculture and Farmers Welfare presented the award the presence of Dr. Sanjeev Kumar Balyan, Hon'ble Minister of State for Agriculture and Food Processing Industries, in the Krishi Unnati Mela 2016. The mela was earlier inaugurated by Hon'ble Prime Minister Shri Narendra Modi and was held during 19-21 March 2016 at New Delhi. Smt. M. Usha is from Kulathumedu village, Pazhaverkadu (Pulicat), Ponneri, Tiruvallur district, Tamil Nadu. Smt.Usha was trained on alternative livelihood using modern brackishwater aquaculture technologies such as mud crab farming, seabass nursery rearing in hapas and polyculture farming of crab and seabass by ICAR-CIBA. The tide-fed brackishwater community ponds in the village were used for earning additional income during lean fishing season, using technologies and technical support provided by the Scientists of ICAR-CIBA. This was made possible by funding from the Department of Biotechnology, Govt. of India and ICAR-Tribal Sub Plan at CIBA.

Hindi Week Celebrated

Hindi week was celebrated at Kakdwip Research Center of ICAR-CIBA during 21st - 26th Sept. 2015 to promote the use of Hindi in Official and Scientific works. In this connection various competition were conducted such as singing, quiz, extempore etc. among the KRC-staffs. Chief Guest of the valedictory function Mr. Prakash Thakur (Assistant Director, EPF) given motivating talk on the how to use Hindi in official and scientific works

'Jai Kisan Jai Vigyan' week celebrated

To commemorate 'Jai Kisan Jai Vigyan' week (23-29 December 2015) an awareness programme was organised on 26th December 2015 in a coastal village Karikattukuppam which has been adopted by the Institute under the "Mera Gaon Mera Gaurav" programme. A team of scientists form CIBA conducted the awareness programme in the village, in which they explained the importance of the 'Jai Kisan Jai Vigyan' week in order to celebrate the birth anniversary of our former Prime Ministers Atal Bihari Vajpayee (December 25, 1924) and Late Shri Chaudhary Charan Singh (December 23, 1902), who immensely contributed for promoting use of science for the welfare of farmers in India. It was also explained on the new slogan 'Jai Jawan, Jai Kisan, Jai Vigyan' of our Hon'ble Prime Minister Shri. Narendra

Modi, emphasising the power of science and technology to transform people's lives from poverty to prosperity through scientific farming practices.

Dr. V. S. Chandrasekaran, Dr. D. Deboral Vimala, Dr.M.Kailasam, Principal Scientists of the Institute narrated brackishwater technologies beneficial to the coastal village people as a means of small scale additional revenue generation such as satellite nursery rearing of Asian seabass (*Lates calcarifer*), mud crab rearing and ornamental fish production. CIBA has already established two small scale nursery rearing units of the ornamental fish pearlspot *Etroplus suratensis* in the village

Jai Kisan Jai Vigyan week celebrated in the coastal village, karikattukuppam

Demonstration of small scale satellite nursery rearing of Asian seabass

CIBA's Annual day celebrations

ICAR-CIBA celebrated its annual day and family get-together on 13th February 2015 at Muttukadu experimental Station. The event was organized by the recreational club of the Institute, a part of the Society of Aquaculture and Fisheries (SCAFI), CIBA-Chennai. The location offered a beautiful view of the Institute's experimental facility, backwaters and sandy beachfront. Dr K Ambassankar Secretary of the recreation club provided the genesis and overview of the program. This get together was the first informal gathering of CIBA's staff including retired employees along with their families. Dr K. K. Vijayan, Director of the Institute and President of the recreation

Director address the staff and their family during the CIBA family get together at Muttukadu

club emphasized the importance of the informal meeting of the CIBA fraternity as an opportunity for interaction, feel of belonging and ownership for the Institute. A cultural program by a ' Sruthilaya' music troop was also organized, and it was a blend of classical and soft melodies, followed by dinner.

Families of CIBA staffs at Muttukadu during the CIBA family get together

Swachh Bharat Abhiyan (Clean India Mission)

SwachhtaAbhiyan Campaign at coastal village Thonirevu

Under Swachh Bharat Abhiyan (Clean India Mission), a number of cleaniningcampaigns were organised.The unserviceable materials from the laboratoriesin the Institute were e-auctioned as per the norms.Areas within the institute including pathways were cleaned up to use the place for practicing sports events.

SwachhtaAbhiyan Campaign at coastal village Karikattukuppam

SwachhtaAbhiyan (National Cleanliness Campaign)

ICAR-CIBA observed the SwachhtaAbhiyan (National Cleanliness Campaign)asa part of Swachh Bharat Mission at Headquarters, Chennai and Kakdwip Research Center (KRC) of ICAR-CIBA, Kakdwip. Awareness on the importance of cleanliness and sanitation and was created among the farmers in the pulicat lake backwater area at Thonirevu and Senjiammannagar villages, Thiruvallur district, Tamil Nadu on 3rd October and 19th October 2015. About 60 coastal women and men including school students in Thiruvallur and Kanchipuram districts participated in these villages. The cleaning materials like dustbin, broom sticks and bucket were distributed to the village people for their use towards cleaning of village premises.

SwachhtaAbhiyanwas also conducted at Gangadharpur village, Kakdwipon 6th October 2015. Local village Panchayat representative and 110 farmers participated in the programme Importance of cleanliness and sanitation was emphasized for a clean locality. Scientists and staffs along with the village farmers cleaned roads and market area. Cleaning materials and implements were distributed to the villagers for their use to clean their locality.

SwachhtaAbhiyan Campaign, on 7th October 2015 among school students at Govt. Higher Secondary School, Vennangupattu village, Kanchipuram district, Tamil Nadu. The meeting was attended by 70 students of 9th-12th standard and other 30 participants including teachers, village leaders, Idaikalinadu welfare society members and scientists from CIBA. An elocution competition was heldfor the students on "Importance of cleanliness and sanitation for healthy environment". Prises were distributed to the winners.

SwachhtaAbhiyan Campaign at school in Vennangupattu, Kanchipuram

SwachhtaAbhiyan Campaign at Gangadharpur, Kakdwip

SwachhtaAbhiyan Campaign was organized at Kakdwip Jnanadamoyee Vidyapith (H.S.), Kakdwip, South 24 Parganas on 7th October 2015. 40 students of classes IX to XI and teachers of the school participated in the programme. As a part of the programme, a speech competition on "Importance of Clean India" was conducted and students were encouraged by distributing prizes.

Active participation of students at Swachhta Abhiyan Campaign organized at Kakdwip Jnanadamoyee Vidyapith (H.S.), Kakdwip.

Awards and Recognitions

Dr. Debasis De, Principal Scientist was selected for the Endeavour Research Fellowship 2015 of Govt. of Australia and undergone a Post-Doctoral Research programme on Supplementation of probiotics and prebiotics in diets for greenlip abalone (*Haliotis laevigata*) for improving survival in response to high water temperature" during 7 April - 6 October 2015 at South Australian Research and Development Institute (SARDI), Aquatic Sciences Centre, 2 Hamra Ave West Beach, SA 5024.

Dr. Gouranga Biswas, Scientist received Dr. C.V. Kulkarni Best Young Scientist Award- Gold Medal for 2014-15 by ICAR-CIFE, Mumbai on 31st August 2015.

Ph.D. Awards

Ms. J. Kiruthika was awarded Ph.D. Degree by the University of Madras with effect from 26th May 2015, for her thesis entitled "Identification and characterization of differentially expressed genes in response to salinity stress in shrimp *Penaeus monodon*" under the guidance of Dr. M. Shashi Shekhar, Principal Scientist, Nutrition, Genetics & Biotechnology Division.

Shri K. Sivakumar was awarded Ph.D. Degree by the University of Madras with effect from 25th May 2015, for his thesis entitled "Efficacy of marine algae against quorum sensing bioluminescence causing *Vibrio harveyi*" under the guidance of Dr. S. Kannappan, Principal Scientist, Crustacean Culture Division.

Shri R. Rajendran was awarded Ph.D. Degree by the University of Madras with effect from 23rd September 2015 for his thesis entitled "Effect of fibrolytic enzymes in improving the nutrient utilization of alternate carbohydrate sources in the diet of tiger shrimp, *Penaeus monodon* (Fabricius, 1794)" under the guidance of Dr. K. Ambasankar, Principal Scientist, Nutrition Genetics & Biotechnology Division.

Shri S. Venu was awarded Ph.D. Degree by the University of Madras with effect from 28th September 2015 for his thesis entitled "Studies on the efficacy of viral vaccine against Nodavirus on the rearing of Asian Seabass, *Lates calcarifer* (Bloch, 1790)" under the guidance of Dr. A. R. Thirunavukkarasu, Principal Scientist & Head (Retd.), Finfish Culture Division.

Shri J. Shanmugakarthik was awarded Ph.D. Degree by the University of Madras with effect from 8th July 2015 for his thesis entitled "Identification of single nucleotide polymorphisms and expression profiling of immune-related genes in white spot disease challenged *Penaeus monodon*" under the guidance of Dr. G. Gopikrishna, Principal Scientist & Head, Nutrition, Genetics & Biotechnology Division.

Shri D. Ramesh Kumar was awarded Ph.D. Degree by the University of Madras with effect from 9th September 2015 for his thesis entitled "Development of antiviral gene therapy for Monodon Baculovirus (MBV) using dsRNA and polyelectrolyte nanocapsule delivery system in *Penaeus monodon* (Fabricius, 1798) post larvae" under the guidance of Dr. T. C. Santiago, Principal Scientist (Retd.), Aquatic Animal Health and Environment Division.

Ms. M. Madhavi was awarded Ph.D. Degree by the University of Madras with effect from 4th November 2015 for her thesis entitled "Studies on the reproductive biology of spotted scat, *Scatophagus argus* (Linnaeus, 1776)" under the guidance of Dr. M. Kailasam, Principal Scientist, Finfish Culture Division.

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, 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.

Publications, participation in conferences, meetings, workshops, symposia

Institute Publication list

Annual Report 2014-15

Training Calendar 2015-16

Jal Tarang, ICAR-CIBA, Issue No.1, Sep. 2015

CIBA Special Publications

1 Training Manual on Diagnos is, prevention and control of brackishwater finfish and shellfish disease. CIBA special publication, TM series, 2015, No 1.

2 Training Manual on Aquatic Animal Health Management in Brackishwater aquaculture. CIBA special publication , CIBA-TM series No 2015-2

3 Training manual on Sustainable Brackishwater Aquaculture Practices (CIBA Special Publication No. 81).

4 Training manual on Diagnosis, Prevention and Control of Brackishwater Finfish and Shellfish Diseases (CIBA Special Publication: TM Series 2015 No. 1).

CIBA Extension Series

Disease management in brackishwater shrimp culture (In Bengali: Nonajaler chingri chashe rog pratirodher janyo bibhinna padakhep) (CIBA Extension Series No. 48). Nursery rearing of seabass seeds in cages (in Tamil),

CIBA Extension handbook No.48.

e- Publication

1. Otta SK, Patil PK, Jithendran KP, Rajendran KV, Alavandi SV and Vijayan KK. Managing *Enterocytozoon hepatopenaei* (EHP), microsporidian infections in vannamei shrimp farming: An advisory. CIBA e-publication No. 29; January 2016

Research Papers

Peer Reviewed Journals

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31 Praveena, P.E., Bhuvaneswari, T., Jithendran, K.P, Otta, S.K, Jagadeesan, V., Krishnan, A.N., Rajan, J.J.S., 2015. Analysis of shrimps in farms of India for the prevalence of IHHNV. Presented In First Tamil Scientific Conference Jointly organized by the Tamil Nadu Veterinary and Animal Sciences University and Agricultural Scientific Tamil Society, New Delhi from 13-14th June, 2015 at Madras Veterinary College, Chennai.

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38 Saraswathy, R., Muralidhar, M., Kumararaja, P., Lalitha, N., Thulasi, D., Nagavel, A., 2016. Potential of shrimp aquaculture pond sediment as agriculture manure. In: XV AZRA International Conference on Recent Advances in Life Sciences organized by Ethiraj college for women, Chennai and AZRA, Bhubaneswar and Zoological survey of India, 11-13 February 2016, p. 138.

39 Shanthi, B., Mahalakshmi, P., Chandrasekaran, V.S., 2015. Indigenous technical knowledge and beliefs of coastal fishers and tribes in Tamil Nadu. In: National Conference on Perspective and Prospects in Aquatic Research. 16th February, Konqunadu Arts and Science College, Coimbatore, Tamil Nadu, pp.18.

40 Sukumaran, K., Kailasam, M., Makesh, M., Biswas, G., Kumar, P., Bera, A., Mandal, B., Rekha, M.U., Subburaj, R., Thiagarajan, G., Vijayan, K.K., 2015. Scope of low volume cages in open water brackishwater fifish aquaculture. In: Book of Abstracts, 5th International Symposium on Cage Aquaculture in Asia, Kochi, Kerala, 25-28 November 2015. p. 76.

41 Thangjam, C.N., Muralidhar, M., Vasanth, M., Nagavel, A., ShanmugaKarthik, J., Koushlesh, S.K., Manna, R.K., Das, S.K., 2016. Assessment of greenhouse gases emission in the selected coastal open water ecosystems of Tamil Nadu, India. In: Book of Abstracts, National Seminar on "Integrating Agri-Horticultural and allied research for food and nutritional security in the era of global climate disruption, ICAR Research Complex for NEH Region, Imphal, Manipur, 4-6 March, 2016. p.120.

42 Vijayan, K.K., Rajendran, K.V., Sanil, N.K., Alavandi, S.V., 2015. *Fish health management in cage aquaculture.* In: Souvenir 5th International Symposium on Cage Aquaculture in Asia, 25-28 November 2015, Kochi.

Participation in Conferences, Meetings, Workshops and Symposia

International

1 Endeavour Awards Professional Development Workshop at Adelaide, Australia on 28th April 2015 – Dr. Debasis De.

2 FAO-NACA Regional Workshop on "Documentation and Dissemination of Successful practices of Sustainable Intensification of Aquaculture (SIA) in Asia-Pacific" at Bangkok, Thailand during 16-18th June 2015 – Dr. T. K. Ghoshal.

