



वार्षिक प्रतिवेदन ANNUAL REPORT

1992-93



केन्द्रीय खारापानी जलजन्तु पालन संस्थान

(भारतीय कृषि अनुसंधान परिषद)

नं.१४१, मार्शल्स रोड, एगमोर, मद्रास - ६०० ००८.

CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)

141, MARSHALLS ROAD, EGMORE, MADRAS - 600 008



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CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE

(Indian Council of Agricultural Research)

141, MARSHALLS ROAD, EGMORE, MADRAS - 600 008.

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Cover Photo:
A view of the farm laboratory at Muttukadu near Madras

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INTRODUCTION

Brief Historical Background

Brackishwater aquaculture has been identified as one of the high potential areas for increasing prawn/fish production and for deriving maximum economic and social benefits such as better utilisation of unproductive and marginally productive coastal lands, swamps and brackishwater bodies, augmenting production for export and foreign exchange earnings, support to food security system, establishment of ancillary industries, generation of employment, and improving the socio-economic conditions of rural poor. As all these activities require adequate and continuous R & D support, the Indian Council of Agricultural Research sanctioned the establishment of the Central Institute of Brackishwater Aquaculture during the VII plan period (1985-90) with effect from 1.4.1985, by reorganisation of the then existing Fisheries Research Institutes of the Council. The Institute started functioning independently since April, 1987. The Headquarters of the Institute is located in Madras City with field and farm facilities at Muttukadu about 30 km south of Madras. The Institute has three Research Centres at Kakdwip (West Bengal), Puri (Orissa) and Narakkal (Kerala).

Mandate

The Institute has the following mandate

- to conduct research leading to development of techno-economically viable and sustainable culture systems for finfish and shellfish in brackishwater
- to carry out research, more specifically on nutrition and feed development, reproductive physiology, pathology, genetics, pond environment, aquaculture engineering and

operational economics to provide technology support for optimising productivity and production and

- to undertake transfer of technology through training, education and extension programmes and to provide institutional consultancy services.

Thrust areas of research during VIII Five Year Plan

- Development of physical facilities of infrastructure and modern laboratories for research at the Headquarters and Research Centres of the Institute
- Development of semi-intensive and intensive culture technologies for different species of prawns for different agro-ecological regions of the country
- Improvement in production and productivity in traditional brackishwater aquaculture systems
- Research in prawn seed production and nursery rearing technology for different scales of operation with innovations on hatchery feeds and water quality management
- Captive prawn broodstock development and management, controlled maturation and spawning and improvement in survival and quality of larvae
- Development of hatchery technology for finfish and establishment of brackishwater multispecies fish hatchery facility with land-based broodstock development
- Development of cost-effective fish production technology in ponds, pens and cages

- Development, testing and release of balanced/practical diet formulations for grow-out culture of prawns and fishes; micro-encapsulated larval and post-larval feeds; biotech products in feeds
- Development of *Artemia* cyst and biomass production technology; intensification of live food mass production systems
- Establishment of prawn/fish disease diagnostic and treatment facilities and research on viral, protozoan and metazoan diseases and their prevention, prophylaxis and control; fish health management
- Basic research on ecophysiology, physiology of digestion, excretion, reproduction, physiological stress and pond bioenergetics
- Aquaculture stock improvement through genetic engineering, ploidy manipulation and selective breeding
- Biotechnological approaches in reproduction, nutrition, growth, disease control and pond health management
- Coastal zone management with reference to aquaculture and environment
- Studies on aquaculture economics
- Aquaculture engineering research for systems, designs and materials for hatcheries and farms
- Transfer of technology through training, demonstration, information system, publications and institutional consultancy

Infrastructure Development

The laboratories at the Headquarters and administrative offices have been shifted to a more spacious building at 141, Marshalls

Road after vacating the two buildings at 1, Karneeswarar Koil Street, Mylapore and 12, Leith Castle Street, Santhome.

During the year, the construction of a farm laboratory was completed at Muttukadu. The soil and water chemistry, nutrition and biology laboratories are housed in this building.

Shri K.C. Lenka, Honourable Union Minister of State for Agricultural Research and Education, Animal Husbandry and Dairying inaugurated this farm laboratory and laid the foundation stone for the hatchery on 5 May 1992.

A wet laboratory was also added to the existing facilities at Muttukadu in the course of the year. Construction of the experimental hatchery/laboratory for prawn seed production is in progress at Muttukadu.

Equipments imported during the year 1992-93 are: Gel Drier, Ultra Low Temp. Freezer, Soil pH Meter, Pressure Sand Filters and Salinity Refractometers. A heavy duty Xerox machine, a personal computer with laser printer and UPS, a top loading balance and electronic testing equipment were also added to the laboratories during the year.

Organisation

The research programmes of the Institute were carried out under the following divisions

1. Crustacean Culture Division
2. Fish Culture Division
3. Technology Improvement Division
4. Aquaculture Environment and Engineering Division
5. Economics, Extension and Information Division

The broodstock maintenance, breeding and larval rearing of *Penaeus monodon* and *P.indicus*, culture of live food organisms, grow-out culture programmes and crab culture were handled by the Crustacean Culture Division. Breeding and culture of brackishwater fishes were dealt with by the Fish Culture Division. Nutritional aspects of fish and prawn, feed technology, pathology, ecophysiology and reproductive physiology programmes were taken up by the Technology Improvement Division. Aquaculture Environment and Engineering Division dealt with brackishwater environment, soils and their productivity, hatchery design, layout and systems and development of the useful machines and structures for brackishwater aquaculture development. The Economics, Extension and Information Division looked after the technology transfer programmes and aquaculture economics. The Library and Technical Cell were looked after by a Principal Scientist. An Engineering Cell was also created during the year to facilitate the construction work at the Institute.

Two projects funded by other agencies viz., 'Studies on the quantitative requirements of essential aminoacids and fatty acids for the prawn *Penaeus monodon*' and 'Impact of brackishwater aquaculture on the environment' were also carried out. Further, two other projects funded by external agencies on 'Development of feed technology for semi-intensive/intensive prawn farming' and 'Basic research on pond bio-energetics, digestive enzymes and microflora in fish and prawn under aquaculture' were initiated during the course of the year.

A total number of 18 projects (14 departmental and 4 funded by other agencies) were undertaken during the year.

Budget

During the year 1992-93 an expenditure of Rs. 98.50 lakhs under Plan and Rs. 77.49

lakhs under Non-Plan was incurred by the Institute.

Major Research Accomplishments

The Institute made good progress in the research programmes in spite of the constraints of inadequate infrastructure facilities. The Institute made significant progress in developing a mature broodstock of *Lates calcarifer* in captivity. Technique of implantation of LHRH_a in pellet form in fish was developed; LHRH_a in conjunction with HCG, was responsible for achieving maturation.

Induction of maturity and spawning in ablated females of *Penaeus monodon* was successfully accomplished by changing 90% of seawater per day and using fresh flesh of squid and clam @ 15% of the total biomass given twice a day, with a supplemental diet of polychaete worms.

Higher biomass production of *Artemia* was obtained in a laboratory experiment with the indigenous strain from a saltpan near Madras (250 g/tonne of water) when compared to San Francisco Bay Strain (210 g/tonne of water).

At Kakdwip, the combined production of *Penaeus monodon* and *P. penicillatus* was 261.46 kg/ha/6 months and 340.00 kg/ha/6 ¹/₂ months. Pen culture of milk fish, *Chanos chanos*, carried out in the lagoon at Muttukadu, resulted in a recovery rate of 72.14% after 317 days of culture and a production rate of 980 kg/ha. The stocking density was 7,500 no./ha and the fish were fed on a formulated pelleted feed.

In the experiments on cryopreservation of milt of mullet, it was found that 5% DMSO as cryoprotectant with Fish Ringer as extender could be used, as revealed by good sperm motility of *Liza macrolepis*.

Thoracic ganglion implantation technique in *P. monodon* was standardised in laboratory conditions with the possibility of stimulating gonad maturation.

The causative agent for vibriosis in *P. monodon* was identified as a gram negative bacterium *Vibrio alginolyticus* and methylene blue was found to be effective in its treatment. *Vibrio harveyi* was identified as the causative agent of the luminescent bacterial disease in *P. monodon* larvae. The black gill disease in *P. monodon* was found to be due to poor water quality following heavy rains coupled with a sudden drop in salinity from 15 ppt to 5-7 ppt.

A comprehensive survey was conducted to study the availability of various marine protein sources in the states of Andhra Pradesh, Goa, Gujarat, Karnataka, Kerala, Maharashtra, Orissa and Tamil Nadu for considering the low value by-catch as raw materials for prawn/fish feed industry. The survey revealed that there is a flourishing trade in all the states in these items, the largest consumer being the poultry feed industry. However, these resources are available only during fishing season, for 4-6 months in a year which vary from state to state.

Through feed trials, an effective mineral mixture, as feed additive was evolved for culture of *P. monodon*.

Three feeds viz., "starter", "grower" and "finisher" were formulated and developed at the Institute, using indigenous feed materials for the grow-out culture of *P. monodon*. Three grades of microparticulate feed i.e. 200, 500 and 1000 micron size were prepared according to the formula evolved by the Institute for feeding post-larvae of *P. indicus*.

The scientists of the Institute provided technical guidance for the hatcheries at Kumta in Karnataka, Chinnaveerampatinam in Pondicherry and MATSYAFED hatchery at Kannur in Kerala.

To study the socio-economic aspects of prawn culture, employment opportunities and extension requirements, a project was initiated, to begin with, in Andhra Pradesh and Tamil Nadu.

K. Alagarwami
Director

GENERAL INFORMATION

Management Committee

The fourth and fifth meetings of the Management Committee of the Institute were held on 8.12.1992 and 18.3.1993.

Staff Research Council

A meeting of the Staff Research Council was held on 8.12.1992 to review the progress of the on-going research projects.

Research Advisory Committee

Research Advisory Committee meeting pertaining to NARP Phase II project funded by World Bank through ICAR was held at the Institute on 11.3.1993. The meeting was presided over by Dr. M. Yusuf Kamal, Asst. Director General, ICAR.

Assistance rendered

Shrimp seed production technology for *Penaeus indicus* was demonstrated by the scientists at the Departmental Prawn hatchery at Kumta, Karnataka and suggestions for improvements were provided for the prawn hatchery at Chinnaveerampatinam in Pondicherry. Technical guidance was provided to the staff of the MATSYAFED hatchery, Kanur, Kerala, in shrimp breeding and seed production technology.

The scientific personnel at the Kakdwip Research Centre assisted and interacted with the high level team of the FAO/UNDP of the Project Formulation Mission for Model Watershed for Coastal Agroclimatic Zone.

Scientific monitoring of the semi-intensive culture of tiger prawn in the TASPARG farm at Nellore was continued.

The Institute participated in the INDQUA aquaculture show organised by the MPEDA at Madras during 19-23 March 1993.

Services in Committees

Dr.K. Alagarwami, Director, served as

- Member, Task Force on Aquaculture and Marine Biotechnology, Department of Biotechnology, Govt. of India.
- Member, CRSARD, Dr. M.S. Swaminathan Research Foundation.
- Member, Central Board of Fisheries, Govt. of India.
- Member, ICAR Regional Committee No. VIII.
- Member, Editorial Board for Indian Journal of Fisheries.
- Member, Standing Committee for Agriculture, Tamil Nadu State Planning Commission.
- Chairman, Expert Committee to review the working of FFDAs in Tamil Nadu, Dept. of Fisheries, Govt. of Tamil Nadu.
- Member, Agency for Development of Aquaculture in Kerala, Govt. of Kerala.

The following scientists served as resource persons/ counsellors at the INDQUA show, Madras, 19 - 23 March 1993.

- Shri A.V.P. Rao, Principal Scientist
- Shrimp hatchery
- Dr. S. A. Ali, Senior Scientist
- Shrimp feed technology

- Dr. S.K. Pandian, Senior Scientist
- Shrimp culture
- Shri. M. Kathirvel, Scientist (S.G)
- Crab culture
- Dr. A.R.T. Arasu, Scientist (S.G)
- Fish culture
- Shri S. V. Alavandi, Scientist
- Shrimp diseases
- Dr. A. Laxminarayana, Senior Scientist,
served as consultant to the Government of
Cambodia, in shrimp breeding and
hatchery technology, from 16 November to
9 December 1992.

Training

Under the Indo-Cuban Work Plan, Dr. Jose Galindo Lopez, Scientist from Cuba, was given training in prawn hatchery technology, culture of live food organisms and in the nutrition of farmed shrimps from 21 September to 3 October 1992.

Demonstrations and field training on brackishwater aquaculture were organised at the Head Quarters and research centres of the Institute as given below:

Madras

- B.F.Sc. students, Department of Fishery Biology, G.B. Pant University of Agriculture and Technology, on 3 June, 1992
- ARS Scientists (on training) from CIFA, during 21-22 October 1992
- Students from the Marine Biological Research Station, College of Fisheries, Konkan Agricultural University, Ratnagiri, Maharashtra, during 3-4 December 1992
- B.Sc. (Zoology) students with elective in Fisheries and Aquaculture, Queen Mary's College, Madras, on 15 December 1992

Kakdwip

- Fish farmers from the 24 Parganas (N & S) on different occasions
- Staff from CICFRI, Barrackpore, from 9-11 June 1992
- Students from the Department of Marine Science, Ballygunj Science College, University of Calcutta, on 16 June 1992
- FFDA trainees from Kakdwip Block, on 10 February 1993
- Trainees from the Socio-Economic Development Programme, Pisciculture Training and Extension Centre, Haridevpur, Dhaliapara, Dist. 24 Parganas, on 20 February 1993
- B.Sc. students of Ramananda Centenary College, Purulia, on 24 February 1993
- Trainees of the Department of Fisheries, Govt. of West Bengal, on 6 March 1993
- Trainees from the Directorate of Fisheries, Govt. of West Bengal, on 18 March 1993

Puri

- M.Sc. students of the Inland Fisheries Training Centre of CIFE, Barrackpore

Narakkal

- Trainees sponsored by MPEDA on 2 May 1992, 23 September 1992 and 6 February 1993
- Trainees from the Syndicate Bank
- Trainees from Department of Fisheries, Govt. of Maharashtra
- B.F.Sc. students, College of Fisheries, Mangalore

- B.F.Sc. students, College of Fisheries, Panangad, Kochi
- M.Sc. students, NSS Hindu College, Changanassery
- D.F.Sc. trainees, CIFE, Bombay.

