ANNUAL REPORT

2009 - 2010

CENTRAL INSTITUTE OF FRESHWATER AQUACULTURE
(Indian Council of Agricultural Research)
KAUSALYAGANGA, BHUBANESWAR 751 002, ORISSA, INDIA

CREDIT LINE

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PREFACE

Greetings from Team CIFA!

The year 2009-2010 has been a momentous one for the CIFA family. At the ICAR HQ, Dr. S. Ayyappan assumed charge as the new Secretary of DARE and the Director General of ICAR on January 1, 2010. His appointment is a very special event to the CIFA family – not only because this is the first time a fisheries scientist has been selected for this coveted position, but more importantly, Dr. S Ayyappan began his ARS career at CIFA. He rose up to the position of the Director of CIFA in 1996. He steered the course of CIFA until June 2000 before moving on to CIFE as its Director and then to the ICAR HQ as DDG (F). We at CIFA join the entire ICAR fraternity in welcoming the new DG and Secretary and look forward to his leadership and guidance in renewing our commitment to the cause of agriculture research for development.

The year also marked the strengthening of our partnership with the National Fisheries Development Board (NFDB), a number of State Departments of Fisheries, North East Region, various development agencies, our sister institutions in the ICAR system and NGOs. This renewal of relationships was the highlight during the National State Fisheries Ministers' Conference in July 2009 chaired by the Honorable Union Minister for Agriculture Shri Sharad Pawar and Union Minister of State for Agriculture Prof. K. V. Thomas. This important event was co-organized by the DAHDF, NFDB and CIFA. CIFA will soon develop roadmaps with NFDB to develop Best Management Practices for *Pangasius* culture, National carp broodstock upgradation, and establishing broodstock bank for giant freshwater prawn. With assistance from CIFA various State Departments of Fisheries have already initiated plans for wider dissemination of the genetically improved rohu – "Jayanti rohu".

After working for over a decade in the NER, CIFA has come to realize that the fisheries sector in the region suffers from a paradox of high potential for growth but registers low overall productivity leading to a huge gap in demand and supply of food fish in the region. The R & D efforts, over the years, appear to have been conducted in a fragmented and isolated manner. In an effort to bring together the scientists, research managers and development agencies on a common platform and to reinforce efforts towards a sustainable development of the fisheries and aquaculture in the NER, CIFA organized a workshop in Gangtok in March 2010. The main outcome was a unanimous agreement – the Gangtok Declaration 2010 – to establish a "Network for Sustainable Development of Fisheries and Aquaculture in North Eastern Region". Modalities for governance and R&D priorities are being worked out.

CIFA places on record its sincere gratitude and appreciation to the outgoing RAC (2007-2010) chaired by Dr. M. Narayanan Kutty for their guidance and support throughout their tenure. CIFA welcomes the new RAC (2010-2013) with Dr. Maniranjan Sinha as the Chairperson and Drs. Aparna Dixit, K M Shankar, Sher Ali, R. Paul Raj, V. V. Sugunan, P. Jayasankar and I as members. While commending the research, training and extension activities of the Institute, the new RAC have drawn our attention to new challenges. We commit ourselves to rising up to these challenges.

The team CIFA invites you to review our progress of activities in various divisions and disciplines during the year 2009-2010 described briefly in the following pages.

Ambekar E. Eknath, Ph.D.
Director

CONTENTS

EXECUTIVE SUMMARY

1.	Name & address of the Institute	Central Institute of Freshwater Aquaculture Kausalyaganga, Bhubaneswar 751 002 Orissa, India
	a) Headquarter	Kausalyaganga, Bhubaneswar 751 002 Orissa
	b) Regional Centres	i) Regional Research Centre Rahara Fish Farm, Rahara 743 186 West Bengal (Field Station at Kalyani A/5, Phase-III Santhalpara, Nadia Kalyani 741 235, West Bengal)
		ii) Regional Research Centre Hessarghatta Lake, Bangalore 560 089 Karnataka
		iii) Regional Research Centre Penamaluru Fish Seed Farm, Penamaluru Vijayawada 521 139, Andhra Pradesh
	c) KVK	Krishi Vigyan Kendra Kausalyaganga, Bhubaneswar 751 002 Orissa

2. Budget (2009-10)

a) Institute (Rs in lakhs)

Plan		Non-Plan	
Provision	Expenditure	Provision	Expenditure
550.00	550.00	1579.40	1574.02

b) External sources (Rs in lakhs)

Source	Amount
BTIS	1.94
ICAR/AP Cess	1.73
Pension & Gratuity	173.90
ICAR/APA/IPR/NFBSRA	26.05
ICAR National Fellow/Winter School	0.17
P Loans & Advances	7.00
Total	210.79

c) Revenue generated (2009-10) (Rs in lakhs)

Farm produce	5.39
Sale of fish and poultry	12.06
License fee/water charges	2.26
Analytical testing fee	0.06
Cost of tender forms	1.93
Services rendered	3.72
Training	1.64
Miscellaneous	13.14
Interest on loans and advances	7.03
Total:	47.23

3. Staff position (as on 31.3.2010)

Director	1
HoD	4
Principal Scientist	11
Senior Scientist	30
Scientist (SS)	3
Scientist	9
Technical Staff	52
Administrative Staff	37
Skilled Support Staff	118
Total	265

4. Research Projects

a) Institute-based : 16
b) Externally-funded : 19

5. Training programmes conducted

Level	No. of programmes	No. of participants
National	09	331
International	-	-

6. Human Resource development

a) No. of persons trained at national level : 09
b) No. of persons trained at international level : 02

7. Workshops organized

National : 08
International : 01

8. Participation in symposia/seminars/workshops, etc.

Level	No. of participants
National	38
International	03

9. Infrastructure development

- Renovation of the main office building and farm facilities
- Completion of third floor of Office-cum-laboratory building
- Completion of Post-Graduate hostel
- Development of unutilized 10 ha of swampy area into large sized ponds Facilities created for climate change experiment
- Laterite stone lining of experiment ponds (12 nos of 0.08 ha each)
- Construction of cemented cistern with water supply and shed nets
- Construction of hatchery shed and breeding tank

Renovation, modernization and maintenance

- Modernization of laboratories
- Renovation of farmers hostel
- Renovation of kitchen, bathroom and toilet of 120 residential quarters
- Maintenance of farm facilities, office building, aquarium, ATIC building at Headquarters and other facilities at the Regional Research Centres located at Bangalore, Vijayawada and Rahara

10. Salient Research Achievements

- Precocious gonadal maturity was attained in Indian major carps by the administration of a formulated agent named GONAFELF.
- In *Anabas testudineus,* increase in the number of males did not show any significant differences in the rate of fertilization.
- Induced breeding trials with *Horabagrus brachysoma* have indicated better fertilization and hatching rates when the female brood fishes were 3+ year classes. A low stocking density (10 nos./m^2) during fingerling rearing period was found desirable for optimum growth and survival.
- A total of 1350 advanced fry of *Puntius filamentosus* were produced from 6 breeding trials by hormone administration. Multiple breeding in captivity was achieved.
- Denisonii barb was found to be compatible with other barb species, such as filament barb, tiger barb and melon barb.
- Forty pairs of rosy barb were successfully bred in captivity and produced about 30000 advanced fry.
- Growth studies in a synthetic base population of giant freshwater prawn collected from three different geographical regions (Gujarat, Kerala and Odisha) showed significantly different performance of Kerala stock from other two.

- Phytoremediation potential of water hyacinth *Eichhornia crassipes* for the removal of Copper and Lead was demonstrated.
- The approach of CIFA towards aquaculture development of NE region has been revised. The strategy for aquaculture development in the region should be on progressive and participatory modes and as an initial step, a network of scientists of the region would be formed to carryout R&D activities.
- Rohu fingerlings may adapt to low ambient Oxygen levels and/or low Oxygen levels may not be the only factor causing mortality in seed rearing ponds.
- Cryopreservation technology can contribute significantly toward fish seed quality improvement and genetic up-gradation of stock. Further, transportation of 1-2 lakhs seed can be achieved with just 20 ml cryopreserved milt of carps.
- About 87% of the adopted farmers at Keonjhar and 82% at Kendrapara could achieve 2- $\geq$ 4 fold increase in production from carp polyculture. Average annual income of 87% of farmer at Keonjhar and 96% at Kendrapara increased by 2-$\geq$4 fold due to aquaculture technology dissemination.
- Under the programme of improved Rohu 'Jayanti', a total of 157 lakhs of spawn were produced and disseminated.
- Ten microsatellite loci in improved rohu could assign percentage of progeny of one family by 70% accuracy.
- Rohu β-actin promoter was cloned, sequenced and promoter/regulatory regions were identified and their functional activity checked.
- A total of 90 DNA barcode sequences for catla, rohu, mrigal, fimbriatus and bata were deposited in Gen Bank. Close genetic relationship between catla and fimbriatus as well as paraphyly within the genus *Labeo* were evident.
- Transcript level of HUFA-synthesizing enzyme delta 6-desaturase in rohu was highest in vitellogenic female followed by fingerling, juvenile and spawn. Of the two transcripts, the lower one was intense in fingerling and juvenile, but absent in the adults of both sexes.
- Spermatogonia transcription factor Plzf and Oct-4 in rohu were cloned, sequenced and submitted in GenBank. These genes are potentially useful to identify and characterize differentiated states of spermatogonial cells during in vitro propagation.
- Analysis of rohu brain and liver ESTs revealed 86% of non-redundant sequences and 4% normal sequences.
- Replacement of fish meal with plant ingredients did not influence the final EPA and DNA levels of catla, rohu and mrigal.
- Under controlled rearing system in an artificial photo-thermal regime, maturation in rohu brood stock was initiated during January and by the end of February, complete gonadal development was attained.
- Post feeding Oxygen consumption and Carbon-dioxide production as well as post-prandial Oxygen consumption rate were significantly higher in the improved (Jayanti) rohu in comparison with normal counterpart.
- Oil cakes such SOCs, TOC and MOC can be used as cheap source of plant protein to prepare farm made feeds for carp culture. Feed in pellet form certainly give better result than dough form.
- Using implant technique, primary culture from testis of mrigal was developed and cryopreserved.
- Due to argulosis an average loss of about Rs.21,000/ha/yr. has been estimated in India.
- Although rohu has higher super oxide production capacity, serum ceruloplasmin and antiprotease activity as compared to silver cap, but low level of alternative complement activity might be making the former more susceptible to argulosis
- Commercial grade lactic acid bacteria have pronounced probiotic effect on the growth and survival of rohu fingerlings when challenged with *Aeromonas hydrophila.*
- A total of 14 Toll-like receptors genes, 5 in carps, 3 in catfish and 6 in shark were identified. In rohu, TLR-3 and TLR-5 were found to be differently activated in response to their specific ligands.
- RNA-dependent RNA polymerase recombinant protein up-regulated immune relevant genes in white tail disease positive in *Macrobrachium rosenbergii.*
- FRP mini carp hatchery system is suitable for production of fish spawn up to 0.5million number in a single operation.
- Mitochondrial DNA sequencing has indicated high level of genetic homogeneity in Irrawaddy dolphin population of Chilika lagoon and their close genetic relatedness to their counterparts from Thailand.
- With consultancy from CIFA, the Amalgamated Plantation Pct. Ltd. (APPL), Assam has been able to produce 2.5 – 3.5 t/ha. of carps in their estates despite prevailing highly acidic soils.

INTRODUCTION

Mandate

With a view to give proper direction and attention to such areas of research that would enable development of freshwater resources to obtain increased yield per unit area, thereby leading to higher aquaculture production from the culturable/reclaimable ponds and tanks in the country, the following is the revised mandate of CIFA.

- To conduct basic, strategic and applied research in freshwater aquaculture;
- To enhance production efficiencies through incorporation of biotechnological tools;
- To undertake studies on diversification of aquaculture practices with reference to species and systems; and
- To provide training and consultancy services

Brief History

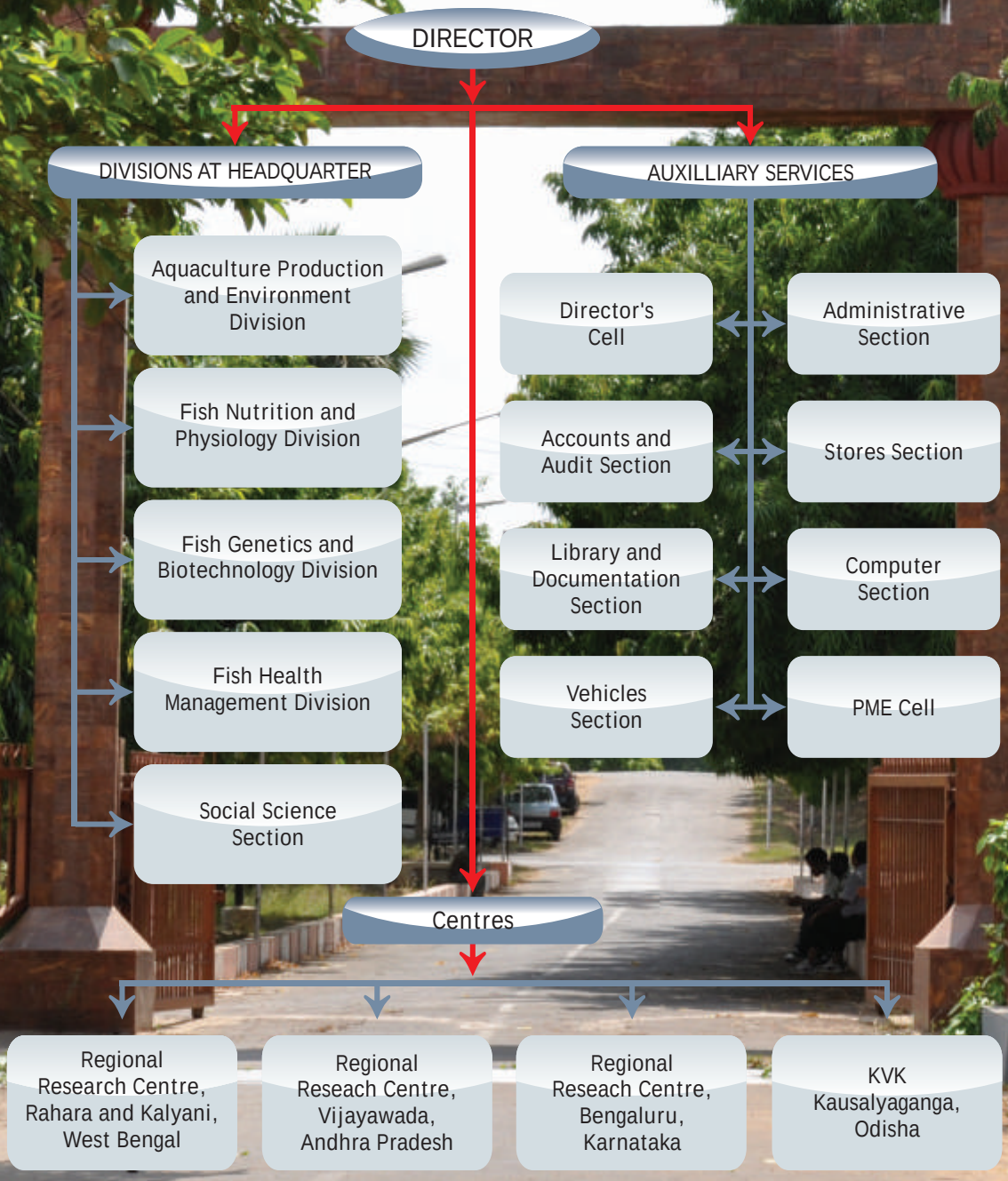
The Central Institute of Freshwater Aquaculture had its beginnings as the Pond Culture Division of the Central Inland Fisheries Research Institute, which was established at Cuttack, Orissa in 1949. The Division was later upgraded as the Freshwater Aquaculture Research and Training Centre (FARTC) established at Bhubaneswar in 1976 with UNDP/FAO assistance. Further, the Centre attained the status of an independent Institute under the organization plan of ICAR during 1986 and the functional existence of the Institute came into effect from 1st April, 1987.

The Institute has a comprehensive mandate of research, training, education and extension in different aspects of freshwater aquaculture. With the largest freshwater farm comprising over 380 ponds of assorted sizes and yard facilities in the country at Kausalyaganga, 10 km from the township of Bhubaneswar, the Institute is undertaking researches on carps, catfishes, freshwater prawns and molluscs. The Institute possesses fully equipped laboratories in the disciplines of finfish and shellfish breeding, aquatic chemistry, microbiology, fish physiology, nutrition, genetics, biotechnology, pathology, ornamental fish breeding and culture, engineering, economics, statistics and extension.

The Institute has three Regional Research Centres operating in different parts of the country to cater to the specific needs of the regions. These are: Regional Research Centre, Rahara (West Bengal), Regional Research Centre, Bangalore (Karnataka) and Regional Research Centre, Vijayawada (Andhra Pradesh).

The Institute is recognized as the Regional Lead Centre on Carp Farming under the Network of Aquaculture Centres in Asia-Pacific (NACA), which is now an intergovernmental organization. A Depository Library of the Food and Agricultural Organisation of the United Nations (FAO) is also operational at the Institute.

CIFA ORGANOGRAM



RESEARCH ACCOMPLISHMENTS

A. Aquaculture Production and Environment

Project Title	:	Derivation and characterization of fish embryonic stem cells
Project Code	:	E-42
Funding Agency	:	DBT
Duration	:	April 2008-March 2011
Project Personnel	:	P. Routray (PI), S.K. Swain, P.K. Meher and D. K. Verma

Derivation and characterization of embryonic stem (ES) cells of Indian major carp, *Catla catla* (Ham.)

Embryonic stem like cells were derived from mid-blastula stage embryos of *Catla catla* under feeder free condition and designated as CCES. The conditioned media was optimized with 10 % fetal bovine serum (FBS), fish embryo extract (FEE) having 100 µg/ml protein concentration, 15 ng/ml basic fibroblast growth factor (bFGF) and basic media containing Leibovitz-15, DMEM with 4.5 g/l glucose and Ham's F12 (LDF) in 2:1:1 ratio. Cells were attached on the gelatin-coated plates after 24 h of seeding and ES like colonies obtained at day 5 onwards. A stable cell culture was obtained after passage 15 and further maintained up to passage 44. These cells were characterized with their typical morphology, high alkaline phosphatase (AP) activity, positive expression of cell surface antigen SSEA-1, transcription factor Oct4 and germ cell marker vasa up to extended periods as shown in Fig.1. The undifferentiated state was confirmed by their ability to form embryoid bodies and differentiation potential. ES cells were also differentiated to beating cardiomyocytes and the same was comparable to the *in vitro* hearts (Fig. 2).

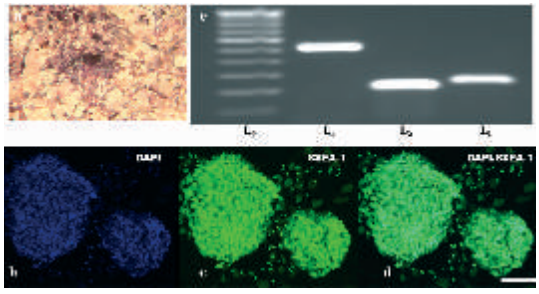


Fig.1 Characterization of CCES cells. (a) AP positive colony of catla ES cells at passage 30, (b,c,d) ES cell colonies under confocal microscopy labeled with DAPI and immunostained with SSEA-1 and DAPI/SSEA-1 respectively. (e) Reverse transcriptase (RT) PCR analysis for the presence of Vasa and Oct 4 m RNA in catla ES cells at passage 31. Lane '0': 100 bp marker, Lane 1: 517bp β-actin-positive control, Lane 2: 212 bp vlg and Lane 3: 248 bp Oct4 transcripts.

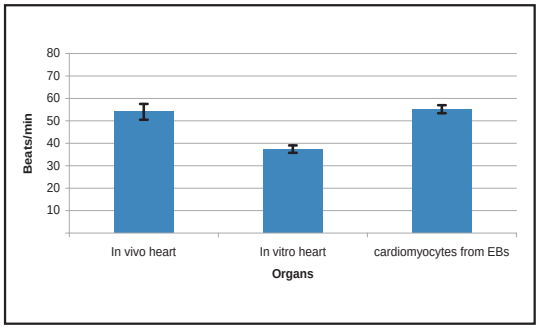


Fig.2 Comparative account of beat rates of *in vitro* cultured cardiomyocytes and in vivo heart of catla. Data expressed as mean ± SEM.

Transcription factor OCT 4 of catla was cloned to be utilized as a marker for ES cells in IMC

Primers were designed and a partial cDNA (248 bp) was amplified and cloned from ES cell RNA. The sequence showed 99 & 98% and 95 & 92% similarity in nucleotide and amino acid level with the Oct 4 homologue of *Danio rerio* and *Pagrus major* respectively. The sequence has been deposited in the NCBI GenBank (Accession No: GU289876).

Attainment of Precocious gonadal maturity in carps

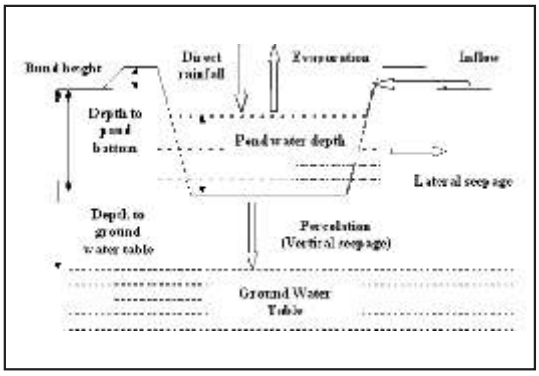
Precocious gonadal maturity was attained in Indian major carps by the administration of a formulated agent named GONAFELF

Precocious gonadal maturity was observed in carps by application of a formulated agent called GONAGEL-F. It has been observed that IMCs attained precocious maturity very early in the season by application of this product. This product has also been tested in Orissa State Fisheries Department and shown encouraging results. It is an established fact that attainment of maturity in catla is a major problem in aquaculture, but, the application of this product has achieved 30% more maturity in catla brood fish. This product was also tested in a farmers pond and successful maturity and spawning was reported.

Sub-project	:	Water budget modeling of freshwater fish pond under warm and humid climate
Project Code	:	I-54(c)
Funding Agency	:	Institute-based
Duration	:	April 2006 - March 2010
Project Personnel	:	K. K. Sharma (PI), B. C. Mohapatra, P. C. Das, S. Chand and B. Sarkar

Analysis of pond water budget indicated put during May and June, water requirement was 2-3 times higher due to seepage and evaporation losses

Water budget experiment was done in nine small ponds (size 25x18 m, depth 1.0 m) to study the hydrology of small ponds in CIFA farm. The selected ponds have high seepage rate due to higher elevation. The average monthly water budgets showed that in July and October, the losses from the ponds were compensated either from direct rainfall or ground water flow to the pond. The seepage and evaporation losses were very high during May and June and the water



requirement was calculated to be 2 to 3 times more as compared to other months. The pond evaporation varied from 2 to 6 mm per day during the period. Similarly seepage losses were between 1 to 12 mm per day. The total water requirement varied from nil to maximum 198 cubic metre per month per pond.

Sub-project	:	Farming of freshwater climbing perch, *Anabas testudineus* (Bloch) and development of technological package
Project Code	:	I-54(d)
Funding Agency	:	Institute-based
Duration	:	April 2006 – March 2010
Project Personnel	:	Kuldeep Kumar (PI), A. K. Sahu, Rajesh Kumar, U. L. Mohanty and B. Mishra

Breeding and seed production of *Anabas testudineus*

The breeding trials were taken up as early as second week of February, 2009 with two sets of *Anabas* successfully achieving fertilization of 34.0 and 51.65 %, respectively. During the normal breeding season, the fertilization was 64.0-71.9 % and hatching was 78-98.4%. The survival of larvae was very low during April and May 2009, attributed to high atmospheric temperature, which however, was usual from mid June with the onset of monsoon. It was observed that the increase in numbers of males during breeding did not show any significant difference in rate of fertilization.

Table 1 Details of breeding attributes of *Anabas*

Parameters	February, 2009	June, 2009	October, 2009
No. of females	3	11	4
Avg. size of females (g/cm)	60.0/14.3	31.7/ 12.5	57.3/ 13.9
No. of males	3	18	7
Avg. size of males (g/cm)	32.0/12.9	20.2/ 11.1	28.1/12.2
Dose of Ovaprim for females (µl/g)	1	1	1
Dose of Ovaprim for males (µl/g)	0.5	0.5	0.5
Water temp. (ºC)	24	29.0	24.0
Fertilization (%)	42.8	71.0	28.0
Hatching (%)	85	99	99

Multiple and prolonged breeding of *Anabas testudineus*

The success of multiple breeding with *Anabas* was again confirmed for the third consecutive year. Other than multiple trials, breeding could be prolonged up to the second week of October, during which the fertilization was only 55.4% with 88.1% of hatching. *Anabas* was bred during the second week of March 2010, which confirmed early breeding for the fourth consecutive year. The fertilization rate and hatching were 55% and 89%, respectively.

Effect of different formulated feeds on growth of *Anabas testudineus*

Experiment was carried out in 18 circular concrete tanks of 500 liters capacity, each containing 30 fish (201 g). Each of the six treatment group was fed with different supplementary diet. The treatment groups were T_1 (Rice polish-RP 50% & Groundnut oil cake -GNOC 50%), T_2 (RP 49%, GNOC 49% & Vitamin & mineral mix. 2%), T_3 (RP 25%, GNOC 40%, Fish meal 20% & Soybean meal 15%), T_4 (RP 23%, GNOC 40%, Fish meal 20%, Soybean meal 15% & Vitamin & mineral mix. 2%), T_5 (RP 35%, GNOC 40% & Soybean meal 25%), T_6 (RP 33%, GNOC 40%, Soybean meal 25% & Vitamin & mineral mix. 2%). The experiment was conducted for a period of 60 days. Feeding was given @ 3% of their body weight once in a day.

In *Anabas testudineus*, increase in the number of males did not show any significant differences in the rate of fertilization

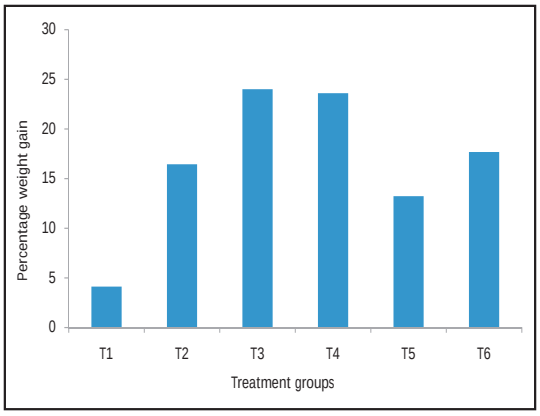


Fig.3 Effect of different formulated feeds on growth of *Anabas testudineus*

Growth was higher in T_3 (24.01%) and T_4 (23.60%) in comparison to other treatment groups, attributed to higher protein content and availability of animal protein (fish meal).

Culture of *Anabas* in concrete tanks

Anabas fingerlings were stocked at 1000 nos/tanks (67 fishes/m^2) (5.1 g/6.5 cm) during September 2008 to observe the efficacy of two different feeds on their growth. The fish fed with floating pellets have grown to a size of 23.48 g/8.93 cm while fish fed with floating pellets (85%) and fish meal (15%) grown to an average size of 24.42 g/9.68 cm, indicating no significant difference between the two treatments.

Cage culture

Four cages of size 6.75 m^2 were fabricated from locally available materials and were stocked with *Anabas* @ 350 fingerlings (11.73 g/8.58 cm) per cage. Fishes were fed with floating pellets @ 3% of their body weight. In five months of culture fish grew to an average size of 31.3 g/ 11.47 cm. The average production was 0.39 kg/m^2 with 66.66% of recovery. In another experiment, two cages were stocked with 200 fingerlings (5.6 g/6.5 cm) which grew to a size of 14.9 g/9.02 cm in a period of 3 months. The production was 0.30 kg/m^2 with 68.5% recovery.

Sub-project	:	Studies on Indian freshwater pearl mussel with reference to nacre formation
Project Code	:	I-54(f)
Funding Agency	:	Institute-based
Duration		April, 2006 – March, 2010
Project Personnel	:	Kuldeep Kumar (PI), S. Nandi, H. K. Barmal, Ashis Saha, Rajesh Kumar, and U. L. Mohanty

An attempt was made for reconstruction of a fresh SSH cDNA library for the implanted mantle epithelium of *Lamelidens marginalis* with minimum number of amplification in TOPO cloning vector. About 96 clones were sequenced, out of which 77 were readable. Among these sequences 25 showed BLAST(X) hit, 48 BLAST(N) hit and 4 with no BLAST(X) or BLAST(N) hit (noble sequences). Many of these BLAST(X) hits were similar to ribosomal proteins and some of them showed significant similarity with the sequences of *Hyriopsis cumingii* at the nucleotide level. All the 77 sequences resulted into 44 unique sequences that were submitted in NCBI database (Access no GR 881523- 66).

Sub-project	:	Characterization of growth pattern of diversified carp species under monoculture
Project Code	:	I-54(g)
Funding Agency	:	Institute-based
Duration		April 2007 - March 2010
Project Personnel	:	P. C. Das (PI), J. K. Jena and B. Mishra

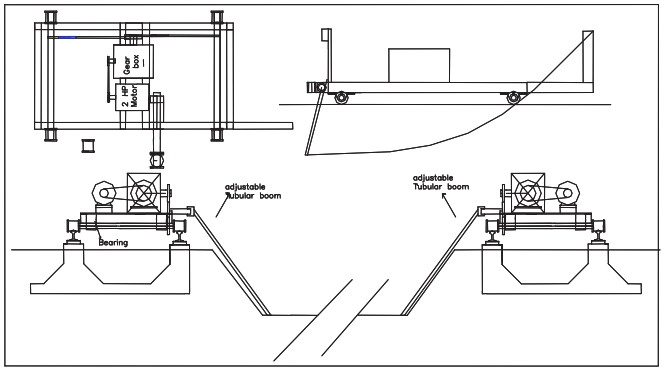
Grow-out performance of *Labeo rohita* in monoculture with varied intervals of nitrogen fertilization

A grow-out monoculture experiment for rohu, *Labeo rohita* was conducted for one year in nine earthen ponds of 0.04 ha each to study the impact of nitrogen fertilisation at varied intervals. Fingerlings were stocked at 8000 nos/ha. In the experiments conventional manuring and phosphatic fertilisation were followed. Nitrogen fertilisation was carried out at 15, 10 and 7 days intervals as the three treatments T-1, T-2 and T-3, respectively. Ponds with nitrogen fertilisation at 10 days intervals (T-2) showed prevalence of better water quality and low fluctuation of the critical water parameters such as pH, dissolved oxygen and inorganic nutrients compared to the other two treatments. Year round average plankton productivities in T-3 was higher while those in T-1 and T-2 did not differ significantly. Fish survival in T-2 was similar to T-3 and both were significantly higher than T-1. However, performance of fish in terms of average growth attainment and biomass yield was significantly higher in T-2 followed by T-3 and T-1. The study revealed that nitrogen fertilization at 10-day intervals is a better option over that at 7- or 15-days intervals in grow-out carp culture pond for maintaining good environmental condition and increasing fish production.

Sub-project	:	Design, development and performance evaluation of improved mechanized fish harvesting system for aquaculture pond
Project Code	:	I-54(i)
Funding Agency	:	Institute-based
Duration	:	April 2007 - March 2010
Project Personnel	:	K. K. Sharma (PI), S. Chand, B. Sarkar and S. K. Nayak

A motor-driven mechanical fish-netting device for a fishpond (size 50 x 20 m) has been designed, developed and installed in the Institute's fish farm. Further modification in the present system is being incorporated in the form of mechanical lifting device.

Techno-economic analysis of the system was made based on the assumed lifespan of 15 years for the device. Two man-hours are required in each operation. It is estimated that for manual netting of similar pond size, approximately 8.33 man-hours are required in single operation and thus total benefits may be derived in 10 years. The benefit cost ratio (B/C) was calculated to be 1.14. The pay back period, which is a powerful tool for success of any project or technology, is estimated to be 5.4 year.



Nitrogen fertilization at 10-day interval was found to be a better option than at 7- or 15 days intervals in grow out culture pond for maintaining good environmental condition and for increasing fish production

Sub-project	:	Mass seed production and grow-out culture of diversified catfishes: *Pangasius pangasius* and *Horabagrus brachysoma*
Project Code	:	I-54(j)
Funding Agency	:	Institute-based
Duration	:	April 2007 – March 2010
Project Personnel	:	S.K. Sahoo (PI), A. K. Sahu, S.S. Giri and S. Chandra

Induced breeding and seed rearing of *Pangasius pangasius*

Induced breeding of Pangas was attempted employing 1.0-2.5 kg female and 1.2-1.5 kg male. The female broods were injected with 1.0-3.5 ml GnRH based hormone either in single or two split doses per kg body weight. The time taken for response to stripping for females injected with 1 ml (single dose) and up to 3.5 ml/kg body weight in split doses were 16 and 20-23 h, respectively. The ovulation rate, fertilization and hatching rate were also reduced in higher dose injected females. This might be due to severe stress due to multiple injections to females. The fertilization and hatching ranged from 25-63% and 9-50%, respectively.

Induced breeding trials with *Horabagrus brachysoma* have indicated better fertilization and hatching rates when the female brood fishes were 3+ year classes. A low stocking density (10 nos./m^2) during fingerling rearing period was found desirable for optimum growth and survival

Pangas juvenile raising trial was undertaken by stocking fingerlings (3.9 g) at different densities (5, 10 and 15/m^2). After eight months of rearing the fishes grew to average size of 73, 60 and 58 g at density of 5, 10 and 15/m^2, respectively. The average rate of survival in all the trials was more than 90%. Higher growth and survival even at higher density of 15/m^2 indicated the feasibility of increasing the stocking density further during juveniles rearing.

Induced breeding and seed rearing of *H. brachysoma*

Induced breeding trials were undertaken employing *H. brachysoma* females of average weight of 59, 75 and 91 g, which were 2+, 3+ and 4+ year old, respectively. The females were administered 1-1.5 ml per kg body weight and stripped after 12-13 h. It was observed that 50% females of 2+ year group only responded to stripping, whereas 70-80% response was observed in 3+ and 4+ years old females. The fertilization and hatching did not vary much, which ranged 66-77% and 58-67%, respectively. The results indicated advantages of 3+ year females to avoid breeding failure.

A trial was undertaken by stocking 0.3 g fingerling at 10, 20 and 30/m^2 to evaluate the growth and survival during fingerlings production. The resultant sizes after six months rearing were 15, 11 and 8 g respectively. However, the survival was not affected among the three densities, which was >80%. The study recommends lower stocking density of 10 nos/m^2 during fingerlings rearing for optimum growth and survival.

Sub-project	:	Breeding and culture of *Rhinomugil corsula* (Ham.) and its incorporation in polyculture
Project Code	:	I-54(k)
Funding Agency	:	Institute-based
Duration	:	April 2007 – March 2010
Project Personnel	:	Radheyshyam (PI)

Polyculture of *R. corsula* with prawns in stone-lined ponds

Study was carried out in stone lined ponds (10 x 8 m) with 1 m water depth stocked with *R. corsula* fingerlings of 2.95±0.16 g @ 7,500/ha. *M.*

malcolmsonii juveniles of 0.2±0.03 g were stocked @ 25,000/ha. While GOC + wheat bran was provided in suspended baskets @ 5-10% of the body weight as fed for *R. corsula*, commercial prawn feeds was broadcasted in the marginal area of the tank as feed for prawn. In 9 month rearing, the R. *corsula* grew to 113.1±21.44 g and *M. malcolmsonii* 8.16±1.82 g.

Polyculture of *R. corsula* in village pond

Polyculture of *R. corsula* was carried out in two village ponds with carps stocked @ 1,000/ha with the stocking size of 3.13±0.38 g in pond-I and stocked @ 2,000/ha with the stocking size of 3.13±0.38 in pond-II. In both the ponds carp fingerlings of *L. rohita*, *C. catla* and *C. mirgala* were stocked in the ratio of 1:1:1 @ 4,000/ha. After 9 months of rearing the final weight of *R. corsula* was 132.88±18.57 g in Pond-I and 93.81±10.95 g in Pond-II.

Food and feeding habit of *R. corsula*

Specimens of 18-310 g were collected from village ponds and the gut contents were analyzed, which showed 33.94% detritus, mud and sand; 28.65% decayed organic matters, 27.69% phytoplankton, 6.18% zooplankton and 3.55% benthic organisms, indicating omnivorous feeding behavior of *R. corsula*.

Brood stock development

R. corsula of 100-150 g (1 yr+) were collected from village ponds and reared for brood stock development in stone lined tanks. Fish were fed with GOC and wheat bran daily.

Sub-project	:	Development of breeding protocols and larval rearing of Indigenous species *Puntius filamentosus* and *Puntius denisonii*
Project Code	:	I-54(m)
Funding Agency	:	Institute-based
Duration	:	April 2008 – March 2012
Project Personnel	:	S. K. Swain (PI), K. D. Mahapatra, P. Swain, Shailesh Saurabh and Rajesh N. (from Jan 2010)

Breeding of *Puntius filamentosus*

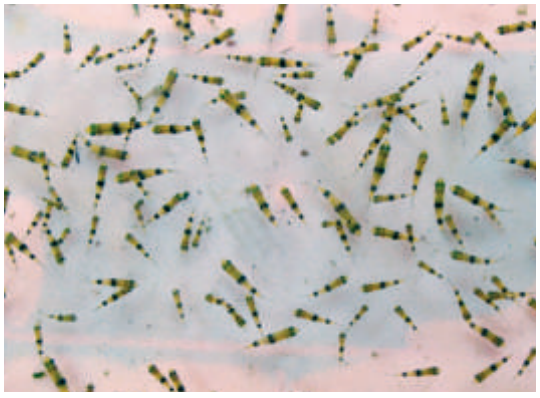
Brood stocks of *P. fillamentosus* (13-28 g) were collected from the rearing tank and males and females were kept separately under the shade net facility. Six breeding trials were made at different months (March, June, August and September) by inducing hormone, Ovaprim at a dose of 25 µl/fish. Breeding was carried out in breeding hapa, simulating natural environment, where the male-female ratio was kept at 3:2. The latency period

A total of 1350 advanced fry of *Puntius filamentosus* were produced from 6 breeding trials by hormone administration

was 60-70 h and hatching period was 72 h. All together 1350 advanced fry were produced from the breeding trials in a period of three months.

Multiple breeding of Filament barb with hormone induction

Multiple breeding trial of *P. filamentosus* (14.5-24.5 g, 9.85-11.25 mm) was undertaken under shade net facility at water and air temp 27.1 and 31.2^{0}C respectively. A single pair could be bred three times in a year. Eggs were non-adhesive in nature. The latency period were found to be 65 and 72 h respectively. Two vertical bands appeared after 10 days of rearing and vanished after 3 months of rearing. The posterior band found to concentrate at the caudal peduncle region as a large patch. Tips of bifurcated caudal fin showed



black and red colour looks and were more attractive when they are 3 months old. All together 160 advanced fry of 10-15 mm was recovered from the breeding trials after two months.

Forty pairs of rosy barb were successfully bred in captivity and produced about 30000 advanced fry

Effect of different live food on growth and survival of filament barb fry

A 45 day feeding trial was conducted to evaluate the effect of live foods on growth and survival of filament barb fry (121.93 mg/28.8 mm). Fry fed with cultured tubifex worms and plankton resulted significantly higher growth compared to fry fed control diet and live artemia nauplii.

Performance of *P. filamentosus* under different environmental conditions

Two hundred numbers of *Puntius filamentosus* with an average weight of 0.12 g was stocked in 1 sq. meter tank having 2 feet water depth in duplicate under green shade net (85%) and indoor rearing tanks to observe the growth and survival under the same feeding condition, with the floating carp feed. The growth was significantly higher (0.88 g) in shade net condition compared to in indoor rearing tank (0.66 g). The survival in shade net condition was also higher (90%) compared to indoor condition (76%) attributed to availability of phytoplankton and periphyton in the former.

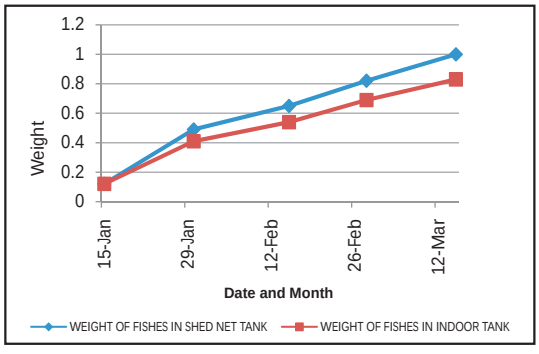


Fig.4 Growth curve of *puntius filamentosus*

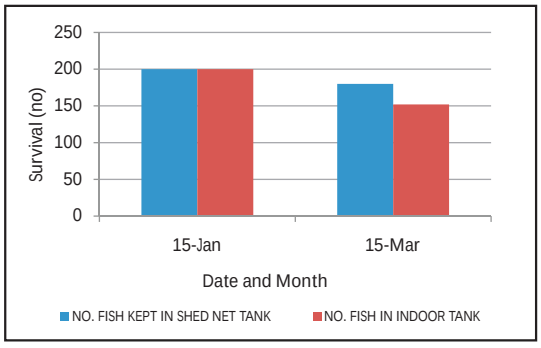
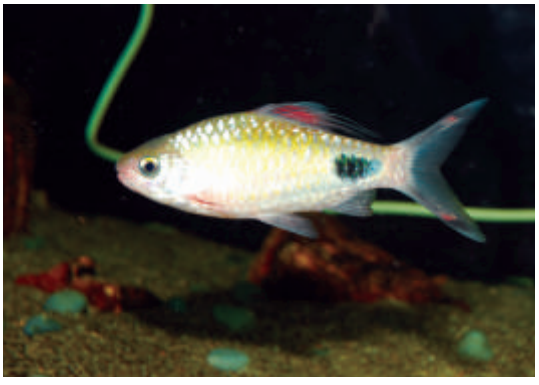


Fig.5 Survival of *puntius filamentosus* fry under different environmental conditions

Compatibility study of the denisonii barb

Denisonii barb was stocked along with filament barb, tiger barb and melon barb in different aquaria under usual rearing conditions and their compatibility was evaluated. Denisonii barb was observed to be compatible with the other barbs and did not show any abnormal behavior during four months experimental period.

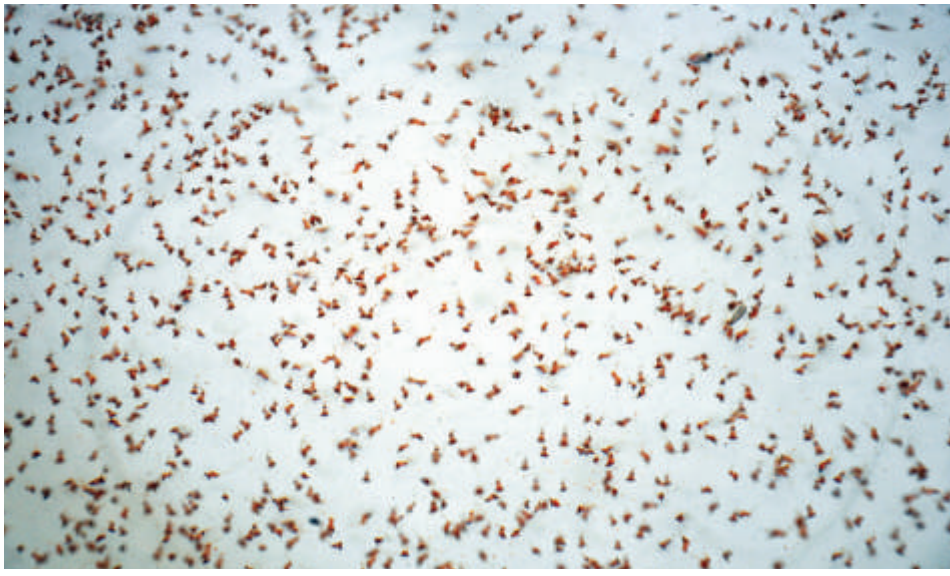


Project Title	:	Genetic improvement of freshwater prawn, *Macrobrachium rosenbergii* (de Man) in India
Project Code	:	E-40
Funding Agency	:	World Fish Centre, Malaysia
Duration	:	April 2007 – April 2009 (extended upto July 2010)
Project Personnel	:	Bindu R. Pillai (PI), K. D. Mahapatra, S. C. Rath, Lopamudra Sahoo, Lalrin Sanga and S. Sahu

Establishment of synthetic base population of *Macrobrachium rosenbergii* for selective breeding

A synthetic base population was established using a complete diallel cross design involving three populations of *Macrobrachium rosenbergii* collected from three locations in India (Gujarat, Kerala and Orissa) that represent different agro-ecological regions and are geographically distant from each other.

Denisonii barb was found to be compatible with other barb species, such as filament barb, tiger barb and melon barb



Due to the difference in the size groups of the three stocks they did not respond simultaneously. Hence, the crossing was undertaken in phase manner. The total larvae from 84 full-sib families were reared for 4-6 weeks in brackishwater (10‰) and the post-larvae from these full-sib families were reared in nylon hapas in freshwater (earthen ponds) until they attained taggable size. The prawn juveniles from 60 full-sib families representing all the nine possible crosses were then tagged individually with visible implant alpha numeric tag VIA (standard size format 1.0 x 2.5 mm) as well as with visible implant elastomer (VIE) tag as a batch tag (nine codes for the nine crosses). A total of 2233 prawn juveniles from 30 full-sib families (80 juveniles from each family) representing all the nine crosses of the three stocks were tagged in the first-phase and stocked for communal rearing. In the second batch, 2537

Growth studies in a synthetic base population of giant freshwater prawn collected from three different geographical regions (Gujarat, Kerala and Orissa) showed significantly different performance of Kerala stock from other two

juveniles from 30 full-sib families were tagged and stocked for communal rearing. Communal rearing of first batch juveniles were carried out in two well-prepared 400 m^2 earthen ponds during September 2008 to February 2009 and communal rearing of second batch juveniles were carried out in another two earthen ponds (0.04 ha) during January to April 2009. Stocking density employed was 3 nos/m^2.

First batch juveniles were harvested for final data collection during first week of February. All the survived prawns were collected, sexed, measured individually (total length, carapace length, standard length, wet weight). Males were categorised according to their morphological appearance into Blue Claw males (BC), Orange Claw males (OC) and Small males (SM). Females were grouped into immature, maturing, fully mature, berried females and spent females. Presence and absence of VIA and VIE tags were also noted. Prawns with readable VIA tags were retagged with large format VIA tag. Second batch juveniles were harvested during second week of April 2009.

In the first batch of rearing the survival rate of juveniles ranged from 81.4 to 85.1% after 120-135 days. Retention of VIA tag ranged from 69.8 to 71.4% and that of VIE tag ranged from 91.7 to 96%. Readability of VIA tag ranged from 81.5 to 82.9%. In the second batch of rearing the survival rate ranged from 84.3 to 86.7% after 120-125 days. Retention of VIA tag ranged from 89.4 to 90.4% and that of VIE tag ranged from 95.2 to 97.4%. Readability of VIA tag ranged from 87.6 to 89.2%.

Data analysis revealed significant sex and age effect and non-significant pond effect in harvest weight. Kerala stock was found to be significantly different from Orissa and Gujarat stock. Non-significant total heterosis effect was observed for different measurable parameters. A synthetic base population was established and from the higher ranked individuals breeders for the first generation was selected.

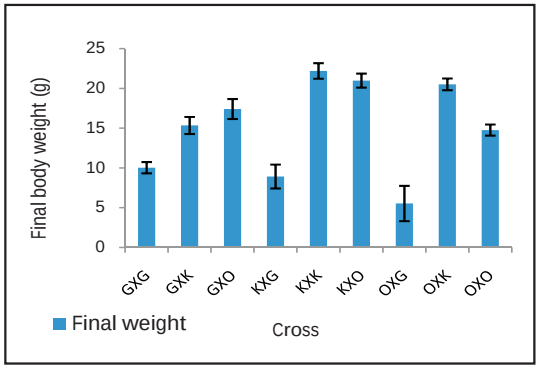


Fig.6 Least square means and standard errors for body weight (g) for nine crosses after pond, sex and age effect adjustments. GXG (Gujarat x Gujarat) GXK (Gujarat x Kerala) GxO (Gujarat x Orissa) KXG (Kerala x Gujarat) KXK (Kerala x Kerala) KXO (Kerala x Orissa) OXG (Orissa x Gujarat) OXK (Orissa x Kerala) OXO (Orissa x Orissa).

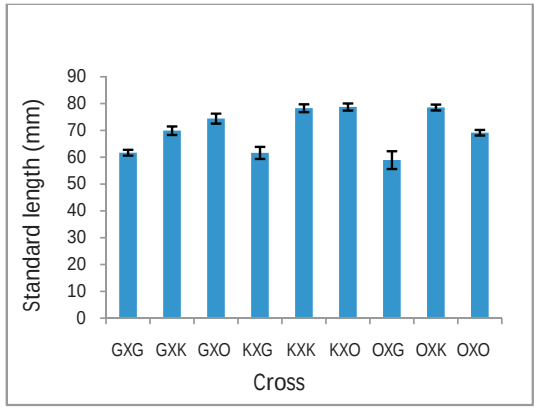


Fig.7 Least square means and standard errors for standard length (mm) for nine crosses after pond, sex and age effect adjustments. GXG (Gujarat x Gujarat) GXK (Gujarat x Kerala) GxO (Gujarat x Orissa) KXG (Kerala x Gujarat) KXK (Kerala x Kerala) KXO (Kerala x Orissa) OXG (Orissa x Gujarat) OXK (Orissa x Kerala) OXO (Orissa x Orissa).

Production of Generation 1 (G1)

Breeding of selected individuals for the production of generation 1 was carried out in two batches. In the first batch a total of 28 males and 95 females were selected for mating based on breeding value and stocked in mating hapas at 1:3 or 1:4 sex ratio. Fifty-three full-sib larval families were produced, out of which 8 were lost due to bacterial diseases. Larval rearing of forty five batches was successfully completed and post-larvae were collected from these for further growth. Post-larvae from all the forty-five full-sib families were reared up to taggable size in nylon hapas. A total 3488 juveniles from 45 full-sib families were tagged individually with VIA tag and stocked in three communal grow-out ponds.

In the second batch 34 males and 99 females were selected for mating in September 2009. Fifty-five berried females were collected and out of which 38 completed the embryonic development and released larvae. Larval rearing of 38 full-sib families was carried out during November–December 2009. Larval rearing of 32 families was successfully completed and post-larvae were collected from these for further rearing. Post-larvae from 32 full-sib families were grown to taggable sized juveniles in nylon hapas. A total of 1838 juveniles from 32 full-sib families were tagged individually with VIA tag and stocked in two communal grow-out ponds.

Grow-out of G1 individuals

Three 400 m^2 earthen ponds were prepared for stocking the first batch of tagged juveniles. All the ponds are provided with aeration connection from an air blower. The tagged prawns were stocked at 3/m^2 during November 2009. The prawns are fed with commercial prawn pellet feed at 10% of the biomass per day. The water level is maintained at 1 m loss due to evaporation and seepage was compensated regularly. Important water quality parameters such as pH, dissolved oxygen, ammonia nitrogen are being monitored at weekly intervals.