3 Thriving Abalone Project workshop at the South Australian Research and Development Institute Aquatic Sciences Centre, West Beach, South Australia during 17-18th June 2015 – Dr. Debasis De.

4 Australian Abalone Grower's Association workshop at the South Australian Research and Development Institute Aquatic Sciences Centre, West Beach, South Australia during 13-14th August 2015 – Dr. Debasis De.

5 9th International Abalone Symposium at Yeosu, Korea during 5-10th October 2015 – Dr. Debasis De.

National

Dr. K. K. Vijayan, Director

6 Technical Committee Meeting 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, organized under the chairmanship of Fisheries Development Commissioner, DAHDF, Ministry of Agriculture on 13th May 2015.

7 Meeting of the Directors of Fisheries Sciences Division for discussing the budget provision and prioritizing work components/ procurement of equipments, etc. organized by DDG (Fy.), at NASC, New Delhi on 14th May 2015 (FN).

8 Interactive Meeting of Vice-Chancellors of Agricultural Universities and ICAR Directors at NASC Complex, New Delhi during 14-16th May 2015.

9 Second level one day Interactive Workshop for selected shrimp farmers of Kerala in connection with developing a Kerala model for *L.vannamei* culture, at Fisheries Station, Puduveypu on 25th May 2015.

10 Scientific Advisory Committee of Rajiv Gandhi Centre for Aquaculture, at MPEDA, Kochi on 15th June 2015.

11 Eighty Fourth Meeting of the Board of Management of TANUVAS in Swarajya Hall of Madras Veterinary College, Vepery on 26th June 2015.

12 Delivered Lecture for the participants of DST sponsored National Training Programme for Fisheries Professionals in Molecular Biology and Biotechnology, organized by Central Marine Fisheries Research Institute, Kochi on 13th July 2015.

13 First meeting of the Project Screening Committee (PSC) for granting permission for establishment and

operation of shrimp broodstock multiplication centre, organized by Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, at Krishi Bhavan, New Delhi on 20th July 2015.

14 ICAR Foundation Day and National Conference of Krishi Vigyan Kendras, held at Patna on 25th July 2015.

15 International Seminar on "New Horizons in Microbiology – Challenges and Prospects", organized by Mohamed Sathak College of Arts and Science, Chennai on 31st July 2015.

16 International Consultation on "Science, Technology and Public Policies for achieving the zero hunger challenge" at M.S.Swaminathan Research Foundation, Chennai on 9th August 2015.

17 Seminar on "Genetics and Sustainable Aquaculture 2015" organized by Rajiv Gandhi Centre for Aquaculture (RGCA) at Hotel Green Park, Chennai on 10th August 2015.

18 2-day ASEAN-INDIA Workshop on Marine Biotechnology at National Institute of Oceanography, Goa during 16-17th August 2015.

19 27th Executive Committee Meeting of National Fisheries Development Board (NFDB), as DDG's nominee at NFDB, Hyderabad on 3rd September 2015.

20 2nd Meeting of the Project Screening Committee (PSC), constituted under the guidelines for establishment of operation of SPF Shrimp Broodstock Multiplication Centre (BMC), at Krishi Bhavan, New Delhi on 15th September 2015.

21 52nd Executive Committee & 22nd Annual General Body Meetings of Rajiv Gandhi Centre for Aquaculture (RGCA), at MPEDA, Kochi on 22nd September 2015.

22 Meeting with Managing Director, MATSYAFED, Trivandrum in connection with the technical collaboration in the area of brackishwater aquaculture development on 30 September 2015. Visited MATSYAFED Hatchery and Shrimp farms at Kannur and Tellicherry during 30th September to 1st October 2015.

23 Workshop on Sustainable Growth in Agriculture in Agro- Climatic Zone XI : East Coast Plains and Hilly Region, organized by ICAR jointly coordinated by CIBA, Chennai and ATARI, Bengaluru, held at CIBA, Chennai on 29th October 2015.

24 46th Meeting of the Institute Management Committee of CIBA on 4th November 2015.

25 First Meeting of the Project Monitoring Committee on the SPF Shrimp Seed Multiplication Centre, scheduled on 13th November 2015 at National Fisheries Development Board, Hyderabad on 13th November 2015.

26 5th International Symposium on Cage Aquaculture in Asia organized by CMFRI, Kochi during 25-28th November 2015.

27 3rd Meeting of the Project Screening Committee (PSC) constituted under the Guidelines for establishment of operation of SPF Shrimp Broodstock Multiplication Centre (BMC) at Krishi Bhavan, New Delhi on 14th December 2015.

28 Seabass Harvest Mela in Farmer's brackishwater cage culture demonstration site at Kondungallur, Trichur District, Kerala under Seabass satellite seed rearing programme between CIBA and Mr.Sukumar, Farmer, Ernakulam, Kerala on 24th December 2015.

29 Meeting with the Managing Director, MATSYAFED to discuss regarding the signing of MOU between CIBA and MATSYAFED for collaborative research programmes in brackishwater aquaculture initiatives in Kerala, at MATSYAFED Prawn Hatchery on 16th January 2016.

30 National Consultation on the Management of the emerging pathogen, Enterocytozoon hepatopenaei (EHP), and related issues in Indian Shrimp aquaculture sector, organized at CIBA, Chennai on 19th January 2016.

31 Interactive meeting of Vice-Chancellors of Agricultural Universities and ICAR Directors followed by ICAR Director's Conference at A.P.Shinde Hall, NASC, New Delhi during 23-24th January 2016.

32 8th Aquaculture Event "Aqua India 2016 – Indian Aquaculture: Assuming responsibilities and adapting to changes", organized by Society of Aquaculture Professionals at Visakhapatnam during 29-30th January 2016.

33 Meeting with the Indian Institute of Technology, Madras, regarding the signing of Memorandum of Understanding for Research Collaboration between CIBA and IIT, at Dean's office, IIT, Chennai on 3rd February 2016.

34 International Conference "Towards Sustainable Blue Economy: Production strategies – TaSBE – 2016" organized by Kerala University of Fisheries and Ocean Studies (KUFOS), Kochi on 5th February 2016.

35 Inauguration of the International Centre for Research and Training for Below Sea Level Farming, at Rice Research Centre of the Kerala Agricultural University at Monkombu, in Kuttanad on 6th February 2016.

36 National Workshop on Antibiotic residue analysis in aquaculture environment, organized by CIBA in collaboration with CIFT, Kochi, under the All India Network Project on Fish Health at CIFT, Kochi on 11th February 2016.

37 57th Meeting of Coastal Aquaculture Authority at Chennai on 17th February 2016.

38 Selection Committee Meeting at Kerala University of Fisheries and Ocean Studies, Kochi on 18th February 2016.

39 4th Meeting of the Project Screening Committee constituted under the guidelines for establishment of operation of SPF Shrimp Broodstock Multiplication Centre (BMC), organized by the Ministry of Agriculture & Farmers' Welfare, DAHDF at Krishi Bhavan, New Delhi, 18th Meeting of the Committee on Introduction of Exotic Aquatic Organisms into Indian Waters, organized under the Chairmanship of Joint Secretary (Fy.), DAHDF, at Krishi Bhavan, New Delhi & Sixth Meeting of the Technical Advisory Committee, constituted for overall monitoring and supervision of the National Surveillance Programme for Aquatic Animal Diseases, under the Chairmanship of Joint Secretary (Fy.), at Krishi Bhavan, New Delhi on 22nd February 2016.

40 Second Convocation of Tamil Nadu Fisheries University at Dharbar Hall, Raj Bhavan, Chennai on 27th February 2016.

41 25th Research Council Meeting of Tamil Nadu Veterinary and Animal Sciences University, in the Conference Hall, Madras Veterinary College, Chennai on 4th March 2016.

42 Meeting of the Technical Evaluation Committee of ESSO-NIOT to evaluate the proposal of establishing a multispecies marine finfish hatchery at Pamanji, Nellore, Andhra Pradesh, organized at NIOT, Chennai on 5th March 2016.

43 National Seminar on Seafood Safety, Trade and Management, jointly organized by School of Industrial Fisheries of Cochin University of Science and Technology and University Grants Commission in association with Central Institute of Fisheries Nautical Engineering and Training (CIFNET) at CIFNET, Kochi on 10th March 2016.

44 51st Meeting of the Academic Council of Central Institute of Fisheries Education (CIFE) at CIFE, Mumbai on 15th March 2016.

45 National Workshop on "Marketing strategies for newly cultured fishes in India", jointly organized by CIBA and Fisheries Technocrats Forum (FTF), Chennai, at CIBA, Chennai on 16th March 2016.

46 Start-up India Awareness Programme: Brackishwater Start-up Initiative, organized at CIBA, Chennai on 17th March 2016.

Participation in Workshops/Seminar/Meeting byScientists

47 Meeting on NKN Chennai PoP on 9th April 2015 at National Informatics Centre, Chennai – Dr. P. Mahalakshmi.

48 Meeting of Advisory Board & Expert Group of Primary Sector Mission – Implementation of various activities in Fisheries Sector in Andhra Pradesh at Hyderabad on 10th April 2015 – Dr. M. Muralidhar.

49 Two days workshop on" Making engineering scientists' contribution more meaningful to stakeholders and the nation" organized by the Division of Agricultural Engineering, ICAR, New Delhi on 13th April 2015 – Dr. M. Jayanthi.

50 Brain Storming Session to discuss the issues on setting up of nauplii rearing centres, effectiveness of PCR laboratories in hatcheries and on the need for identifying efficient disease diagnostic laboratories" held at CAA, Chennai on 15th April 2015- Dr.S.K.Otta

51 Fish Farmers Mela organized by the Department of Fisheries at Trichy and Karur Districts of Tamil Nadu during 16-17th April 2015 – Dr. D. Deboral Vimala.

52 One Day Technical Program on "Vannamei Shrimp Farming – Current Status, Trends & Options" organised by the Society of Aquaculture Professionals on 27th April 2015 at Hotel JP, Koyambedu, Chennai – Dr. V. S. Chandrasekaran.

53 International Conference on "Low Temperature Science and Biotechnological Advances" organized by the ICAR-NBPGR and NAAS India in Collaboration with Society for Low Temperature Biology (SLTB) UK and Royal Botanic Gardens, RBG, Kew, UK at NASC Complex, New Delhi during 27-30th April 2015 – Shri Aritra Bera.

54 National Conference on "Vocational Training and Higher Education Towards Skilling India" organized by the Associated Champers and Commerce & Industry of India (ASSOCHAM) at Hotel Accord Metropolitan at Chennai on 29th April 2015 – Dr. T. Ravisankar.

55 First Meeting of the Expert Committee to Develop Technical Design for Aquatic Animal Quarantine and Disease Diagnostic Laboratory at Krishi Bhavan, New Delhi on 8th May 2015 – Dr. S.V. Alavandi

56 AGRI SEARCH 2050 organized by the Indian Council of Agricultural Research at NASC Complex, New Delhi on 18th May 2015 – Ms. Babita Mandal.

57 Consultation Workshop on Fisheries, Aquaculture, Oil & Natural Gas and Tourism Sector Policy level plans, to be held on 25th May 2015 at Rajahmundry. EGREE Foundation under the initiative of GoI-UNDP-GEF-GoAP Project "Mainstreaming Coastal and Marine Biodiversity Conservation into Production Sectors" Group leader for discussions on Biodiversity friendly aquaculture sector plan – Dr. M. Muralidhar.

58 The 4th Annual Review Workshop on Stock characterization, captive breeding, seed production and culture of hilsa (*Tenualosa ilisha*) during 28-29th May 2015 at New Delhi – Dr. Prem Kumar.

59 8th Meeting of the Technical Committee to review the functioning of the Aquatic Quarantine Facility (AQF) at Coastal Aquaculture Authority, Chennai on 5th June 2015 – Dr. S.V. Alavandi

60 Delivered a lecture on "Present status of Estuaries along the Chennai coast" in the public awareness programme on "World Ocean Day" celebration on 08th June 2015 in the Fishery Survey of India campus, Royapuram, Chennai – Dr. V. S. Chandrasekaran.

61 Integrated Modeling workshop during 8-9th June 2015 at IARI, New Delhi – Shri J. Ashok Kumar.

62 First Tamil Scientific National Conference organized by the Tamil Nadu Veterinary and Animal Sciences University and Agricultural Scientific Tamil Society, New Delhi at Madras Veterinary College, Chennai during 13-14th June 2015 – Dr. P. Nila Rekha, Dr. K. Ambasankar, Dr. M. Kumaran, Dr. P. Ezhil Praveena.

63 Project launching workshop of All India Network project on Fish Health held on 20th June 2015 at Chennai – Shri J. Ashok Kumar.

64 National Fish Farmers Day celebration at CIFE, Kolkata on 10th July 2015 – Dr. T. K. Ghoshal, Dr. Prem Kumar.

65 Fourth Annual Workshop of NICRA at CMFRI, Kochi during 13-14th July 2015 – Dr. M. Muralidhar, Dr. J. Syama Dayal.

66 First Meeting of Aquaculture Subcommittee, FAD 12:1 of BIS held on 16th July 2015 at CIBA, Chennai – Dr. K. Ambasankar.

67 10th Meeting of Fish, Fisheries and Aquaculture Sectional Committee, FAD 12 held on 17th July 2015 at CIBA, Chennai – Dr. K. Ambasankar.

68 Preparatory meeting of a proposed project at BCKV, Kalyani on 31st July 2015 – Dr. T. K. Ghoshal.

69 Workshop on Research Data Repository during 4-5th August 2015 at NASC, New Delhi – Shri J. Ashok Kumar

70 The 5th advisory committee meeting of the project "Stock characterization, captive breeding, seed production and culture of hilsa (*Tenualosa ilisha*) on 6th August 2015 at CIFRI, Barrackpore – Dr. Prem Kumar.

