



वार्षिक प्रतिवेदन ANNUAL REPORT 1993-94



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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Published by
Dr. K. Alagarwami
Director

Edited by
Munawar Sultana
Scientist (Selection Grade)
and
M. Kathirvel
Scientist (Selection Grade)

Assistance
Shiranee Pereira
Scientist
and
P.M. Abdul Kadir
Technical Officer

Cover Photo:

A shrimp farm situated adjacent to paddy, banana and coconut fields in Narasapur, West Godavari District, Andhra Pradesh.

CONTENTS

	Page No.
INTRODUCTION	1
Brief historical background	
Mandate	
Thrust areas of research during VIII Five Year Plan	
Infrastructure development	
Organisation	
Budget	
Major research accomplishments	
 GENERAL INFORMATION	 5
Management Committee	
Staff Research Council	
Quinquennial Review Team	
Research Advisory Committee of NARP	
World Bank Review Committee of NARP	
Scientific Monitoring Committee of DBT	
ARS/NET Examination	
Assistance rendered	
Services in committees	
Training under World Bank - assisted project	
Other trainings	
Manpower development	
Deputation	
Visits	
Seminars/Symposia/Workshops	

Meetings	
Consultation	
Recognition of the Institute	
Honours and Awards	
Library, Information and Documentation	
Reports	
Visitors	
PROGRESS OF RESEARCH	12
Crustacean Culture Division	12
Fish Culture Division	15
Technology Improvement Division	19
Aquaculture Engineering and Environment Division	25
Extension, Economics and Information Division	28
Externally Funded Projects	30
LIST OF PUBLICATIONS	35
PERSONNEL	36

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 un-productive 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 located 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 act as a repository of information on brackishwater fishery resources with a systematic data-base
- to undertake transfer of technology through training, education and extension education programmes
- to provide consultancy service

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 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 feed 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 construction of the experimental hatchery for prawn seed production is in progress at Muttukadu. Fish broodstock holding tanks with a total seawater holding capacity of 500 t each, are under construction at Muttukadu.

Four numbers of essential staff quarters (Type - I) have been completed at Muttukadu.

Equipments imported during the year 1993-94 are: Salinity Refractometers, Nikon Trinocular Research Microscope and Tecator Fibretec System. Shimadzu HPLC System with accessories for amino acid analysis, NIR Spectrophotometer and a Multiphor Electrophoresis System were imported under NARP II Sub-project on Aquaculture. Binocular and trinocular research microscopes, Gas Chromatograph with EC detector, a Fax machine and EPABX System were also procured during the year.

Organisation

The research programmes of the Institute were carried out under the following 5 divisions

Crustacean Culture Division (CCD)

Fish Culture Division (FCD)

Technology Improvement Division (TID)

Aquaculture Engineering and Environment Division (AE & ED)

Extension, Economics and Information Division (EE & ID)

Maintenance of broodstock, breeding and larval rearing of *Penaeus monodon* and *P.indicus*, grow-out culture of penaeid prawns in different ecosystems, culture of live food organisms and crab culture were taken up by the Crustacean Culture Division. Broodstock maintenance, breeding and culture of brackishwater fishes were dealt with by the Fish Culture Division. Research on nutritional aspects of fish and prawn, feed technology, pathology, ecophysiology and reproductive physiology programmes were taken up by the Technology Improvement Division. Aquaculture Engineering and Environment Division (unit) conducted studies on brackishwater environment, soils and their productivity and hatchery design and layout systems. The Extension, Economics and Information Division (unit) looked after the technology transfer programmes and aquacul-

ture economics. The Library and Technical Cell were under the responsibility of a Principal Scientist. An Engineering Cell attended to the construction work of the Institute.

A total number of 18 projects (14 departmental and 4 sponsored) were undertaken during the year.

Budget

During the year 1993-94 an expenditure of Rs 80.34 lakhs under Plan and Rs 90.76 lakhs under Non-Plan was incurred by the Institute.

Major research accomplishments

Research on captive broodstock of *Penaeus monodon* was continued with maturation diet and water quality management. With natural food of squid and clam meat, supplemented with polychaetes, 40 prawns matured and yielded 39 viable spawnings, resulting in the production of 4.9 million nauplii. Rearing the postlarvae using *Artemia* nauplii and clam custard, a survival rate of 42.8% was obtained from PL-3 to PL-22.

The backyard hatchery technology for *P. indicus* was perfected using mixed phytoplankton and squilla powder as larval and postlarval feeds.

Captive broodstock holding was strengthened with the addition of seabass *Lates calcarifer* (size range 1.5-2.5 kg) and grey mullet *Mugil cephalus* (size range 0.3-1.5 kg) in cage/pond at Muttukadu.

Under shrimp culture programme, the tiger shrimp *P. monodon* reached an average size of 21 g, with a production rate of 450 kg/ha/4 months in the confined rainfed pond system of Chilka lake, Orissa, with CIBA extensive feed. Pen and pond culture

of milkfish *Chanos chanos* in Muttukadu lagoon showed that pond gives a higher production rate (gross yield 800 kg/ha/267 days) than pen (gross yield 329 to 527 kg/ha/year).

Artemia cyst and biomass production taken up in a private salt pan area (0.4 ha pond) near Madras, using imported San Francisco Bay strain of *Artemia* sp., yielded a cyst production of 15 kg/ha/212 days.

Good progress was achieved in the programmes of feed formulation, production and testing for various production systems such as larval rearing, grow-out and maturation. Freeze-dried microparticulate diet for *P. monodon* could be used as replacement for microalgae at 25-50% level without affecting growth and production rates. Testing of maturation diets for broodstock prawn (*P. monodon*) is under progress. Grow-out feeds formulated for *P. monodon* and *P. indicus* under extensive and semi-intensive systems, have been used in the experiments at Keutakudi (Chilka) and Narakkal Centre respectively.

Disease problems in Muttukadu hatchery and farm were monitored and cases of cardiac myxosporcosis in pearlspot *Etroplus suratensis* and trematode *Diplectanum latessi* infection in seabass *Lates calcarifer* have been investigated in detail.

ELISA test and dot immunoassay have been developed and are under the process of standardization for diagnosis of Vibriosis caused by *Vibrio parahaemolyticus*, a common pathogen in prawns and one of the isolates has been selected for preparation of vaccine.

The technique of cryopreservation of milt has been standardised for mullet, *Liza macrolepis*. The post-thaw spermatozoa cryopreserved in the extender Fish Ringer with 5% DMSO (Dimethylsulphoxide) as cryo-

protectant, were used for the reutilization of ripe ova collected from mature spawners by induction of ovulation with homoplastic pituitary extracts. The fertilization rate achieved with cryopreserved milt was 40-50%.

Histochemical studies of the thoracic ganglia of mature *P. monodon* showed the presence of neurosecretory material associated with maturation. Gel electrophoresis of the ganglion extract of female prawns showed the presence of an extra protein fraction of low molecular weight.

Case studies of environmental impact of prawn farming in Kandleru creek area and in the coastal farms in Nellore Dist., Andhra Pradesh were taken up and completed. Based on this study, a set of recommendations for environment management with regard to aquaculture were formulated.

A detailed survey of prawn farms in Tamil Nadu and Andhra Pradesh was taken up with the help of the Dept. of Fisheries and a database has been developed. An

economic analysis of the different production systems has been worked out. The Institute has also rendered extension service through training programmes and interaction with farmers from private and corporate sectors.

Under the sponsored research projects (NARP-II, DBT and ICAR Cess Fund), satisfactory progress has been achieved.

Qualitative and quantitative requirements of essential amino acids and fatty acids for *P. monodon* have been assessed.

Indigenous raw material resources for use as feed ingredients have been evaluated and experimental feeds formulated, produced and tested on a laboratory scale. Basic studies on digestive enzymes, their kinetics, gut microflora, digestibility, response to environmental parameters and bioconversion of feed materials have been initiated.

K. Alagarwami
Director

GENERAL INFORMATION

Management Committee

The sixth and seventh meetings of the Management Committee of the Institute were held on 7 June 1993 and 23 December 1993.

Staff Research Council

The Staff Research Council of the Institute held its annual meeting on 17-20 April 1993 to review the progress of the various on-going research projects and to formulate project proposals for the next year.

Quinquennial Review Team

The preliminary meeting of the QRT met at Madras on 23-24 November 1993 under the Chairmanship of Prof. C.V. Kurien, to review the work conducted by the Institute during the years 1987-1993. The QRT visited Puri and Kakdwip research centres of the Institute from 6-8 January 1994.

Research Advisory Committee of NARP

The Research Advisory Committee meeting of the NARP Phase II Project, funded by the World Bank was held under the Chairmanship of Dr. M. Yusuf Kamal, Assistant Director General (Fy.I), at the Institute on 20 August 1993.

World Bank Review Committee of NARP

World Bank Review Committee of NARP Project consisting of Dr. M. Balasubramoniam, Agricultural Specialist, World Bank and Dr. K.N. Singh, Assistant Director General (NARP), ICAR, visited the Institute on 19 August 1993, to review the research progress of NARP Phase II, Sub-project activity on Aquaculture, at CIBA, Madras.

Scientific Monitoring Committee of DBT

The first meeting of the Scientific Monitoring Committee of DBT-funded project on 'Development of feed technology for semi-intensive/intensive prawn farming' was held on 10 September 1993 at the Institute, under the Chairmanship of the Director, Dr. K. Alagarswami. Dr. K. Radhakrishna, Assistant Director General (M.Fy), Prof. R. Kathirvel, Head, Dept. of Animal Nutrition, TANUVAS and Dr. A.S. Ninawe, Senior Scientific Officer I, DBT, attended the meeting.