Project Title	:	Impact of aquaculture on environment
Project code	:	I-67
Funding Agency	:	Institute-based
Duration	:	April 2009 – March 2012
Project Personnel	:	S. Adhikari (PI), A. E. Eknath, J. K. Jena, K. C. Pani and B. S. Giri

Assessment of soil and water quality of intensive fish ponds

The ammonium nitrogen in water of some intensive fishponds of Kolleru Lake area ranged between 0.22 to 3.2 mg/l while nitrate nitrogen varied between 0.25 to 2.5 mg/l. The nitrite nitrogen varied from 0.02 to 0.65 mg/l while albuminoidal nitrogen ranged from 0.12 to 2.0 mg/l. The phosphate phosphorus contents varied from 0.21 to 3.0 mg/l. Dissolved organic matter showed a variation from 2 to 17 mg/l while the potassium content of the pond water ranged from 5 to 45 mg/l. This nutrient enriched water has the possibility of being utilized as liquid fertilizer for horticultural crops. The organic carbon content of pond's sediment of this area varied from 0.54 to 1.6%. Available nitrogen and available phosphorus of these ponds's sediment ranged from 8 to 40 mg/100 g and from 2 to 26 mg/100 g of sediment, respectively.

The nutrient enriched pond water from Kolleru Lake area has the potential to be utilized as liquid fertilizer for horticultural corps

Assessment of nutrient loads on the pond bottoms of intensive fish ponds

The analysis of bottom sediment after a culture period of Indian major carps of these fishponds of Kolleru Lake area showed an accumulation of 600 kg/ha/yr of organic carbon occurred in the bottom sediment. The analysis also accounted for the accumulation of 114 kg/ha/yr of nitrogen in available form. An accumulation of 28 kg/ha/yr of phosphorus in available form also occurred in the bottom sediment in these fish ponds. High nutrient content of the pond bottom sediment (sludge) makes it suitable to be used as fertilizer.

Phytoremediation potential of water hyacinth *Eichhornia crassipes* for the removal of Copper and Lead was demonstrated

A study conducted in rural Odisha community pond revealed a strong correlation between pond lease period and fish production

Phytoremediation of copper and lead in aquatic systems

The present study demonstrated the phytoremediation potential of water hyacinth *Eichhornia crassipes* for the removal of copper (Cu) and lead (Pb). Young plants of equal size were grown in tap water and supplemented with 0.35, 0.70 and 1.05 mg/l of Cu and 0.25, 0.54 and 0.90 mg/l of Pb individually for 25 days. The experiment showed that both copper and lead had effects on plant relative growth. The plant at all the concentrations removed more than 90% of copper and lead. Removal of metals from water was fast especially in the first five days. The accumulation of Cu and Pb in roots and stems increased with the initial concentration. At all levels the plants accumulated the highest concentration of Pb in roots, while the highest concentration of Cu was accumulated in stems. The biocencentration factor (BCF) of Cu was higher than that of Pb at the same duration, suggesting that the accumulation potential of *E. crassipes* for Cu was higher than that for Pb and could be used to treat wastewater contaminated with low Cu and Pb accumulations.

Project Title	:	Community based management for sustainable aquaculture in rural areas
Project code	:	I-68
Funding Agency	:	Institute-based
Duration	:	April 2009 – March 2012
Project Personnel	:	Radheyshyam (PI), A. E. Eknath, S. Adhikari, G. S. Saha, H. K. De, N. K. Barik, Lekha Safui and S. Chandra

Study attempted to assess fish production related constraints in community ponds in Orissa. Data were collected from 81 randomly chosen community leaders from Dist. Khurda and Puri in 2009 using purposely prepared questionnaires. Major difficulties faced in community aquaculture were enlisted. Difficulties were leveled on a 10-point scale. After survey, scale 1-10 was grouped into 3 parts to ascertain low (1-4), medium (5-7) and high (8-10) degree of constraints. Of the surveyed ponds, 78% were leased for 1-3 years. It has been observed that with the increase in leasing period fish production was increased. In 1, 3 and 5 year leased ponds fish production was 739, 994 and 1634 kg/ha/yr respectively, suggesting need of higher lease period for better production. Due to frequent change in lessee, 59% community leaders opined "lack of technical know-how" as high level constraint. Because of short lease period of community ponds weed and predatory fishes were rarely eradicated and manured. As such 72% and 69% farmers reported presence of weed and predatory fishes and poor plankton production respectively as high degree of constraint. One of the major constraints faced by farmers (52%) was lack of supplementary feeding. Community pond owners did not have their own nets for sampling and harvesting and over 86% respondents opined it as a major constraint.

Farmers also expressed several other constraints like lack of technical support, high lease values, aquatic weed infestation, lack of finance for culture operation, heavy silt deposition in pond bottom, disease outbreak, poor water retention capacity of pond, prevention of manure/fertilizer/fish medicines application, fish

poisoning and poaching due to social rivalry, conflict in distribution/sharing of produce/profit, and marketing problems in decreasing order of severity. A single factor in isolation or many factors in combination might have affected adversely fish production in community ponds. It needs attention to mitigate the constraints so as to accelerate fish production for improving food and nutritional security and employment generation for the rural poor.

After survey 34 community ponds covering an area of 32 ha involving 400 women (24 WSHG) and 170 males (17 Community) were identified for community-based management for sustainable aquaculture in rural areas. Two freshwater aquaculture field schools were established at Sarakana and Bhatapadagarh Fish Farm.

Project Title	:	Development of livelihood through freshwater aquaculture for the tribal people of North-eastern states
Project code	:	I-69
Funding Agency	:	Institute-based
Duration		April 2009 – March 2012
Project Personnel	:	A. E. Eknath (PI), P. P. Chakraborty, N. M. Chakraborty, A. K. Datta, A. K. Sahoo, S. K. Swain, Kuldeep Kumar, G. S. Saha, B. N. Paul, R. N. Mandal, N. K. Barik, P. L. Lalrinsanga, Rajesh Kumar, S. C. Mandal and B. K. Pandey

During the year 2009-10 the past experiences and activities undertaken by the Institue in the aquaculture development of the Northeastern Region were reviewed. It was decided to change the approach of the work towards a programme mode. The programme would contextualise and focus on the whole region in the perspective while developing future activities. The institute also required to develop priorities and focus area of work for the NER activities. To develop strategies and priorities for the NER, workshops were conducted in Shillong with the following details.

Regional Consultative Workshop on Sustainable Aquaculture development

The Institute organised a regional consultation to devise strategies for research and development for aquaculture in the North-eastern Region during 16 -17, September 2009 at Shillong, Meghalaya. The focus of the programme was to develop research priorities for the CIFA for next five years. Mr. Senli Ao, Director of Fisheries, Nagaland; Mr. Imadul Haque, Director of Fisheries, Assam; Mr. Tage Moda, Director of Fisheries, Arunachal Pradesh; Mr. Riyan Santiray, Director of Fisheries, Tripura; Mr. K. Rokima, Director of Fisheries. Mizoram; Mr. F. G. Momin, Director of Fisheries, Meghalaya; Dr. Sarat Kumar, Director of Fisheries, Manipur; T. Bhutia, Joint Director of Fisheries, Sikkim. The Directors and representatives of other

The approach of CIFA towards aquaculture development of NE region has been revised. The strategy for aquaculture development in the region should be on progressive and participatory modes and as an initial step, a network of scientists of the region would be formed to carryout R&D activities

ICAR fisheries institutes like CIFA, CIFRI, DCWFR and CIFT also participated besides the subject matter experts like Dr. M. Sinha, Advisor, Fisheries government of Tripura. Shri. P. K. Borthakur, Commissioner and Secretary of Fisheries, Govt. of Assam and Dr. S. V. Ngachan, Director, ICAR Research Complex for NEH Region presented their viewpoints in the inaugural session of the workshop. The development stakeholders like North-eastern Council (NEC), National Fisheries Development Board (NFDB), North-eastern Development Finance Institution (NEDFI) and National Bank for Agriculture and Rural Development (NABARD) provided their responses and status of interventions for the development of fisheries in the NER.

All the State Fisheries Directors presented the issues, constraints, opportunities and support required for aquaculture development in the regions followed by the interventions by ICAR through various specialised research organisation operating in the region. The responses and opportunities available among the stakeholders for the development in the region were discussed thoroughly. At the end, the strategies for aquaculture development and research priorities for the CIFA were worked out in a participatory mode, which was adopted by the house unanimously.

To carryout these priorities and strategies developed in the workshop it was decided to form a network of scientists of the region to carry out the research and development activities. The network meeting was conducted in Gangtok with following details.

Network for Sustainable Development of Fisheries and Aquaculture

A two days workshop was conducted by the institute at Gangtok, Sikkim during 11-12 March, 2010. During the technical sessions, the presentations were made on the status of fisheries in respective states, thematic presentations on seed, feed, management, paddy-cum-fish culture, integrated farming, ornamental fish culture, aquaculture diversification, magur and murrels. Besides, the presentations on the CIFA intervention, priorities and approaches for the aquaculture development in the Northeastern region was presented. These presentations were made to trigger in-depth discussion on each of the themes and strategies. It emerged in the workshop that the best way forward is to bring together the large number of scientists and researchers in the region on a common platform to address issues and problems of the region. After the scientific deliberations the delegates unanimously resolved to establish a Network for Sustainable Development of Fisheries and Aquaculture in NER as part of the Gangtok Declaration adopted by the delegates at the end of the meeting. An *ad hoc* constituent committee was formed to prepare the documents and modalities for governance and sustainability of the Network. Mr. Chauhan in his address emphasized the need for transferring of technologies like pig-cum-fish culture and poultry-cum-fish culture for an integrated development of the sector.

The meeting was attended by Sri D. N. Takarpa, Honourable Minister for Health, Livestock, Fisheries and Parliamentary affairs; Shri V. Chauhan, Secretary, Department of Animal Husbandry, Fisheries and Veterinary Services, Sri M. T. Bhartiya, General Manager, NABARD, Mumbai and Dr. H. Rahman, Joint Director, ICAR Complex, Sikkim as special guests. Other delegates and contributors to the technical sessions were Dr. M. L. Bhaumik, Dr. D. N. Das, D. S. K. Das, Dr. U. Barua, Dr. Debapriya Sarkar, Dr. K. Kalita, Dr. P. K. Goswami, Dr. H. K. Gogoi, Sri. Deep Jyoti Barua, Sri Jyotish Barman, Sri Ganesh Chandra. The State Fisheries departments were represented by Sri. I.

Haque, Director of Assam; Sri P. W. Bhutia, Director Sikkim and Mrs. C. T. Sangma, Ex-Director Meghalaya.

About 40 scientists, researchers and development workers involved in fisheries and aquaculture development in the region attended the programme. Among others who attended the workshop were Mr. I. Haque, Director of Fisheries, Assam; Mr. P. W. Bhutia, Director of Fisheries, Sikkim; and Dr. H. Rahman, Joint Director, ICAR Research Complex, Sikkim.

Regional programme in Silchar during 23-27, November 2009

As the follow-up programme of Shillong workshop a regional programme was organised at Silchar in which the priorities and strategies for the aquaculture development was laid out. It was decided to intervene in low altitude zone of the region having significant aquaculture potential. The Barak valley constituting three districts i.e., Silchar, Karimganj and Hailakhandi offers a great potential for aquaculture development in terms of the resources and need of the region. There are about 50,000 ponds covering an area of 20,000 acres constituting about 25% of the pond resources. These water areas are low in productivity due to lack of access to technology and development incentives. To meet these anomalies it was decided to initiate the technological interventions in the region. During the programme an exhibition was organized at Assam University, Silchar in which CIFA technologies were showcased. Training programmes on composite fish culture and ornamental fish culture were organized. An ornamental fish hatchery unit facility was also inaugurated and operationalized during the programme.

Project Title	:	Smart pond management system for freshwater aquaculture (CIFA-CEERI Collaborative Project)
Project Code	:	E-45
Funding Agency	:	DBT
Duration	:	February 2008-February 2011
Project Personnel	:	J. K. Jena (PI) and P. C. Das

Study on low dissolved oxygen tolerance of fingerlings of *Labeo rohita*

Mesocosm experiment was conducted in twelve cylindrical FRP tanks of 100 l to study the low dissolved oxygen tolerance in fingerlings of *Labeo rohita*. The tanks were stocked with fingerlings of 7.92 ± 0.25 g at 8, 16, 24 and 32 numbers in triplicate which served as the four treatments, T1, T2, T3 and T4, respectively. Stocking of fish was followed by hourly measurement of the dissolved oxygen, pH and temperature of each tank up to 26 hours exposure with a six hours interruption from 8th to14th hour. Three similar FRP tanks filled with water were maintained separately and all the parameters were also measured so as to correct the oxygen reduction in treatment tanks for microbial respiration.

The dissolved oxygen content reduced in all the tanks continuously (Fig. 8) and the magnitude of reduction was higher in treatments stocked with higher fish biomass. The oxygen content reduced initially at a greater pace, but slowed down later. During the study, no abnormal movement except occasional surfacing in T4 was observed among the fingerlings. Such observation suggests their oxygen consumption to be greatly influenced by the ambient oxygen level. In Indian major carp, oxygen content below 3 mg/l is reported to be critical for their survival. However in the present study, oxygen level though drastically reduced to a level below 0.56 mg/l in T3 and 0.32 mg/l in T4 at the end of 14 hours, the fishes could survive further till the end of 26 hours. Such observation in

Rohu fingerlings may adapt to low ambient Oxygen levels and/or low Oxygen levels may not be the only factor causing mortality in seed rearing ponds

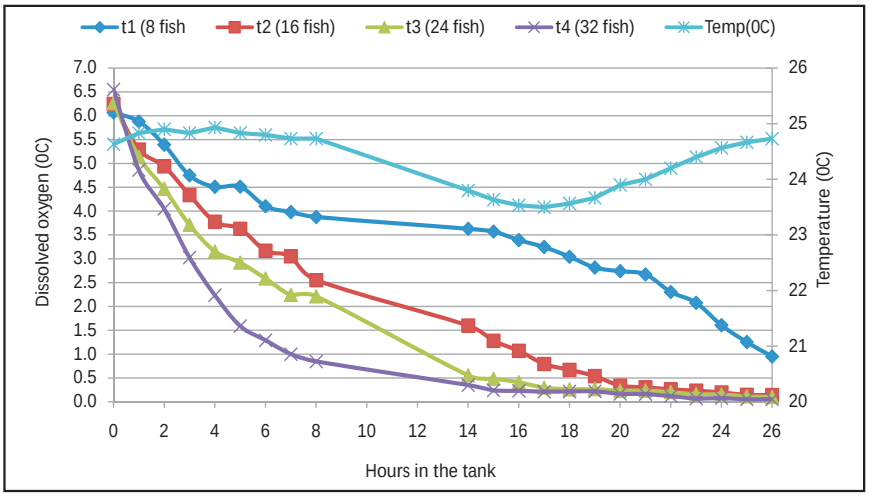


Fig.8 Tolerance of rohu fingerlings to low DO exposure

one hand indicated the capability of the fingerlings to adjust their oxygen consumption level and withstand the low oxygen situation, and on the other, this probably indicated that low dissolved oxygen is not the only factor causing mass mortality as observed in the seed rearing tank since the fishes could survive for 12 hours under the low dissolved oxygen levels of 0.56 to 0.05 mg/l in T3 and T4.

Impact of low dissolved oxygen on growth of rohu fingerlings

Experiment was carried out to assess the impact of low dissolved oxygen content of water on the growth of fingerlings of *rohu*. Eight fingerlings of rohu were stocked in each of the 12 FRP tanks with 80 l water. The tanks were divided into two groups: while one group (four tanks) was continuously aerated from an air blower, tanks in the other group were not provided any aeration. While the dissolved oxygen level was consistently maintained at 4-5 mg/l in aerated tanks, the same in the non-aerated tanks never increased above 2 mg/l. Formulated feed was provided in each tank *ad libitum* twice daily during morning and evening hours. Water exchange was performer at 10% every morning during which excreta and left-over feed were removed through siphoning.

Evaluation of prototypes of Smart Pond Management system

With an aim to monitor water quality characteristics of pond on a continuous basis, the initial model of the Smart Pond Management System has been developed by CEERI which contains facilities for measurement of temperature, dissolved oxygen and pH of pond water on a continuous basis. The system has been evaluated initially at CIFA farm. Based on the performance of the model, some modification has been worked out and incorporated in the next model of the sampler. The new system is under evaluation for its performances in the CIFA farm premises.

Project Title	:	A value chain on production and utilization of Indian major carps and prawn from aquaculture system (As a Consortium Partner in Value Chain Project of NAIP under Component 2)
Project Code	:	E-48
Funding Agency	:	NAIP-ICAR, New Delhi
Duration	:	June 2008-June 2012
Project Personnel	:	J. K. Jena (CCPI) and P. K. Sahoo (CCPI)

Collection of *A. hydrophila* isolates and development of monovalent vaccine

Nine different *A. hydrophila* isolates collected from various parts of India were biochemically characterized. The strains were further confirmed by PCR. Studies on biofilm development is in progress.

Characterization of immune relevant genes for immune response study

RNA of *Channa striatus* collected from culture ponds was isolated from liver, kidney and spleen. Primers based on heterologous gene sequences were designed to amplify some of the immune relevant genes. Transferrin and complement factor 3 genes have been successfully amplified

from the species and the amplicons are further cloned to obtain sequence information.

Purification and characterization of IgM of *Channa striatus*

The purpose of the experiment was to purify and characterize IgM from *Channa* for further development of ELISA to quantify antibody after vaccination. The purity of the sample was clearly evident from the presence of a single band on

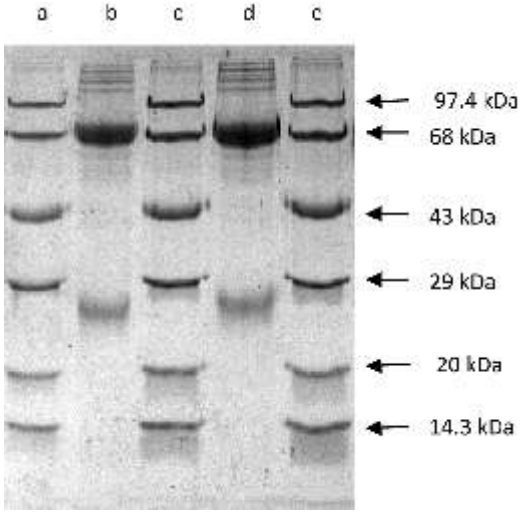


Fig.9 SDS PAGE (a,c, d- Molecular weight marker, b,d-Channa Ig)

native gradient PAGE. SDS-PAGE, under reducing conditions, dissociated the Channa Ig into H and L chain subunits (Fig.9). The H chain subunits possessed molecular weights of approximately 72.27 kDa and light chains of 27.15 kDa.

Western Blotting

The specificity of the rabbit antisera to Channa Ig was checked by western blotting. The successful transfer of protein bands from SDS-PAGE gel could be assessed by amido black staining of the blot (Fig 10a). In immunostaining of the blot with the rabbit anti-Channa Ig serum, both the H and L chains of reduced Channa Ig were found to be stained. But with the reduced Channa serum the antisera cross-reacted with several other bands. When the adsorbed antisera were used in immunostaining, such cross reactions could successfully be

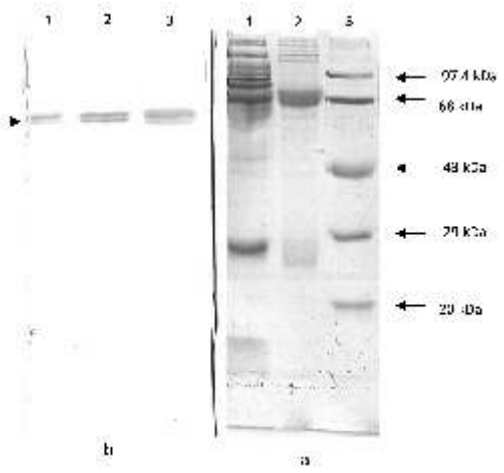


Fig.10(a,b) Western blot analysis (Lanes b 1-3: amido black staining, lanes a 1-3: immune staining). Lane a3: Molecular weight marker, lane b2, a2: purified Channa Ig, Lane b1, b3, a1: normal Channa serum.

eliminated (Fig.10b). It only reacted with the H chain bands in both reduced *Channa* serum as well as reduced purified *Channa* Ig.

Indirect ELISA assay

Indirect ELISA assay was performed to determine the antibody titre in *Channa striatus*. The standard curve was made using purified Channa Ig. Using purified Channa Ig as internal standard, the relative Ig concentration was found to be 3.48 ± 0.41 mg/ml (mean of 30 juveniles). These results were expressed as the mean of duplicate determinations for each experiment to which the control values were subtracted.

Evaluation of different substrates on production performance of carps through bacterial biofilms as additional food spectrum

Experiments has been initiated in 12 earthen ponds of 0.05-0.07 ha each to evaluate contribution of bacterial biofilms on growth, production and possible enhancement of generalized disease resistance in the cultured species viz., catla (*Catla catla*), rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigala*), fringe-lipped carp (*L. fimbriatus*) and Kuria labeo (*L. gonius*).

Cryopreservation technology can contribute significantly toward fish seed quality improvement and genetic up-gradation of stock. Further, transportation of 1-2 lakhs seed can be achieved with just 20 ml cryopreserved milt of carps

Project Title	:	A value chain in murrel production in Tamil Nadu and Orissa (Component 2)
Project Code	:	E-52
Funding Agency	:	NAIP-ICAR, New Delhi
Duration	:	July 2008 – June 2012
Project Personnel	:	Kuldeep Kumar (CPI), A. K. Sahu, Rajesh Kumar and U. L. Mohanty

Breeding and seed production

About 41,000 of murrel fry (*Channa striatus* 40,000 and *C marulius* 1,000) *were* produced by creating natural ecological environment in pond during the year under report. These were reared in concrete tanks to fingerlings. Over 10,000 fingerlings of *C. striatus* and about 500 *C. marulius* were produced. The early fry was fed exclusively with plankton but late fry was provided grounded fishmeal. About 20-30% of brood stocks responded to naturally created environmental conditions.

Fry and fingerling rearing

Channa striatus fry was stocked in concrete tanks @ 70 and 140/m^2 (initial size: 0.386 g/3.54 cm) for a period of 25 days. Initially fry were fed with plankton *ad libitum* and later on fish meal powder was given in addition to plankton. Survival levels of 97.14 and 16.04% were achieved at stocking density 70 and 140/m^2 respectively. Fingerlings were fed with insects and boiled chopped chicken viscera. It was observed that 2-3% of the fry grew very fast and started consuming the smaller ones. The higher survival rate was obtained when the bigger size fry were segregated at regular basis and non-separation led to poor survival. This indicates the high cannibalistic nature of the species. Thus, regular segregation during seed rearing is recommended to achieve high survival.

Pond culture of murrels

The ponds were stocked with advanced fingerlings of *C. striatus* (avg. wt 88.55 g) @ 6,250/ha for one year. Fishes were fed with boiled and minced poultry offal (90%) in combination with rice polish (10%) @ 5% of their body weight. Production of 2184 kg/yr/ha was achieved with 46.4% recovery.

Technology dissemination

Three Women SHGs and one NGO were adopted for murrel farming. A community pond owned by women SHG (142 members) from Balipatna Block, Khurda district was stocked with fingerlings of *C. striatus* (avg. size 76.3 g/21.66 cm) and *C. marulius* (avg. size 45.4 g/19.26 cm). One NGO of Ranghalo village, Nimapara block, Puri Dist. was given advanced fingerlings of *C. striatus* (avg. size 76.3 g/21.66 cm). Technical inputs related to murrel farming are being provided to these groups on a regular basis. Further, a total of 85 farmers from 6 different villages of Puri and Khurda District have been identified for adoption of murrel farming in coming years. All together 87 farmers including a Women SHG & NGO were given training on "Murrel Seed Production and Culture" in two phases during 22-24 February and 4-6 March 2010. A Pamphlet on Farming of Snakeheads was released by the honourable Chief Minister, Assam on the occasion of Assam Matsya Mahotsav, organized by the Department of Fisheries, Govt. of Assam during 30th Jan- 1st Feb 2010.

Project Title	:	Sustainable livelihood improvement through integrated freshwater aquaculture, horticulture and livestock development in Mayurbhanj, Keonjhar and Sambalpur districts of Orissa (CIFA-IIHR-CARI-XIMB Collaborative Project)
Project Code	:	E-54
Funding Agency	:	NAIP-ICAR, New Delhi
Duration	:	April 2009 – June 2012
Project Personnel	:	J. K. Jena (CPI), P. C. Das, S.K. Sahoo, B. C. Mohapatra, S. K. Swain, H. K. De, N. K. Barik, P. K. Meher, S. C. Rath, Rajesh Kumar, Suresh Chandra, Bibhudutta Mishra, Sovan Sahu and Ambekar E. Eknath

Sustainable livelihood improvement through integrated freshwater aquaculture, horticulture and livestock development

The Central Institute of Freshwater Aquaculture (CIFA) in collaboration with Central Horticultural Experimental Station of IIHR (CHES), Bhubaneswar, Regional Centre of CARI, Bhubaneswar and Centre Development Research and Training (CENDERET) of Xavier Institute of Management, Bhubaneswar have initiated a developmental project in Mayurbhanj, Keonjhar and Sambalpur districts of Orissa with objectives to improve the livelihood of 3000 farm families through integrated development of freshwater aquaculture, livestocks and horticulture based non training and on-farm demonstration. A total of eight clusters possessing distinctly different characteristics with regards to agro-climatic condition, topography, economic condition of people, farming situation in the area and social status have been identified in the three districts for project implementation, which include three in Mayurbhanj, three in Keonjhar and two in Sambalpur. After several visits by the scientists of the participating institutes and discussions with the officials of the development departments of the respective clusters, two to three villages from each of the clusters has been identified initially for implementation of the project. PRA has been conducted in the identified villages and the base line resource inventory work has been completed in all the clusters. The proposed interventions for each of the identified families are being worked out for implementation.

Project Title	:	Carp seed production in mobile hatchery and rearing for livelihood development for SC/ST communities in selected Districts of Orissa
Project Code	:	E-56
Funding Agency	:	DBT
Duration	:	June 2009-June 2012
Project Personnel	:	B. C. Mohapatra (PI) P.C. Das, S. Adhikari, H.K.De, Suresh Chandra and Bibhudatta Mishra

Th project has been initiated with the main objectives of establishment of ten FRP carp hatcheries in C.D. Blocks of the district; Induced breeding of carps in hatcheries, seed rearing for fry, fingerling and yearling production; and providing hands on training on aquaculture technologies.

Preliminary survey work was conducted for selection of beneficiaries for implementation of

technologies in two districts namely Mayurbhanj and Nayagarh of Odisha. Visits were made to five CD blocks namely Baripada, Shyamakhunta, Betonati, Chitroda and Moroda of Mayurbhanj District and Nayagarh, Khandapara, Ranapur and Nuagaon of Nayagarh District for selection of sites for FRP carp hatchery establishment.

The project personnel participated in the Krishi Mela at Banamalipur Village of Khandapada Block on 16 January 2010 and apprised the objectives of the project to the 500 farmers present. Discussions were held with the BDO, the Block Chairman and all Gram Panchayat level functionaries to facilitate the project implementation.

Project Title	:	Quality seed production and stock upgradation of carps through use of cryopreservation technology in the selected hatcheries of India
Project Code	:	E-60
Funding Agency	:	NFDB
Duration	:	October 2009-October 2012
Project Personnel	:	P. Routray (PI), A. E. Eknath, K. D. Mahapatra and D. K. Verma

To improve the quality of the fish seed, the primary strategy has been exchange of broodstocks, but the cumbersome process of transport and subsequent mortality of brood fish has been an impediment. Use of cryopreserved milt of unrelated healthy fish stocks and their use in different hatcheries of India has been proposed as an effective strategy. Transportation of 1-2 lakh seed can be achieved with just 20 ml cryopreserved milt of carps. Moreover, the non-availability of male brood in the small farms during spawning time may be addressed. Similar strategies have revolutionized the livestock sector in the country. It is envisaged to establish, upgrade and utilize the existing facility and knowledge of fish semen cryobanking facilities at different hatcheries of India with ultimate goal of genetic upgradation of the fish stocks of seed producers.

Project Title	:	Economic and livelihood development of SC/ST population through freshwater aquaculture technologies
Project Code	:	E-36
Funding Agency	:	DBT
Duration	:	April 2006- August 2009
Project Personnel	:	B. K. Das (PI), B. C. Mohapatra, D. N. Chattopadhyay, H. K. De and S. Chandra

Freshwater aquaculture technologies like seed rearing of major carps, grow-out culture of carps, monoculture and polyculture of prawn, culture of advanced fingerlings and operational procedure of FRP carp hatchery for fish breeding and seed production have been implemented in Keonjhar and Kendrapara Districts with an aim to motivate the rural poor towards fish farming practices. The average fish production of the adopted ponds in Keonjhar and Kendrapara has increased by 4.17 and 1.33 times and the average income of beneficiaries has increased by 5.74 and 1.58 times respectively. Adoption of widows and orphan girl as beneficiaries under the project made them economically independent.

During the reporting period 117 farmers (54 SC farmers and 83 ST farmers) covering a culture area of 9.49 and 9.88 ha were adopted in Kendrapara and Keonjhar districts, respectively. Demonstration of induced breeding of IMC in FRP hatchery was undertaken in both the districts.

Inauguration of FRP carp hatchery and induced breeding

The FRP hatchery site at Sirsipal was inaugurated by Dr A. E. Eknath, Director, CIFA in presence of Dr B. K. Das, Sr Scientist, CIFA on July 25, 2009. Dr Eknath addressed 50 tribal farmers including 20 women of Keonjhar Sadar.

During July 2009, induced breeding of *IMC* was undertaken in FRP hatchery installed at Tanar and Sirsipal. A total 0.55 million (two trials) and 2.2 million (two trial) spawns of *IMC* could be produced at Sirsipal and Tanar, respectively which were stocked in the nursery ponds for further rearing.

Development of Yearlings Bank

The farmers have accepted the culture of yearlings in seasonal ponds and there is a very high demand for yearlings in both the districts. The two yearlings bank developed in both the districts have been successful in meeting the demand of nearby areas. Keeping in view the profit earned from yearling sale, Maa Biswamata SHG has gone for an expansion and dug out 10 new ponds for rearing fry to yearlings.

Site-specific integrated farming system

Site-specific integrated aquaculture system was adopted in both Districts of Keonjhar and Kendrapara. Horticulture and floriculture components adopted by the farmers during the first phase added on an average earnings of Rs 3495 per annum.

Banaraja variety of poultry bird was supplied to 23 tribal beneficiaries (6-10 birds each) in the hilly region of Telkoi. After 6 months of rearing they started laying eggs and each bird laid 15-18 eggs per month. After a period of 9 months these birds weighed 3-3.5 kg.

White Leg Horn variety (110 nos. birds, 21 days old) was supplied to five beneficiaries at Kendrapara which started laying eggs after 8 months and weighed around 2.5-3.0 kg. The farmers from Aul earned an additional income of Rs 250-300 per month from sale of eggs but farmers from Giribandha utilized 20-30% of eggs for household consumption and sold the rest in market.

Fish production from carp polyculture

The average fish production from the adopted farmers' ponds in Keonjhar and Kendrapara prior to adoption was 230.29 kg/ha and 676.72 kg/ha respectively, which increased to 491.62 kg/ha (Fig.11) and 972.19 kg/ha/annum (Fig.12) after

About 87% of the adopted farmers at Keonjhar and 82% at Kendrapara could achieve 2- ≥ 4 fold increase in production from carp polyculture. Average annual income of 87% of farmer at Keonjhar and 96% at Kendrapara increased by 2-≥4 fold

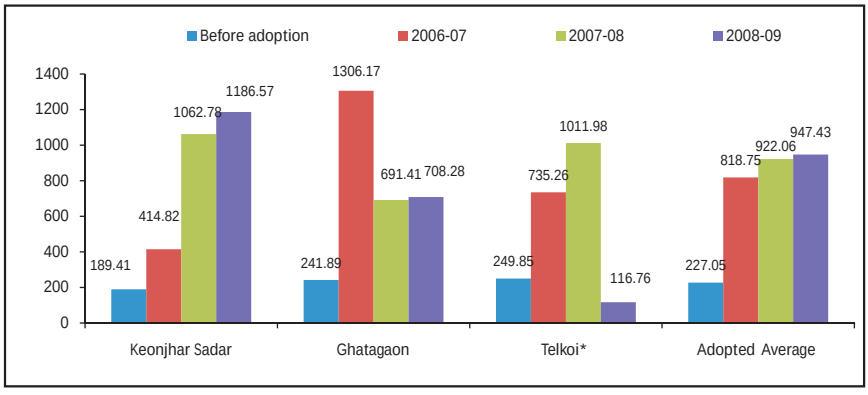


Fig.11 Average fish production in the adopted ponds of Keonjhar

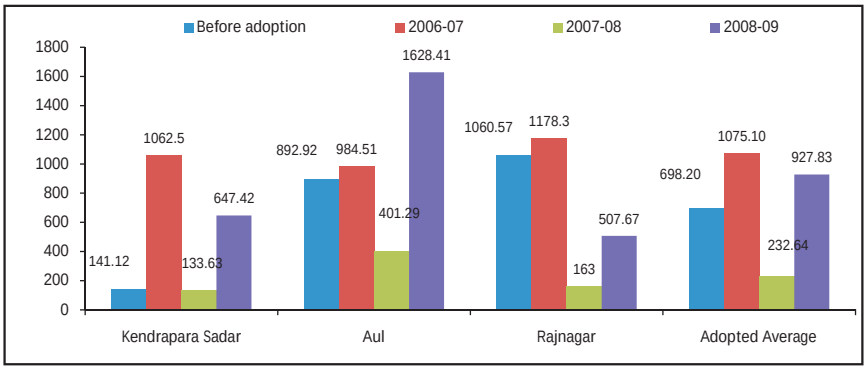


Fig.12 Average fish production in the adoption ponds of Kendrapara

intervention. The production from these ponds ranged from 200 - 3750 kg/ha. About 87% of the adopted farmers at Keonjhar and 82% at Kendrapada could achieve 2 to 4 fold increase in production from carp poly culture.

Income and Employment generation

The average annual income of the adopted farmers prior to adoption was Rs 1,524 and Rs 25,849 for Keonjhar and Kendrapara respectively, which showed corresponding increase by 5.74 and 1.58 times *i.e.* Rs 8,334 and Rs 40,900 after adoption. Average annual income of 87% of farmers at Keonjhar and 96 % at Kendrapada increased by 2-4 fold.

DST Women Scientist Schemes

Project Title	:	Extraction and purification of bioactive compounds from freshwater microalgae and its effects on fish immune system
Duration	:	October 2008–September 2011
Funding Agency	:	DST Women Scientist WOS-A/LS Scheme, Govt. of India
Project Personnel	:	J. Pradhan (PI) and B. K. Das (Mentor Scientist)

Cultivation *Spirulina* and preparation of extract

Axenic culture of *Spirulina platensis* was undertaken in freshly prepared Zarrouk culture medium. The algal cells were harvested at the late *exponential phase* of growth using standard technique of fliltration, contrifugation and pelleting and used for further experiments.

Antibacterial activity of *Spirulina* against *Pseudomonas* spp. and *A. hydrophila*

Antibacterial sensitive test of crude extracts of *Spirulina* was done by single disc diffusion method. Both ethanolic (SpE) and methanolic (SpM) extracts were effective against all the strains of Pseudomonas spp. and A. hydrophila. It was observed that the antibacterial activity of all extracts (SpE, SpM, SpA) was significantly different ($p \leq 0.05$) from each other, when tested against above pathogens except *P. aeruginosa* (PA2) and *A. hydrophila* (AH1, MTCC 646). P. putida (PP1) and two strains of A. hydrophila (AH2, AH4) showed maximum zone of inhibition (14.3, 15.66, 15.33mm) to ethanolic extract of *Spirulina*. Methanolic extract (SpM) showed moderate to high zone of activity (8.6, 11.3, 11 mm) against above selected strains of Pseudomonas and A. hydrophila. The effectiveness of Spirulina extracts was cited in Table 2 & Fig.13.

Table 2 Antibacterial activity of various extracts of *Spirulina* against different strains of *Pseudomonas*

Extracts	Disc Potency µg/10µl	*Pseudomonas* spp. (Zone size in mm)							
		PP1	PP2	ATCC (49128)	PA1	PA2	ATCC (27853)	PF1	PF2
SpE	100	14.3±0.3^{a}	13.0±0.5^{a}	14.3±0.3^{a}	13.3±0.3^{a}	12.3±0.3^{a}	12.6±0.3^{a}	13.3±0.3^{a}	12.3±0.3^{a}
SpM	100	8.6±0.3^{b}	10.3±0.3^{b}	10.6±0.3^{b}	10.3±0.3^{b}	11.3±0.6^{a}	10.6±0.3^{b}	8.66±0.3^{b}	10.0±0^{b}
SpA	100	0	0	0	9.33±0.3^{b}	0	8.66±0.3^{c}	8.33±0.3^{b}	0

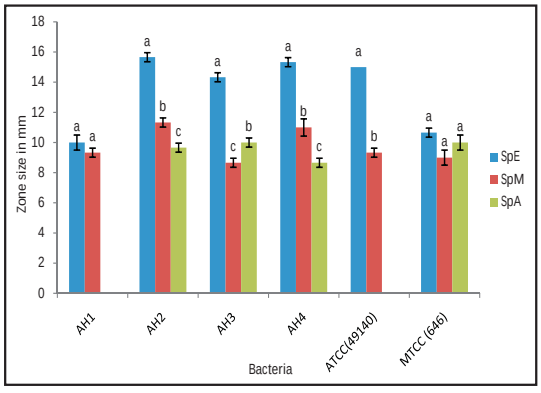


Fig. 13 Antibacterial activity of various extracts of *Spirulina* against *Aeromonas hydrophila*

Antibacterial activity of Spirulina against Edwardsiella tarda, Escherichia coli and Vibrio

Ethanolic, methanolic and aqueous extracts were tested against *E. tarda*, six strains of *Vibrio* and six strains of *E. coli* (Table 2). *V. anguillarum* (VAN) and *V. fischeri* (VFS) showed maximum zone of inhibition (15.3 mm) to the ethanolic extract (SpE) of *Spirulina*. It was also noticed that ethanolic extract SpE is more effective (15.6 mm) against two strains of *E. coli* (O1, O115), whereas four strains of *E. coli* (O1, O115, O111, O109) was resistant to aqueous extract of *Spirulina* (SpA). Antibacterial activity of both ethanolic and methanolic extracts was significantly different ($p \leq 0.05$) from each other against above selected pathogens like *E. tarda*, *Vibrios* and *E. coli*. Ethanolic extract showed comparatively higher antibacterial activity whereas aqueous extract was less effective (Fig. 14).

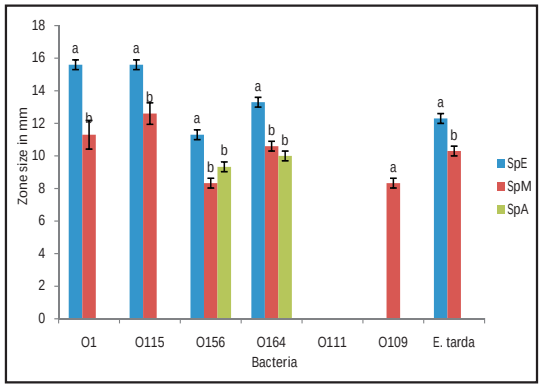


Fig. 14 Antibacterial activity of various extracts of *Spirulina* against different strains of *E. coli and E. tarda*

Table 3 Antibacterial activity of various extracts of *Spirulina* against different strains of *Vibrio*

Extracts	Disc Potency µg / 10 µl	*Vibrio* (Zone size in mm)					
		VA	VP	VH	VF	VAN	VFS
SpE	100	13.3±0.3^{a}	13.3±0.3^{a}	11.6±0.3^{a}	11.6±0.3^{a}	15.3±0.3^{a}	15.3±0.3^{a}
SpM	100	9.66±0.3^{b}	11.3±0.3^{b}	9.33±0.3^{b}	9.66±0.6^{b}	12.3±0.3^{b}	11.6±0.3^{b}
SpA	100	0	0	10.6±0.3^{a}	9.66±0.3^{b}	0	0

MIC values of different extracts of *Spirulina against different bacterial strains*

The Minimal Inhibitory Concentration (MIC) of the extracts of *Spirulina platensis* (SpE, SpM and SpA) were done by tube dilution method. Crude ethanolic, methanolic and aqueous extracts of *Spirulina* showed MIC values of 100-500 g against all the selected strains of *Pseudomonas* and *A. hydrophila,* whereas ethanolic extract showed minimum MIC value of 200 g against *P. aeruginosa* (ATCC 49128) and 100 and 150 g against *A. hydrophila* AH4 and AH2 respectively (Fig. 15).

MIC values against *Vibrio*, *E. coli* and *E. tarda* were determined and represented in Table 4. The MIC values of ethanolic extract ranged from 100-450 g against above selected pathogens showing minimum values of 100 g against two strains of *E. coli* (O1, O115) and 150 g against two species of *Vibrio* (VAN, VFS). MIC values of aqueous extract were above 500 g against *E. coli*.

Purification of fractionated Ethanolic extracts of Euglena by Preparative TLC (PTLC)

PTLC of fraction E4 and E8

Preparative TLC was prepared by coating 10x10 cm glass plate by silica gel in 0.2 mm (0.1 mm) thickness. Before preparative TLC the sample was developed in TLC plate for studying the Rf value, which were within 0.3 to 0.6. Then the solvent system for PTLC was decided and the sample E4 and E8 fraction was developed in a PTLC plate with solvent system 15% EA/Hex and 7% EA/Hex respectively. Two spots (P4 and P5) were observed in E8 sample with Rf values of 0.580 and 0.903 respectively and sample with silica were scraped from the plate and dissolved in chloroform and few drops of acetone overnight. Then it was filtered and become solvent free by slight heating. The concentrated sample was transferred in a

Table 4 MIC (g/ml) of ethanolic (SpE), methanolic (SpM) and aqueous (SpA) extracts of *Spirulina* against *different strains of Vibrio, E. coli and E. tarda*

Extracts	MIC values (µg/ml)												
	VA	VP	VH	VF	VAN	VFS	O1	O115	O156	O164	O111	O109	E.tarda
SpE	350	300	450	400	150	150	100	100	400	350	-	-	450
SpM	500	450	500	500	350	450	450	400	-	500	-	-	500
SpA	-	-	500	500	-	-	-	-	-	500	-	-	-

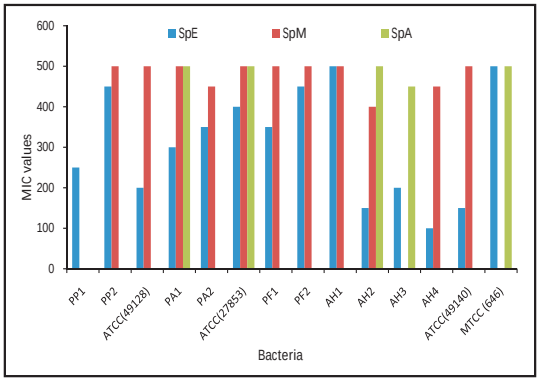


Fig. 15 MIC (g/ml) of ethanolic (SpE), methanolic (SpM) and aqueous (SpA) extracts of *Spirulina* against different strains of *Psedomonas* and *Aeromonas hydrophila*

Fig. 16 TLC spots of fraction P4 and P5 developed in 7% EA/Hex

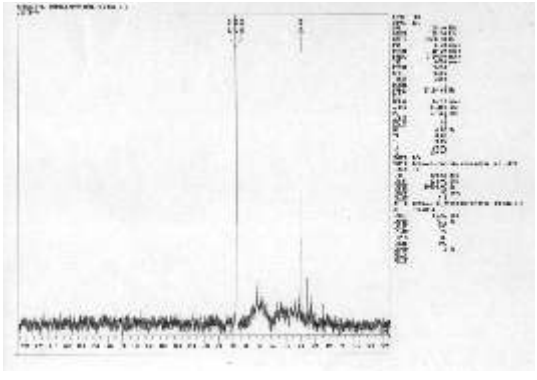
small vial and putting in desicator for proper drying. Both P4 and P5 show same spot in TLC study (Fig. 16). So both the samples were mixed. Then the sample was prepared for NMR study. Above procedure was followed for E4 fraction.

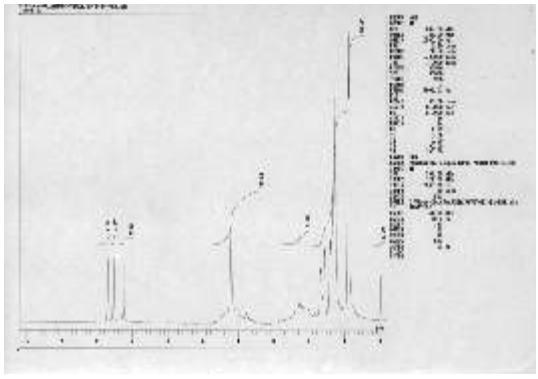
NMR Study of pure fractions (P4 and E4)

The NMR of pure fractions, E4 and P4 were studied by taking the H^1NMR and C^{13}NMR spectra (Figs. 5,6,7,8). It was expected that the compounds might be simple hydrocarbons or lipids.

Project Title	:	Seed production of the freshwater pearl mussel *Lamellidens marginalis* and *L. corrianus* under indoor conditions
Duration	:	September 2007–August 2010
Funding Agency	:	DST Women's Scientist WOS-A Scheme, Govt. of India
Project Personnel	:	Gayatri Mishra (PI) and Kuldeep Kumar (Mentor Scientist)

In vitro culture of glochidial larva to produce juvenile mussel was attempted. Glochidia remained under viable conditions for 24 hrs. However, the best viable period was up to 6 hours for *in vitro* and infestation study. Among the host collected maximum infestation was observed in murrel (*Channa striatus*) within 24 hours of treatment. Among the test species maximum glochidial infestation was found in *C. stiatus* (90%), followed by *P. sarana* (75%), *C. mrigala* (60%) and *L. rohita* (60%). Glochidia collected





from *L. corrianus* had more incidence of infestation in *P. sarana, C. striatus* and *L. rohita* as compared to other host species. However, glochidia from *L. marginalis* had more affinity towards *C. striatus*, *L. rohita*, *P. sarana* and *C. mrigala* in that order. A difference in incubation time for juvenile production was noted depending on the host species employed. The best suited algal feed for the juveniles were *Chlorella* sp. However, after duration of six months a mixed cultured green feed of *Chlorella, Chlorococcum, Scenedesmus* and diatoms were seen to be effective in their further growth and survival.

Project Title	:	Organic farming using vermicompost for sustainable and low cost production of fish and some horticultural crops
Duration	:	August 2008 – August 2011
Funding Agency	:	DST Women's Scientist WOS-A Scheme, Govt. of India
Project Personnel	:	Amita Chattopadhyay (PI)

Thirty demonstration models for vermicompost production for the beneficiaries in eighteen villages, under six blocks of two districts (Khurda & Puri) were established. Eleven units were rectangular brick tanks of dimensions of 5 ft x 3 ft x 2.5 ft and rest were a group of four circular tanks each of 3 ft diameter and 2 ft depth provided with tap to collect vermiwash. Both types have capacity of 1 tonne vermicompost production/year. All the tanks were provided with shed made of bamboo poles and black polythene

Imparting training on harvesting and packaging of vermicompost to a SHG

Vermicompost packets produced at CIFA

sheet. The species of earthworm used for vermicomposting was either *Eisenia foetida* or *Perionyx exacavatus.*

Two hundred thirty members belonging to sixteen SHG's and some individual farmers of different villages have been successfully trained on methods of production, collection and application of vermicompost. Most of them are now producing vermicompost either for the purpose of marketing or application in their own farm. Six different types of vermicompost (by variation of organic wastes) were produced at the demonstration unit of CIFA along with analysis of their physio-chemical parameters and nutrient contents.

The products from vermicompost units were sold to the beneficiaries. Integration of vermi-pisci-horticulture has been initiated for three self-help groups namely Jagannath Seva Sangathan, Palli Bikash Mahila Mondal and Nabin Prabha Mahila Mandal of Balipatna block of Khurda district.

A typical vermicompost demonstration model beside a pond for vermi-pisci-horticulture

Project Title	:	Growth and production efficiency of three larger Macrobrachium species, *Macrobrachium rosenbergii*, *Macrobrachium malcolmsonii* and *Macrobrachium gangeticum* under mono- and-polyculture practices
Duration	:	February 2009–February 2012
Funding Agency	:	DST Women's Scientist WOS-A Scheme, Govt. of India
Project Personnel	:	Prasanti Mishra (PI), B. R. Pillai (Mentor Scientist) and H. K. Barman (Mentor Scientist)

Breeding and seed production of *Macrobrachium gangeticum*

The larvae took 5-7 days from stage I-V, 5-6 days from stage V to VI and 8-10 days from stages VI-XI and 2-3 days from XI-PL with total duration of 20-26 days as reported earlier. The appearance of first few post-larvae was recorded on day 19. The harvesting of PL was done from day 20–35 in which

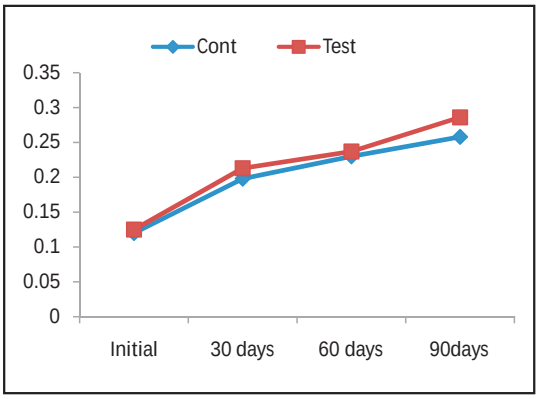


Fig. 17 Growth performance of *M. gangeticum* in two different feed item under lab condition

maximum PL were on day 29-31. As many as 17,650 post-larvae were harvested from all the tanks with average survival 33.8%.

Evaluation of the growth of post-larvae *M.gangeticum* using commercial probiotics

The periodic growth as observed on monthly basis revealed growth rates of 2.6 mg and 2.93 mg/day in units provided with conventional and test feeds respectively after first 30 days of rearing. The respective growth rates declined thereafter, registering 1.04 and 0.79 mg/day showing better growth in conventional feed over test feed. Although the growth was improved (1.65 mg/day) again in the test feed units during last 30 days of rearing, this rate remained more or less similar (0.96 mg/day) in units provided with conventional feed.

At the end of 90 days culture, the average growth rates were 1.5 mg and 1.79 mg/day in the experimental units provided with conventional and test diets respectively showing slightly better results in test feed over conventional feed. The average survival was 89%. The final average weight of prawns registered for conventional and test feeds were 0.2590.08 and 0.2870.06 mg which were 11.05% and 127.8% higher over the initial size after 90 days of culture (Fig.17). The growth variations with the provision of two feeds was not significantly different.

Evaluation of probiotics on the production potential of *M. rosenbergii* and *M. gangeticum* during grow-out culture

The results on growth revealed significantly ($P<0.5$) higher survival of 55-87% in *M. rosenbergii* in the conventional diet over the test diet (42-55%). Similar to that of survival, maximum growth was registered in the conventional diet (av. wt. 25.5-26.6 g) over the test diet (av. wt. 16.6-23.2 g). On the contrary *M. gangeticum* recorded extremely poor growth in both test diets during four months culture. The data on gross production indicated that *M. rosenbergii* contributed 97.3% and 98.7% in both conventional and test diets

while the contribution of *M. gangeticum* was extremely low. A gross production of 475 kg and 237 kg/ha in four months were achieved when the conventional and test diets were used showing better growth performance of conventional diet over test diet.

Least variation in post-larval production (30-35 PL/l) was achieved in *M. gangeticum* in all four replicate compared to wide variations (22.2 - 38.0 PL/l) reported elsewhere indicating better management technique.