Manpower Development

Dr. K.O. Joseph, Scientist, attended the senior level training programme on 'The Applications of Bio-indicators in the Conservation of Bio-diversity' conducted by Dr. M.S. Swaminathan Research Foundation, Madras, from 4-21 May 1992

Shri R. Elankovan, Librarian (T-4), attended the training course on 'Computer Applications in Libraries (CDS/ISIS)' conducted by NAARM from 28 September 1992 to 9 October 1992, at Hyderabad

Shri N. Kalaimani, Scientist (SG), attended a training course on 'Computer Applications in Agricultural Research' conducted by NAARM, Hyderabad, from 13-24 July 1992

Smt. Imelda Joseph, Scientist, underwent a training from 4 - 18 March 1993, on certain aspects of aquatic botany including microalgae and macrophytes, their culture and growth kinetics, at CAS in Botany, Madras University.

Visits

Dr. S.A. Ali, Senior Scientist, visited CIFA, Bhubaneswar and delivered a lecture on 'Growth promotion in prawn through dietary supplementation of various additives' to the trainees in aquaculture nutrition, on 19 November 1992

Dr.A. Laxminarayana, Senior Scientist, visited the Government shrimp hatchery at Kumta, Karnataka and demonstrated the shrimp seed production technology to BFDA officials

Shri A.V.P. Rao, Principal Scientist and Dr. L.H. Rao, Senior Scientist, visited the shrimp hatchery being constructed at Chinnaveerampatinam, Pondicherry and suggested improvements.

Seminars/Symposia/Workshops

The Director and scientists of the Institute participated in the following Seminars/Symposia/Workshops held during the year.

- ITTO-CRSARD Project for the establishment of an **International Network for Conservation and Sustainable Utilization of Mangrove Forest Genetic Resource**, conducted by Dr. M.S. Swaminathan Research Foundation, at Madras, on 7 May 1992

Dr. K. Alagaraswami

- Workshop on **Marine Environment Management and Protection** conducted by National Institute of Oceanography, Goa, on 12 May 1992.

Dr. K. Alagaraswami

- National Workshop on **Marine Fisheries for Higher Production** at Kochi, 9-10 June 1992

Dr. K. Alagaraswami

- Workshop on **Shrimp Culture**, conducted by the MPEDA, Vijayawada, on 2 July 1992

Dr. K. Alagaraswami

- Summer Institute on **Aquaculture and Environment** organised by CIFE, Bombay, on 24 July 1992. Delivered two lectures viz., 'Intensification of brackishwater aquaculture and its effect on the environment' and 'Sea farming and possible environmental impact'

Dr. K. Alagaraswami

- As National Environment Coordinator attended the Regional Study and Workshop on **Environmental Assessment and Management of Aquaculture Development** organised by NACA/RAPA/FAO, in Bangkok, during 15-18 September 1992. Presented the country paper on 'Major Environmental Issues Affecting Aquaculture Development in India'

Dr. K. Alagarswami

- Seminar on **Shrimp Feed** organised by the U.S. Wheat Associates, New Delhi, held at Madras on 19 March 1993

Dr. S.A. Ali

Meetings

The Director and scientists of the Institute attended the following meetings

- Fifth meeting of the Task Force on Aquaculture and Marine Biotechnology, Dept. of Biotechnology, Govt. of India, New Delhi, 18.6.1992

Dr. K. Alagarswami

- Meeting of the Screening Committee for allotment of brackishwater aquaculture lands, Dept. of Fisheries, Govt. of Andhra Pradesh, Hyderabad, 1.7.1992

Dr. K. Alagarswami

- Meeting with FFDA as chairman of the Expert Committee constituted by the Govt. of Tamilnadu at Thanjavur on 13-14.7.92 and at Krishnagiri on 29-30 July 1992

Dr. K. Alagarswami

- Meeting of FFDA Expert Committee constituted by the Govt. of Tamil Nadu to review the work of FFDA's, at Madurai on 9.8.1992

Dr. K. Alagarswami

- ICAR Directors' Conference, Delhi, 13.8.1992

Dr. K. Alagarswami

- General body meeting of OSSPARC at MPEDA, Kochi, 24.8.1992

Dr. K. Alagarswami

- Seventh meeting of the Committee for the Introduction of Exotic Aquatic Species, CMFRI, Kochi, 25.8.1992

Dr. K. Alagarswami

- Special meeting of the ICAR Society at NAARM, Hyderabad, 30.8.1992

Dr. K. Alagarswami

- Meeting on NARP - Phase II, New Delhi, 4.11.1992

Dr. K. Alagarswami

- Third meeting of the governing body of the Agency for Development of Aquaculture in Kerala (ADAK), Thiruvananthapuram, 11-12 November 1992

Dr. K. Alagarswami

- Seventh Meeting of Central Board of Fisheries, Hyderabad, 14-15 November 1992

Dr. K. Alagarswami

- Meeting of the Action Plan Group of the ICAR Regional Committee, No. VIII, 9-10 February 1993

Dr. K. Alagarswami

- Review Committee Meeting to review the inception reports submitted by the consultants of the World Bank assisted shrimp farms at Bedeipur - Narendrapur in Orissa, P.T. Palem II in Andhra Pradesh, Meendweep in West Bengal, at CICEF, Bangalore, 12.5.1992

Shri A.V.P. Rao

- Conference on the Industrialisation of Myladuthurai, Poompuhar, 7.3.1993

Shri K.N. Krishnamurthy

- Meeting of the heads and officers-in-charge of the local ICAR establishment and the ministers and secretaries of Depts.

of Agriculture, Animal Husbandry and Fisheries, Govt. of Orissa, convened by the Hon'ble Minister of State for Agriculture (DARE), Shri K.C. Lenka, Bhubaneswar, 1.6.1992

Dr. R.D. Prasadam

- First National Meet on Aquafarming Systems Research, jointly organised by CIFA, Orissa University of Agriculture and Technology and Association of Aquaculture, Kausalyaganga, 10-11 February 1993

Dr. R.D. Prasadam

- National Convention on Agricultural Policy and Intellectual Property Rights in Agriculture held at IARI, New Delhi, 16-18 November 1992

Dr. L.H. Rao
and Dr. K. Gopinathan

- Third meeting of the Expert Group constituted to make an indepth study of the problems faced by fishermen of Ash-tamudi lake in Kerala, 13.10.1992

Dr. A. Laxminarayana

Honours and Awards

The scientists mentioned below were presented with the INDAQUA awards by MPEDA, Ministry of Commerce, Govt. of India on 23.3.1993 at the INDAQUA-93 show, held at Madras

Dr. L.H. Rao, Senior Scientist, for Shrimp Backyard Hatchery Technology

Dr. S.A. Ali, Senior Scientist, for his contribution in Aquaculture Research on Shrimp Feed

Shri Shankar Alavandi, Scientist, for his contribution in Aquaculture Research on Shrimp Diseases

Library, Information and Documentation

Library Holdings

The library acquired 41 books during the period to meet the reference needs of the scientific personnel and subscribed to 12 foreign and 20 Indian journals. The library as in March '93 had a total holding of 772 books, 415 reprints and photocopies, 210 reports and 435 miscellaneous publications.

Exchange Services

The library maintained exchange relationship with national and international organizations of mutual interest. The library maintained the mailing of the Institute's Annual Report and other publications to various research organisations, universities and other agencies.

Information Services

The library section extended its information service to the scientific personnel of research organisations, universities, research scholars and students through reference of books and journals in the library. The section also provided reprography service to the scientists as and when needed.

Shri Syed Abdul Khair, Deputy Director, Fisheries Research Institute and Ph.D. Fellow, Department of Fisheries, Rajshahi, Bangladesh, visited the Institute for library consultation and reference work from 9-20 February 1993.

Publications

- Annual report for the year 1991-92
- Prawn Farming - candidate species - CIBA Bulletin No.2
- Pamphlet on the organisation and activities of CIBA.

Reports

- Report submitted to the Planning Commission, Govt. of India, on the Action Plan for improving the existing brackishwater aquaculture programmes in India and role of CIBA in its implementation.
- Report of the Expert Committee to review functioning of Fish Farmers Development Agencies constituted by Govt. of Tamil Nadu.
- Deputation report of Dr. K. Alagarswami, on his visit to Bangkok, Thailand, to attend the Regional Study and Workshop on Environmental Assessment and Management of Aquaculture Development.
- Technical Evaluation Report of Killai Brackishwater Farm, submitted to Dept. of Fisheries, Tamilnadu.

List of Papers / Lectures presented at Seminars / Symposia

Alagarswami, K. 1992. Prof. R.V. Seshiah Memorial Lecture at CAS in Marine Biology, Annamalai University, April 1992

Alagarswami, K. 1992. 'Aquaculture and Sustainable Utilisation of Mangrove Forests'. Lecture delivered at Dr. M.S. Swaminathan Research Foundation under ITTO/CRSARD Project for the Establishment of an International Network for Conservation and Sustainable Utilisation of Mangrove Forest Genetic Resources, May 1992

Alagarswami, K. 1992. 'Culture Fisheries and Marine Environment', and 'Marine Environment Management and Protection'. Lectures delivered at the Workshop on Marine Environment Management and Protection, NIO, Goa, May 1992

Alagarswami, K. 1992. 'Major environmental issues affecting aquaculture develop-

ment in India'. Country paper presented at the Initial Workshop and Planning Meeting of Regional Study and Workshop on the Environmental Assessment and Management of Aquaculture Development, organised by NACA/RAPA/FAO, Bangkok, Thailand, September 1992

Alagarswami, K. 1993. 'Impact of aquaculture operations on the environment'. Paper presented at the Seminar on Aquaculture and the Environment, organised by SCICI, Hyderabad, March 1993

Alagarswami, K. 1993. 'Planning for augmenting shrimp seed production'. Paper sent for publishing in the special issue of Fishing Chimes, March 1993

Kathirvel, M. 1993. 'Culture of mud crabs'. Paper presented at the Business Session of 'INDAQUA 93' organised by MPEDA, at Madras, March 1993.

Visitors

Headquarters

Shri K.C. Lenka, Hon'ble Union Minister for DARE

Prof. V.L. Chopra, Director General, ICAR

Dr. P.V. Dehadrai, Deputy Director General (Fisheries), ICAR

Dr. S.N. Dwivedi, Officer on Special Duty (Aquaculture), ICAR

Dr. V.R.P. Sinha, Director, CIFE, Bombay

Shri S. Ramakrishnan, IAS, Secretary to Govt. of Tamil Nadu, A.H. & Fisheries Dept.

Smt. Latika D. Padalkar, IAS, Commissioner for Fisheries, Govt. of Tamil Nadu

Smt. Priya Prakash, IAS, Principal Advisor (Agri), Planning Commission, Govt. of India

Dr. K.L. Sehgal, Director, NRC for Coldwater Fisheries, Haldwani

Dr. K. Gopakumar, Director, CIFT, Kochi

Dr. George John, Director, DBT, Govt. of India, New Delhi

Dr. D. Sudarsan, Director General, Fisheries Survey of India, Bombay

Shri C. Chandran, IAS, Special Secretary (Fisheries), Govt. of Kerala

Shri C.S. Rangachari, IAS, Principal Secretary to Govt. of Andhra Pradesh, Dept. of A.H. & Fisheries

Dr. P. Das, Director, NBFGR, Allahabad

Commission from the University of Madras under the leadership of Dr. (Smt) K. Radha Shanmughasundaram, Prof. and Head, Dept. of Medical Biochemistry

Dr. M. Y. Kamal, Assistant Director General, ICAR

Kakdwip Research Centre

Mr. David Feldman, Farming Systems Specialist (FAO/UNDP)

Mr. Dennie Neville Cahill - Soil Conservation Specialist (FAO/UNDP)

Mr. Jimmie Mascaranas, Socio-Economic Specialist (FAO/UNDP)

Dr. S.L. Seth, Additional Commissioner, Watershed Management Specialist, Ministry of Agriculture, Govt. of India

Mr. Johnathan Landech - Extension Specialist (FAO/UNDP)

Dr. V.R. Desai, Acting Director, CICFRI, Barrackpore

Mr. S.K. Paul, Field Surveyor, NBFGR, Allahabad

Puri Research Centre

Shri K.K. Bajpai, Deputy Secretary, ICAR, New Delhi

Shri S.K. Mohanty, Deputy Director, Department of Fisheries, Govt. of Orissa

Shri T.S. Murthy, Deputy Director, Department of Fisheries, Orissa

Narakkal Research Centre

Shri A.K. Luke, Commissioner of Fisheries, Govt. of Gujarat

Mr. K.N. Menon, Dept. of Fisheries, Gujarat

Mr. K.K. Narayanan, Fisheries Development Corporation, Gujarat

PROGRESS OF RESEARCH

CRUSTACEAN CULTURE DIVISION

Development of hatchery technology for penaeid prawns (CCD/HT/1)

Madras : A.V.P. Rao (PL), L. H. Rao, K. Devarajan, S. Kulasekarapandian, S. Srinivasagam (upto Oct.'92), P.Ravichandran (from Nov. '92), K.O. Joseph and V. Sreekrishna

Narakkal : A. Laxminarayana and S.M. Pillai

Induced maturation of *Penaeus monodon*

Induction of maturity and spawning in ablated females of *Penaeus monodon* was done successfully by changing 80-90% seawater per day and using fresh flesh of squid and clam @ 15% of the biomass supplemented with polychaete worms. The details of the four trials conducted during the year are given in Table 1.