ARS/NET Examination

ARS/NET Examination of ASRB for the year 1992 was conducted by the Institute at Madras from 26-28 October 1993.

Assistance rendered

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

Dr. B.P. Gupta, Senior Scientist, visited Pondichery and Karaikal from 30 June 1993 to 3 July 1993, for site selection for an aquaculture farm at Karaikal, under the DBT project at Dr. M.S. Swaminathan Research Foundation.

Dr. K. Alagarswami, Director and Dr. L.H. Rao, Senior Scientist, visited Pondichery and Karaikal from 6-8 September 1993, to inspect the shrimp hatchery and farm of the Pondichery Fisheries Dept. The technology for the departmental hatchery is being provided by the Institute.

Dr. A. Laxminarayana, Senior Scientist, visited Gujarat from 11-21 October 1993, to conduct a survey for the establishment of a shrimp hatchery on the invitation of the Commissioner of Fisheries, Gujarat.

Services in committees

Dr. K. Alagarwami, Director, served as

- Member, Governing Committee of Centre for Research on Sustainable Agricultural and Rural Development, Dr. M.S. Swaminathan Research Foundation.
- Member, Governing Council of Andaman and Nicobar Shrimp Farming Research and Development Agency, MPEDA.
- Member, Research Advisory Council of Fisheries Department, Govt. of Tamil Nadu.
- Member, ICAR Regional Committee No. VIII.
- Member, Committee on Aquaculture and Environment, Govt. of Andhra Pradesh.
- Member, Central Board of Fisheries, Ministry of Agriculture, Govt. of India.
- Member, Editorial Board for Indian Journal of Fisheries, I.C.A.R.
- Member, General Body of OSSPARC, MPEDA.
- Member, Scientific Panel of Fisheries, I.C.A.R.

Training under World Bank - assisted project

The Institute was given the responsibility of conducting a training course in Semi-intensive Shrimp Farming Technology, by the Dept. of Agriculture and Cooperation, Ministry of Agriculture, under the Shrimp and Fish Culture project (World Bank Assisted) of Govt. of India. Under this project, 20 Brackishwater Fish Farmers Development Agency officials, 10 each from West Bengal and Orissa viz., Shri D.K.

Kunango, Shri R.K. Lenka, Shri G.C. Routry, Shri P.K. Naayak, Shri N.C. Bastia, Shri D.D. Mohanty, Shri M. Biswal, Shri S.C. Pradhan, Shri R.N. Mohanty and Shri P.K. Mohanty from Orissa and Shri Tapan Kumar Banerjee, Shri Narayan Biswas, Shri Dinesh Kumar Mandal, Shri Asit Dhar, Shri Dipak Dutta, Shri Manindranath Maity, Shri Promotha Nath Nayek, Shri Rabindranath Dutta, Shri Purendu Sekhar Manna and Shri Ajoy Chakraborty from West Bengal, were trained for a period of one month from 15 December 1993 to 15 January 1994 and 24 December 1993 to 24 January 1994 respectively.

Other trainings

Shri R.V. Naik, Superintendent of Fisheries, Govt. of Goa, Panaji, underwent a training in brackishwater aquaculture from 13-17 April 1993.

Shri P.K. Sharma, Deputy Director, Shri Madanlal, Shri Manaklal and Shri Gomsingh, Fisheries Extension Officers and Shri R.C. Chauhan, Fishery Officer, Govt. of Rajasthan, were trained in shrimp farming and hatchery management from 19-29 April 1993.

Shri S.K. Lal Mohamed, Shri Lakshminarayanan and Shri M. Anantharaju, Inspectors of Fisheries, BWSS, Kakinada, were imparted training in the methodology for collection and preservation of water, sediment and biological samples on 9-10 June 1993.

Two officers from Dept. of Fisheries, Shri P.K. Ojha and Shri R.N. Lamrod, Asst. Directors, Govt. of Rajasthan, were trained in *Artemia* cyst production from 12-17 July 1993.

Five officers from the BFDA and Fisheries Dept. of Andhra Pradesh viz., Shri P.S.N. Raju, C.E.O., BFDA, Nellore, Shri M. Anantharaju, Inspector of Fisheries, Kakinada, Shri S.K. Lal Mohamed, Inspector of Fisheries, Nellore, Shri L. Lakshminarayanan, Inspector of Fisheries, Ongole and Shri A.V. Raghava Reddy, Inspector of

Fisheries, Nellore, participated in a practical training programme arranged at the Institute from 14-16 July 1993, to conduct case studies on prawn farming and environmental issues of Nellore Dist., Andhra Pradesh.

Shri M.P. Ramesan and Shri Abdul Samad, two ARS probationers, received subject-matter training for a period of 6 months from 21 February 1994.

Demonstrations and lectures on brackishwater aquaculture were also arranged for the following at the Headquarters and research centres of the Institute:

- 70 grass-root level trainees (Sagar Block) deputed by Directorate of Fisheries, Govt. of West Bengal, 11 July 1993
- A Research Fellow, Dept. of Geography, University of Burdwan, 7 December 1993
- 29 students from College of Fisheries, Mangalore, 23 March 1994
- 15 students of Calcutta University (Dept. of Marine Science), 28 March 1994

Madras

- Trainees from the Staff Research Institute of the Dept. of Fisheries, Govt. of Tamil Nadu, 13 May 1993
- B.F.Sc. students from G.B. Pant University of Pantnagar, U.P., at Muttukadu, 30 June 1993

Narakkal

- 16 trainees from MPEDA
- 14 M.Sc. Zoology students from Govt. Arts College, Coimbatore
- 3 students from Fisheries College, Mangalore

Puri

- A batch of 29 students of Final year B.F.Sc. from College of Fisheries, Mangalore, 20 February 1994

Kakdwip

- 13 students from Central Institute of Fisheries Education, Bombay, 24 April 1993
- 12 students (2nd year) of Marine Science, Calcutta University

Manpower development

Dr. S.S. Mishra, Scientist, underwent training in 'Cell culture and diagnostic methods in Virology' at the National Institute of Virology (ICMR), Pune, from 12-20 April 1993 and in 'Techniques for isolation and identification of viral agents using modern diagnostic procedures', at the Indian Veterinary Research Institute, Izatnagar, from 7-28 August 1993.

Shri P.S. Sudheesh, Scientist, underwent training in 'Plankton and Benthic fauna studies', at Central Marine Fisheries Research Institute, Kochi, from 27 June 1993 to 13 July 1993.

Dr. K.V. Rajendran, Scientist, underwent training in 'Techniques of fish immunology', sponsored by the Dept. of Biotechnology, Govt. of India, at the Dept. of Fishery Microbiology, College of Fisheries, University of Agricultural Sciences, Mangalore, from 6-24 September 1993.

Dr. Mathew Abraham, Senior Scientist and Shri S.Krishnaswamy, Assistant Finance and Accounts Officer, underwent a training on 'Introduction to personal computers', at the National Informatics Centre, Madras, from 6-10 September 1993 and 26-30 July 1993, respectively.

Dr. M. Krishnan and Shri T. Ravisankar, Scientists, were trained in Fox plus/d base programming at the National Informatics Centre, Madras, from 22-26 November 1993 and 21- 25 February 1994, respectively.

Deputation

Dr. K. Alagarwami, Director, visited China as a member of the Indian Delegation on Fisheries, Govt. of India, from 26 June to 10 July 1993.

Dr. K. Alagarwami, Director, visited Bangkok, Thailand, to attend the 'Final Workshop and Regional Study on the Environmental Assessment and Management of Aquaculture Development', from 21-26 February 1994, organised by the FAO/RAPA/ NACA, to participate as the National Environment Coordinator and to present the Country Report.

Visits

Dr. K. Alagarwami, Director, accompanied by Dr. M.J. Philips, TCP Environment Specialist, NACA, visited TASPARC and other farms at Nellore and carp culture farms at Kolleru lake, from 26-29 April 1993.

Dr. K. Alagarwami, Director, visited Ahmedabad for discussions with Commissioner of Fisheries, Govt. of Gujarat, on 14 and 15 October 1993, regarding master plan preparation for brackishwater areas in Gujarat.

Seminars/Symposia/Workshops

The Director participated in the following Seminars / Symposia / Workshops held during the year:

- **Workshop on Fisheries Development in Tamil Nadu**, TNFDC, Madras, 12 July 1993
- **Seminar on Shrimp Farming**, organised by MPEDA, Dept. of Fisheries, Tamil Nadu and the Indian Overseas Bank, at Madras, 26 November 1993

The scientists participated in the following Seminars/Symposia held during the year:

- **Seminar on Prawn/Shrimp Farming**, organised by MPEDA and ADAK at Kochi, 11 March 1994 and gave a talk on 'Technoeconomic feasibility of setting up a shrimp hatchery'

Dr. A. Laxminarayana

- **Symposium on Aquatic Resources Conservation and Reservoir Fisheries** at Bhopal, 23-24 December 1993 and presented a paper on 'Nutrition and feed technology for cultured prawns'

Dr. C. Gopal

Meetings

The Director attended the following meetings:

- First meeting of the Committee on Aquaculture and Environment, Govt. of Andhra Pradesh, Madras, 17 May 1993
- Meeting to finalise the Mission Mode Programme in Aquaculture, Dept. of Biotechnology, New Delhi, 18 May 1993
- Meeting in the Ministry of Commerce, Govt. of India, regarding Problems of Aquaculture Enterprise, New Delhi, 3 June 1993
- Meeting with Mexican Delegation for collaboration in prawn culture, New Delhi, 4 June 1993
- Meeting of the Governing Council of Andaman and Nicobar Island Shrimp Development Agency, MPEDA, Madras, 7 June 1993