The commercial feed probiotics incorporated feed mixture found to have beneficial effect during post larval rearing of *M. gangeticum* over grow-out culture. Both survival and production declined significantly during grow-out culture in both the species of *M. rosenbergii* and *M. gangeticum.*

Development of better management technique particularly efficient feeding and water quality management has yielded least variation in post-larval production. The commercial feed probiotics did not show any positive result during grow-out culture of for *M. rosenbergii* and *M. gangeticum* which, however shown positive results during post-larval rearing of *M.gangeticum.*

Project Title	:	Demonstration of FRP hatchery techniques and environmental management leading to fish seed production and rearing through women participation in Khurda District, Orissa
Duration	:	August 2009 – August 2011
Funding Agency	:	DST Women Scientist WOS-B Scheme, Govt. of India
Project Personnel	:	Anusaya Mallick (PI), B. C. Mohapatra (Mentor Scientist)

Initiated in August, 2009 the project has been implemented in Khurda District, Orissa for the purpose of raising economic condition and livelihood of the socially and economically backward people of the district, especially women

beneficiaries in the selected villages through freshwater aquaculture technologies like breeding & seed rearing of carps, grow-out carp culture and integrated fish farming.

Sixty women farmers including 4 SHG groups having total pond culture area of 14.87 acre (20 nos of ponds) were selected for adoption of technologies. The primary data were collected from the beneficiaries in a developed questionnaire. Most of the farmers belonged BPL and SC categories. Carp breeding was demonstrated to the beneficiaries in two hatcheries. Different freshwater aquaculture technologies were also made available to them. One breeding programme was conducted at Kaijanga Village, Balipatna (Khurda District) and 3 lakhs spawn of rohu and mrigal were produced.

The selected beneficiaries were provided hands-on training on different management protocol including pond preparation, liming, fertilization and stocking of seed. Fry of catla, rohu and mrigal were stocked at a density of 3,000 nos/ha in the ratio of 1:2:1. They were transported from the adopted hatchery at Kaijanga, Khurda District. A total of 17,850 fry were stocked in adopted ponds. The physico-chemical characteristics of water and soil of fish ponds were monitored in every month.

Two Village-level training programmes were conducted at Kaijanga and Sobani Villages, one on carp egg collection and incubation and the other on carp seed rearing and grow out culture in which, 20 women farmers participated.

B. Fish Genetics and Biotechnology

Project Title	:	Genetic upgradation of freshwater fish and shellfish
Project Code	:	I-59
Funding Agency	:	Institute-based
Duration	:	April 2007 – March 2010
Sub-project (a)	:	Genetic improvement of rohu for growth and disease resistance against aeromoniasis through sustainable selective breeding
Project Personnel	:	K. D. Mahapatra (PI), P. K. Sahoo, J. N. Saha and B. K. Choudhary

Production of fullsib families of 2009 Year Class

A total of 56 fullsib families and control group were produced in the year 2009 (Seventh generation) from 51 sire and 36 dams brood fishes from 2007 and 2006 year classes.

Tagging of improved rohu for growth trait

Tagging with Passive Integrated Transponder tag was completed for 1866 individuals from 56 fullsib families and control group. They were reared in three monoculture ponds for further study. Final sampling of the 2007 year class will be completed during April 2010 and further data analysis will be conducted after the final sampling.

Dissemination of improved rohu

Under the dissemination of "Jayanati" rohu program, against the target of 50 Lakhs, 157.25 Lakhs improved rohu spawn were produced. Out of

these, 22.00 Lakhs of spawn were distributed to West Bengal, Assam and Uttar Pradesh. Rest were distributed among fish farmers from different parts of Orissa including local fish farmers from self help groups, private fish farmers, Govt sector etc. Improved rohu fingerlings (3825 nos) were distributed to Bihar, West Bengal and Orissa. Fingerlings were also supplied to Orissa State Fishery Department under the Brood stock improvement program.

Disease resistance against aeromoniasis

Under the selective breeding of second trait i.e disease resistance against aeromoniasis in rohu, resistant and susceptible lines were produced and tagged. They were being reared along with other fullsib families for further study. In addition to

that, tagging of 51 fullsib families, control group was completed and in total 1563 numbers of fingerlings were tagged with PIT tag and stocked in two cisterns for further challenge.

Sub-project	:	Development of DNA markers in *M. rosenbergii* and genetic characterization of Jayanti families
Project Code	:	I-59(b)
Funding Agency	:	Institute-based
Duration	:	April 2007 – March 2010
Project Personnel	:	P. Das (PI), P. Jayasankar, K.D. Mahapatra, B.R. Pillai, J. N. Saha, P. K. Meher and L. Sahoo

DNA markers in *M. rosenbergii*

In the second phase of marker development, about 85 microsatellite-containing positive clones were sequence characterized, resulting in 33 good repeat sequences with flanking regions enough for designing primers. PCR amplification of all the loci using designed primers could result in only 25 amplifiable loci. Sequences of all the 25 loci were deposited in GenBank (Acc. Nos. HM004559 – HM004581). For genetic characterization of *M. rosenbergii*, pleopod collection and DNA isolation/ quantification of at least 50 individuals from Kerala, Gujarat and Orissa populations have been completed for genotyping with labeled primers.

Development of Genetic stocks for linkage and QTL mapping

Three F1 mapping families (MR-K-1-08, MR-K-2-08 and MR-K-3-08) have been generated from Kerala stock of *M. rosenbergii* constituting more than 200 offsprings. Evaluation of these mapping families is in progress.

Parentage analysis in Jayanti rohu

Ten hypervariable loci have been used in a multiplex manner to genotype 8 families (10 individuals each) to deduce parentage. All the loci have been used to test one family initially in order to assign parentage. This correctly traces parentage up to 70 %. Different locus combinations are in progress to maximize the assignment accuracy.

Ten microsatellite loci in improved rohu could assign percentage of progeny of one family by 70% accuracy

Sub-project	:	Transgenics of freshwater fishes
Project code	:	I-59(d)
Funding Agency	:	Institute-based
Duration	:	April 2007 – March 2010
Project Personnel	:	H. K. Barman (PI), P. Jayasankar and S. K. Swain

Isolation of functional β- actin promoter of rohu, *Labeo rohita*

The β-actin gene is expressed ubiquitously in almost all eukaryotic cells. The β-actin promoter has been cloned and characterized in mammals and several fish species. This promoter was also successfully used for generating several transgenic animals and few transgenic fishes. The use of 'autotransgene' construct, where the promoter/regulatory element and targeted structural gene derived from the same species, was demonstrated to be beneficial in transgenesis. Isolation of β-actin promoter of rohu (*L. rohita*) will have potential use in expressing desired genes of interests for generating transgenics. During the reporting period, rohu β-actin 5'-flanking region was cloned, sequenced

Rohu β-actin promoter was cloned, sequenced and promoter/regulatory regions were identified and their functional activity checked

Under the programme of improved Rohu 'Jayanti', a total of 157 lakhs of spawn were produced and disseminated

and promoter/regulatory regions were identified. Functional activity testing of the isolated promoter was done by expressing reporter genes driven by this promoter (Fig.18). This promoter will have potential implications in generating transgenic rohu in addition to basic biological studies.

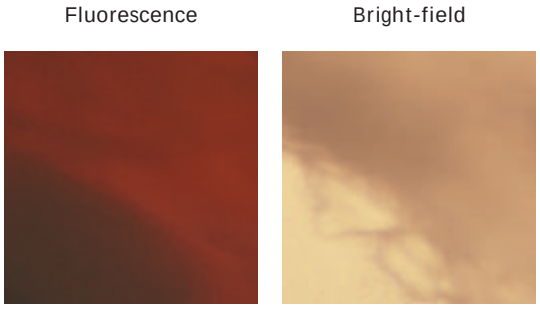


Fig.18 Red fluorescence protein (RFP) expression driven by the rohu -actin promoter in muscle at the site of injection at day 15. Images are taken under fluorescence- (left panel) and bright-field (right panel).

Sub-project	:	DNA barcording of Indian major and minor carps
Project code	:	I-59(e)
Funding Agency	:	Institute-based
Duration	:	April 2009 – March 2011
Project Personnel	:	P. Jayasankar (PI), P. Das and L. Sahoo

COI sequencing of carp haplotypes

Primers FishF1(5'-TCAACCAACCACAAAGACATTGGCAC-3') and FishR2 (5'-ACTTCAGGGTGACCGAAGAATCAGAA-3') generated robust PCR products of mtDNA COI in all the individuals of carp species tested with readable sequences ranging from 601 to 654 bp. Mitochondrial region shows distinctive sequences for individual species. A total of 90 sequences were submitted to GenBank under the accession numbers, EU847510, EU847512-EU847514, GU195050-GU195124 and HM147881- HM147891. While *Catla catla (Hap1Cc & Hap2Cc)*, *Cirrhinus mrigala (Hap1Cm & Hap2Cm), Labeo calbasu (Hap1Lc & Hap2Lc) and L. bata (Hap1Lb & Hap2Lb)* showed two haplotypes each, there was only a single haplotype in *Labeo rohita (Hap1Lr)* and *Labeo fimbriatus (Hap1Lf)*. Alignment of partial sequences of the haplotypes showed 491 identical sites and 110 variable sites with 96 transitions, 5 transversions and 9 pairs showing both transition and transversion. The analysis revealed nucleotide frequencies as T=28.1, C=27.6, A=26.7 and G=17.7.

Sequence divergence

Highest intergeneric divergence was between *C. catla* and *C. mrigala*, while the highest interspecific divergence was shown by *L. bata* and *L. calbasu*. In general, *C. mrigala* showed high sequence divergence from other carp species studied here. Lowest intergeneric sequence divergence was between *C. catla* and *L. fimbriatus*. The average intraspecific divergence was 0.17% for *C. catla*, *L. mrigala, L. calbasu* and *L. bata* whereas 0.00% for *L. rohita* and *L. fimbriatus*.

Phylogenetic analysis

Bootstrap analysis consensus trees obtained from Neighbor Joining and Maximum Parsimony (Fig. 19 a&b) showed similar pattern in the genetic relationship among the carp species.

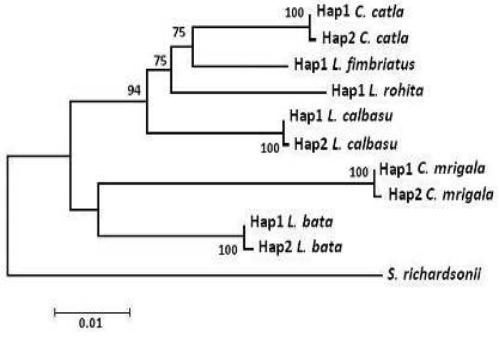


Fig.19(a) Neighbor Joining (NJ) consensus trees of Indian carp haplotypes inferred from mtDNA COI. The numbers on the modes represent bootstrap values. The numbers in the parenthesis represent the number of fishes of each species found to have that haplotype. *Schizothorax richardsonii* is the outgroup.

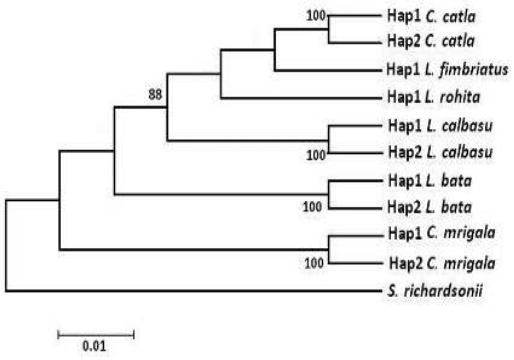


Fig.19(b) Maximum Parsimony (MP) consensus trees of Indian carp haplotypes inferred from mtDNA COI. The numbers on the modes represent bootstrap values. The numbers in the parenthesis represent the number of fishes of each species found to have that haplotype. *Schizothorax richardsonii* is the outgroup.

Broadly, there were 2 clads, Clad I represented by catla, rohu, fimbriatus and kalbasu, while Clad II represented by mrigal and bata. There were four sub-trees with high bootstrap values. Sub-tree of mrigal cluster was closer to that of bata than to others. Sub-trees of catla and fimbriatus were tightly clustered and showed separation from rohu and kalbasu.

A total of 90 DNA barcode sequences for catla, rohu, mrigal, fimbriatus and bata were deposited in Gen Bank. Close genetic relationship between catla and fimbriatus as well as paraphyly within the genus *Labeo* were evident

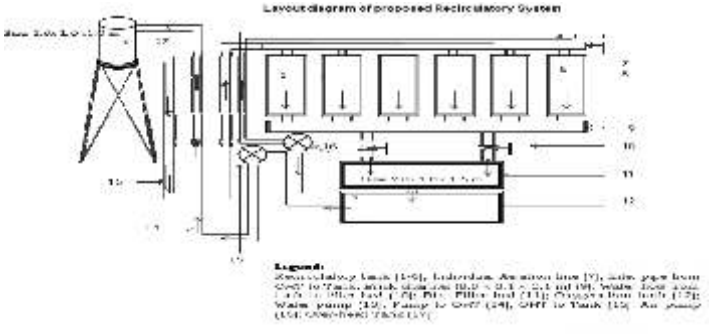
Sub-project	:	Improvement of production efficiency and rearing time of full-sib families of Jayanti rohu (*Labeo rohita*) in recirculatory system
Project code	:	I-59(f)
Funding Agency	:	Institute-based
Duration	:	April 2009 – March 2011
Project Personnel	:	J. N. Saha (PI), K. D. Mahapatra and Bikash Sarkar

Three days old Jayanti rohu spawn were stocked in six FRP circular tanks (445 L capacity) at three stocking densities (250, 500 and 1000 nos.) in duplicate. Sieved groundnut oil cake powder and rice polish/bran in mixed 1:1 ratio were fed three times a day. Apart from partial running water, every week tanks have been cleaned completely and fresh pond water added. Water flow was maintained 5 to 6 litres/ min.

During Ist sampling i.e. after 85 days rearing of spawn, a large variation in growth pattern was observed in different tanks. Partials of stocking and growth rate of species are furnished in table 5. It has been observed that growth in FRP tanks is not uniform.

Table 5 Growth of "Jayanti rohu" in partial running water tanks with different stocking density

Tank No.	Stocking density (24.08.2009)	Stocking size	Ist sampling size, mm (20.11.2009)			Final sampling size, mm (02.02.2010)			Water flow per min.
			Max.	Min.	Average	Max.	Min.	Average	
1 2	250	Spawn	91	18	37.3	105	22	75.4	5 to 6 lit./min
3 4	500	Spawn	92	14	34.7	93	20	70.8	
5 6	1000	Spawn	60	15	26.5	82	18	51.2	



Sub-project	:	Selective breeding *Macrobrachium rosenbergii* for resistance to *Macrobrachium rosenbergii* noda virus
Project code	:	I-59(g)
Funding Agency	:	Institute-based
Duration	:	April 2009 – March 2010
Project Personnel	:	A. E. Eknath (PI) and P. K. Sahoo

To develop a challenge model, suspected prawn samples from hatcheries and farms of different parts of Andhra Pradesh and Tamil Nadu were collected and tested by RT-PCR-based diagnostics developed at this Institute to detect nodavirus. Only two samples received from A.P. were found positive. The virus suspension received from OIE reference laboratory was used to propagate virus in *in vitro* (using C6/36 cell line) as well as *in vivo*. The *in vitro* multiplied virus material failed to reproduce the disease in PLs. Attempts are being taken to multiply virus in PLs to generate sufficient viral inoculums for challenge of *M. rosenbergii* families.

Project Title	:	Molecular studies on HUFA synthesizing capabilities of rohu, *Labeo rohita* (Ham)
Project Code	:	E-43
Funding Agency	:	DBT
Duration	:	January 2008–December 2010
Project Personnel	:	S. Nandi (PI), S. S. Giri, P. K. Mukhopadhyay and S. N. Mohanty

Transcript level of HUFA-synthesizing enzyme delta 6-desaturase in rohu was highest in vitellogenic female followed by fingerling, juvenile and spawn. Of the two transcripts, the lower one was intense in fingerling and juvenile, but absent in the adults of both sexes

1) Tissue expression study of delta-6 desaturase

RT-PCR: As delta 6-desaturase catalyzes the committing and rate-limiting step for the entry of 18:3n-3(α-linolenic acid) into the HUFA synthesis pathway for its ultimate conversion into EPA/DHA, the tissue level availability of Its transcript was further investigated (as reported in the previous annual report). Estimation of delta 6-desaturase expression was repeated by semi quantitative RT-PCR with the liver RNA of all the stages like fingerling, juvenile, grow out and adult as well as in total RNA of three day old spawn. The relative expression was compared in the agarose gel during exponential phase of amplification for both beta actin and desaturase at the PCR cycle number of 23. Not much variation in the band intensity could be appreciated among different growth stages after normalization with beta actin, except a little lower in case of spawn and comparatively lower intensity found in adult (Fig.20, panel a,b).

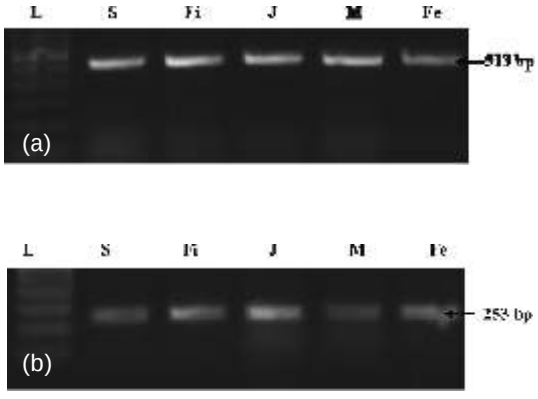


Fig.20 RT PCR of liver cDNA with (A)beta actin(513bp) and (B)desaturase(253bp)primers:
L-100bp ladder, S-Spawn (3 days), Fi-Fingerling (30 g), J-Juvenile (150 g), M- Male (850 g), Fe-Female (700g)

Real time PCR: Relative transcript level during different growth stages (spawn, fingerling, juvenile and adult) of rohu was further quantified by real time PCR using 1st strand cDNA as template mixed with 10µl SYBR Green I master mix. (Roche, Germany) and 10pmol of each primer (LightCycler480, Roche). It showed that transcript level was highest in vitellogenic female, followed by fingerling, juvenile and spawn; and the least was observed in grow-out and adult male (Fig.21).

Northern blot: On the other hand, two transcripts (upper and lower) of about 1kb difference were identified by the desaturase cDNA probe in the Northern blot, among which the lower one was present in all the stages with almost equal intensity but the upper transcript was more intense in fingerling and juvenile stages as compared to hatchling (spawn); but was almost

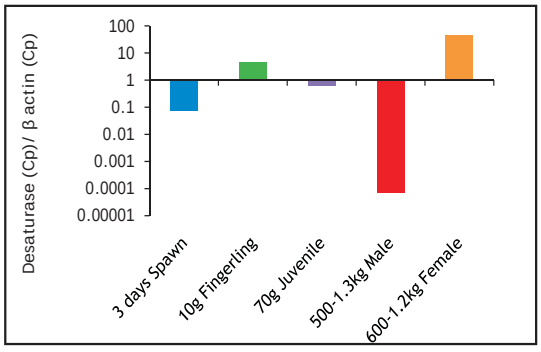


Fig.21 Realtime PCR estimate of relative transcript level of ?6 desaturase in rohu

absent in adult (Fig.22, panel a,b). Interestingly, it was again found in vitellogenic female indicating its reappearance during this stage. Further

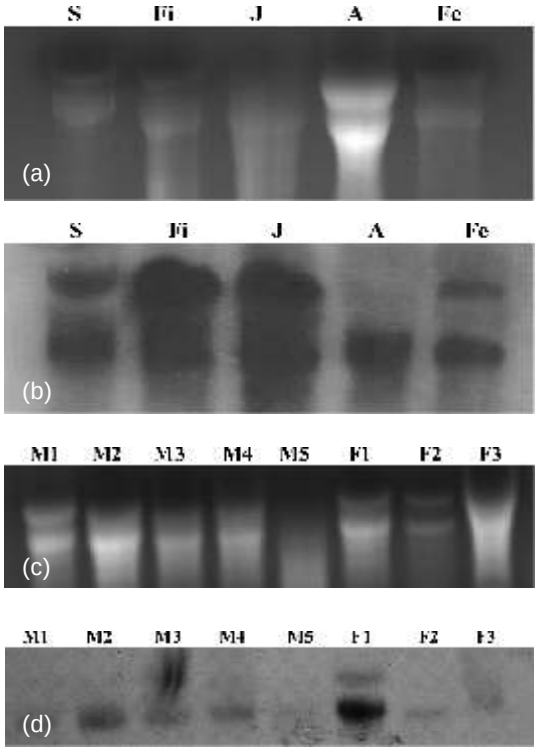


Fig.22 Northern Blot (panel B&D) of liver RNA (panel A&C) from different stages of rohu with 6 Desaturase probe

Panel a & b: S- Spawn (3 days), Fi- Fingerling (30 g), J- Juvenile (150 g), M- Adult Male (850 g), Fe- Adult female (700g) ;

Panel c & d: M1- male (590g, 34cm), M2-male (600g, 36cm) M3-male (750g, 39cm,), M4-Male (750g, 36cm), M5- male (1000g, 42cm), F1-female (550g, 30cm), F2-Female (400g, 32cm), F3-Female (700 g, 33cm)

northern experiment with rohu liver RNA from all adult males and females (Fig.22,panel c,d) showed that the larger transcript was absent in both the male and female rohu except during vitellogenesis.

2) Enzyme activity of delta-6 desaturase in rohu liver microsomes

Delta-6 desaturase activity of hepatic microsomes were estimated spectrophotometrically by monitoring NADH induced reduction and linoleoyl-CoA stimulated reoxidation of cytochrome b_5 in a dual wavelength spectrometer(model Varian 50 bio) at 424 and 409 nm. Desaturase assay in the liver microsomes of different growth stages revealed that fingerling (10g) possess the maximum activity, followed by juvenile (70g), but was significantly lower in grow out(180g) as well as in adult stages(500g & above)(Fig.23) However, the enzyme activity was observed markedly increased in vitellogenic female even more than that observed in fingerlings.

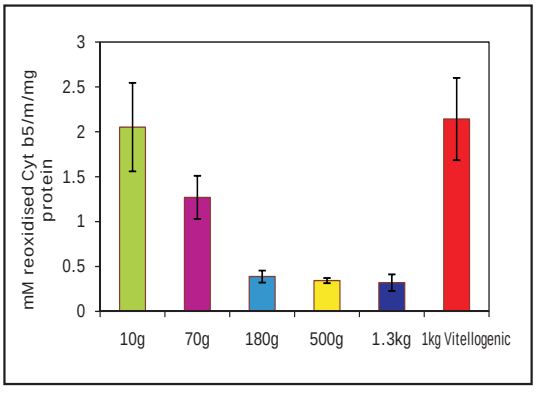


Fig.23 Delta 6 Desaturase activity of rohu liver microsomes in different growth stages

3) Feeding trial with different oil supplementation

A 90 days feeding trial was conducted in the nutrition yard of the institute to study the effect of feeding different oil supplements on the regulation of liver delta-6 desaturase both at transcript level as well as microsome enzyme activity level of *L. rohita* fingerlings. For the purpose 5(five) iso- proteineous (30% cp) and iso-lipidic (8%) formulated feeds, f-1, f-2, f-3, f-4 & f-

5 were prepared containing fish oil, linseed oil, ground nut oil, mustard oil and mixed veg oil (Lin: GN: Soya = 1:1:1) respectively as oil supplements. Each treatment group was having three replicates each containing 12 fingerlings. The liver samples for each treatment group were collected at the end of experiment making a pool from each replicate. The samples for transcript study were collected in liquid nitrogen and kept at –80^{0}C for further analysis where as the liver microsomes were prepared under ice on the same day for enzymatic study. Comparison of desaturase activity among fingerlings fed with different oil treatments showed maximum activity in linseed oil group, which was still lower than normal fingerlings (without any oil supplementation). This was followed by mustard oil and ground Nut oil treatment groups. Activity was found most suppressed (reduced) in fish oil and mixed oil treatment groups (Fig.24).

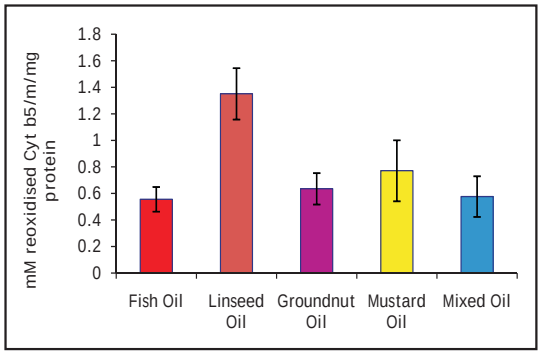


Fig.24 Delta 6 Desaturase activity of rohu fingerlings in liver microsomes with different feed (oil)treatments

Spermatogonia transcription factor Plzf and Oct-4 in rohu were cloned, sequenced and submitted in GenBank. These genes are potentially useful to identify and characterize differentiated states of spermatogonial cells during *in vitro* propagation

Project Title	:	Exploring *in vitro* culture and characterization of spermatogonial stem cells (SSCs) of Indian major carp, *Labeo rohita*
Project Code	:	E-46
Funding Agency	:	DBT
Duration	:	May 2008 – April 2011
Project Personnel	:	H. K. Barman (PI) and A. Saha

Spermatogenesis is under the dual control of extrinsic and intrinsic drivers. Local regulation involves intercellular communication between germ and sertoli cells, and between sertoli, myloid and interstitial leydig cells through growth factors including neutrotropic factors such as glial cell- line-derived neutrotropic factor (GDNF). *Gfr1* and RET are the two receptors of GDNF. *Gfr1* is expressed during GDNF mediated SSC – renewal. It is a SSC-specific gene with a critical function of self-renewal and maintenance of SSC. Thus it can be used as a good marker gene in studying the SSC-self renewal. Little is known about the molecular mechanism by means of which spermatogonia can self renew. It has been shown that Zfp-145, encoding the transcriptional repressor *Plzf*, has a crucial role in spermatogenesis. *Plzf* expression was restricted to gonocytes and undifferentiated spermatogonia. *Plzf* is spermatogonia specific transcription factor in the testis, required for self-renewal and maintenance of stem cell pool. The SCF and its receptor *c-Kit* are an appropriate example to illustrate the role of signaling molecules in the physiology and pathology of spermatogenesis. The SCF/*c-Kit* regulates primodial germ cells migration, proliferation, and apoptosis during fetal gonadal development. SCF/*c-Kit* also regulates Spermatogonial proliferation, survival and differentiation in adult animal. *Oct-4* is a transcription factor expressed in germ cells. *Oct-4* is crucial for the maintenance of the totipotency of stem cell. Keeping this in view, these important gene were cloned and sequenced.

The sequence information of *Plzf* and *Oct4* of *L. rohita* was submitted into GenBank database (GenBank Acc no # GU338377.1 and GU443948.1). Similarly, the 457 bp and 416 bp of *Gfr1* and 677 bp and 716 bp of *c-Kit* were characterized by sequence analysis. The BLAST search revealed that the sequenced data received upon sequencing matches with zebra fish databases (ranging homologies 90% - 97%). These genes will be of great help in identifying and characterizing undifferentiated vs differentiated state of

spermatogonial cells during *in vitro* propagation. In addition, sequence data of Exon1 can be utilized for characterizing and isolating 5'-flanking regions, containing promoter/regulatory elements, of SSC-specific genes such that of *Oct-4* and/or *Plzf* being involved in SSC self-renewal activities. A suitable reporter vector driven by these promoter/regulatory elements can be constructed for the purpose of *in vivo* characterization. Further, rohu SSC population was enriched by gradient centrifugation followed by MACS (magnetic activated cell sorting) using *Gfr1*and *Thy1*$^{+}$ antibodies. Thereby, rohu undifferentiated spermatogonial cells could be propagated *in vitro*.

Project Title	:	Construction and analysis of Expressed Sequence Tag libraries for rohu *Labeo rohita* (Ham)
Project Code	:	E-47
Funding Agency	:	DBT
Duration	:	July 2008 – July 2010
Project Personnel	:	S. Nandi (PI), P. Das, H. K. Barman, P. K. Meher, A. Saha and R. K. Hazra

i) Analysis of rohu brain and liver EST libraries

Till today about 2100 clones from the two normalized cDNA libraries (Brain and liver) were sequenced in 16 channel 3130 Ix automated sequencer (Genetic analyser, ABI), out of which sequence data could be obtained for 1928 clones. Among these 1016 clones were from brain library deriving 775 readable sequence and 912 clones were from liver library of which 873 were readable. The repeat sequences were removed. It was observed that the 775 readable sequence of rohu brain produced 105 contigs and 598 singletons, resulting a total of 703(91%) unique sequences. Similarly, 873 readable liver ESTs produced 81 contigs and 631 singletons, resulting together 712 (86%) unique sequences. Sequences were analysed after removing vector sequences as well as adapter and primer sequences from both ends before searching for the homologies against the database. The homologies were searched by using Basic Local Alignment Search Tool (BLAST) of NCBI. The sequence analysis was carried out for the 427 sequences of brain and 833 sequences for liver. It showed that among the brain ESTs 131(30%) having significant similarities to known genes (BLASTx hits), whereas 229 (54%) showed similarities with unannotated sequences (BLASTn hits) and 16 (4%) sequences were found totally novel (having no similarity in the database). Three hundred and thirty (40%) liver ESTs were having similarities to known genes (BLASTx hits), whereas 458 (55%) showed similarities with unannotated sequences (BLASTn hits) and 45 (5%) sequences were found totally novel (having no similarity in the database). Two hundred and two brain ESTs (GR426801-GR426902 and GR463794-GR463893) and 235 liver ESTs (GR957987-GR958186 and GR977067- GR977101) were deposited in GenBank EST database (Table 6).

Analysis of rohu brain and liver ESTs revealed 86% of non-redundant sequences and 4% normal sequences

Table 6 Analysis of Rohu Brain and Liver ESTs

	BRAIN	LIVER
No. of clones sequenced	1016	912
Readable sequences	775	873
Data analyzed	427	288
Average length	500bp	450bp
Contigs	(320-1300 bp range): 23(49 sequences)	200- 700 bp range) 18(46 sequences)
Singletons	346	230
Non redundant sequences	369 (86%)	248 (86%)
Known sequences (BLASTx hits)	131 (30%)	136 (50%)
Un-annotated sequences (Only BLASTn)	229 (54%)	128 (46%)
Novel sequences	16 (4%)	12 (4%)
Submitted to NCBI Database	202	235
Accession numbers	GR426801-GR426902 and GR463794-GR463893	GR957987-GR958186 and GR977067-GR977101

2) Construction of new normalized libraries for intestine and trunk kidney of rohu :

Construction of two new normalized libraries for Intestine and Kidney of rohu has been initiated with the collection of these tissues from different phases and growth stages under liquid nitrogen and kept frozen at –80^{0}C. RNA were isolated from these tissues and integrity was checked in denaturing gel (Fig.25 a, b).

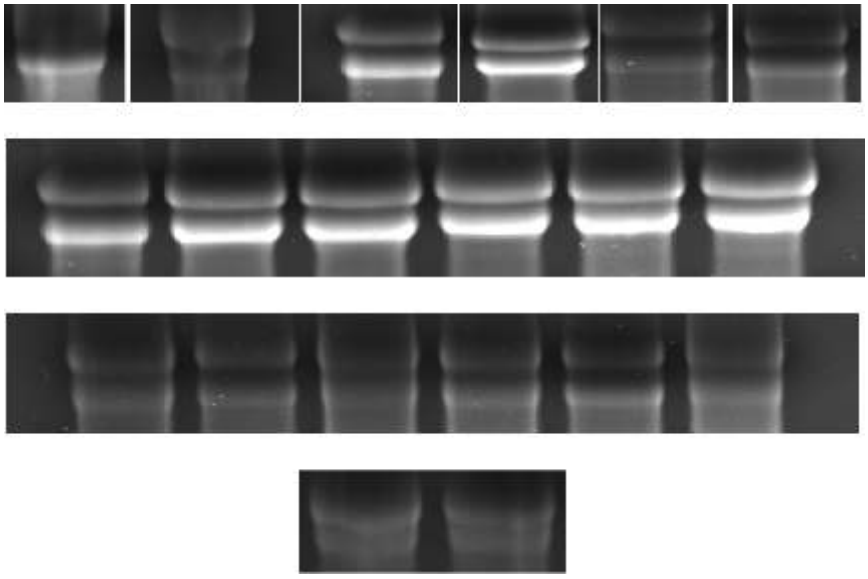


Fig.25(a) RNA of intestine from different growth stages of rohu

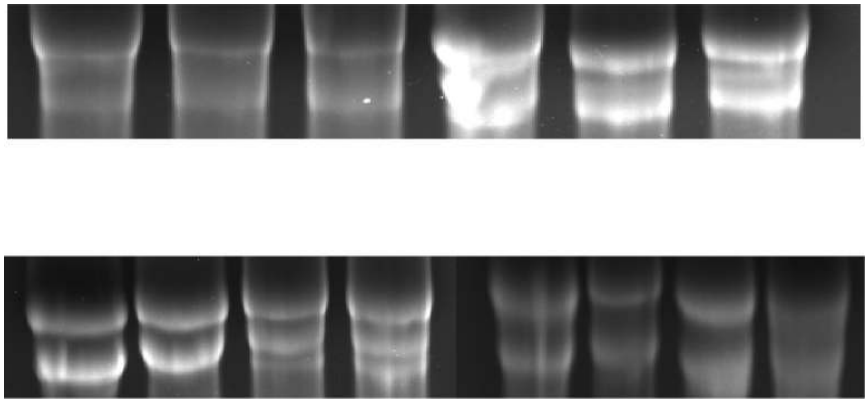


Fig.25(b) RNA of trunk kidney from different growth stages of rohu

Project Title	:	First generation linkage map in *Labeo rohita* (rohu): A potential genomic resource for identification of trait associated genes.
Project Code	:	E-59
Funding Agency	:	DBT
Duration	:	September 2009–August 2012
Project Personnel	:	P. Das (PI), P. K. Meher, L. Sahoo and P. Jayasankar

Large scale DNA extraction of existing linkage-mapping panels (R1xK2-2008 & R2xK2-2008; 100 individuals each family) was complete. Evaluation of these two families using 63 rohu microsatellite markers resulted in more than 40% and 30% informative loci, respectively. Database search for repeats, heterologous primer designing, Oligo synthesis & cross- species amplification was completed for about 100 loci initially. About 10% of the loci were found to be informative in mapping panels. Enriched library preparation is under progress.

C. Fish Nutrition and Physiology

Project Title	:	Sustainable aquafeeds to maximize the health benefits of farmed fish for consumers (AquaMax)
Project Code	:	E-35
Funding Agency	:	European Commission
Duration	:	April 2006 – August 2010
Project Personnel	:	S. N. Mohanty (PI) and S. S. Giri

Aquamax is a European Commission funded integrated project in which 32 laboratories from 14 countries are participating. The strategic goal of Aquamax is to replace as much as possible of the fish meal and fish oil currently used in fish feeds with sustainable, alternative feed resources that that are as free of undesirable contaminants as possible, consistent with maximizing the growth performance, feed conversion efficiency, health and welfare of the farmed fish, and maximizing the health promoting properties, safety, quality and acceptability of the final product to the consumer. In case of IMC the largest portion of aquaculture production is derived from polyculture of carp with other freshwater species. Therefore, the research in carp feeding covers studies on utilization of omega-3 fatty acids from natural food resources. The research on compounded feeds is motivated by an increase in the intensive culture of carp. Worldwide, about 80 percent of carp is farmed without the use of modern compounded feeds.

An experiment was conducted to study the effect of complete replacement of fish meal and fish oil by plant ingredients on fillet EPA, DHA and fatty acid profile in IMC in a 10 month pond culture study. The control feed contained fish meal and fish oil (Fig.26). The test feed contained all plant ingredients without any ingredient of animal origin (Fig.27). Replacement of fish meal with plant ingredient did not influence the fillet EPA and DHA levels in all three species of IMC.

Replacement of fish meal with plant ingredients did not influence the final EPA and DNA levels of catla, rohu and mrigal

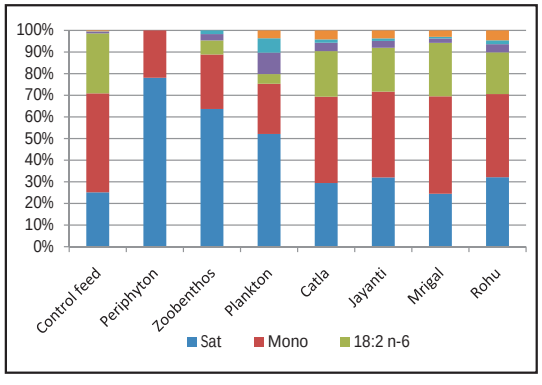


Fig.26 Fillet fatty acid profile of IMC fed fish meal and fish oil incorporated diet under Aquamax project.

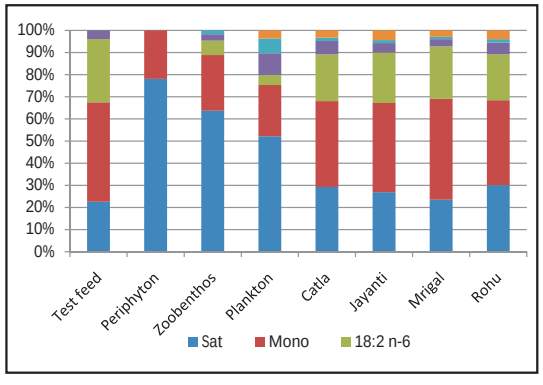


Fig.27 Fillet fatty acid profile of IMC fed all plant ingredient based diet under Aquamax project.

Project Title	:	Photothermal manipulation on neuroendocrine regulated reproduction in carp, *Labeo rohita* under controlled environment
Project Code	:	I-61
Duration	:	April 2007 – March 2010
Funding Agency	:	Institute-based
Project Personnel	:	S. K. Sarkar (up to August, 2009)(PI), Ashis Saha, S. Nandi, P. Routray, J. Mohanty, C. Devraj, S. Dasgupta (up to May, 2009) and D. K. Verma

Under controlled rearing system in an artificial photo-thermal regime, maturation in rohu brood stock was initiated during January and by the end of February, complete gonadal development was attained

Fig.28 November 2009

Fig.29 January 2010

Fig.30 Matured during feb 2010

Off season gonadal maturation experiment was repeated during 2009-10. Matured male and female rohu were bred during August, 2009 and spent broods (0.6-1.3 kg) were kept in rearing pond (0.1 ha) for one and half months before putting them in actual experimental tanks. Nine pairs of male and female rohu were stocked under controlled rearing system in an artificial photo thermal regime during first week of October, 2009. Sign of initial gonadal development (bulging of anterior abdomen) in some of the fishes could be observed by the sampling done on 19th of November (Fig.28). Ovarian maturation was clearly appreciable in fish during 3rd week of January 2010 as assessed by secondary sexual characteristics (Fig.29). The sampling done during 4th week of February showed almost completion of gonadal development as assessed by physical appearance like bulging of abdomen, protruding vent etc. (Fig.30)

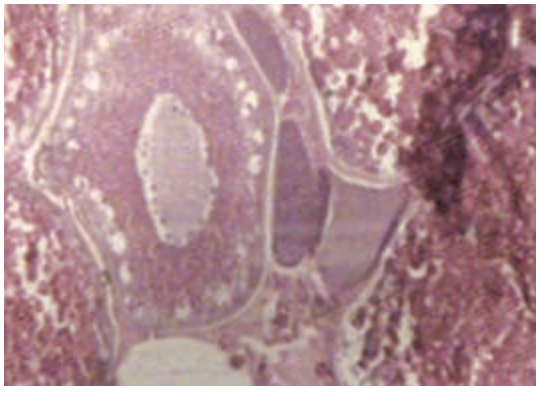


Fig.31 T.S. through developing oocytes with initiation of yolk vesicles during Oct.

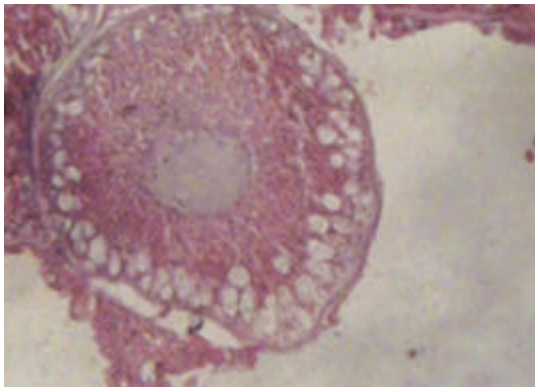


Fig.32 T.S. through developing oocytes with yolk vesicles laddened with yolk during October.

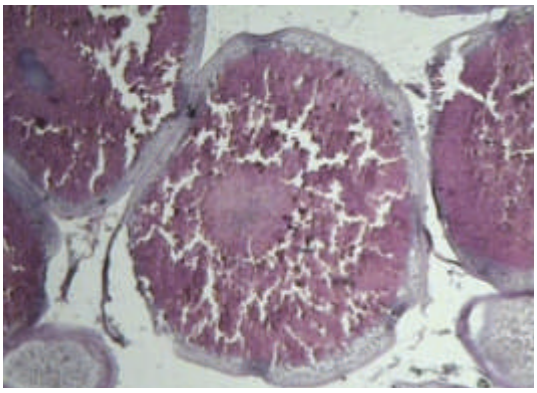


Fig.33 T.S. through developing ovary with centrally placed GV and yolk arround during Nov

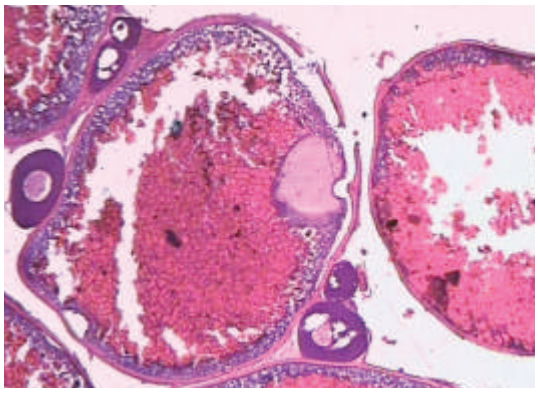


Fig.35 T.S. through matured oocytes showing ascentric position of GV and the micropyle there in Dec.

Histomorphological observation of ovarian maturation

Rohu was bred during last week of July and spent brood were kept in rearing pond for six weeks. Healthy spent fish were stocked under photothermal condition during 1st week of September. Periodic sampling was done to study gonadal growth of the fish and histomorphological study was carried out on collected ovarian samples. During 2nd week of October ovaries showed stage of non-vitellogenic oocytes and initiation of yolk deposition (Figs. 31 & 32). Vittelogenic oocytes with centrally placed GV was observed during November (Fig.28). Same oocytes became gravid during November and December with acentric GV (Fig.33). The mycropyle was clearly observed during the period (Fig.34).

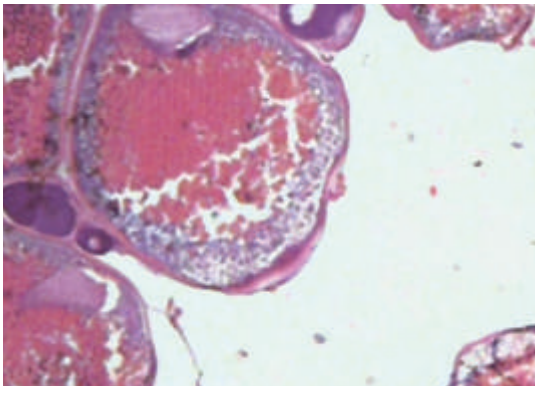


Fig.34 T.S. through matured ovary shows ascentric GV, yolk materials and oocyte envelope

Project Title	:	Energy metabolism in Jayanti rohu
Project Code	:	I-66
Funding Agency	:	Institute-based
Duration	:	April 2009 – March 2011
Project Personnel	:	C. Devaraj (PI), S. N. Mohanty, S. C. Rath and S. Sarkar

Pre-feeding and postprandial oxygen consumption and carbon dioxide production were measured in fry (60.02±0.01 mg) and fingerlings (2.99±.03 g) of Jayanti rohu and normal rohu. The energy equivalent of metabolic rates was calculated by using a weighted oxycalorific coefficient (13.6 kJ/g O_2) (Tables 7 & 8)

Results indicated that the mean routine metabolic rate in unfed fishes did not vary significantly ($p>0.05$) over a 24 h period. Post-feeding oxygen uptake and carbon dioxide production increased significantly ($p<0.05$) over routine rate in fishes fed with 25 and 30% protein incorporated diets. Post-feeding oxygen consumption and carbon dioxide production were significantly ($p<0.05$) higher in fry of Jayanti rohu compared to control rohu (Figs.36 & 37). Similarly, in the Jayanti rohu fingerlings the post-prandial oxygen consumption rate was significantly ($p<0.05$) higher than fingerlings of control rohu (Fig.38).

Post feeding Oxygen consumption and Carbon-dioxide production as well as post-prandial Oxygen consumption rate were significantly higher in the improved (Jayanti) rohu in comparison with normal counterpart

Table 7 Oxygen uptake and carbon dioxide production during unfed and post-feeding of the Jayanti rohu and control rohu when fed on 25 and 30% protein diets (mean ±SD)

	Oxygen uptake (ppm/g/day)			Equivalent energy (kJ/g/day)			Carbon dioxide production (ppm/g/day)		
	Pre-feeding	Post-feeding (Protein %)		Pre-feeding	Post-feeding (Protein %)		Pre-feeding	Post-feeding (Protein %)	
		25%	30%		25%	30%		25%	30%
Jayanti rohu fry	19.38 ±0.23	26.45 ±0.17	30.93 ± 0.13	0.26 ± 0.003	0.36 ± 0.002	0.42 ± 0.002	17.82 ± 0.02	21.26 ± 0.02	26.24 ± 0.01
Normal rohu fry	19.32 ±0.31	23.25 ±0.19	27.84 ± 0.25	0.26 ± 0.004	0.31 ± 0.003	0.37 ± 0.003	17.63 ± 0.01	21.05 ± 0.01	24.11 ± 0.02

Table 8 Oxygen uptake and carbon dioxide production during unfed and post-feeding of the Jayanti rohu and control rohu

Fingerlings	Oxygen uptake (ppm/g/day)		Equivalent energy (kJ/g/day)		Carbon dioxide production (ppm/g/day)	
	Pre-feeding	Post-feeding	Pre-feeding	Post-feeding	Pre-feeding	Post-feeding
Jayanti rohu	4.76 ± 0.01	8.01 ± 0.05	0.065 ± 0.0001	0.11 ± 0.001	4.1 ± 0.02	6.9 ± 0.01
Normal rohu	4.74 ± 0.02	6.65 ± 0.06	0.064 ± 0.0002	0.09 ± 0.001	3.72 ± 0.02	5.44 ± 0.02

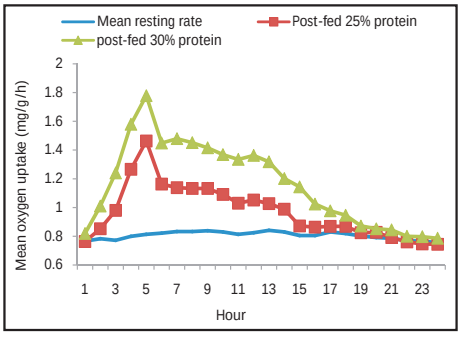


Fig.36 Changes in mean oxygen uptake over mean resting rate in Rohu fry on 25 and 30% protein diet

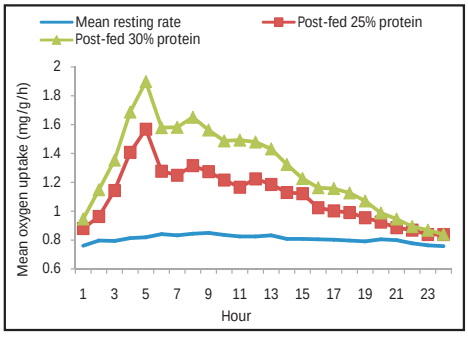


Fig.37 Changes in mean oxygen uptake over mean resting rate in Jayanti rohu fry on 25 and 30% protein diet

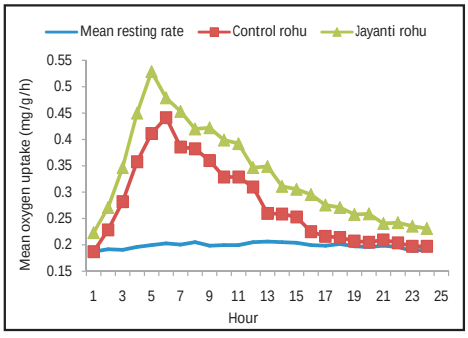


Fig.38 Changes in mean oxygen uptake over mean resting rate in Jayanti rohu and normal rohu fingerlings

OUTREACH PROJECTS

Project Title : Outreach activity on fish feed (Activities 1-4)

Funding Agency : ICAR

Duration : April 2008- March 2012

Project Personnel : P. K. Mukhopadhyay (PI) (up to August 2009), S. S. Giri (from August 2009) (PI), S. N. Mohanty, P. K. Mukhopadhyay, P. V. Rangacharyulu, N. Sridhar, S. K. Sahoo, P. C. Das, S. C. Rath and D. N. Chattopadhyay

Activity-1 : Feed enhancement and larval growth and survival of *Pangasius pangasius*

Co-PI and Nodal Officer: S. S. Giri

Co-PI : S. K. Sahoo

Feeds were formulated and tested to wean *Pangasius pangasius* larvae. It was observed that after 8-10 of days of hatching larvae accepted the artificial feeds. Acceptability of feeds by the larvae was very good and the survival of larvae was about 35-40% on feeding formulated feeds.

Activity-2 : Feed technology development for pond and cage culture of IMC and peninsular carps

Co-PI and Nodal Officer : Dr. S. N. Mohanty

Co-PIs : P. K. Mukhopadhyay, N. Sridhar, S. C. Rath, P. C. Das and D. N. Chattopadhyay

Feeding demonstration in farmers ponds

Six ponds in three different villages were selected for demonstration. In each village, demonstration of dough and pellet feeds was done for feeding of IMC in polyculture ponds. Hands on training was provided to prepare farm made feed to the fish farmers at the farm sites. Locally available feed ingredients such as sunflower oil cake (SOC), til oil cake (TOC), mustard oil cake (MOC) and rice bran were collected and three feeds were formulated with average crude protein 25% and crude lipid of 6-8% at farm site and the production cost ranged from Rs. 10-12.per kg feed. Feeds were applied both in form of pellet and dough separately in different ponds. The data on ingredient component, proximate composition of feed and fish, stocking and harvesting as well as expenditure and income is presented in tables 9-14.