In the second trial viable nauplii were obtained only in two spawnings. This was attributed to the poor quality of spermatophores of males kept in captivity for long periods. In the fourth trial eggs did not hatch in five cases due to low temperature (24°C).

Larval rearing of *Penaeus monodon*

In all, 24 larval rearing trials were carried out using *Chaetoceros calcitrans*, egg yolk or clam suspension, *Artemia* nauplii and clam custard as larval feeds. In two trials the rearing medium was treated with tetracycline @ 2-3 ppm everyday and the survival percentage of nauplii to PL-2 ranged from 40.0- 52.7 with an average of 46.3. However in another 6 trials conducted in a shed exposed to diffused sunlight addition of antibiotic to the medium did not improve the survival. In the remaining trials large-scale mortality of larvae occurred due to bacterial diseases caused by *Vibrio* sp. and

Table 1: Experiments on induced maturation of *Penaeus monodon*

Date of ablation & duration of expt. (days)	No. of females ablated	Size range (mm/g)	Sex ratio F:M	Feeds used (% of total Biomass)	Water Change/ Day(%)	Total No. of spawnings	Total No. of eggs (lakhs)	No. of Viable spawnings	No. of eggs/ spawning (lakhs)	No. of nauplii/ spawning (lakhs)
9.3.92 (82)	11	F205-230/ 70-150 M160-220/ 50-80	2:1	clam & squid 15% Pc 8%	80-90	24	55.03	14	2.50	1.21
3.6.92 (50)	12	F210-260/ 105 -155 M70-200/ 50-100	2:1	clam & squid 15% Pc 8%	80-90	16	47.10	2	3.54	1.70
23.7.92 (40)	25	F196-250/ 80-180 M175-220/ 50-100	1:1	clam & squid 15% Pc initially 5% increased to 10%	80-90	19	42.50	11	2.23	0.82
1.3.93 (30)	12	F205-250/ 90-170 M170-230/ 60-110	2:1	clam & squid 15% Pc 5%	80-90	18	48.30	13	2.84	1.34

Pc - Polychaete worms; F - Female; M - Male

due to the excessive growth of algae in tanks by over-exposure to sunlight.

The postlarvae were reared at densities of 20/l and 30/l, using *Artemia* nauplii and clam custard. The survival from PL-3 to PL-19 ranged from 25.7-65.0% with an average of 40.7%. The low survival rate was attributed to the poor quality of borewell water. The water quality from the borewell at Muttukadu analysed in June-July 1992 revealed the following characteristics: Salinity 31-31.5 ppt, pH 7.8-8.1, total alkalinity 104 ppm (as CaCO₃), total hardness 5206-5208 ppm, NH₃-N 0.01-0.02 ppm, NO₂-N 0.01- 0.14 ppm, COD 0.60-0.80 ppm and H₂S BDL. The water was analysed for pesticides and heavy metals. The bacteria reported in the larval rearing tanks were *Vibrio alginolyticus*, *V. parahaemolyticus*, *Flavobacterium* sp., *V. harveyi* and *Aeromonas* sp.

Seed Production of *Penaeus indicus* adopting backyard technology

Narakkal

Following backyard hatchery technology, 9 trials were conducted for seed production of *Penaeus indicus* in 1-2 t FRP tanks using mixed phytoplankton, dominated by *Chaetoceros* sp. as larval feed. The survival from nauplii to PL-1 ranged from 22.3- 81.1%, with an average of 53.5%. The postlarvae were further reared using squilla powder of 200 micron to 1 mm particle size.

Culture of live food organisms (CCD/LFC/1)

Madras: S. Kulasekarapandian (PL), S. Srinivasagam (upto Oct. '92), P. Ravichandran (from Nov. '92), K. Devarajan, K.O. Joseph and C. Gopal

Axenic cultures of *Chaetoceros calcitrans* were maintained in UV filtered seawater under controlled temperature (20-24°C) using Walne's medium at a light intensity

of 1000-1500 lux. A maximum cell density of 7.2 million cells/ml was achieved. Mass culture of *C. calcitrans* was done in outdoor FRP tanks (200 l - 1.5 t) in filtered seawater enriched with modified 'F' medium. A maximum cell density of 2.0 million cells/ml was obtained in 24 hr, from an initial inoculum of 0.1 million cells/ml.

Brachionus plicatilis was cultured in filtered seawater (30- 33 ppt), enriched with modified Yashima medium and a starter culture of *Chlorella* sp. From an initial inoculum of 10 animals/ml and 15 animals/ml, the population grew to 82 animals/ml and 192 animals/ml respectively in 6 days. Continuous culture of *Chlorella* sp. was maintained in outdoor tanks in filtered seawater enriched with groundnut oilcake @ 150 ppm. From an initial inoculum of 15 animals/ml in the above medium, the population increased to 230 animals/ml in 4 days. After harvesting 80% of the population, fresh *Chlorella* sp. culture was introduced and rotifer culture was continued.

Brine shrimp culture

Artemia culture was done in a 0.4 ha pond in a private salt pan at Kelambakkam from 18.2.93. The salinity was maintained between 75-100 ppt. The pond was fertilised with a basal dose of urea, single superphosphate and diammonium phosphate @ 50 kg per hectare and 400 kg of chicken droppings packed in gunny bags were suspended in the pond. The San Francisco Bay strain of *Artemia* was inoculated @ 37 nauplii per litre. Refertilization of the pond was done every 15 days at half the basal dose.

The chemical characteristics of the pond soil and water before and after treatment are furnished in Table 2.

In a laboratory experiment, when *Artemia* (Kelambakkam strain) nauplii were stocked @ 145 no./l and *Chlorella* sp. was used as feed, a production of 250 g (wet weight) *Artemia* biomass was obtained per tonne of water

Table 2: Chemical characteristics of the pond soil and water in *Artemia* culture pond.

	Before Treatment	After Treatment
Soil Phase		
pH	8.10	7.60
EC (mmhos/cm)	78.00	72.00
Organic Carbon (%)	0.30	0.52
Available Phosphorus (mg/100g)	1.20	2.80
CaCO ₃ (%)	2.20	2.00
Iron (%)	0.52	0.56
Water Phase		
Phosphate (ppm)	0.08	0.26
Nitrate (ppm)	0.12	0.41
Alkalinity (ppm)	160.00	182.00
COD (ppm)	7.80	18.20
Iron (ppm)	0.10	0.14

in 30 days. However, when San Francisco Bay strain of *Artemia* nauplii was stocked @ 142 no./l and *Chlorella* sp. along with rice bran was used as feed, the biomass production at the end of 32 days was 210 g per tonne of water.

Culture of penaeid prawns in different ecosystems (CCD/CP/1)

Madras: A.V.P. Rao (PL), M. Kathirvel, K. Gopinathan and B.P. Gupta

Kakdwip: Hardial Singh, R.K. Chakraborti and Ashish Chowdhury

Puri: R.D. Prasad, L. Krishnan (upto Nov. 1992) C.P. Rangaswamy (from Sep. 1992) and S. Srinivasagam (from Nov. 1992)

Narakkal: A. Laxminarayana and S.M. Pillai

Kakdwip

Two tide-fed ponds (0.275 ha and 0.375 ha) after liming @ 700 kg/ha, were stocked with tiger prawn seed (avg. size 12.3 mm/6.15 mg) in

February 1992, at a stocking density of 1,00,000 no./ha and 1,25,000 no./ha. Pelleted feed developed by CIBA was provided @ 10% total weight and gradually reduced to 6% in the 4th month. The overall production rate for *P. monodon* and auto-entry stock was 546.8 kg/ha/6 months in pond 1 and 572.6 kg/ha/6¹/₂ months in pond 2. *P. monodon* composition was 25.8% and 32.6% respectively and *P. penicillatus* composition was 22.0% and 26.8% respectively in the two ponds. Miscellaneous prawns and fishes contributed to the rest of the production rate. Auto entry could not be avoided inspite of all precautions.

The physico-chemical parameters of the ponds were as follows:

Water phase: salinity 3.0-17.6 ppt, total hardness 680-2382 ppm, total alkalinity 98-178 ppm, pH 7.30-8.89, phosphate 0.00-0.37 ppm, ammonia 0.01-1.31 ppm, D.O. 1.3-1.7 ppm (at 06.30 hrs), calcium 56-262 ppm, magnesium 131-419 ppm and sulphide 0.001- 0.038 ppm.

Soil phase: pH 7.64-8.60, organic carbon 0.30-0.81%, available nitrogen 72.8-165.2 ppm,

available phosphorus 51.0-82.0 ppm, sulphate 425-1100 ppm, EC 4.5-6.7 mmhos/cm and redox value -49 to -196 mV.

A 0.09 ha pond was stocked with *Penaeus penicillatus* juveniles (avg. size 56.1mm/2.12 g) at a density of 1,00,000 no./ha during April 1992. Feeding was done with CIBA feed. The prawns grew to 115 mm/ 11.6 g in 88 days.

Puri

At Keutakudi, 12 ponds of the BFDA were stocked with postlarvae of *P. monodon* (avg. size 30.2 mm/175 mg) at a density of 30,000 no./ha in 6 ponds and 40,000 no./ha in the other 6 ponds in December 1991. Feeding was done with CIBA pelleted feed and crushed *Pila* meat in replicates of 3 each @ 33% body weight initially and gradually reduced to 5% during the fourth month. The retrieval ranged from 4.2-20.7% and 5.9-14.9% for the densities 40,000 no./ha and 30,000 no./ha respectively. The low survival was attributed to predation by water birds, otters and poaching. The production rate was 200 kg/ha/131 days with pellet feed at 40,000 stocking density. The experiment showed that the performance of pellet feed was superior to *Pila* meat in respect of growth, survival and production of prawns. About 30% of the prawns harvested was in the size range of 33 - 50 g.

In January 1993, 24 ponds of 0.02 ha each, were stocked with *P. monodon* seed (avg. size 12.6 mm/17.0 mg) in 8 replicates of 3 densities of 20,000, 30,000 and 40,000 per hectare. Feeding was done with CIBA pellets.

Narakkal

A 0.05 ha tide-fed pond was stocked with *Penaeus indicus* postlarvae (avg. size 11.3 mm/0.017 g) in March 1992 at a density of 1,00,000 no./ha. Feeding was done with CIBA pelleted feed. The production was 504 kg/ha/87

days (avg. size 117 mm/9.1 g) and survival 55.4%.

In February 1993, a second experiment was initiated in the same pond. It was stocked with *P. indicus* seed (avg. size 20.9 mm/0.016 g) @ 1,00,000 no./ha. Supplementary feeding was done @ 10% body weight. The prawns had attained avg. size of 103 mm/5.1 g in 49 days and the study is being continued.

A 0.6 ha perennial undrainable pond was stocked with seed of *Mugil cephalus* (avg. size 31.1 mm/0.310 g) in July 1991 @ 2,000 no./ha. In July 1992, the same pond was stocked with *P. indicus* seed (avg. size 14.6 mm/0.14 g) at 28,300 no./ha. Supplementary feed was not provided. The prawn grew to an average size of 111.6 mm/9.0 g and fish at harvest ranged in size from 360-560 mm/450- 2000 g. The low survival (10%) and production was due to poor pond conditions coupled with development of large numbers of *Villorita cyprinoides* in the pond (0.846-2.403 kg/m²).

In July 1992, the same pond was stocked with *M. cephalus* seed of average size 19.7 mm/0.5 g at 1,330 no./ha. However, due to heavy rains the pond was inundated, vitiating the experiment. The pond was then stocked with *P. indicus* seed (avg. size 18.4 mm/0.028 g) at 45,800 no./ha. No supplementary feed was given. The prawn grew to 85.4 mm/4.5 g in 44 days.

Culture of commercially important portunid crabs (CCD/CF/1)

Madras: M. Kathirvel (PL)

In a nursery pond (0.021 ha) a velon screen enclosure (6 m x 6 m) was erected and 36 *Scylla serrata*, 11 females (avg. size 110.8 mm/186.4 g) and 25 males (avg. size 98.8 mm/152.4 g) were stocked @ 1 crab/m² in October 1992. The pond was inundated and the earthen dykes were eroded during the NE monsoon resulting in loss of the stock.

FISH CULTURE DIVISION

Broodstock development, breeding and seed production of brackishwater finfishes (FCD/BS/1)

Madras : K.N. Krishnamurthy (PL), K.V. Ramakrishna, Mathew Abraham, A.R. Thirunavukkarasu, Munawar Sultana, Kishore Chandra, Shiranee Pereira and V. Sreekrishna

Puri : R.D. Prasadham, C.P. Rangaswamy (from Oct. '92,) L. Krishnan (upto Nov. '92) and P. Ravichandran (upto Oct. '92)

Narakkal : L. Krishnan (from Nov. '92) and S.M. Pillai

Kakdwip : Hardial Singh

Lates calcarifer

Maintenance of a broodstock of *Lates calcarifer* (9 no.) of size range 470-800 mm/3.5-10.0 kg, initiated in 1990-91, was continued at Ennore in an earthen pond of 0.03 ha. Fish were fed regularly with live *Tilapia* and 50-70% of the water was exchanged thrice a week. During this period the temperature ranged between 25.5-33.5° C, salinity 5-34 ppt and pH 7.7-8.2. The gonad development of the fish was periodically monitored. In the second week of June 1992, a few males had attained maturity without hormone treatment and exuded milt under slight pressure. One female (780 mm/8 kg) was found to have well developed ova with an average ova diameter of 0.40 mm. LHRH α in pellet form was implanted in this fish in split doses of 125 μ g/kg body weight at an interval of 15 days. This helped improve the growth of ova to 0.54 mm. A final dose of LHRH α @ 125 μ g/kg in combination with HCG @ 500 IU/kg was administered and the fish was released into the spawning tank along with two oozing males. Even after 2 days, no spawning was observed.