71 Three Day International Consultation on "Science, Technology and Public Policy for Achieving Zero Hunger Challenge" organized by the M.S.Swaminathan Research Foundation at Chennai during 7-9th August 2015 – Dr. T. Ravisankar, Dr. C. P. Balasubramanian, Dr. K. Ambasankar, Dr. M. Kumaran, Dr. P. Mahalakshmi , Ms. Babita Mandal.

72 Attended the workshop on the third edition of the Dr.Silas Annual Endowment Lecture on "Genetics and sustainable aquaculture" organized by Rajiv Gandhi Centre for Aquaculture on 10th August 2015, Chennai – Dr.K.P. Kumaraguru Vasagam, Dr. N. Lalitha, Dr. P.S.Shyne Anand, Smt. R.Vidya.

73 Workshop on Climate Change at CMFRI, Kochi during 13-14th August 2015 – Dr. J. Syama Dayal.

74 International Workshop on "Resource Conservation and alternate Livelihood opportunities along Coastal Tamil Nadu" organised by Tamil Nadu Fisheries University in collaboration with University of Amsterdam (UVA), Netherlands at Hotel Residency Towers, Chennai-17 during 19 – 20 August 2015 – Dr. V. S. Chandrasekaran.

75 Meeting with Shri Sudhir Bhargava, Member of Governing Body of ICAR at NIRJAFT, Kolkata on 22nd August 2015 – Dr. T. K. Ghoshal.

76 One Day Interactive FDIS/ISO 9001:2015 Awareness Training Course organized by the Intertek India Private Limited at Guindy, Chennai on 28th August 2015 – Dr. M. Muralidhar, Dr. J. Syama Dayal, Dr. Prasanna Kumar Patil, Dr. K. Vinaya Kumar.

77 ICAR sponsered short course on Business Planning and Developing New Agro-Technology Enterprises held during 2nd to 11th Sept 2015 at ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram- Dr.P.K.Patil

78 Water logging and soil salinity in irrigated agriculture organized by the Central Board of Irrigation and Power in association with Central Water Commission & Indian Council of Agricultural Research to be held during 3-4th September 2015 at Chandigarh – Dr. M. Muralidhar.

79 Brain-storming meeting in connection with Mid-term Review Meeting of ICAR Regional Committee-II on 10th September 2015 at CIFRI, Barrackpore – Dr. Sanjoy Das.

80 Second Meeting of the Committee to suggest amendments to CAA Rules and Guidelines held at Chennai on 11th September 2015 – Dr. M. Muralidhar.

81 Public Forum on "Leveraging Agriculture for Nutrition and Health" organized by the Leveraging Agriculture for Nutrition in South Asia at Sambasivam Auditorium, MSSRF, Chennai on 14th September 2015 – Dr J. Syama Dayal.

82 FAO sponsored Re-echo Seminar on Acute Hepatopancreatic Necrosis Disease (AHPND) at NBFGR, Lucknow during 14-15 September, 2015 – **Dr.S.V. Alavandi**

83 One day Round -Table Discussion on AHPND and Development of National Action Plan at NBFGR, Lucknow on 16 September, 2015 - Dr.S.V. Alavandi

84 Delivered lecture on "Risks associated with extreme weather in aquaculture and their management" on 15th Sept, 2015 in DST sponsored SERB training programme on "Agrometeorological techniques for risk assessment and management of extreme events" conducted by CRIDA, Hyderabad during 1-21 September, 2015 - Dr.M.Muralidhar

85 FAO 'Re-echo seminar on Acute Hepatopancreatic Necrosis Disease (AHPND) held at NBFGR, Lucknow during September 14-15, 2015 –Dr.S.V.Alavandi, Shri T. Sathish Kumar

86 Mid-term Review meeting of ICAR regional committee-II at CIFRI, Barrackpore on 19th September 2015 – Dr. Sanjoy Das.

87 Delivered talk on "Impact of global warming on shrimp farming" during Stakeholders' Consultative Meet on Sustainable Shrimp Farming organised by Tamil Nadu Fisheries University at Nagapattinam on 21st September 2015 – Dr. R. Saraswathy.

88 Workshop on "Responsible fishing for sustainable conservation of fishery resources" organized by the Post Tsunami Sustainable Livelihoods Programme, Project Management Unit of Department of Rural Development & Panchayat Raj, Government of Tamil Nadu at Chennai during 28-29th September 2015 – Dr. B. Shanthi, Dr. M. Kumaran, Dr. P. Mahalakshmi.

89 National Conference on "Biomolecules for the control of viral and MDR Pathogens (BCVMP-2015)" organized by the School of Life Sciences, University of Madras held at University of Madras , Chennai during 30th September to 1st October 2015– Dr. S.V. Alavandi, Dr. S. Avunje

90 National Symposium on Comparative Endocrinology and Reproductive Biology at Visva-Bharati University, West Bengal during 1-3rd October 2015 – Dr. Prem Kumar.

91 As Nodal Person in the Sensitization Workshop on "Mera Gaon – Mera Gaurav" organized by the ICAR-Agricultural Technology Application Research Institute (ATARI) at Directorate of Extension, Hebbal Campus, University of Agricultural Sciences, Bengaluru on 3rd October 2015 – Dr. D. Deboral Vimala.

92 Visited Indian Institute of Spices Research, Calicut to have discussions with bioinformatics team during 8-9th October 2015 – Shri J. Ashok Kumar.

93 Conference on "Future of Automotive Design" organized by the Tamil Nadu Technology Development and Promotion Centre of Confederation of Indian Industry at Hotel Le Royal Meridien, Chennai on 9th October 2015 – Dr. P. Nila Rekha.

94 Workshop Liaison Officers at ISTM, New Delhi during 12-13th October 2015 – Dr. M. Kumaran.

95 Participated in the Stakeholders Meeting for "Coastal Regulation Zone – ICZMP – Preparation of DPR on the implementation of ICZM by National Centre for Sustainable Coastal

Management (NCSCM)" held on 15th October 2015 at Anna University, Chennai. - Dr M. Jayanthi

96 One Day User Awareness Programme on "Shodhganga and Anti-Plagiarism Software-URKUND jointly organized by the University of Madras and INFLIBNET at Chennai on 29th October 2015 – Dr. K. P. Jithendran.

97 Agro ecosystem workshop for East-coast plains and Hilly regions on 29th October 2015 at CIBA, Chennai – Dr. M. Kumaran.

98 One day workshop for the Agro Ecosystem of Coromandal and Northern Circar Coast of Eastern Plains at Chennai on 29th October 2015 – Dr. K. Ambasankar.

99 Participated in National conference on coastal environment organized by Center for remote sensing and geoinformatics, Sathyabama University sponsored by Ministry of Earth science , Govt. of India and presented a paper on Coastal water resource management for sustainable aquaculture during 29-30th October 2015 - Dr P. N. Nila Rekha

100 Workshop on Lower Gangetic plains Region on 31st October 2015 at CIFRI, Barrackpore – Dr. T. K. Ghoshal.

101 Meeting with DDG (AE) and DDG (Fy) for implementation of Mera Gaon Mera Gaurav Scheme at ICAR-ATARI, Salt Lake on 1st November 2015 – Dr. T. K. Ghoshal.

102 9th Meeting of the Technical Committee to review the functioning of the Aquatic Quarantine Facility (AQF), and provide technical inputs on the inclusion of EHP, AHPND and CMNV for screening imported broodstock at Coastal Aquaculture Authority, Chennai on 3rd November 2015 - Dr. S.V. Alavandi

103 11th International Food Conference on "Food Composition and Public Health Nutrition" jointly organized by the Indian Council of Medical Research, International Network of Food Data Systems & Food and Agriculture Organization of the United Nations at Hyderabad during 3-5th November 2015 – Dr. J. Syama Dayal.

104 4th Annual symposium of Society of Biological Chemists (India) Coastal Karnataka Chapter held on 14th November 2015- Dr.S.K.Otta

105 Interactive Co-Learning Workshop on "Philosophy, Methods and Ethics in Science" organized by the ICAR-Madras Research Centre of Central Marine Fisheries Research Institute at Chennai during 16-18th November 2015 – Dr. K. Vinaya Kumar, Dr. Krishna Sukumaran, Dr. P. S. Shyne Anand, Dr. Sujeet Kumar, Mrs. Vidya Rajendran, Dr. Satheesha Avunje, Shri K. P. Sandeep, Ms. Babita Mandal, Shri Aritra Bera, Shri T. Sathish Kumar, Ms. M. U. Rekha.

106 National Seminar on Hilsa Fisheries and Conservation at ICAR-CIFRI, Barrackpore, West Bengal on 18th November 2015 – Dr. Debasis De.

107 Workshop on Improving Technical Support, Extension & Demonstration Services to the Farmers – Eastern Plateau and Hill Agro-climatic Region (Agro Climatic Zone Workshop) organised by ICAR-CIFA and ICAR-ATARI, Jabalpur, Madhya Pradesh held at ICAR-CIFA, Kausalyaganga, Bhubaneswar on 23rd November 2015 – Dr. V. S. Chandrasekaran.

108 Participated and Presented a paper "Best Management Practices in Shrimp aquaculture'on one day training program on advancement in shrimp aquaculture organized by FFDA, Department of State Fisheries Kannur Kerala, Nov 24, 2015 – Dr. C. P. Balasubramanian

109 Participated in the Stakeholders Meeting for "Coastal Regulation Zone – ICZMP – Preparation of DPR on the implementation of ICZM by National Centre for Sustainable Coastal Management (NCSCM)" at Secretariat, Chennai on 24th November 2015. - Dr M. Jayanthi

110 5th International Symposium on "Cage Aquaculture in Asia (CAA5)" jointly organized by the Asian Fisheries Society (AFS), ICAR-Central Marine Fisheries Research Institute (CMFRI) & Asian Fisheries Society Indian Branch (AFSIB) at CMFRI, Kochi during 25-28th November 2015 – Dr. M. Kailasam, Dr. A. Panigrahi, Dr. Krishna Sukumaran, Dr. P. S. Shyne Anand, Shri K. P. Sandeep, Shri Aritra Bera.

111 National Symposium on "Challenges and Advances in Diagnosis of Livestock, Poultry and Fish: Redefining the Role of Veterinary Pathologists" jointly organized by the International Association of Veterinary Pathologists & Department of Veterinary Pathology at NTR College of Veterinary Science, Gannavaram during 3-5th December 2015 – Dr. P. Ezhil Praveena.

112 National Conference on "Natural Resources, Diversity and Sustainable Development" organized by the Department of Zoology, North Bengal University in Association with Foundation for Science and Environment at University of North Bengal at West Bengal during 11-12th December 2015 – Dr. Sanjoy Das.

113 XXII Annual Convention (VIBCON-2015) & National Symposium on "Immunomics and Proteogenomics in livestock health & productivity" organized by the ICAR-National Research Centre on Equines at Hisar, Haryana during 17-19th December 2015 – Dr. Sanjoy Das.

114 Second workshop/meeting on "Fisheries Department – Management of shrimp hatcheries – Orientation and capacity building of shrimp hatchery operators for registration, maintenance, bio-security and observance of hatchery protocols-workshop" at SIFT, Kakinada on 19th December 2015 – Dr. S. K. Otta.

115 Invited speaker by Deptt. of Fisheries, Govt. of W.B to deliver talk Integrated planning for overall development of brackishwater aquaculture at Bengal Fish Festival in Kolkata on 19th December, 2015-Dr.T.K. Ghoshal

116 Workshop on "Soil and Water Health Cards Distribution to Brackishwater Aquaculture Farmers" on the Occasion of Celebration of International Year of Soils 2015 at, Mahabalipuram on 19th December 2015 – Dr. K. Ambasankar.

117 Farmer-Scientist interaction meet on "Importance of quality fish seed in Aquaculture" at Namkhana, West Bengal on 23rd December 2015 – Dr. T. K. Ghoshal.

118 Advisory committee meeting of UGC Special Assistance Program at Microbiology Department, University of Delhi, South Campus, New Delhi on 30th December, 2015 - Dr.S.V. Alavandi

119 Research Expert in the Workshop organized by Directorate of Research, Extension & Farms, West Bengal University of Animal & Fishery Sciences, Kolkata on 6th January 2016 – Dr. T. K. Ghoshal.

120 One-day Workshop on "Integrated Coastal Zone Management for Tamil Nadu" organized by the National Centre for Sustainable Coastal Management & Anna University at Anna University, Chennai on 12th January 2016 – Dr. M. Jayanthi, Dr. P. Nila Rekha.

121 As external expert in Second Extension Education Council of Tamil Nadu Fisheries University at FC & RI, Thoothukudi on 12th January 2016 – Dr. M. Kumaran.

122 Interaction meet cum workshop on National Agricultural Innovation Fund (NAIF) at Board Room, NASC complex, PUSA, New Delhi on 13th January 2016 – Dr. T. Ravisankar.

123 11th National Symposium on Innovations in Coastal Agriculture- Current Status and Potential under Changing Environment at ICAR-IIWM, Bhubaneswar during 14-18th January 2016 – Dr. T. K. Ghoshal, Dr. Sanjoy Das, Dr. Gouranga Biswas, Ms. Babita Mandal.

124 Workshop on Brackishwater Aquaculture at Haroa Dev. Block, N 24 Pgs. on 21st January 2016 – Dr. T. K. Ghoshal.

125 Participated and presented in the APEDA training program for the member of evaluation Committee under NPOP held in APEDA office, Sirifort, New Delhi on 22nd Jan, 2016 - Dr A. Panigrahi

126 National Seminar on Fisheries and Aquaculture: Livelihood security, Sustainability and Conservation at College of Fisheries, Agartala during 21-22 January 2016 – Dr. Debasis De, Dr. S. K. Otta.

127 International Conference on "Advances in Engineering, Science & Technology (ICET-16)" organized by the Institute for Engineering Research and Publication (IFERP) at Chennai during 23-24th January 2016 – Dr. P. Mahalakshmi.