- Scientific Monitoring Committee meeting of DBT Project I at C.I.F.T., Kochi, 8 June 1993
- Tamil Nadu State Planning Commission meeting, Madras, 28 July 1993
- Staff Research Council meeting of Tamil Nadu Fisheries Dept., Madras, 3 September 1993
- Fifth Annual General Body Meeting of Dr. M.S. Swaminathan Research Foundation, Madras, 6 September 1993
- Meeting organised by MPEDA regarding Quarantine Clearance for Import of Live Items, Madras, 25 September 1993
- ICAR Directors' Conference, New Delhi, 5-6 October 1993
- Special Annual General Body meeting of Dr. M.S. Swaminathan Research Foundation, Madras, 19 October 1993
- Second meeting of Committee on Aquaculture and Environment, Govt. of Andhra Pradesh, Madras, 6 November 1993
- 15th meeting of the ICAR Regional Committee No. VIII at I.I.H.R., Bangalore, 20-21 January 1994

The scientists attended the following meetings:

- Tamil Nadu State Planning Commission Meeting, Madras, 8 June 1993

Shri K.N. Krishnamurthy

- Meeting on the Aquaculture Projects in the Dept. of Biotechnology, New Delhi, 3 August 1993

Shri K.N. Krishnamurthy

- Meeting of the Sub-group ICADP (Integrated Coastal Area Development Programme) of State Planning Commission, Tamil Nadu, Madras, 13 August 1993 and 13 September 1993

Shri K.N. Krishnamurthy

- Governing Body Meeting of Aquaculture Development Agency for Kerala (ADAK), Thiruvananthapuram, 28 July 1993

Dr. A. Laxminarayana

- Review Committee Meeting of ADAK to review the Hatchery Planning Report, Thiruvananthapuram, 22 December 1993

Dr. A. Laxminarayana

- Meeting of Sunderban Biosphere Reserve, Calcutta, 21 March 1994

Shri S.R. Das

Consultation

Dr. K. Alagarswami, Director, as a nominee of the Govt. of India, participated in the consultations for the establishment of a sub-group of the Bay of Bengal Committee to prepare proposals for regional fisheries research programmes, organised by BOBP at Madras on 7-8 February 1994.

Recognition of the Institute

The Institute has been recognised by the University of Madras, as a centre for conducting research leading to Ph.D degree (inter-disciplinary) in Fishery Biology, Aquaculture and Genetics, Nutrition and Biochemistry, Marine Ecology, Pathology and Microbiology in Aquaculture, Comparative Endocrinology and Reproductive Biology, from 9 June 1993.

Honours and Awards

Shri A.R.Thirunavukkarasu, Scientist (SG), was awarded the doctoral degree in Marine Biology by the Annamalai University, for his thesis entitled 'Impact of critical pollutants (mercury, Endosulfan and oil) on the Indian white prawn, *Penaeus indicus*', in September 1993.

Shri. S.S. Mishra, Scientist, was awarded the doctoral degree in Veterinary Virology by the Indian Veterinary Research Institute (Deemed University), Izatnagar, U.P., for his thesis entitled 'Molecular characterisation of fowlpox virus: protein and genomic profile of vaccine strain and field isolates', in January 1994.

Shri M. Krishnan, Scientist (S.S), was awarded the doctoral degree in Agricultural Economics by the Indian Agricultural Research Institute, New Delhi, for his thesis entitled 'Multi-objective analysis of paddy-fishery enterprise system in the Kuttanad region of Kerala State', in February 1994.

Shri P. Ravichandran, Scientist(SG), was awarded the doctoral degree by the University of Madras, for his thesis entitled 'Studies on the growth and nitrogen metabolism of the jumbo tiger prawn, *Penaeus monodon* Fabricius (Crustacea: Decapoda) in relation to ambient pH, salinity and ammonia', in March 1994.

Library, Information and Documentation

Library Holdings

The Institute's library acquired 35 books and subscribed to 13 foreign and 21 Indian journals during the year to meet the reference needs of the scientific personnel. The library as on March 1994 had a total holding of 815 books, 420 reprints and photocopies, 220 reports and 450 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.

Reports

The Final Country Report (India) on Environmental Assessment and Management of Aquaculture Development, was presented by Dr. K. Alagarwami, Director, at the Regional Study and Workshop organised by NACA/RAPA/FAO, at Bangkok, Thailand, in February 1994.

A report on 'Case studies on Environmental Assessment of Shrimp Farming in Nellore Dist. Andhra Pradesh', was presented by Dr. K. Alagarwami, Director, at the meeting of the committee appointed by the Govt. of Andhra Pradesh to consider issues for preparation of Master Plan for Shrimp Farming in Nellore Dist., held at Govt. Secretariat, Hyderabad, on 15 March 1994.

Visitors

Headquarters

Dr. Mike Philips, FAO/TCP/NACA Environment Project, Bangkok, Thailand

Mr. R.L. Falco, Sr. Project Advisor, World Bank Project, CICEF, Bangalore

Mr. Jaime B. Dominisac, Shrimp Aquaculturist, World Bank Project, CICEF, Bangalore

Mr. Morgan Jensen, World Bank Project, CICEF, Bangalore

Shri G.C. Srivastava, Secretary, ICAR

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

Dr. M. Yusuf Kamal, Asst. Director General (Fy. I), ICAR

Dr. K. Radhakrishna, Asst. Director General (M.Fy.), ICAR

Prof. R. Kathirvel, Head, Dept. of Animal Nutrition, TANUVAS

Dr. A.S. Ninawe, Senior Scientific Officer-I, DBT

Prof. C.V. Kurien, Retired Director, Faculty of Marine Sciences, Cochin University of Science and Technology

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

Shri J.V.H. Dixitulu, Editor, Fishing Chimes

Prof. R. Ramamurthy, Head, Dept. of Zoology, S.V. University, Tirupati

Dr. D.A. Biwalkar, Officer-in-charge, SCICI, Ltd., Vishakapatnam

Shri. Anil Agarwal, Senior Scientist, ICAR

Shri N. Parthasarathy, Joint Secretary to Govt. of India and Financial Advisor, DARE

Dr. M. Balasubramanyam, World Bank, New Delhi

Prof. A. Ahamad, Deputy Director General (Edn.), ICAR

Shri K.P.P. Nambiar, Director, INFO- FISH, Kaula Lumpur

Shri D.K. Reddy, Director, DARE, Govt. of India, New Delhi

Shri N.P. Gupta, IAS, Secretary to Govt. of Tamil Nadu, AH&Fy. Dept.

Shri Vasant Kumar, Financial Analyst, World Bank

Smt. Padma Venkatachallam, Dy. Commissioner (Fy.), Ministry of Agriculture, Govt. of India, New Delhi

Dr. K.N. Singh, Asst. Director General, NARP

Kakdwip Research Centre

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

Shri J.V.H. Dixitulu, Editor, Fishing Chimes

Dr. D.A. Biwalkar, Officer-in-charge, SCICI Ltd., Vishakapatnam

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

Dr. Singh, Fishery Biologist, NBFGR, Allāhabad

Puri Research Centre

Prof. C.V. Kurien, Retired Director, Faculty of Marine Sciences, Cochin University of Science and Technology

Dr. R. Ramamurthy, Head, Dept. of Zoology, S.V. University, Tirupati

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

Shri Anil Agarwal, Senior Scientist, ICAR,

Dr. D.A. Biwalkar, Officer-in-charge, SCICI Ltd., Visahakapatnam

Shri J.V.H. Dixitulu, Editor, Fishing Chimes,

Narakkal Research Centre

Shri K.V. Raghu, MPEDA

Dr. Karuppannen, Professor of Zoology, Govt. Arts College, Coimbatore

PROGRESS OF RESEARCH

CRUSTACEAN CULTURE DIVISION

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

Madras: L.H. Rao (PL), K. Devarajan, S.K. Pandian, P. Ravichandran, K.O. Joseph, P.S. Sudheesh and P.S.P. Gupta

Narakkal: A. Laxminarayana and S.M. Pillai

Puri: S. Srinivasagam, C.P. Rangaswamy and R.D. Prasadham

Broodstock maintenance

Adult *Penaeus monodon* of both sexes procured from the sea near Royapuram and Ennore and Kovalam backwaters were maintained in 12 t FRP tanks, on a diet of fresh clam and squid @ 15% of total biomass, supplemented with polychaete worms @ 8% of biomass and with 70-90% seawater exchange daily.

Induced maturation and spawning of ablated *P. monodon* females was successfully done in fibre-glass tanks, maintaining a 1: 2 male to female ratio. The prawns were fed with clam and squid meat @ 15% of the total biomass, supplemented with polychaete worms @ 8-10% of the total weight. Water management included exchange of 90% seawater everyday. The details of the three trials conducted during the year are given in Table 1. The salinity was maintained at 30 ppt during the experimental period.

A total number of 48.83 lakh nauplii were obtained from 39 viable spawnings. The average number of eggs and nauplii per spawning varied from 2.34 to 2.72 lakh and 0.92 to 1.35 lakh, respectively (Table 1).