On examination the female was found to have fully developed ovary, weighing 0.94 kg and the ova measured 0.70-0.75 mm with a single oil globule of 0.22-0.25 mm diameter. This is the first report of induced maturation of *Lates* in captivity in India. In March 1993, this stock along with 6 more juveniles (290-410 mm/300-1000 g) were transported to Muttukadu. Meanwhile 32 fish (475 g-1.45 kg) were procured at Muttukadu and are being maintained in two cages (10 m x 5 m) and fed on live *Tilapia*.

A breeding camp was set up at Alupatna in Chilka lake. However, due to cyclone it had to be closed after 10 days. Though mature males were available, mature females could not be observed during the period.

Mugil cephalus

The maintenance of the captive broodstock of *Mugil cephalus* (59 no.) at Ennore in a 0.025 ha pond, initiated in June 1991, was continued. The average stocking size was 303.6 mm/377.8 g. The fish were fed with a formulated feed consisting of groundnut oil cake - 40%, fish meal - 20% and vitamin-mineral mix 5 g/kg, in dough ball form @ 7% body weight. About 70% of the pond water was replenished thrice a week. During this period temperature ranged from 26.0-33.5° C, salinity 5-35 ppt and pH 7.8-8.2.

In July 1992, due to the accumulation of effluents discharged by local factories into the Ennore creek, the broodstock was affected and only 23 fish survived. These were released back into the pond, when water conditions improved. In July 1992, the female fish were in the stage II of maturity and the ova diameter ranged from 90-100 μ m. In December 1992 they were in the stage III of maturity and average ova diameter was 211 μ m. The males

were also in oozing condition. However in January 1993, when the fish were sampled for hormone implantation, the gonads were found to have regressed and the fish were found to be heavily infected with copepod parasite of *Caligus* sp. In spite of the different treatments including 1% formalin dip, the whole stock died within a period of 10 days. At Muttukadu, a stock of 32 fish (360-475 g) are being maintained.

Etroplus suratensis

A captive broodstock (60 no.) of pearlspot continued to be maintained at Ennore in a 0.01 ha pond. Two sets of successful natural breeding of *E. suratensis* were observed and 3161 fry (avg. size 40.5 mm) were collected from the above pond. In June 1992, the water quality of the pond deteriorated and required dewatering and desilting. A total of 45 breeders were recovered and restocked in the pond in July 1992. One set of breeding was observed in November 1992 and an estimated number of 2000 fry were produced. The broodstock were maintained on a formulated feed consisting of ground nut oil cake - 40%, rice bran - 40%, fish meal - 20% and vitamin-mineral mix 5 g/kg, fed @ 7% body weight. During this period the temperature ranged from 25.5-34.0°C, salinity 0-34 ppt and pH 7.8-8.1. Salinity fluctuation appears to have restricted the breeding frequency of the pearlspot.

At Narakkal, no breeding could be taken up due to inundation of the ponds. At Kakdwip 42 breeders (avg. size 141-284 mm/129- 590 g) were maintained in a 0.08 ha pond from July 1992. They were fed with rice bran + fish meal (1:1) @ 2-3% body weight daily. The salinity ranged from 10-15 ppt. Upto September 1992, a total number of 6065 fry (4-32 mm) were produced.

Culture of Finfishes (FCD/FC/I)

Madras : K.V. Ramakrishna (PL), A.R. Thirunavukkarasu, Munawar Sultana, Kishore Chandra and Shiranee Pereira.

Kakdwip : S.R. Das and B.K. Banerjee

Narakkal : L. Krishnan (from Nov. '92) and S. M. Pillai

Culture of Seabass, *Lates calcarifer*

Kakdwip

Nursery rearing of *Lates calcarifer* was done in a pond of 0.09 ha for a duration of 68 days from July '92 - September '92. The fry had an average size of 30.7 mm/3.54 g at stocking. They were reared on live mysid @ 200 g/day for the first 30 days. Subsequently they were fed with live fish and prawn @ 250 g/day. At the end of 68 days of nursery rearing, the fingerlings had an average size of 121.5 mm/28.6 g with a survival rate of 34.28%.

Grow-out rearing was done for a period of 6 months from September '92 - March '93. The fish were fed on live fish/prawn @ 250 g four times a fortnight. The fish sampled at the end of 6 months were in the size range of 190.0 mm - 343.8 mm/138.0 g - 566.0 g. The total catch was 10.2 kg. The bycatch included *P. monodon* of average size 202.6 mm/76.8 g.

The physico-chemical characteristics of the nursery pond were: Temperature 29-30°C; pH 7.6-8.0; salinity 3-7 ppt; DO 5.6- 7.8 ppm. In the grow-out pond: pH 7.9-8.2; salinity 2-15 ppt; DO 5.6-11.8 ppm.

Culture of *Chanos chanos*

Madras

Collection and transportation of fry

In June '92 20,000 fry of milkfish of average size 11.36 mm was brought from Pamban to Muttukadu under oxygen packing @ 2000 no./5 l of water. The average survival rate over 20 hr transportation was 70.8%. A batch of 4000 fry were sent from Madras to Kakdwip @ 1000 no./5 l under oxygen packing. The sur-

vival rate was 80% at the end of 18 hours transportation. During the second week of June, 1500 fry (15-24 mm) were collected from Kovalam backwaters.

Cage rearing

Prior to stocking in cages the fry were held in FRP tanks for 15 days and maintained on groundnut oil cake and rice bran (1:1) @ 10% body weight daily. Two cages I and II (10 m x 5 m) were stocked with *Chanos* (avg. size 26.20 mm) at 60 no./m² and 40 no./m² respectively. Over a period of 131 days, in cage I and II the fish attained an average size of 126.05 mm/15.0 g with a survival rate of 62.6% and 142.5 mm/26.0 g with a survival rate of 72% respectively.

Culture in pens

The milkfish juveniles (avg. size 109 mm/8.85 g) were stocked in two pens of 0.10 ha each in August '91 at a density of 7500 no./ha and harvested in June '92. The fish were initially fed with a moist diet of groundnut oil cake and rice bran at 1:1 ratio and then on a formulated feed comprising of fish meal - 15%, soya cake - 20%, groundnut oil cake - 25%, rice bran - 27%, starch - 11% and vitamin - mineral mix - 2%. The average size at harvest in Pen I was 302.45 mm/181.70 g. The recovery rate at the end of 317 days was 72.14% yielding 98.0 kg i.e. 980 kg/ha of milkfish, 25.54 kg of miscellaneous fish and 3.73 kg of *P. monodon*. In Pen II at the same stocking density and feeding practice, the average size at harvest was 295.20 mm/175.25 g. The recovery rate was 39.6% giving an yield of 53.20 kg i.e. 532 kg/ha, 15.0 kg miscellaneous fish and 2.07 kg of *P. monodon*.

In August '92, the pens were restocked with fish juveniles of *Chanos* of average size 126.05 mm/15.0 g @ 5000 no./ha. Over a 180 day culture period, the fish attained a size of 193.86 mm/73.96 g in Pen I and 198.36 mm/98.10 g in Pen II.

Kakdwip

For the first time, experiments on milkfish culture was taken up at Kakdwip. The seed was supplied from Madras. Two nursery ponds of 0.027 ha each were stocked with *Chanos* fry (avg. size 14.6 mm) at 67,000 no./ha, after pond preparation, using both organic manure and inorganic fertilizers. The fish harvested at the end of 3 months, in September '92, had an average size of 60 mm/29 g and the survival rate was 20.2%. The poor survival rate was due to the entry of *L. calcarifer* in spite of the precautions taken. For nursery rearing of milkfish, a supplementary feed in powder form comprising of fish meal-15%, soyacake-20%, groundnut oil cake-25%, rice bran-27%, starch-11% and vitamin - mineral mix-2% was given @ 5% body weight twice daily. The physico- chemical characteristics of the pond water during the culture period were: Salinity 0-15 ppt; DO 8.2 ppm (avg.); pH 7.8 - 8.3; Transparency 24-33 cm.

These fingerlings were stocked in grow-out ponds at 2000 no./ha. A feed of similar composition as for nursery rearing but in doughball form, was fed @ 3-5% of body weight once daily. At the end of 6 months, the average size attained was 307 mm/205 g. The physico-chemical characteristics during the culture period were: Salinity 5-16 ppt; DO 8.2 ppm (avg.); pH 8.0 (avg.); Transparency 17-33 cm.

Culture of Etroplus suratensis

Kakdwip

A nursery pond of 0.08 ha, after liming and fertilising with organic manure and inorganic fertilizers, was stocked in June 1992 with pearlspot (avg. size 30 mm/0.761 g) at 50,000 no./ha and harvested at the end of 90 days. Artificial feed of rice bran, fish meal and groundnut oil cake (4:1:1) was applied in powder form twice daily @ 5% body weight. At harvest, the fish showed an average size of 80.3

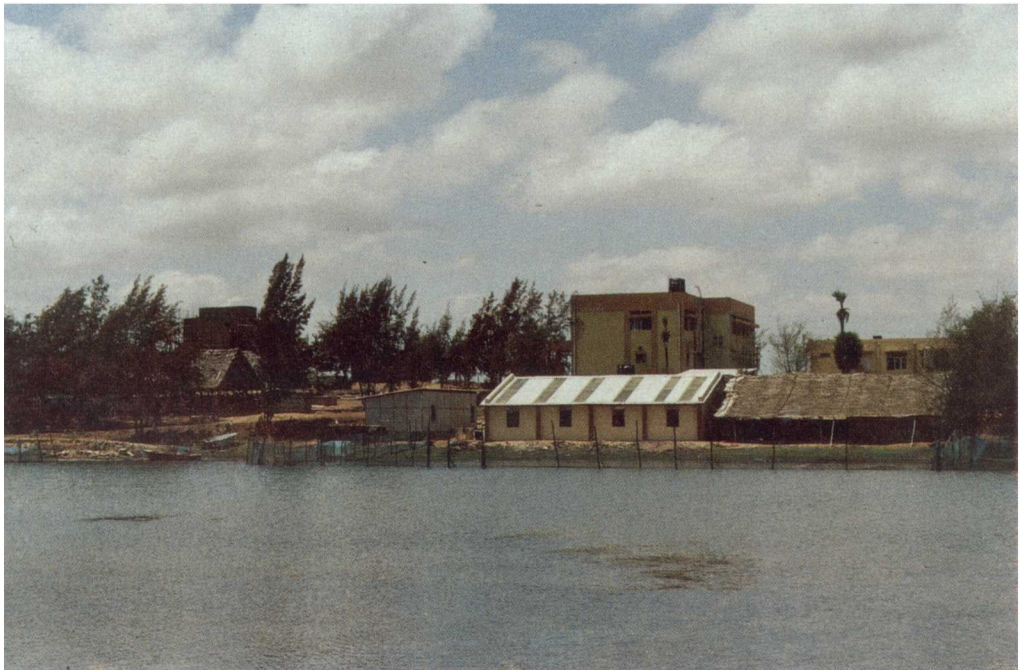


Honourable Union Minister for Agriculture Dr. Balram Jakhar in a discussion with the Director, Scientists and Staff of CIBA

Honourable Union Minister Shri K. C. Lenka at the inaugural of the farm Laboratory.



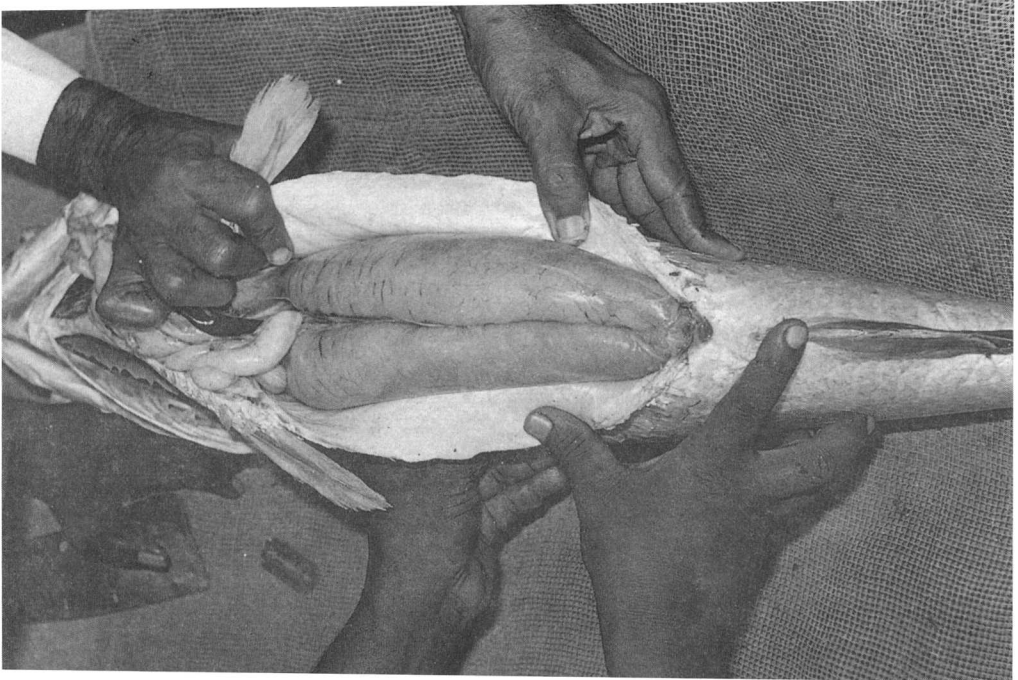
Honourable Union Minister of State for DARE, Animal Husbandry and Dairying, declaring open the farm Laboratory at Muttukadu. Dr. P.V. Dehadrai, Dy. Director General (Fy) and Dr. M.S. Swaminathan, Eminent Agricultural Scientist and Dr. K. Alagarwami, Director, CIBA are looking on.