Oil cakes such SOCs, TOC and MOC can be used as cheap source of plant protein to prepare farm made feeds for carp culture. Feed in pellet form certainly give better result than dough form

Table 9 Ingredients composition (%) and cost of feed/kg (Rs)

Ingredients (%)	Feed 1	Feed 2	Feed 3
SOC	51	10	13
TOC	10	42	10
MOC	10	10	40
RP	28	37	36
Vit & Min	1	1	1
Binder (wheat flour)	2	2	2
Cost/kg (Rs)	10.98	11.27	11.90

Table 10 Proximate composition of feed

Feeds (Major ingredient)	Crude protein (%)	Crude lipid (%)	Ash (%)	Crude fat (%)	NFE (%)
F1 (SOC)	24.22	7.43	8.31	19.94	40.1
F2 (TOC)	24.40	7.61	11.33	15.94	40.70
F3 (MOC)	26.07	6.40	9.63	14.59	43.31

Table 11 Initial proximate composition of whole body of IMC

Location	Species	Moisture (%)	Crude protein (%)	Crude lipid (%)	Ash
Site 1	Catla	76.67	66.90	08.55	20.8
	Rohu	76.25	69.54	12.18	16.0
	Mrigal	70.32	64.65	16.10	16.12
Site 2	Catla	75.28	72.22	8.36	15.30
	Rohu	79.43	74.26	06.84	16.12
	Mrigal	75.09	71.43	08.86	16.48
Site 3	Catla	79.50	68.14	6.26	21.96
	Rohu	77.13	68.72	7.50	21.20
	Mrigal	79.86	70.89	5.88	20.40

Table 12 Final proximate composition

Sites	Species	Moinsture (%)		Crude protein(%)		Crude lipid (%)		Ash (%)	
		Dough	Pellet	Dough	Pellet	Dough	Pellet	Dough	Pellet
Site-1	Catla	73.79	73.09	70.58	68.72	10.83	10.15	16.25	19.98
	Rohu	73.69	71.44	70.25	69.33	10.52	12.11	17.20	15.83
	Mrigal	73.71	69.61	71.00	66.78	9.87	15.50	17.40	15.27
Site-2	Catla	71.59	73.71	73.20	74.15	11.00	9.56	14.44	14.55
	Rohu	76.47	77.60	75.40	75.10	9.08	9.10	14.40	14.50
	Mrigal	71.42	71.11	73.22	72.88	10.75	10.10	15.00	16.00
Site-3	Catla	74.03	78.12	72.63	73.97	10.17	9.10	15.86	15.88
	Rohu	73.03	74.55	72.08	72.87	10.22	10.04	14.66	15.90
	Mrigal	71.93	73.85	71.85	72.39	10.12	10.17	15.24	16.12

Table 13 Stocking and harvest data of different demonstration ponds

Sites	Pond area/ Feed	Initial stocking Biomass	Total production (kg)	Production/ha (kg)
1 (MOC Based)	0.32 ha (Dough)	27.80	335	1047
	0.4 ha (Pellet)	68.04	623	1557
2 (SOC BASED)	0.4 ha (Dough)	130.6	1166	2915
	0.4 ha (Pellet)	156.9	1369	3422
3 (TOC BASED)	0.3 ha (Dough)	66.7	677	2257
	0.3 ha (Pellet)	94.1	750	2500

Stocking density 5000/ha
Feeding @ 2-3% of fish biomass

Table 14 Expenditure & Income

Site	Feed Types	Feed (kg) consumed	Fish (kg) produced	Apparent FCR	Expenditure (Rs)	Income (Rs)
1 (MOC Based)	Daugh	555	335	1.71	7404	18425
	Pellet	900	623	1.44	11510	34265
2 (SOC BASED)	Daugh	1440	1166	1.2	17111	75790
	Pellet	1525	1369	1.11	18444	88985
3 (TOC BASED)	Daugh	887	677	1.31	11096	44005
	Pellet	905	750	1.2	11299	48750

Hence, oilcake such as SoC, ToC and MoC can be used as cheap source of plant protein to prepare farm made feeds for carp culture . The feed in pellet forms gives better results than dough form.

On farm feeding trials for the peninsular carp *Labeo fimbriatus*

Fingerlings of *L. fimbriatus* of average weight 9.06±0.57 g were stocked in 9 numbers of cement cistern of 24 M^3 capacity. Three feeds were prepared with the composition as shown in Table15.The fingerlings were fed initially at 8% body weight with these three feeds. As the feed consumed was very minimal, the quantity of feed were reduced and fed at 4% of body weight. The final feeding rate was adjusted to 2.5 % for Feed No.1 and Feed Nos 2&3 at 2%. The initial proximate composition of the three feeds as well as the fingerlings was estimated. Water parameters were monitored regularly. Among the three feeds Feed 1 was well accepted and resulted in good growth of the fishes compared to Feed No 2 and 3.

Table 15 Composition of feed

Feed Ingredients	Feed 1	Feed 2	Feed 3
	% Incorporation		
Groundnut oil cake	49.5	-	-
Sunflower oil cake		40	38
Soyabean meal		18	13
Silkworm pupae meal			5
Rice bran	49.5	41	43
Vit & Min mix	1	1	1

Cage culture demonstration at Bishnupur (Bankura District), West Bengal

Feeding trial of carps in four cages (5X2X1 m^3) with pelleted feeds and dough form of feed at Pokabundh water impoundment (5.3 ha), Bishnupur, Bankura District of West Bengal is in progress. Cages were stocked with silver carp, catla, rohu and mrigal (1:1.5:3:4.5) at 675 fish/ cage with an average initial body weight of 3.3 g. The fish was fed by conventional hand feeding method with pelleted and dough form of feed. The ingredient composition of the feed (approx. CP 23% and fat 8%) was mustard oil cake (25%), linseed oil cake (25%), rice bran (40%), wheat flour (5%), common salt (1%), vegetable oil (3%) and vitamin-mineral premix (1%). A grinding machine and a feed pelletizer are provided to one Fishermen cooperative society having 18 members (Mallabhum Fisher Cooperative Society, Bishnupur, Bankura Dist.). They prepare the above feed for cage demonstration purpose.

Activity-3 : Setting up of poilot scale feed mill for scaling up of feed technology and demonstration

Co-PI and Nodal officer : P. V. Rangacharyulu
Co PIs : P. C. Das and S. C. Rath

Appropriate machines, required for the production of both floating and sem-isinking pellets at CIFA Campus, Kausalyaganga has been finalized for procurement. The feed mill can produce 100-250 kg feed of different pellet size per hour.

Activity-4 : Setting up of a national feed testing facility for quality assessment certification

Co-PI and Nodal Officer : P. K. Mukhopadhyay

Co-PIs: S. N. Mohanty, P. V. Rangacharyulu, N. Sridhar, B. N. Paul, S. S. Giri and S. C. Rath

Required equipments are proposed and some of the equipments are prioritized for procurement.

Project Title : Outreach activity on nutrient profiling and evaluation of fish as a dietary component

(CIFA Component)

Funding Agency : ICAR

Duration : April 2008- March 2012

Project Personnel : *S. N. Mohanty (P.I)*
B. N. Paul and N. Sridhar

Fish samples of various size groups were collected from different sources on different seasons from West Bengal, Orissa, Chhatisgargh and Karnataka for analysis. Data on proximate composition of IMC and catfish including climbing perch are presented in Tables 16 & 17 whereas mineral content of the fishes are given in Tables 18 & 19. The vitamin content of *Heteropneustis* and *Anabas* are shown in Table 20.

Table 16 Proximate composition of IMC (% w/w basis)

Particulates	Weight groups (g)	Moisture (%)	Crude protein (%)	Fat (%)	Ash (%)
Labeo rohita	≤50	62.05-80.59	9.86-23.02	0.94-4.09	2.12-5.79
	>50-500	60.45-79.31	12.00-24.99	0.76-3.83	1.98-4.33
	>500-2000	70.05-79.16	11.25-23.57	0.75-4.82	1.81-4.22
	>2000	73.88-77.58	14.29-17.45	1.1-4.81	1.72-2.65
Catla catla	≤50	77.32-81.15	10.34-15.06	1.82-2.29	3.34-3.67
	>50-500	68.33-82.00	11.71-19.83	1.4-3.08	2.55-4.17
	>500-2000	70.37-78.60	14.3-17.53	1.15-5.39	2.41-3.51
	>2000	69.28-76.02	14.54-21.43	2.57-8.94	1.76-3.05
Cirrhinus mrigala	≤50	66.74-79.37	10.91-15.1	0.99-3.98	2.5-4.34
	>50-500	72.45-79.35	15.1-18.85	1.27-3.28	2.66-4.05
	>500-2000	71.03-80.1	12.61-18.72	1.17-5.03	2.13-3.46
	>2000	73.93-75.95	15.31-18.1	1.12-6.49	2.09-2.83

Table 17 Proximate composition of catfish and perch (% w/w basis)

Particulates	Weight groups (g)	Moisture (%)	Crude protein (%)	Fat (%)	Ash (%)
Clarias batrachus	≤50	62.39-78.06	15.27-17.38	2.91-3.77	1.77-2.42
	>50	73.94-78.10	15.17-17.52	0.7-6.62	2.09-2.59
Heteropneustes fossilis	≤50	70.17-79.34	14.43-19.5	2.26-5.52	1.79-3.07
	>50	65.43-81.48	13.21-20.26	1.3-8.64	2.24-3.5
Anabas testudineus	≤50	62.72-77.02	14.29-18.97	1.92-18.97	2.71-7.59
	>50	61.94-67.65	12.67-17.49	7.35-14.52	3.82-7.16

Table 18 Mineral content of IMC (mg/100 g w/w basis)

Particulates	Weight(g)	Na	K	Ca	Fe	Mn	Zn	Se
Labeo rohita	≤50	151.1-232.55	152.11-387.02	45.39-207.39	1.64-3.72	1.32-2.1	2.86-4.83	0.15-1.20
	>50-500	124.55-257.76	179.35-337.64	57.47-253.76	0.77-2.52	0.19-2.6	1.12-2.44	0.05-0.94
	>500-2000	135.88-214.71	175.43-342.85	66.12-160.21	0.89-3.49	0.19-0.48	1.03-2.44	0.05-1.51
	>2000	180.07-186.44	326.06-340.87	46.08-50.18	2.13-2.52	0.21-0.31	1.2-1.34	0.7-1.16
Catla catla	≤50	169.61-171.51	243.55-249.08	145.38-167.08	1.82-3.16	0.21-0.51	0.01-3.89	0.13-0.54
	>50-500	136.42-188.59	254.46-329.19	26.65-188.23	0.9-5.63	0.1-0.96	0.01-3.75	0.13-1.55
	>500-2000	154.71-224.74	264.6-343.34	25.68-161.92	0.99-5.09	0.08-0.54	0.04-2.04	0.14-0.87
	>2000	162.2-231.4	206.4-281.74	43.17-172.27	1.16-3.38	0.21-0.63	0.94-1.18	0.26-0.78
Cirrhinus mrigala	≤50	176.43-182.07	157.5-321.89	57.46-286.56	2.75-5.1	0.34-0.53	2.09-2.23	0.08-1.15
	>50-500	130.14-202.48	224.22-239.31	38.69-241.46	1.00-2.99	0.11-0.55	0.05-1.77	0.02-1.22
	>500-2000	158.07-237.35	225.64-326.19	90.62-252.27	0.84-3.56	0.33-0.6	0.17-1.16	0.12-0.61
	>2000	162.48-164.88	237.26-290.38	135.57-155.24	1.58-1.96	0.43-0.44	0.940.99	0.24-0.26

Table 19 Mineral content of catfish and koi (mg/100 g w/w basis)

Particulates	Weight (g)	Na	K	Ca	Fe	Mn	Zn	Se
C batrachus	≤50	149.39-205.48	216.35-241.99	7.56-7.98	0.25-1.29	0.1-0.16	0.39-0.47	0.22-1.19
	>50	152.42-223.7	205.27-259.97	8.01-85.32	0.61-2.64	0.08-0.7	0.54-1.35	0.16-2.34
H fossiliis	≤50	154.36-231.75	189.93-309.35	13.26-110.31	2.83-7.53	0.24-1.03	0.17-1.53	0.02-1.33
	>50	131.25-217.73	161.67-375.46	52.72-274.78	1.21-5.49	0.31-0.95	0.46-2.69	0.15-1.2
A. testudineus	≤50	156.06-252.88	75.89-218.54	135.95-271.09	2.16-12.01	0.3-1.24	0.1-2.06	0.11-1.4
	>50	138.52-199.28	192.07-256.31	117.73-268.57	1.33-4.61	0.32-1.17	0.11-1.21	0.05-1.91

Table 20 Fat soluble vitamin content of koi and singhi (w/w basis)

Particulars	Weight (g)	A(I.U/100g)	D(I.U/100g)	E(I.U/100g)	K(µg/100g)
A. testudineus	≤50	85.77	121.6	0.7	0.53
	>50	93.9	43.12	1.997	1.16
H. fossilis	>50	0.86	13.6	0.16	3.8

Survey work

Survey on fish consumption and clinico-epidemiological studies on general health profile of population vis-à-vis fish intake was undertaken at Jagdalpur, Chattisgarh. Bastar region of Chattisgarh were covered and information was collected on structured Survey proforma of the Outreach Activity-3. During the survey data was collected from 30 villages and 750 individuals.

D. Fish Health Management

Project Title	:	Immune responses in carps with particular reference to immune related genes
Project Code	:	I-57(a)
Funding Agency	:	Institute-based
Duration	:	April 2007 – March 2010
Sub-project	:	Cloning and sequencing of interferon-inducible genes of *Labeo rohita*
Project Personnel	:	B. K. Das (PI), B. K. Mishra and S. Nandi

RNA was extracted from the kidney tissue of the poly I:C injected rohu and cDNA synthesis was done using ABI cDNA kit. Primers were designed to amplify the partial sequence of Mx gene (186 and 418 bp). Mx mRNA gene of *Labeo rohita* has been partially sequenced and submitted in GeneBank. Mx gene of rohu has 93% percent identity with *Ctenopharyngodon idella* and *Carassius auratus* each. Besides this, Mx gene of *Cirrhinus mrigala* has also been partially sequenced and submitted in the GenBank.

Sub-project (d)	:	Three dimensional fish cell culture using nano fibre-based scaffolds
Project Code	:	I-57(d)
Funding Agency	:	Institute-based
Duration	:	April 2008 – March 2010
Project Personnel	:	P. Swain (PI), B. K. Das, P. Routray and N. K. Maiti

Using implant technique, primary culture from testis of mrigal was developed and cryopreserved

Establishment of primary culture from testis of Indian major carp, *Cirrhinus mrigala* using explant technique

Using explant technique primary culture from testis of Indian major carp, *Cirrhinus mrigala* was developed and cryopreserved. Explants plated on fibronectin-coated flasks, attachment and proliferation of fibroblast like cells occurred within 3 days (Fig.40) forming confluent monolayer within 10 days (Fig.41). Among the four types of media such as Dulbecco's modified Eagle's medium (DMEM), Leibovitz 15 (L-15), Minimum Essential Medium (MEM) and M199 tested; cell growth and proliferation was significantly ($p>0.05$) better in DMEM (5.58×10^5 cells) followed by L-15 (5.46×10^5) as compared to M199 and MEM. On comparison of *serum from* goat (GS), calf (NBCS) and chicken (CS)at 5, 10 and 15% concentrations, it was found that proliferation of cells was directly proportional to the concentration of the serum. However, no

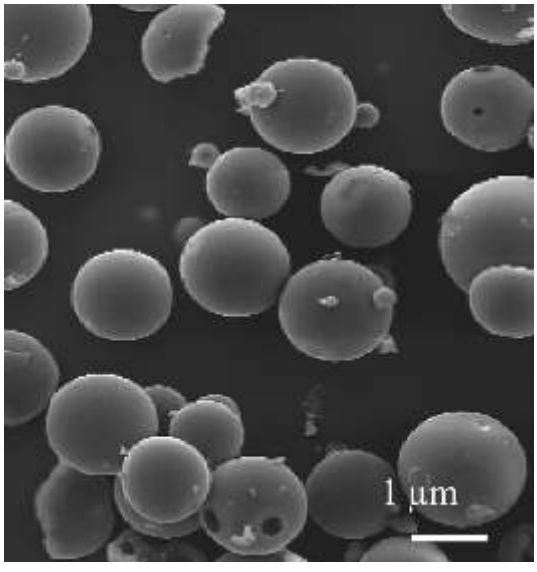


Fig.39 Scanning electron micrograph of outer membrane proteins loaded PLGA microparticles (bar = 1 µm).

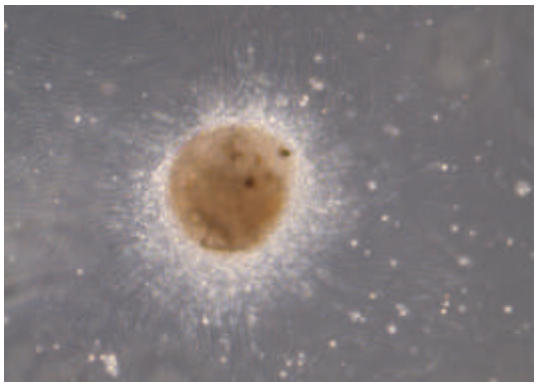


Fig.41 Photomicrograph of proliferating cells (3rd day) from tissue explant culture (testis) of Indian major carp, *Cirrhinus mrigala* (X 100).

significant difference ($p<0.05$) in viable cells could be recorded for NBCS and GS at both 10 and 15% serum concentration where as CS at 15% was found to have mild toxic effect since all the cells became rounded off. Upon cryopreservation, the percentage cell viability was highest (73-77%) in 10% dimethyl sulphoxide (DMSO) followed by 10% glycerol (65-68%) whereas a combination of both resulted in least cell viability (59-63 %). However, there was no significant difference ($p<0.05$) in percentage cell viability in 30 and 90 days cryostorage in any of the cryoprotectants used. The results indicate that fibroblast- like cells derived from testis of *C. mrigala* have a high multiplication potential in fibronectin coated flasks supplemented with media (DMEM), serum (10% GS) and can be successfully subcultured and cryopreserved.

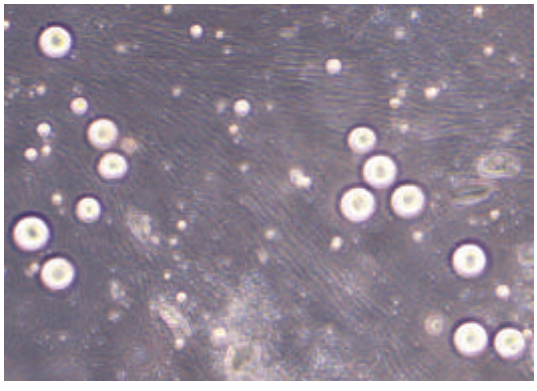


Fig.41 Photomicrograph of confluent monolayer (5th passage, 7th day) showing fibroblast- like cells (X 100) from tissue explant culture (testis) of Indian major carp, *Cirrhinus mrigala* cultured in DMEM and supplemented with 10% goat serum.

Project Title	:	Studies on association of viral infections in diseases of koi carps by immunological and molecular techniques
Project Code	:	E-39
Funding Agency	:	DBT
Duration	:	December 2006–January 2010
Project Personnel	:	P. Swain (PI), B. K. Mishra, S. K. Swain and N. K. Maiti

Five hundred and forty one samples of koi, common carp, goldfish were screened for koi herpes virus, cyprinid herpes virus I, cyprinid herpes virus II, nodavirus and spring viraemia of carps by PCR, RT-PCR and ELISA and found negative for these infections. A nested PCR was developed to detect Koi herpesvirus using a set of new primers targeting conserved region of major capsid protein of Koi herpes virus. With collaboration of NBFGR, Lucknow, a new cell line from koi fin explants was developed and reached a passage level of 45. This Koi cell line is being used for studying gene expression using GFP reporter gene and the cell line is stable.

Project Title	:	A comprehensive study on Argulosis: Host-parasite interaction with respect to modulation of innate and specific immune responses, and development of preventive or control measures
Project Code	:	E-41
Funding Agency	:	National Fund for Basic & Strategic Research in Agricultural Sciences
Duration	:	December 2007–January 2012
Project Personnel	:	P. K. Sahoo (PI), J. Mohanty, J.K. Jena and Hema Prasanth

Due to argulosis an average loss of about Rs.21,000/ha/yr. has been estimated in India

Loss due to argulosis in different regions of India

The survey was continued to collect different species of *Argulus* available in India as well as to assess the loss incurred by fish farmers due to this parasite in the country. Argulosis outbreak and prevalence were surveyed in six States of India (Orissa, Andhra Pradesh, West Bengal, Karnataka, Meghalaya and Himachal Pradesh) comprising of 67 aqua-farmers with 979.3 ha water area. The loss due to argulosis at farmer's ponds was estimated by taking into consideration the mortality occurred, loss in growth by reduction of weight, and expenditure towards drugs/chemicals applied for this disease (Fig.42). The expenditure towards labour charges could not be included due to l sufficient data. The survey period was from 2008 to 2010. An average loss to the tune of Rs. 21,000/ha/yr.

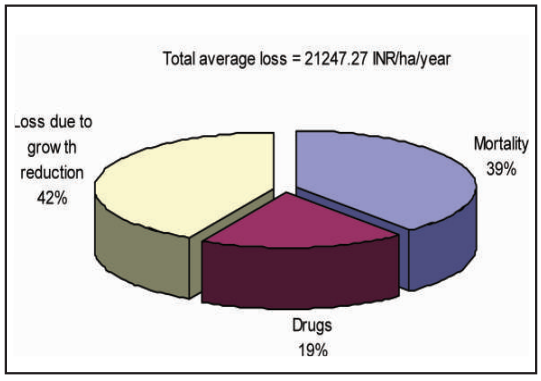


Fig.42 Estimation of loss due to argulosis at farmer's ponds

Species identification of *Argulus* by RADP-PCR and phylogenetic analysis

Argulus parasites collected from different regions of India (10 regions: 1, Tura, West Garo Hills, Meghalaya; 2, Kaikoleru, A.P.; 3, Kolleru, A.P.; 4, Vijayawada, A.P.; 5, Hessarghata, Karnataka; 6, Bangalore (goldfish), Karnataka; 7, Kolkata bheries; 8, Kolkata Kalyani, West Bengal; 9, CIFA, Orissa; 10, Siula, Puri, Orissa) were used for RAPD-PCR analysis. Four sets of RAPD 10 mer primers (OPA, OPC, OPH and OPY) were used to screen all the samples (Figs. 43 & 44). Specific bands found for parasites from particular regions and common bands for all the regions were from the gel and eluted as per procedure of Gel Extraction kit (Genei, India). The fragments were cloned using pGEMT vector and DH5 strain of *E. coli* and 3 clones of each fragment were sequenced.

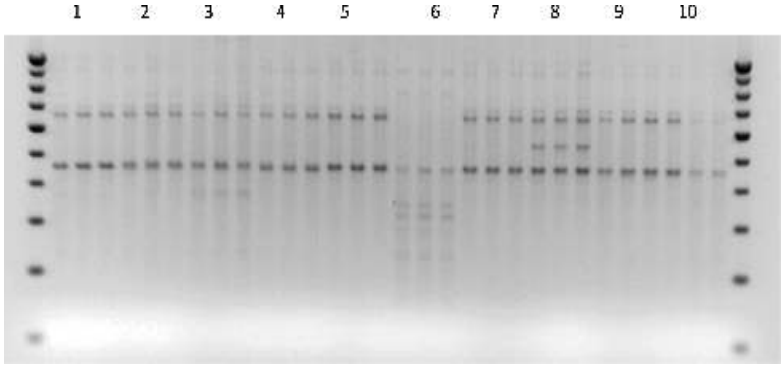


Fig.43 Common fragment obtained at ~450 bp using OPY17 primer for parasites from 10 different regions

The sequences obtained were used to design genus- and species-specific primers. The primers were also tested for their genus or species specificity.

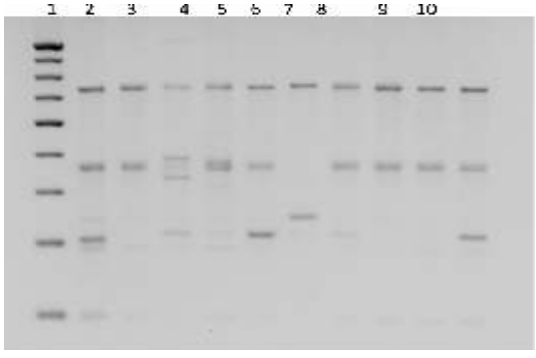


Fig.44 Common fragment obtained at ~750 bp using OPA19 primer for parasites from 10 different regions

Inter-species innate immune responses in one *Argulus*-susceptible and one comparatively *Argulus*-resistant carp species

The juveniles of rohu and silver carp (15 nos each) were collected from one non-infected pond without any previous infection history. The fish

were bought to wet laboratory and maintained for 2 weeks under standard feeding and other environmental conditions for acclimatization in six tanks of 500 l capacity with five numbers each. After two weeks, the fishes were bled and the following observations were made (Table 21).

Table 21 Innate immune parameters of silver carp and rohu blood samples

Parameter	Silver carp		Rohu		*P*-value
	Mean	SE	Mean	SE	
NBT (OD at 540 nm)	0.40	0.03	0.56	0.03	0.00
Glucose (g/dL)	76.06	4.49	70.98	3.91	0.44
Ceruloplasmin (Units/25uL)	0.21	0.01	0.33	0.03	0.00
Antiprotease (% inhibition)	24.44	2.37	85.67	0.82	0.00
ACH50 (units/ml)	23.239	0.5	17.94	0.7	0.00
Myeloperoxidase (OD at 450 nm)	1.12	0.14	0.78	0.09	0.07
Lysozyme (ug/ml)	5.34	0.34	5.54	0.26	0.66

From the above results, it seems rohu has higher super oxide production capacity, serum ceruloplasmin and antiprotease activities as compared to silver carp. However, a low level of alternative complement activity as marked in rohu might be playing a major role for making this fish species more susceptible as compared to silver carp.

Although rohu has higher super oxide production capacity, serum ceruloplasmin and antiprotease activity as compared to silver cap, and low level of alternative complement activity might be making the former more susceptible to argulosis

Project Title : Isolation and characterization of microbes from freshwater ecosystem (Component 1)

Project Code : E-49

Funding Agency : NBAIM, ICAR

Duration : 2006–2010

Project Personnel : N. K. Maiti (PI) and S. Mohanty

More than 200 samples were collected with their geographical location, from different districts of Orissa including Khurda, Puri, Nayagarh and Ganjam. Quantification of different functional types viz., cellulase, xylanase, lipase, geletinase, protease, phosphatase, pectinase, chitinase, amylase, resistant to heavy metals were carried out. Several ammonia oxidizer and multiple heavy metal-resistant bacteria were identified and 16s rDNA PCR-RFLP was carried out on those stains. *Bacillus subtilis* endoglucanase-specific primer was designed from the available sequences from NCBI database. The primers designed generated a single band of 1311 bp and were tested for other related *Bacillus* species including ATCC strains of positive and negative endoglucanase activity. The primer showed specific bands only in endoglucanase positive *Bacillus subtilis* strains.

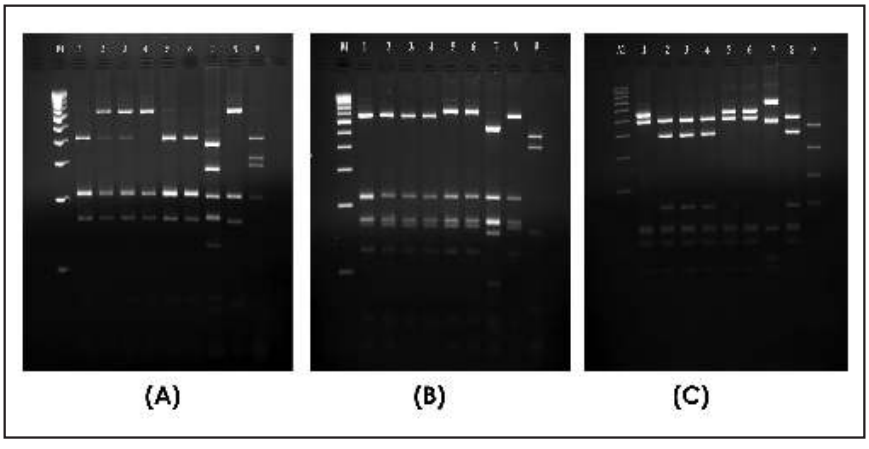


Fig.45 Agarose gel electrophoresis of *AluI* (A), *HaeIII* (B), *MspI* (C) digested PCR product. Lane 1, size marker (100 bp ladder), lanes 2-11 nitrifying bacterial isolates

Table 22 Ammonia and nitrite oxidizers and their enzymatic properties

Sample ID	Species	Ammonia & nitrite oxidizer	Phosphate solublizer
SCA-181	*Pseudomonas otitidis*	+	+
SCA-183	*Pseudomonas* sp	+	+
SCA-184	*Pseudomonas* sp	+	+
SCA-192	*Pseudomonas* sp	+	+
SCA-193	*Pseudomonas* sp	+	+
SCA-194	*Pseudomonas* sp	+	+
SCA-13	*Stenotrophomonas maltophilia*	+	-
SCA-22	*Pseudomonas* sp	+	-
SCA 25	*Gordonia rubripertincus*	+	-

Table 23 Heavy metal resistance bacteria and their functional characteristics

Sample ID	Identified microorganisms on 16s rDNA sequences	Heavy metal resistance (10 mM)	PSB	Amylase	Lipase	Nitrate reduction
11N	*Staphylococcus pasteuri*	Co, Pb, Ni, As	+	+	+	+
AP8	*Klebsiella pneumoniae*	Cd, Co, Pb, Ni, As	+	+	-	+
GP31	*Acinetobacter calcoaceticus*	Co, Pb, Ni	+	+	+	-
NP-142	*Enterobacter* sp	Cd, Co, Pb, Ni,As	+	+	+	+
NP-152	*Enterobacter* sp	Cd, Co, Pb, Ni, As	+	+	+	+

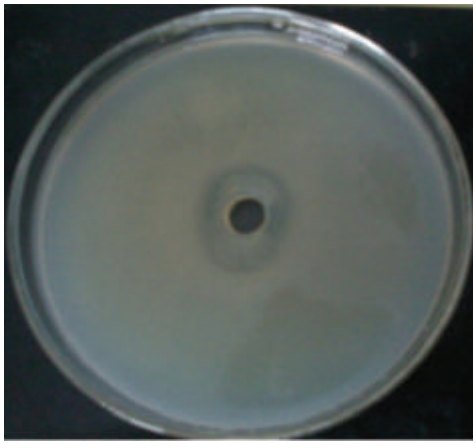


Fig.46(a) Amplification of endoglucanase-specific region of *Bacillus subtilis*

Fig.46(b) *Aneurinibacillus thermoaerophilus* inhibiting the growth of *Brevibacillus thermoruber. (B) Chryseobacterium gleum large pearl shaped bacterium (C) Long chain spore-forming rods -Bacillus macauensis*

There was higher prevelance of multiple heavy metal resistant bacteria in samples collected. Primers designed can be successfully applied for identification of endoglucanase positive *Bacillus subtilis.*

Project Title : Investigations on the efficacy of commercial lactic acid bacteria as freshwater fish/shellfish probiotics

Project Code : I-58

Funding Agency : Institute-based

Duration : April 2007 – March 2011

Project Personnel : S. Mohanty (PI), N. K. Maiti, P. K. Sahoo, B. C. Mohapatra and S. K. Sahu.

Probiotic effect of Lactic acid bacteria on rohu (*L. rohita*)

A series of experiments were conducted on the efficacy of commercial Lactic acid bacteria as probiotics in modulating freshwater fish health and growth. Rohu juveniles were fed with three different proiotic-based diets for a period of 45 days. The effect of probiotic feeding was evaluated in terms of impact on growth, immunity and disease resistance.

Effect on immune parameters

Non-specific immune parameters viz., NBT activity, packed cell volume, myeloperoxidase, ceruloplasmin, antiprotease activities and total protein concentration were measured. The probiotics treatments was more effective in rohu as compared to magur. Combined species of probiotics bacteria were found to perform better than single species treatment.

Challenge studies

Probiotic-fed rohu fingerlings were injected with definite dose of *A. hydrophila* through intraperitonial route. The survival percentage was 40-60% in experimental group compared to 20-30% in control group. This suggests that the probiotics treatment confers added protection on prolonged feeding.

Growth study

There was significant difference in growth in all the experimental groups over control during all the sampling time.

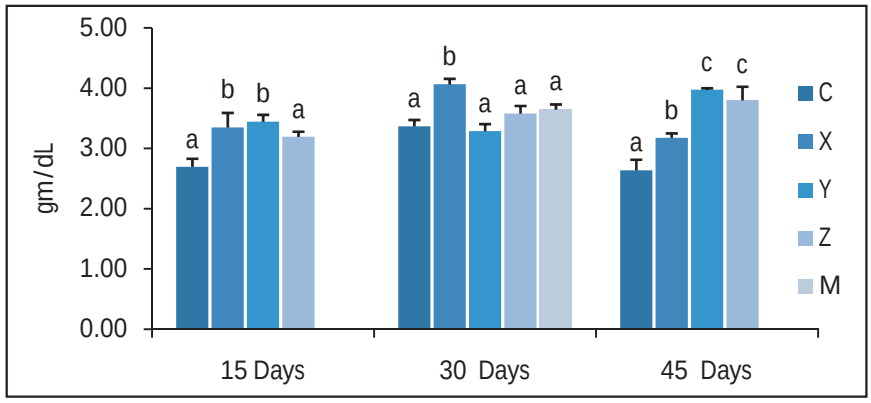


Fig.47 Total protein level following probiotic treatment

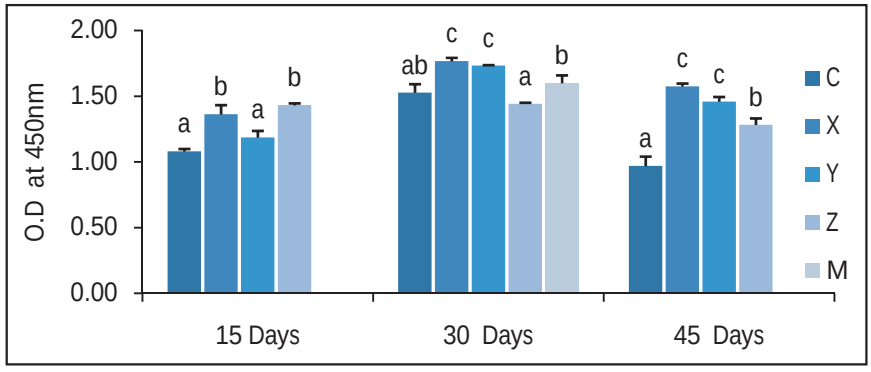


Fig.48 Myeloperoxidase activity following probiotic treatment.

Project Title : Improved disease resistance of rohu carp and tiger shrimp farmed in India: developing and implementing advanced molecular methods and streamlining access to and use of genetic resources

Project Code : E-51

Funding Agency : DBT

Duration : January 2009-January 2012

Project overall coordinator: S. Ayyappan, Secretary, DARE and DG, ICAR

Project coordinator for rohu component: A. E. Eknath, Director, CIFA

Project Personnel : P. K. Sahoo (PI), K.D. Mahapatra, H.K. Barman, J.N. Saha and P. Das

Commercial grade lactic acid bacteria have pronounced probiotic effect on the growth and survival of rohu fingerlings when challenged with *Aeromonas hydrophila*

Challege test conducted on 12 full-sib families

Rohu fingerlings from 2008 year-class (full-sib groups) were challenged with one pathogenic strain of *Aeromonas hydrophila* intraperitoneally at $2x10^6$ cfu/20 g fish. Tissues (liver and/or muscle from 100 early dead and 100 late dead or survivors were collected for further DNA extraction. The details of mortality are given in table 24.

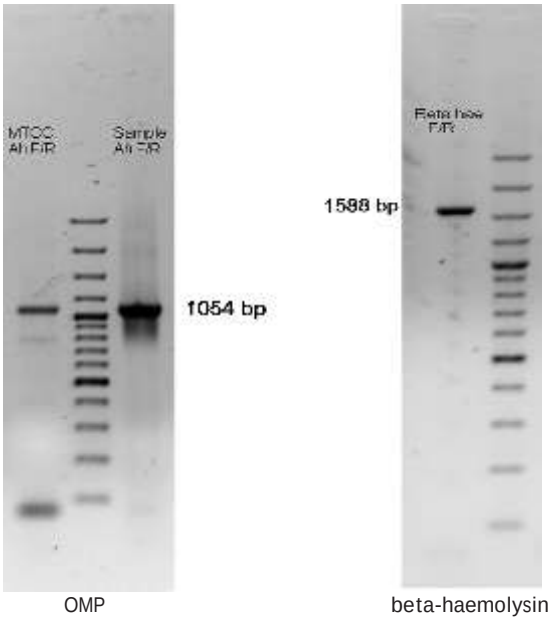
Table 24 Challenge Data Sheet

Sl. No.	Family No.	Total No. of Fishes	Total Mortality	% of Dead
1	F 41	520	224	43.1
2	F 61	484	422	87.2
3	F 29*	535	434	81.1
4	F 44*	447	329	73.6
5	F 34	484	378	78.1
6	F 38	549	448	81.6
7	F 21	476	276	58.0
8	F 49	537	415	77.3
9	F 13	524	358	68.3
10	F 12	518	318	61.4
11	F 22	490	254	51.8
12	F 24*	501	400	79.8
		6065	4256	70.1

* Both dead and survived samples are collected within 12 hours of challenge

Standardization of PCR for diagnosis of *A. hydrophila*

A PCR-based assay system was standardized to identify *A. hydrophila* from challenged animals to confirm the cause of mortality. The primers are designed based on the published sequence information of haemolysin and major outer membrane protein gene and PCR based assays were standardized (Fig.49).



OMP beta-haemolysin

Fig.49 PCR-based assay to diagnose the cause of mortality by *A. hydrophila* based on primers designed to amplify OMP and betaahemolysin genes

Project Title	:	Toll-like receptors in phylogenetically divergent fish species- their contribution in modulating the innate immunity (Component 4)
Project Code	:	E-53
Funding Agency	:	NAIP
Duration	:	January 2009- March 2012
Project Personnel	:	M. Samanta (PI)

The five TLR genes were indentified (TLR-2, 3,4,5 and 21) in carps; three TLRs (TLR-2, 20 and 21) in catfish and six TLR genes (TLR-1,2,3,6,7,10) in shark. Basal expressions of these TLR-genes have been studied in various tissues of carp and catfish, and analysis of tissue specific TIR-domain expression in different species of shark. In *L. rohita*, TLR-3 & 5 gene were found to differentially activated in response to their specific ligands. We have constructed cDNA library was constructed from rohu (*L. rohita*) gill and obtained the nucleotide sequence of 54 clones. The cDNA library of shark *(Chiloscyllium sp.)* spleen has partially been constructed and 308 clones have been sequenced.

Project Title	:	Immunomodulation studies in freshwater prawn *Macrobrachium rosenbergii* using recombinant proteins of *Macrobrachium rosenbergii* nodavirus
Project Code	:	E-55
Funding Agency	:	DBT
Duration	:	July 2009-July 2011
Project Personnel	:	P. K. Sahoo (PI), M.S. Shekhar (CIBA), B.K. Das, N. K. Maiti

White tail disease in India

White tail disease caused by *Macrobrachium rosenbergii* nodavirus in association with extra small virus is one of the major causes for the decrease in production of the freshwater prawn. During this period samples were collected from twelve different locations of Andhra Pradesh and Orissa states, and samples from two locations of Andhra Pradesh were found to be positive for *Mr*NV and XSV using CIFA developed RT-PCR-based diagnostic kit.

Immunomodulation study in prawn using RNA-dependent RNA polymerase recombinant ptotein of *Mr*NV

RNA-dependent RNA polymerase recombinant protein was used in an immunomodulation trial using juveniles of *Macrobrachium rosenbergii*. The prawns were injected with graded levels (0, 1 and 10 g) of recombinant RdRp protein and sequential changes in haemolymph and few of the immune relevant genes were studied after 6 h of injection till 14 days. A higher total haemocyte count was noticed at 6, 24 h and 14 days post injection of recombinant protein. A significant ($P < 0.05$) up-regulation in β-glucan binding protein (BGBP), 2-macroglobulin (A2M), cytochrome oxidase (cyt.ox), prophenol oxidase (PPO) and superoxide dismutase (SOD) levels were mostly observed in RdRp injected prawns at 6, 12, 24 h and 7 days of injection in comparison to control prawns. However, the expression of the above genes returned back to control levels at 14 days of post-RdRp-injection except PPO and BGBP levels. There was marked up-regulation in most of the genes at lower dose of RdRp injection within 6-24 h in comparison to higher dose whereas most of the genes were up-regulated after 7 days post-injection at higher level of RdRP administration.

Project Title	:	Development of vaccine against *Aeromonas hydrophila*
Project Code	:	I-65
Funding Agency	:	Institute-based
Duration	:	April 2008 – March 2011
Project Personnel	:	B. K. Mishra (PI), B. K. Das and M. Samanta

Bacterial strain and growth

The optimum temperature for *A. hydrophila* growth in nutrient broth medium was found to be 30^{0}C.

A total of 14 Toll-like receptors genes, 5 in carps, 3 in catfish and 6 in shark were identified. In rohu, TLR-3 and TLR-5 were found to be differently activated in response to their specific ligands

RNA-dependent RNA polymerase recombinant protein up-regulated immune relevant genes in white tail disease positive in *Macrobrachium rosenbergii*

Haemolytic activity

The haemolysin product was secreted into the medium during the early exponential phase of bacterial growth and tends to increase throughout the remaining exponential phase and started degrading during stationary phase. The haemolytic activity was very less in the supernatant fluid till the mid-log phage, increased exponentially subsequently in the later part of the log phase followed by slow decline during stationary phase. The highest haemolytic activity of ECP was found from the culture grown at 35^{0}C for 30 h. After 30 h onwards-haemolytic activity was decreased. Haemolytic activity was found to be less in the ECP obtained from the culture grown at 25^{0}C.

Proteolytic activity

The proteolytic activity of ECP collected from the bacterial culture at 30^{0}C was found to be the highest. The proteolytic activity was less till 18 h of incubation period and increased sharply from 24 h onwards. The ECP from the culture grown at 35^{0}C showed very less proteolytic activity whereas moderate proteolytic activity was found when the ECP was collected from the culture grown at 25^{0}C.

LD_{50} value and lethal toxicity of ECP of *A. hydrophila*

Rohu infected with varied dilution of *A. hydrophila* ranged from 1.7 x 10^3 to 1.7x 10^5 CFU/ ml and the mortality was recorded up to 5 days. The LD_{50} value was found to be 1.7 x 10^4 CFU/ ml for H_1 strain.

The filter sterilized supernatant fluid from cultures grown at 35^{0}C and 30^{0}C killed all the rohu injected (100% mortality), while live cells caused 90% mortality within 12-24 h. Heat-treated ECP at 60^{0}C and 80^{0}C for 10 minutes showed less mortality (60% and 40%, respectively) than that of untreated ECP. The toxicity of the ECP was completely lost after boiling for 10 min at 100^{0}C. No mortality was recorded within 72 h of post-injection.

Dot blots assay of polyclonal antibody raised against OMP

Polyclonal antibody was raised against OMP of *Aeromonas hydrophila* showed positive results in the dot blot assay to the ICP. ECP and OMP (Fig.50). Further OMP was injected to rohu fingerlings (30 numbers) and monitored the antibody production for 2 months using dot blot assay and found positive (Fig.51).

Detection of virulence associated genes

Aerolysin gene corresponding to 1.2 kbp has been partially sequenced and submitted to the GeneBank for accession.

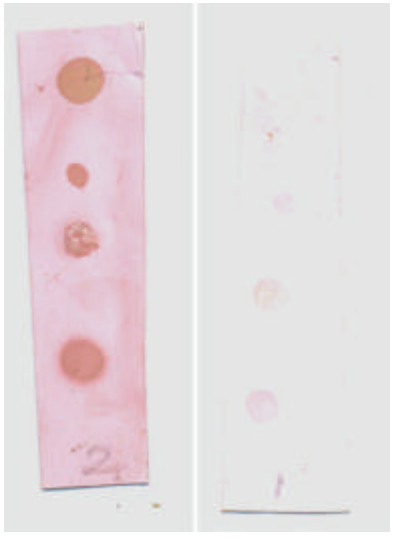


Fig.50 Dot Blot showing positive results to OMP, CMP and ICP

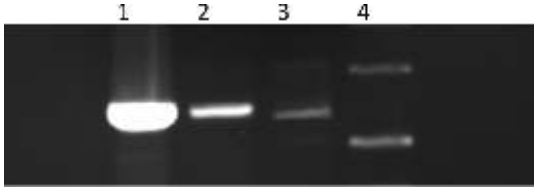


Fig.51 Aerolysin gene amplification
1.H1, 2. H3, 3. ATCC 49140, M. Molecular marker

Project Title	:	Indo-Norwegian platform on fish and shellfish vaccine development (Evaluation of major porins, ompC and ompR of *Areomonas hydrophila* as potential vaccine candidates and identification and characterization of immune genes of Indian major carp, *Labeo rohita*)
Project Code	:	E-57
Funding Agency	:	DBT, Govt. of India and NRC, Norway
Duration	:	August 2009-August 2012
Project Personnel	:	A. Dixit (JNU) (PI), P.K. Sahoo and L.C. Garg (NII)

One recombinant protein coding for omp C of *A. hydrophila* was provided by JNU. Fishes were vaccinated with this protein and booster dose given twice on 21st day and 35th day of vaccination. Serum and kidney tissues were collected on day 0, 10, 28, 42 and 140. The fishes were challenged on day 10, 56 and 140 of immunization. The relative percent survival (RPS) was not significantly different in the vaccinated group in comparison to PBS-injected group (Fig.52).

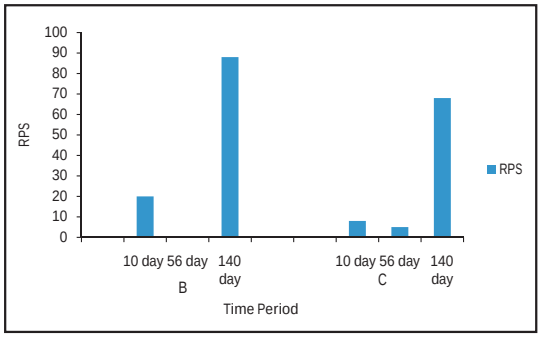


Fig.52 The relative percent survival (RPS) in different groups of fish at different period of challenge with *A. hydrophila*(B-PBS injected; C-RP injected)

Project Title	:	Bioprospecting of genes and allele mining for abiotic stress
Project Code	:	E-58
Funding Agency	:	NAIP
Duration	:	June 2009-March 2012
Project Personnel	:	N. K. Maiti (CCPI), H. K. Barman, P. Jayasankar, Kuldeep Kumar, C. Devraj, S. Mohanty and M. Samanta

A. Microbial Component

We surveyed three hotspring sites (Attri, Tarabalu and Berhampur, Orissa) and collected 51 samples from sediment and water bodies and obtained 94 bacterial isolates (84% Gm postive and 16% Gm negative). Isolation temperature ranges between 45 °C to 65 °C. Whereas, Gram negative Bacillus (*Pseudomonas, Aeromonas* sp) could be isolated at initial incubation temperature at 37°C, which could be cultured up to 45 OC.1 6SrDNA- PCR, based genotyping was carried out for their clustering. We targeted to amplify HSP-70 gene of the thermophilic bacterial isolates *viz, Bacillus* sp, *Pseodomonas* sp. and *Aeromonas* sp. PCR amplification showed 989,930, 630 bp fragment in Bacillus species with four different primer combinations whereas in *Aeromonas*, we obtained 781 bp and in Pseudomonas sp. 877 bp fragments.

Our data shows that in the hotsprings, the predominant bacteria are Gm(+)ve *Bacillus* sp. and these expressed heat shock protein (hsp) gene-70.

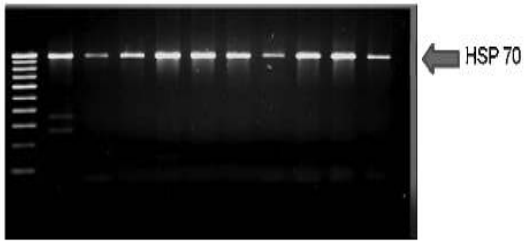


Fig.53 PCR based amplification of HSP gene of *Bacillus* spp (989 bp)

B. Fish component

1. Bioprospecting of genes for anoxia tolerance in *C. striatus*:

Induction of Hypoxia in laboratory conditions in C. striatus:

- *Forty* numbers of *Channa striatus* (Mean weight 14g, TL 120 mm) were stocked in four 200 L tanks (100x50x40 cm^3) containing 10 fishes per tank (2 normoxic and 2 hypoxic tanks). Each tank was filled with 80 L of ground water. Tanks designed for hypoxic experiment were additionally bottom-filled with pond mud (average height: 7.5 cm per tank).
- Normoxic condition was maintained in control tank which included aeration for 8 hrs per day and frequent exchange of water attaining constant 80 L of water (without pond mud). While the experimental tanks were exposed to hypoxic conditions with a mud base, wherein water was allowed to be evaporated out naturally with no exchange of water in the absence of aeration.
- Dissolved oxygen (D.O.) levels were recorded and monitored regularly .The D.O. level was gradually and significantly decreased in hypoxic tanks as compared to normoxic water over a period of times. The fishes in both tanks are surviving. The same experiment is being continued.
- The serum lactate dehydrogenase (LDH) level and hexokinase activity in brain, as the indicators of hypoxic condition, were estimated. The D.O. levels of normoxic (control plain water) and hypoxic (muddy water) tanks were measured at regular intervals showing decrease in D.O. levels with the increase in LDH activity in hypoxic fishes as compared to normoxic fishes. The serum LDH and brain hexokinase activities increased in hypoxic fishes (Fig.54 and 55) . These results demonstrated the efficient induction of hypoxic condition.

The cDNA library construction by SSH technique to identify the anoxia tolerant transcripts:

mRNA was extracted from liver, brain, heart and muscle of 10 individuals each from normoxic and hypoxic fishes and constructed SSH cDNA library (hypoxia cDNA as tester and normoxic cDNA as driver). The hypoxia enriched cDNA was cloned into pGEMT-easy vector and transformed into DH5α cells. About 600 colonies were picked up for insert checking (Fig.56) and 214 positive clones were sequenced. Initially, 143 non-redundant EST sequences with an average size of 0.6 kb were screened on-line against GenBank entries. As shown in (Fig.57), homology analysis using the BLAST tool identified 58% as known genes linked to hypoxia, 16.7% as uncharacterized showing homology to unannotated ESTs or genomic sequences, and 25.8% as unknown sequences (not matching with either EST or genomic database). Both uncharacterized and unknown clones are likely to be novel transcripts functionally linked with hypoxia.

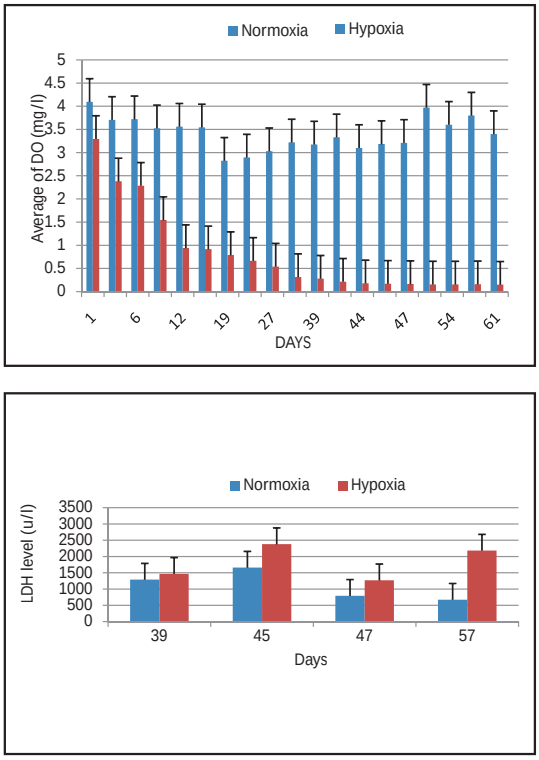


Fig.54 Bioprospecting of genes for anoxia tolerance in *C. striatus*. Induction of hypoxic condition. The D.O. levels of normoxic (control plain water) and hypoxic (muddy water) tanks measured at regular intervals showing decrease in D.O. levels (upper panel) with simultaneous increase in serum LDH activity (lower panel) in hypoxic fishes as compared to normoxic fishes.

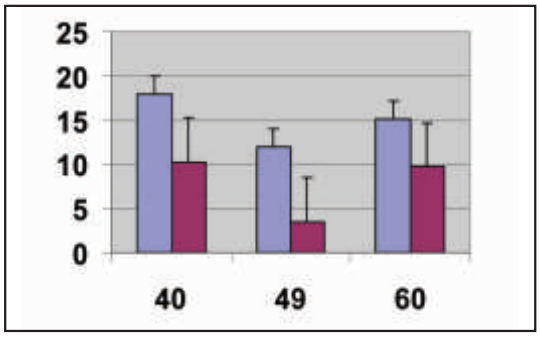


Fig.55 The heightened hexokinase activity measured in brain of hypoxic fishes as compared to normoxic fishes also supports the efficient induction of hypoxic condition.