128 Evaluation of operation of SPF shrimp broodstock multiplication centre operated by RGCA at TASPARC hatchery, Visakhapatnam on January 28th 2016 - Dr.S.V. Alavandi

129 Institute Management Council of the ICAR-Central Island Agricultural Research Institute (ICAR-CIARI) on 28th January 2016 at Port Blair – Dr. M. Kumaran.

130 Second International Symposium on Genomics in Aquaculture, ICAR-CIFA, Bhubaneswar, Odisha during 28-30th January 2016 – Dr. M. Shashi Shekhar, Shri J. Ashok Kumar, Dr. Gouranga Biswas.

131 Aqua India 2016, Indian Aquaculture: Assuming responsibilities and adapting to Changes at Visakhapatnam during 29-30th January 2016 – Dr.S.V. Alavandi, Dr. B. Shanthi , Dr. P. Nila Rekha, Dr. Debasis De, Dr. M. Makesh, Dr. Sanjoy Das, Dr. Sujeet Kumar, Dr. K. Vinaya Kumar, Dr P.S. Shyne Anand, Dr. Prem Kumar, Dr. P. Kumaraja, Ms. Christina L., Mrs. Vidya Rajendran, Dr. Satheesha Avunje, Shri K. P. Sandeep, Ms. Babita Mandal, Shri Aritra Bera, Shri T. Sathish Kumar, Ms. M. U. Rekha.

132 National Consultation on 'Human and Aquaculture Medicines and Bio-fuel from Marine Biological Systems - Status, Constraints and the Way Forward'. Made a presentation on "Antimicrobial agents in aquaculture and the need for developing novel drugs" at Kochi during 1-3rd February, 2016 - Dr.S.V. Alavandi

133 Meeting of CCPIs and CIs of partner institutes of hilsa project funded by NASF at ICAR-CIFRI, Barrackpore, West Bengal on 3rd February 2016 – Dr. Debasis De.

134 Young Scientists' Meet – 2016 and delivered an invited talk on 5th February 2016 organised by the Zoological Society, Kolkatta and Department of Zoology at the University of Calcutta, University of Calcutta – Dr. V. S. Chandrasekaran.

135 International conference on "Towards a Sustainable Blue Economy: Production, strategies and Policies" organized by Kerala University of Fisheries & Ocean Studies, Kochi during 4-6th February 2016 – Dr. K. P. Kumaraguru Vasagam, Dr. P. Kumararaja.

136 XVI Biennial conference of Animal Nutrition Society of India, ANSICON-2016 on Innovative Approaches for Animal Feeding and Nutritional Research, held at ICAR-NDRI, Karnal during 6-8th February 2016 – Dr. J. Syama Dayal, Dr. Debasis De.

137 Delivered lecture on 'Soil and water quality management for sustainable shrimp farming' in Trainer's training programme (TTP) on "Shrimp farming, hatchery seed production and regulations, organized by Coastal Aquaculture Authority at Chennai as part of upgradation of skills & capacity building to AP State Fisheries Departmental Officers during 9-11 February, 2016 and 8-10, March 2016 - Dr.M.Muralidhar

138 Annual Review meeting of National Agricultural Science Fund (NASF) at New Delhi during 9-11th February 2016 – Dr. Debasis De.

139 XV AZRA International Conference on Recent Advances in Life Sciences organized by Ethiraj college for women, Chennai and AZRA, Bhubaneswar and Zoological survey of India during 11 -13th February 2016 – Dr. R. Saraswathy.

140 National workshop on Antibiotic Residue Analysis in Aquaculture Environments organised at Central Institute of Fisheries Technology, Kochi during 11-12th February 2016-Dr. Bhuvaneswari, Dr.P.K.Patil, Dr. S .Avunje

141 National Conference on "Perspectives and prospects in aquatic research" organized by the PG and Research Department of Zoology, Kongunadu Arts and Science College (Autonomous) at Coimbatore on 16th February 2016 – Dr. B. Shanthi.

142 Two days meeting on the "Constitution of working group for preparation of India's country report for the state of the World's Aquatic Genetic Resources for food and agriculture (SoWAqGR)" organized by the Fisheries Division at New Delhi during 16-17th February 2016 – Dr. M. Shashi Shekhar.

143 International Conference on Aquatic Resources and Sustainable Management at Science City, Kolkata during 17-19th February 2016 – Dr. T. K. Ghoshal, Dr. Debasis De, Dr. Gouranga Biswas, Dr. Prem Kumar.

144 Fourth meeting of the Advisory Committee on Hilsa Conservation and Research at Chamber of Hon'ble MIC, Fisheries, West Bengal on 22nd February 2016 – Dr. Debasis De.

145 International Symposium on "Microbiome in Health and Disease" ICAR-NIANP, Bangalore & ADNAT, Hyderabad at ICAR-NIANP, Bangalore during 23-25th February 2016 – Dr. M. Shashi Shekhar, Dr. Satheesha Avunje.

146 Review meeting of "Network Project on Agricultural Bioinformatics and Computational Biology" under CABin scheme at IASRI, New Delhi during 24-25th February 2016 – Shri J. Ashok Kumar.

147 National Seminar on "Advances in Marine Natural Products and Nutraceutical Research" organized by the Society of Fisheries Technologists India in association and ICAR-Central Institute of Fisheries Technology at Kochi on 26th February 2016 – Dr. Satheesha Avunje.

148 4th Meeting of the Advisory Committee on Hilsa Conservation & Research Centre, Chamber of Hon'ble MIC, Fisheries, West Bengal on 2nd March 2016 – Dr. Debasis De.

149 8th Bangalore India Nano conference with focal theme "Nano Horizons" organized by Department of Information Technology, Biotechnology and Science & Technology during 3-4th March 2016 at Bangalore – Dr. R. Saraswathy.

150 Delivered an invited talk in the National Symposium on "Marine Bio-resources and Coastal Livelihoods" organized by the Gujarat Institute of Desert Ecology at Bhuj, Kachchh, Gujarat during 4-5th March 2016 – Dr. C. Gopal, Dr. V. S. Chandrasekaran.

151 International workshop on Antibiotics and Antimicrobial Resistance in Water Systems-Prevalence and Impacts held at IIT (Madras), Chennai on 7th March 2016- Dr.P.K.Patil

152 Delivered an invited talk in the "National Training on Fisheries Management" as a resource person (Sponsored by MHRD-Govt. of India, New Delhi) on 9th March 2016 organized by CAS in Marine Biology, Annamalai University, Parangipettai, Tamil Nadu – Dr. V. S. Chandrasekaran.

153 Deliver Talk on International Conference & Exhibition on "Sustainable technologies, development and opportunities in fisheries" organized by the APTDC, CII and Department of Animal Husbandry and Fisheries (FISH), Government of Andhra Pradesh at Kakinada on 12th March 2016 – Dr. M. Kailasam.

154 Southern Regional Consultation, Forum for Indian Development Cooperation, New Delhi, The Bay of Bengal Programme, Chennai and The Madras Institute of Development Studies at Chennai on 15th March 2016 – Dr. C. P. Balasubramanian.

155 Sensitizatin workshop on Agri-Business Incubation, organized by ICAR-NAARM and ICRISAT, Hyderabad held at ICAR-NAARM, Hyderabad during 21st and 22nd March 2016 - Dr.P.K.Patil

156 International Conference on "Aquatic Exotics: Trends, Challenges and Policies" organized by the Department of Aquatic Biology & Fisheries, University of Kerala at Thiruvananthapuram during 28-30th March 2016 – Dr. C. P. Balasubramanian.

157 Panel member of the interview board, National Centre for Sustainable Aquaculture at Kakinada on 29th March 2016 – Dr. M. Kailasam, Dr. T. K. Ghoshal, Dr. S. Kannappan.

Consultancy services for establishment of shrimp hatchery with K.R.Seafoods, Porbandar, Gujarat

MoU was signed for the consultancy service for shrimp hatchery establishment with Mr. Rajesh Chamadia, K.R.Sea foods, Gujarat.

Memorandum of Understanding (MoU) was signed for the Consultancy service for shrimp hatchery establishment with Mr. Rajesh Chamadia, K.R.Sea foods, Gujarat on 10th April 2015. K.R.Sea foods is a small group of fisherman at Porbandar, involved in fishing, processing and exports since 35 years. The group consists of 25 fishing trawlers and 20 gill net fishing boat. Consultancy fee of Rs.4,49,440/- Establishment of a shrimp hatchery in the Northern part of Gujarat coast is a great advantage for development of brackishwater aquaculture in west coast as presently shrimp seed is being airlifted from East coast.

Consultancy for establishing satellite Asian Seabass nursery CIBA and Deejay Group, Bangalore

MoU was signed with Deejay Group from Bangalore, to establish satellite Asian Seabass nursery

MoU was signed with Deejay Group, Bangalore on 20th May 2015 to establish satellite Asian Seabass nursery. Hatchery and nursery operations are the main bottlenecks preventing the expansion of Asian seabass, establishment of this satellite nursery will help the establishment of seabass farming in west coast of Karnataka. The institute will provide the technology inputs required for nursery rearing, along with the supply of the inputs such as seabass fry, nets and required larval feeds for nursery rearing. The fingerlings that produced in the satellite rearing facility will be sold to fish farmers in the region.

Transfer of technology for indigenous shrimp feed production

MoU was signed with Shri. Karuna Raju, shrimp farmer from Bapatla, Andhra Pradesh for the technology transfer on indigenous shrimp feed production

MoU was signed with Shri. Karuna Raju, shrimp farmer, Bapatla, Andhra Pradesh for the technology transfer on indigenous shrimp feed production on 20th June 2015. Shri.Karunaraju is a progressive farmer from Andhra Pradesh having shrimp farming experience for over a decade and now wants to enter into the shrimp feed business. A consultation fee of Rs. 5,70,000/- was paid during the signing of MoU.

Knowledge Partnership for Development of Eco-friendly And Innovative Penaeid Shrimp Production Technology

MoU was signed with Ecosecure systems, Chennai for the Knowledge partnership for development of Ecofriendly, Innovative and Penaeid shrimp production technology, in the presence of Dr.J.K.Jena, Deputy Director General (Fy), ICAR

Institute has signed an MoU with Ecosecure systems, Chennai on 12th August 2015for the Knowledge partnership for development of Ecofriendly, Innovative and Penaeid shrimp production technology. On behalf of Ecosecure systems Mr.AnilGhanekar handed over the consultation fee of Rs. 1,14,000/-. This was the best example of Public Private Partnership (PPP) model for development of eco-friendly aquaculture. Dr.J.K.Jena, Deputy Director General (Fy), ICAR, New Delhi participated in the meeting and appreciated the efforts of CIBA in promoting innovative and sustainable technology development. It is envisaged to develop a bioflac based EIP technology in the project.

Culture demonstration of Indian White shrimp (*Penaeus indicus*)

MoU was signed with Smt. Girija, Shri.Gopalakrishnan and Shri.Syed Mahamood progressive aqua farmers for Indian white shrimp farming

Culture demonstration of Indian White Shrimp (*P. indicus*) is the key for the introduction of new species for diversification. In this direction a MoU was signed with Smt. Girija, Shri.Gopalakrishnan and Shri.Syed Mahamood progressive aquafarmers from Tamil Nadu on 25th September 2015 at Chennai Headquarter.

Culture demonstration of organic shrimp using CIBA organic feed

Low fish meal based organic feed for the culture of black tiger shrimp, *Penaeus monodon* was developed at CIBA through extensive research and field testing. Institute entered an agreement with M/S. Jass Venture Private Limited on 29th November 2015 for the transfer of this green

CIBA signed an agreement for organic feed technology with M/S. Jass Venture Private Limited from Kerala in the presence of Dr. A. K. Singh, Deputy Director General (Extension & Fisheries) and Dr.S.D. Singh, Assistant Director General (Fisheries), ICAR

technology for organic shrimp farming. Shrimp feed be produced in CIBA feed mill, only certified feed mill for production of organic shrimp feed in the country. Dr. A. K. Singh, Deputy Director General (Extension & Fisheries) and Dr. S.D. Singh, Assistant Director General (Fisheries), ICAR, New Delhi were present during the meeting. Young entrepreneur, Mr. Anil Sasidharan joint owner of the company signed the agreement. The feed developed for the culture of organic shrimp was named as Green Shrimp Feed-BT.

Knowledge partnership on development of new generation formulated shrimp feed

MoU was signed on Public Private Partnership mode with M/S. Revelations Biotech Private Limited, Hyderabad for the development and technology transfer of 'New Generation Formulated Shrimp-feed.

MoU on Public Private Partnership mode was signed with M/S. Revelations Biotech Private Limited, Hyderabad for the development and technology transfer of 'New Generation Formulated Shrimp-feed' on 12th November 2015. Revelations Biotech Private Limited is presently engaged in providing advanced scientific solutions in the areas of Enzyme Engineering, Molecular Diagnostics, Molecular biology, X-Ray Structure Analysis and Structure Guided Drug Design. The company has developed a unique feed additive that helps in improving the growth and FCR of shrimp, and interested to develop new generation feeds with the inclusion of the novel feed additive On behalf of Revelations Biotech Ltd Dr.RavichandranBeeram, signed the MoU and handed over the intellectual fee of Rs 6,84,000/- to the institute.

The knowledge partnership for establishment of satellite Asian seabass nursery

To popularize the culture of Asian seabass institute has signed a MoU with Shri.JacobJhonson, Chennai for the Knowledge Partnership on Satellite Asian Seabass Nursery on 16th December 2015. The objective of this MoU was to setup satellite Asian Seabass nursery and facilitate supply of the quality seed to aqua farmers of the region.