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

Duration of expt. (days)	No. of females ablated	Size range (mm/g)	Feed used (% of total biomass)	Total no. of spawnings	Total no. of eggs (lakhs)	No. of viable spawnings	Avg. no. of eggs/spawning (lakhs)	Avg. no. of nauplii/spawning (lakhs)
38	12	F 205 - 250/90 - 170 M 170 - 230/60 - 110	Clam and squid meat 15 Polychaetes 8	10	22.8	6	2.40	0.92
67	12	F 195 - 275/75 - 195 M 175 - 200/60 - 80	Clam and squid meat 15 Polychaetes 8	23	51.1	20	2.34	1.35
15	16	F 195 - 250/80 - 160 M 195 - 210/55 - 80	Clam and squid meat 15 Polychaetes 10	15	40.9	13	2.72	1.23

F - Female ; M - Male

Larval rearing

Twenty-seven larval rearing trials were conducted in borewell water with salinity maintained at 30 ppt, using *Chaetoceros calcitrans*, clam tissue suspension, *Artemia* nauplii and clam custard as larval feeds.

Ten trials were run using untreated seawater and 9 trials in seawater treated with Calcium hypochlorite (3 ppm), EDTA (5 ppm) and tetracycline (3 ppm). Average survival of larvae upto PL-2 in untreated water was 23%. However, it was observed that treated seawater did not improve larval survival significantly. In the remaining trials, large-scale mortality of larvae occurred due to bacterial and MBV disease.

Postlarval rearing

Postlarvae (PL-3) were reared at a density of 13-14 individuals/l using *Artemia* nauplii and clam custard as postlarval feed and a maximum survival of 66.6% with an average 42.8% at PL-22 was obtained. A total number of 67,630 PL-18 to 28 were produced.

Seed production of *Penaeus indicus* adopting backyard hatchery technology:

Narakkal

Adopting backyard hatchery technology, 16 trials were conducted for the seed production of *Penaeus indicus* using mixed phytoplankton dominated by *Chaetoceros* sp. as larval feed upto PL-1. An average survival of 46% (ranging from 30.0-52.3%) from nauplii to PL-1 was obtained. The postlarvae were further reared using *Squilla* powder as feed.

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

Kakdwip: Hardial Singh (PL) and R.K. Chakraborti

Puri: C.P. Rangaswamy, S. Srinivasagam and R.D. Prasadham

Madras: M. Kathirvel, P.S. Sudheesh, T.C. Santiago and B.P. Gupta

Narakkal: S.M. Pillai and A. Laxminarayana

Experimental work on culture of prawns was carried out at Puri and Narakkal centres and at Muttukadu. In all the systems, environmental constraints in respect of pond soil and water quality, including flooding, have been faced. Feeds produced at the Institute were used in all experiments. In Keutakudi ponds (near Puri), *P. monodon* showed a growth of 133 mm/21 g from initial 15 mm/0.008 g in 4 months. In other experiments retarded growth was seen due to poor environmental conditions.

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

Madras: S. Kulasekarapandian (PL), P. Ravichandran, K. Devarajan, K.O. Joseph and Imelda Joseph

Algal culture

Axenic cultures of *Chaetoceros calcitrans*, *Tetraselmis* sp. and *Isochrysis* sp. were maintained in UV filtered seawater, under controlled temperature (20-24°C) using Walne's medium, at a light intensity of 2000-3000 lux. A maximum cell density of 5.1 million cells/ml in 5 days, 1 million cells/ml in 4 days, and 1.9 million cells/ml in 4 days was achieved for *C. calcitrans*, *Tetraselmis* sp. and *Isochrysis* sp. respectively.

Mass culture of *C. calcitrans* was done in outdoor tanks in filtered seawater of 30-32 ppt salinity, enriched with modified 'F' medium. A maximum cell density of 1 million cells/ml was obtained in 24 h.

Brine shrimp culture

San Francisco Bay strain of *Artemia* sp. was stocked in a 0.4 ha pond in a private salt pan at Kelambakkam, at a stocking density of 37 nauplii/l. The population reached a density of 228 individuals/l and cyst production was noticed in the salinity range of 120 to 145 ppt. A total cyst production of 15.13 kg/ha was obtained in 212 days. Hatching efficiency of cyst produced was 2.13 lakh nauplii per gram of dry cysts with a hatching rate of 61%.

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

Madras: M. Kathirvel (PL)

The mud crab *Scylla tranquebarica* (100 no., average size 78 mm/100 g) was stocked in a 100 sq.m pen, constructed in a culture pond at Muttukadu. The crabs were fed with clam meat @ 10% of the biomass everyday. Over a culture period of 120 days, the crabs grew to an average size of 123 mm/408 g.

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, P. Kishore Chandra and Shiranee Pereira

Narakkal: L. Krishnan

Kakdwip: Hardial Singh

Lates calcarifer adults and sub-adults in the size range of 640-885 mm/4.5-7.0 kg and 292-411 mm/0.3-1.0 kg respectively, were shifted from Ennore to Muttukadu in March 1993. The adults were maintained in a large plastic pool and the sub-adults were in a lagoon pond of 0.01 ha. The fish were fed with live trash fish @ 7% body weight. In July 1993, the adult fish succumbed to a trematode parasitic infection of *Diplectanum latesi*, in spite of the formalin and malachite green treatment. Mortality of sub-adults also occurred, probably due to poor water quality. However, presently 52 fish in the size range of 325-340 mm/1.50-2.75 kg are being maintained in cages at Muttukadu.

Continuous efforts are being made to develop a broodstock of *Mugil cephalus* at Muttukadu. In August 1993, fishes in the size range of 340-590 mm/0.40-2.45 kg, maintained in a pond (0.01 ha), suffered mortality due to handling stress. Fresh batches of *M. cephalus* procured during December 1993-March 1994 in the size range 200-460 mm/0.35-1.50 kg are being maintained on a pelleted feed given @ 7% body weight daily. Induced breeding of *M. cephalus* could not be taken up due to the non-availability of breeders both from the captive broodstock and the commercial catches.

Three spawnings of *Etroplus suratensis* (average weight 65g) were observed during November-December 1993 and about 1,500 fry were produced at Muttukadu. A part of the stock escaped into the lagoon due to flooding in December 1993. The pond has been re-stocked after draining of the floodwater. The fish are being maintained on groundnut oil cake and rice bran (1:1) @ 7% of the body weight daily. The physico-chemical characteristics of the pond water ranged from: temperature 27-34°C; pH 7.3-8.5; salinity 5-34 ppt; DO 4-12 ppm. At Kakdwip, pearlspot broodstock (average size 221 mm/327 g) were maintained in a 0.08 ha pond provided with nesting material. The fish were fed daily on a powdered mixture of rice bran, groundnut oil cake and fish meal (1:1:1) fortified with Supplevite-M (2.5 kg/100 kg feed) @ 2-3% body weight. In July-September 1993, 2,618 fry were produced as a result of natural breeding. Subsequently, the same broodstock were transferred to two ponds (0.12 ha each) and maintained on a diet of rice bran, fish meal and groundnut oil cake (4:1:1) given @ 3% body weight daily. During October-December 1993, a total of 3,015 fry were obtained through natural breeding. The physico-chemical characteristics of the pond water during the period ranged from: salinity 7.0- 12.0 ppt; pH 7.8-8.7 and DO 7.8-11.2 ppm. At Narakkal, pearlspot breeders were stocked in two ponds (0.02 ha each) with 16 fishes in each pond. The size range of fish stocked was 115-152 mm/30-80 g and 148-198 mm/75-160 g in ponds 1 and 2 respectively. The fish were maintained on a diet of groundnut oil cake, rice bran and wheat bran cake (1:1:1) in dough form given @ 5% body weight daily. Nesting materials were provided in both the ponds. A total of 1,145 fingerlings of size range 70-80 mm/3.5-7.0 g were collected from the two ponds. In September 1993, one of these

ponds was cleared and re-stocked with pearlspot (43 no., average size 104 mm/92g) and the same feeding regime was continued.

Culture of finfishes (FCD/FC/1)

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

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

Narakkal: L. Krishnan

Culture of seabass, *Lates calcarifer*

Kakdwip

Nursery rearing of *Lates calcarifer* (average size 28 mm/0.43 g) was done in a pond (0.09 ha) from July to September 1993. The fry stocked @ 22,200 no./ha were fed with live fish and prawn given @ 150 g/day for the first 20 days followed by 180 g/day for the remaining 50 days. After 70 days of rearing, the fish attained an average size of 94 mm/11 g with a survival rate of 21.4%. Grow-out culture was done in a 0.275 ha pond @ 1,750 no./ha. The fish were maintained on a diet of live feed given @ 250 g, four times a fortnight. The fish attained an average size of 278 mm/267 g at the end of 170 days of culture. The hydrographical parameters of the pond recorded during the period were: salinity 2-15 ppt; pH 7.0-8.2 and DO 2.6-9.8 ppm.

Narakkal

Lates calcarifer (average size 190 mm/98 g) stocked in a 0.02 ha pond @ 800 no./ha and maintained on a diet of live trash fish, attained an average weight of 300 g over a period of 5 months.

Culture of milkfish, *Chanos chanos*

Madras

Fry rearing

Milkfish fry were procured in batches from Kovalam, during June and July 1993 and reared in FRP tanks on a pelletised feed, given @ 10% body weight for a period of 3 weeks, prior to stocking in pens. One batch of fry of average size 16 mm stocked @ 375 no./t of water, attained an average size of 33 mm/0.83 g with a survival rate of 56.3% and another batch of fry of the same initial size, attained an average size of 60 mm/2 g with a survival rate of 52.2%. A third batch of fry of average size 28 mm/0.5 g stocked @ 500 no./t of water, attained an average size of 44 mm/2 g with a survival rate of 60%.