Fig.56 Insert checks from hypoxic liver cDNA library.

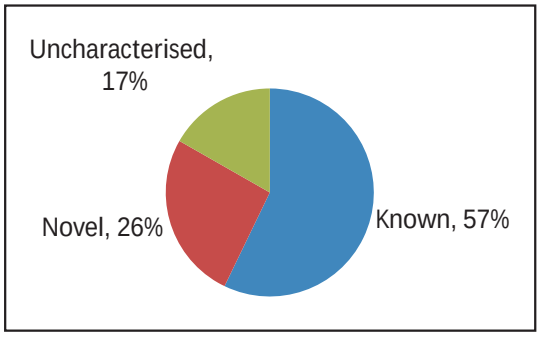


Fig.57 The graph showing the percentage of known, uncharacterized and novel clones in hypoxic *C. striatus* liver SSH library.

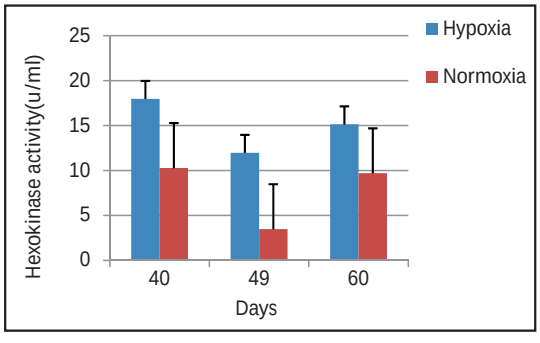


Fig.58 RT-PCR for expression profiles in *C. striatus liver.*

2. Bioprospecting of genes for salinity tolerance in *M. rosenbergii*:

Salinity exposure of adult *M. rosenbergii:*

- The adult *M. rosenbergii* was exposed to two different levels of salinity i.e. 10 ppt and 0 ppt for several days. The gill samples were collected at different days of treatments (both saline and freshwater). Half of the samples were preserved in RNA later solution and the rest was used for RNA.
- Further, the gill of adult *M.rosenbergii* was collected from two different levels of salinity i.e. 30 ppt and 0 ppt following different days of treatments. Half of the sample was preserved in RNA later solution and the rest was used to extract RNA.
- Larvae of *M. rosenbergii* were collected at different stages (upto 30 days) being maintained at 10 ppt salinity (natural condition). However, the post-larvae (PL) were collected at 0 ppt salinity at different time intervals beyond 30 days of stocking/culture. Half of each sample was preserved in RNA later solution and rest was utilized for total RNA extraction.
- The Na^+/K^+ ATPase activities of adult gill, larvae and post-larvae were estimated. The heightened activities in saline treated shrimps (Fig. 59 and 60) indicated the possible switching-on of salinity tolerance function.

The cDNA library construction by SSH technique to identify the salinity tolerant transcripts:

Gills from adults treated with saline water as also from freshwater were collected (10 individuals in each group). The mRNA was extracted following standard protocol and SSH cDNA library (saline-water cDNA as tester and freshwater cDNA as driver) of gill was constructed. Subtraction efficiency was estimated by PCR amplification of β-actin gene on subtracted and unsubtracted cDNA libraries (Fig. 61). The saline enriched cDNA was cloned into pGEMT-easy vector and transformed into DH5α cells. About 600 colonies were picked up for insert checking (Fig. 62) and

165 positive clones were sequenced. Initially, 95 non-redundant EST sequences with an average size of 0.6 kb were screened on-line against GenBank entries. As shown in Fig.63, homology analysis using the BLAST tool identified 28.4% as known genes linked to salinity, 49% as uncharacterized showing homology to unannotated ESTs or genomic sequences, and 26% as unknown sequences (not matching with either EST or genomic database). Both uncharacterized and unknown clones are likely to be novel transcripts functionally linked with salinity.

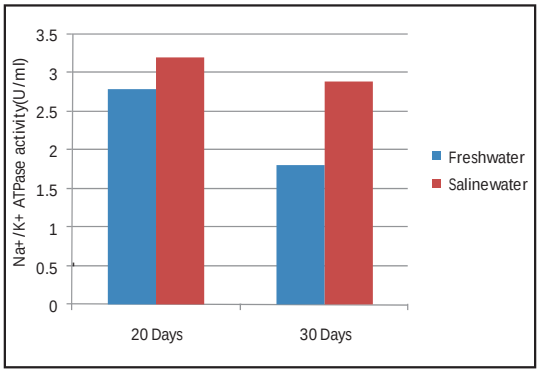


Fig.59 Na+/K+/ATPase activity measured in gill of adult *M. rosenbergii*.

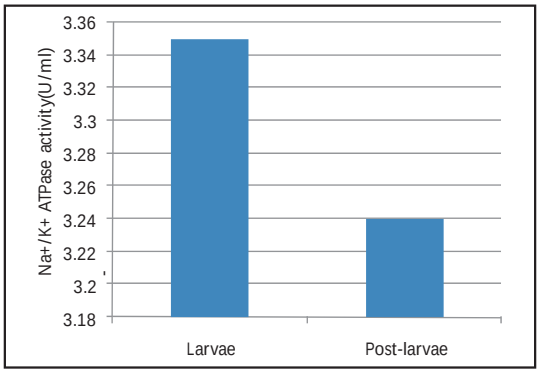


Fig.60 Na+/K+/ATPase activity measured in larvae and post-larvae of *M.rosenbergii*

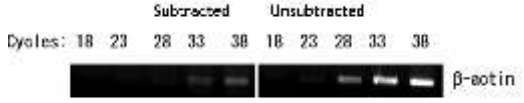


Fig.61 Efficiency verification SSH library. Subtraction efficiency was estimated by PCR amplification of ?-actin gene on subtracted and unsubtracted cDNA libraries. The number of PCR cycles is indicated above of each lane

Fig.62 Insert checks from saline gill cDNA libraryl.

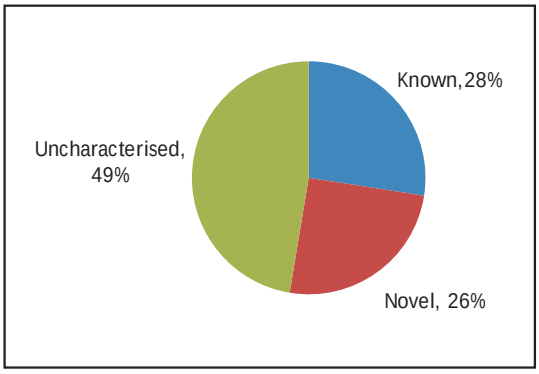


Fig.63 The graph showing the percentage of known, uncharacterized and novel clones in saline *M. rosenbergii* gill SSH library.

E. Social Sciences

Project Title	:	Effectiveness of training programmes on freshwater aquaculture conducted by CIFA
Project Code	:	I-55
Funding Agency	:	Institute-based
Duration	:	April 2007-March 2010
Project Personnel	:	H. K. De (PI), G. S. Saha and N. Panda

The project was aimed to evaluate the effectiveness of the training progammes conducted by CIFA. Under the study the all categories of trainees i.e students, researchers and officials of fisheries departments who attended training programmes during 2005-2009 were sampled. Their response and use of the knowledge were evaluated using a pre-designed questionnaires. A total of 195 out of 400 were responded as they returned the questionnaires with a few suggestions for improving the training programmes.

The study suggested that the trainees expressed very high level of satisfaction on the training provided by CIFA. The various aspects of the training progammes i.e frequency of using reference materials, usefulness, satisfication with course content, follow up of CIFA etc were used as indicators for evaluation of training programmes. The ten thematic training programme were evaluated. The null hypothesis (Ho) was that there was no association between the training programmes and the views expressed by the trainees. By using the Chi-square test, the null hypothesis was rejected at 5% level of significance for 7 d.f. ($p<0.05$) and it was concluded that there was an association between the training programmes and the views expressed by the trainees.

Table 25 Effectiveness of the training programme (Number of responses reported)

Training Programmes (themes)	Effective	Not effective	Total
Aquaculture Nutrition	297	12	309
Extension	274	14	288
Molecular Biotechnology	198	29	227
Pearl culture	181	10	191
Freshwater Aquaculture	306	25	331
Fish Disease Diagnosis	170	9	179
Fish Immunology	196	7	203
Molecular Genetics	155	1	156
Seed Production	152	1	153
Portable Carp Hatchery	100	19	119
TOTAL	2029	127	2156

Some of the trainees expressed the constraints for not utilizing the new skills and technologies acquired from CIFA in their field of work due to different reasons.

Table 26 Reasons for non utlisation of the training

Constraints	No of response	Percentage
Lack of infrastructure/ time / fund	95	48.7
Lack of administrative support	23	11.8
Lack of motivation	12	6.2
Others	19	9.7
Missing (Not responded)	46	23.6
Total	195	100.0

Project Title : Aquaculture in changing climate – A study based on the perceptions of freshwater aquaculture

Project Code : I-63

Funding Agency : Institute-based

Duration : April 2008 – March 2011

Project Personnel : G. S. Saha (PI), Radheyshyam, H. K. De, Kuldeep Kumar and P. P. Chakraborty

Data have been collected from 152 freshwater fish farmers of Uttar Pradesh, Assam, West Bengal, Orissa, Chattisgarh and Tamilnadu. The average age of the farmer is 43 years with 11 years of experience in fish farming. The average farm size is 6 acres. While about half of the farmers are doing agriculture and fish culture together, 32% are depending on fish farming as sole source of income. An overwhelming majority of the farmers (93%) are the owners of their farms. Growout culture mainly with Indian Major Carps is the prominent fishery practice of the farmers. It is interesting to note that the farmers were well aware about the rising atmospheric temperature (89%) deforestation (88%)and increased water pollution (84%l which are the indicators of climate change. Farmers were of the opinion that the changing climate would affect fish breeding, fish seed production, pond environment, grow out culture and post harvest operations. They also felt that there could be deterioration of water quality

(82%), change in breeding habits (70%), poor survival of seed (80%), rise in disease occurrence (68%) and poor yield (72%). There would also be effect on post-harvest operations as farmers felt that there would be vulnerability of fish transport system (72%), early spoilage of harvested fish (71%) reduction in keeping quality (69%) and change in fish taste (63%). Study also documented the farmer's wisdom with regards to mitigation of the risks and coping strategies to adopt the future altered climate scenario.

Project Title	:	Evaluation of the economics of production and management of selected freshwater aquaculture technology in India
Project Code	:	I-64
Funding Agency	:	Institute-based
Duration	:	April 2008 – March 2011
Project Personnel	:	N. K. Barik (PI), J. K. Jena and S. K. Swain

The project targets at economic evaluation of carp culture as well as seed production technologies for the reporting year. Both secondary as well as primary data were collected. The salient achievements of the study is presented below.

Performance and efficiency of carp production

The six sets of data representing Demonstration, Small farms, FFDA supported small farmers, Medium farmers, Large farmers and base line data (based on 1981 suevey made by IIM, Ahmedabad) were collected and compared. It was found that the size of the farm across all categories of the farmers are similar in the country except large farmers of Andhra Pradesh. The Small farmers were less efficient in terms of per unit area production but they were efficient economically as they earn more profit per unit of money invested in carp culture.

Table 27 Total cost, production and profit in carp production

Attributes	Size of pond in ha	Year	Production per ha (kg.)	B/C ratio
1 Demonstration[1]	0.38	1978	4175.8	1.92
2 Small farmers [2]	0.44	2008	2620.2	3.0
3 Baseline[3]	0.88	1981	854.9	1.43
4 Small farmers [4]	0.42	2008	2034	2.6
5 Medium farmer[5]	0.68	2007	4542.5	1.48
6 Large Farmer [6]	7.04	2007	9287.5	1.53

([1]-126 cases of carp culture by CIFRI, [2]-Farmers in Orissa under FFDA intervention, [3]- data collected by IIM, Ahmedabad, [4]- Small farmers of Orissa, [5]- Medium farmers of West Bengal under WorldFish Cente-ICAR study, [6]- large farmers of Andhra Pradesh under the WorldFish Cente-ICAR study)

Evaluation of seed production technology

The evaluation made by comparing between the small farmers engaged in the seed production and recommended practices of CIFA. The primary data on the seed production were collected from 17 farmers of Nuapada district. It was found that the seed producing farmers were both economically as well as production wise efficient. As they produce seed in smaller number at the same time the profitability is reported to be significantly higher than the recommended level. The study clearly showed the small farmers are the best targets for the promotion of the seed production activities.

Table 28 Evaluation of seed production technology

Inputs/indicators	Economic performance		Cost composition (%)	
	Research station	Farmers Pond	Research station	Farmers Pond
Manures fertiliser (Rs)	800	267.2	17.6	20.7
Seed (Rs)	2500	993.0	54.9	62.1
Feed (Rs)	750	16.4	16.5	1.0
Others (Rs)	500	322.3	11.0	20.2
Total cost	4550	1598.8	100	100.1
Gross income (Rs)	10500	9973		
Profit (Rs)	6000	8375		
B/C ratio	2.3	6.2		
Period (days)	21	20		
Survival rate (%)	30	14.8		

Project Title : Biotechnological Information system (BTIS) network for Aquaculture

Project Code : E-01

Funding Agency : DBT

Duration : 1991-92 cont. till date

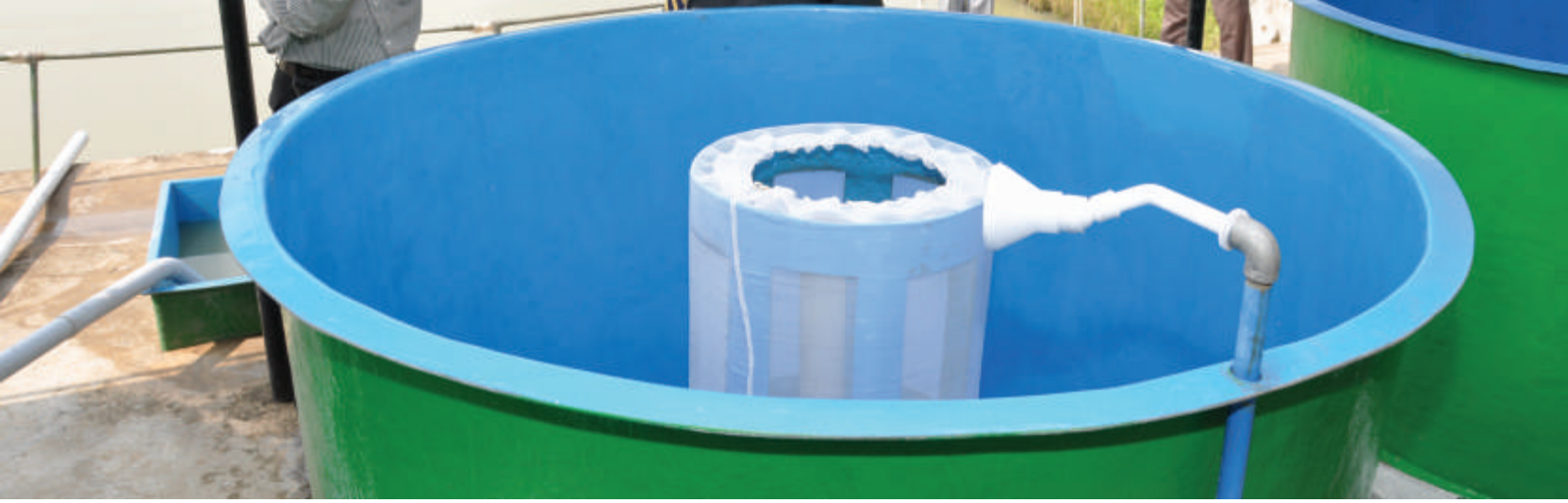
Project Personnel : A. S. Mahapatra (PI), G. S. Saha, N. K. Barik, N. Panda and D. P. Rath

The CIFA is the only fisheries institute in ICAR to be part of the BTIS network. Under this network there are 5 Centre of Excellence (CoEs), 10 Distributed Information Centers (DICs), 45 Sub-Distributed Information Centers (Sub-DICs) and 79 Bioinformatics Infrastructure Facility (BIF) for Biology Teaching Through Bioinformatics (BTBI). CIFA is one of the Sub DICs. Under this programme high quality infrastructure related to hardware and software has been developed and maintained. Updation of Website has been carried out regularly along with maintenance of CIFA Intranet. Online access to library data base as well as journal and scientific publications was provided for internal use of the Institute.

A 2-days National Workshop on "Application of Bio-informatics in Aquaculture" under Biotechnology Information System Network (BTISnet) on 26th and 27th March, 2010 was organised. Altogether 12 lectures were delivered by experts from Institute of Life Science, OUAT and CIFA Bhubaneswar on the various topics on bio-informatics. A total of 47 students and research scholars from OUAT, Bhubaneswar, KIIT, Bhubaneswar and North Orissa University, Baripada and CIFA participated in the workshop and got an exposure to the ongoing research works in the frontier areas of bio-informatics. A training manual and CD was also released on this occasion.

Project Title	:	Transfer of technology of composite carp culture through demonstration among SC/ST women in Boudh & Purulia District
Project Code	:	E-61
Funding Agency	:	DST
Duration	:	November 2009 – November 2011
Project Personnel	:	H. K. De (PI), Radheyshyam, D. N. Chattopadhyay, G. S. Saha and A. K. Dash

The research project envisages overall economic development of 200 SC/ST women in two backward districts, viz, Boudh (Orissa) & Purulia (West Bengal). The initial assessment of the households were made indicating small scale, traditional and extensive nature of aquaculture practices.. The present level of technology adoption generates very low level of production, income and employment. Moreover, there are concern for the food and nutritional security. The project aimed at extending scientific fish farming practices in seasonal water bodies. The site selection for demonstration and selection of beneficiaries is in progress and expected to give results from first year onwards.



F. Application of Plastics in Aquaculture

Project Title	:	Application of Plastics in Agriculture: Plant environmental control and agricultural processing
Project Code	:	E-03
Funding Agency	:	AICRP, ICAR
Duration	:	From May 1988 and continuing
Project Personnel	:	B. C. Mohapatra (PI), S. P. Mohanty, N. K. Maiti, K. K. Sharma, B. B. Sahu, N.K. Barik, B. Sarkar and D. Majhi

FRP mini carp hatchery system is suitable for production of fish spawn up to 0.5million number in a single operation

Evaluation of FRP mini carp hatchery

FRP mini carp hatchery was operated in farmer's field at Koijanga Village, Khurda District for breeding of Indian major carps through KVK (Khurda) and at CIFA Farm, Kausalyaganga. The system was found suitable for production of spawn up to 0.5 million in one operation.

Designing Automatic Fish Feeder

Automatic feeder was redesigned with incorporation of field data. The system has opening at the bottom outlet with a horizontal sluice using two solenoid switches of 24 V. The solenoid switch is opened with a timer control, adjustable to seconds. The power is given by 24 V battery which is charged by solar charger. The entire system is placed in FRP enclosure fitted at the bottom of the feeder and is placed on a circular FRP float. For anchoring the feeder system eyehooks are provided.

Fish packaging experiment

During the year whole fish packaging in "Carry bag" type was developed. Fish can be packed in carry bags after harvesting and the same can be chilled or frozen. The consumer can select the fish and carry home for table use. LDPE plastic and laminated materials were tested as packaging material for enhancing the shelflife of filleted freshwater fish. Fillets were also sprayed with lactic acid bacteria and given nisin treatment before vacuum packaging. Rohu was used as the test specimen, sprayed with different live lactic

acid bacteria and packaged under vacuum. The packets were stored under different refrigerated storage conditions. No appreciable change was observed in test samples as compared to control under normal refrigeration conditions. The shelflife experiments are planned to be conducted next with other food grade bacteria and biopreservatives.

Fillets, chunks and nuggets are packed in Styrofoam tray and wrapped by LDPE, polypropylene and laminated pouches. Laminated pouch has been found most suitable for packing of fish cut-up parts.

Consultancy projects

Project title : Genetic Study of Irrawaddy Dolphin (*Orcaella brevirostris*) in Chilika Lake

Funding agency : Chilika Development Authority, Govt. of Orissa

Duration : January – June 2009

Project personnel : P. Jayasankar (PI) and P. Das

Mitochondrial DNA CR sequence comparison showed two haplotypes in the Chilika population of *O. brevirostris*, with one animal differing from the rest of the animals by one base change. CYB sequence comparison showed a single haplotype in the Chilika population of the species.

The consensus NJ and MP trees based on CR sequences (Fig.64) showed closest genetic proximity of Indian haplotypes with those from Thailand. The haplotypes from Cambodia were next closer and ones from Indonesia were farthest from the Indian haplotypes. Present results suggest possible occurrence of more than one genetic population of Irrawaddy dolphin in the Asian region. The consensus NJ and MP trees based on CYB sequences (Fig.65) also showed closest genetic proximity of Indian haplotype with that from Thailand.

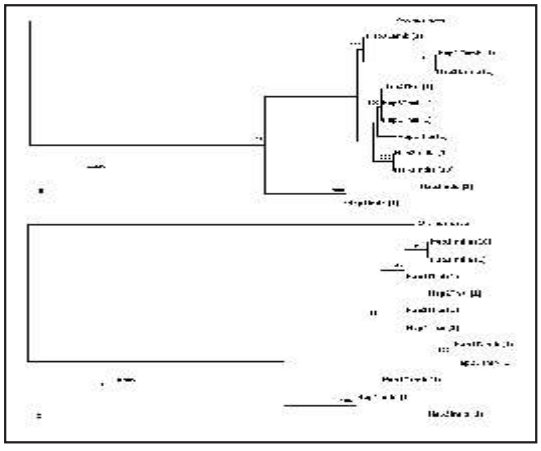


Fig.64 Consensus Neighbor Joining (a) and Maximum Parsimony (b) phylogenetic trees of *Orcaella* haplotypes inferred from mtDNA CR sequences. The numbers on the nodes represent bootstrap values. The numbers in parentheses represent the number of animals found to have that particular haplotype. *Orcinus orca* represents outgroup

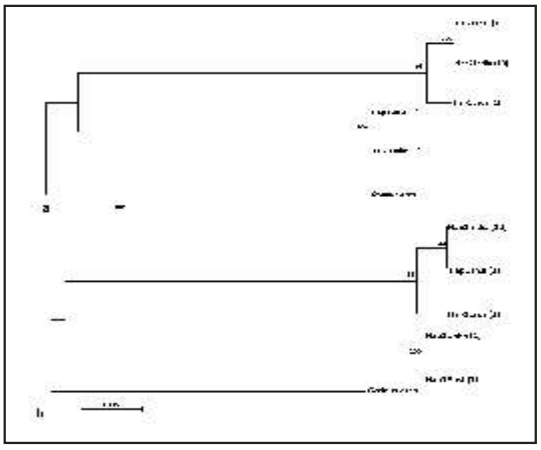


Fig.65 Consensus Neighbor Joining (a) and Maximum Parsimony (b) phylogenetic trees of *Orcaella* haplotypes inferred from mtDNA CYB sequences. The numbers on the nodes represent bootstrap values. The numbers in parentheses represent the number of animals found to have that particular haplotype. *Orcinus orca* represents outgroup

Presence of only two haplotypes (just one animal differing from the other haplotype consisting of ten animals at a single site out of total 395 bp compared) in CR sequences and only one haplotype in CYB sequences (ten animals) of the Irrawaddy dolphin in the present study may indicate high level of genetic homogeneity in Chilika lagoon, though a larger scale of genetic analysis with other markers, including microsatellites may be required to conclusively establish this.

PCR-based sex identification was necessitated because accurate field observation of sex was not possible in some of the animals used for the present study. *SRY* gene showed 217-bp band while *ZFX/ZFY* band had a size of 443 bp. PCR appears to favour the amplification of the shorter fragment, i.e. the *SRY* fragment. Hence, false female positive tests never resulted from male DNA. This further supports the reliability of this system with two sets of primers and can provide the secondary confirmation necessary for positive sex identification in marine mammal specimens, or a primary method where accurate field observation of sex is not possible. The present method is technically simple, requiring only PCR and agarose gel electrophoresis. By using HotStart *Taq*

Mitochondrial DNA sequencing has indicated high level of genetic homogeneity in Irrawaddy dolphin population of Chilika lagoon and their close genetic relatedness to their counterparts from Thailand

enzyme, the specificity of PCR could be improved as the process would discourage non-specific amplification.

It was observed that the females of *O. brevirostris* with calves prefer to remain in shallower regions of the lake and are relatively less mobile compared to males. Though the present sample size was small (n=11) due to solely opportunistic sampling, eight of the animals were males and the rest females, which may indicate relatively higher risk of males to accidental death in the lagoon from gill net fishing and boat operations, owing to their more active free ranging behaviour.

It is important to continue to examine the population discreteness and genetic variation of Irrawaddy dolphin in Chilika lagoon *vis-à-vis* its global geographic distribution for formulating the conservation plans of the species.

Project title	:	Public-Private partnership of CIFA-TATA Tea in Assam
Funding agency	:	TATA Tea
Duration	:	January 2008–January 2011
Project personnel	:	J. K. Jena (PI), P. C. Das, S. Adhikari and B. S. Giri

As a step to encourage Public-Private partnership for aquaculture development, CIFA has been extending co-operation in the form of consultancy programme to Amalgamated Plantation Pvt. Ltd. (APPL) in Assam (Formerly TATA Tea). The consultancy is mainly advisory in nature, aimed at pond construction and fish seed production and grow-out culture management. During three visits last year, the Team looked into all the relevant aspects of seed production and grow-out culture management of carps. Besides, the team conducted Off-campus training for the technicians engaged in different farms. Further, various issues were also monitored through telephonic discussion and e-mail communications.

With consultancy from CIFA, the Amalgamated Plantation Pct. Ltd. (APPL), Assam has been able to produce 2.5 – 3.5 t/ha. of carps in their estates despite prevailing highly acidic soils

With consultancy from CIFA, the APPL has expanded aquaculture farming area to an extent of 90 hectare spreading over its 11 tea estates across Assam. The venture is realizing satisfactory production levels of 2.5-3.5 tonnes/ha in almost all the estates in spite of acidic soil pH in most of the farmers. Besides, APPL is also engaged in seed production of carps at its Hatikuli Estate and seed rearing in several estates which is catering to the local seed demand besides fulfilling its own requirement. Hatchery seed production, seed rearing and grow-out culture are in full swing in all these farms.

Project title	:	Scaling up aquaculture in Western Odisha Rural Livelihoods Project (WORLP) districts
Funding agency	:	NR Management Consultants India Pvt. Ltd., New Delhi
Duration	:	June- September 2009
Project personnel	:	B. C. Mahapatra (PI),A. E. Eknath, J. K. Jena, Suresh Chandra, and D. Majhi

Under the project catla and rohu were successfully bred at West Utkal Agriculture Center (WUAC), Diptipur and the seed were released in the nursery ponds for fingerling and yearling production. Two training programmes on "Freshwater aquaculture" were conducted during 19 & 20 July 2009 for the farmers (53 nos) of Gaislat and Padmapur Blocks, Bargarh District

Project title	:	Scaling up aquaculture in WORLP districts-Phase 2
Funding agency	:	NR Management Consultants India Pvt. Ltd., New Delhi
Duration	:	December 2009-March 2010
Project personnel	:	B. C. Mahapatra (PI),A. E. Eknath, J. K. Jena, Bibhudatta Mishra, and D. Majhi

Fishery Resource Survey in Western Orissa

Under the project 379 ponds (area coverage 2258 acre) were surveyed in three blocks of Bargarh District for collection of information on aquaculture with the help of a specific questionnaire developed by CIFA. Out of surveyed ponds, 275 were seasonal and 104 were perennial ones. In Padmapur Block, 98 ponds covering 620 acre; in Sohela Block 47 ponds with 401 acre and in Gaisilat Block 234 pond with 1237 acre were surveyed. Soil and water samples from 123 ponds were collected for analysis of physico-chemical parameters.

The water bodies/ ponds/ tanks more than 4 acre area are locally known as *Kanta* and less than 4 acre called as *Munda*. They are irregular in shape, having uneven bottom and variable depth. Due to scanty rainfall and rainfed nature, there has been severe water scarcity in many ponds over the years. The water depth in most of these ponds reduced to 3-4 ft by March and several of these dry up during summer months (April-June). Several of the ponds were found to be chocked with *Ipomea* and other submersed aquatic weeds. Villagers used them for agriculture, community bathing, for livestock, etc. Standardized practice & techniques of rearing spawn to fry, fry to fingerlings and table size fishes were not followed by any of the respondents, resulting lower growth and survival of fish. Feed, fertilizer, lime, etc. were not applied in ponds. In 10% ponds surveyed, it was recorded that extensive type of fish farming is practiced. Some ponds/ water bodies were stocked with fish species such as rohu, catla, mrigal, common carp, grass carp and big head with variable stocking densities (100-10,000 per acre). Except one portable plastic hatchery at WUAC, Diptipur established only in 2007; the seed production is almost non-existent in the region. The seed requirement were met from Govt. hatchery at Chiplima (60 km) or Private hatchery at Patnagarh, Bolangir (75 km).

Water bodies surveyed for water parameters were with near neutral pH. Most of these ponds were found to have poor productivity, as evident from the recorded nitrate and phosphate values. Organic carbon contents and total nitrogen levels were recorded low with C/N ratio of most of the ponds exceeding desired levels of 6:1-12:1. The C/N ratio indicates poor productive status of the pond soil.

The project recommended awareness and training to village committee and individual farmers, cluster fish farming, local seed production and scientist farming practices to improve the aquaculture in the region.

G. Field Station, Kalyani

Project Title	:	Grow-out culture of *Ompok pabda* and breeding of *Ompok bimaculatus*
Project Code	:	I-54(n)
Funding Agency	:	Institute-based
Duration	:	April 2009-March 2012
Project Personnel	:	N. M. Chakrabarty, P. P. Chakraborty, S. C. Mandal and N. D. Saha, A. K. Dutta, B. N. Paul and R. N. Mondal

Breeding of pabda

Adult *Ompak pabda* were reared in farm ponds to raise brood stock. They were fed with boiled chicken viscera @ 8-10% of stocked biomass. The fish attained maturity at one year age. Size range of mature brood fishes were 15.5-18.5 cm/45-115g.

From first week of July to end of August, 2009 altogether 52 nos mature females weighing 4.05 kg (av. wt 77.88 g) were bred with Ovaprim as inducing agent @ 1.0–1.5 ml/kg and 0.5 ml/kg body weight to female and male respectively. Females were stripped after 6–8 hours of injection for spawning and eggs were collected in dry enamel trays. The abdomen of male was cut open to collect testis. The collected testes were macerated thoroughly and the sperm suspension was sprinkled over the eggs and mixed properly for fertilization. The eggs were washed with clean pond water and distributed uniformly in fibre glass tanks maintaining water height of 15 cm under constant aeration. Hatching took place between 23–24 hours of incubation after fertilization at 27-32°C. An average of 60% fertilization was recorded. The newly hatched larvae measuring 4–5 mm retained with large ovoid yolk sack which got absorbed in 3–4 days. The average hatching was 48% and a total of 2.07 lakh hatchlings were obtained from the 52 females.

Rearing of pabda

The fry of pabda were reared in a hapa (5 m x 3 m x 1 m) and fed with chopped tubifex worm. The fingerlings of 7.4 cm/2.23 g grew to average of 9.96 cm/5.25 g in a period of 38 days. A total of 43,000 fingerling were produced during the period.

A comparative and comprehensive study of embryonic and larval development stages of *O. pabda* and *O. bimaculatus* was made and salient distinguishing characters are enumerated in the table 26.

Table 29 Comparative character of embryonic and larval stages of *O. pabda and O. bimaculatus*

	Stage - Characters	*O. pabda*	*O. bimaculatus*
1.	Ovary		
	a) Overy & Eggs	Different sizes	Uniform size
	b) Diameter of ripe eggs	0.768-0.865 mm	0.858-1.365 mm
	c) Colour	Dull green	Brown
2.	Fertilized Eggs		
	a) Diameter		
	Zona radiate	1.479-1.649 mm	1.712-1.921mm
	Vitelline membrane	1.139-1.224 mm	1.225-1.429 mm
	Egg proper	0.917-1.088 mm	1.190-1.360 mm
	b) Colour	Dull green	Radish brown
3.	Embryo		
	a) Size	Comparatively small	Comparatively large
	b) Colour of yolk	Green	Brown
4.	Larvae		
	a) Just hatched		
	i) Size	3.701 mm	4.268 mm
	ii) Colour of yolk sac	Green	Brown
	iii) Myotomes		
	Pre-anal	11	11
	Post-anal	27-30	37-40
5.	Post-larvae		
	i) Yolk just absorbed		
	ii) Length	4.301 mm	6.039 mm
	iii) Colour	More translucent; brownish with a slight yellow tinge; melanophores larger and numerous, forming faint bands	Less translucent; brownish melanophores minute and numerous and almost uniformly distributed.
	Maxillary barbles	Do not reach the commencement of anal fine	Reach beyond commencement of anal fine
	Anal fines	53-54 rays	67-68 rays
	Colour	Brownish with 3 longitudinal bands, 1st on back, 2nd on lateral line and 3rd , which is defused above the anal fin with a yollow band in between the 1st two. Melanophores larger and less numerous.	Dark brownish; no longitudinal bands; no yellow bands; melanophores more numerous and concentrated on the back.
	Shoulder spot	Less conspicuous	Conspicuous
	Caudal spot	Not fully formed	Fully formed
	Maxillary barbles	Do not reach the commencement of the anal fin	Reach beyond commencement of the anal fin
	Anal fin	Broader with 53-57 rays	Narrow with 67-68 rays.

Mass scale seed production in private farm

The Regional Centre at Kalyani provided technical guidance for breeding and seed production of pabda to a progressive and leading fish seed producer from Sibdaspur village, district 24 Parganas(N), West Bengal during July-August, 2009. Fifty five numbers of gravid female and 45 numbers of mature male were supplied to the farmer from Kalyani Farm for breeding at his farm. Standardized protocol for breeding were followed. Multiple breeding of pabda were also achieved in his firm. More than lakh hatchlings were produced, which were reared in a series of cement cisterns (10x10x1.5 ft) maintaining water depth of 10-20 cm with constant aeration and water exchange. About 40,000 fry were produced from which 21,650 fingerlings were obtained.

The grow-out culture of pabda was also demonstrated to a women SHG at Gaighata under Comprehensive Area Development Corporation, a Govt. of West Bengal undertaking by supplying 1400 nos fingerling of pabda (av. size 7.0 cm) which found to grew to a size of 9-11.5 cm by March, 2010.

Technical guidance on breeding and seed rearing of pabda was given to a progressive farmers of West Bengal

H. Regional Research Centre, Rahara

Project Title	:	Aquaculture diversification and wastewater management
Sub-project (a)	:	Breeding of some locally available commercially important fishes - its rearing in freshwater and wastewater
Project Code	:	I-60
Funding Agency	:	Institute-based
Duration	:	April 2007 - March 2010
Project Personnel	:	A. K. Datta (PI), S. P. Rai (upto June 2009), P. P. Chakraborty (from July, 2009), B. N. Paul, D. N. Chattopadhyay (from May, 2009), R. N. Mandal, S. K. Manna and B. K. Pandey

Nursery rearing of pabda (*Ompok pabda*)

Rearing of pabda spawn to fry was conducted in replicated FRP tanks (0.3-1.3 m^2) kept under shed at five stocking densities (1-5 million/ha) for a period of 14 days with a view to finding out the optimum stocking density during nursery rearing. At the same time they were also reared in an open finely meshed nylon hapa fixed in a plankton populated perennial pond @ 2.7 million/ha. The 3-day old spawn measured 5.50.3 mm/1.20.12 mg. Fish were fed *ad libitum* with mixture of live zooplankton and chopped tubifex initially for 4 days and later on with chopped tubifex only. Plankton was provided thrice a day @ 0.02 ml/litre of water i.e. 0.1 ml plankton/spawn (2700 plankton/spawn/day). Tubifex was provided twice a day @ 6.6 mg/spawn/day. Spawn reared in hapa was not provided with any exogenous feed. Artificial shelters/hideouts (plastic pipe and hydrilla plant) were provided to create natural habitat to the fish. Uneaten food removal was regularly monitored. The average size recorded in FRP tanks ranged 25.8-31.67 mm and 0.16-0.26 g (Table 27) with the survival range of 71.0-87.7%. Growth of pabda spawn reared in hapa within the same period was 25 mm/0.14 g with 32% survival. The result showed the necessity of supplementary feed in addition to plankton in case of high density rearing. The growth and survival figures obtained showed possibly of rearing up to 4 million/ha.

Supplementary feeding is necessary for pabda rearing from spawn to fry, if high density is attempted

Table 30 Growth and survival of pabda fry nursery rearing

Stocking density (million/ha)	Initial size	Final size		Absolute growth increment (g/d)	Survival (%)
		Length (mm)	Weight (g)		
1	5.5±0.3 mm / 1.2±0.12 mg	31.67 ± 0.07 ^{a}	0.259 ± 0.03 ^{a}	0.018 ± 0.002 ^{a}	83.8 ± 2.0 ^{a}
2		27.12 ± 0.07^{b}	0.196 ± 0.01 ^{ab}	0.013 ± 0.001 ^{b}	80.1 ± 10.1 ^{a}
3		28.7 ± 0.3 ^{b}	0.219 ± 0.02 ^{ab}	0.015 ± 0.001 ^{ab}	87.8 ± 5.6 ^{a}
4		27.4 ± 0.4 ^{b}	0.201 ± 0.02 ^{ab}	0.014 ± 0.001 ^{ab}	84.6 ± 4.6 ^{a}
5		25.78 ± 0.61 ^{b}	0.166 ± 0.01 ^{b}	0.012 ± 0.001 ^{b}	71.0 ± 8.3 ^{a}

Values (mean SE) with different superscript are significantly different from each other ($P < 0.05$)

Fingerlings raising at varied densities

Rearing of fry to fingerlings was conducted in FRP tanks (1.3 m^2 each), cemented cistern (38.5 m^2) and nursery pond (200 m^2) at different stocking densities (1, 2, 3, 4 and 5 lakh/ha) with three replicates for all except in cemented cistern and nursery pond. During the course of rearing, water was replenished at every alternate day from the FRP tanks for first 15 days thereafter at an interval of 3-4 days. Fish were fed *ad libitum* with tubifex initially for 37 days of rearing and thereafter upto next 13 days with mixture of both tubifex and boiled chopped chicken viscera, and finally only with boiled chopped chicken viscera. Artificial shelter / hideouts were provided and uneaten food was removed regularly by siphoning from FRP tanks. Results of 112 days of culture showed no significant difference in survival among the stocking densities of 1-2 lakh/ha. The growth rate significantly ($P < 0.05$) decreased with increase in stocking densities (Table 31).

Grow-out culture

Pabda fingerlings were stocked in a earthen pond of 200 m^2 and cemented cistern of 60 m^2 for grow-out culture at density of 30,000 and 50,000/ha, respectively. Fish is being fed *adlibitum* with boiled chopped chicken viscera and are being provided with artificial shelter/hideouts. Within the culture period of 94 days, the fish exhibited average weight of 10.27-12.49 g from initial of 2.7 g. The culture is in progress.

Evaluation of larval feed for *O. pabda*

A feeding trial was conducted for pabda spawn (5.43 mm/1.23 mg) for a period of 24 days with provision of supplements feed with different graded of lipids from 4-8%, stocked at density of 1 million/ha. The net weight gain was 0.33±0.06, 0.42±0.04 and 0.37±0.07 g in feed 1-3. The final carcass composition was moisture 83.05, C.P 5.97, fat 1.11 and ash 4.07% (wet weight basis) by feeding different levels of lipids. The survival was

Table 31 Density dependant growth and survival of pabda during fingerling rearing

Stocking density (lakh/ha)	Stocking size		Culture period (d)	Survival (%)	Harvesting size		Av. wt. gain (g)	Growth rate (g/d)
	L (mm)	Wt. (g)			L (mm)	Wt. (g)		
1	26.1	0.06	112	97.77 ± 2.22^{a}	100.56 ± 3.33^{a}	3.5 ± 0.29^{a}	3.44 ± 0.29^{a}	0.031 ± 0.002^{a}
2				84.44 ± 8.67^{a}	77.4 ± 3.2^{b}	2.42 ± 0.18^{bc}	2.356 ± 0.18^{bc}	0.021 ± 0.001^{bc}
3	25.3	0.15	95	88.33 ± 1.66^{a}	57.23 ± 2.63^{a}	1.15 ± 0.12^{a}	1.0 ± 0.12^{a}	0.011 ± 0.001^{a}
4				74.6 ± 5.72^{a}	74.26 ± 8.31^{a}	2.10 ± 0.33^{ab}	1.95 ± 0.33^{ab}	0.021 ± 0.003^{ab}
5				77.5 ± 9.01^{a}	75.9 ± 7.26^{a}	2.95 ± 0.76^{b}	2.8 ± 0.76^{b}	0.028 ± 0.008^{b}

[Values (mean SE) with different superscript are significantly different from each other ($P < 0.05$)]

more than 90% in all the treatments with no significant difference among them.

Dietary lipid requirement of *O. pabda*

An indoor feeding experiment was conducted with pabda fry (41.22 mm/0.82 g) at stocking density of 3 lakh/ha for 80 days with different lipids levels from 2-8%. The ingredients were fish meal, soyabean meal, Carboxy Methyl Cellulose (CMC), corn powder, sunflower oil, fish oil and vitamin & mineral mixture. The resultant net weight gain was significantly higher in Feeds 2 and 3 (Fig.66). The initial carcass composition were moisture 82.40, crude protein 12.36, fat 1.98 and ash 1.65% (w/w basis) and final proximate composition were moisture 80.76 to 82.89, C.P. 10.86 to 12.97, fat 1.3 to 2.73 and ash 2.4 to 2.55% (wet weight basis) by feeding different levels of lipids. The study revealed that the dietary lipid requirement of the species is 4-6%.

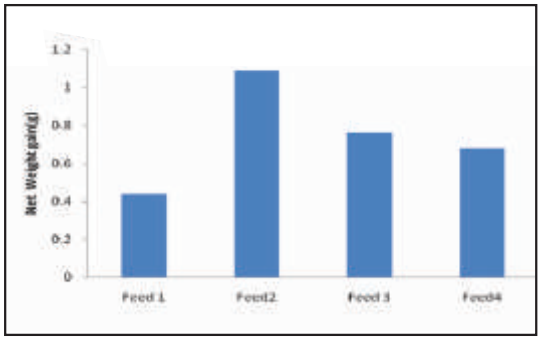


Fig.66 Net weight gain of pabda fingerling with deferent levels of lipid

Culture of tubifex worm

Experiment was conducted in three different sites viz., hatchery canal (1.83 m^2), Earthen pot (0.125 m^2) and six compartments made inside hatchery (each 0.673 m^2) under flow-through system for production of tubifex. Worm collected from wild sources were inoculated at experimental sites @ 50 g/m^2. Prior to inoculation, mixture of raw cowdung and loamy soil (1:4) was spread over the bottom of experimental sites. Management procedures included maintenance of water flow round the clock at average flow rate of 1.3 l/minute. Raw cowdung was provided as input in the range of 250-300 g/m^2 at alternate day. Anecdotal growth pattern of worm was noticed, but absolute growth was found after final harvest, which showed a growth range of 280-400% at different sites. Critical observation reveals that water temperature played a vital role over the growth of tubifex worm irrespective of size of the experimental set up. Growth of worm slowed down with lowering of temperature, registered growth rate of 5-0% at 18-20°C water temperature during early period of December. However, during peak winter at 12-14°C the growth of worm initially declined which led further to mass mortality though other parameters of water remained unchanged.

Mixed culture of *Etroplus* and carps

With a view to assess the performance of *Etroplus* in mixed culture system, the species was stocked in earthen pond @ 1,500 nos/ha together with Indian major and medium carps @ 5,000 fingerlings/ha, the species composition and ratio of carps being catla (40%), rohu (30%), mrigal (20%) and bata (10%). Average weight of stocked fish after 12 months rearing were *Etroplus* 161.0 g from 88.3 g, catla 734.34 g from 19.5 g, rohu 662.2 g from 17.5 g, mrigal 506.8 g from 55.5 g and bata 219.4 g from 7.3 g. Survival rate of the respective species were 76.0, 71.5, 79.33, 94.0 and 100.0% having absolute growth increment of 0.2, 1.99, 1.79, 1.25, 0.58 g per day. Total fish production from the pond was 2645 kg/ha/yr of which *Etroplus* contributed 6.97%. The size of *Etroplus* during harvest ranged 145.0 to 230.0 g. Contribution of various fish species towards total production has shown in Fig. 67.

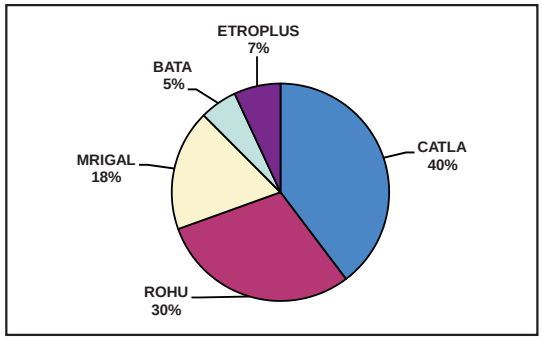


Fig.67 Percentage contribution of *Etroplus* and other carps in polyculture

Culture of *Labeo bata* in sewage-fed pond

Prior to initiation of culture, a pond of 0.26 ha was fertilized basally with primary treated municipal sewage @ 835 m^3/ha in the dilution of 1 SW: 2.5 FW followed by application of lime @ 200 kg/ha for stabilization. Further, the treated municipal sewage was applied at 276 m^3/ha/month with weekly intake of 69 m^3/ha. The pond was stocked initially with fingerlings of bata @ 22,000/ha employing multiple stocking and harvesting process. Harvesting was continued after 5 months of initial stocking and the harvested number was replenished soon after each harvest, maintaining the constant density of 22,000/ha. Specimens weighing 25-40 g are being harvested. The experiment is on progress.

Sub-Project (b) : Bioaccumulation of heavy metals in waste ecosystem and its bioremediation

Heavy metals

Heavy metal concentration of the untreated, treated and sewage-fed pond was recorded regularly and average values of different parameters are presented in Table 32.

Further studies on the accumulation of heavy metals in flesh of carps grown in sewage –fed ponds were undertaken. The study reveals that the values of Cd, Pb anf Cr were negligible, while concentration of Zn was maximum in the flesh of all carps. Values of different parameters in respect of different fish are presented in table 33.

Table 32 Heavy metal deposition (ppm) in fish flesh (mg/kg dry wt)

Metals	Rohu (150-200 g)	Catla (150-600 g)	Mrigal (500-800 g)	Bata (15-25 g)
Cu	2.2	1.5	3.0	1.5
Cd	ND	ND	ND	ND
Pb	N.D	ND	ND	ND
Cr	ND	ND	ND	ND
Mn	3.5	ND	9.6	0.3
Zn	60.0	16.0	70.0	18.3

ND= not detectable

Table 33 Average concentration of heavy metals (ppm) in untreated, treated and sewage pond water

Metal	Untreated	Treated	Pond water
Fe	4.60	2.47	2.20
Cu	0.03	0.03	0.03
Zn	0.46	0.07	0.03
Mn	0.33	0.42	0.40
Cd	0.02	0.01	0.01
Pb	Tr T	r	Tr
Hg	Tr T	r	Tr

Tr = trace

Microbiological studies of wastewater

Samples from dairy waste and domestic sewage were screened on Tween-80 (0.5%) medium to find out lipolytic activity of bacteria. Ten samples each from both the sources were finally selected and kept on nutrient agar for further study. Identification of lipolytic bacteria up to genus was done based on IMViC and selected biochemical test.

All the 20 bacterial samples selected were of *Pseudomonas* genus and were capable of

degradation of oil. Degradation of Tween-80 (Polyoxyethylene sorbitan monohydrate-0.1 %) was rapid and degraded completely at 30-32°C. Instead of Polysorbate, pure coconut oil was used as substrate and it was observed that tested *Pseudomonas* group is capable of degrading 0.1 % oil within 72 hours at 30-32°C.

Another substrate, milk fat was used and found slower degradation rate compared to vegetable (coconut) oil even in 7 days at 30-32°C. The observation reveals that the *Pseudomonas* sp. is good lipolizer and may be useful to degrade fat content of dairy effluent after amelioration.

Sub-project (c) : Nutrient flow in pond aquaculture system using livestock and community wastes

Nutrient flow in integrated farming with duck

Integrated fish culture with duck (khaki campbell) was demonstrated in a pond belonging to Samaj Sevak Sikshan Mandir, R. K. Mission, Belur Math and which was stocked with silver carp (15%), catla (25%), rohu (30%), mrigal (20%) and bata (10%) @ 5,000 nos/ha. Ducks were stocked @ 250 nos/ha. One crop of silver carp was harvested after 4.5 months which was again stocked with the same number.

Average weight attained by different fish were silver carp (1st crop) 953 g from initial of 245.0 g in 4.5 months, silver carp (2nd crop) 378.8 g from 34.0 g in 5.4 months, catla 675.0 g from 100.5 g, rohu 543.8 g from 57.5 g, mrigal 481.3 g from 46.0 g and bata 231.3 g from 88.5 g within the culture period of 9.7 months.

Total quantity of fish harvested was 196.3 kg which works out to 2,804 kg/ha in 9.7 months. Besides fish, 28 kg duck meat from total 20 nos duck along with about 2,000 eggs from 16 females were obtained.

An observation revealed that manure output from individual ducks was about 3.88% of total live body weight of duck, @ quantifying daily total manure output from 20 duck as 1.4 kg. Manurial and proximate values were crude protein 7.53%, fat 0.47%, nitrogen 1.41%, ash 22.36% and moisture 67.72%. It has also been estimated that one individual can void 120-150 g droppings of which organic matter is reported as 26%.

After complete harvest the pond was stocked further with catla, rohu, mrigal, bata and silver carp in the respective proportion of 30, 35, 20, 5 and 10 % at a total density of 5000 nos/ha. Ducklings (24 nos) were reared on the dyke of pond @ 300 nos/ha which grew to adult within 100 days. The stocking size of different fish species were 64.8 g for catla, 29.5 g for rohu, 58.3 g for mrigal, 14.8 g for bata and 91 g for silver carp which attained average weight of 534.4 g, 393.7 g, 568.8 g, 180.0 g and 394.4 g respectively within 6.5 months.

Carps growth in sewage fed pond has high zinc content in the flesh

Sub-Project (d) : Management of aquatic weeds pertaining to fish culture

Culture of beneficial weeds and its application

Duckweeds are widely used as fish food by the farmers. With view to assessing the growth of aquatic weeds pertaining to fish culture, culture of *Wolffia arrhiza* was undertaken. Experimental sites (cemented cisterns and FRP tanks) were inoculated with aquatic weeds @ 800 g/m^2 (w/w). Prior to inoculation, the culture media was fertilized with cow dung @ 7.5 t/ha having organic carbon content of 28-30%. Harvesting was initiated after 15 days of inoculation and thereafter harvesting was done at an alternate day, registering the rate of weeds production as 11.5 kg/m^2/harvest (115.3 t/ha, wet weight basis). Observation reveals that the particular weed has tremendous acceptability and preference by the fish species. It is also observed

that the growth of the fish was not hampered when aquatic weeds were supplemented for one month in lieu of the conventional feed. Some of the physico-chemical parameters have been recorded as pH 7.8; total alkalinity 250 ppm; BOD_5 12 mg/l; NH_4-N 5.2 ppm; P_2O_5 0.1 ppm; water temperature 22^{0}C.

Weeds control by chemical application

Based on the promising results obtained from yard trial, combination of urea + bleaching powder (3:2) @ 167 and 112 kg/ha, respectively was applied in pond infested mainly with *Ipomoea aquatica, Alternanthera sessilis, Pistia strateoles, Spirodella polyrrhiza, Lemna minor* and *Azolla pinnata*. The result showed that chemical combination acted well on flowers, tender leaves and soft apical parts which mainly consisted of parenchymatous tissues.