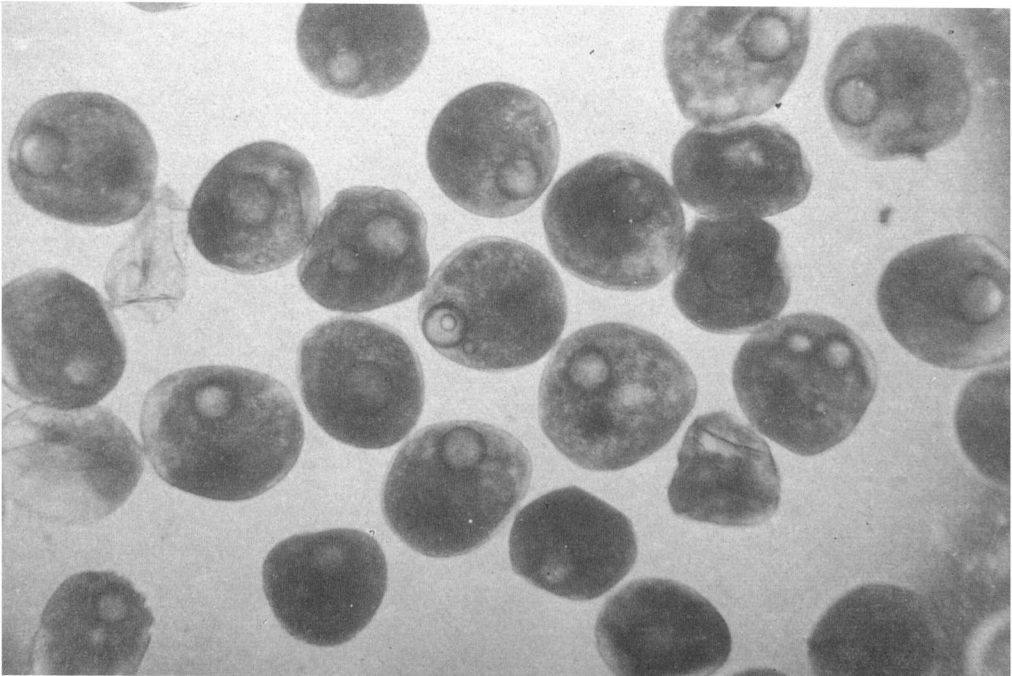
A view of the backyard shrimp hatchery at Muttukadu; farm Laboratory buildings are in the background.



Nutrition and feed technology Laboratory.



In situ view of the fully developed ovary of the sea bass, *Lates calcarifer* after implantation of LHRH a pellet.



Microscopic view of the ova of the sea bass, *Lates calcarifer*.



Harvested biomass of the brine shrimp, *Artemia*.



Bacterial Septicaemia disease of the Tiger shrimp, *P. monodon* showing the flared up gill cover.

mm/11.0 g and the survival rate was 55.6%. The physico-chemical parameters during the culture period were: salinity 4-16ppt; DO 8.5 ppm (avg); pH 7.6-8.7.

chemical characteristics of water in the ponds were: salinity 3.5-15 ppt; DO 8.5 ppm (avg.); pH 8.4 (avg.).

Narakkal

Grow-out culture was done in a pond of 0.184 ha, from September 1992 to March 1993. The fish were stocked after liming and fertilising the ponds. At an average stocking size of 80.3 mm/11 g the fish had attained 122 mm/42 g at the end of March 1993. The fish were fed with rice bran, groundnut oil cake and fish meal in the ratio of 4:1:1 fortified with Supplivite-M @ 5% body weight twice daily. The physico-

Three experiments on the monoculture of *E. suratensis* were conducted in ponds of 0.02 ha each. The ponds were prepared after dewatering and eradication of weed fish using *Croton tiglium* @ 50 kg/ha and lime @ 1000 kg/ha. Details of the experiment are given in Table 3.

Table 3. Monoculture of *E. suratensis* at Narakkal

Expt. No.	Duration	Stocking density	Size at stocking range (average) (mm/g)	Feeding practice	Size at harvest (mm/g)	Increment (mm/g)	Survival (%)	Bycatch (kg)	Remarks
I.	19-3-92 to 21-12-92 (274 days)	10,000 no./ha (200 no.)	50-70/3-7 (53-9/4.4)	Fed daily with RB:WB:GNC (1:1:1) @5% body weight	100-173/25-105 (147.5/64.9)	93.6/60.5	53 (106 nos)	13.0 tilapia	265 kg/ha production Ponds inundated during rains
II.	19-3-92 to 17-12-92 (271 days)	-do-	-do-	Fed on formulated feed ES.5 and RB:WB:GNC (1:1:1) @ 5% body weight	104-130/25-40 (114.7/31)	60.5/26.6	83 (166 nos.)	7.5 tilapia	240 kg/ha production Ponds inundated during rains
III.	5-2-93 to 12-4-93 (66 days)	2500/ha (50 nos)	60-124/5-50 95.1/25.3	Fed daily with RB:WB:GNC (1:1:1) @5% body weight	120.5/42.0 (at the end of 66 days)	25.4/16.7	In progress	---	---

TECHNOLOGY IMPROVEMENT DIVISION

Development of feeds for aquaculture of brackishwater prawns and finfish (TID/NT/1)

Madras : S.A. Ali, (PL)(from Oct. '92), C.P. Rangaswamy (upto Sep. '92), D. Narayanaswamy, M. Natarajan, C. Gopal, G. Mallickarjuna (upto Oct. '92) and J.V. Ramana

Narakkal : S. A. Ali (upto Sep. '92)

Survey of marine protein sources for aquatic feeds

A comprehensive survey was carried out on the availability of various marine protein sources in the states of Andhra Pradesh, Goa, Gujarat, Karnataka, Kerala, Maharashtra, Orissa and Tamil Nadu. The data were collected from major fishing harbours, State Fisheries Departments, CMFRI centres, MPEDA centres, fish merchants and fish meal plants located in each state.

The data collected during the survey were analysed and the availability of different

protein sources in each state estimated. The details of the same have been elaborated in Table 4.

The estimates show that there is a total potential of 1,76,593 t of trash finfish, Maharashtra and Gujarat being the two major contributors (28,000 t each); followed by Karnataka, Orissa, Tamilnadu, Goa, Kerala and Andhra Pradesh in the descending order of magnitude. Bombay duck constituted the major finfish resource in Gujarat. In other maritime states, sardines, mackerel, ribbon fish, anchovies, carangids and sciaenids were the major finfish resources. Group-wise abundance in each state has also been elaborated in Table 4. Apart from finfish, 57,942 t of mantis shrimp, 3,936 t of cuttlefish and 31,235 t of prawn head waste are also estimated to be available from different states. Eventhough over 20,000 t of clam and mussel meat resources have been estimated in different states, their availability for feed purposes was limited due to the increasing demand of molluscan meat for export.

Table: 4. Marine protein resources for aquatic feeds in different states (Estimated availability in tonnes/annum)

Name of resource	Andhra Pradesh	Goa	Karnataka	Kerala	Gujarat	Maharashtra	Tamil Nadu	Orissa	Total
Finfish (dry)	4122	7652	26545	6482	27965	28500	13308	23456	176593
Mantis shrimp (Squilla dry)	6912	4312	15780	3356	14900	11400	501	781	57942
Cuttle fish (dry)	734	170	71	701	998	1100	—	162	3936
Squid (dry)	1896	115	48	476	1500	2590	262	90	6977
Prawn head (dry)	5200	1561	500	4629	9900	8000	345	1100	31235
Clam meat (fresh)	8100	1200	697	8000	40	400	—	1	18438
Mussel meat (fresh)	864	—	—	3000	—	—	—	8	3872
Crab (dry)	—	73	—	—	3925	1835	213	—	6046
Fish meal	750	865	4037	—	12035	10037	—	1350	29074

The total quantity of fish meal being produced in the country is estimated to be in the order of 29,000 t annually, of which only one third accounts for sterile fish meal with protein content of 50-55%. The rest is made by pulverising dry fish and the protein content ranges from 35-47%. While Karnataka is the major producer of sterile fish meal (4000 t/yr), Gujarat and Maharashtra produce mainly pulverized dry fish meal. Orissa, Goa and Andhra Pradesh produce small quantities of fish meal ranging from 700-1000 t/annum. In Kerala, the five fish meal plants with an installed capacity of 10,600 t/annum were non-functional due to an apparent shortage of raw material.

As a by-product of fish meal manufacture, fish meal plants in Karnataka produce fish oil (297 t/annum). Fish oil is also available in Kerala to the tune of about 262 t/annum. Proximate composition analysis of the samples collected from different places, revealed notably high percentage of insoluble ash indicating the presence of sand, stone, etc., which may be due to sun drying on beaches.

The survey revealed that there is a flourishing trade in all maritime states for marine protein sources, the largest consumer being the poultry feed industry. The protein sources are, however, available only during peak fishing seasons ranging from 4-6 months in a year. October-April is generally found to be the active season in different states. The price of marine protein sources were found to vary widely in different states. The cost of trash fish ranges from Rs. 5,000-12,000/t. While

mantis shrimp and prawn head varies from Rs. 3,000-6,000/t, fish meal is sold at Rs. 5000-15,000/t depending on the quality and protein content. Fish oil was priced at Rs. 15,000-30,000/t.

Formulation and evaluation of vitamin mixture

With the objective of evolving a suitable vitamin mixture in practical feeds for *P.monodon*, five vitamin mixtures were formulated in different combinations comprising of Vitamin A, B- group, C,D,E and K in various proportions. Each vitamin mixture was incorporated in a basal feed formula at 3% level. The feed was prepared as dry pellets and the experiment conducted for 60 days with juveniles of *P. monodon*. Based on the experimental results, the vitamin mixture which gave the best performance in terms of growth, FCR and survival has been adopted for use in tiger prawn feeds.

Formulation and development of prawn feeds

Indigenous feed ingredients like anchovy meal, squid meal, prawn head meal, soyabean meal, wheat flour, tapioca and rice flour etc., were used to formulate two feeds at 40% and 35% protein levels. Each feed was prepared in three grades viz., 'Starter' (1.0 mm granules), 'Grower' (2.0 mm pellets) and 'Finisher' (2.5 mm pellets). The percentage composition of the feeds and their performance in the laboratory experiments have been given in Tables 5 and 6.

Table: 5. Percentage composition of starter (S1, S2) grower (G1, G2) finisher (F1, F2) feeds for *P. monodon*

Ingredients	S1	S2	G1	G2	F1	F2
Fishmeal	40.00	20.00	35.00	17.00	30.00	15.00
Squid meal	5.00	2.00	5.00	2.00	5.00	2.00
Prawn head meal	5.00	8.00	5.00	8.00	5.00	8.00
Soybean meal (heat treated)	24.00	30.00	24.00	28.00	20.00	25.00
Wheat flour	11.25	20.75	—	25.75	9.75	10.00
Topioca starch	—	—	16.25	—	6.50	—
Rice flour	—	—	—	—	8.00	10.00
Fish oil	4.00	2.00	4.00	2.00	5.00	3.00
Lecithin	0.50	0.50	0.50	0.50	0.50	0.50
Yeast	1.00	1.00	1.00	1.00	1.00	1.00
Alfalfa	2.00	2.00	2.00	2.00	2.00	2.00
Spirulina	0.20	—	0.20	—	0.20	—
Cholesterol	0.05	—	0.05	—	0.05	—
Vit. mix *	1.00	0.50	1.00	0.50	1.00	0.50
Min. mix **	5.50	2.75	5.50	2.75	5.50	2.75
Guar gum	0.50	0.50	0.50	0.50	0.50	0.50
Gingelly Cake	—	10.00	—	10.00	—	10.00
Maize flour	—	—	—	—	—	9.75
Crude Protein	40.00	34.00	38.00	32.00	35.00	30.00
Calorific value (Kcal/g)	400.00	380.00	390.00	370.00	400.00	385.00

* Vitamin mixture provided Vit A (10000 IU) 6.0; Vit D (2000 IU) 0.05; Vit E (200 IU) 100; Vit K 20; Choline Chloride 1500; Niacin 100; Riboflavin 40; Pyridoxine 50; Thiamine 30; Pantothenic acid 100; Biotin 2; Folic acid 5; Vit B120.10; Inositol 250; Vit C 800 and Corn flour 6996.85 mg/kg feed.

** Mineral mixture provided 8.5g Calcium phosphate (monobasic); 6.25g Calcium carbonate; 35.5g Potassium dihydrogen orthophosphate; 2.5 Magnesium sulphate; 0.06g Manganese chloride; 0.02g Copper sulphate; 0.1g Zinc sulphate; 0.05g Ferric citrate; 0.007g Potassium iodide; 0.0009g Cobalt chloride; 0.0005g Selenium chloride; 0.0005g Chromium chloride; and 2.0111g Corn flour per kilogram feed.