New partnership on the food safety and quality to upkeep brackishwater aquaculture produce

MoU) was signed with Seafood Exporters Association of India (SEAI) for addressing the important issues such as emerging disease problems and antibiotic residue in brackishwater aquaculture sector

A Memorandum of Understanding (MoU) was signed with Seafood Exporters Association of India (SEAI) on 17th December 2015 for addressing the important issues such as emerging disease problems and antibiotic residue in brackishwater aquaculture sector. This collaboration is an important event in the history of aquaculture in India, in realizing sustainable future of the sector. On behalf of SEAI Mr.EliasSait, Secretary General, SEAI and Mr. Santhana Krishnan, CEO, Maritech Ltd., participated in the meeting. The collaborative program is planned to address issues related to aquatic animal health, seafood safety, antibiotic residue and conduct awareness programmes on responsible use of farm inputs, BMPs, biosecurity, HACCP etc. An amount of Rs.16,92,000/- was charged as consultation fee for this program.

Sustainable brackishwater aquaculture initiatives in collaborative with Matsyafed, Kerala

MoU was signed with Matsyafed, Govt of Kerala (Kerala State Co-operative Federation for Fisheries Development Ltd., Thiruvananthapuram) for the collaborative programme on brackishwater aquaculture initiatives in Kerala.

MoU was signed with Matsyafed, Govt of Kerala (Kerala State Co-operative Federation for Fisheries Development Ltd., Thiruvananthapuram) for the collaborative programme on brackishwater aquaculture initiatives in Kerala on 16th January 2016. This strategic MoU is meant for joint development of sustainable brackishwater farming models for promoting brackishwater aquaculture in Kerala. Satellite nursery rearing of popular farmed Brackishwater finfishes viz. Asian seabass (*L. calcarifer*), Milk fish (*Chanos chanos*) and Pearlspot (*Etroplus suratensis*), hatchery production of high health seeds of penaeid shrimps (*P. vannamei*, *P. monodon* and *P. indicus*) and establishment of feed mill for the production of cost effective formulated feeds are some of the programmes on the anvil under this MoU.

Memorandum of Understanding for collaborative research programmes and knowledge partnership with Indian Institute of Technology, Madras (IIT-M)

MoU was signed with IIT Madras for collaborative research at the Centre for Industrial Consultancy and Sponsored Research (IC&SR), IIT Madras

MoU was signed with IIT Madras for collaborative research on 3rd February 2016 at the Centre for Industrial Consultancy and Sponsored Research (IC&SR), IIT Madras. On behalf of IIT-M Prof. Krishnan Balasubramanian, Dean (IC&SR) signed the agreement and expressed the interest of IIT-M to pursue research in the area marine resources to derive mutual benefits. Collaborative research would help in generating novel research output with potential commercial utilization and sharing of the intellectual property. Research towards bio-prospecting of micro-organisms from marine sources and process optimization for the same is planned under the project.

Technical support and partnership farming for development of farming models

MoU was signed with Shri.M.K.Abdulla and his associates from Padanna, Kasaragod for technical partnership and assistance relating to innovative sustainable brackishwater farming model including the development of vannamei farming on 10th February 2016. The objective of this MoU was to develop innovative brackishwater farming models and to develop a sustainable polyculture/ Integrated Multi Trophic Aquaculture (IMTA) model with *L. vannamei* farming and other species combinations. CIBA will provide scientific support and technical collaboration to the client to develop innovative brackishwater farming models.

MoU was signed with Shri.M.K.Abdulla and his associates from Padanna, Kasaragod for technical partnership and assistance relating to innovative sustainable Brackishwater farming model

Institute Technology Management Unit

ICAR-Industry day

ICAR- Industry Day was celebrated in Central Institute of Brackishwater Aquaculture (CIBA) on 16th July, 2015. The Programme started with Indian Council of Agricultural Research (ICAR) geeth at 3 pm. Dr.T.Ravisankar, Principal Scientist & Scientist In-charge, welcomed the gathering. He remarked the importance of celebrating the Industry day that is to ultimately help farmers to meet their requirements. He also said that ICAR envisaged more on public private partnership to transfer or commercialize technologies developed by ICAR institutes. He formally introduced the invitee expert, Dr.Subhendu Chakrabarti, Senior Principal Scientist-Business Process Division, Central Leather Research Institute (CLRI), Chennai. Dr.K.K.Vijayan, Director, CIBA welcomed the Chief Guest and gave opening remarks. He pointed out the importance of Intellectual Property Rights (IPR) in the knowledge economy and importance of being aware of happenings in IP protection domain.

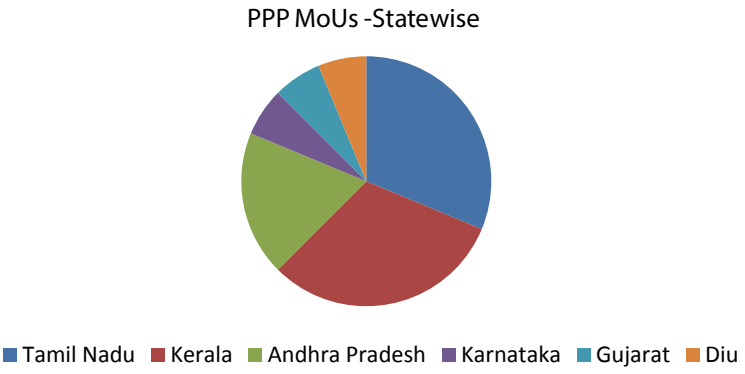
Dr.Subhendu Chakrabarti congratulated scientists & staff of CIBA on Indian Council of Agricultural Research (ICAR)'s 86th foundation day celebration. His address covered the following aspects: Acquisition of patents, copyrights, advantages of patenting; Non-patentable subject matters, patentable inventions, Provisional and Complete specifications of patent applications, patent drafting, PCT applications (Patent Cooperation Treaty) and International Searching Authority (ISA) which was followed by Questions & Answers session. Dr.SubhenduChakrabarti distributed the cash prizes for three best interactions made by Shri.S.Rajamanickam, Senior Technical Officer, Dr.M.Makesh, Senior Scientist and Dr.M.Muralidhar, Principal Scientist for the first, second and third cash prizes respectively. The meeting ended with a vote of thanks by Dr.P.K.Patil, Senior Scientist, CIBA.

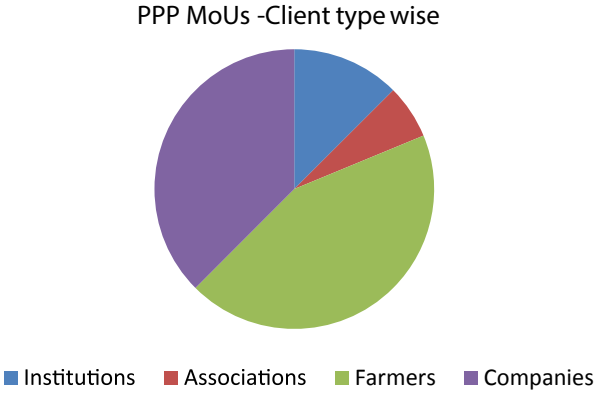
Funding support obtained

- ICAR grant –Rs 6.00 lakhs
  NAIF –ICAR- Rs-79.00 lakhs

Major activities

- During the year 2015-16 sixteen MoUs were signed in the area of finfish and shellfish hatchery establishment, seed production, farming, nutrition, health, food safety and molecular biology.
- Modalities of technology outreach include consultancy services, joint development, collaborative research and knowledge partnership.
- Intellectual Property (IP) and start up India awareness programs and agroecosystem planning workshops were also conducted.





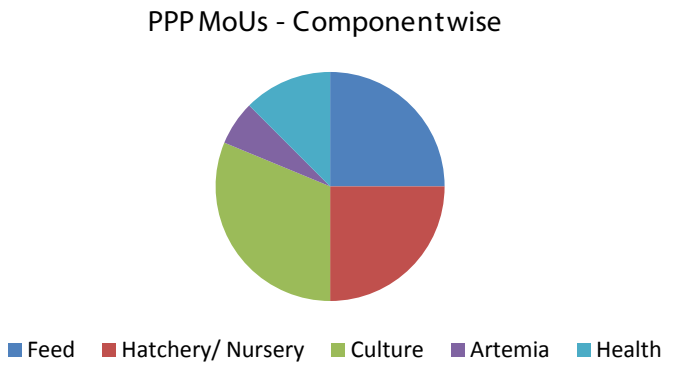
Salient findings/leads

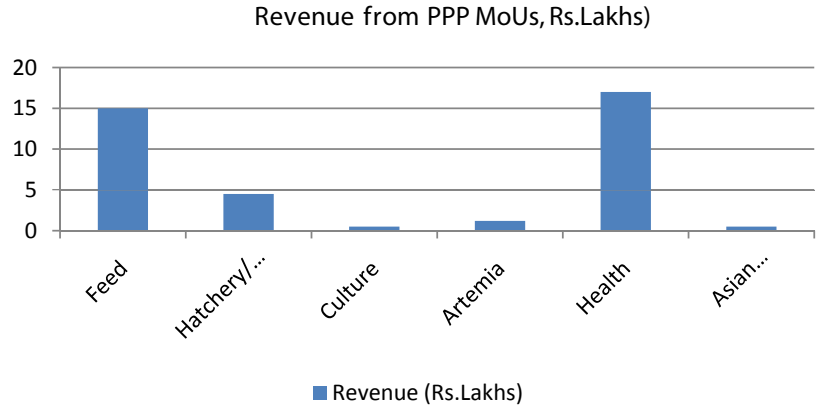
1 Conscious effort was taken to engage stakeholders from all the coastal states of India. Five States and one Union Territory were covered this year.

2 On client type, corporate sector /research institutions, farmers and other stakeholders like Seafood Exporters Association of India (SEAI) were also given adequate importance. A total number of six corporate entities two institutions, 1 association and 7 farmers were brought in as clients.

3 Four MoUs for transfer of feed technology, four for hatcheries, five MoUs for culture aspects, two on health and one on artemia production were signed.

4 Out of the revenue received the health related MoUs brought in Rs.17, 10,170 and accounting for 45 per cent.





Research and Administrative Meetings

The Research Advisory Committee

The Research Advisory Committee of CIBA was constituted by ICAR (Council's order F.No.18-6/2007-ASR-I dated 22.7.2013) for a period of three years with effect from 25 July 2013:

Chairman	Dr.M.V.Gupta
Members	Dr. (Mrs.) Krishna Srinath
	Mr.Udaya Ram Jyothy
	Dr.R.A.Selvakumar
	Dr.P.A.LokaBharati
	Dr.Sridhar Sivasubbu
	Dr.Madan Mohan
	Dr.K.K.Vijayan
Member Secretary	Dr.M.Jayanthi

The 20th meeting of the Research Advisory Committee (RAC) of CIBA was held on 8th April 2015 at CIBA Headquarters, CIBA, Chennai

Institute Research Council

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. Gopal
	Dr.S.V.Alavandi
	Dr.G.Gopikrishna
	Dr. M. Kailasam
	Dr.V.S.Chandrasekaran
	Dr.M.Muralidhar
	Dr.K.Ambasankar
	Principal Investigators of all the projects
Member Secretary	Dr. M. Jayanthi

The 32nd IRC Meeting was held on 6-7th May 2015 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

ADG (M.Fy.), ICAR

The Dean, TANUVAS, Chennai

The Commissioner of Fisheries, Gujarat

The Commissioner of Fisheries, Tamil Nadu

The Dean, Fisheries College & Research Institute, TANUVAS, Tuticorin

Dr. K. Ashok Kumar, PS, ICAR- CIFT, Cochin

Dr. Bindu R. Pillai, PS & Head, ICAR- CIFA, Bhubaneswar

Dr. Vijaya Gopal, PS, ICAR- CMFRI,Kochi

Dr. Joe Kizhakudan, PS, ICAR- CMFRI, Chennai

The Assistant Finance &Accounts Officer, ICAR-IIHR, Bengaluru

Co-opted Members

Member Secretary

Sh. K.V.S. Satyanarayana, Administrative Officer

Members

Dr. M. Kumaran, Finance & Accounts Officer (I/c)

Dr. M. Jayanthi, PS & OIC (Engg. Cell)

Shri. R. Kandamani, AAO

Smt. V. Usharani, AAO

Dr. T. Ravisankar, Principal Scientist & Head of Office

The 46th IMC meeting held on 4th November 2015.

Institute Joint Staff Council (IJSC)

The composition of the Institute Joint Staff Council (reconstituted by CIBA for a period of three years upto 18.02.2016 vide Office Order F.No.13-1/2012-Admn. Dated 19.02.2013) is as follows:

Official Side

Chairman	Dr. K.K. Vijayan
Members	Dr.G. Gopikrishna, P.S. & HOD NGBD
	Dr. M. Muralidhar, P.S.
	Dr. M. Kumaran, P.S.
	Shri. R.G. Ramesh, A.A.O.

Staff Side

Secretary	Shri, N. Jagan Mohan Raj, Sr. Technical Asst.
Members	Shri D.M. Ramesh Babu, Sr. Technical Asst.
	Shri R. Kandamani, A.A.O.
	Shri P. Srikanth, UDC
	Shri S. Kuppan, Skilled Support Staff
	Shri M. Pichandi, Skilled Support Staff

(Shri P. Srikanth, UDC, Member, IJSC is also a member of CJSC of ICAR)

The first IJSC Meeting for the year 2015-16 was held on 7th August 2015

Grievane Committee

The composition of the Institute Grievance Committee (reconstituted by CIBA for a period of two years with effect from 1st December 2013 vide Office Order F.No.6(2)/2007-Admn. Dated 23.11.2013) 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. A. Manoharan, Assistant
Staff Member	Shri. M. Pichandi, Skilled Support Staff

Women Complaint

Women Complaint Committee has been constituted as follows:

Chairman	Dr. R. Saraswathy
Members	Dr. Prasanna Kumar Patil
	Dr. Sherly Tomy
	Dr. Vinaya Kumar Katneni
	Shri. S. Nagarajan
	Smt. E. Mary Desouza
External Member	Dr. Lita Sunder, Madras Christian College

Services and Assignments

Services in Committees

Dr. K. K. Vijayan, Director

Member, Executive Committee and Governing Body, Rajiv Gandhi Centre for Aquaculture (MPEDA), Mayiladuthurai.