Table 34 Results of weeds control

Chemical dose	Observation			
	Immediate effect	After 10 days	After 20 days	After 30 days
Urea + bleaching (167 and 112 kg/ha, single treatment (1st application)	Curling of flowers and tender leaves	Wilting of mature leaves, but few new shoots regenerate	Wilting of mature shoots, but few new shoots regenerate	Regenerate occurs
Urea + bleaching (167 and 112 kg/ha, after 10 days of 1st treatment (2nd application)	Curling of flowers and tender leaves	Major organs dry, no new shoots regenerate	Complete dry and decompose starts	Dry and leaves decomposed, no regeneration

Project Title	:	Diversification in freshwater aquaculture for sustainable production
Sub-project	:	Influence of nutrients factor on growth performance of *Eichhornia crassipes* and *Vallisneria spiralis*
Project Code	:	I-54(h)
Funding Agency	:	Institute-based
Duration	:	April 2007 - March 2010
Project Personnel	:	R. N. Mandal (PI), S. Adhikari and K. C. Pani

The study was carried out in the sites selected randomly in wetland areas at the vicinity of Kalyani high way near the Rahara fish farm. Monthly sampling following quadrate method for measurement of weeds biomass along with nutrient status of both soil and water was done. The study revealed that in the habitats where *Eichhornia crassipes* grow, availability of the nutrients such as organic carbon, phosphorus, ammonium nitrogen and orthophosphate was found to be higher during the months of August – November. Higher values of nitrogen were recorded in the later months. In accordance to higher amount of nutrients mainly organic carbon and phosphorus in habitats, biomass of the weed was maximum as reflected in RGR value (Table35). Statistical analysis following Canonical Discriminant Function Coefficients showed that 81.4% increase of biomass occurred out of total growth during the months of August to January, followed by 16.2% increase of biomass during July to September. Minimum growth was recorded in rest of the months.

Table 35 Month-wise chemical parameters of soil and water and RGR of *E. crassipes*

Months	Soil						Water				RGR (kg/day)	
	Nitrogen (mg/100 g)		Phosphorus (mg/100 g)		Organic Carbon (%)		NH_4^-N (ppm)		P_2O_5 (ppm)			
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
May	8.75^{e}	7.18^{e}	0.25^{f}	0.104^{e}	2.44^{e}	0.57^{cd}	0.115^{de}	0.048^{ef}	0.125^{f}	0.04^{d}	0.69^{c}	0.45^{f}
Jun	8.81^{de}	7.74^{d}	0.25^{f}	0.108^{de}	2.95^{cd}	0.56^{d}	0.108^{e}	0.044^{f}	0.142^{e}	0.04^{d}	0.79^{d}	0.48^{e}
Jul	8.86^{d}	7.77^{d}	0.36^{e}	0.116^{cd}	2.87^{cd}	0.58^{c}	0.133^{bc}	0.055^{ef}	0.183^{ab}	0.06^{abc}	0.74^{c}	0.48^{dc}
Aug	9.14^{c}	8.06^{c}	0.38^{d}	0.121^{c}	3.88^{a}	0.65^{ab}	0.138^{ab}	0.077^{ab}	0.186^{a}	0.07^{a}	0.75^{b}	0.49^{c}
Sept	10.15^{b}	8.07^{c}	0.47^{a}	0.212^{a}	3.44^{b}	0.66^{ab}	0.147^{a}	0.079^{a}	0.163^{cd}	0.06^{bc}	0.76^{a}	0.54^{a}
Oct	10.20^{b}	8.33^{a}	0.43^{b}	0.178^{b}	3.05^{c}	0.67^{a}	0.145^{a}	0.050^{f}	0.170^{bc}	0.07^{ab}	0.73^{c}	0.52^{b}
Nov	10.36^{a}	8.18^{b}	0.42^{bc}	0.120^{c}	2.82^{d}	0.65^{ab}	0.129^{bc}	0.061^{cde}	0.151^{de}	0.06^{bc}	0.73^{c}	0.49^{cd}
Dec	10.32^{a}	8.01^{c}	0.41^{c}	0.126^{c}	2.81^{d}	0.64^{b}	0.127^{bc}	0.064^{bcd}	0.156^{de}	0.06^{bc}	0.69^{e}	0.45^{f}
Jan	10.30^{a}	8.06^{c}	0.42^{c}	0.116^{cd}	2.75^{d}	0.65^{ab}	0.124^{cd}	0.073^{abc}	0.148^{e}	0.057^{c}	0.67^{f}	0.44^{g}

(The same letters in column are not significantly different at the level of p<0.05)

In *Vallisneria spiralis*, nutrients availability was found in higher amounts during July to November, and accordingly growth increase of biomass occurred as reflected in RGR values (Table 36). Statistical analysis employing Canonical Discriminate Function Coefficients focused that 65.7% increase of biomass occurred during the months of August to December, followed by 29.7% increase of biomass during July to September. Organic carbon in soil, ammonium nitrogen and phosphorus in water were found most influential among the other nutrients to enhance the growth of the species.

Critical analysis reveals that in both the species higher amount of nutrients are responsible for maximum increase of biomass. Nevertheless, phosphorus and organic carbon played an influential role among all the nutrients recorded for increase of biomass in *E. crassipes*, whereas organic carbon in soil, ammonium nitrogen and phosphorus in water were found most influential among the other nutrients to enhance the growth of *V. spiralis*. The observation supports the results obtained from microcosm experiment conducted *in situ*, where organic carbon and phosphorus were found more influential than other nutrients.

Among the nutrients, phosphrous and ornganic carbon play influencial role in increasing biomass of aquatic weed *Eichhornia crassipes* and *Vallisneria spiralis*

Table 36 Month-wise chemical parameters of soil and water and RGR of *V. spiralis*

Months	Soil						Water				RGR (kg/day)	
	Nitrogen (mg/100 g)		Phosphorus (mg/100 g)		Organic Carbon (%)		NH_4^-N (ppm)		P_2O_5 (ppm)			
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
May	8.64^{e}	7.48^{d}	1.82^{cd}	1.32^{c}	0.686^{g}	0.59^{e}	0.13^{bc}	0.042^{cde}	0.132^{b}	0.04	0.043^{b}	0.025^{d}
Jun	9.0^{cd}	7.50^{d}	1.86^{cd}	1.48^{b}	0.704^{f}	0.65^{abc}	0.12^{c}	0.044^{bcd}	0.132^{b}	0.03	0.047^{ab}	0.026^{cd}
July	9.2^{bc}	8.02^{b}	2.04^{abc}	1.52^{ab}	0.718^{e}	0.65^{ab}	0.12^{c}	0.05^{abc}	0.148^{a}	0.04	0.047^{ab}	0.026^{cd}
Aug	9.42^{a}	8.44^{a}	2.1^{ab}	1.62^{a}	0.724^{de}	0.66^{a}	0.14^{ab}	0.062^{a}	0.152^{a}	0.05	0.048^{ab}	0.026^{cd}
Sept	9.42^{a}	8.44^{a}	2.14^{a}	1.62^{a}	0.736^{cd}	0.66^{a}	0.148^{a}	0.06^{ab}	0.156^{a}	0.04	0.049^{ab}	0.029^{abc}
Oct	9.22^{b}	8.54^{a}	2.1^{ab}	1.62^{a}	0.770^{a}	0.66^{ab}	0.13^{bc}	0.06^{ab}	0.132^{b}	0.05	0.048^{ab}	0.030^{ab}
Nov	9.08^{bcd}	7.98^{bc}	1.96^{abcd}	1.52^{ab}	0.740^{c}	0.64^{bcd}	0.13^{bc}	0.042^{cde}	0.128^{bc}	0.04	0.051^{a}	0.030^{ab}
Dec	9.04^{bcd}	7.92^{bc}	1.76^{d}	1.50^{ab}	0.756^{b}	0.63^{cd}	0.12^{c}	0.032^{de}	0.118^{cd}	0.04	0.050^{a}	0.032^{a}
Jan	8.98^{d}	7.86^{c}	1.9^{bcd}	1.48^{b}	0.724^{de}	0.62^{d}	0.128^{bc}	0.026^{e}	0.112^{d}	0.04	0.047^{ab}	0.028^{bcd}

(The same letters in column are not significantly different at the level of p<0.01)

Puntius pulchellus was bred in captivity for the first time, this achievement is significant especially in the context of diversification in aquaculture

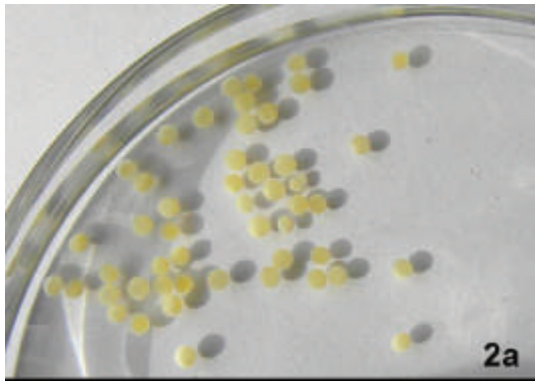
I. Regional Research Centre, Bangalore

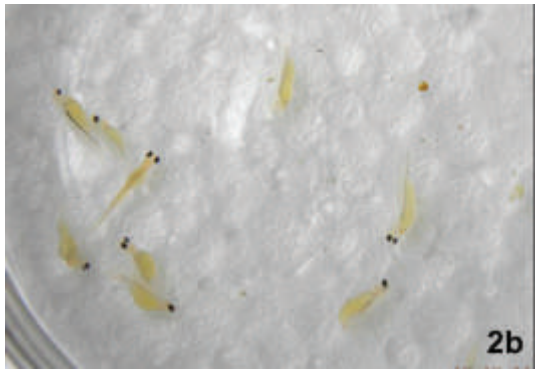
Project Title	:	Propagation of selected peninsular/indigenous fishes for incorporation in to aquaculture and modification of aquaculture practices for water deficient regions
Project Code	:	I-62
Funding Agency	:	Institute-based
Duration	:	April 2007 – March 2010
Project Personnel	:	M. R. Raghunath (PI), N. Sridhar and Hemaprasanth

Induced breeding of the threatened peninsular carp *Puntius pulchellus*

*Puntius pulchellus (*popularly called as Haragi meenu in Karnataka), a threatened species of peninsular carp, endemic to the Krishna river basin, was induced bred for the first time by administering a combination of synthetic (GnRh analog) and natural hormones (pituitary extract). As adult fish in wild have become rare, fingerlings collected from the Tunga river, were acclimatized to aquaculture ponds and raised to adult size. Sexual dimorphism was observed in the adults only during the breeding season. The males were recognized by pink papillomatous mass at the tip of the snout and darker (black) coloration of scales on the ventral side, while females were identified by the absence of pink coloration on snout, lighter body coloration and a soft bulging abdomen.

The selected females and males were administered recommended intramuscular dosages of the synthetic hormone and pituitary glands extract (PGE) successively at an interval of 6 hours. After 6h of administering the PGE,





females were stripped and the eggs collected in a dry enamel bowl immediately after which the milt from males was stripped directly on the eggs. After 15-20 min of fertilization, the eggs (Plate 2a) were washed and transferred to a modified glass jar type hatchery. The first larva hatched after 48 hours, laden with a heavy yolk sac. After a period of 6 days the larvae were capable of active swimming during which they were fed with plankton. Various stages of the development of the larvae to fry are shown in Plates 2b&c. The breeding of *P. pulchellus* assumes significance specifically in the context of raising a diversified carp species for addition to the species pool to augment aquaculture production.

Collection and adaptation of peninsular carps

A total of 180 numbers of *P. pulchellus* and *P. kolus* were collected from the wild and transported to CIFA farm. The fishes are at present being acclimatized to static water conditions in cemented cisterns at the Center. A new fishing area for collection of *P.kolus* was discovered during this trip.

Indoor rearing of common carp spawn at varied density and feeding

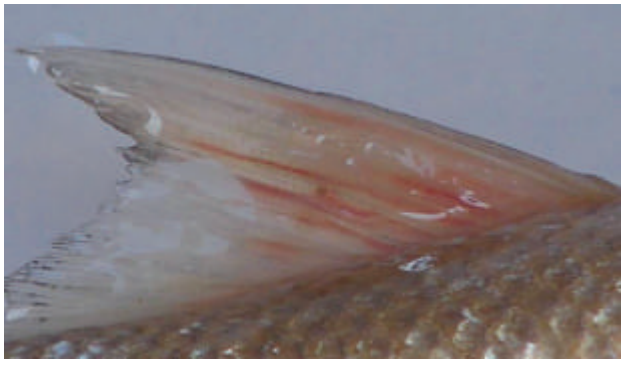
Common carp spawn (5d) stocked at 10 and 30 million/ha in 40 l tubs were fed with either (a) Plankton (*ad libitum*), (b) Egg yolk-*Spirulina* feed (powder) or (c) a Liquid feed formulation of dried brewers yeast, starch and whole egg. The latter two diets were fed at 20% of body weight of the larvae. Continuous aeration and water exchange (1/3rd on alternate days) were provided. At the lower stocking density of 10 million/ha, survival was best in plankton fed spawn followed by liquid feed and least in case of egg yolk-spirulina diet. While growth was also best in the plankton fed diet, yolk-spirulina diet gave the next best growth followed by least growth in case of the liquid feed diet.

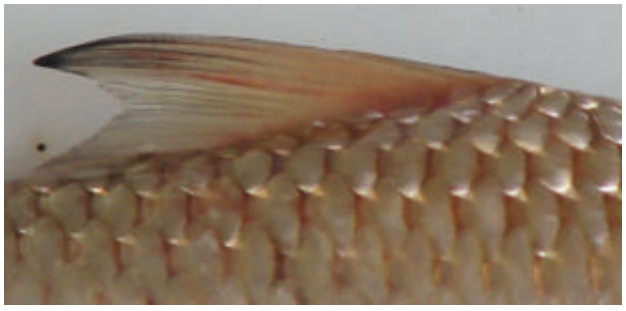
At the higher stocking density of 30 million/ha, survival figures followed the same pattern as in case of the lower stocking density. But stocking at higher density required more nutrient dense diet as best growth was obtained with yolk spirulina diet followed by plankton feed and least in case of the Liquid feed formulation.

Pattern of parasitic infection in Peninsular fish species

Juvenile/fingerling specimens of Haragi meenu (*Puntius pulchellus),* Kolasu *(P.kolus),* Gende*(P.carnaticus)* and Deccan mahseer (*Tor khudree)* were infected with metanauplii of *Argulus*. Eggs laid by gravid *Argulus* females in an experimental

While *Puntius* spp. are highly vulnerable to argulus, *Tor khudree* is resistant to this parasitic infection





Administration of Doramectin through feed can effectively cure *Lernaea* infection in *P. pulchellus*

set up were cultured in the laboratory in a BOD incubator and the infective stages *viz.*, metanaupli obtained were used to infect these peninsular fishes. The fishes were exposed to 200 and 500 metanauplii/fish for *P.kolus and P.pulchellus*, while a dose of 350 metanauplii/fish was used in case of *P.carnaticus*. Higher infective doses were tried in case of *Tor khudree.* It was seen that while all the three *Puntius spp* tested were highly susceptible to *Argulus* infection, *Tor khudree* was quite resistant. The damage by argulus was mainly seen at base of fins.

Susceptibility of Lernaea cyprinacea to *Puntius pulchellus*

Puntius pulchellus sub-adults previously unexposed to *Lernaea* infection were transferred to a polyculture pond with *Labeo fimbriatus, Cirrhinus mrigala, Ctenopharyngedon idella* and *Cyprinus carpio. The pond* which had a moderate infection with *Lernaea* for two months had been treated with Deltamethrin to remove the infection and the fish were free of infection at time of *P. pulchellus introduction.* After a month, only *P. pulchellus* and *L. fimbriatus* sub-adults acquired *Lernaea* infection with severe infection and symptoms in the former and a moderate infection in the latter.

Efficacy of Doramectin against infection of Lernaea cyprinacea in *Puntius pulchellus*

Administration of Doramectin @ 1 mg/kg body weight of fish incorporated in feed for ten days can effectively cure *Lernaea* infection in *P. pulchellus* within 24-29 days as compared to the normal course of 56-65 days taken by the fish in infected control to recover from this parasite.

J. Regional Research Centre, Vijayawada

Project Title	:	Improving production efficiency in aquaculture through integrated nutrient management
Project Code	:	I-56
Funding Agency	:	Institute-based
Duration	:	April 2007 – March 2010
Project Personnel	:	P. V. Rangacharyulu (PI), B. B. Sahu (upto May 2009), B. K. Choudary (from May, 2009) and B. S. Giri

To study the growth potentials of advanced fingerlings of rohu under pond culture conditions, juveniles of 210 g weight were stocked @ 3,750/ha and fed with deoiled rice bran and groundnut oil cake (80:20) for a period of 150 days. At the end of culture period final weight of fish obtained was 890±10 g.

To evaluate the growth of pungas (*Pangasianodon hypophthalamus*) under pond culture conditions pungas fingerlings of average weight 50 g were stocked @ 15,000/ha and were fed with boiled broken rice mixed with deoiled rice bran (1:1) for 160 days. Final weight of fish harvested was 900 g.

Application of fish hydrolysate in the diets of *Pungus* fingerlings has improved the growth of fish by 13-17% compared to control. *Pungus* fingerlings stocked @ 15,000/ha were fed with boiled broken rice and deoiled rice bran (1:1) as control and added with 3% fish hydrolysate for 150 days under pond culture conditions. The growth increments are presented in Table 37

C. straitus fingerlings of average weight 20.5 g were stocked in 400 l circular tanks @ 20 no per tank. Fish were fed with three iso-nitrogenous feeds using fish meal, meat meal and dried chicken viscera for a period of 120 days at 5% of body weight significantly higher growth obtained in fish meal based feed compared to other two protein sources, the details of which are presented in Table 38.

Table 37 Growth and FCR of Pungas fed with fish hydrolysate

Feed	Initial weight (g)	Final weight (g)	Growth (g)	FCR
Control (cooked rice broken+DOB 1:1)	52.50	720±20	667.50	3.53
Control+3% FH	53.60	821.5±30	767.90	3.26

Table 38 Growth and FCR of *C. striatus* fed with different animal protein sources

	Avg. initial wt (g)	Avg. final wt (g)	Growth (g)	FCR
D-1	20.5	145.5 ± 5.7	124.5	3.63
D-2	20.1	121.2 ± 4.3	100.9	4.15
D-3	20.3	109 ± 3.23	88.7	4.76

TECHNOLOGY TRANSFER, WORKSHOPS, TRAINING AND FARMERS MEETS

Activities of Krishi Vigyan Kendra (KVK)

Vocational training and training to in-service personnel

The KVK organized a number of need-based vocational training programmes for the farmers, rural youths and in-service personnel in different disciplines (Table 39) and carried out extension activities (Table 34). The Scientific Advisory Committee meeting of the KVK of the Institute was held on 5 February, 2010.

Table 39 Vocational training for farmers and in-service personnel

Discipline	No. of courses	Duration (days)	No. of participants		
			Others	SC/ST	Total
Crop production	03	03	0	25	25
Horticulture	12	12	185	30	215
Animal Science	12	13	99	76	175
Women in agriculture	10	11	73	37	110
Plant protection	16	16	113	87	200
Fisheries	0	0	0	0	0
Total	53	55	470	255	725

Table 40 Vocational training for rural youth

Thematic area	No. of courses	Duration (days)	No. of participants		
			Others	SC/ST	Total
Vermicompost for income generation	01	10	0	05	05

Table 41 Training for extension functionaries/In-service personnel

Thematic area	No. of courses	Duration (days)	No. of participants		
			Others	SC/ST	Total
Advance management of farm animals	01	02	11	04	15
Commercial cultivation of medicinal plants	01	02	12	03	15

Table 42 Frontline demonstration programme

Crop/Enterprise	Variety	No. of farmers
Poultry	Vanaraj	15
Dairy	Supplivite-M feeding for higher milk production	30
Pointed gourd	Swarna Alaukik	06
Okra	OH-152(SG)	12
Bitter gourd	Integrated Nutrient Management	15
Fishery	Fry rearing	06
Paddy	IDM	10
Paddy	Herbicide-Oxadiargyl	10
Ground nut	Smruti	12
Vermicompost	Use of agro/household waste	05
Chilli	IPM	10
Paddy	IPM	10

Table 43 Other extension activities

Nature of extension activity	No. of activities	Farmers			Extension Officials			Total participants		
		ST/SC	Others	Total	ST/SC	Others	Total	ST/SC	Others	Total
Kisan mela	01	146	304	450	-	-	-	146	304	450
Research articles	01	-	-	-	-	-	-	-	-	-
Extension literature	06	-	-	-	-	-	-	-	-	-
Advisory services	30	30	81	111	-	-	-	30	81	111
Scientific visit to farmers field	106	751	890	1641	-	-	-	751	890	1641
Farmers visit to KVK	55	170	218	388	-	-	-	170	218	388
Animal health camp	01	30	20	50	0	2	2	30	22	52
Total:	200	1127	1513	2640	0	2	2	1127	1515	2642

Institutional training activities

The Institute has offered several short-term training courses during the year for capacity-building of field-level functionaries, with particular focus on trainers training, who in turn would transmit advanced technical know-how to the end-users. Courses were demand-driven and the delivery was based on the principle of 'learning by doing' with adequate background in theory. Besides, extension officers in the State Department of Fisheries, college/university teachers, students, entrepreneurs and NGO officials were also benefited from the courses. Training programmes conducted this year are presented in Table 44.

Table 44 Training programmes conducted during 2009-10

Sl. No.	Title	Course Director/ Coordinator	Duration	No. of participants
1.	Summer School on "Recent advances in application of molecular and quantitative genetics in aquaculture and fisheries"	Dr P. Jayasankar	1-21 June, 2009	15
2.	Second workshop of the collaborative project between CIFA and World Fish Centre, Malaysia on "Genetic improvement of *Macrobrachium rosenbergii* in India"	Dr B. R. Pillai	22-24 June, 2009	9
3.	Training on Office Procedures, Service Rules, Maintenance of Labware and Equipment, Maintenance of Farm Tools and Equipment/Hatchery Management for the Supporting staff of the Institute and its Regional Centres.	Administrative Officer	21-28 July, 2009	108
4.	Aquaculture Field Day (for women SHG of Kandhamal District, Orissa)	Dr G. S. Saha	18 August, 2009	20
5.	Training on "Ornamental fish breeding and culture" for DRWA	Dr S. K. Swain	25 August, 2009	35
6.	Concepts of HACCP & its application in aquaculture	Dr B. K. Mishra	22-24 September, 2009	50
7.	Ornamental fish culture to the Self-Help Group of women trainees of KVK, Suttur, Karnataka (at RRC, Bangalore)	Dr M.R. Raghunath	28-31 October, 2009	10
8.	Winter School on "Application of molecular and serological tools in fish disease diagnosis"	Dr B. K. Das	9-29 November, 2009	19
9.	Training on "Farming of ornamental fish" for participants of ATMA, Deogarh dist.	Dr S. K. Swain	27-28 December, 2009	25
10.	Workshop and Brainstorming session on Bioinformatics applications in fish/shellfish genomics	Dr P. Jayasankar Dr P. Das Dr S. Nandi & Dr H. K. Barman	12-13 January, 2010	53
11.	Application of bioinformactics in aquaculture	Sri A.S. Mahapatra	26-27 March, 2010	47
	Total participants			391

Agricultural Technology Information Centre (ATIC)

The Agricultural Technology Information Centre as a sub-component of the "Innovations in Technology Dissemination" under National Agricultural Technology Project (NATP) has been established at the Institute to provide technology products, services and information through a single window system to farmers and entrepreneurs. During the year more than 4354 visitors comprising of farmers, entrepreneurs, students etc. visited the centre. This centre has also generated revenue of Rs. 28,850.00 from sale of priced publications. A large number of pamphlets/booklets were also distributed to the visitors. A HELPLINE services has been initiated wherein a group of experts attend to telephonic queries on fixed days of the week. Presently, the Helpline works during 3.30 p.m. to 5.00 p.m. on every Tuesday and Friday. A total of 25 calls were received during the year.

Extension activities of RRC, Rahara

Training and exposure visits

Duration	Topic	Number of participants	Category	Sponsors
9 – 11 Jun 2009	Breeding of ornamental fish for village women	19	Women farmers	Eco-friendly Human and Natural Resources Development Foundation, Chinsurah, Hooghly
20 - 26 Jul 2009	Induced breeding of carps and nursery pond management	37	Rural youth	R.K.Mission Samaj Sevak Sikshan Mandir, Belur Math
1 - 8 Aug 2009	Skill development	28	SSG III Staff members of RRC Rahara & Kalyani	CIFA
9 May – 10 Mar 2009	Rural Development and Self Employment	37	Rural youth	R.K.Mission Samaj Sevak Sikshan Mandir, Belur Math
Total		121		

Exposure visit of farmers and students

Date	Number of participants	Category	Sponsors
12.11.09	19	College students (3rd year, Zoology)	Barrackpore Rastraguru Surendranath College
28.1.10	38	College students	Bangabasi Morning College
22.2.10	25	Fish farmers	Fisheries Dept, Bihar
17.3.10	27	Farm women	CIFE trainees from Darbhanga, Bihar,
30.3.10	12	Trainees	CIFRI trainees from Baishali, Bihar
Total	121		

Exposure visit of ARS probationers

Duration	Topic	Number of participants	Category
16 - 18 Nov 2009	Orientatation programme	2	ARS scientists of CIFA

Survey works of RRC, Rahara

(i) A Survey of sewage fed aquaculture practices in farmers' field was carried out to assess the status of the sewage fed aquaculture in West Bengal. As a part of the programme the following sites were visited and interactions were made with regard to problems and possible solutions in fish culture, production, profit and market availability.

- Rahara, West Bengal on 12 June, 2009.
- Sewage-fed farm(using city sewage) of Sri S.D.Ghosh, Aloke Mandal and Sailen Pal covering 133 ha at Jhagrasisa & Gomukhpota under East Calcutta Wet Land on 25 November, 2009.

(ii) Survey & Farmers interaction were made to assess the general state of the aquaculture and aquaculturists in West Bengal. The survey were made as a routine exercise to interact and develop network with the farmer and the information collected to be used as feed back for research in future. The following sites were surveyed.

- Fish seed market and private hatchery at Naihati to record seed availability, demand, transport and price.
- Common carp spawn production centre at Amrapally, Garifa, 24-Parganas (N) as successful case of seed production enterprise undertaken collectively by seven families.
- Harane Gheri (Bheri Fishery) at N-24 Parganas district of W.B. where more than 30 adibasi farmers and farmwomen (SC/ST) have adopted CIFA technologies.
- A village (Kutubpur, N 24 Parganas) on 31 December 2009 The remote villages of Bankura district (Lachmangarh, Bhogra village under Hirbundh Block) during 28-30 May, 2009.
- An entrepreneur at Ghatakpukur, South 24-Parganas.
- 30 tribal women doing fish culture in Harani Gheri (North 24-Parganas, West Bengal) during second week of June, 2009.

Extension activities of Field Station, Kalyani

- The Field Station of CIFA, Kalyani, adopted a progressive fish breeder at Sibdaspur, Kampa, 24 Parganas(N), West Bengal for breeding of pabda. He has produced about one lakh spawn. Sri Kironmoy Nanda, Hon'ble Minister of Fisheries, Govt. of West Bengal visited his farm on 12 July 2009 and appreciated the initiatives taken by CIFA for commercialization of Pabda, which has high demand in the market.

North-eastern Region Activities

CIFA holds Aquaculture Field Program for the North-East

The Institute organized a three-day field programme on freshwater aquaculture during 20-22 July 2009. A total of 17 participants, including 6

female candidates, from four northeastern states *viz*., Manipur, Arunachal Pradesh, Meghalaya and Nagaland took part in the event. The programme provided a common platform and opportunity for the participants to see and learn new techniques, discuss operational difficulties and obtain practical guidance and solutions from the experts.

An exposure visit to the farms of two successful private entrepreneurs technically supported by CIFA was also arranged to see and interact with an ornamental fish breeder and one carp seed producer. The training and exposure was highly motivating for them to strart new ventures in their respective places.

Regional consultation meeting for sustainable aquaculture development in the NEH Region

The Institute organised a regional consultation to devise strategies for research and development in aquaculture for the North-eastern Region during 16-17 September 2009 at Shillong, Meghalaya. The focus of the programme was to develop research priorities of CIFA for the next five years. The workshop was attended by State Fisheries Directors of Assam, Meghalaya, Manipur, Mizoram, Nagaland, Tripura and Arunachal Pradesh, and Joint Director of Sikkim. The Directors or representatives of ICAR fisheries institutes of CIFA, CIFRI, DCWFR and CIFT also participated besides subject matter experts. Dr. M. Sinha, Advisor, Fisheries Government of Tripura and Dr. P. C. Mahanta, Director, DCWFR, Shri. P. K. Borthakur, Commissioner and Secretary of Fisheries, Govt. of Assam and Dr. S. V. Ngachan, Director, ICAR Research Complex for NEH Region presented their viewpoints in the inaugural session of the workshop. The development stakeholders like North-eastern Council (NEC), National Fisheries Development Board (NFDB), North-eastern Development Finance Institution (NEDFI), National Bank for Agriculture and Rural Development (NABARD) provided their responses and interventions for the development of fisheries in the North-East Region.

In the two day workshop all the State Fisheries Directors presented the issues, constraints, opportunities and support required for the aquaculture development in the regions followed by the interventions by ICAR through various specialised research organisation operating in the region. The responses and opportunities available among the stakeholders for the development in the region were discussed thoroughly. At the end, the strategies for the aquaculture development and research priorities for the CIFA were worked out in a participatory mode which was adopted by the house unanimously.

Integrated progamme at Silchar

As a follow up to the Regional consultation meeting for sustainable aquaculture development in the NEH Region held during 16-17 September 2009 at Shillong, Meghalaya in which it was decided to intervene in the low altitude zone of the region with significant aquaculture potential, a programme was organized at Silchar, Assam during 23-27, November, 2009.

The following activities were undertaken

- Exhibition of CIFA technology at Assam University, Silchar
- Training programme on composite fish culture and ornamental fish culture
- Operationalisation and inauguration of ornamental fish hatchery unit facility at Assam University, Silchar
- Collection of data on the aquaculture practices from farmers
- Identification of the farms for setting up demonstration trials on composite fish culture

As a new initiative, an ornamental fish culture unit was established at Department of Ecology and Environment, Assam University, Silchar with the financial and technical support of CIFA. The hatchery was installed to encourage breeding and conservation of locally available ornamental fishes.

First ever network meeting of aquaculture scientists in North-Eastern Region

In a bid to form a network of fisheries R&D workers for the development of the North-East Region, the Institute organized a two-day workshop at Gangtok during 11-12 March, 2010. Sri D. N. Takarpa, Hon'ble Minister for Health, Livestock, Fisheries and Parliamentary Affairs, Sikkim, in the presence of Sri V. Chauvan, IAS, Secretary, Animal Husbandry and Fisheries, Sikkim, inaugurated the meeting.

It was decided in the course of the meeting that in the ensuing year, CIFA would intensify its efforts towards development of aquaculture by transferring technologies and training line department officials and entrepreneurs in the region. The scientists and researchers in freshwater aquaculture in the region are unable to work as a team in a synergistic mode due to the lack of a common platform. In this direction, CIFA has formed a network to carry out the research and development activities in the region.

The workshop came out with the "Gangtok Declaration" to commit and consolidate a network mode of the research and development in the North East Region. An ad-hoc constituent committee was formed to prepare the documents and modalities of the network. Besides the network, the meeting also had detailed discussion on the strategies and options available for the development of the region. On this occasion, the CIFA also showcased the portfolio of aquaculture technologies ready to be extended to the various agro-climatic zones of the North East Region.

About 40 scientists, researchers and development workers involved in fisheries and aquaculture development in the region attended the programme. Among others who attended the workshop were Mr. I. Haque, Director of Fisheries, Assam; Mr. P. W. Bhutia, Director of Fisheries, Sikkim; and Dr. H. Rahman, Joint Director, ICAR Research Complex, Sikkim.

Gangtok Declaration

- Develop a common vision for sustainable aquaculture and fisheries development of the region.
- Complement and strengthen the existing capacity to develop a critical mass of professionals to address common issues and problems unique to the North East Region.
- Sharing of resources – infrastructure and professional expertise.
- Provide a forum for sharing of ideas, technologies and information.
- Provide Policy advocacy for enhanced and sustainable development of fisheries and aquaculture in the North East Region.

Special Day Celebrations

A total of 4 Field Days were organized for the farmers of various districts of Orissa covering 242 fish farmers including 102 farm women. The field days include to the aquaculture farm visits, laboratories and other facilities. The farmers visit

the learning stations which include hatchery and culture facilities for carps, air-breathing species & catfishes, freshwater prawns, ornamental fishes, flow through system, cage culture, feed mill, mechanized harvesting system, aquarium, Krishi Vigyan Kendra (KVK), Agricultural Technology Information Centre (ATIC) and others. They are also engaged in focused group interactions with the scientists who provide practical solutions to their operational difficulties. Many facets of aquaculture, such as fish breeding, soil & water quality management, fish health & nutrition etc. are also explained to them with the help of audio-visual aids.

Field Days	Date	Blocks/Districts	SC	ST	Others	Male	Female	Total
Aquaculture Field Day	9 June, 2009	Mayurbhanj & Jharsuguda	19	51	55	70	55	125
Aquaculture Field Day	12 June, 2009	Koraput & Balasore	12	17	38	40	27	67
Aquaculture Field Day	18 Aug. 2009	Kandhamal	10	10	-	-	20	20
Aquaculture Field Day	28 Aug. 2009	Khurda	2	-	28	30	-	30
Total			43	78	121	140	102	242

Fish Farmers' Day

The Institute celebrated National Fish Farmers' day on its campus on 10 July, 2009. Mrs Usha Padhi, IAS, Director, Mission Shakti was the chief guest of the function. Over 300 persons comprising of fish farmers, farmwomen, researchers, students and general public participated in the programme. Farmers were exposed to various facilities of the Institute *viz*., Fish farm, hatcheries, feed mill, aquarium, Agricultural Technology Information Centre, etc. The sets of farm literature in Oriya language were distributed among the farmers. During the meet the scientists addressed farmers' queries on various aspects of freshwater aquaculture in the local language. Nine fish farmers from Khurda, Bargarh and Puri districts who have adopted the institute's technologies and thereby providing leadership in the community were felicitated on the occasion. Sri Mihir Sagar of Bargarh for adopting portable hatchery, Ch. Narasimha Rao of Vijaywada, Andhra Pradesh for producing design pearls Four aqua-farmers of Khurda and Puri were also felicitated by the Institute for their contributions in furthering freshwater aquaculture technology developed by CIFA.

Fish Farmers' Day at WAD, Rahara

National Fish Farmers' day was observed on 10 July 2009 at WAD, Rahara along with the staff of the Kalyani Field Station. Total of 78 farmers from different districts of West Bengal attended the meet. Swami Swanniruddhanandaji, Principal, Ramkrishna Mission Samaj Sevak Sikshan Mandir, Belur Math, was present as Chief Guest, and Dr. Apurba Ghosh, former Director, CIFRI, Barrackpore and the First Officer-in-Charge, WAD, Rahara, attended the meet as Guest of Honour. Progressive farmers were felicitated for their outstanding work in the field of freshwater aquaculture.

Hindi Chetana Mas Celebrations

Hind Chetana Mas was observed at the Institute to propagate the use of *Rajbhasa* among the staff members. Three competitions *viz*., essay writing, music and speech in Hindi were organized on 13

September 2009 for the children of the staff members. Similar competitions in Hindi and a workshop on *Rajbhasa* were organized for the staff members on 14 September 2009. Around 40 participants from the scientific, technical and administrative cadres participated in the workshop, in which discussions were held on the use of simple Hindi in routine official activities and scientific writing. Hindi Diwas was also observed on 14 September, 2009 at the RRC, Rahara.

CIFA Foundation Day

The Foundation Day of the Institute was celebrated on 8 January, 2010. Retired Directors,

scientists and other staff members of the Institute assembled in large numbers to observe this important day. In a scientist-farmers interaction meeting held as part of this celebration, large number of farmers and farm women actively participated and sought advise for their farm related problems.

National Science Day

The Institute observed National Science Day on 26 February, 2010 by hosting a science awareness

programme for school children. Nearly 400 students from neighbouring high schools participated in the programme. The theme was 'Gender equity for prosperity with peace' which advocates equality for men and women in society, reducing the gender bais in the society. The students were taken on a guided tour to the CIFA farm, hatcheries, production systems, integrated farming systems, KVK, ATIC and Aquarium. They also interacted with the scientists of the Institute on the science and developments in aquaculture.

International Women's Day

A function was organized at the Institute on the occasion of the International Women's Day on 8 March, 2010. The Chief Guest on the occasion was Padmashree Priyambada Mohanty Hejmadi, renowned academician, administrator and Odishi classical dancer. The programme was coordinated by the Women's Cell, CIFA. On the occasion a blood donation camp was organized in collaboration with Red Cross Society. The progarmme was hugely successful as many staff members voluntarily donated blood.

Commercialisation of products/ processes

The following technology was commercialized during 2009-10.

Technology	Licensee	License fee (Rs in lakhs)
CIFA-CRYO – A manually operated handy cryofreezer for gamete cryopreservation (commercialized on 24 February, 2010)	M/s Biotecknika, Bhubaneswar	2.51

Mega seed project – seed production in agricultural crops and fisheries

The mega seed project is a flagship project of the ICAR to increase the availability of the quality seed in the country. CIFA is the lead institute for fish seed production. As a part of the project, the institute is coordinating activities of other centres besides producing significant quantities of seed. During the reporting year a total of more than 390 lakhs seeds were produced and distributed to the farmers.

Dr S. K. Swain, Pr. Scientist delivered a Radio talk on 22 January, 2010 on Management and care of ornamental fish during winter months on All India Radio (Krushi Sansar).

Dr. S.C. Rath, Sr. Scientist delivered three Radio talks, three television Programmes and two GRAMSAT programmes on Fish feed preparation and application in farm ponds.

Television programmes of DD-6, Bhubaneswar were telecasted on 23, 25 and 27 November 2009 for fish farmers of Orissa to popularize the farm made feed preparation and application in aquaculture.

Table 45 Fish seed production (in lakhs) under mega seed project

Name of Center	Component species	Target 2009-10	Achievement 2009-10	Target 2010-11
CIFA Headquarters	Carp	650.00	338.54	650.00
	Catfish	2.00	1.30	2.00
	Freshwater Prawn	7.00	3.48	7.00
	Ornamental Fish	3.00	3.01	3.00
RRC, Bangalore	Carp	100.00	42.62	100.00
	Ornamental Fish	2.00	1.50	2.00
RRC, Vijaywada	Catfish	1.00	-	1.00

Programmes on Television/Radio/Video films

A talk was delivered on All India Radio, Cuttack on fish seed production on 9 August 2009.

A GRAM SAT programme (Live satellite interaction programme for farmers) was organized on farm made feed preparation at pond site, its storage and application on 26 August 2009 for Orissa fish farmers.

Dr S. K. Swain, Pr. Scientist coordinated television documentation on ornamental fish farming, problems and prospects in Orissa for the weekly programme (*Mo Odisara Unnnati*), which was telecasted by OTV Bhubaneswar on 27 May 2009. He also coordinated television documentation on Prospect of ornamental fish farming telecast by OTV, Bhubaneswar on 04 January, 2010.

Publicity through Print Media

The extension section of the Institute is involved in highlighting the achievements of the Institute in the print and electronic media. Last year a large number of news items were published in various news papers in English, Hindi and Oriya languages.

Group visits organised

During the year 2009-2010 about 102 groups visitited the organizations. The groups comprised of students, practicing farmers, farmwomen, extension workers and others. Durations of the visits were mostly one day, in few cases 2-3 days. Visitors were taken around the farm facilities, museum, and selected laboratories and ATIC. Educational videos were screened for the visitors. For farmer groups, interactive sessions were with the scientists were organised for addressing various queries.

Other extension activities

Besides Institutional programmes, many other progammes for extension and dissemination of the technology were organsed. Some of them are as follow.

Programme	Venue	Date	Beneficiaries
Inauguration of FRP hatchery site and Training	Keonjhar	25 July, 2009	50
Training on Techniques of pabda rearing and culture in ponds	Kalyani	27 August, 2009	23
Farmers' training programe on Fish Farming (organized by CIFA in collaboration with NR International)	Diptipur, Bargarh	19 October, 2009	27
Training on ornamental fish breeding and culture (organized by KIIT, Bhubaneswar)	Village Balianta, Khurda	6 November, 2009	47
Training on farming of ornamental fish	Assam University, Silchar	26 November, 2009	37 (women)
Management of culture and breeding of small and endangered fish species	Kalyani Field Station	19 February, 2010	32
Training programmes under the NAIP project on "A value chain on murrel production in Tamil Nadu and Orissa"	Kausalyaganga	22-24 February, 2010 & 4-6 March, 2010	87
Training and demonstration of breeding of ornamental fishes	Village Landijhari, Deogarh district, Orissa	25 March 2010	32
Technical guidance for construction of carp hatchery	Brick Field Fish Farm,	April 2009-October 2010	Odisha State Fishery Dept.
Training programme on Magur breeding, Integrated farming	Assam University, Silchar	25 November 2009	25
Rohu and mrigal breeding in FRP mini carp hatchery (3.0 lakh spawn produced)	Kaijanga village, Khurda district, Orissa	27 August 2009	9

EDUCATION AND INFORMATION SYSTEM

Library

The Dr Hiraral Chaudhuri Library at the Institute is a specialized one having a vast collection of books and journals on Fisheries and Aquaculture. It has about 6500 books/ monographs, 2500 back volume journals and other reference material. Besides the 2700 internal users of the library (which include scientists, research scholars, & M.F.Sc. students), 675 visitors from other organizations also utilised the available resources during the reporting year.

The library subscribed to 37 international and 64 Indian journals during the year. About Rs 25 lakhs were spent exclusively towards subscription of international journals. It has been recognised as the FAO Depository Library and has a good collection of FAO publications related to fisheries and allied agricultural sciences.

The users of the library extensively used the Consortium of E-resources on Agriculture (CeRA). A user awareness programme on the CeRA was organized by the library during the year. In addition to the above online access in CeRA, the library provides Document Delivery services to various institutions (including the SAUs) under the NARS.

The library is fully automated and barcoded with Libsys 4.0 software.

To keep abreast of the current developments, it also provides monthly 'Current Contents' service by compiling the content pages of current journals received. It also sends the publications of the Institute to other Research Organisations, State Fisheries Departments, Fisheries Colleges, entrepreneurs and farmers to keep them abreast with the latest developments in freshwater aquaculture.

The library also provides photocopy facility, and during the year 2009-10 more than 70,000 copies have been done. Most of the photocopies provided to the Scientists and technical staff officially were from the holdings of the library.

Planning, Monitoring and Evaluation Cell

During the year under report, the Planning, Monitoring and Evaluation Cell undertook the following work:

- Documentation and dissemination of scientific output of the Institute through CIFA Newsletter, Annual Report and other publications
- Organizing monthly meetings of senior officers to discuss the monthly progress of various activities of the Institute including research, teaching, training, publications and other administrative and financial matters. The proceedings were prepared and follow-up action monitored.
- Assistance provided for conducting IRC and RAC meetings
- Correspondence with the ICAR Headquarters, ICAR Fisheries Institutes, SAU's and other organizations on various research issues
- Maintenance of Research Project Files
- Six-monthly assessment reports of scientific staff
- Action taken reports on recommendations of ICAR Regional Committee Meetings

Publications

- Annual Report of the Institute for 2008-09
- CIFA News Vol. 15 (No. 2, 3, 4); Vol. 16 (No. 1)
- Research Project Proposals – 2009-10

Communication of reports

- Material for DARE-ICAR Annual Report 2008-09
- Action taken report on proceedings of the meeting of Directors of ICAR Institutes
- Monthly, quarterly and half-yearly progress reports to the Council
- Replies to Parliament queries

AWARDS AND RECOGNITIONS

Recepient	Award	Venue	Year
P. P. Chakrabarti, Sr. Scientist	Young Scientist Associate award from Bioved Research foundation for contribution to NEH states.	Allahabad University	2010
P. P. Chakrabarti, Sr. Scientist	Smt.Juthika memorial award from Science Association of Bengal for contribution to R &D	Jadavpur University, Kolkata	2010
S. K. Swain, Principal Scientist	Acharya Prafulla Chandra Roy Memorial National Science Day Award 2010 from Science Association of Bengal	Jadavpur University, Kolkata	2010

Academic Accomplishments/Recognitions

- Dr B. K.Mishra, Head, FHM was felicitated with a citation on 16 October 2009 by the Krushak Sambad, Bhubaneswar. Further he was awarded Fellow of Academy of Environmental Biology at the inaugural session of the 29th Annual Session of the Academy of Environmental Biology held at International Crops Research Institute for Semi-Arid Tropics, Hyderabad on 20 November 2009. He has also received the Congress of Zoology Medal from Hon'ble Minister of Fisheries, Govt. of Assam during All India Zoology Congress at CIFE, Mumbai
- Dr B. C. Mohapatra, Sr. Scientist, was conferred with 'Life Time Achievement Award' by the Doiocese of Sambalpur, Mission Compound, Bolangir and West Utkal Agricultural Centre, Bargarh, Orissa for his services to the fish farming communities of Western Orissa in general and Bargarh and Nuapada Districts in particular. This award was presented by Rt. Rev. Pinuel Dip, Bisop, Diocese of Sambalpur in the Pastor Conference held at Raj Khariar on 13 December 2009.
- Dr. Kanta Das Mahapatra, Principal Scientist was selected by CGIAR, Washington DC, USA as Chairman of the Selection Committee for International Fund for Agriculture Research (IFAR) Fellowship Program for 2009.
- The Stall of Orissa Watershed Development Mission in the Krushi Mohostav 2010 exhibition in which CIFA participated won the State-level Award in the category of Best Stall.
- Dr S. K. Swain, Principal Scientist and Dr P. Routray, Senior Scientist were awarded diploma in Marker Assisted Selection (MAS) in

fish breeding by University of Chile, Sangiago, Chile on 30th June, 2009.

- A scroll of honour was presented to Dr. P. Routray, Senior Scientist by the National Aquaculture Development Authority (NAQDA), *Ministry of Fisheries & Aquatic Resources, Colombo* for his contributions to the development of freshwater aquaculture, fisheries and establishment of fish semen cryobank at Aquaculture Development Centre, Dambulla, Sri Lanka.

CIFA Annual Day

The 23rd Annual Day of the Institute was celebrated on 1 April 2009. The Chief guest on the occasion was Dr. S. Ayyappan, DDG (Fy), ICAR. About 15 retired staff members were felicitated for their lifetime contributions. Dr.Ayyappan presented them with scrolls of honours and shawls. Among others who spoke on the occasion were Dr Vinayak Rath, Vice-Chancellor, Utkal University; Dr D. P. Ray, Vice-Chancellor, OUAT; Dr Krishna Srinath, Director, Directorate of Women in Agriculture; Dr Ashwani Kumar, Director, Water Technology Centre and Dr T. Adhya, Director, Central Rice Research Institute, Cuttack.

Over 100 farmers including 35 tribal women from Kandahmal attended the programme. A farmers' meet was also held on the occasion.

Prof. Binayak Rath, Vice-Chancellor, Utkal University, distributed the CIFA Annual Awards and the scholarships to the children of staff members. The recipients of the awards are as follows:

The CIFA Annual Awards for the year 2008 instituted from the interest accrued on the cash prize of ICAR Best Institution Award, 1996 were conferred on the following staff members of the Institute.

Best Division	:	Fish Nutrition and Physiology Division
Best Scientist	:	Dr.H.K.Barman
Best Technical Person	:	Dr S.Dasgupta
		Dr (Mrs) Utkal Laxmi Mohanty
Best Administrative Person	:	Shri K.C.Das
Best Supporting Staff	:	Shri Baman Jally
Best Extension Worker	:	Dr Suresh Chandra
		Shri Ajaya Kumar Dash
Best Research Scholar	:	Dr Bikash Ranjan Mohanty
Best Hindi Worker	:	Dr Bibhudatta Mishra
		Shri Debendra Tarai
Higher scorer in Class-X (children of staff member)	:	Ms. Takshashila Pani

CIFA has instituted two scholarships for promoting academic excellence among the children of the staff. One, with a donation of Rs. 1,20,000 by Dr Hiralal Choudhuri in the memory of his father as 'Girish Chandra Chaudhuri Memorial Scholarship' and the other with a donation of Rs. 60,000 by Dr S. Ayyappan in the name of his mother as 'Smt. S. Susheelamma Scholarship'..

Recipients of scholarships for the year 2008-09

Girish Chandra Chaudhury Memorial Scholarship			Smt. S. Susheelamma Scholarship		
Level of study	Name of the student	Amount (Rs.)	Level of study	Name of the student	Amount (Rs.)
XI, XII	Pushpa Sahoo (D/o Sri D. C. Sahoo)	2400	VII, VIII	Soumya Sumitra (D/o Sri D. Sahoo)	1200
Graduation	Dipti Mathuria (D/o Sri S. C. Mathuria)	3000	IX, X	A. Shuvam (S/o Dr. D. K. Verma)	1800

RESEARCH COORDINATION AND MANAGEMENT

Research Advisory Committee

The first meeting of the newly reconstituted Research Advisory Committee, for a period of three years i.e. 1.2.2010 – 31.1.2013, was held at the Institute during 3-4 March, 2010. The Chairman of this committee is Dr M. R. Sinha, Advisor (Fisheries), Govt. of Tripura and the members are Dr R. Paulraj, Member-Secretary, Coastal Aquaculture Authority, Chennai; Prof. K. M. Sankar, College of Fisheries, Mangalore; Dr Aparna Dixit, Dean, School of Biotechnology, Jawaharlal Nehru University, New Delhi; Dr Sher Ali, Prof. National Institute of Immunology, New Delhi; Dr V. V. Sugunan, Asst. Director General (I.Fy), ICAR, New Delhi. Dr P. Jayasankar, HoD, Fish Genetics and Biotechnology, CIFA is the Member-Secretary. The major recommendations of the RAC centred around the following issues:

- Production of "safe fish", through interventions like organic farming
- Water budgeting and modeling
- Environmental balance
- Relook at the farm mechanization project
- Standardization of seed production in murrels, magur, Ompok and pangas
- More critical look at commercial fish production through aquaculture in Andhra Pradesh in the context of safety measures
- Improvement of pearl production
- Development of generic feeds and utilization of locally available cheap feed ingredients
- Heterotrophic feed production
- Marker system for DNA barcoding and comparative & functional genomics
- Relook at recombinant vaccine production for aeromoniasis
- Amplification of full length genes
- Cell line research
- Production loss due to disease
- Host parasite relationship
- Assessment of impact of CIFA technologies, including their economic viability
- Review of waste water aquaculture practices at Rahara centre
- Need for keeping high standards in publication scenario

Institute Research Council

The mid-term IRC meeting was held during 3-5 December, 2009 and Annual meeting was held during 15-19 April, 2010 under the Chairmanship of Dr A. E. Eknath, Director. All the Institute-based and externally funded projects were thoroughly reviewed and new project proposals were presented.

Institute Management Committee

The 31st Institute Management Committee meeting was held on 14 January, 2010 under the Chairmanship of Dr A. E. Eknath, Director, CIFA. It was attended by Dr. D. P.Ray,Vice-Chancellor, OUAT, Bhubaneswar; Dr.J.K.Jena, HoD, Aquaculture Production and Environment Division, CIFA; Dr. D. P. Sinhababu, Principal Scientist, CRRI,

Cuttack; Dr. Aparna Choudhuri, Senior Scientist, CIFE,Mumbai; Shri A.K.Lal, F&AO,CIFA as Members and Shri S.Purkayastha, Administrative Officer, CIFA as the Member – Secretary. Agenda items included confirmation of the proceedings of the 30th Institute Management Committee Meeting, discussion on the highlights of few research programmes of the Institute (selective breeding of rohu, disease resistance against aeromoniasis for rohu, selective breeding programme of *M. rosenbergii*, portable FRP carp hatchery, species diversification, fish genetics and biotechnology), procurement of equipments during 2009-10, procurement of airconditioners and computers against replacement, disposal of vehicle and ehnacement of of budget for security.