Table: 6. Mean percent survival, growth and food conversion ratio in *P. monodon* fed with starter (45 days), grower and finisher (30 days) feeds.

	S1	S2	G1	G2	F1	F2
No. of animals/tank	30	30	10	10	5	5
Initial mean length (mm)	12.90	12.90	84.40	83.20	109.50	107.90
Initial mean weight (g)	0.01	0.01	4.32	4.09	10.14	9.83
Final mean length (mm)	27.10	30.10	101.30	99.10	119.90	115.10
Final mean weight (g)	0.12	0.12	7.46	7.50	13.58	12.67
Length gain (%)	111.00	134.00	20.00	19.00	9.00	7.00
Weight gain (%)	1100.00	1100.00	73.00	84.00	34.00	29.00
Survival (%)	70.00	78.00	100.00	100.00	100.00	100.00
FCR	2.30	3.20	4.10	4.80	5.20	5.40

Feed production trials

Feed production trials were conducted at Ennore using the feed formulation No. CIBA/TP/II, consisting of fish meal, squid meal, squilla meal, prawn head meal, soyabean cake, fish oil, alfalfa, tapioca starch, vitamins and minerals. The ingredients were powdered in a hammer mill, followed by a micropulveriser and further homogenised in a horizontal mechanical mixer. Tapioca starch, gelatinised in boiling water (30%), was added to the ingredient mixture and the feed was pelletized using a 3 mm diameter die and pellets dried in an electrical dryer. Following the above method, feed was produced to meet the institutional needs in conducting grow-out culture of tiger prawn.

Three grades of microparticulate feed in 200, 500 and 1000 micron size were prepared according to the formula No. CIBA/WP/I to feed post-larvae of *P. indicus* in hatchery and nursery.

Diagnosis and control of finfish and shellfish diseases (TID/DIS/1)

Madras : S.V. Alavandi, K.K. Vijayan and S.S. Mishra

Narakkal : S. A. Ali (upto Sept '92)

Disease investigations in penaeid prawns

Madras

Vibriosis in *Penaeus monodon* broodstock

In June 1992, several breeders maintained at Muttukadu hatchery of the Institute, succumbed to a disease characterised by reddish discolouration of the appendages and melanised patches on the branchiostegites and abdominal segments. The uropods were found to be necrosed and the hepatopancreas and gills were pale brown in colour, indicating mild melanisation. The causative organism of the

disease, isolated from the hepatopancreas and melanized regions of the diseased prawn, was identified as the gram negative bacterium *Vibrio alginolyticus*. *In vitro* sensitivity of this bacterium to various chemicals and antibiotics was tested and methylene blue was found to be effective.

Luminescent bacterial disease in *P. monodon* postlarvae

During the same period, in June 1992, there occurred a mass mortality of postlarvae (PL-20) of *P. monodon* at the hatchery in Muttukadu. The diseased larvae showed characteristic bioluminescence at night. Microbiological analysis of prawn larvae and rearing water revealed the presence of a gram-negative bacterium, identified as *Vibrio harveyi*. This bacterium was found to be sensitive to methylene blue *in vitro*.

Exoskeletal spotting of *P. monodon* and cotton shrimp disease in *P. indicus*.

In December 1992, the above said disease was encountered in a private shrimp farm at Tuticorin, in Tamil Nadu. The affected tiger prawns were characterised by white circular exoskeletal spots of about 2 cm diameter on the thoracic and caudal segments. White prawns were found to be cotton white and appeared cooked.

Microbiological analysis of the water, swabs from the white spots, hepatopancreas and haemolymph drawn from the heart of the diseased prawns revealed the presence of a gram negative bacterium, *Aeromonas* sp. The water samples also revealed the presence of another gram negative bacterium *Pseudomonas* sp. No fungal growth was observed. Microscopic examination of the white spots revealed large irregular cyst-like structures having round to oval spore-like structures of 8-10 μ m near the periphery of the cyst, in both the tiger and white prawn. The gill lamellae in tiger prawn alone showed the presence of

round/oval bodies (4-6 μm) and spore-like structures (2-3 μm) enclosed in a sac that was terminally located. In white prawn, several yellowish oval bodies (5-6 μm) with serrated margin were observed. The gut samples of these prawns also revealed spore-like formations similar to that found on the exoskeleton. Histological examination of the exoskeleton, gills and hepatopancreas showed the presence of spike-like projections which extended into the chitinous exocuticle layer from the endocuticle. The hepatopancreas showed extensive atrophy and degeneration of epithelial cells. Gill sections showed the presence of deeply stained large elliptical bodies (8-10 μm) and one such section revealed a sporangium-like structure with four oval bodies (3-4 μm) in the lumen. Although the symptoms observed indicate it to be a case of cotton shrimp disease, the known causative agents viz., microsporidia could not be isolated.

Black gill disease in *P. monodon*

In December 1992 mortality of cultured shrimp was reported in the TASPARG shrimp farm at Nellore. The prawns were characterised by black gills. Microbiological examination of the gills and haemolymph of the diseased prawns revealed the presence of a gram negative bacterium *Aeromonas* sp. However this disease condition is also attributed to be due to poor water quality. In this case heavy rains and subsequent drop in salinity from 15 ppt to 5-7 ppt and related stress factors in terms of water quality could have caused the manifestation of the disease.

Narakkal

Soft shell syndrome in *P. indicus*

The culture ponds of the MAT-SYAFED at Narakkal were monitored for soft prawns. Two ponds (0.25 and 1.00 ha) were

stocked with *P. indicus* @ 1 lakh/ha in February 1992. In the last week of March 1992, about 10% of the stocked population showed soft shell characteristics when the prawn were in the size of 90-100 mm/5-7 g and the salinity in the ponds was 15-20 ppt. The affected prawns were segregated into two groups of 10 each and reared separately in a hapa fixed in a feeder canal and the second group in a 500 l FRP tank and maintained on a diet of fresh clam meat. In the culture pond, the density was reduced and water exchange resorted to by pumping water. It was observed that the prawns both in the hapa and tank recovered within a week whereas those in the ponds recovered in two weeks. In the second pond (1.0 ha), water exchange was maintained by pumping water and the water area was compartmentalised using asbestos sheets so as to effect water circulation. In this pond too, the prawns recovered within a week and the stock was harvested in May 1992.

Disease investigation in fish

Parasitic infestation in *Mugil cephalus*

In February 1993, the broodstock of *M. cephalus* maintained at the Ennore field centre of the Institute, succumbed to a heavy parasitic infestation. The parasites were identified to be copepods of the *Caligus* sp. and *Lernanthropus* sp. and a hirudinean, resembling *Hemiclepsis*. Liming of the pond and formalin treatment of the affected fish failed to control the infestation.

Eye disease in *Mystus gulio*

In July 1992, several catfish of the genus *Mystus gulio*, from the backwaters of Mutukadu, were found to be affected with disease showing degeneration of eyes. Microscopic examination of this tissue showed the presence of

a parasite *Gyrodactylus* and a gram negative bacterium, *Aeromonas* sp.

Microbial flora of *Lates calcarifer* and pond water and soil

Swabs from the site of hormone implantation of the broodfish, soil and water samples were collected from the Ennore field centre during maturation induction studies on *Lates calcarifer*. Bacterial population was found to be in the order of 6×10^5 /ml in water and 2600×10^5 /g in soil samples. The bioluminescent bacterium *Vibrio harveyi* and *Aeromonas* sp. were isolated from the soil samples. Water samples were found to contain *Photobacterium* sp. and *Aeromonas* sp. From the site of hormone implantation, *Aeromonas* sp., *Photobacterium* sp. and *Chromobacterium* sp. were isolated. Bacterial flora of normal fish comprised of *Aeromonas* sp. and *Photobacterium* sp.

Physiological responses of prawns to important environmental factors in grow-out ponds (TID/EP/1)

Madras : A. R. Thirunavukkarasu (PL), B.P. Gupta, K.O. Joseph, C. Gopal and K.K. Vijayan

Investigations were carried out in field and laboratory conditions to study the impact of abiotic factors on the physiological response in *Penaeus monodon*.

Field study

The study was conducted at the TASPARG/MPEDA farm at Pudiparthi, Nellore, during the fourth and fifth crop (March - July 1992, October - December 1992) where *P. monodon* was cultured on a semi-intensive scale in eleven ponds, in a total water spread area of 5.86 ha. The details of the culture operation are elaborated in Table 7.

Table 7: Details of IV Crop culture in TASPARG/MPEDA semi-intensive culture ponds

Pond No.	Water spread area (ha)	Stock	Stocking rate (No./m ²)	Culture duration (days)	Avg. size of prawn harvested (g)	Total yield (tons)	Total qty feed given (tons)	FCR	Production rate (tons/ha)	Survival rate %
1.	0.28	114000	40	147	24.74	1.901	3.164	1.66	6.79	67.40
2.	0.30	81000	27	126	27.00	1.990	3.127	1.52	6.63	91.00
3.	0.32	86000	26	132	26.60	1.720	2.690	1.57	5.34	75.19
4.	0.31	77000	25	138	26.80	1.390	3.020	2.16	4.51	67.69
5.	0.33	100000	30	148	28.30	1.870	2.880	1.54	5.66	80.30
6.	0.35	92300	26	135	25.20	2.110	3.090	1.46	6.43	90.80
7.	0.91	227000	25	126	20.50	3.740	5.470	1.46	4.11	80.08
8.	0.72	187000	26	134	25.40	3.510	4.630	1.32	4.89	73.94
9.	0.79	195000	25	144	24.80	3.440	4.830	1.41	4.35	71.07
10.	0.75	197000	26	136	21.20	3.160	5.660	1.79	4.22	75.77
11.	0.80	208000	26	128	20.96	3.770	5.230	1.39	4.72	86.52

P.monodon seed were stocked @ 25-40 PL/m² (avg. 27 PL/m²) and the culture duration extended between 126-148 days. The production ranged from 4.11 - 6.79 tonnes/ha (avg. 4.9 tonnes/ha). Except in Pond No. 4 where a locally manufactured 'standard feed' was given, an imported feed was used in the others. The FCR for the imported feed ranged from

1.32- 1.79 while for the local feed it was 2.16. The survival rate varied from 67.4-91.0%.

The soil and water of four ponds (pond no. 2,5,8 and 11) were sampled at regular intervals and details of the analyses are given in Table 8.

Table 8: Soil & water characteristics of the TASPARC/MPEDA ponds, Nellore, during April to July 1992

WATER		SOIL	
Parameters	Range	Parameters	Range
Temperature (°C)	27.50-30.80	Redox Potential(mV)	+ 10.00 to -160.00
Salinity (ppt)	15.00-28.00	EC (mmhos/cm)	9.50-18.50
Transparency (cm)	40.00-60.00	Organic carbon (%)	0.62-0.88
pH	6.80-9.40	Calcium carbonate(%)	2.20-3.20
Total Alkalinity (mg/l)	132.00-154.00	Available	3.90-6.00
Total hardness (mg/l)	2854.00-5328.00	phosphorous(mg/100g)	
Ammonia (mg/l)	0.01-0.50		
Nitrate (mg/l)	0.01-0.03		
COD (mg/l)	11.40-22.00		
H ₂ S	BDL		

BDL - Below Detection Level.

During the fifth crop in December 1992, the prawns were found to be affected by 'Black-gill disease'. The water and soil samples were analysed when the disease was encountered and results are given in Table 9.

25% body weight with pelletised feed. The maximum growth rate was observed in prawns exposed to 15 ppt and it was lowest at extreme salinities. Details are presented in Table 10.

Table 9: Water & Soil characteristics of TASPARC culture ponds during December 1992.

Parameters	Pond No.1	Pond No.2	Pond No.3
WATER			
Salinity (ppt)	6.00	7.00	7.00
pH	7.80	7.80	7.60
Alkalinity (mg/l)	164.00	172.00	162.00
Total hardness (mg/l)	1148.00	1228.00	1206.00
Ammonia (mg/l)	0.62	0.51	0.68
Nitrite (mg/l)	0.08	0.06	0.09
H ₂ S (mg/l)	0.10	0.10	0.20
COD (mg/l)	51.60	52.40	54.00
SOIL			
Redox Potential (mV)	-210.00	-210.00	-210.00
Organic carbon (%)	1.40	1.30	1.40
Calcium carbonate (%)	2.10	2.10	2.20
Available phosphorous (mg/100g)	7.20	6.90	6.80

The high concentration of ammonia, hydrogen sulphide, organic carbon, the increased COD and high negative redox potential in the ponds indicate unhygienic conditions which could be the causative factors for the outbreak of 'black-gill disease'

Laboratory study

Experimental studies were conducted to understand the influence of salinity and lunar periodicity on the feed consumption, FCR, growth and moulting frequency in *Penaeus monodon* in controlled conditions.

Table : 10 Growth and moulting frequency of *Penaeus monodon* in different salinities.

Salinity (ppt)	Wet weight gain (mg)		Moulting frequency (hrs)
3	150	± 30	192
5	229	± 50	168
15	1300	± 120	156
25	514	± 80	180
35	150	± 20	180
40	42	± 30	252

Lunar periodicity

Two sets of experiments were conducted during the full moon and new moon periods. In the first set, *P. monodon* (30 nos, 50- 70 mm/0.60-1.50 g) in the premoult stage, were kept under observation for 5 days.