Pen culture

Pen culture of milkfish was conducted in two pens, Pen 1 and Pen 2 (0.10 ha each) from August 1992 to August 1993. Milkfish seed of average size 126 mm/15 g, were stocked @ 5,000 no./ha in each pen. The average size of fish at harvest was 536 mm/ 0.94 kg and 540 mm/0.90 kg from Pen 1 and Pen 2, respectively. The survival was very poor in both cases, the yield of milkfish being 4.7 kg and 4.5 kg respectively. The yield of miscellaneous fishes such as *Mugil cephalus*, *Liza macrolepis*, *Lutjanus* sp., *Siganus* sp., *Etroplus suratensis*, *Epinephelus* sp. etc., was 48.03 kg and 28.42 kg in Pen 1 and 2 respectively. The gross yield, without supplementary feed, was 527.34 kg/ha/yr and 329.20 kg/ha/yr in Pen 1 and 2 respectively.

The physico-chemical characteristics of the water were: temperature 27-33° C; salinity 18-45 ppt; DO 4.4-12.0 ppm; total alkalinity 56-80 ppm; phosphate 0.002-0.06 ppm; nitrate 0.01-0.048 ppm; gross primary production 41.69-221.89 mgC/m³/hr and net primary production 10.4-208.85 mgC/m³/hr.

Pond culture

Milkfish seed of average size 44 mm/2 g were stocked @ 5,000 no./ha in a 0.15 ha pond at Muttukadu, in July 1993. The fish were fed daily with a mixture of groundnut oil cake and rice bran (1:1) in dough form and subsequently with a pelleted feed comprising of fish meal 16%, soyabean meal 20%, groundnut oil cake 14%, gingelly oil cake 10%, wheat bran 10%, rice bran 10%, tapioca 16%, soybean oil 2% and vitamin-mineral mix 2%. The feeding rate was initially 5% and later reduced to 3% of body weight.

The fish attained an average size of 284 mm/150 g at the end of a culture period of 267 days. The recovery rate of milkfish was 26.7%, giving an yield of 30 kg. The other miscellaneous fishes harvested included grey mullet, *E.suratensis*, *Tilapia*, *Nematolosa* sp., *Therapon*, eel, etc., which gave a total yield of 82.50 kg along with 7.50 kg of prawns. The total gross yield was 120.05 kg (800 kg/ha/267 days).

The physico-chemical characteristics of the pond water were: temperature 27-34°C; salinity 20-45 ppt; pH 7.6- 8.8; DO 4.8-13.0 ppm; total alkalinity 46-120 ppm; phosphate 0.001-0.06 ppm; nitrate 0.009-0.032 ppm; gross primary production 41.7-427.08 mgC/m³/hr and net primary production 20.8-291.67 mgC/m³/hr.

The soil characteristics of the pond were: texture-sand 75%, silt 10% and clay 15%; pH 7.5-7.9; redox potential (Eh)-60 to -110 mV; electrical conductivity 6.25-16.40 mmhos/cm; organic carbon 0.51-1.10%; available nitrogen 41.0-58.0 mg/100 g soil; available phosphorus 0.8-1.9 mg/100 g soil and CaCO₃ 0.9-1.75%.

Kakdwip

Milkfish seed of average size 160 mm/29 g (size range 120-215 mm/10-66 g) transported from Madras, were stocked in a nursery pond (0.375 ha) @ 1,950 no./ha in September 1992. The pond was fertilised

with urea and single superphosphate @ 25 kg/ month. The fish were fed with a supplementary feed in dough form composed of fish meal 15%, soycake 20%, groundnut oil cake 25%, rice bran 27%, starch 11% and vitamin-mineral mix 2% @ 3-5% of body weight. However, during October 1993, 53 fishes suffered mortality due to 'Ulcerative Disease Syndrome'. The remaining stock was treated with potassium permanganate @ 10 ppm and lime @ 200 kg/ha was also applied. Partial harvesting done at intervals, yielded 92.5 kg of milkfish and 100.0 kg of miscellaneous fishes. The average size of the milkfish harvested was 354 mm/290 g. The hydrographical parameters of the pond were: temperature 24-32°C; salinity 9-18 ppt; pH 7.3-9.3 and DO 5.7-9.5 ppm.

Culture of grey mullet *Mugil cephalus*

Madras

M. cephalus seed of average size 73 mm/5 g (size range 48-92 mm) procured from the Buckingham Canal backwaters at Muttukadu, during May 1993, were reared in FRP tanks on a pelleted feed given @ 10% body weight for a period of 20 days, prior to stocking in the ponds.

Fry rearing

The average size attained and survival of fry recorded at different stocking densities viz., 50, 30, 20 and 12 no./t of water were 98 mm/10 g, 106 mm/12 g, 102 mm/10 g and 120 mm/16 g respectively and 48, 72, 43 and 62 % respectively.

Pond culture

M. cephalus seed (average size 125mm/16 g) were stocked in a 0.15 ha pond at Muttukadu, @ 3,000 no./ha in August 1993. The same feeding pattern as in the case of pond culture of milkfish was followed. The fish attained an average size of 345 mm/0.65 kg at the end of a 7 month culture

period. The yield of *M. cephalus* was 13.65 kg, the recovery rate being 46.7%. The gross yield including miscellaneous fishes mainly *Tilapia* and *Therapon* sp. was 57.65 kg (384.33 kg/ha/7 months).

The hydrological characteristics were: temperature 27-34°C; salinity 23-34 ppt; pH 7.7-8.8; DO 2.8-10.0 ppm, total alkalinity 96-130 ppm; phosphate 0.002-0.04 ppm; nitrate 0.015-0.201 ppm; gross primary production 83.33-208.30 mgC/m³/hr and net primary production 41.66-166.67 mgC/m³/hr.

The soil characteristics were: redox potential (Eh) -30.0 mV; electrical conductivity 6.25 mmhos/cm; pH 7.8; organic carbon 0.30%; available nitrogen 59 mg/100 g soil; available phosphorus 2.1 mg/100 g soil; and CaCO₃ 1%. The texture of the soil was 80% sand, 5% silt and 15% clay. The benthic population ranged from 4580-10,080 no./m².

Culture of *Etrophus suratensis*

Kakdwip

Nursery rearing

Pearlspot seed of average size 28 mm/0.68 g (size range 23-40 mm/0.2-1.7 g) were stocked in a 0.08 ha nursery pond @ 50,000 no./ha, in June 1993. The fish were fed with supplementary feed consisting of rice bran, fish meal and groundnut oil cake (4:1:1) @ 5% of body weight, twice in a day. Over a period of 90 days, the fish grew to an average size of 75 mm/7 g (size range 44-95 mm/2-18 g) with a survival rate of 50.4%.

An experiment to study the growth and survival of pearlspot fry at different stocking densities was conducted with fry of average size 25 mm/0.4 g, stocked @ 10, 15 and 20 no./m² in FRP tanks and fed with rice polish @ 10% of body weight, once daily. After 75 days of rearing, the

fry attained an average size of 31 mm/0.54 g with a survival rate of 81.6%; 29 mm/0.45 g with a survival rate of 65.5% and 29 mm/0.48 g with a survival rate of 66.6% at 10, 15 and 20 no./m² respectively.

Grow-out culture

Pearlspot seed of average size 80 mm/11 g (size range 58-118 mm/5-30 g) were stocked @ 10,000 no./ha in a 0.18 ha pond, in September 1992. The fish were fed @ 5% of body weight with rice bran, fish meal and groundnut oil cake (4:1:1) and Supplevite M added @ 2.5 g/kg feed. The fish attained an average size of 146 mm/65 g at the end of one year culture period with a gross yield of 81.96 kg (445.43 kg/ha/yr) of which pearlspot contributed 72 kg and miscellaneous fishes 9.96 kg.

The pond (0.18 ha) was re-stocked in September 1993 with pearlspot seed of average size 75 mm/7.2 g (size range 44-95 mm/2.2-17.5 g) @ 10,000 no./ha. The fish were fed with the same feed as in the earlier experiment. Over a period of 5 months the fish attained an average size of 112 mm/28 g (size range 55-150 mm/8-80 g).

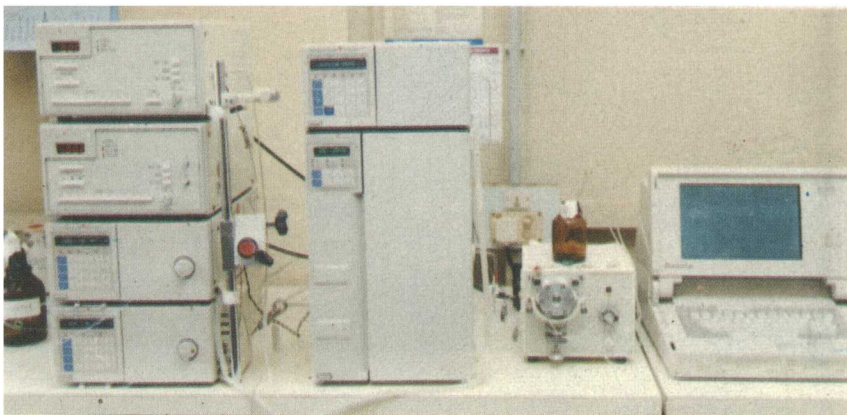
Narakkal

Pearlspot seed of average size 95 mm/25 g were stocked in a 0.02 ha pond @ 2,500 no./ha in February 1993. The fish were fed daily with a mixture of groundnut oil cake, rice bran and wheat bran (1:1:1) @ 5% of body weight. The fish attained an average size of 156 mm/92 g at the end of six months culture period.