Institute Joint Staff Committee

The IJSC meeting of the Institute was held on 10 February, 2010.

Quinquennial Review Team

The Chairman and members of the QRT (2003-2008) visited the Institute on 8 April 2009 and had interactions with the Director and staff members.

The QRT team comprising of Dr. Modadugu V. Gupta (Chairman), Prof. (Mrs.) Aparna Dixit (Member), Prof. N.K. Subhedar (Member), Prof. (Mrs.) I. Karunasagar (Member), Prof. B.C. Mal (Member), Dr. P. K. Joshi (Member) and Dr. J.K. Jena (Member Secretary) submitted its Final Report to ICAR, New Delhi during the period. The major recommendations of the QRT include:

- Need for revisiting research programs / priorities
- Need for multi-disciplinary research
- Study on water budgeting in aquaculture
- Pilot testing and establishing commercial viability of technologies
- Socio-economics research to be strengthened
- Regional Research Centers to address (i) the regional problems/ issues, and (ii) transfer/ adopt to local situation the technologies/ modules/management practices developed at headquarters. It is also recommended that CIFA/ICAR to consider relocating the Rahara Center in one of the north-eastern states.
- Central laboratory facilities to be made for sensitive/ sophisticated/ expensive equipments
- Changes in cadre strength
- Recognition in Staff Assessment for field work and impact of research

International Cooperation

Myanmar Fishery Delegation Learn Indian aquaculture

A 15-member Myanmar fisheries delegation led by Mr. U Than Lwin visited the Institute and its Regional Centre at Vijayawada during 14-21 July 2009 to study the remarkable aquaculture development in India, the second highest aquaculture producer in the world, next to China. The team included 11 members of Myanmar Fish Farmers Association, 2 members each from Myanmar Fisheries Federation and Aquaculture Division of Myanmar Fisheries Department. They also visited progressive farming sites like Kolleru area of AP and learnt the lesson on the aquaculture growth in India.

Establishment of Fish Semen Cryobank at Sri Lanka

Asynchronous breeding of fishes is a worldwide problem in many cultured fin fishes. In many hatcheries around the world, males mature first and after a time gap the females mature, causing a mis-matching of spawning in brood fishes. This results in poor fertilization of eggs and economic

loss to farmers. This has been reported especially from countries like Sri Lanka where two monsoon seasons prevail. Cryopreservation of semen collected from these fishes at their prime maturity and utilization of the same can be an alternative to overcome the non-synchronization breeding. In this regard, CIFA offered consultancy after getting a request from NAQDA, Ministry of Fisheries & Aquatic Resources, Sri Lanka to establish a fish semen cryobank at Sri Lanka.

Dr. P. Routray Senior Scientist worked as a consultant to assist the Sri Lankan officials in establishment of the *fish semen cryobank* and visited Srl Lanka during 14-31 March, 2010. Under this programme, a fully operational Fish Semen Cryobank was established at Aquaculture Development Centre, Dambulla, Sri Lanka. Twenty aquaculturists from Sri Lanka were trained on fish semen cryobanking. On this occasion, Director General of NAQDA, Dr. Ivan Silva released the manual on "Cryobanking in aquaculture".

Indo-French Seminar on Recent Advances in Aquaculture

A seminar on Recent Advances in Aquaculture was jointly initiated by Dr S. Kaushik, INRA, St-Pée sur Nivelle, France and Dr S. Ayyappan, Deputy Director General, (Fy), ICAR in order to strengthen the existing collaboration in freshwater aquaculture between the two countries during 30-31 August, 2009. The scientists of the Fish Nutrition and Physiology Division, CIFA co-ordinated the workshop and Director, CIFA as the local scientific host, coordinated the sessions. The seminar dealt with most recent advances in major research areas, to have a comparative evaluation and mutual appraisal of the evolution of aquaculture research in both contexts and to prepare for future co-operative research in fish farming between Indian and French research groups. The seminar was attended by more than 50 participants from different institutions from India and France. During the seminar more than twenty oral presentations were made by Indian and French scientists on general aquaculture systems and sustainability issues, reproductive physiology, genetic improvement strategies, fish nutrition and health issues. This was followed by separate working groups to draft focused cooperative research work plans for future. The participants also visited the farm and research facilities of CIFA on 1 September 2009 and interacted with the researchers. Further, they visited the Regional Research Centre of CIFA at Vijayawada and surveyed the Krishna Godavari basin aquaculture activities during 2-5 September 2009.

WORKSHOPS/ SEMINARS

National Consultation of State Fisheries Ministers

A National Consultation of State Fisheries Ministers, Secretaries, Heads of Fisheries

Research Institutes of ICAR and Heads of other Fisheries Institutions was held under the Chairmanship of Shri Sharad Pawar, Hon'ble Union Minister for Agriculture, Consumer Affairs, Food and Public Distribution at Bhubaneswar during 4-5 July, 2009. Shri Naveen Patnaik, Hon'ble Chief Minister of Orissa was the Chief Guest of the function and Prof. K. V. Thomas, Hon'ble Union Minister of State for Agriculture, Consumer Affairs, Food and Public Distribution was the Guest of Honour. Dr Mangala Rai, Secretary, DARE and Director General, ICAR, and Dr S. Ayyappan, DDG(Fy), ICAR were instrumental in conducting the conference and delivered key note addresses. The primary objective of the meeting was to develop a road map for generating 10 million tones of fish by 2012 from the present level of 7.13 million tones. There are avenues to meet domestic demand and to enhance export earning potential in terms of value added products and ornamental fish trade. The livelihood and economic security of fishers were also the main issues discussed in the conference, as also interventions required in areas of technology, infrastructure, marketing and capacity building. The ICAR was directed to carry out an intensive and comprehensive study and survey of socio-economic conditions of fishermen, so that a national policy on welfare of fishermen could be developed based on reliable data.

Shri Sharad Pawar, Hon'ble Union Minister for Agriculture, Consumer Affairs, Food and Public Distribution, along with other dignitaries visited the Institute on 5 July, 2009. They were highly impressed to see the field and laboratory facilities at the Institute. An exhibition depicting the frontier activities in aquaculture was also organized on the occasion.

Launching workshops of NAIP projects

The Indian Council of Agricultural Research (ICAR) under its ambitious programme National Agricultural Innovation Project (NAIP) is providing substantial financial support for developing cutting edge agricultural technologies. The launching workshop of the NAIP projects entitled "Toll like receptors in phylogenetically divergent fish species –their contribution in modulating the innate immunity" (Component 4) and "Sustainable livelihood improvement through integrated freshwater aquaculture, horticulture and livestock development in Mayurbhanj, Keonjhar and Sambalpur Districts of Orissa" (Component 3) were held on 31 July 2009. Speaking on the occasion Dr Mruthyunjaya, National Director, NAIP said that agriculture and allied sectors including animal husbandry and fisheries are in need of innovative technological solutions that would render farming a more profitable vocation, besides ensuring food and nutrition security. Towards this endeavour the Council is spending Rs. 1200 crores over a period of six years. CIFA has bagged two competitive projects worth Rs. 3.58 and 5.03 crores, respectively. The Institute as a lead center would operate the projects in collaboration with other research institutions for the next three years. Dr A E. Eknath, Director, CIFA informed that the first project would aim at developing an alternative method of disease management in carps, catfishes and sharks. The other project is developmental in nature, and it aims at comprehensive development of livelihood of 3000 farm families through fisheries, horticulture and livestock rearing. This work would be carried out in Mayurbhanj, Keonjhar and Sambalpur districts among socio-economically weaker sections of the society. Dr K. Ravindran, Director, Institute of Life Sciences, Bhubaneswar, Dr A. K. Bandopadhyay, National Coordinator, NAIP and Dr M. L. Bhowmik, ex-Dean, College of Fisheries, Tripura also spoke on the occasion.

CAC Meeting of NAIP-Livelihood Project

The 1st CAC meeting of the NAIP project on "Sustainable livelihood improvement through integrated freshwater aquaculture, horticulture and livestock development in Mayurbhanj, Keonjhar and Sambalpur Districts of Orissa" was held in CIFA on 31 July, 2009. Dr. M. L. Bhowmik,

Chairman; Dr. S. K. Roy, Dr. A. E. Eknath, Director, CIFA and Dr J K Jena, CPI as Members were present. The project personnel from all the Consortia partner Institutes were also present in the meeting.

The 2nd CAC meeting of the NAIP Livelihood project was held in the Institute on 19 January, 2010. Dr. M. L. Bhowmik: Chairman, CAC; Dr. A. P. Srivastava, National Co-ordinator, NAIP and Dr J K Jena, CPI as Members were present. Besides the CAC Members, the project personnel from all the Consortia partner Institutes were present in the meeting. Details about the progress about the project, problems and future plan were discussed.

Sequence data analysis workshop

A sequence data analysis workshop was organised during 5-7 November 2009 at the Institute under the project "Improved disease resistance of rohu carp and tiger shrimp farmed in India: Developing and implementing advanced molecular methods, and streamlining access to and use of genetic resources" in which all the project team members from Norway, CIFA and CIBA participated.

Workshop on 'Peninsular Aquaculture: Quest for Solutions'

The Regional Research Centre, Bangalore, of the Institute hosted a one day workshop "Peninsular Aquaculture: Quest for Solutions" on 26 February, 2010 at Bangalore with an objective to develop a common understanding and strategy for the development of peninsular aquaculture. Representatives from the state fisheries departments of Andhra Pradesh, Karnataka and Kerala participated in the workshop. It was also attended by experts from NFDB, CIFA, CIFE, CIFRI, State Pollution Control Board, Watershed development agencies, University of Agricultural Sciences (Bangalore) and the Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar. Issues pertaining to aquaculture resources, challenges in utilizing mulltiple-ownershop-short-season-water bodies, and species diversification of aquaculture were some of the issues discussed in three technical sessions. The workshop recommended the following points for action:

- Prioritization of species on a short and long term basisDeveloppment of Hatchery and culture technologies of Etroplus suratensis for Andhra Pradesh and Kerala.
- Development of A culture technologies of Mastacembelus armatus and Anabas testudineus for AP
- Improvemetn in the Brood stock management, seed rearing techniques for higher seed production for Karnataka.
- Development of a comprehensive plan for brood stock up gradation at national level is required.

Workshop on 'Bioinformatics applications in fish/shellfish genomics'

A Workshop and Brainstorming session on Bioinformatics applications in fish/shellfish genomics was held at the Institute during 12-13 January, 2010. The workshop had 53 participants from all over the country. Dr. Dineshkumar, Sr.Scientist from NBPGR, New Delhi and Dr. P. Jayasankar, HoD, Fish Genetics and Biotechnology Division were the chief organisers of this workshop.

HUMAN RESOURCE DEVELOPMENT

Training received by the staff members of the Institute as part of the human resources development initiative

Events/Training	Venue	Period	Participant(s)
Training on Marker Assisted Selection (MAS) (sponsored by NAIP)	University of Chile, Chile	31 March – 30 June, 2009	S. K. Swain P. Routray
Special training programme on Handling of CAT Cases and Court Cases	ISTM, New Delhi	26-28, August 2009	S. Purkayastha K. C. Das
Training on Quality Management System and Internal Audit as per ISO/ IEC 17025-2005	CIPET, Bhubaneswar	26-29, August 2009	U. L. Mohanty
Management development programme on Leadership for innovation in agriculture	IIM, Lucknow (Noida Campus)	18-22, January, 2010	A. E. Eknath
IPR Management Development Programme	Indian Institute of Management, Indore	8-10, February, 2010	P. Jayasankar S.S. Giri M. Samanta
Training on Design and synthesis of peptide antigens for diagnosis	Division of Animal Biotechnology, IVRI, Izatnagar	10-17, February, 2010	S. Nandi
Training on "IPR management, technology transfer, licensing" etc.	National Institute of Intellectual Property Management (NIIPM), Nagpur	15-16, February 2010	J. N. Saha
Hands on training on "Quantitative proteomics" organized in connection with the 14th ADNAT convention	CCMB, Hyderabad	26 February – 12 March, 2010	J. Mohanty
Refresher course on Application of bioinformatics on modern biology	Vidyasagar University, Midnapore, W.B.	27 March, 2010	M. Samanta

Participation of Scientists/Technical Officers in Workshops/Seminars/Symposia/ Conferences/ Meeting in India and abroad

Events	Venue	Duration	Participant(s)
Brainstorming meeting	Regional Research Centre of CMFRI, Kochi at Mandapam	18-20 April, 2009	A.E. Eknath
Intensive Hindi workshop	CIHT, Government of India, New Delhi	20-24 April, 2009	Binod Chaudhary Rajesh Kumar Shailesh Saurabh
Seminar on Human development of fishers in India (organized by INFOIN)	OUAT, Bhubaneswar	24 April, 2009	P. Jayasankar
Meeting on gene prospecting project sensitizing	New Delhi	5 May, 2009	A. E. Eknath
XXth Governing Council meeting of NACA	Xiamen, China	11-15 May, 2009	A. E. Eknath
Meeting of Planning Commission	New Delhi	18 May, 2009	A. E. Eknath
Meeting of the sub-committee for R & D in Biotechnology (Science and Technology Department, Govt. of Orissa)	ILS, Bhubaneswar	25 May, 2009	P. Jayasankar
Review meeting of foreign aided projects in Fisheries Division, ICAR	CIFRI, Barrackpore	27 May,2009	A. E. Eknath S. N. Mohanty B. R. Pillai P. K. Sahoo
Seminar on ...	AMIT, Bhubaneswar	27 May, 2009	P. Swain
Meeting on Consultation of fishery resources management plan for Chilika Lagoon	Bhubaneswar	28 May, 2009	A.E. Eknath P. Jayasankar
Seminar on 'Sundarban's day'	Jadavpur, Kolkata	3 June, 2009	R.N. Mandal A. K. Datta
Fish Seed Committee meeting (Govt. of Andhra Pradesh)	Hyderabad	7-8 July, 27-28 July and 18-19 August, 2009	P.V. Rangacharyulu
Conference of Directors of ICAR Institutes	New Delhi	16-17 July, 2009	A.E. Eknath
Convergence Workshop of NREGA, Ministry of Rural Development	New Delhi	29 July, 2009	J. K. Jena
Annual workshop of AICRP on APA	SKUAST-K, Srinagar, J&K	18-20 August, 2009	B. C. Mohapatra N. K. Barik

Events	Venue	Duration	Participant(s)
Workshop on "Conservation and wise use of natural resources of Chilka lagoon with community participation" organized by JICA & CDA	Bhubaneswar	3 September, 2009	P. Jayasankar
Workshop on Consultative CSO-SPF	NR International, Bhubaneswar	5 September, 2009	B. C. Mohapatra
National Symposium on Coldwater fisheries management: New strategies and approaches at eco-camp of ABACA (organized by the Directorate of Coldwater Fisheries Research)	Nameri, Tezpur, Assam	2-4 October, 2009	A. E. Eknath
Training on Technical and administrative support for consortia based research in agriculture	MANAGE, Hyderabad	4-16 October, 2009	Bibhudatta Mishra
Third sub-committee meeting on Organic aquaculture	APEDA, New Delhi	5 October, 2009	J. K. Jena
Interface meeting of Scientists in Nutrition, Biochemistry and Physiology in fisheries research	National Institute of Animal Nutrition and Physiology, Bangalore	19 October, 2009	S. N. Mohanty N. Sridhar S.S.Giri C. Devraj
Bioprospecting of genes and Allele Miniting for Abiotic	NASC Complex, New Delhi	21 October 2009	H.K. Barman
Chief guest at the training programme on Broodstock management and hatchery practices for freshwater fisheries (organized by College of Fisheries, Mangalore)	Fisheries Research and Information Centre, Bangalore	22-23 October, 2009	A. E. Eknath
Consultation Workshop on "Integrated management planning for Chilika Lake, Orissa" (organized jointly by CDA & Wetlands International)	Bhubaneswar	23 October, 2009	P. Jayasankar
Annual general meeting of the project Sustainable aqua feeds to maximize the health benefits of farmed fish for consumers (AquaMax)	Budapest, Hungary	27-28 October, 2009	S. N. Mohanty S. S. Giri
4th Aquaculture Sub-Committee Meeting of APEDA	CIBA, Chennai	28 October, 2009	J. K. Jena
Mid-term Review meeting convened by the Planning Commission	CIFRI, Barrackpore	30 October, 2009	A. E. Eknath
Review meeting of the Indo-Norway project on Disease resistance	CIBA, Chennai	3 November, 2009	A. E. Eknath P.K. Sahoo

Events	Venue	Duration	Participant(s)
Meeting of the CIFA-World Fish Center collaborative project on Genetic improvement of giant freshwater prawn *Macrobrachium rosenbergii* and the World Aquaculture Society Conference (Asia Pacific Aquaculture 2009)	Kuala Lumpur, Malaysia	3-6 November, 2009	K.D. Mahapatra B. R. Pillai
Coordination Committee Meeting of AICRP on APA	MPUAT, Udaipur	16-17 November, 2009	Dr B.C. Mohapatra,
Workshop on Functional genomics and proteomics	Institute of Life Sciences, Bhubaneswar	18-20 November, 2009	P. Jayasankar
Symposium on Biosafety and environmental impact of genetically modified organisms and conventional technologies for pest management	ICRISAT, Hydrabad	20 November, 2009	B. K. Mishra
Seminar on Managing rural livelihood in India: Challenges and opportunities	OUAT, Bhubaneswar	27-28 November, 2009	H. K. De N. Panda
Chief Guest in the Winter School on Novel techniques in handling preservation and product development of freshwater fish	CIFT, Kochi	30 November, 2009	A. E. Eknath
Annual Conference of Indian Society of Agricultural Statistics	RAU, Samastipur (Pusa), Bihar	3-5 December,2009	N. Panda
Seminar on Women in Agriculture	DRWA, Bhubaneswar	4-5 December, 2009	D.K. Verma
Seminar on Patents	NIIPM, Nagpur	8-11 December, 2009	P. Das
Workshop on Integrated fisheries in low land area	NABARD, Bhubaneswar	10-11 December, 2009	S.C.Rath
Conference on Sustainable marine fisheries management	College of Fisheries, Mangalore	22-23 December, 2009	A. E. Eknath
National Seminar on “Recent trends in utilization of plants in human welfare”	Ramakrishna Mission Ashram, Narendrapur	24-25 December, 2009	P. K. Mukhopadhyay R. N. Mondal
National on “Enhancing efficiency of Extension for sustainable agriculture and livestock production”	IVRI, Izatnagar	29-30 December, 2009	H K De
4th Meeting of the Sub-committee on Organic aquaculture	CIBA, Chennai	December, 2009	J. K. Jena
Workshop on “Sustainable *Macrobrachium rosenbergii* Aquaculture-A Genetic Approach”	CIFE, Mumbai	8-9 January, 2010	B. R. Pillai

Events	Venue	Duration	Participant(s)
5th Meeting of the Sub-Committee for Preparation of Guidelines for Organic Aquaculture of APEDA	CIBA, Chennai	11-12 January, 2010	J. K. Jena
Interaction meet of Engineering scientists working in fisheries and animal science institutes of ICAR	CIAE, Bhopal	11-12 January, 2010	M. R. Raghunath K. K. Sharma
Workshop on "Marine Mammal strandings"	CMFRI, Cochin	20-24 January, 2010	P. Jayasankar
Review of foreign aided projects in the Fisheries Division	ICAR, New Delhi	29 January, 2010	S. N. Mohanty P. K. Sahoo B. R. Pillai
Meeting of the Fisheries Research Institutes convened by DG, ICAR	ICAR, New Delhi	30 January, 2010	A. E. Eknath J. K. Jena
Assam Matsya Mahochhav	Guwahati, Assam	30 January to	A. E. Eknath
		01 February, 2010	S. K. Swain G. Saha
CAC meeting of NAIP project	Palayamkotii, Tamil Nadu	1 February, 2010	Rajesh Kumar
National workshop "Sensitization on network and web hosting"	NAARM, Hyderabad	2-3 February, 2010	H. K. De
International Seminar on Ornamental fish breeding and trade	Cochin	13-14 February, 2010	S.K.Swain Rajesh N
Meeting of Directors of ICAR Research Institutes	ICAR, New Delhi	15-16 February, 2010	A. E. Eknath
SAU Vice-Chancellor's Conference	New Delhi	17 February, 2010	A. E. Eknath
Seminar on "Patent Search"	IPIIM, Nagpur	17-18 February, 2010	P. K. Mukhopadhyay R. N. Mandal
Meeting-cum-workshop of ICAR Zonal technology management and business planning and development	IINRG, Ranchi	19-20 February, 2010	P. Swain J.K. Jena P. Routray P. Das S.K. Swain
5th AOHUPO Congress, 14th ADNAT Convention and I st PSI Conference on "New Perspectives in Proteome Research"	CCMB, Hyderabad	21-25 February, 2010	J. Mohanty

Events	Venue	Duration	Participant(s)
Seminar on 'Small indigenous freshwater species: Their role in poverty alleviation, food security and conservation of biodiversity'	CIFRI, Barrackpore	23-25 February, 2010	A. K. Dutta P. K. Mukhopadhyay
Seminar on recent development in Fish biotechnology	Jadavpur University, West Bengal	27 February, 2010	S. K. Swain
Meeting on Fisheries development action plan	NFDB, Hyderabad	1 March, 2010	P.V. Rangacharyulu B. S. Giri
Regional Workshop of the NAIP	Birsa Agriculture University, Ranchi	4 March, 2010	J. K. Jena
Meeting of NFDB	CIFE, Kolkata	4 March, 2010	A. K. Datta
Stakeholders Workshop for Finalization of the Guidelines for Organic Aquaculture	APEDA, New Delhi	5 March, 2010	J. K. Jena
Seminar on Applications of Biotechnology and Development of Bihar	BIT, Patna	21-23 March, 2010	P. Jayasankar
Workshop on "Village Tank Management "	Administrative Academy of Madhya Pradesh, Bhopal	22 March, 2010	J. K. Jena
NFDB-FAO Mission Consultative meeting on Development of Fisheries Sector in India	NFDB, Hyderabad	24-25 March, 2010	A. E. Eknath J. K. Jena P. K. Sahoo
International workshop on Conservation of the Irrawaddy dolphin with special reference to the underwater acoustic study (organized by CDA)	Bhubaneswar	25 March, 2010	P. Jayasankar
Workshop on Hindi	Central Hindi Training Institute, New Delhi	--	Rajesh Kumar U. L. Mohanty

Outreach Activities

Three Outreach activities have been initiated by the ICAR during the XIth Plan, considering the need for focused attention in some key areas of research that cut across the mandate of more than one Institute under the Fisheries Division. These are:Fish feeds, Fish genetics stock, Nutrient profiling and evaluation of fish as a dietary component.

These outreach activities will function under a consortium mode let by a Lead Institute in active parternership with other participating Institutes i.e., NBFGR, CIFRI, CIFT, CIBA, CMFRI and NRCCWF. The CIFA is the Lead Institute for the outreach activity on Fish feeds and participating Institute in the other two outreach activities. The following meetings under outreach activities were conducted during 2009-2010.

Programme	Venue	Duration	Participants
Outreach programme on Fish Feeds	CIFA, Bhubaneswar	7-10 October 2009	PI and other scientists
Mid-term Review meeting of Outreach Project	CIBA Chennai	19 November, 2009	B. N. Paul
Review meeting of the Outreach programme of the ICAR on Fish feeds, Fish genetic stock and Nutrient profiling of fish	NASC Complex, New Delhi	5-6 March, 2010	A. E. Eknath S. N. Mohanty P. K. Mukhopadhyay S. S. Giri P. Das

Fish feeds

- Demonstration on farm-made fish feed preparation was organized at Korai Block of Jajpur District, Orissa on 20 August 2009. Twenty-four farmers of 'Maa Chaiti Durga Fisherman Co-operative Society' participated in the programme.
- A demonstration programme on farmed-made fish feed preparation was organized at Korai Block of Jajpur District, Orissa on 20 August, 2009. Twenty four farmers of 'Maa Chaiti Durga Fisherman co-operative society participated in the programme and were trained for on-farm feed preparation. A hand-out in Oriya on fish feed preparation technique and feeding practices to be adapted was distributed among the participants
- Cage aquaculture is an eco-friendly approach of resource utilization to increase productivity and livelihood from a reasonably larger water body. The Institute and Central Inland Fisheries Research Institute, Barrackpore have jointly taken up a cage culture demonstration at Bishnupur, District Bankura, West Bengal, where the advantage of using formulated pellet feed was demonstrated to the fish farmers through Mallabhum Fishermen's Co-operative Society. A portable feed pelletiser including a pulverizer unit was provided to the Society for pellet feed preparation on the cage culture site. The farmers were also given 'hands on' training to operate this portable feed mill unit. On 27 May, 2009, Dr. S. Ayyappan, DDG(Fy), ICAR, handed over the unit to Sri S. D. Ghosh, President of the Society and initiated the portable feed mill operation programme in the presence of Dr. V.V Sugunan ADG (Fy), Dr. A. E. Eknath, Director CIFA, Dr. K .K. Vass, Director CIFRI, Dr. S.N. Mohanty Head, Fish Nutrition and Physiology Division CIFA, Dr. P. K. Mukhopadhyay, Coordinator Outreach project on fish feed, Dr. U.K. Bhowmik, Head Riverine Ecology and Fisheries Division, CIFRI, Dr. B.C. Jha, Head, Reservoir and Wetland Fisheries Division, CIFRI, Dr. M. K.

Das, Head Fisheries Resource and Environmental Management Division, CIFRI, Dr. A. Hazra Principal Scientist, CIFRI and other scientists and farmer members.

Nutrient profileing and evaluation of fish as a dietary component

A 15-day field survey was undertaken at Bastar region of Chhattisgarh. During the survey about 10 villages were covered and information collected about socio-economic status, feeding habits, body weight and other details of the villagers as per the Survey Proforma. Blood samples of the villagers were also collected for Hb% estimation of both males and females in connection with the study.

Genetic Stock

Survey and sample collection from Naraj (River Mahanadi), Kantilo (River Mahanadi), Satkosia Gorge (River Mahanadi), Sambalpur (River Mahanadi), Kaluria (River Bramhani), Baliapal (River Subernarekha), Vijaywada (River Krishna) and Rajmundry (River Godavari) were done. The summary of samples collected is given below.

Summary of Sample Collection

SL.	Species Name	River/Tributary	No. of Samples
1	*Labeo rohita*	Mahanadi	39
2	*Catla catla*	Mahanadi	51
3	*Cirrhinus mrigala*	Mahanadi	51
4	*Labeo fimbriatus*	Mahanadi Godavari	37 04
5	*Cirrhinus mrigala*	Subarnarekha	01

DNA isolation and Quantification

DNA isolation was one of the technical programs population genetic variations at both nuclear and mitochondrial DNA. The DNA was isolated from each fin clip that was collected from different samples from different rivers. The DNA was isolated by normal Phenol-Chloroform method and stored with proper labeling. DNA was quantified in 0.8% Agarose Gel by quantifying markers and the quality was tested by spectrophotometer.

Morphometric and Biological Analysis

The body weight and morphological measurements were recorded for each individual sample. Second, photographs (in duplicate) were taken for truss measurement and analysis. Dissecting and observing the gonad confirmed sex and maturity stage. Gonad weight was taken for the calculation of GSI. For Truss analysis, the exact image of each individual was uploaded on to computer and analysis done using specific software. Gonad sub-sampling was done for the estimation of average fecundity rate. For growth measurements, 5-6 scales were collected from each sample and preserved temporarily in saline water. In the laboratory, the images were stored through a scanner for further study.

PCR amplification of Mitochondrial Genes

Mitochondrial genes such as Control region (CR) and ATPase-6 were PCR amplified in Rohu, Catla, Mrigal and Fimbriatus (10 samples each) using universal primers and sequenced.

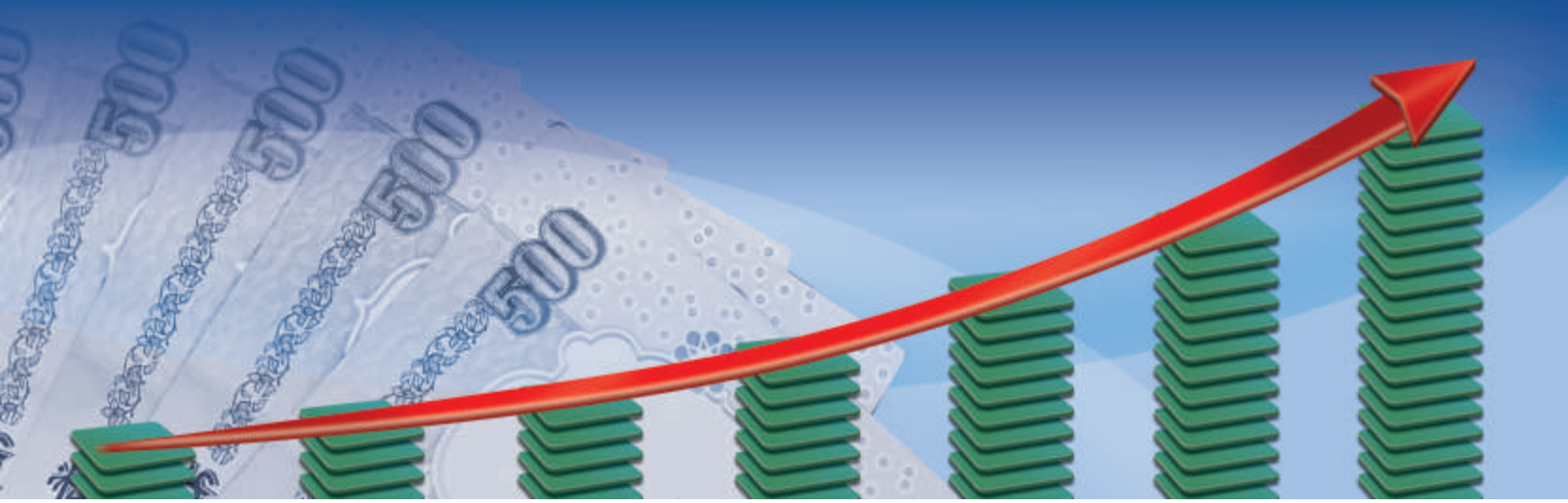
Partial Genomic Library in *L.fimbriatus* for Microsatellite isolation

For microsatellite isolation from *L. fimbriatus genome,* a partial genomic library has been made and is under screening.

EXHIBITIONS

The Institute participated in the following exhibitions during 2009-10

Exhibition	Venue	Period
National conference of state fisheries ministers	Bhubaneswar	4 - 5 July, 2009
INFISH-2009 (organized by NFDB and Dept. of Fisheries, Govt. of AP)	Hyderabad	11 - 13 July, 2009
National seminar	Eco-camp, Tezpur, Assam	2 - 4 October, 2009
Exhibition on WORLP activities in Western Orissa organized by NR International	XIMB, Bhubaneswar	9 - 10 November, 2009
Krishi Mela	G.K.V.K. Bangalore	19 - 22 November, 2009
Farmers' meet	Silchar, Assam	25 - 26 November, 2009
Women in Agriculture Day	Directorate of Women in Agriculture	4 - 5 December, 2009
Kalyani Book Fair	Kalyani, West Bengal	4 - 13 December, 2009
Fishco Festival 2010	College of Fisheries, Mangalore	22 - 24 January, 2010
Assam Matsya Mahotsav 2010	Guwahati, Assam	30 January – 1 February, 2010
International Symposium	Cochin	15 - 17 February, 2010
Krishi Mela	Hebbal, Bangalore	20 - 21 February, 2009
Regional Agri Fair	IINRG, Ranchi	22 - 24 February, 2010
Exhibition organized by Bengal Association of Science	Jadavpur University	27 February, 2010
Krushi Mahostav-2010 (State-level Exhibition on Agriculture) in collaboration with Orissa Watershed Development Mission	Exhibition Ground, Bhubaneswar	5 - 8 March, 2010
Network meeting	Gangtok	11 - 12 March, 2010



BUDGET

A. Provision from the ICAR (2009-2010)

Sl. No.	Sub-head	Non-Plan		Plan	
		Provision made in RE 2009-2010	Expenditure	Provision made in RE 2009-2010	Expenditure
1.	A) Establishment charges	1399.90	1399.90		
	B) Wages	40.85	40.85		
	C) OTA				
2.	Traveling allowances	6.92	6.92	25.00	25.00
3.	HRD			5.00	5.00
4.	A) Other charges including equipments	120.00	114.62	305.00	305.00
	B) Cyclone, damage restoration				
5.	Works	11.73	11.73	195.00	195.00
6.	Information Technology			15.00	15.00
7.	Others			5.00	5.00
8.	A) Catch-up grant equipment				
	B) Catch-up grant building				
	C) NEH				
	Total (1-8):	1579.40	1574.02	550.00	550.00

DISTINGUISHED VISITORS

Kausalyaganga, Bhubaneswar

- Dr P. R. Bhatnagar, Project Coordinator, AICRP on APA, Ludhiana visited APA Centre, CIFA (27 April 2009)
- Prof. M. C. Dash, Former Vice-Chancellor, Sambalpur University (1 June 2009).
- Shri Gokulram, Secretary to GoI, Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries to the hatchery and farm facilities of the Institute (4 June 2009)
- Dr S. Ayyappan, DDG(Fy), ICAR (1-5 July 2009)
- Dr Victor Martinez, Animal Breeding and Genomics Programme, Faculty of Veterinary Sciences, University of Chile gave a talk on 'The use of molecular genetics and genomics in breeding of aquacultural species' (8 July 2009)
- Dr K.Gopakumar, former DDG (Fy), ICAR, and presently Chairman, QRT, CIFT, Kochi along with Dr Meena Kumari, Director, CIFT and held discussions with the Director and Heads of Divisions, CIFA regarding possibilities of collaborative work in post-harvest technology between the Institutes.(11 August 2009)
- Dr. S. Kaushik, INRA, St-Pee sur Nivelle, Dr. Franoise Medale, Dr. Genevive Corraze, Dr. Sandrine Skiba-Cassy, Dr. Alex Fostier, Dr. Catherine Labbe, Jerome Bugeon, Dr Eric Duchaud, Dr. Jerome Lazard, Dr Joel Aubin, Mr Joachim Boissy, Dr. Joel Gatesoupe, Dr. Marc Vandeputte, Dr. Madeleine Douaire, Dr. Shiva Prasad, Director, IFCPAR, Dr. K. P. Joy, Professor Banaras Hindu University (1 September 2009)
- Dr Kari Kolstad, Team leader, Genetics Group NOFIMA, Norway; Dr Nick Robinson, Sr. Scientist, NOFIMA, Australia Office; and Dr Matthew Baranski, Res. Scientist, NOFIMA (5-7 November 2009)
- Swamiji Ashryananda inaugurated the Winter School on 'Application of molecular and serological tools in fish disease diagnosis' (9 November 2009)
- Women Scientists who participated in the management development programme at Xavier Institute of Management, Bhubaneswar (20 November 2009)
- Dr S. K. Kar, Director, RMRC, Bhubaneswar (27 November 2009)
- Dr V. V. Sugunan, ADG(I.Fy), ICAR, New Delhi addressed the scientists on 'Log frame analysis and outcome mapping' of research projects during Mid-term IRC.(3 December 2009)
- Dr M. J. Modayil, Hon'ble Member, ASRB (8-11 December 2009)

- Mr. Willem Johannes Wolff, Councelor for Agriculture, Nature and Food Quality, Embassy of Kingdom of the Netherlands, New Delhi and Mr. Anand Krishnan, Senior Policy Advisor, Agriculture (12 January 2010)
- Dr G. Mohan Kumar, IAS, Commissioner-cum-Secretary, Fisheries and Animal Resources Development Department and other officers from the Department of Fisheries, Govt. of Orissa had an interaction with the Director and scientists regarding collaborative work on technology transfer in Orissa(16 January 2010)
- Trainees from Department of Personnel and Training, Institute of Secretarial Training and Management, New Delhi (22 January 2010)
- Dr (Ms) C.H. Sasikala, Associate Professor and Head, Dept. of Environment, JNTU, Hyderabad gave a lecture on 'Culturable and genomic diversity of prokaryotes' (28 January 2010)
- Twenty Opinion Leaders from Karnataka (15 February 2010)
- Dr Bangali Baboo, National Director, NAIP (25 February 2010)

Regional Research Centre of CIFA, Vijayawada

- Dr A. S. Ninawe, Hon'ble Vice-Chancellor, Maharashtra Animal and Fisheries Science University, Nagpur (27-28 January 2010)
- Mr. Joil Aubin, INRA & Mr. Jerome Lazard, CIRAD Aquaculture Research Unit, France (03 September 2009)

Regional Research Centre of CIFA, Bangalore

- Dr.S.Ayyppan, D.D.G.(Fy), ICAR (22 May 2009)
- Dr Gopal, Extension Officer, AH Dept. Tumkur and Dr H. K. Manjunath AD (AH) along with 8 women of the Sri Lakshmi Self Help Group from Swandenahalli regarding the possibilities of aquaculture alternatives to the SHG members (20 July 2009)

PUBLICATIONS

Research papers

Behera S. K., J. Mohanty, T. Swain and S. K. Garnayak, 2009. Isolation and characterization of serum immunoglobulins from kalbasu (*Labeo calbasu*) (Hamilton, 1822). *Asian Fisheries Science*, 22: 481-489.

Behera, T., P. K. Nanda , C. Mohanty, D. Mohapatra, P. Swain, B. K. Das, P. Routray, B.K. Mishra and S. K. Sahoo, 2010. Parenteral immunization of fish, *Labeo rohita* with Poly D, L-lactide-co-glycolic acid (PLGA) encapsulated antigen microparticles promotes innate and adaptive immune responses. *Fish and Shellfish Immunology,* 28: 320-325.

Behera, T., P. K. Nanda, C. Mohanty, D. Mohapatra, P. Swain, B. K. Das, 2009. Parenteral immunization of fish Labeo rohita with poly D.L. lactide-co-glycolic acid encapsulated antigen microparticles promotes innate and adaptive immune responses. *Fish and Shellfish Immunology*, 27:1-6.

Bhat, Shripathi, Alok Patel, P. Das, P. K. Meher, B. R. Pillai and P. Jayasankar, 2009. Isolation and characterization of microsatellite loci in giant freshwater prawn, Macrobrachium rosenbergii. *Conservation Genetics,* 10:1473–1475.

Chakrabarti, P. P., N. M. Chakrabarti and S. C. Mondial, 2009. Breeding and seed production of butter catfish, *Ompok pabda* (siluridae) at Kalyani centre of CIFA, India. *Aquaculture Asia,* 14(1): 33-3.

Chattopadhyay, D. N., J. P Verma, Radheyshyam, B. Behera, S. Sarkar and P.K. Mukhopadhyay, 2009. On-farm evaluation of formulated feeds on the breeding performance of *Catla catla* reared in rural ponds. *Aquaculture Nutrition*, Blackwell publishing Ltd. pp 1-9.

Das, B. K., B. Collet and A. E. Ellis, 2009. Induction and persistence of Mx protein in tissues, blood and plasma of Atlantic salmon parr, *Salmo salar*, injected with poly I:C. *Fish & Shellfish Immunology*, 26: 40-48.

Das, B. K., C. Debnath, P. Patnaik, D. K. Swain, Kuldeep Kumar and B. K. Mishra, 2009. Effect of b-glucan on immunity and survival of early stage of *Anabas testudineus* (Bloch) in *Fish and Shellfish Immunology,* 27: 678-683.

Das, B. K., J. Pradhan and S. Sahu, 2009. The effect of *Euglena viridis* on immune system of rohu, *Labeo rohita. Fish and Shellfish Immunology*, 26: 871-876.

Das, D. N., R. N. Mandal and P. K. Mukhopadhyay, 2009. Deepwater rice-fish integrated culture system: a viable option for increasing fish production as well as natural water harvest. *World Aquaculture.* 40: 58-63.

Das, P. C., J. K. Jena, N. B. P. Nanda and D. D. Bhatnagar, 2010. Cube root powder is a better piscicide than bleaching powder for pre-stocking carp nursery pond preparation. *Ecotoxicol. Envir. Chem.,* 92(1): 137-147.

Das, S., B. N. Paul, J. Sengupta and A. K. Datta, 2009. Beneficial effects of fish oil to human health. *Agricultural Reviews,* 30: 199-205.

Dash, C. P., P. Routray, S. N. Dash, P. Swain, D. K. Verma and P. K. Nanda, 2009. Localization of primordial germ cells (PGCs) in different developmental stages of rohu, *Labeo rohita* (Ham.). *Indian Journal of Animal Sciences*. 79(6): 645-649.

Dash, Nihar Ranjan, Surjya Narayan Dash, P. Routray, Sribatsha Mohapatra, Prakash C Mohapatra, 2009. Targeting nonhealing ulcers of lower extremity in human through autologous bone marrow-derived mesenchymal stem cells. *Rejuvenation Research,* 12(5): 359-366. doi:10.1089/rej.2009.0872.

Dash, S. S., B. K. Das, P. Pattnaik, S. K. Samal, S. Sahu and S. Ghosh, 2009. Biochemical and serological characterization of *Flavobacterium columnare* from freshwater fishes of Eastern India. *Journal of World Aquaculture Society*, 40(2): 236-247.

De, H. K., Radheyshyam, G. S. Saha and R. Srichandan, 2009. Fisheries sector in Orissa: prospects and potentials. *Aqua International*, 16(10): 28-31.

Eknath, A. E. and G. Hulata, 2009. Use and exchange of genetic resources of Nile tilapia (*Oreochromis niloticus*). *Reviews in Aquaculture* 1:197–213.

Giri, S. S., S. K. Sahoo and S. N. Mohanty, 2009. Replacement of by-catch fishmeal with dried chicken viscera meal in extruded feeds: effect on growth, nutrient utilisation and carcass composition of catfish *Clarias batrachus* (Linn.) fingerlings. *Aquaculture International. DOI: 10.1007/s10499-009-9265-3.*

Jayasankar, P., B. Anoop, M. Rajagopalan, K. M. M. Yousuf, P. Reynold, P. K. Krishnakumar, V. V. Afsal and Anoop A. Krishnan, 2009. Indian efforts on the inventorization of marine mammal species for their conservation and management. *Asian Fisheries Science*, 22: 143-155.

Kaushik, S. and P. K. Mukhopadhyay, 2009. Small scale vs. large scale farms: feed and fertilizer application in aquaculture. *Agrovet Buzz.,* 2(2): 42-44.

Kumar, Kuldeep, U. L. Mohanty, S. Dasgupta and A. K. Sahoo, ... Seasonal variation in *Anabas testudineus* (Bloch) reproduction under captivity. *Journal of Inland Fisheries Society of India,* .41(2).

Kumar, Kuldeep, U. L. Mohanty, S. Dasgupta, A. K. Sahoo, B. Mishra and J. K. Jena, 2009. Multiple spawning in *Anabas testudineus* (Bloch) in captivity. *Journal of Inland Fisheries Society of India,* 42(1).

Kumar, V., B. R. Pillai, P. K. Sahoo, J. Mohanty and S. Mohanty, 2009. Effect of dietary astaxanthin on growth and immune response of giant freshwater prawn *Macrobrachium rosenbergii* (De Man). *Asian Fisheries Science*, 22: 61-69.

Mahapatra, K. D., P. K. Sahoo, J. N. Saha, B. Mohanty, M. Sahoo, M. Rye and R. Salte, 2009. Response to selection for resistant to Aeromonas hydrophila in a susceptible line of rohu carp *Labeo rohita*. *In Asia Pacific Aquaculture*, Nov. 3-6, 2009, Kuala Lumpur, Malaysia.

Mandal, R. N., S. Adhikari, K. C. Pani, P. P. Chakraborty and N. Sarangi, 2010. Role of aquatic macrophytes for removal of nutrients from fish culture ponds. *Environment and Ecology,* 28: 164-167.

Marhual, N. P. and B. K. Das, 2009. Use of Random amplified polymorphic DNA and Restriction Fragment Length Polymorphism for typing Vibrio alginolyticus isolated from Bleck tiger Shrimp Penaeus monodon. *Journal of Pure and Applied Microbiology,* 3(1): 75-82.

Mishra, B., S. Ayyappan, J. K. Jena, P. Patri, P. K. Behera, P. K. Aravindakshan and C. S. Purushothaman, 2009. Carp polyculture in aquaculture sewage treatment plant and its impact on soil and water characteristics. *Indian J. Fish.,* 56(4): 271-276.

Mishra, Jashobanta, P. K. Sahoo, B. R. Mohanty and Abhilipsa Das, 2009. Sequence information, ontogeny and tissue-specific expression of complement component C3 in Indian major carp, *Labeo rohita* (Hamilton). *Indian Journal of Experimental Biology*, 47: *672-678*.

Misra, C. K., B. K. Das, S. C. Mukherjee, 2009. Immune response, growth and survival of *Labeo rohita* fingerlings fed with levamisole supplemented diets for longer duration. *Aquaculture Nutrition*, 15:356-365.

Mohanta, K. N., S. N. Mohanty, J. K. Jena and N. P. Sahu, 2009. A dietary energy level of level of 14.6 MJ kg^{-1} and protein-to energy ratio of 20,2 g MJ^{-1} results in best growth perfermance anfd nutrient accretion in silver barb *Puntius gonionotus fingerlings. Aquaculture Nutrition*, 15: 627-637

Mohanty, G., J. Mohanty, S. K. Garnayak and S. K. Dutta, 2009. PCR based detection of furadan genotoxicity effects in rohu (*Labeo rohita*) fingerlings. *Veterinary Research Communications*, 33: 771-780.

Mohanty, G., J. Mohanty, S. K. Garnayak and S. K. Dutta, 2009. PCR based detection of phorate genotoxicity effects in rohu (*Labeo rohita*) fingerlings. *Research Journal of Biotechnology*, 4: 23-30.

Mohapatra, B. C., Bikash Sarkar, K. K. Sharma and D. Majhi, 2009. Design and development of demand feeder for carp feeding in outdoor culture system, Agricultural Engineering International: *The CIGR Ejournal*, Volume XI.

Mohapatra, B. C., Bikash Sarkar, K. K. Sharma and D. Majhi, 2009. Development and testing of demand feeder for carp feeding in outdoor culture system. *Agricultural Engineering International: the CIGR Ejournal,.* Vol XI: 2009.

Mukhopadhyay, P. K. 2009. Fish as a nutritional source of long chain fatty acids. *Science & Culture,* 75: 53-60.

Nanda, N. B. P., P.C. Das and J. K. Jena, 2009. Use of rotenone as piscicide: Toxicity levels in a few common freshwater predatory and weed fishes. *J. Appl. Aquac.,* 21(4): 241-249.

Nanda, P. K., P. Swain, S. K. Nayak, S. Dash, P. Routray, S. K. Swain and B. C. Patra, 2009. Goat serum as an alternative to establish cell culture from Indian major carp, *Cirrhinus mrigala. In Vitro Cell.Dev.Biol.-Animal,* 45:148–151.

Panda, N., 2009. Role of bank credit on performance of women self-help groups in marine fisheries sector in Orissa. *J. Mar. Biol. Assoc. India*, 51(2): 242-245.

Panda, N., K. B. Dutta and H. K. De, 2008. Estimation of direct effect of the parameters on economic empowerment of women through aquaculture activities by using path analysis. *J.Ext. Edu.,* XIII(1&2): 103-107.

Panigrahi, A., A. S. Azad, B. K. Das, J. Dandpat, G. Das, S. Behera and S. S. Mishra, 2009. Probiotic induced immunomodulation: Investigation into cellular and molecular mechanism involved. *Research Journol of Biotechnology,* 4(3): 7-13.

Patel, Alok, P. Das, Ashoktaru Barat, P. K. Meher and P. Jayasankar, 2010. Utility of cross-species amplification of 34 rohu

microsatellite loci in Labeo bata, and their transferability in six other species of the cyprinidae family. *Aquaculture Res*., 41: 590-593.

Paul, B. N., A. K. Datta, and S. N. Mohanty, 2009. Dietary Protein requirement of *Labeo bata* fry. *Animal Nutrition and Feed Technology,* 9: 179-184.

Paul, B. N., S. S. Giri, S. Sarkar, S. N. Mohanty and N. Sarangi, 2010. Effect of feeding different levels of protein and lipid on growth and carcass composition of *Puntius gonionotus. Animal Nutrition and Feed Technology,* 10: 81-86.

Pillai, Bindu R., Lopamudra Sahoo, K. D. Mahapatra, Raul Ponzoni, Sovan Sahu, Swagatika Mohanty, Vijaykumar and Swagatika Sahu, 2009. Evaluation of a new Fluorescent Internal Tag (soft Visible Implant Alphanumeric Tag) in Freshwater Prawn *Macrobrachium rosenbergii*, *The Israeli Journal of Aquaculture-Bamidgeh*, 61(4): 345-350.

Radheyshyam, 2009. Farming the freshwater prawn *Macrobrachium malcolmsonii*, *Aquaculture Asia*, 14(1): 29-32.

Radheyshyam, H. K. De and G. S. Saha, 2009. Role of Community in production and supply of larger quality fingerlings, *Aquaculture Asia*, 14(1): 16-17.

Routray, P., Chidananda Dash, Surjya Narayan Dash, Seema Tripathy, D. K. Verma, S. K. Swain, P. Swain and B. C. Guru, 2009. Cryopreservation of isolated blastomeres and embryonic stem-like cells of Leopard danio, *Brachydanio frankei*. *Aquaculture Research*, 41(4):579-589. doi: 10.1111/j.1365-2109.2009.02456x.

Sahoo, M., S. Dasgupta and P. K. Mukhopadhyay, 2009. Biological effects of ascorbic acid in fish reproduction. *Agrovet Buzz*, 2(3): 39-44.

Sahoo, P. K., B. R. Mohanty, J. Kumari and A. Barat, 2009. Cloning, nucleotide sequence and phylogenetic analyses, and tissue-specific expression of the transferrin gene in *Cirrhinus mrigala* infected with *Aeromonas hydrophila*. *Comparative Immunology, Microbiology and Infectious Diseases, 32: 527-537.*

Sahoo, S. K., S. S Giri, S. Chandra and A. K. Sahu, 2010. Stocking density-dependant growth and survival of Asian sun catfish, *Horabagrus brachysoma* (Gunther 1864) fry during hatchery rearing. *Journal of Applied Aquaculture,* 22(1): 86-91. DOI: 10.1080/10454431003600563.

Samal, S. K., B. K. Das, S. Ghosh, and S. Sahu, 2009. *In vitro* susceptibility of *Pseudomonas sp.* isolated from freshwater fish to antimicrobial agents. *Indian Journal of Fishery,* 56(3): 227-230, 2009.

Samantaray, B. R., C. P. Khuntia and B. K. Das, 2009. Antibacterial activity of crude mucus extract of Ompok pabda against common bacterial fish pathogen. Environment and Ecology, 27: 1657-1659.

Sharma, K. K., Bikas Sarkar, S. Chand, and S. K. Nayak, 2009. A mechanized harvest system for freshwater fish pond. *Aquacultural Engineering,* 41:147-151.

Swain, P. and S. K. Nayak, 2009. Role of maternally derived immunity in fish - review. *Fish and Shellfish Immunology, ……*1-11.

Verma, D. K, P. Routray and N. Sarangi, 2009. Seasonal variation in semen characteristics and biochemical composition of seminal plasma of Mrigal, *Cirrhinus mrigala* (Ham.). *Asian Fisheries Science,* 22: 429-443.