Member, ICAR Regional Committee No.VIII

Member, Scientific Advisory Committee for Dr.Perumal Krishi Vigyan Kendra.

Member, Executive Committee Member - National Centre for Sustainable Aquaculture (NaCSA).

Member, Committee for protection of fish germplasm through registration and documentation, constituted by ICAR.

Member, Scientific Advisory Committee, Krishi Vigyan Kendra, Tiruvallur.

Member, State Level Committee on Animal Genetic Resources (SLCAnGR), constituted by Department of Animal Husbandry & Veterinary Services, Government of Tamil Nadu, Chennai.

Member, Board of Management of Tamil Nadu Fisheries University, Nagapattinam.

Member, Board of Management of Tamil Nadu Veterinary and Animal Sciences University, Chennai.

Member, Committee for examining the issues related to establishment of SPF *Penaeus monodon* Multiplication centre at Srikakulam, Andhra Pradesh, under the Chairmanship of Joint Secretary (Fy.), DAHD&F with DDG (Fy.), ICAR.

Member, Advisory Committee on Hilsa Conservation and Research.

Member, Academic Council of Central Institute of Fisheries Education, Mumbai.

Member, Governing Body of State Fisheries Resource Management Society (FIRMA), Thiruvananthapuram.

Member Advisory Board for Fisheries Sector Development, constituted by Special Chief Secretary (Planning), Planning Department, Govt. of Andhra Pradesh.

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.

Member, Coastal Aquaculture Authority.

Member, Working Group constituted to formulate the aquaculture strategy of the country, by ESSO-NIOT.

Member - 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.

Chairman, Technical Evaluation Committee (TEC) constituted by the Director, ESSO-NIOT to evaluate the group's proposal for establishing a multispecies marine finfish hatchery at Pamanji.

Member, Advisory Board constituted for organizing "International Seminar on New Education Policy and NAMODI Framework", to evolve a framework of future education policy and to provide a Vision Document as reference material in devising New Education Policy, by Indira Gandhi National Tribal University, Anuppur, Madhya Pradesh.

Member, Advisory Committee of the National Symposium "Marine Bioresources and Coastal Livelihoods" organized by Gujarat Institute of Desert Ecology, Bhuj during 4-5 March 2016.

Other Staff of CIBA

Member of Technical and Inspection Committee for regulating establishment and operation of SPF Shrimp Broodstock Multiplication Centres in the coastal areas nominated by Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Family Welfare, Government of India, prepared a) Standard operating procedures (SOP) for Penaeus vannamei Broodstock Multiplication Centre and inspected MPEDA/RGCA SPF Shrimp Broodstock Multiplication Centre at TASPARC, Visakhapatnam and submitted the report to the Ministry. – M.Muralidhar

Inspected the sites nearer to Machilipatnam in Krishna District on 16.01.2016 for the establishment of ICAR-CIBA Centre in Andhra Pradesh and submitted the feasibility report - Dr.C.Gopal, Dr.M.Muralidhar, Dr.M.Kailasam and Dr.J.Syama Dayal

Invited by the Doordarshan to deliver talk on Brackishwater Aquaculture and Environment – Dr.R.Saraswathy

Member of Aquaculture Zoning Committee of Nellore District, Andhra Pradesh – Dr.M.Muralidhar

Management Representative, ISO 9001:2008 implementation Committee - Dr.M.Muralidhar

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

External examiner for M.F.Sc. Thesis Evaluation and Viva-voce Examination in the Department of Aquaculture, Faculty of Fishery Sciences, WBUAFS, Kolkata-Dr. T.K.Ghoshal, Dr. Gouranga Biswas

Chairman of assessment committee of Technical staff and Member of the assessment committee for assessment/promotion of Scientist and Administrative staff of the Ramkrishna Ashram Krishi Vigyan Kendra - Dr. T.K.Ghoshal.

Reviewer for Aquaculture Report (Elsevier journal) - Dr. Debasis De

Reviewer for evaluation of projects submitted to DBT, GoI for funding - Dr. Debasis De

Reviewer for the journal BMC Veterinary Research (BioMed Central) - Dr. Sanjoy Das

Editorial Board Member for Menba Journal of Fisheries Faculty, Kastamonu University, Turkey - Dr. G. Biswas

Reviewer for various international journals, such as Aquaculture, Aquaculture Research, Journal of the Marine Biological Association of the United Kingdom, Archives of Polish Fisheries and Journal of Biological Methods - Dr. G. Biswas

ASRB assignment in New Delhi on application screening during 14-17th April 2015 and 16th November 2015-Dr. K. Ambasankar

Advisory services to the Ministry of Agriculture and farmers' welfare, DAHD&F, New Delhi towards the import of aquaculture inputs- Dr.K. Ambasankar.

Technical guidance to the Tamil Nadu state Fisheries department for establishment of fish feed mill plant at Thanjavur - Dr.K. Ambasankar

Technical guidance to RGCA towards the production Broodstock shrimp feed by establishing shrimp feed pelletizer - Dr.K. Ambasankar

Acting as member of the Fish, Fisheries and Aquaculture sectional committee FAD12 and Aquaculture sub committee FAD12.1 - Dr.K. Ambasankar

Deliver the guest lecture entitled "Brackishwater and Marine Fish Nutrition in DBT sponsored National Training for Fisheries Professionals in Molecular Biology and Biotechnology at CMFRI, Cochin" on 10th September 2015. Dr.K. Ambasankar

Served as doctoral committee member in SRM University and B.S. Abdur Rahman University, Chennai – Dr. K.P. Kumaraguru vasagam

Inspected the sites nearer to Machilipatnam in Krishna District on 16.01.2016 for the establishment of ICAR-CIBA Centre in Andhra Pradesh and submitted the feasibility report - Dr. K. P. Jithendran

Set M.F.Sc. Question paper for Fish Immunology course, TN Fisheries University- Dr. K. P. Jithendran

Evaluated the project proposals received from KSTE, Trivandrum (Sudha SN College, Kannur). - Dr. K. P. Jithendran

Evaluated the project proposals received from DBT, New Delhi. - Dr. K. P. Jithendran

External examiner for Ph.D. Viva Voce examination at SN College, Kannur - Dr. K. P. Jithendran

Evaluated and submitted a report of the applications for selection for Tamil Nadu Scientist Award (TANSA, 2014) In Biological Sciences - Dr. K. P. Jithendran

ASRB assignment on December 18th 2015 for moderating the questions and answers of ARS/NET 2015 - Dr. K. P. Jithendran

Member of inspection committee constituted by CAA- CIBA, Chennai to inspect hatcheries for permitting the import of SPF free broodstock located at Kanchipuram and Villupuram districts, TN - Dr. K. P. Jithendran, Dr. Satheesha Avunje

Invited speaker by Sundarban Dev. Board, W.B. to deliver talk on livelihood options of youths with brackishwater aquaculture in Sundarban - Dr. T. K. Ghoshal

Invited speaker by Dept. of Fisheries, Govt. of W.B. to deliver a talk on Nutrition and Feed management in brackishwater aqiuaculture at Haroa, North 24 Parganas - Dr. T. K. Ghoshal

Resource person for Trainers Training Programme (TTP) on Shrimp farming, Hatchery seed production and regulations to AP state fisheries officials conducted by CAA, Chennai - Dr. M. Poornima

DBT nominee of Institutional Biosafety Committee (IBSC) for Madras Veterinary College, TANUVAS, Chennai - Dr. M. Poornima

Member of inspection committee constituted by CAA- CIBA, Chennai to inspect hatcheries for permitting the import of SPF free broodstock located at Visakhapatnam and East Godhavari districts, Andhra Pradesh - Dr. M. Poornima

As Surveillance team member investigated disease outbreak and submitted disease investigation report to state fisheries department (Tamilnadu), Chennai - Dr. M. Poornima

Invited by the Doordarshan to deliver talk on Brackishwater Aquaculture and Environment - Dr. R. Saraswathy

Member of DBT expert committee meeting on "Marine Synthetic Biology - Dr. S. K. Otta

Member of DBT expert committee for Environment Biotechnology Programme for the Northeast Region of India (DBT-NERBPMC) - Dr. S. K. Otta

Invited speaker and Co-chaired the session "Microbial interactions, host response and drug delivery" for 4th Annual symposium of Society of Biological Chemists (India) Coastal Karnataka Chapter - Dr. S. K. Otta

Lead speaker and Co-chaired the session "Aquatic Animal Health and Environment (AAH&E)" for the national seminar on "Fisheries and Aquaculture: Livelihood security, Sustainability and Conservation" at College of Fisheries, CAU, Lembuchera, Tripura - Dr. S. K. Otta

Invited speaker for the summer-Winter school programme on "Advanced Training on Marine Microbiology and Its Industrial Applications" organised by DBT, Vel Tech High Tech Engineering College, Chennai - Dr. S. K. Otta

External examiner for Ph.D. viva examination at College of Fisheries, Mangalore - Dr. S. K. Otta

External examiner for Ph.D. viva examination at Fisheries College and Research Institute, Thoothukudi - Dr. S. K. Otta

Project reviewer for DBT and ICAR-extramural funds - Dr. S. K. Otta

Reviewer for African Journal of Aquatic Sciences, Journal of the World Aquaculture Society and Journal of Environmental Biology - Dr. S. K. Otta

Delivered lectures on diseases in brackishwater aquaculture systems in various Workshop-cum-Training programmes organized by Sundarban Development Board, Govt. of West Bengal - Dr. Sanjoy Das

Guest of Honour in the seminar on "Trends and Future Strategies in Fisheries Research and Extension: Bangladesh and West Bengal" organized by West Bengal Professional Fisheries Graduates' Association, Kolkata - Dr. G. Biswas

Delivered lectures on brackishwater aquaculture opportunities in various Workshop-cum-Training programmes organized by Sundarban Development Board, Govt. of West Bengal. Delivered a lecture on brackishwater aquaculture opportunities in a 3-day Gram Panchayat level training programme on "Fish culture in rural areas" organized by Department of Fisheries, Govt. of West Bengal at Rishi Bankim Chandra G.P. Meeting Hall, Kakdwip, South 24 Parganas.-Dr. G. Biswas

Delivered a lecture on Different Options in Brackishwater Aquaculture with Special Emphasis on L. vannamei Culture in a Workshop organized by Department of Fisheries, Govt. of West Bengal at Haroa, North 24 Parganas- Dr. G. Biswas

CIBA nominee for disposal of infected imported shrimp broodstock at quarantine facility at RGCA - Dr. Satheesha Avunje

Member of inspection committee constituted by CAA-CIBA, Chennai to inspect hatcheries for permitting the import of SPF free broodstock located at Nellore and Prakasam Districts, Andhra Pradesh - Shri T. Sathish Kumar

Distinguished visitors

Headquarters

Sl. No	Details of visitors	Date of visit
1	Dr.S.Ayyappan, Director General, ICAR	09.05.2015
2	Shri. Radha Mohan Singh, Honourable Union Agriculture Minister	09.05.2015
3	Mr.S.Muthukaruppan, President, Society for the Aquaculture Professionals (SAP)	20.06.2015
4	Dr.P.Ravichandran, Member Secretary, CAA	20.06.2015 19.01.2016 16.03.2016
5	Dr.Subhendu Chakrabarti, Senior Principal Scientist - Business Process Division, Central Leather Research Institute (CLRI), Chennai	16.07.2015
6	Mr.R.Gyanashekar, Deputy Director of Census Operations, Ministry of Home Affairs, Chennai	19.08.2015
7	Shri.E.Mariappan, Director-News, Doordharsan Kendra, Chennai	16.10.2015
8	Dr. A. K. Singh, Deputy Director General (Agricultural Extension & Fisheries), ICAR	29.10.2015
9	Dr.S.D.Singh, Assistant Director General (Inland Fisheries), ICAR	29.10.2015
10	Dr. Sreenath Dixit, Director, ATARI, Bengaluru,	29.10.2015
11	Dr. Chari Appaji, Director, ATARI, Hyderabad	29.10.2015
12	Dr.Gopal Krishna, Director, CIFE, Mumbai	29.10.2015
13	Dr.S.K.Ambast, Director, IIWM, Bhubaneswar	29.10.2015
14	Dr.RVSK Reddy, Director of Extension,	29.10.2015
15	Dr.YSRHU, Venkataramannagudem, West Godavari Dist. AP	29.10.2015
16	Dr. T.V.Ramana Dean, Fisheries, SVVU, Tirupati	29.10.2015
17	Dr.R.S.S.Hopper Director, Eco Technology Centre, MSSRF, Chennai	29.10.2015
18	Dr.N. Felix, Professor and Head, Fisheries Research Centre, Tamil Nadu Fisheries University	29.10.2015
19	Dr.D.Balaguravaigh, Professor & Univ. Head Department of Soil Science & Agril. Chemistry, SVAU, Tirupati, A.P.	29.10.2015
20	Dr.Ajay Parida, Executive Director, MSSRF	29.10.2015
21	Sh. K.V.Rao CGM, NABARD, Chennai	29.10.2015

22	Dr.Thanga Thamil Vanan, Prof.Head, LPM, MVC, TANUVAS	29.10.2015
23	Dr. P. Punna Rao, Pr. Scientist (Agril. Extension) ANGRAU, Hyderabad, Andhra Pradesh	29.10.2015
24	Sh. G. Nagabhushanam, GM, FCI South, Chennai	29.10.2015
25	Sh. M.Renold, Regional Executive, Fertilizer Association of India	29.10.2015
	Mr.S.Santhanakrishnan, CEO, Marine Technologies, Chennai.	30.11.2015 19.01.2016 16.03.2016
26	Dr.K.Vijayakumaran, Principal Scientist, MRC of CMFRI	30.11.2015
27	Dr. (Mrs.) Beela Rajesh, IAS, Commissioner of Fisheries, Tamil Nadu	19.01.2016
28	Mr. Elias Sait, Secretary General, SEAI	19.01.2016
29	Dr. A.R. Thirunavukkarasu, Chairman, FTF	16.03.2016
30	Dr. V. V. Sugunan, Former ADG-ICAR	16.03.2016