Salinity

P. monodon (40-60 mm/0.6-1.50 g) was reared in selected salinity levels ranging from 3-40 ppt for 30 days. The prawns were fed @

Salinity, pH and temperature were 32 ppt, 8.2 and 28°C respectively. 73.33% of the prawns moulted within 3 days *i.e.* one day prior to full moon, on full moon day and the day following full moon. In the second experiment, inter-moult prawns in the same size group were kept under observation during the new moon period. 50% of the prawns moulted during this period. These results indicate a relationship between lunar phase and moulting in prawn. The economic implications of this study are that, in culture operations, feeding rate can be reduced during full moon and new moon days, as feeding intensity is less during moulting. Secondly, freshly moulted prawns fetch a low price due to high water content and hence harvesting may be avoided during these days.

Reproductive physiology of brackishwater fish and prawns (TID/RP/1)

Madras : K. Alagarwami (PL) , T.C. Santiago, N. Kalaimani, Munawar Sultana, K. K. Vijayan, P.S.P. Gupta and Kishore Chandra

Puri : L. Krishnan (upto Oct. '92)

Narakkal : L. Krishnan (from Nov. '92)

Liza macrolepis

Milt of *Liza macrolepis* obtained by manual stripping was preserved in different diluents to study the effect of various extenders in a range of dilutions with cryoprotectants at

various concentrations, on spermatozoa motility. The four extenders tried were Fish Ringer, 5% glucose, sea water and Tris buffer. The spermatozoa exhibited maximum pre-freeze motility (>50%) in both Fish Ringer and 5% glucose in dilution ratios ranging from 1:2 to 1:5. In sea water, motility ranged from 20-40% while it was nil in Tris buffer. Liquid semen motility studies showed that sperms exhibited motility (>50%) upto 24 hr in both Fish Ringer and 5% glucose solution. Therefore these two extenders were chosen for the cryopreservation of *L. macrolepis* sperms. Cryoprotectants, DMSO (Dimethylsulphoxide) and glycerol were added to these extenders and it was found that 5% DMSO in Fish Ringer retained good motility of spermatozoa. Sperm samples which exhibited greater than 50% motility in various diluents were selected for cryopreservation in liquid nitrogen. Post-thaw motility of cryopreserved milt showed 30-40% motility.

Penaeus monodon

Histochemical studies of the thoracic ganglion from mature *Penaeus monodon* indicated the presence of neurosecretory material which stimulated gonad maturation. Thoracic ganglion implantation techniques in *P. monodon* were standardised in laboratory conditions. Similarly, injection of thoracic ganglion extract was also standardised. These techniques will be used to test the effect of GSH in the ovarian maturation of *P. monodon*.

AQUACULTURE ENVIRONMENT AND ENGINEERING DIVISION

Brackishwater soils and their productivity (AEED/SS/1)

Madras : B.P. Gupta (PL) and
K.O. Joseph

Kakdwip : R.K. Chakraborti

To study the rate of release of native soil nutrients to water phase, surface saline soil collected from Mahabalipuram was used. A laboratory experiment was conducted whereby the concentration of nutrients viz., nitrogen and phosphorus released into water at salinities of 0,10,20,30,40 and 50 ppt over a period of 0-29 days was regularly monitored. The experiment revealed that nitrogen content in water increased with the increase of salinity and reached a maximum at 20 ppt. Further, the maximum release of nitrogen in water occurred between 22-29 days after the start of the experiment. The release of native phosphorus from the soil to water phase was also seen to be relatively higher at 20 ppt and the maximum release of phosphorus occurred between 3-9 days after the initiation of the experiment. The characteristics of the soil used in the above experiment were: sand 51.0%, silt 13.0%, clay 36.0%, pH 7.8, EC (1:2.5) 13.2 mmhos/cm, CaCO₃ 1.0%, organic carbon 0.12%, Av. P 3.0 mg/100 g and Av. N 18.8 mg/100 g.

A similar experiment was conducted at Kakdwip using soil from the inter-tidal mud

flats. The release of nutrients was monitored at regular intervals for a period of 50 days at 0 and 10 ppt salinities. It was observed that nitrogen reached its peak on the 50th day in 0 ppt and on the 30th day in 10 ppt.

Evaluation of Healthstone and BN-10 in removing ammonia and hydrogen sulfide from brackishwater systems

Healthstone and BN-10 are two commercial preparations being widely used in semi-intensive prawn culture systems for the removal of ammonia and hydrogen sulfide. To test the efficacy of these materials, experiments were conducted under laboratory conditions. It was observed that with the combined application of healthstone and BN-10, 71.6% of the added ammonia was removed after five days of application. Similarly, by the combined addition of these two bioaugmentors, 98% of added hydrogen sulfide was removed on the second day and complete removal was observed on the third day of application.

Survey of Killai Farm

The Killai farm of the Dept. of Fisheries, Government of Tamilnadu, which has a single water spread area of 5 ha was surveyed to assess its potential for brackishwater aquaculture, in December 1992-January 1993. Physico-chemical characteristics of soil and water are given in Tables 11 and 12.

Table 11. Soil Characteristics of Killai Farm

	Sand (%)	Silt (%)	Clay (%)	pH	EC (mmhos/cm)	Av. P (mg/100g)	Org. Carbon %
Stn. 1-5							
0-10 cm	64.0	13.7	22.3	8.5	26.0	5.2	1.09
10-30 cm	62.8	13.6	23.6	8.6	18.9	4.3	0.80
30-50 cm	61.4	15.0	23.6	8.7	16.7	4.0	0.69
Stn. 6							
0-10 cm	65.0	13.5	21.0	8.4	20.0	3.0	0.32
10-30 cm	64.8	13.6	21.6	8.5	19.0	2.6	0.30
30-50 cm	64.2	13.8	22.0	8.5	18.0	2.7	0.31
Stn. 7-8							
0-10 cm	71.2	10.6	18.2	8.1	17.0	4.5	0.43
10-30 cm	70.5	10.2	19.3	8.3	16.0	3.9	0.43
30-60 cm	70.2	10.5	19.3	8.4	15.2	3.9	0.35
60-90 cm	67.8	11.2	21.0	8.5	15.0	3.8	0.34
Stn. 9							
0-10 cm	73.0	6.2	20.8	8.4	22.0	2.6	0.24
10-30 cm	71.0	8.0	21.0	8.4	21.0	2.6	0.22
30-60 cm	70.0	9.0	21.0	8.5	20.0	2.6	0.22
60-90 cm	69.0	9.5	21.5	8.5	20.0	2.4	0.20

Table 12. Physico-chemical characteristics of Killai Farm and adjoining creek water

Parameters	KILLAI FARM STATIONS					CREEK
	1	2	3	4	5	
Salinity (ppt)	27.50	27.00	27.50	27.50	27.50	28.00
pH	8.40	8.40	8.50	8.50	8.50	8.20
Transparency (cm)	12.00	11.00	13.00	13.00	13.00	13.00
Total Alkalinity (ppm)	108.00	110.00	106.00	108.00	108.00	98.00
Total hardness (ppm)	5518.00	5506.00	5410.00	5418.00	5426.00	5320.00
DO (ppm) S	5.20	5.00	5.40	5.00	5.20	5.60
DO (ppm) B	2.40	2.40	2.60	3.20	3.00	4.40
C.O.D (ppm)	26.00	22.00	25.20	20.00	22.20	14.00
Phosphate (ppm)	0.05	0.04	0.03	0.04	0.04	0.03
NH ₃ (ppm)	0.32	0.22	0.18	0.18	0.18	0.05
NO ₂ (ppm)	BDL	0.02	BDL	BDL	BDL	BDL
Mercury (μg/ml)	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002

COD - Chemical Oxygen Demand

S - Surface

DO - Dissolved Oxygen

B - Bottom

BDL - Below Detection Level.

Analysis of data showed that the pond soil and water are in a sub-optimal state and are not conducive for farming. The redox potential ranged from -200 to -280 mV, showing highly reducing conditions of the pond soil. Hydrogen sulphide in pond sediment ranged from 0.1-0.4 ppm. Further, there are locational and design constraints which cannot be easily overcome and even if attempts are to be made at high costs, it may not necessarily be successful in converting it into a semi-intensive prawn culture farm.

Layout systems and design of small scale prawn hatchery (AEED/HD/1)

Madras : K. Alagarwami (PL), A.V.P. Rao, L.H. Rao and P. Lakshmanadoss

The drawings of the Institute's hatchery at Muttukadu were finalised and civil works initiated by the CPWD.

The scientists of the Institute visited the shrimp hatchery of the Government of Karnataka at Kumta at their request and demonstrated shrimp seed production technology (*P. indicus*) and suggested improvement.

Design and development of machinery and structures for aquaculture (AEED/AE/1)

Madras : P. Lakshmanadoss(PL)

Design and development of automatic feed dispensing unit

The system is operated by an electric motor, transmitting the power through a very low speed reduction gear and shafts fitted with ratchet wheels. The feed is dispensed to the tanks from the movable inner trays housed in a fixed outer container. The feed may be dispensed at intervals by a control system operated by a timer switch. The inner trays and outer containers have been designed and drawings prepared. One such feed dispensing unit is under fabrication for a trial run and possible modification of inner trays is under way.

Design and fabrication of temperature control unit

To maintain a constant optimal temperature in larval rearing tanks regardless of seasonal fluctuations in temperature, a temperature control unit has been designed and drawings prepared. A single unit was fabricated and trial runs have been made.

Use of non-conventional energy resources for aquaculture

Preliminary investigations were carried out and the installation of a wind mill (geared type) for pumping brackishwater with the help of Tamilnadu Energy Development Agency (TEDA), is under way.

EXTENSION, ECONOMICS AND INFORMATION DIVISION

Investigations on the brackishwater aquaculture practices adopted by different categories of farmers - An integrated approach (EEID/EXTN/1)

Madras: K.Gopinathan(PL), M. Krishnan, T. Ravisankar and Deboral Vimala

With a view to evaluate the present status of brackishwater culture systems and existing farming practices adopted by private and public undertakings, this project was taken up in April 1992. The other objectives were to study the socio-economic aspects of aquaculture programmes, employment generation and to study the extension requirements of fish/prawn farmers.

Four coastal regions viz., Nellore and Gudur regions in Andhra Pradesh and Cuddalore and Madras regions in Tamilnadu have been surveyed so far. At Nellore, 12 farms owned by private entrepreneurs and one Govt. sponsored farm were studied. Extensive and semi-intensive prawn culture were practised and the cultivated species *Penaeus monodon* and *P. indicus* were stocked @50,000 - 75,000 no./ha in semi-intensive culture and @ 12,500 no./ha in extensive systems. Indigenous feed

mixtures were used in extensive farming while pelleted brand feeds were generally used in semi-intensive farming. The production ranged from 600-800 kg/ha in extensive farming and varied from 2000-4500 kg/ha in semi intensive culture. *P. monodon* harvested at the size range of 18-40 g, was sold at an average price of Rs. 220/40 counts/kg. *P. indicus* harvested at 16-30 g, fetched a price of Rs. 160/40 counts/kg.

At Gudur, extensive type of farming is practised by small and medium farmers. At Chidambaram, in Cuddalore region, semi-intensive culture of *P. monodon* is practised at a stocking density of 80,000 - 1,00,000/ha and pelleted feeds are used in these farms. The production ranged from 1,000 kg - 2,000 kg/ha.

The development and spread of shrimp farming in these regions has led to the improved socio-economic conditions of the farmers in particular and the economy of the districts in general. Extensive or improved extensive system, is regarded as a low cost - high revenue enterprise in these regions. Invariably, the small farmers expressed a need for appropriate technology of shrimp farming and effective extension mechanism.

EXTERNALLY FUNDED PROJECTS

Projects funded by Dept. of Biotechnology

Protein requirements of *P. monodon*.

Studies on the quantitative requirements of amino acids and fatty acids for the prawn *Penaeus monodon* and use of additives in grow- out feeds for improving feed efficiency and growth promotion

Coordinator - K. Alagarwami
Personnel - C. P. Rangaswamy (upto Sep. '92.), S. A. Ali, D.N. Swamy and C. Gopal

With the inception of the project in April 1991, infrastructure facilities were set up to conduct experimental work. It included the construction of a shed, procurement of FRP tanks and laboratory equipment.

To study the protein requirements of *P. monodon*, an experimental diet with graded protein levels of 0, 10, 20, 30, 35, 40, 45, 50, 55 and 60% was formulated using casein, egg albumin and gelatin as the protein sources. Apart from the above, the levels of all other ingredients viz., shark liver oil, sunflower oil, lecithin, cholesterol, mineral and vitamin mixture, sodium succinate, sodium citrate, agar-agar and carboxy methyl cellulose were constant. Dextrose and starch were varied so as to ensure that all diets have an energy range of 3.578- 4.342 kcal/g (Table 13).

Table 13. Formulation of experimental diets

Ingredients	Level of Protein (%)									
	0	10	20	30	35	40	45	50	55	60
1. Casein (lipid free)	—	11.30	21.30	31.30	36.30	41.30	46.30	51.30	56.30	61.30
2. Egg Ablumin	—	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
3. Gelatin	—	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
4. Dextrose	22.70	15.70	13.70	11.70	9.70	8.70	7.70	6.70	5.70	3.70
5. Starch	47.00	40.00	33.00	27.00	24.00	20.00	16.00	12.00	8.00	5.00
6. Lecithin	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7. Sharkliver oil	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
8. Sunflower oil	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
9. Cholesterol	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
10. Sodium succinate	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
11. Sodium citrate	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
12. Mineral mixture	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
13. Vitamin mixture	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
14. Agar agar	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
15. CMC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
16. Alpha Cellulose	7.10	5.80	4.80	3.80	2.80	2.80	2.80	2.80	2.80	2.80
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Kcal/g	3.488	3.679	3.809	3.941	4.027	4.072	4.117	4.162	4.207	4.25

The experiment was run in a flow-through system in cylindro-conical tanks for 60 days. Post-larvae of *P. monodon* (PL-25) (avg. wt. 217.97 ± 5.07 mg) were stocked in all tanks @ 20 larvae/tank and fed at 15% body weight in two instalments, at 10 AM and 6 PM. Temperature, pH and salinity were recorded daily while ammonia, nitrate and nitrite were done weekly.