Vipinkumar, V. P., R. Sathiadhas and H. K. De, 2009. Impact of institutional dissemination of technologies and extension services on marine fisheries and mariculture to stakeholders. *J. Mar. Biol. Ass. India,* 51(1): 93-97.

Wang, S., E. Peatman, J. Abernathy, G. Waldbieser, E. Lindquist, P. Richardson, S. Lucas, M. Wang, Li P, J. Thimmapuram, Liu L, D. Vullaganti, H. Kucuktas, C. Murdock, B. C. Small, M. Wilson, Liu H, Y. Jiang, Y. Lee, F. Chen, J. Lu, W. Wang, P. Xu, B. Somridhivej, P. Baoprasertkul, J. Quilang, Z. Sha, B. Bao, Y. Wang, Q. Wang, T. Takano, S. Nandi, S. Liu, L. Wong, L. Kaltenboeck, S. Quiniou, E. Bengten, N. Miller, J. Trant, D. Rokhsar, Z. Liu, 2010. The catfish genome consortium. Assembly of 500,000 inter-specific catfish expressed sequence tags and large scale gene-associated marker development for whole genome association studies. *Genome Biol*., 22: 11(1).

Books/Book chapters

Dasgupta, S. and P. K. Mukhopadhyay, 2009. Sewage-fed aquaculture: a viable option for water productivity enhancement. *In*: *Aquaculture management* (Eds. U. C. Goswami and D. Kumar), Narendra Publishing House, Delhi. pp. 303-319.

De, H. K., M. Kumaran and G. S. Saha, 2010. New initiatives in aquaculture extension. Narendra Publishing House, Delhi, pp. 1-201.

Eknath, A. E. and P. K. Sahoo, 2009. Genetics of disease resistance in fish. *In:* Winter School on Application of molecular and serological tools in fish disease diagnosis, CIFA, Bhubaneswar, 9-29 November 2009, pp.217-225.

?Gupta, S. D. and S. C. Rath, 2009. Carp breeding and seed production (Book chapter Update). Hand Book of Fisheries and Aquaculture an ICAR Publication.

Jayasankar, P. 2009d. PCR and its applications in fish health management.*In*: Winter School on Application of Molecular and Serological Tools in Fish Disease Diagnosis. CIFA, Kausalyaganga, 9-29 November 2009, pp. 25-32.

Jayasankar, P. and B. Anoop, 2010. Identification of Marine mammals of India. Narendra Publishing House, Delhi, pp. 1-124.

Jayasankar, P. 2010. Application of Bioinformatics in DNA Barcoding. *In*: National Workshop on Application of Bioinformatics in Aquaculture. Bioinformatics Centre on Aquaculture, CIFA, Kausalyaganga, 26-27 March 2010, pp. 17-18.

Jena, J. K., G. Mitra, B. Patro, D. Mta, B. Mishra and P. C. Das, 2009. Outdoor larval rearing of fringe-lipped carp, *Labeo fimbriatus* (Bloch) with provision of different inputs. *In*: Larvae 2009 (Eds. C. I. Hendry, G. Van Stappen, M. Wille and P. Sorgeloos), 5th Fish and Shellfish Larvae Culture Symposium. European Aquaculture Society, Special Publication No. 38. pp. 81-184.

Kumar Kuldeep, Gayatri Mishra, U. L. Mohanty and J. K. Jena, (year.) Freshwater pearl farming. *In*: New Frontiers of Zoology (Eds. B. N. Pandey and P. N. Pandey), Narenrda Publishing House, Delhi, pp 97-109.

Sarkar, S. K. and S. C. Rath, 2009. Breeding of Indian major carps: An overview. In: New Frontiers of Zoology (Eds. B. N. Pandey and P. N. Pandey).

Sahoo, P. K. and Abhilipsa Das, 2009. Nodavirus associated with white tail disease of freshwater prawn *Macrobrachium rosenbergii and its diagnosis. In:* Winter School on Application of molecular and serological tools in fish disease diagnosis, CIFA, Bhubaneswar, 9-29 November 2009, pp. 84-87.

Technical pamphlets/bulletin

Bartely D.M., J.A.H. Benzie, R.E. Brummett, F. B. Davy, S.S. De Silva, A. E. Eknath, X. Guo, M. Halwart, B. Harvey, Z. Jeney, J. Zhu, U. Na-Nakorn, T. T.T. Nguyen, and I. I.

Solar, 2009. The use and exchange of aquatic genetic resources for food and agriculture. *Background Study Paper* No. 45, September 2009: 1-39.

Kumar, Kuldeep, P. P. Chkrabarty, S. K. Swain and G. S. Saha, 2009. Released on the occasion of Regional consultative workshop for sustainable aquaculture development in NEH region, 16-17 Sept 2009

Swain, S. K., P. P. Chakraborty, N. K. Barik, G.S. Saha, A. E. Eknath, 2010. Farming of ornamental fish: An emerging opportunity, Released on the occasion of network meeting of aquaculture scientists in the North-eastern Region during 11-12 March, 2010.

Swain, S. K., G. S. Saha and J. K. Jena, 2009. *Mahila Mananka Sasaktikaran Pain Rangeen Machha Chasa* (in Oriya) (Empowerment of women in ornamental fish farming). Released during Training programme on Ornamental fish for the participants of Barkot Block, Deogard District during 27-28 December, 2009.

Pamphlet on Transfer of technology of composite carp culture through demonstration among SC/ST women in Boudh & Purulia, (year)

Pamphlet on Farming of Snakeheads was released by the Hon'ble Chief Minister, Assam on the occasion of Assam Matsya Mahotsav, organized by the Department of Fisheries, Govt. of Assam during 30 Jan-1 Feb 2010.

Others

Das, B. K., Samal, S.K., Samantaray, B.R., and Mishra, B.K. 2009. Genetic diversity of *Pseudomonas putida* field population revealed by RAPD fingerprinting from freshwater fishes. e-planet.7(2):1-7.

Marhual, N.P. Samal, S.K. and Das B.K. 2009. Random amplified polymorphic DNA-PCR typing of *Vibrio parahaemolyticus* isolated from black tiger shrimp *Penaeus monodon. e-planet*.7(1):1-6

Sarangi, N., B. C. Mohapatra, S. Chandra, H. K. De, D. N. Chattopadhyay, A. Mallick, P. Patnaik, D. K. Swain, S. Ghosh and B. K. Das, 2009. Floriculture-cum-pisciculture: an income generation opportunity for tribal women of Keonjhar, Orissa. *e-planet*, 7(1): 47-49.

GenBank Submission

Barman, H. K., Das V., Mohanta R., Mohapatra C., Panda R.P. and Jayasankar P. (2010) *Labeo rohita* beta-actin gene, promoter region and partial cds. GU338376.

Barman,H.K., Panda,R.P., Swain,A., Mohapatra,C., Eknath,A.E. (2009) Genes preferentially expressed in Labeo rohita (rohu) testis generated by subtractive and suppressive hybridization. GR911356 – GR911432

Das, A. and P. K. Sahoo, 2009. *Puntius sarana* partial mRNA for TLR22-like gene. Accession#: FN548001

Das, A., B. R. Mohanty, P. R. Rauta, S. P. Nayak, P. K. Sahoo, 2009. *Puntius sarana* mRNA for hepcidin (hamp gene). Accession#: FN429020

Das, A., B. R. Mohanty, S. P. Nayak, P. R. Rauta, P. K. Sahoo 2009. *Puntius sarana* partial mRNA for CXC chemokine (cxc gene). Accession#: FN429019

Das, V., Barman H.K., Jayasankar P., Panda R.P., Mohapatra C. and Eknath A.E. (2010) *Labeo rohita* myosin light polypeptide chain (mylz2) mRNA, partial cds. GQ487579.

Jayasankar, P., A. Patel, P. Das, S. Panda, M. Khan 2009. *Orcaella brevirostris* control region partial sequence, mitochondrial.

Accession#: GQ507771-80, 851929 (11 sequences)

Jayasankar, P., A. Patel, P. Das, S. Panda, M. Khan 2009. *Orcaella brevirostris* cytochrome b (cytb) gene, partial cds; mitochondrial. Accession#: GQ507781-90 (10 sequences)

Jayasankar, P., L. Sahoo, P. Das 2010. Cytochrome oxidase sub unit I (COI) partial gene; partia cds; mitochondrial. *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, *Labeo calbasu*, *L. fimbriatus* and *L. bata*. Accession#: EU847510, EU847512-EU847514, GU195050-GU195124 and HM147881-91 (total 90 sequences)

Maiti, N. K., 3 sequences have been submitted at NCBI gene bank with the following Accession number GQ214132, GQ214131, GQ214130

Mohanty, B. R. and P. K. Sahoo, 2009. *Labeo rohita* partial mRNA for tumor necrosis factor alpha (TNF alpha gene). Accession#: FN543477

Mohapatra, C., Barman H.K., Panda R.P. and Das V. (2010) *Labeo rohita* POU domain class transcription factor I (poufI) mRNA, complete cds. GU443948.

Mohapatra, C., Barman H.K., Panda R.P., Das V. and Saha (2010) *Labeo rohita* promyelocytic leukemia zinc finger protein (ZBTB16) mRNA, complete cds. GU33837.

Nayak, S. P., B. R. Mohanty, A. Das, P. R. Rauta, P. K. Sahoo, 2009. *Labeo rohita* partial mRNA for CXC chemokine (cxc gene). Accession#: FN429018

Sahoo, P. K. and B. R. Mohanty, 2009. *Labeo rohita* partial mRNA for TLR22-like gene. Accession#: FN548000

PERSONNEL

(as on 31.3.2010)

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- Dr Bindu R. Pillai
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- Dr S. S. Giri
- Dr P. Swain
- Dr S. K. Sahoo
- Dr P. K. Sahoo
- Dr Samiran Nandi
- Dr P. Routray
- Dr B. C. Mohapatra
- Dr B. K. Das
- Dr P. C. Das
- Dr S. Mohanty
- Dr H. K. Barman
- Dr H. K. De
- Dr S. C. Rath
- Dr D. N. Chattopadhyay
- Sri P. K. Meher
- Dr R. N. Mondal
- Dr Ashis Saha
- Dr J. N. Saha
- Dr M. Samanta

Scientist (Senior Scale)
- Sri A. S. Mahapatra
- Sri N. K. Barik
- Dr K. K. Sharma

Scientist
- Dr B. K. Choudhary
- Ms Lopamudhra Sahoo
- Dr Lakshman Sahoo
- Sri Shailesh Saurabh

Dr Rajesh Kumar
Dr C. Devraj
Sri P. L. Lalrinsanga
Sri Rajesh N.
Sri Ramesh Rathod

Technical (T-9)
Dr Balaram Behera

Technical (T-8)
Kum. Lekha Safui
Sri S. Dalai

Technical (T-7-8)
Sri A. K. Dash
Sri Surendra Singh
Ms B. L. Dhir
Dr B. K. Banja
Dr K. C. Pani
Sri Satyendu Sarkar

Technical (T-6)
Sri S. K. Manna
Ms Sukanti Behera
Dr B. K. Pandey
Dr Suresh Chandra
Ms N. Panda
Dr Bikash Sarkar
Dr B. S. Giri

Technical (T-5)
Sri Suresh Chand
Sri S. Mahali
Sri S. C. Mondal
Mrs U. L. Mohanty
Sri D. K. Verma
Sri Sovan Sahoo
Sri D. P. Rath
Sri S. K. Mohanty
Sri P. B. Bhakat
Dr Bibhudatta Mishra

Technical (T-4)
Sri Santosh K. Nayak
Sri Suratha K. Naik

Technical (T-3)
Sri C.H. Raghavandra
Sri Rabindra Das
Sri J. K. Ghosh
Sri B. Tata Rao
Sri Dukhia Majhi

Technical (T-2)
Sri Aruna Kumar Behera
Sri Lingaraj Muduli
Sri Debendra Tarai
Sri R. C. Swain
Sri Y. R. G. Rao
Sri N. D. Saha

Medical Officer
Dr Kailash Ch. Dash

Security Officer
Sri Debabrata Sahoo

Compounder
Sri Aurobinda Patra, T-3

Mike Operator
Sri Bhagabat Ch. Das, T-2

Powertiller Operator
Sri Affcer Mohamad, T-2

Drivers
- Sri B. K. Behura, T-5
- Sri Rabindra Tarai, T-5
- Sri Alekh Nayak, T-2
- Sri G. Vadi Velu, T-2
- Sri Trinath Behura, T-2
- Sri K. C. Das, T-2
- Sri S. C. Panda, T-2
- Sri Dinabandhu Pradhan, T-1
- Sri Sibo Prasad Behera, T-1

Administrative Officer
- Sri S. Purkayastha

Finance and Accounts Officer
- Sri A. K. Lal

Private Secretary
- Sri M. D. Das

Assistant Administrative Officers
- Sri K. C. Das
- Sri P. K. Ghosh
- Sri G. S. Rao
- Sri J. R. Biswal
- Sri P. C. Behera

Assistants
- Sri N. C. Naik
- Sri P. B. V. S. Murty
- Sri Indramani Muduli
- Sri P. K. Sethy

Senior Clerks
- Sri Banamali Behera
- Ms Golap Bhanja
- Sri Jadumani Khatua
- Sri S. Nandi
- Sri Birabar Amanta
- Sri A. K. Prusty
- Sri Jitendranath Jena
- Sri Swamiji Sen

Lower Division Clerks
- Sri Sukanta Sarkar
- Sri B. K. Barik
- Sri R. K. Behera
- Sri S. K. Rath
- Sri Niranjan Behera
- Sri Chhakei Behera
- Sri A. R. Behera
- Sri S. Biswas
- Sri Rajesh Ku. Das
- Sri Arijit Panda
- Sri Prakash Ch. Parida
- Sri Manish Ku. Singh
- Sri Jogendra Dalai

Personal Assistant
- Ms A. Manjula
- Ms Singa Soren

Junior Stenographers
- Ms Smita Acharya

Skilled Support Staff
- Sri Basudev Dehuri
- Sri R. Yesiah
- Sri R. L. Debroy
- Sri Malige Gowda
- Sri A. Kemparasa
- Sri Indra Bahadur
- Sri Golekha Parida

Sri K. C. Jally
Sri Sridhar Parida
Sri A. Mahalik
Sri Jairam Das
Sri Y. Parida
Sri C. C. Samal
Sri Rahemat Khan
Sri M. C. Rao
Sri Sital Ch Haldar
Sri Teegala Muthyullayya
Sri P. L. Choudhury
Sri Jatadhari Swain
Sri Parasuram Das
Sri Debahari Behera
Sri K. C. Naik
Sri Jaydev Paria
Sri G. C. Mallick
Sri Nishamani Jena
Sri B. B. Pandit
Sri Sudam Behera
Sri P. K. Naik
Sri Rajan Swain
Sri Pitambar Swain
Sri Ramesh Ch Ghadei
Sri R. K. Bhol
Sri Pasupati Das
Sri G. P. Burman
Sri N. C. Kirtonia
Sri M. M. Bhoi
Sri Banamali Mallick
Sri G. K. Sahoo
Sri R. C. Jena
Sri Birbar Sahoo
Sri Dil Bahadur

Sri Sarata Ch Khuntia (on suspension)
Sri Parmananda Parida
Sri Resham Bahadur (I)
Sri Ranjan K. Das
Sri Rabin K. Das
Sri Biswanath Haldar
Sri Shyam Bhoi
Sri Natabar Pallai
Sri Sudarshan Swain
Sri Sultan Khan
Sri Trinath Pradhan
Sri R K Sahoo
Sri Kapilash Barik
Sri Resham Bahadur (II)
Sri Nakul Samal
Sri Laxman Bhoi
Sri Kailash Ch Jena
Sri Rahaman Shariff
Sri Gandharb Mallick
Sri H. K. Behera
Sri Golekha Behera
Sri Purna Bhoi
Sri Muralidhar Bhoi
Sri Sridhar Kahali
Sri A. K. Routh
Sri Pahali Bhoi
Sri B. B. Ghadei
Sri Gayadhar Behera
Sri Basudev Routray
Sri Satrughan Bhoi
Sri Prahallad Swain
Sri Chandramani Muduli
Sri Surendra Swain
Sri Jagannath Ojha

Sri Trailokya Nath Pradhan
Sri Haren Sardar
Sri Siddaraju
Sri Ulash Bhoi
Sri Paresh Samanta
Sri Rabindra Kumar Nath
Sri Sudarshan Muduli
Sri R. C. Mallick
Sri Asit Kumar Pal
Sri Gundicha Prusty
Sri Bhagaban Swain
Sri Jagannath Ghadei
Sri Lokanath Swain
Sri Damodar Ghadei
Sri Dilip Das
Sri G. Subramanium
Sri Ratan Das
Sri Ajit Kumar Ray
Sri Dilip Ch. Chanda
Sri Saroj Kumar Parida
Sri Sarat Ch. Barik
Ms Manju Singh
Ms Sandhya Ghosh
Sri Gopal Ch. Mohapatra
Sri Gouriguru Sibananda Bhuyan
Sri Baikuntha Nayak
Sri Manoj Kumar Jena
Sri Ch. M. Rao
Sri Budhia Behera
Sri Bauri Bandhu Pradhan
Sri Aruna Kumar Muduli
Sri Tanay Balav Barik
Md. Mohibullah
Sri G. Adinarayan
Sri M. Narasimhaluru
Sri Prasanna Ku. Behera
Sri P. Rajasekhar
Ms Sonali Adhikari
Sri Samir Das
Sri Nabaghana Ghadei
Ms Kalyani Mondal
Ms Kiron Oraon
Sri Sanatan Pradhan

LIST OF APPROVED ON-GOING PROJECTS

Institute-based projects

Sl. No	Project Code	Title of the project	Project leader	Duration
1.	I-54	Diversification in freshwater aquaculture for sustainable production	Dr J. K. Jena	
		c) Water budget modeling of freshwater fishpond under warm and humid climate	Dr K.K. Sharma	1.4.2006-31.3.2010
		d) Farming of freshwater climbing perch, *Anabas testudineus* (Bloch) and development of technological package	Dr Kuldeep Kumar	1.4.2006-31.3.2010
		f) Freshwater pearl mussel culture	Dr Kuldeep Kumar	1.4.2006-31.3.2010
		g) Characterization of growth pattern of diversified carp species under monoculture	Dr P. C. Das	1.4.2007-31.3.2010
		h) Influence of nutrients factor on growth performance of *Eichhornia crassipes* and *Vallisneria spiralis*	Dr R. N. Mandal	1.4.2007-31.3.2010
		i) Design, development and performance evaluation of improved mechanized fish harvesting system for aquaculture pond.	Dr K. K. Sharma	1.4.2007-31.3.2010
		j) Mass seed production and growout culture of diversified catfishes: *Pangasius pangasius* and *Horabagrus brachysoma*	Dr S. K. Sahoo	1.4.2007-31.3.2010
		k) Breeding and culture of *R. corsula* and its incorporation in polyculture	Dr Radheyshyam	1.4.2007-31.3.2010
		m) Development of breeding protocols and larval rearing of Indigenous species *Puntius filamentosus* and *Puntius denisonii*	Dr S. K.Swain	1.4.2008-31.3.2012
		n) Breeding of *Ompok bimaculatus*, rearing of *Mystus vittats* and growth trials of *pabda* along with other fish species in farmer's ponds	Dr N. M.Chakraborty	1.4.2009-31.3.2012
2.	I-55	Impact of training programmes on freshwater aquaculture conducted by CIFA	Dr H. K. De	1.4.2007-31.3.2010
3.	I-56	Improving production efficiency in Aquaculture through integrated nutrient management	Dr P. V. Rangacharyulu	1.4.2007-31.3.2010
4.	I-57	Immune responses in carps with particular reference to immune related genes		

Sl. No	Project Code	Title of the project	Project leader	Duration
		a) Cloning and sequencing of Interferon Inducible genes of *Labeo rohita*	Dr B. K. Das	1.4.2007-31.3.2010
		d) Three dimensional fish cell culture using nano fiber based scaffolds	Dr P. Swain	1.4.2008-31.3.2010
5.	I-58	Investigations on the efficacy of commercial Lactic Acid Bacteria as Freshwater fish/shellfish probiotics	Dr S. Mohanty	1.4.2007-31.3.2010
6.	I-59	Genetic upgradation of freshwater fish and shellfish	Dr P. Jayasankar	
		a) Genetic improvement of rohu for growth and disease resistance against *Aeromonas hydrophila* through sustainable selective breeding	Dr K. D. Mahapatra	1.4.2007-31.3.2010
		b) Development of DNA markers in *M. rosenbergii* and genetic characterization of *Jayanti* families	Dr P. Das	1.4.2007-31.3.2010
		d) Transgenics of freshwater fishes	Dr H. K. Barman	1.4.2007-31.3.2010
		e) DNA barcoding of Indian major and minor carps	Dr P. Jayasankar	1.4.2009-31.3.2011
		f) Improvement of production efficiency and rearing time of full sibfamiliesofJayantirohu(*Labeo rohita*) in re-circulatory system	Dr J. N. Saha	1.4.2009-31.3.2011
		g) Selective breeding of *Macrobrachium rosenbergii* for resistance to *Macrobrachium rosenbergii* noda virus	Dr A.E. Eknath	1.4.2009-31.3.2010
7.	I-60	Aquaculture diversification and wastewater management	Mr A. K. Datta	1.4.2007-31.3.2010
8.	I-61	Photothormal manipulation on neuroendocrine regulated reproduction in carp, *L. rohita* under controlled environment		1.4.2007-31.3.2010
9.	I-62	Propagation of selected peninsular/ indigenous fishes for incorporation in to aquaculture and modification of aquaculture practices for water deficient regions	Dr M. R. Raghunath	1.4.2007-31.3.2010

Sl. No	Project Code	Title of the project	Project leader	Duration
10.	I-63	Aquaculture in changing climate – A study based on the perceptions of freshwater aquaculturists	Dr G.S. Saha	1.4.2008-31.3.2011
11.	I-64	Evaluation of economics of production and management of selected freshwater aquaculture technologies in India	Sri N. K. Barik	1.4.2008-31.3.2011
12.	I-65	Development of vaccine against *Aeromonas hydrophila*	Dr B.K. Mishra	1.4.2008-31.3.2011
13.	I-66	Energy metabolism in Jayanti rohu	Dr C. Devaraj	1.4.2009-31.3.2011
14.	I-67	Impact of aquaculture on environment	Dr S. Adhikari	1.4.2009-31.3.2012
		a) Impact of global climate change on fisheries and aquaculture		
		b) Environmental management of intensive aquaculture in different agroclimatic zones		
15.	I-68	Community based management for sustainable aquaculture in rural areas	Dr Radheyshyam	1.4.2009-31.3.2012
16.	I-69	Development of livelihood through freshwater aquaculture for the tribal people of North-Eastern states	Dr A. E. Eknath	1.4.2009-31.3.2012

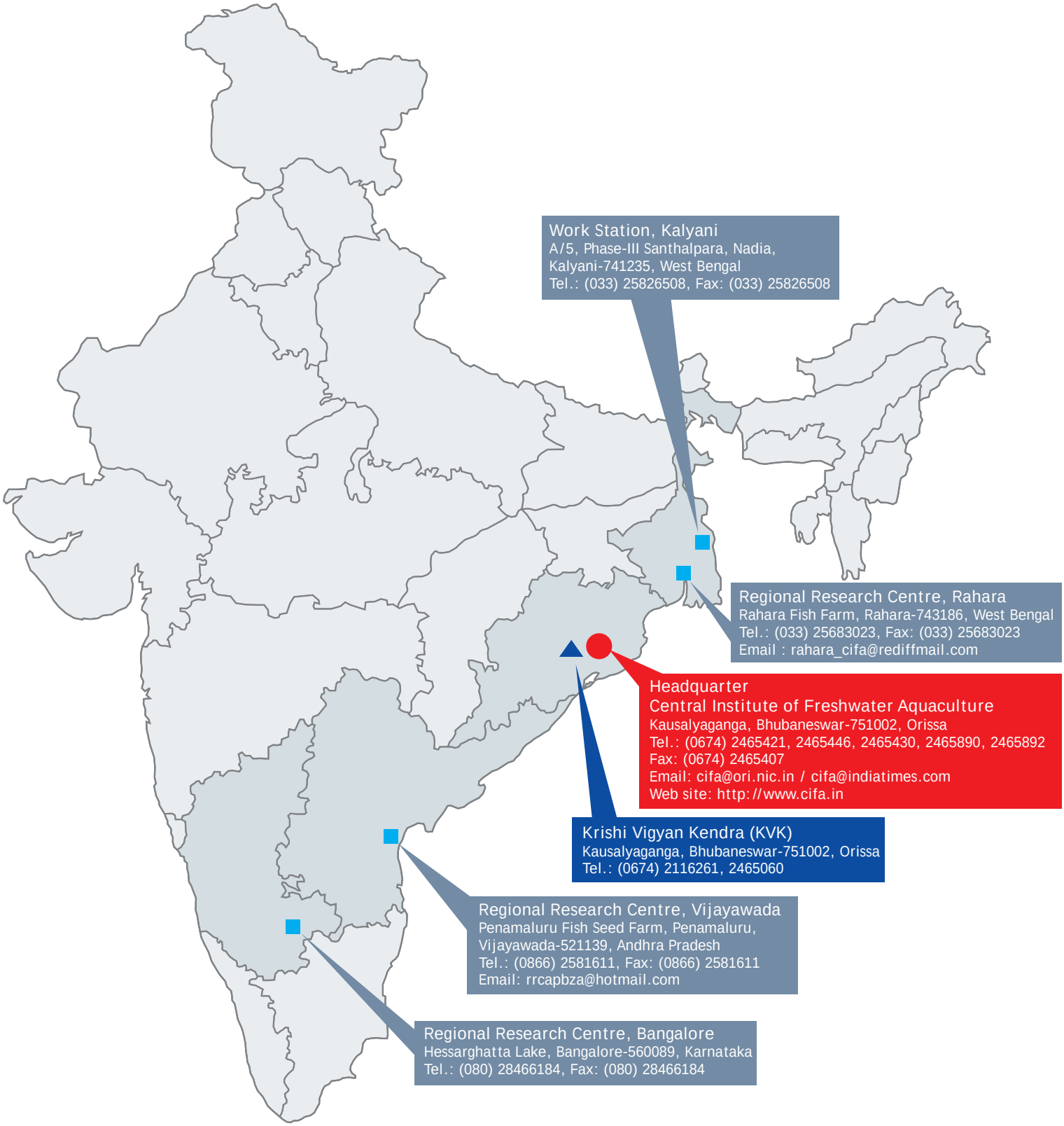
Externally Funded Projects

Sl. No	Project Code	Title of the project	Funding agency	Project leader	Duration
1.	E—01	Biotechnology information system on aquaculture	Department of Biotechnology, Govt. of India	Sri A. S. Mahapatra Scientist	1991 — till date
2.	E—03	Application of plastics in agriculture — plant environment control and agricultural processing (ICAR)	AICRP, ICAR	Dr B. C. Mohapatra, Sr. Scientist	Continuous
3.	E—35	Sustainable aqua—feeds to maximize the health benefits of farmed fish for consumers	European Commission	Dr S. N. Mohanty, Head, FNPD	Jan 2007—Feb 2010 (extended upto August 2010)
4.	E—39	Studies on association of viral infections in diseases of Koi carps by immunological and molecular techniques	Dept. of Biotechnology	Dr P. Swain, Sr. Scientist	Jan 2007— Jan 2010
5.	E—40	Genetic improvement of freshwater prawn *Macrobrachium rosenbergii* (de man) in India	World Fish Centre	Dr Bindu R. Pillai, Sr. Scientist	Apr 2007—Dec 2009 (extended upto June 2010)
6.	E—41	A comprehensive study on argulosis: Host—parasite interaction with respect to modulation of innate and specific immune responses, and development of preventive of control measures	National Fund for Basic and Strategic Research in Agricultural Sciences	Dr P. K. Sahoo, Sr. Scientist	Dec 2007—Jan 2012
7.	E—42	Derivation and characterization of fish embryonic stem cells	Department of Biotechnology, Govt. of India	Dr P. Routray, Sr. Scientist	Jan 2008—Jan 2011
8.	E—43	Molecular studies on HUFA synthesizing capability in rohu (*Labeo rohita*)	Department of Biotechnology, Govt. of India	Dr S. Nandi, Sr. Scientist	Jan 2008—Jan 2011
9.	E—45	Development of smart pond monitoring system	(DBT) — Collaborative by CIFA—CEERT)	Dr J. K. Jena, Head, APED	March 2008 —
10.	E—46	Exploring *in vitro* culture and characterization of spermatogonial stem cells (SSCs) of Indian major carp, *Labeo rohita* (Ham)	Dept. of Biotechnology, Govt. of India	Dr H. K. Barman, Scientist (SS)	May 2008—Apr 2011
11.	E—47	Construction and analysis of expressed sequence tag libraries for rohu (*Labeo rohita*)	Dept. of Biotechnology, Govt. of India	Dr S. Nandi, Sr. Scientist	July 2008—July 2011

Sl. No	Project Code	Title of the project	Funding agency	Project leader	Duration
12.	E—48	A value chain in production and utilization of Indian major carps and prawn from aquaculture system (NAIP)	NAIP	Dr J. K. Jena, Head, APED	Jun 2008—Jun 2012
13.	E—49	Application of microorganisms in agriculture and allied sectors (AMAAS) Theme: *Microbial diversity and identification*: Isolation and characterization of microbes from freshwater ecosystem (Component—1)	NBAIM, ICAR	Dr N. K. Maiti, Pr. Scientist	2006—2010
14.	E—50	Development of a library of putative probionts from marine/freshwater environment belonging to the genus *Pseudomonas, Micrococcus* and *Bacillus* for application in mariculture/freshwater aquaculture system (Component—2)	NBAIM, ICAR	Dr S. Mohanty, Sr. Scientist	Apr 2008—Mar 2010
15.	E—51	Improved disease resistance of rohu carp and tiger shrimp farmed in India: developing and implementing advanced molecular methods and str5eamlining access to and use of genetic resources	Dept. of Biotechnology, Govt. of India	Dr P. K. Sahoo, Sr. Scientist	Jan 2009—Jan 2012
16.	E—52	A value chain in murrel production in Tamil Nadu and Orissa (Component—2)	NAIP	Dr Kuldeep Kumar, Sr. Scientist	Jul 2008—Jun 2012
17.	E—53	Toll—like receptors in phylogenetically divergent fish species their contribution in modulating the innate immunity (Component—4)	NAIP	Dr M. Samanta, Sr. Scientist	Jan 2009—Jan 2012
18.	E—54	Sustainable livelihood improvement through integrated freshwater aquaculture, horticulture and livestock development in Mayurbhanj, Keonjhar and Sambalpur districts of Orissa (Component —3)	NAIP	Dr J. K. Jena, Head, APED	Apr 2009—Jun 2012
19.	E—55	Immunomodulation studies in freshwater prawn *Macrobrachium rosenbergii* using recombinant proteins of MrNv	Dept. of Biotechnology (GoI)	Dr P. K. Sahoo, Sr. Scientist	Jul 2008—Jul2011
20.	E—56	Carp seed production in mobile hatchery and rearing for livelihood development for SC/ST communities in selected districts of Orissa	Dept. of Biotechnology (GoI)	Dr B. C. Mohapatra	Jun 2009—Jun 2012

Sl. No	Project Code	Title of the project	Funding agency	Project leader	Duration
21.	E—57	Indo—Norwegian platform on fish and shellfish vaccine development Sub—project: Evaluation of major porims ompC and ompR of *Aeromonas hydrophilla* has potential vaccine candidates and identification and characterization of IMC, *Labeo rohita* (Sub—project—2)	DBT (Joint International Research Programme under Indo—Norwegian collaboration on aquaculture and marine biotechnology)	Dr P. K. Sahoo, Sr. Scientist	Aug 2009—Aug 2012
22.	E— 58	Bioprospecting of genes and allele mining for abiotic stress	NAIP	Dr.N.K.Maiti	Jun 2009—Mar 2012
23.	E—59	First generation linkage map in *Labeo rohita* (rohu) : A potential genomic resource for identification of trait associated genes	Dept. of Biotechnology, Govt. of India	Dr P. Das	Sep 2009—Sep 2012
24.	E—60	Quality seed production and stock upgradation of carps through use of cryopreservation technology in the selected hatcheries of India	National Fisheries Development Board	Dr P. Routray	Oct 2009—Oct 2012
25.	E—61	Intellectual Property Management and Transfer / Commercialization of Agricultural Technology	ICAR XIth Five Year Plan Scheme	Dr P. Swain	2007—2012
26.	E—62	Transfer of technology of composite carp culture through demonstration among SC/ST women in Boudh and Purulia	Dept. of Science and Technology, Govt. of India	Dr H. K. De	Nov 2009—Nov 2011
27.	E—63	A Study to Assess Literacy, Health and Income Status of Fishers in India (In collaboration with: CMFRI, CIFRI, CIBA, CIFT, CIFE, NCAP)	Dept. of Animal Husbandry, Dairying and Fisheries (DAHD&F), Ministry of Agriculture, GoI	Sri N. K. Barik	Nov 2009—Oct 2010
28.	E—64	Development of DNA vaccine to combat *Edwardsiella tarda* infection in commercially important food fishes	Dept. of Biotechnology, GoI	Dr B. K. Das	—
29.	E—65	Seed production and grow out culture of indigenous catfish, magur through training and demonstration in North—eastern States (Assam and Manipur)	National Fisheries Development Board (Technology upgradation programme)	Dr A. K. Sahu	Mar 2010—Mar 2012

RESEARCH LOCATION



CIFA IN NEWS

Union minister for agriculture Sharad Pawar and state minister for agriculture K.V Thomas (left) at Central Institute of Freshwater Aqualculture in Bhubaneswar on Sunday.

Inaugurating the 3rd National Conference of State Fisheries, Pawar spoke on the impact of climate change on fish. At the meet, experts discussed instances showing effects of global warming on aquatic life.

India is the third largest producer of fish in the world and the second largest aquaculture producer.

"With a contribution of 2.9MT from marine sector and 4.2MT from inland sector, the fisheries has continued to make a significant contribution to nutritional [illegible] country," said Pawar. The two-day confe[illegible] a road map to enhance fish productio[illegible]

(Picture by Sanjib Mukherjee)

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(2009-10)

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me. Dee3e ÒeeeHIe (2009-10) (ª.ueeKe ce)

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3. keÀce®eeej3ee keÀe meK3ee (31.03.2010 IekeÀ)

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IekeÀveekeÀe keÀce®eeje	52
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4. DevemeOeeve Heej3eepevee3e

memLeeiele	16
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5. Dee3eeepele ÒeeMe#eCe keÀe3e-eÀce

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jeäe3e	09	331
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jeäe3e mlej Hej ÒeeMee#ele	09
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7. keÀe3eMeeueeDee keÀe Dee3eepeve

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8.emecHeeepe3ece/meeceveej/keÀe3eMeeueeDee ce GheemLeele (jeäe3e/Devlejeäe3e)

jeäe3e mlej Hej ÒeeMee#ele	38
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- à`mJembmAm H$m AmY{ZH$sH$aU
- A{V{WJh Ed HfH Nmÿmdmg H$m OrUmÕma
- àYmZ H$m`mb` ^dZ Ed _Ëñ` àj Ì g{dYmAm, E{QH$, ^dZ, ESdm[a`_Ed ~Jbé, {dO`dmSm Ed ahaam pñWV AmM{bH$ H$ÝÐm H$s g{dYmAm H$m a I -a I md

4. ue#³e SJe GÎM³e

keÀvêe³e ceeþepeue peeJeHeeueve DevemeOeeve memLeeve keÀ DeeOekeÀ peuekeÀe<e GIHeeove meJeOevee³e ceeþepeue memeeOevee keÀe Heve: meOeee j le leeueeyee SJe peueeMe³ee me oMe ce Òeele FkeÀeF #e$e ce GHepe keÀe ye{eÊe j e keÀ HeejHe#e ce DevemeOeeve keÀ #e$ee ce Ge®ele eoMee SJe ceeieoMeve ove keÀ ce×vepej evecve GÎM³e eo³e ie³e n~

- mele ve SJe eJemlele iejce ceeþeHeevee peuekeÀe<e He×ele keÀ eJekeÀeme keÀ eueS J³eeHeeejkeÀ cenlJe keÀe eHeÀve eHeÀme SJe Meue eHeÀme ce íeue³ee keÀ meJeOeve nle Hee<eCe, Mejej e~e³ee eJe%eeve, DeeveJeeMekeÀe, jeie eveoeve, leeueeye He³eeJejCe, peuekeÀe<e, DeeYe³eee$ekeÀe Fl³eeeo Hej ienve DevemeOeeve~
- oMe keÀ Òeekeàelekeà peuememeeOevee keÀe DeeeLekeÀ GHe³eeeielee nle meÔemeejCe SJe ÒeeMe#eCe Üeje GHeueyOe lekeÀveekeÀe keÀe Ôemeej~
- ceeþepeue keÀe<e me meyeevOele Je%eeevekeÀ leL³ee keÀ Òemeej nle SkeÀ DeeoMe ceeO³ece keÀ a He ce keÀe³e keÀjvee ~

5. mee#eHle Feleneme

keÀvêe³e ceeþepeue peeJeHeeueve DevemeOeeve memLeeve keÀe Me a Deele keÀvêe³e Devle:mLeuee³e celm³e ieJe<eCee memLeeve keÀ Devleiele leeueeye Heeueve eJeYeeie keÀ a He ce nF, epemekeÀe mLeeHevee meve 1949 ce G[emee keÀ keÀìkeÀ peveHeo me nF~ Fme eJeYeeie keÀe yeeo ce DeueJeCe peue GlHeeo ieJe<eCee SJe ÒeeMe#eCe keÀvê (SHeÀ. S. Deej.ìe.mee.) keÀ a He ce eJemleeejle keÀj ³e. Sve.[e.Hee. /SHeÀ.S.Dee. keÀe menе³elee me meve 1976 ce YeJeveéej ce mLeeeHele ekeÀ³ee ie³ee~ Heve: ³en keÀvê Yeejlee³e keÀe<e DevemeOeeve Heej<eo keÀ Heveieþve ³eepevee keÀ lenle Je<e 1986 ce SkeÀ mJele$e memLeeve yevee pee 1 DeÔeue meve 1987 me keÀe³ekeÀeje ÒeeoYeeJe keÀ a He ce meeceve Dee³ee~

memLeeve keÀ Heeme ceeþepeue peeJeHeeueve keÀ eJeeYeVe eJeOeeDee nle DevemeOeeve , ÒeeMe#eCe , eMe#ee Deej mecÒemeejCe keÀ eueS SkeÀ Jeno ue#³e SJe GÎM³e n ~ eJeMeeue ceeþepeue Òe##e$e keÀ a He ce 500 keÀ THej eJeeYeVe Deekeàej keÀ leeueeye Deej ienMeeueeDee keÀe meeJeOee keÀ meeLe oMe keÀ Devoj keÀeMeu³eeieie emLele YeJeveéej Menj me 10 ekeÀcee keÀe oje Hej memLeeve keÀeHe, keÀìeHeÀme, Peeiee Deej meeeHe³ee Hej DevemeOeeve keÀj jne n~ HeCele: DeeOeevekeÀ meeJeOeeDee me HeejHeCe Òe³eeieMeeueeS celm³e SJe keÀJe®eceeve Òepeveve, peuee³e jmee³eve eJe%eeve , peeJe eJe%eeve, celm³e e~e³ee eJe%eeve, Hee<eCe, DeeveJeeMekeÀe, jeie eveoeve, DeeYe³eeev$ekeÀe, DeLeMeem$e Deej mecÒemeejCe eJe<e³ee ce memLeeve keÀe eJeéee keÀ peuekeÀe<e DevemeOeeve keÀvêe ce SkeÀ DeûeCee yevee eo³ee n~ #e$e eJeMe<e keÀe DeeJeM³ekeÀleeDee keÀe Heje keÀjve keÀ eueS, memLeeve ve ®eej #e$ee³e DevemeOeeve keÀvê, oMe keÀ eJeeYeVe Yeeiee ce Heej®eeeuele ekeÀ³e n ~ ³e keÀvê , #e$ee³e DevemeOeeve keÀvê, jnje(Hee½ece yeieeue), #e$ee³e DevemeOeeve keÀvê, keÀu³eevee (Hee½ece yeieeue), #e$ee³e DevemeOeeve keÀvê, nmejleeìe uekeÀ, yeieueej(keÀveeìkeÀ), #e$ee³e DevemeOeeve keÀvê, Heveeceue a, eJepe³eJee[e (DeeOe ÒeoMe) n ~ ³en memLeeve SeMe³ee-HeemeeHeÀkeÀ #e$e ce Sve.S.mee.S. Devleiele peuekeÀe<e keÀvêe keÀ veìJekeÀ (veekeÀe) ce keÀeHe ce íuee Heeueve keÀe #e$e ceeieoMee keÀvê keÀ a He ce e®eevnle n, pee Deepekeàue

Devlejeäe³e meieþve n~ me³ekele jeä melе keà KeeÐe SJe keàe<e meieþve keà Devleieie memLeeve ce Skeà Hemlekeàeue³e mLeeeHelе nDee n~

6. ceK³e DevemeOeeve GHeueeyOe³ee

- ^maVr` _Oa H$mn àOm{V`m _ g{V` Ad`d JmZm\$ë\$ H$ BÝOH$eZ g OZZmJm H$s g_`n~ n[anŠdVm àmßV H$s J`r ï&
- EZm~g QñQ{S{Z`g àOZZ _ A{YH$ Zam H$s CnpñW{V {ZfMZ Xa na H$mB {def à^md àX{eV Zhr H$aVr h ï&
- hmam~Jag ~{H$gm_m àOm{V H$ CËàaU àOZZ à`mgm _3 d{f` _mXm H$ AÊSm _A{YH$ {ZfMZ Ed àñ\$QZ Xa XIr J`r ï& AJ{bH$m CËnmXZ _A{YH$ dTdma Ed Or{dÎmmXa àmßV H$aZ H$ {b` H$_ gM`ZXa (10 _Nm{b`m/dJ²) Cn`mJrnm`rJ`r ï&
- hma_mZ BÝOH$eZ Ûmam npÝQ`g {\$bm_ÝQmgg H$ H$b 1350 ESdmÝg \$mB CËnm{XV {H$` J`r Ed {Z`pÝÌV n[ade _ BgH$ ~hàOZZ _ g\$bVm A{OV H$s J`r ï&
- {\$bm_ÝQ ~m~, QmBJa ~m~ Ed {_bmZ ~m~ àOm{V`m H$ gmW SZrgmZr EH$ Xga H$ {b` AZH$b nm`J`ï&
- {Z`pÝÌV n[apñW{V`m _ amOr ~m~ H$ 40 OmSm H$m g\$bVm ndH$ àOZZ H$a 30,000 ESdmÝg \$mB nXm {H$` J`ï&
- _rRmOb _hmPrJm H$ VrZ AbJ-AbJ ^mJ{bH$ jÌm (JOamV, H$ab Ed CSrgm) H$ {gÝW{QH$ ~g nmnbeZ _dTdma AÜ``Zm g kmV hAm {H$ H$ab ñQmH$ H$s na\$ma_Ýg AÝ` Xm g ~hV AbJ h ï&
- ObH$å^r BH$ma{Z`m H$m{gßg H$s dZñn{V CnMma H$ AÝVJV H$mna Ed {ggm AbJ H$aZ H$s j_Vm àX{eV H$s J`r ï&
- gr\$m H$s CÎman~u amÁ`m __Ëñ` nmbZ {dH$mg H$s {Xem H$ nZ{jV H$a {dH$merb Ed gm_{hH$ ^mJXmar H$s VO na {H$`m{ÝdV {H$`m J`m ï& eédmVr H$X_ H$ ê$n __Nbr nmbZ AZgYmZ Ed {dH$mg H$m ~Tmdm XZ H$ {b` Bg jÌ H$ dkm{ZH$m H$m EH$ ZQdH$ ñWm{nV {H$`m J`m h ï&
- ~rO gdYZ _amh AJ{bH$m` AmdÍ`H$ AZH$b AmŠgrOZ H$ {ZMb ñVa na AnZ H$m Aä`ñV H$a bVr h ï& g~YZ Vmbm~m _AJ{bH$mAm H$s _Ë` H$ {b` H$db H$_ AmŠgrOZ Xa hr {Oå_Xma Zhr ahVr h ï&
- {h_mH$Z àmÚm{JH$s _Ëñ` ~rO H$s JUdÎmm Ed ñQmH$ H$ AmZdm[eH$ gYma __hËdnU ^{_H$m [Z^mVr h ï& H$b 20 {_br H$mn {_ëQ H$ à`mJ Ûmam 1-2 bm I _Ëñ` ~rO àmßV {H$`m Om gH$Vm h ï&
- HDPa H$ 87% Ed H$ÝÐmnmSm H$ 82% AJrH$V _Ëñ` nmbH$m Z {_{IV nmbZ Vmbm~m g 2-4 JZm A{YH$ CËnmXZ àmßV {H$`m ï& _Nbr nmbZ àmÚm{JH$r hñVmÝVaU H$ \$bñdê$n H$D$Pa H$ 87% Ed H$ÝÐmnmSm H$ 90% HfHm H$s AmgV dm{fH$Am` _2-4 JZm A{YH$ ~{Õ XIr J`r ï&
- Zñb gYma H$s J`r O`ÝVr H$m`H$_H$ AÝVJV 157 bm I ñnmZ CËnm{XV H$a hñVmÝV[aV {H$`m J`m ï&
- Zñb gYm{aV amh _10 _mBH$m gQbmBQ bmH$mB, EH$ \$_br H$s à{VeV àmOZr H$s OmZH$mar 70% VH$ gQrH$X gH$Vr h ï&
- amh H$m ~r.E[ŠQZ à_mQa Šbm Z Ed {gŠdÝg {H$`m J`m ï& à_mQa / {Z`ÝÌH$ jÌ {MpÝhV H$a CZH$s H$m`H$s J{V{dY kmV H$s J`r ï&
- H$Vbm, amh, {_Jmb, ~mQm Ed \$_~rEQg H$ H$b 90 SrEZE ~maH$mS grŠdÝgg OrZ~H$ _O_m {H$` J` ï& H$Vbm Ed \$_~rEQg _AZdm{eH$ {ZH$Q gå~ÝY XIr J` `h {ZH$QVm OrZg b{~`m H$ nam\$mBbm H$ _Ü` ^r ñnîQ Wr ï&
- amh _h\$n - gíbfU EÝOmB_ SëQm 6 {SgMaO QmÝg{H$ßQ b~b, dmBQbmO{ZH$ _mXm _g~g A{YH$ Ama BgH$ ~mX AJ{bH$mAm, OdZmBb Ed ñnmZ _nm`m J`m ï& Xm QmÝgm{H$ßQ _g {ZM dmbm AJ{bH$mAm Ed OdZmBb _gKZ Wm O~{H$ OdmZ Za Ed _mXm _`h AZnpñWV nm`m J`m ï&
- amh _ ñna_QmJm{Z`m QmÝg{H$ßQ H$maH$ nrAmBOSE\$ Ed AmŠQ - 4 ŠbmZ Ed grŠdÝg H$a OrZ~H$ H$m ^Om J`m ï& ñna_QmJm{Z`m H$m{eH$mAm H$s BZ{dQm ~{Õ H$ g_` {^ÝZ {^ÝZ AdñWmAm H$s nhMmZ Ed BZH$ M[aIU _`h AË`m{YH$ Cn`mJr h ï&

- amh H$ {X_mJ Ed `H$V H$ BEg{QO H$s OmM g `h kmV hAm h {H$ 86% ZmZ [aSZSÝQ grŠdÝgg Ed 4% gm_mÝ` grŠdÝgO Wr ï&
- amh H$Vbm Ama _Jmb H$ I mX` _ _Ëñ` MU ({\$g _rb) H$s OJh dZñn{V Ad`dm H$ à`mJ g AþÝV_ BE\$E Ed SrEZE ñVa na H$mB à^md Zhr X I m J`m ï&
- {Z`þÝÌV gdYZ VÝÌ _ H${Ì_ àH$me-VmnH$_ ñVa na àOZH$ amh _ OZZmJ H$r n[anŠdVm _mh OZdar g Amaå^ hmH$a \$adar H$ AÝV VH$ OZZmJ H$s nU n[anŠdVm àmßV H$s J`r ï&
- I mX` XZ H$ ~mX AmŠgrOZ Cn`mJ Ed H$m~Z SmB AmŠgmBS CËnmXZ VWm I mX` H$ naZSmBb AmŠgrOZ Cn`mJ H$s Xa O`ÝVr amh _ gm_mÝ` amh H$r An j m A{YH$ X I r J`r ï&
- H$mn nmbZ _ à j Ì {Z{_V Amhma hV gñV àmQrZ òmV H$ ê$n _ ere_ H$s I br, {Vb H$s I br Ed gagm H$s I br à`mJ H$s Om gH$Vr h ï& nbQ (J[QH$mAm) H$ ê$n _ I mX` XZm ~S Jmb H$ ê$n _ XZ H$ ~Om` dhÎma h ï&
- àË`mamnU {d{Y H$ Cn`mJ Ûmam _Jmb H$ dfU g àmW{_H$ H$ëMa {dH${gV H$a {h_mH$Z Ûmam ga{ j V {H$`m J`m ï&
- AmaJbg Zm_H$ dmø naOrdr H$ gH$_U Ûmam ^maV _ AmgV à{V hŠQ`a à{V ~f 21,000 ê$ VH$ H$m Am{WH$ ZH$gmZ H$m AZ_mZ h ï&
- {gëda H$mn H$s An j m `Ú{n amh _ C ƒ gna AmŠgmBS CËnmXZ j _Vm, [ga_ {gébm ßbmO{_Z Ama EÝQrà{QEOO ËŠQdrQr {dÚ_mZ h b{H$Z gå^dV AëQaZ{Qd H$mpåb_ÝQ J{V{d{Y amh H$m AmaJbg H$ à{V À`mXm gdXŽerb ~ZmVr h ï&
- ì`dgm{`H$ ñVa H$ bpŠQH$ E{gS dŠQ[a`m _ AË`m{YH$ àm~m`m{QH$ j _Vm hmVr h ï& BZH$ Cn`mJ g Eam_mZmg hmBS{\$bm MbÝOS amh H$s AJ{bH$mAm _ ~Tdma Ed Or{dVm Xa A{YH$ nm`r J`r ï&
- H$mn _ 5, H$Q{\$g _ 3 Ed gmH$ _ 6, H$b {_bmH$a 14 QmbbmBH$ [agßQa H$s nhMmZ H$s J`r ï& amh _ QrEbAma - 3 Ed QrEbAma - 5 {def {bJm_ÝQ H$ à{V AbJ-AbJ Vah g CÎm{OV hmVm h ï&
- AmaEZE AmYm[aV AmaEZE nmbr_aO [aH$må~rZÝQ àmQrZ _H$m~{H$`_ amOZdaJmB H$ g\$X nN ~r_mar _Bå`Z [abQS OrZ H$m AnaJbQ H$aVm h ï&
- E\$Anr {_Zr H$mn hMar VÝÌ EH$ n[aMmbZ _ 0.5 {_{b`Z VH$ ñnmZ àmßV H$aZ hV Cn`mJr h ï&
- _mBQmH$mpÝS`b SrEZE {gŠdg g àX{eV hAm h {H$ {MëH$m Prb H$s BamdSr Smb{\$Z H$ nmnbeZ _ ~hV A{YH$ EH$ê$nVm h Ama WmBbÊS H$s Smb{\$Z g BZH$s AmZdm{eH$ {ZH$QVm X I r J`r ï&
- gr\$m H$s gbmh Ûmam E_bJ_ZQS ßbÝQeZ àm0 {b{_QS (EnrnrEb), Amgm_ Z AnZ à j Ì _ Am{YH$ Aåbr` dmbr {_År H$ ~mdOX 2.5 - 3.5 QZ / h H$mn CËnmXZ àmßV H$aZ _ g\$bVm nm`r h ï&