Kakdwip Research Centre

Sl. No.	Details of Visitors	Date of Visit
1.	Dr. K.K.Vaas, Ex. Director, CIFRI and Chairman, Advisory Committee, Hilsa Project	07.08.2015
2.	Dr. V.R.Suresh, Director, ICAR-CIFRI	03.12.2015
3.	Dr. Pallipuram Jayasankar, Director, ICAR-CIFA, Bhubaneswar	23.12.2015
4.	Mr. M. V. Rao, Principal Secretary, Deptt. of Sundarban Affairs, Govt. of W.B.	27.02.2016
5.	Shri Manturam Pakhira, Hon'ble MIC, Deptt. of Sundarban Affairs, Govt. of W.B	07.09.2015
6.	Shri Chandranath Sinha, Hon'ble MIC, Deptt. of Fisheries, Govt. of W.B	13.09.2015
7.	Dr. S. Ayyappan, Former Secretary (DARE) & DG (ICAR)	21.03.2016

Personnel

Director: Dr. K. K. Vijayan

Headquarters

Head of Divisions

Dr. C. Gopal, Crustacean Culture Division
Dr. G. Gopikrishna, Nutrition, Genetics & Biotechnology Division
Dr. S. V. Alavandi, Aquatic Animal Health & Environment Division

Principal Scientists

Dr. M. Natarajan (Retired on 31.07.2015)
Dr.K.V.Rajendran (Joined on13.05.2015 Transferredto CIFE Mumbai on 19.11.2015)
Dr. K. P. Jithendran
Dr. V. S. Chandrasekaran
Dr. T. Ravisankar
Dr. M. Muralidhar
Dr. (Mrs.) M. Jayanthi
Dr. (Mrs.) B. Shanthi
Dr. C. P. Balasubramanian
Dr. M. Kailasam
Dr. (Mrs.) D. Deboral Vimala
Dr. M. Shashi Shekhar
Dr. S. Kannappan
Dr. (Mrs.) P. Nila Rekha
Dr. K. Ambasankar
Dr. J. Syama Dayal
Dr. Akshya Panigrahi
Dr. M. Kumaran
Dr. (Mrs.) M. Poornima
Dr. (Mrs.) R. Saraswathy

Senior Scientists

Dr. Prasanna Kumar Patil
Dr. (Mrs.) Sherly Tomy
Dr. Subhendu Kumar Otta
Dr. M. Makesh (Joined on 29.04.2015)
Dr. K. P. Kumaraguru Vasagam
Dr. Satyanarayan Sethi
Dr. (Mrs.) P. Mahalakshmi

Scientist (Senior Scale)

Shri Ashok Kumar Jangam

Scientists

Dr. K. Vinay Kumar
Dr. R. Ananda Raja
Dr. (Mrs.) Krishna Sukumaran
Dr. (Mrs.) P. Ezhil Praveena
Dr. (Mrs.) P. S. Shyne Anand
Dr. (Mrs.) T. Bhuvaneswari
Dr. (Mrs.) N. Lalitha
Dr. P. Kumararaja
Dr. B. Sivamani
Dr. (Mrs.) Vidya Rajendran
Dr. Satheesha Avunje
Shri K. P. Sandeep
Mrs. M. U. Rekha (Joined on 09.04.2015)
Ms. Babita
Shri Aritra Bera
Shri T. Sathish Kumar

Chief Technical Officer

Shri R. Elankovan

Assistant Chief Technical Officers

Dr. S. Sivagnanam
Shri D. Raja Babu
Shri M. Shenbagakumar
Shri R. Puthiavan
Mrs. K. Jacquline

Senior Technical Officers

Shri Joseph Sahayarajan
Shri S. Stanline
Dr. A. Nagavel
Shri R. Subburaj
Shri S. Nagarajan
Shri S. Rajamanickam

Senior Technical Assistants

Shri N. Ramesh
Shri S. Saminathan
Shri N. Jagan Mohan Raj
Shri R. Balakumaran (Driver)
Shri D. M. Ramesh Babu
Shri G. Thiagarajan

Technical Assistants

Shri K. Paranthaman (Driver)
Shri K. Karaian

Senior Technician

Shri K. V. Delli Rao

Administrative Officer

Shri K. V. S. Satyanarayana (Joined on 15.10.2015 - Transferred from DPR, Hyderabad)

Finance & Accounts Officer

Shri Kunal Kalia (Relieved on 16.05.2015 - Transferred to ICAR, New Delhi)

Assistant Administrative Officers

Shri R. G. Ramesh
Shri R. Kandamani
Mrs. V. Usharani

Junior Accounts Officer

Mrs. K. Nandhini (Retired on 31.08.2015)
Shri P. Srikanth, (JAO promoted w.e.f. 01.09.2015)

Personal Assistants

Mrs. S. Nalini
Shri K. G. Gopala Krishna Murthy

Assistants

Shri S. Pari
Shri A. Manoharan
Mrs. E. Amudhavalli
Shri A. Sekar

Stenographer Gr. III

Mrs. K. Hemalatha
Mrs. K. Subhashini

Upper Division Clerks

Mrs. E. Mary Desouza
Shri P. Srikanth (upto 31.08.2015)
Mrs. R. Vetrichelvi

Lower Division Clerks

Mrs. M. Mathuramuthu Bala (Promoted as UDC on 07.11.2015)
Shri B. Palanivelmurugan
Mrs. B. Prasanna Devi
Shri R. Kumaresan
Shri A. Paul Peter

Skilled Support Staff

Shri M. Santhosam
Shri N. Harinathan (Retired on 31.10.2015)
Shri V. Jeevanandam
Shri K. Nithyanandam
Shri V. M. Dhanapal
Shri V. Kumar
Shri E. Manoharan
Shri C. Saravanan
Shri S. Kuppan
Shri M. Pichandi
Shri S. Selvababu
Shri D. Senthil Kumaran
Shri C. Ragu
Shri P. G. Samuvel
Shri M. Sakthivel
Shri R. Mathivanan
Shri R. Indra Kumar
Shri G. Dayalan
Shri Kanaka Prasad
Smt S. Premavathy
Shri J. Murugan

Kakdwip Research Centre

Principal Scientists

Dr. T. K. Ghoshal
Dr. Debasis De

Senior Scientist

Dr. Sanjoy Das

Scientists

Dr. Gouranga Biswas
Dr. Sujeet Kumar
Dr. Prem kumar
Ms. Christina Lalramchhani

Senior Technical Assistant

Shri P. S. Samanta

Technical Assistant

Mrs. Chanda Mazumder

Administrative Staff

Private Secretary

Shri S. K. Halder

Assistants

Shri S. K. Bindu

Skilled Support Staff

Shri N. N. Jana
Shri K. P. Naskar
Shri Purna Chandra Das
Mrs. L. R. Bhuiya
Shri Nayan Tara Dalui (Retired on 30.09.2015)

Redeployed Staff from PRC of CIBA, Puri to CIFA, Bhubaneswar

Technical Assistant

Shri P. C. Mohanty

Skilled Support Staff

Shri Premananda Bisoi
Shri Maharaga Majhi
Shri.U.K.Santra

Infrastructure Development

Headquarters

- Construction of laboratory building at Hqrs
- Construction of Aquaculture laboratory for climate change works over the existing health laboratory at Hqrs
- Construction of additional floor at Hqrs
- Repair and replacement of damaged carpeted flooring at Hqrs

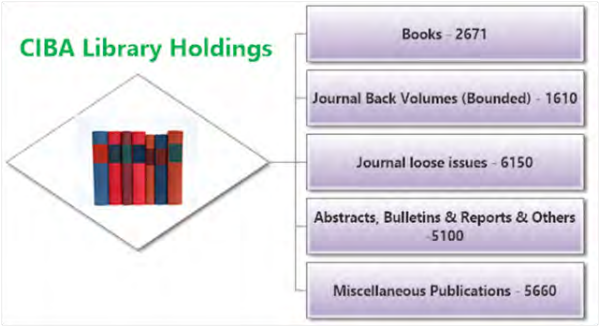
Muttukadu Experimental Station of CIBA

- Repair/Renovation of hatcheries and main building at MES of CIBA, Muttukadu
- Construction of Compound wall and Security room at MES of CIBA, Muttukadu.
- Concrete platform- wet laboratory with green water system at MES of CIBA, Muttukadu.
- Renovation of conference hall at MES of CIBA, Muttukadu
- Repair and renovation of the experimental pond for culture the grey mullet at MES of CIBA, Muttukadu
- Providing solar street lighting at MES of CIBA Muttukadu.
- Repair and Renovation of effluent treatment pond at MES of CIBA, Muttukadu
- Supply, installation, Testing & commission of 200 KVA and 75 KVA gen set for Shrimp hatchery and fish hatchery at Muttukadu

KRC CIBA

- Renovation of existing electrical supply to pumps, aerators, water supply systems including farm lighting etc. in sector- C of KRC of CIBA, Kakdwip.
- Construction of compound wall and fencing in C Sector at KRC of CIBA, Kakdwip
- Repair and replacement of electrical wirings in the farm area (Sector-A), providing transformer between A and B sector and electrical load distribution works in the office building at KRC of CIBA, Kakdwip
- Installation of (a) H.T.Oil Circuit Breaker/ Switchgear, (b) Transformer/ Switchgear/Meter room and (c) Transformer & H.T. Oil switch Meter & transformer room for enhancement of power load from 50 KVA to 200 KVA at KRC of CIBA, Kakdwip
- Construction of substation at KRC of CIBA, Kakdwip

Library and Documentation



Library new procurements and holdings

CIBA Library procured **21** ***new books*** including official language books during this period. Subscription to **9** ***Foreign journals (including online version) and*** **15** ***national journals*** including vernacular language journals for the headquarters and **15** ***national journals*** *for Kakdwip Research Centre* of CIBA were subscribed. The library holdings as on 31st March, 2016 is presented in the smart diagram.

On line access to the CIBA Subscribed & CeRA - journals and Document delivery service

For this year, 2015-16 CIBA- Library has made subscription to peer reviewed, high impact, core fisheries and aquaculture journals (both online & print version) which were not available through CeRA. The library has listed all the full content accessible online journals (for Fisheries & Aquaculture related journals) with their access links in CIBA web portal for the benefit of users of the library**.** The library also has supplied the photocopies of journal articles requested from various ICAR institutes, scientists and research scholars under CeRA-Document Delivery Request (DDR).

Exchange services

CIBA library maintained exchange relationship with national and international organizations working on fisheries and aquaculture on mutual interest. The library maintained the free mailing of institute's annual report and other institute publications to various research organizations, universities and other agencies to give greater to the institute research and development programmes.

Information services to the stakeholders

CIBA library acted as a reference library by providing access to the reference books and journals available in the library to the scientific personnel of other research organizations, academicians, university/college students, research scholars, stakeholders and other related visitors. The library provided reprographic service (Photocopying) to the users on nominal payment basis.

Utilization of funds

During this year a total of ***Rs. 20. 00 Lakhs*** under plan funds were utilized towards the renewal of subscription to journals and procurement of new books for Headquarters and KRC library of CIBA.

E-Learning Centre

As a new initiative in this year the Library Advisory Committee (LAC) has decided to establish a e-learning centre as a annexure in CIBA library. Under this initiative all the institute's (CIBA) publications and the individual scientist's publications will be digitalized and uploaded in the EPrints (open source software) and uploaded in the institute's local server for the benefit of the library users. Furthermore the "CIBA eprints" will linked to the international databases to facilitate visibility of CIBA research achievements across the globe.

RFD for CIBA (2014-2015)

Results-Framework Document (RFD)
for
Central Institute of Brackishwater Aquaculture
(2014-2015)
Address : 75, Santhome High Road, Raja Annamalaipuram,
Chennai-600028 (Tamil Nadu)
Website ID: http://www.ciba.res.in

Section 1:
Vision, Mission, Objectives and Functions

Vision

Environmentally sustainable, economically viable and socially acceptable brackishwater aquaculture, that increases the earnings of small scale fish farmers and provides quality produce to meet the diversified requirements of the consumers.

Mission

Further science to develop cost-effective technologies and facilitate growth of brackishwater aquaculture in an environmentally sustainable and socially acceptable manner.

Objectives

1. Enhancing production and productivity of brackishwater aquaculture systems

Functions

1. To develop economically viable and environmentally sustainable culture technologies for finfish and shellfish in brackishwater systems in different agro-ecological regions.
2. To meet emerging requirements of brackishwater aquaculture, carry out basic and strategic research.
3. To evaluate economically important brackishwater biological resources for their commercial utilization.
4. To provide policy and planning support for socio-economic development, through environmentally sustainable brackishwater aquaculture.
5. To undertake human resources development and transfer of technology programmes through training and extension and to provide consultancy service.