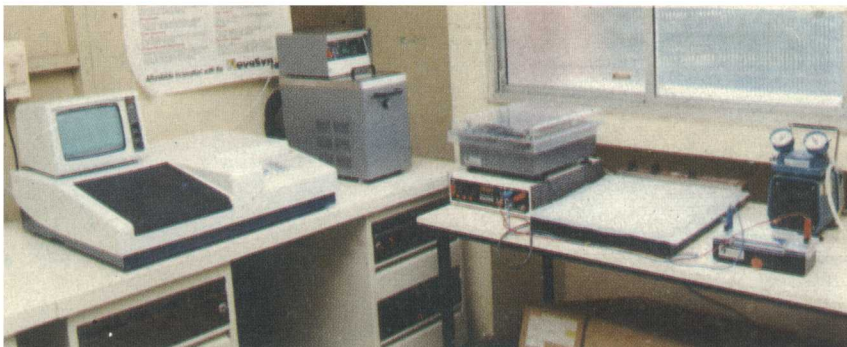
The pond was re-stocked with pearlspot seed of average size 80 mm/6 g @ 10,000 no./ha in August 1993. The same feed and feeding schedule are being followed as in the earlier experiment.



Near Infra Red Spectrophotometer.



"SHIMADZU" High Performance Liquid Chromatograph.



Multiphor Electrophoresis System with laser densitometer (left) and gel drier (right).



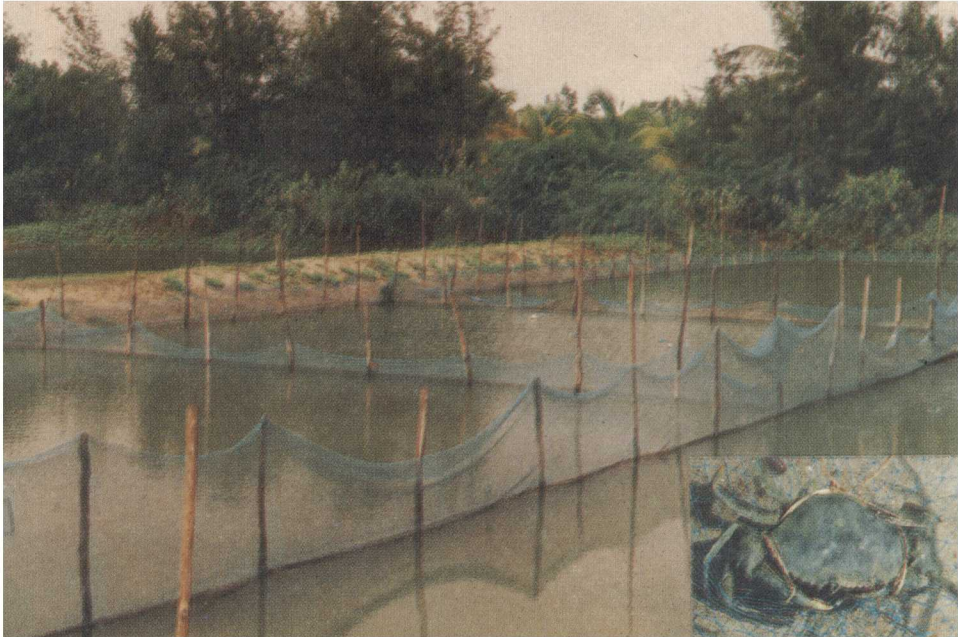
CHEMITO 2865 gas chromatograph with EC detector.



TECATOR Fibretech system.



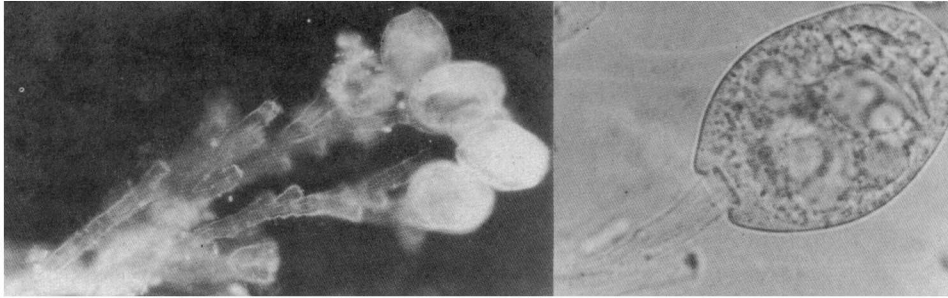
LEICA (left) and NIKON (right) research microscopes.



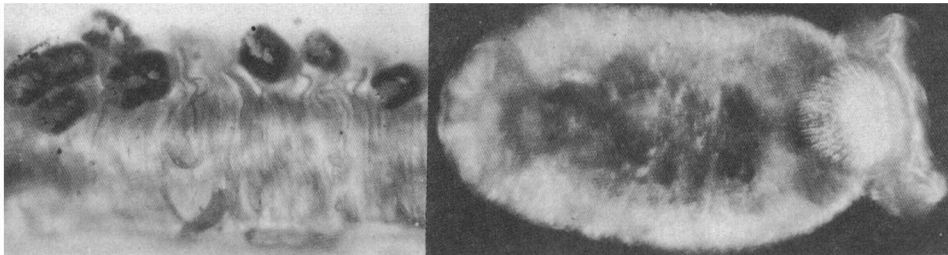
Pen Culture System for mud crab (*Scylla tranquebarica*) at Muttukadu farm (insert at bottom right : grown-up mud crab).



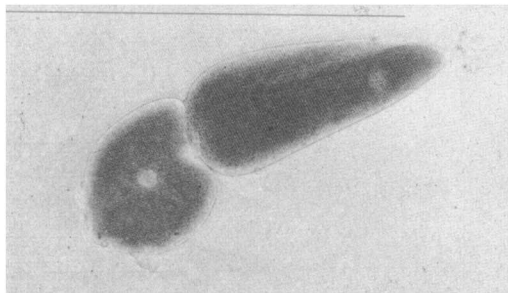
Staff Quarters at Muttukadu Farm Complex near Madras.



Colony of ciliate protozoan epicommensal, *Zoothamnium* sp. from the gills of cultured tiger shrimp *Penaeus monodon* (left) and enlarged view (right).



Monogenetic trematode parasite, (*Diplectanum latesi*) found attached to the gill filaments of indoor tank held broodstock of seabass, *Lates calcarifer* (left) and enlarged view (right).



Enterozoic cephaline gregarine, *Cephalolobus indicus* from the intestine of juvenile white prawn, *Penaeus indicus* from Muttukadu farm.



Ciliate protozoan parasite, *Trichodina* sp. from the gills of grey mullet (*Mugil cephalus*) caught from Muttukadu farm.

TECHNOLOGY IMPROVEMENT DIVISION

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

Madras: S.A. Ali (PL), D. Narayanaswamy, M. Natarajan, C. Gopal and J.V. Ramana

Puri: C.P. Rangaswamy

Formulation and testing of prawn feeds

Indigenous feed ingredients like fish meal, squid meal, prawn head meal, soybean

meal, gingelly cake, wheat flour, tapioca, rice flour, fish oil, alfalfa and *Spirulina* etc., were used to formulate two feeds for *P. monodon* at 40% and 35% protein levels, for semi-intensive and extensive farming respectively. Details of feed composition are given in Table 2. Each feed was prepared in three grades viz., 'Starter' (1.0 mm granules), 'Grower' (2.0 mm pellets) and 'Finisher' (2.5 mm pellets) and tested on three size groups of prawns, PL-20, juveniles (3-4 g) and adults (10 g) respectively.

Table 2: Ingredient composition (%) of prawn feeds I & II

Ingredients	Feed I			Feed II		
	Starter	Grower	Finisher	Starter	Grower	Finisher
Fish meal	40.00	35.00	30.00	20.00	17.00	15.00
Squid meal	5.00	5.00	5.00	2.00	2.00	2.00
Prawn head meal	5.00	5.00	5.00	8.00	8.00	8.00
Soybean meal	24.00	24.00	20.00	30.00	28.00	25.00
Gingelly cake	--	--	--	10.00	10.00	10.00
Wheat flour	10.75	15.75	9.25	20.25	25.25	9.50
Tapioca starch	--	--	6.50	--	--	--
Rice flour	--	--	8.00	--	--	10.00
Fish oil	4.00	4.00	5.00	2.00	2.00	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
<i>Spirulina</i>	0.20	0.20	0.20	--	--	--
Cholesterol	0.05	0.05	0.05	--	--	--
Vitamin Mix *	1.00	1.00	1.00	0.50	0.50	0.50
Mineral Mix **	5.50	5.50	5.50	2.75	2.75	2.75
Guar gum	1.00	1.00	1.00	1.00	1.00	1.00

* Vitamin mixture provided: Vit A 6.0, Vit D 0.05, Vit E 100, Vit K 20, Choline chloride 1500, Niacin 100, Riboflavin 40, Pyridoxine 50, Thiamine 30, Pantothenic acid 100, Biotin 2.0, Folic acid 5.0, Vit B-12 0.10, Inositol 250, Vit C 1200, Filler 6596.85 mg/kg feed.

** Mineral mixture provided: Calcium phosphate (dibasic) 8.5, Calcium carbonate 6.25, Potassium phosphate 35.0, Magnesium sulphate 2.5, Manganese sulphate 0.02, Zinc sulphate 0.10, Ferric chloride 0.05, Copper sulphate 0.06, Potassium iodide 0.007, Cobalt sulphate 0.0009, Selenium chloride 0.0005, Chromium sulphate 0.0005 and Filler 2.0111g/kg feed.