On termination of the experiment, the animals were weighed, freeze-dried, packed and sealed in polythene bags for analysis at CIFT, Cochin.

The study revealed that the highest growth was recorded at 45% protein level; however, there were no significant variations in survival rates in 35, 40 and 45% protein levels.

Lipid requirements of *P. monodon*

Lipid requirement studies in *P. monodon* were carried out using a purified diet with casein, egg albumin and gelatin as the protein source, maintaining the protein level at 45%. Graded levels of lipid 0 (with and without cholesterol), 2,4,6,7,8,9,10 and 12% were formulated. The lipid source was shark liver oil, sunflower oil and lecithin in the ratio of 2:1:1. Apart from these, vitamin mixture, mineral mixture, agar-agar and CMC were constant. The diets were isonitrogenous and the calorific value was made more or less constant by varying the dextrose and starch levels and it ranged from 3.909-4.497 kcal/g.

The experiment was run on a similar set up as described earlier to study the protein requirements of *P. monodon*, for a period of 60 days. Juveniles of *P. monodon* weighing 885.1 ± 257.6 mg were stocked @ 10 no./tank and fed at 15% body weight. Physico-chemical parameters of water were recorded regularly. On termination of the experiment, the prawns were weighed, freeze-dried and stored in sealed polythene bags for analysis at CIFT, Cochin.

The observations indicated that juvenile *P. monodon* require 8% lipid in the diet. Prawn fed on a cholesterol free diet showed poor growth and survival indicating that cholesterol in the diet is essential. Further, prawns fed on a lipid free diet, especially oil based ones, showed poor growth, survival and high FCR suggesting that dietary lipid in the form of oil is indispensable for *P. monodon*.

Development of feed technology for semi-intensive/intensive prawn farming

Coordinator - K. Alagarswami
Personnel : S. Ahamad Ali, (Principal Investigator), C. Gopal and J. V. Ramana

The project was approved by the Dept. of Biotechnology on 26.10.92 and the funds for the same were released on 26.11.92. The project was implemented at the Institute from 19.12.92, with the approval of ICAR.

Work on formulation of nutritionally balanced feeds for target species viz., tiger prawn (*Penaeus monodon*) and Indian white prawn (*P. indicus*) was initiated, for which the latest information on the requirement of dietary nutrients for different growth phases of the prawn was compiled by reviewing literature.

The availability of raw feed material of marine origin was assessed from the data collected in different maritime states, during a feed material survey conducted by the Institute. Preparation of a data file for indigenous feed ingredients, consisting of data on chemical composition and nutritional quality, is in progress. Marine products, plant materials, single cell proteins and important non-conventional feed ingredients are being included in the list.

Action has also been taken for the construction of a shed, procurement of feed mill equipment and experimental tanks, so as to set

up a self-sufficient and independent wet laboratory for experimental purposes.

Project funded by ICAR/National Agricultural Research Project (NARP) II/IBRD

Aquaculture: Basic research on pond bio-energetics, digestive enzymes and microflora in fish and prawn under aquaculture

Sub-activity:

Identification and characterisation of digestive and gut microbial enzymes in brackishwater fish and prawn and enzyme mediated bioconversion of feed ingredients

Principal Investigator: K. Alagaraswami
Personnel : M. Natarajan (Project-in - charge), N. Kalaimani, T. C. Santiago, K. K. Vijayan, S. A. Ali, D. N. Swamy, S. V. Alavandi and C. Gopal

Isolation and identification of gut microflora of wild and captive *P. monodon* and *M. cephalus* and the selection and preservation of isolates with chitinolytic, cellulolytic and proteolytic activity was done. *M. cephalus* collected from Ennore and Muttukadu farm were subjected to microbiological examination of their gut contents. The bacteria isolated from wild fish from Ennore were *Acinetobacter* sp., *Vibrio parahaemolyticus*, *Aeromonas caviae* and *Alteromonas/Flavobacterium* sp., while only *Aeromonas caviae* was recorded in captive fish. The enzymatic activity of the isolates is given in Table 14.

Table 14. Chitinase and Protease activity in bacteria.

S.No.	Bacteria	No. of Isolates tested	Chitinase	Protease
1.	<i>Acinetobacter</i> spp.	1	-ve	-ve
2.	<i>V.Parahaemolyticus</i>	1	-ve	+ ve
3.	<i>Aeromonas caviae</i>	6	all 6 + ve	all 6 + ve
4.	<i>Flavobacterium/</i> <i>Alteromonas</i> group	1	-ve	+ ve

Suitable methods have been selected for the assay of gut enzymes viz., alpha-amylase, cellulase, pepsin, trypsin, alpha- chymotrypsin, chitinase and lipase in *P. monodon* and *M. cephalus*. Standardisation of assay conditions is in progress.

Feed ingredients, rich in protein, chitin and cellulose were identified and analysis of their promixate composition is in progress. The materials identified were fish meal, silkworm pupae meal, squilla meal, prawn head meal, soyabean meal, groundnut oil cake, gingelly cake, *Spirulina*, duckweed, Ipil-Ipil leaf, bagasse and alfalfa. The digestibility coefficient of these materials will be determined, so as to improve their digestibility through suitable bioconversion methods.

An experiment to study the effect of various salinity levels (3 - 45 ppt) on the activity of digestive enzymes viz., alpha-amylase, trypsin, lipase, chitinase and chitobiase in *P. monodon* (juveniles, of 30-60 mm TL) is in progress.

Project funded from AP Cess Fund

Impact of brackishwater aquaculture on the environment

Personnel: K. O. Joseph (Principal Investigator), B.P. Gupta, S.V. Alavandi, P.S. Sudheesh and S.S. Mishra.

The project commenced on 12th November 1992. A bench mark survey and sampling was done to assess the current status

and development of prawn farming in Tuticorin in Tamil Nadu and in the Nellore district of Andhra Pradesh.

The survey revealed that an area of approximately 1,000 ha is under prawn farming in Nellore district, drawing water from the sea, Buckingham canal and Kandleru creek. Along the Kandleru creek, about 2,500 ha of land are available for prawn culture, of which 600 ha are already being used, while another 600 ha are under development. In 60-70% of the area, extensive farming is practised; however, it was

observed that semi-intensive culture practices are being slowly adopted. Tuticorin area in Tamil Nadu has gained considerable importance for seawater-based shrimp farming.

To study the impact of brackishwater aquaculture on environment, 4 farms in Nellore District and one in Tuticorin were selected. Water, sediment, plankton, benthos and bacteriological samples were collected from each farm, influent and effluent canals and adjoining water bodies to assess the impact, if any.

LIST OF PUBLICATIONS 1992-93*

- Ahamad Ali, S., 1992. Evaluation of some animal and plant protein sources in diet of shrimp, *Penaeus indicus*. *Asian Fisheries Science*, 5:277-289.
- Joseph, K.O. and J.P.Srivastava, 1992. Impact of pollution on the hydrobiological features of the estuaries in Madras region. *Trends in Life Sciences*, 6 (1): 29-34.
- Joseph, K.O. and J. P. Srivastava, 1992. Studies on the sediment characteristics of the estuaries around Madras in relation to environmental degradation. *Trends in Life Sciences*, 7(1): 25-28.
- Joseph, K.O. and J. P. Srivastava, 1993. Mercury in the Ennore estuary and in fish from Madras coastal waters. *J. Environ. Biol.*, 14 (2): 55-62.
- Kathirvel, M., 1992. The mud crab. In Hand-book on aquafarming shrimps, lobsters and mud crabs. MPEDA, Cochin, 57-64.
- Kathirvel, M., and S. Srinivasagam, 1992. Resource and exploitation of mud crab *Scylla serrata* (Forsk.) in India. Rep. Seminar on the mud crab culture and trade, Surat Thani, Thailand. *BOBP/RE/51*: 84-94.
- Kathirvel, M. and S. Srinivasagam, 1992. Taxonomy of the mud crab, *Scylla serrata* (Forsk.) from India. *Ibid*: 127-132.
- Kulasekarapandian, S., S. Srinivasagam, K.O. Joseph, K. Alagarwami and A.V.P. Rao, 1992. *Artemia* cyst production at Kelambakkam, India. *Larviculture and Artemia Newsletter*, 24: 37-38.
- Muthu, M.S., K. Alagarwami and M. Kathirvel, 1992. Prawn Farming- Candidate Species. Technical Bulletin, No.2, CIBA, Madras.
- Srinivasagam, S. and M. Kathirvel, 1992. A review of experimental culture of the mud crab, *Scylla serrata* (Forsk.) in India. Rep. Seminar on the mud crab culture and trade, Surat Thani, Thailand. *BOBP/RE/51*: 195-203.

* Also includes publications of scientists of the Institute based on their work in previous Institutes.

PERSONNEL
(Not a Gradation List)

DIRECTOR
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SCIENTISTS

Scientist

Principal Scientist

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Shri A.V.P. Rao
Shri K.N. Krishnamurthy

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Senior Scientist

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Dr. Mathew Abraham
Dr. A. Laxminarayana
Dr. S. Kulasekarapandian
Dr. S.M. Pillai
Dr. T.C. Santiago
Dr. L. Krishnan
Dr. Syed Ahamad Ali
Dr. K. Gopinathan
Dr. C.P. Rangaswamy
Dr. B.P. Gupta
Dr P.K. Ghosh
(On deputation to Jadavpur
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Registrar w.e.f. 14.1.1992)
Dr. Smt. Munawar Sultana
Dr. M. Natarajan
(transferred from
IVRI w.e.f. 16.4.1992)

Scientist (SG)

Shri K. Devarajan
Shri Hardial Singh
Shri S. R. Das
Shri P. Ravichandran
Shri M. Kathirvel
Shri A.R. Thirunavukkarasu
Shri R.K. Chakraborty
Shri S. Srinivasagam
Shri D. Narayanaswamy
Shri N. Kalaimani

Shri B.K. Banerjee
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Shri M. Krishnan
Shri S.V. Alavandi
Dr.C. Gopal
Dr. K.K. Vijayan
Shri T. Ravisankar
(posted to CIBA w.e.f. 3.4.1992)
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Dr. (Kum) Shiranee Pereira
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Dr. S.S. Misra
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Dr. J.V. Ramana
(posted to CIBA w.e.f. 16.11.1992)
Dr. P.S.P. Gupta
(posted to CIBA w.e.f. 24.11.1992)
Dr. P. Kishore Chandra
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Shri. V. Chellapandian
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Shri P.S. Sudheesh
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Dr. K.V. Rajendran
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Smt. Imelda Joseph
(posted to CIBA w.e.f. 1.2.1993)
Shri. G. Mallikarjuna
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and resigned from ICAR service
w.e.f. 8.10.1992)

Technical Officer

Shri K.V. George, T-8
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Dr. V. Sreekrishna, T-6
Shri Asish Chowdhury, T-5
Shri P.M.A. Kadir, T-5

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Shri S. Krishnan, T-II-3
Shri S. Sivagnanam, T-II-3
Shri R. Puthiavan, T-II-3
Shri S. Gopalakrishnan, T-II-3
Shri V.R. Senthil Kumar, T-II-3
Shri D. Rajababu, T-II-3
Shri K.K. Surendran, T-I-3
Shri C.S. Sasidharan, T-I-3
Shri M.G. Sivadasan, T-I-3
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Shri Udayanath Jally, T-1
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ADMINISTRATIVE PERSONNEL

Administrative Officer

Shri R. Dorairaj
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Shri K. Baburajan
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Shri P.N. Rajasekharan Nair
(promoted w.e.f. 18.4.1992)

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Shri P. Prasad
Shri S.K. Haldar
Shri V. Balaji
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Junior Clerk

Shri K. Mani
Shri P.K. Roy
Shri S.K. Bindu
Smt K. Nandini
Shri R. Kandamani
Shri R.G. Ramesh
Smt V. Usharani
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Shri M.G. Subramani, T-I-3
Shri M. Gopinathan Nair, T-2
Shri B.B. Roy, T-1
Shri P.C. Mohanty
Shri K. Paranthaman

SUPPORTING STAFF

S.S.Gr. IV

Shri A.K. Mondal
Shri M.I. Raju
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Shri S.S. Maity

Shri D.N. Sahoo
Shri P. Manickyam
Shri N.C. Jena
Shri Sita Ram Das
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Shri B.C. Paik
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Shri Pranesh Chandra Saha

Shri Phani Gharami
Shri Sudarshan Naik
Shri Bijay Bhoi
Shri Balram Das
Shri S.K. Venkatachalam
Shri K.U. Gopi
Shri Nitai Chandra Som
Shri Patit Paban Halder
Shri Abhimanyu Naskar
Shri R.K. Roy
Shri P.S. Samantha
Shri T.V. Shaji
Shri K. Kunjuraman
Shri K. Thankappan
Shri N.C. Mondal
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Shri M.D. Suresh
Shri M. Santhosham
Shri N. Harinathan
Shri V. Jeevanandam
Shri Amar Gharami
Shri K. Mariappan
Shri Maharaja Majhi
Shri Narendra Nath Jena
Shri Krishna Pada Naskar
Smt S. Santhi
Shri Premanda Bisoi
Shri V.M. Dhanapal
Shri K. Nityanandam
Shri M. Subramani
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Shri A. Manoharan
Shri V. Kumar
Shri E. Manoharan
Shri K.V. Delli Rao
Shri C. Saravanan
Shri S. Kuppan
Shri Uttam Kumar Santra
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