Section 2: Inter se priorities among Key Objectives, Success Indicators and Targets

S. No.	Objectives	Weight	Actions	Success Indicators	Unit	Weight	Target / Criteria Value				
							Excellent	Very Good	Good	Fair	Poor
							100%	90%	80%	70%	60%
1	Enhancing production and productivity of brackishwater aquaculture systems	80	Improvement of culture technologies for crustaceans & fin fishes	Explorations /surveys carried out	Number	15.00	19	16	13	10	7
				Field/on-farm trials conducted	Number	15.00	11	9	7	5	3
				Feed formulation developed for candidate species	Date	15.00	28.02.2015	07.03.2015	14.03.2015	21.03.2015	28.03.2015
				Methodologies, technologies and advisories developed	Number	10.00	6	5	4	3	2
			Technical and policy support to stakeholders	Awareness building through trainings and meetings	Number of trainees / participants	10.00	1320	1100	880	660	440
				Quality seed produced	Lakh	10.00	20	17	14	11	8
				Commercialization, consultancy, patents and copy rights	Number	5.00	4	3	2	1	0
2	*Publication/ Documentation	5	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	No.	3	31	26	21	16	11
			Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	2	30.06.2014	02.07.2014	04.07.2014	07.07.2014	09.07.2014
	*Fiscal resource management	2	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	92	90
	* Efficient Functioning of the RFD System	3	Timely submission of Draft RFD for 2014-2015 for Approval	On-time submission	Date	2	May 15, 2014	May 16, 2014	May 19, 2014	May 20, 2014	May 21, 2014
			Timely submission of Results for 2013-2014	On-time submission	Date	1	May 1 2014	May 2 2014	May 5 2014	May 6 2014	May 7 2014
	*Enhanced Transparency / Improved Service delivery of Ministry/ Department	3	Rating from Independent Audit of implementation of Citizens' / Clients' Charter (CCC)	Degree of implementation of commitments in CCC	%	2	100	95	90	85	80
			Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	1	100	95	90	85	80

S. No.	Objectives	Weight	Actions	Success Indicators	Unit	Weight	Target / Criteria Value				
							Excellent	Very Good	Good	Fair	Poor
							100%	90%	80%	70%	60%
1	Enhancing production and productivity of brackishwater aquaculture systems	80	Improvement of culture technologies for crustaceans & fin fishes	Explorations /surveys carried out	Number	15.00	19	16	13	10	7
				Field/on-farm trials conducted	Number	15.00	11	9	7	5	3
				Feed formulation developed for candidate species	Date	15.00	28.02.2015	07.03.2015	14.03.2015	21.03.2015	28.03.2015
				Methodologies, technologies and advisories developed	Number	10.00	6	5	4	3	2
			Technical and policy support to stakeholders	Awareness building through trainings and meetings	Number of trainees / participants	10.00	1320	1100	880	660	440
				Quality seed produced	Lakh	10.00	20	17	14	11	8
				Commercialization, consultancy, patents and copy rights	Number	5.00	4	3	2	1	0
2	*Publication/ Documentation	5	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	No.	3	31	26	21	16	11
			Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	2	30.06.2014	02.07.2014	04.07.2014	07.07.2014	09.07.2014
	*Fiscal resource management	2	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	92	90
	* Administrative Reforms	7	Update organizational strategy to align with revised priorities	Date	Date	2	Nov.1 2014	Nov.2 2014	Nov.3 2014	Nov.4 2014	Nov.5 2014
			Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of corruption (MSC)	% of implementation	%	1	100	90	80	70	60
			Implementation of agreed milestones for ISO 9001	% of implementation	%	2	100	95	90	85	80
			Implementation of milestones of approved Innovation Action Plans (IAPs)	% of implementation	%	2	100	90	80	70	60

Section 3: Trend Values of Success Indicators

S. No.	Objectives	Actions	Success Indicators	Unit	Actual Value for FY 2012-2013	Actual Value for FY 2013-2014	Target Value for FY 2014-2015	Projected Values for FY 2015-2016	Projected Values for FY 2016-2017
1	Enhancing production and productivity of brackishwater aquaculture systems	Improvement of culture technologies for crustaceans & fin fishes	Explorations /surveys carried out	Number	14	15	16	16	16
			Field/on-farm trials conducted	Number	6	7	9	9	9
			Feed formulation developed for candidate species	Number	-	-	07.03.2015	-	-
			Methodologies, technologies and advisories developed	Number	4	4	5	5	6
		Technical and policy support to stakeholders	Awareness building through trainings and meetings	Number of trainees/ participants	-	-	1100	1100	1100
			Quality seed produced	Lakh	20.7	15.45	17	17	17
			Commercialization, consultancy, patents and copy rights	Number	3	4	3	2	3
	*Publication/ Documentation	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	No.	-	-	26	-	-
		Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	-	-	02.07.2014	-	-
	*Fiscal resource management	Utilization of released plan fund	Plan fund utilized	%	-	-	96	-	-
	*Efficient Functioning of the RFD System	Timely submission of Draft RFD for 2014-2015 for Approval	On-time submission	Date	-	-	May 16, 2014	-	-
		Timely submission of Results for 2013-2014	On-time submission	Date	-	-	May 2, 2014	-	-

S. No.	Objectives	Actions	Success Indicators	Unit	Actual Value for FY 2012-2013	Actual Value for FY 2013-2014	Target Value for FY 2014-2015	Projected Values for FY 2015-2016	Projected Values for FY 2016-2017
1	Enhancing production and productivity of brackishwater aquaculture systems	Improvement of culture technologies for crustaceans & fin fishes	Explorations /surveys carried out	Number	14	15	16	16	16
			Field/on-farm trials conducted	Number	6	7	9	9	9
			Feed formulation developed for candidate species	Number	-	-	07.03.2015	-	-
			Methodologies, technologies and advisories developed	Number	4	4	5	5	6
		Technical and policy support to stakeholders	Awareness building through trainings and meetings	Number of trainees/ participants	-	-	1100	1100	1100
			Quality seed produced	Lakh	20.7	15.45	17	17	17
			Commercialization, consultancy, patents and copy rights	Number	3	4	3	2	3
	*Publication/ Documentation	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	No.	-	-	26	-	-
		Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	-	-	02.07.2014	-	-
	*Fiscal resource management	Utilization of released plan fund	Plan fund utilized	%	-	-	96	-	-
	*Enhanced Transparency / Improved Service delivery of Ministry/Department	Rating from Independent Audit of implementation of Citizens' / Clients' Charter (CCC)	Degree of implementation of commitments in CCC	%	-	-	95	-	-
		Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	-	-	95	-	-

Section 4 (a): Acronyms

S.No	Acronym	Description
1	BMP	Better Management Practices
2	CAA	Coastal Aquaculture Authority
3	KVK	Krishi Vigyan Kendra
4	MPEDA	Marine Product Export Development Authority
5	NFDB	National Fisheries Development Board
6	PPP	Public Private Partnership
7	SPF	Specific Pathogen Free
8	MoU	Memorandum of Understanding
9	GIS	Geographic Information System

Section 4 (b): Description and definition of success indicators and proposed measurement methodology

S.No.	Success Indicator	Description	Definition	Measurement	General Comments
1	Explorations/surveys carried out	This indicator includes genetic studies (numbers of locations), social science surveys, disease surveillance surveys, environmental impact assessment and monitoring surveys (including GIS), explorations made for samples collection in ingredient availability survey for feed formulations etc.	An effort made in an area for collecting live/frozen samples for genetic studies is defined as an exploration. A data collection effort to understand socio-economic status or to document impact of technologies is defined as social science survey. A sample collection survey in an area for screening diseases is defined as disease surveillance survey. A sample collection survey in source water bodies and discharge water from farms to monitor impact of aquaculture on environment and vice-versa including GIS is defined as environmental monitoring survey. A survey made in an area for new ingredients for aqua-feed formulations is defined as ingredient availability survey.	Number	This activity is pre-requisite for several research programs.
2	Field / on-farm trials conducted	This indicator Includes grow out trails and products testing trails at institute and farmers' fields for candidate species, Asian seabass, Tiger shrimp, Indian white shrimp, Pacific white shrimp, Grey mullet, Pearlspot, Banana shrimp, Milk fish, Cobia, ornamental fishes etc.	Any culture activity at station or field to demonstrate in-house technologies and products is defined as a On-farm or field trial.	Number	This activity is essential for refinement/verification and validation of hatchery and culture technology and newly developed products.
3	Feed formulation developed for candidate species	This includes new feed formulations developed for candidate species	Any feed developed with a new formulation and tested for use in aquaculture is defined as a new feed formulation.	Number	This activity is an integral part of development of culture technology for candidate species of brackishwater aquaculture.

4	Methodologies, technologies and advisories developed	New methodologies, technologies, scientific advisories or any other significant output that lead to improvement of culture technology for candidate species or more scientific understanding would be reported under this indicator.	A new process or approach developed to breed candidate species or to produce seed from candidate species; databases developed for stakeholders; technologies for genetical improvement and culture to enhance production/productivity of candidate species; for better diagnose/prevent/control measures developed for concerned diseases; documentation of interventions for upliftment of socio-economic status of farmers, and impact of brackishwater aquaculture on environment/climate and vice-versa would be covered as methodology or technology or scientific advisory.	Number	This is a continuous process leading to improvement of overall development of brackishwater aquaculture.
5	Awareness building through trainings and meetings	Exposure to stakeholders through training and interactions (farmers meets/stakeholder meets/workshops/ symposia/exhibitions etc.) is covered under this indicator.	Number of trainees/participants from training programs/Scientists-farmers interaction meetings, workshop/symposia/exhibitions etc. would be covered.	Number	This activity is to create awareness and train stakeholders on various aspects of brackishwater aquaculture.
6	Quality seed produced	Quantum of quality seed produced for aquaculture species.	Actual number of quality seed produced.	Number (in lakhs)	To make quality seed available to farmers, and for own research trials.

Section 5: Specific performance requirements from other departments that are critical for delivering agreed results

Location Type	State	Organization Type	Organization Name	Relevant Success Indicator	What is your requirement from this organization	Justification for this requirement	Please quantify your requirement from this organization	What happens if your requirements is not met
Across country	Coastal states	Department	CAA/NFDB/MPEDA/ All State Depts. of Fisheries	Awareness building through trainings and meetings	Nomination of officials (200 persons in 2014-15)	Nominations for different training programmes	200 trainees need to be nominated	Trainees trained-number will come down
Across country	All	Private & Department	Private entrepreneurs & Patent office	Commercialization, consultancy, patents and copy rights	Co-operation for speedy clearance of MoUs and applications	Speedy clearance of MoUs and applications	Speedy clearance	The achievements may come down

Section 6: Outcome / Impact of activities of Department/Ministry

S. No.	Outcome/ Impact	Jointly responsible for influencing this outcome/impact with the following organization (s)/ department(s)/ministry(ies)/	Success indicator(s)	Unit	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
1	Increased production of farmed shrimps through BMPs/SPF seeds	MPEDA/ State Depts. of Fisheries/ NFDB	National shrimp production	Ton (in lakh)	2.5	2.6	2.8	3.0	3.0
2	Cost effective shrimp farming through low cost feeds/other inputs	PPP (E.g.)CIBA feed @ Rs 5 less / kg of feed	Reduction in cost of production	Rs. (in lakh)	110	120	120	120	120
3	Human resource development	NFDB, State Depts. of Fisheries, KVKs and Private sector	Trainees / Participants	No.	1342*	1292*	1100	1100	1100

Annual (April 1, 2014 to March 31, 2015) Performance Evaluation Report in respect of RFD 2014-2015 of RSCs i.e. Institutes

Name of the Division: Fisheries Science

Name of the Institution: ICAR - Central Institute of Brackishwater Aquaculture

RFD Nodal Officer of the RSC: Dr. M. Muralidhar

S. No.	Objective(s)	Weight	Action(s)	Success Indicator(s)	Unit	Weight	Target / Criteria Value					Achievements	Performance		Percent achievements against Target values of 90% Col.
							Excellent 100%	Very Good 90%	Good80%	Fair 70%	Poor 60%		Raw Score	Weighted Score	
1	Enhancing production and productivity of brackishwater aquaculture systems	80	Improvement of culture technologies for crustaceans & fin fishes	Explorations / surveys carried out	Number	15.00	19	16	13	10	7	20	100	15	125.0
				Field/on-farm trials conducted	Number	15.00	11	9	7	5	3	12	100	15	133.3
				Feed formulation developed for candidate species	Date	15.00	28.02. 2015	07.03.2015	14.03.2015	21.03.2015	28.03.2015	30.09. 2014	100	15	-
				Methodologies, technologies and advisories developed	Number	10.00	6	5	4	3	2	6	100	10	120.0
			Technical and policy support to stakeholders	Awareness building through trainings and meetings	Number of trainees / participants	10.00	1320	1100	880	660	440	1863	100	10	169.4
				Quality seed produced	Lakh	10.00	20	17	14	11	8	28.05	100	10	165.0
				Commercialization, consultancy, patents and copy rights	Number	5.00	4	3	2	1	0	8	100	5	266.7

2	*Publication/ Documentation	5	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	No.	3	31	26	21	16	11	32	100	3	123.1
			Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	2	30.06.2014	02.07.2014	04.07.2014	07.07.2014	09.07.2014	27.06.2014	100	2	-
	*Fiscal re-source man-agement	2	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	92	90	99.97	100	2	-
	* Efficient Functioning of the RFD System	3	Timely submission of Draft RFD for 2014-2015 for Approval	On-time submis-sion	Date	2	May 15, 2014	May 16, 2014	May 19, 2014	May 20, 2014	May 21, 2014	28.04.2014	100	2	-
			Timely submission of Results for 2013-2014	On-time submis-sion	Date	1	May 1 2014	May 2 2014	May 5 2014	May 6 2014	May 7 2014	16.04.2014	100	1	-
	*Enhanced Transparency / Improved Service delivery of Ministry/ Department	3	Rating from Independent Audit of implementation of Citizens' / Clients' Charter (CCC)	Degree of im-plementation of commitments in CCC	%	2	100	95	90	85	80	100	100	2	-
			Independent Audit of implementation of Griev-ance Redress Management (GRM) system	Degree of success in implementing GRM	%	1	100	95	90	85	80	100	100	1	-
	* Administrative Reforms	7	Update organizational strat-egy to align with revised priorities	Date	Date	2	Nov.1 2014	Nov.2 2014	Nov.3 2014	Nov.4 2014	Nov.5 2014	29.10.2014	100	2	-
			Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of corruption (MSC)	% of implemen-tation	%	1	100	90	80	70	60	100	100	1	-
			Implementation of agreed milestones for ISO 9001	% of implemen-tation	%	2	100	95	90	85	80	100	100	2	-
			Implementation of mile-stones of approved Innova-tion Action Plans (IAPs)	% of implemen-tation	%	2	100	90	80	70	60	100	100	2	-

Total Composite Score: 100.00

Rating: Excellent

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 1987, 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, Sundarban, in West Bengal.

An entrepreneur cheerfully holding a bag of hatchery produced milkfish seeds during the event of seed release

Back Cover : Farm raised milkfish in farmer's hand

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"Brackishwater aquaculture for food, employment and prosperity"

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