At the end of a 60 day laboratory feeding trial, the average growth recorded in the case of the first and second feed formulations with the three grades of feeds viz., 'Starter', 'Grower' and 'Finisher' was 0.4 g, 9.5 g and 15.7 g respectively for feed I and 0.37 g, 9.3 g and 13.7 g respectively for feed II, from an initial average weight of 0.01 g, 4.3 g and 10.1 g respectively. The FCR registered by the three grades of feed I ranged from 2.0-2.3. However, with feed II the FCR ranged from 2.49 for 'Starter' to 6.92 for 'Finisher'. Production trials of feed I were conducted to standardize processing technology.

Formulation and testing of micro-particulate feeds for prawn larvae

A micro-particulate test diet was formulated in three grades viz., 50, 200 and 500 micron particle size, for larvae and postlarvae of tiger prawn, *P. monodon*, with clam meat (25%), squid meal (17%), fish meal (16%), casein (11%), soybean meal (16%), yeast (2%), *Spirulina* (1%), lecithin (0.5%), cholesterol (0.5%), wheat flour (5%) and vitamin and mineral mix (2% each). The diet was prepared by the freeze-drying technique using a combination of gelatin and gaur-gum (1% each) as binder. The following experimental regime was adopted in laboratory trials to test the diet on protozoa of *P. monodon*.

Treatment	Feed combination	
	Diatoms (%)	Particulate diet (mg/larvae)
I (control)	100	0
II	75	0.04
III	50	0.08
IV	25	0.12
V	0	0.16

The average survival of postlarvae was 32, 36, 23, 20 and 12% respectively, for treatments I to V. The larvae metamorphosed to postlarvae on the 9th day in treatment I, though best survival was obtained in treatment II. These results indicate that micro-particulate diet can be used successfully at 25-50% replacement levels of live-algal diet without affecting development, growth and survival of the larvae.

Formulation of feeds for broodstock prawns

With the objective of developing a suitable feed formula for broodstock prawns in captivity, three different test feeds were formulated using clam meat, squid meal, anchovy meal, soybean meal, *Artemia* biomass, polychaete worms and other additives. Details of feed composition are given in Table 3. The freeze-drying technique was employed for preparation of feeds. Feeding trials with broodstock prawns are underway.

Prawn feed production trials

A 50 kg capacity steam cooker was added to the existing feed mill equipment at Ennore Field Centre. In order to improve water stability of prawn feed pellets, the feed mix containing 26% water was steam-cooked without pressure at 100°C, for 10 minutes, to gelatinise starch. Following this procedure, production trials of CIBA/TPG/II (extensive type) and CIBA/TPG/IV (semi-intensive type) were carried out. Details are given in Table 4.

A total quantity of 1,000 kg of the extensive type feed was produced and used in feeding trials conducted at the Puri Research Centre. Another 600 kg of semi-intensive feed was produced and is being tested on tiger prawn at the Muttukadu field centre.

Table 3: Ingredient composition (%) of test feeds for broodstock prawns

Ingredients	Feed No.		
	1	2	3
Clam meat	30.0	28.0	26.0
Squid meal	25.0	22.0	20.0
Fish meal (anchovy)	18.0	17.0	16.0
Soybean meal	10.0	10.0	10.
<i>Artemia</i> biomass	--	6.0	--
Polychaete worms	--	--	10.0
Cholesterol	0.3	0.3	0.3
Lecithin	1.0	1.0	1.0
Yeast	2.0	2.0	2.0
<i>Spirulina</i>	1.0	1.0	1.0
Vitamin mixture	1.0	1.0	1.0
Mineral mixture	3.0	3.0	3.0
Guar-gum	1.0	1.0	1.0
Starch	7.7	7.7	7.7

Table 4: Ingredient composition (%) of feeds CIBA / TPG / II and CIBA / TPG / IV

Ingredients	CIBA / TPG / II	CIBA / TPG / IV
Fish meal	26.0	40.0
Prawn head meal	5.0	5.0
Squilla meal	5.0	--
Squid meal	5.0	5.0
Soybean meal	22.0	25.0
Wheat flour	--	10.8
Tapioca starch	28.0	--
Alfalfa meal	2.0	2.0
Fish oil	--	3.0
Shark liver oil	3.0	--
Lecithin	2.0	0.5
<i>Spirulina</i>	--	0.2
Yeast	--	1.0
Guar gum	--	1.0
Vitamin and mineral mix.	2.0	6.5

Formulation and production of feed for finfishes

A feed was formulated for milkfish *C. chanos* and grey mullet *M. cephalus* using fish meal (16%), soybean meal (20%), groundnut oil cake (14%), gingelly oil cake (10%), wheat bran (10%), rice bran (10%), tapioca starch (16%), soybean oil (2%) and vitamins and minerals (2%). The feed has a moisture content of 8.66%, crude protein 34.31% and fat 4.05%. About 750 kg of this feed was prepared and is being tested on milkfish at Muttukadu farm.

Use of growth promoter

An organic compound, tiamulin hydrogen fumarate (Tiamutin) having both growth promoting and anti-bacterial properties, was incorporated in a standard feed formula at 0, 100, 200 and 400 mg/kg feed and tested on the tiger prawn *P. monodon*. The results have shown that Tiamutin at 100 mg/kg feed has a positive growth promoting effect.

Feeds and feeding practices in brackish-water prawn farms

As a part of the database for R & D in brackishwater prawn farming, a survey was conducted on the feeds and feeding practices adopted by prawn farmers in the states of Andhra Pradesh and Tamil Nadu. The information obtained from seven districts of Andhra Pradesh and four districts of Tamil Nadu is being processed.

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

Madras: S.V. Alavandi (PL), K.K. Vijayan, S.S. Mishra and K.V. Rajendran

Narakkal: S.M. Pillai

Disease investigations in penaeid prawns

Disease problems in hatchery and farm were monitored and investigated. Tiger prawn, *P. monodon* samples from Nellore were found to contain *Moraxella* sp. and *Aeromonas* sp., while water and soil samples were dominated by *Vibrio* sp. and *Aeromonas* sp. Prawn samples from Tuticorin, were characterised by a yellow-orange discolouration of the gills, attributed to environmental stress and no bacterial infection was observed.

A ciliate protozoan, *Zoothamnium*, the causative agent for fouling disease, was recovered from the gills of *P. monodon* in the culture ponds at Muttukadu. A mild to heavy infection of a cephaline gregarine parasite has been noticed in wild *P. indicus* juveniles collected from the lagoon at Muttukadu.

Disease investigations in finfishes

Fish samples from the backwaters of Muttukadu were examined for parasites. Taxonomic identification of the causative agent, histopathological manifestations and the ecological aspects of the parasitation are being investigated in detail. Studies on cardiac myxosporeosis in *E. suratensis* were carried out. Besides, parasites viz., the isopod *Caligus* sp. and a ciliate protozoan *Trichodina* sp. have been recorded from this fish.

A heavy infection of monogenetic trematode, *Diplectanum latesi*, on the gills of seabass *L. calcarifer*, caused total mortality of broodstock at Muttukadu. Secondary infection due to *Aeromonas hydrophyla* was also observed.

Immuno-diagnostic tests

Immuno-diagnostic tests viz., dot immunoassay, enzyme-linked immunosorbent assay (ELISA) and fluorescent antibody technique (FAT) are being developed and standardised for rapid diagnosis of shrimp

bacterial diseases. Sensitivity of dot immunoassay and ELISA was 2 ng and 50 ng of bacterial (*Vibrio parahaemolyticus*) antigen respectively. Cross reaction with *V. alginolyticus* and *Aeromonas* sp. was observed in these tests. Hence, attempts are now being made to prepare monospecific sera using cross adsorption tests, in order to increase the specificity of the tests. Anti-rabbit sera was raised in guinea pigs and Fluorescein-iso-thiocyanate (FITC) conjugate was prepared for use in FAT. The test is now being standardised.

Development of vaccine for Vibriosis

Three isolates of *V. alginolyticus* were tested for their virulence in tiger prawn, *P. monodon*. Approximately 6-16 g size *P. monodon* were injected with 0.1 ml of bacterial dilutions ranging from 10^6 - 10^8 per ml. One isolate produced 100% mortality. Preparation of vaccine using this bacterial isolate is in progress.

Physiological responses of prawns to important environmental factors (TID/EP/1)

Madras: A.R. Thirunavukkarasu (PL), K.K. Vijayan and P.S.P. Gupta

Influence of salinity and pH on growth rate and moulting frequency in *P. monodon*

Salinity

Intermoult prawns in the size range of 100-112 mm/9.7-12.3 g, were exposed to different salinity levels viz., 5, 10, 15, 25, 35 and 45 ppt, for a period of 30 days. They were maintained on a diet of fresh clam meat fed *ad libitum*. Sampling was done every 10 days. Details of growth and moulting frequency are presented in Table 5.

Better growth rate and moulting frequency were recorded in 15 ppt followed by 10 and 25 ppt.

pH

Intermoult prawns of two different size groups viz., 70-80 mm/2.2-4.7 g and 105-118 mm/10.3-13.8 g were exposed to different pH levels viz., 6, 8 and 10 for a period of 30 days. The former size group was maintained on a diet of fresh clam @ 20% of body weight and the latter size group was fed *ad libitum*. Details of growth, moulting frequency and FCR recorded, are presented in Table 6.

Table 5: Moulting frequency and gain in weight in different salinity ranges

Salinity (ppt)	Gain in weight (wet weight g)	Moulting frequency (hr)
5	1.86 ± 0.14	360
10	2.90 ± 0.06	360
15	2.94 ± 0.18	192
25	2.60 ± 0.03	240
35	1.09 ± 0.61	420
45	1.04 ± 0.81	640

Better growth rate and conversion efficiency were obtained in pH 8. Though moulting was faster in pH 6, it is not reflected in growth, indicating that energy has been utilised to combat the low pH stress condition.

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

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

Narakkal: L. Krishnan

Studies were conducted on the cryopreservation of milt in the mullet, *Liza macrolepis*. The effect of different extenders and cryoprotectants was assessed based on

the evaluation of sperm motility and sperm concentration. Direct correlation was observed between optical density of milt and sperm concentration.

The spermatozoa exhibited good pre-freeze motility (>80%) in the extender Fish Ringer with 5% DMSO (Dimethylsulphoxide) as cryoprotectant. The post-thaw motility ranged between 30-50%. Fertilization of ova of *L. macrolepis* was achieved with cryopreserved milt, the rate of fertilization being 40-50%.

Gel electrophoresis of extracts obtained from thoracic ganglion of female and male *P. monodon* indicated the presence of an extra protein fraction of low molecular weight in the female.

Table 6: Moulting frequency and gain in weight in different pH levels

pH	Wet wt. gain (mg)	Moulting frequency (hr)
Expt. 1		
6	1.19	190
8	1.17	204
10	0.56	261
Expt. 2		
6	2.05	220
8	3.68	285
10	1.96	565

AQUACULTURE ENGINEERING AND ENVIRONMENT DIVISION

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

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

Kakdwip: R.K. Chakraborti

Effect of different water salinity levels on the decomposition of organic manures

Madras

Two experiments, each in triplicate, were conducted to study the decomposition of organic manures at different water salinity levels. Surface saline soil samples collected from Mahabalipuram with the following characteristics: sand 51.0%, silt 13.0%, clay 36.0%, pH 7.8, EC 13.2 mmhos/cm, CaCO_3 1.0%, organic carbon 0.12%, available phosphorus 3.0 mg/100 g soil and available nitrogen 18.8 mg/100 g soil, were treated with dried and powdered cattle manure @ 1 and 2% in the first experiment and similarly with chicken manure @ 0.3 and 0.6% in the second experiment. Soil samples (1 kg each) were submerged in water (30 cm water column) at four different salinities viz., 0, 10, 20 and 30 ppt. The experiment was conducted in the dark for a period of 37 days. Nutrient concentration and hydrological characteristics were noted on day 3, 6, 9, 12, 15, 22, 29 and 37.

The average concentration of free CO_2 in water under chicken manure treatment decreased with increasing salinity, whereas in the case of cattle manure it increased, though no definite trend was observed. A decrease in the concentration of dissolved oxygen was also observed at all salinity levels due to the application of both organic manures; the magnitude of decrease being generally higher with cattle manure. In the

control (without organic manure) the free CO_2 content was nil. The average pH of water showed a decreasing trend with both manures, which may be attributed to the formation of free CO_2 and organic acids.

The amount of available nitrogen ($\text{NH}_4^+ + \text{NO}_3^-$) in water increased gradually with days of incubation in both manure treated series, the maximum concentration being observed on the 29th day. It was also observed that the concentration of NH_4^+ was always higher than NO_3^- . The concentration of available phosphorus in water was also found to increase with days of incubation. The maximum release of phosphorus in water was noticed on the 12th day at all salinity levels with both manure treatments.

In order to assess the rate of mineralisation of organic manures at different salinity levels, the soil samples were removed from the containers at the end of the experiment and are being analysed for available phosphorus, available nitrogen and organic carbon.

Kakdwip

A similar experiment was conducted for a period of 51 days, using cattle manure @ 1% and 2%, at a water salinity of 10 ppt, using mudflat soil. It was observed that in both treatments, available nitrogen and available phosphorus increased in water with days of incubation, with maximum levels recorded on day 37 and 51 respectively.

With regard to soil, the salt content increased with days of incubation, with a simultaneous increase in organic carbon. However, available nitrogen and phosphorus decreased.

Survey of coastal saline soils at Karaikal

Karaikal region of Pondichery was surveyed to assess the suitability of the area for aquaculture. The sites surveyed were situated at Akkravattam, Oduthurai and Vanjoor. The physico-chemical characteristics of the soil and water analysed from the different sites are given in Table 7.

Case study of brackishwater pond soil during culture and harvest

In order to study the changes in soil characteristics of brackishwater prawn culture ponds, nine farms located in Nellore Dist. of Andhra Pradesh (5 semi-intensive and 4 extensive) were selected. Soil samples were collected during grow-out and harvest periods and were analysed for pH, organic

Table 7: Soil and water characteristics of Akkravattam, Oduthurai and Vanjoor in Karaikal

Parameters	Akkravattam	Oduthurai	Vanjoor		
			1	2	3
<u>Soil</u>					
Sand (%)	82.5	66.5	82.0	82.5	62.5
Silt (%)	0.5	5.5	1.0	0.5	7.5
Clay (%)	17.0	28.0	17.0	17.0	30.0
pH	8.2	7.6	7.4	7.4	7.7
Organic carbon (%)	0.5	0.5	0.4	0.4	0.8
CaCO ₃ (%)	0.3	0.3	0.8	0.5	0.5
EC (mmhos/cm)	5.8	23.0	8.5	6.3	29.9
<u>Water</u>					
Salinity (ppt)	36.0	-	-	-	28.0
pH	8.0	-	-	-	7.5
CO ₃ ⁻ Alkalinity (ppm)	18.0	-	-	-	Nil
HCO ₃ ⁻ Alkalinity (ppm)	88.0	-	-	-	130.0
Total Alkalinity	106.0	-	-	-	130.0

Table 8: Characteristics of pond soil under semi-intensive and extensive culture in Nellore district, A. P.

Parameters	Semi-intensive		Extensive	
	Grow-out	Harvest	Grow-out	Harvest
pH	7.30 - 7.40	7.90 - 8.10	7.30	8.00
Org. C (%)	0.38 - 0.43	0.67 - 0.76	0.50	0.72
Eh (mV)	-133.00 to -149.00	-185.00 to -194.00	-153.00	-166.00

carbon and electrical conductivity and the details are presented in Table 8. It was observed that during the harvest period there was an increase in pH and organic carbon. Reducing conditions of bottom sediment were also high.

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

Madras: P. Lakshmanadoss

Design and development of automatic feed dispenser

The inner trays and outer container of the feed dispensing unit were designed. The inner trays are coupled with the square-threaded shaft, operated by an electric motor, through the reduction gear. Feed dispensing set to different intervals can be controlled by a timer-linked switch system. The circuit and wiring diagram of the control system have been prepared. Trials with a prototype have been carried out and the system is working as per design.

Use of non-conventional energy resources for brackishwater aquaculture

The installation of a geared windmill at Muttukadu, to pump saline ground water to the ponds, is nearing completion. NEPC-

MICON is supplying and commissioning the geared windmill under government subsidy basis. A 1 m dia. open well with precast cement collars, is to be constructed for the wind mill.

Design and development of water temperature control unit

A temperature control unit has been fabricated to raise the water temperature by 4°C i.e. from 28 to 32°C. An open circular tank (400 l capacity) was supplied with air circulation and provided with the two heating coils (each 2 KW capacity). The time taken to raise the temperature by 4°C was found to be one hour. The total power consumed was calculated to be 4 KW/hour-4 units.

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

Further improvements in construction of the prawn hatchery at Chinnaveerampatinam, belonging to the Government of Pondichery, were suggested. The drainage system for the prawn hatchery of the Institute at Muttukadu has been designed in detail and the drawings prepared. The fish hatchery of the Institute to be constructed at Muttukadu has been designed and drawings completed.

EXTENSION, ECONOMICS AND INFORMATION DIVISION

Investigations on the brackishwater aquaculture practices adopted by different categories of farmers - An integrated approach

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

shrimp farming practices was taken up in the districts of Tamil Nadu and Andhra Pradesh. Forty-two farms in the three districts of Andhra Pradesh viz., Krishna, Guntur and Kakinada and twelve farms in two districts of Tamil Nadu viz., South Arcot (Chidambaram and Cuddalore) and Nagai Quaid-e-Milleth were surveyed. The details of the data collected are presented in Table 9.

Collection of data on the existing

Table 9: Basic data on aquaculture practices in Andhra Pradesh & Tamil Nadu

State / District	Area	Type of culture	Seed source	Total no. of farms	Feed source	Remarks
ANDHRA PRADESH						
KRISHNA	Krutivenu Pedaydaru Venkatadurgapuram	Extensive Improved extensive Extensive	Wild	11	Local & Imported	Black gill disease reported
	GUNTUR Karalapalem Adavaldeevi Thummala	Extensive " "	Wild	10	Imported	Pesticide and industrial pollution reported
KAKINADA	Chollangi Coringa Polykurru Gaddimoha Bhairavalanka Seetharamapuram	Semi-intensive and modified extensive	Wild	21	Local & Imported	Pollution from locally prepared feeds
TAMILNADU						
SOUTH ARCOT	Chidambaram	Improved extensive &	Hatchery	23	Imported	Disease reported
	Cuddalore	Semi-intensive				
NAGAI-Q-MILLETH	Sirkazhi Radhanallur Mahendrapalli Periamedu	Improved extensive & semi-intensive	Hatchery	12	Local & Imported	--

Extensive and improved extensive culture was practised in Krishna and Guntur districts, whereas in Kakinada, improved extensive as well as semi-intensive culture was done.

Most of the farms depended on wild seed collection, while a few depended on hatchery-reared seed. The stocking density adopted in improved extensive farming ranged from 15,000-35,000/ha, while in semi-intensive it ranged from 1-1.5 lakhs/ha. The production recorded in the former system varied from 100-700 kg/ha in Kakinada and 1,000-1,250 kg/ha in South Arcot, while in the latter it varied from 1,000-3,500 kg/ha and 3,500-4,000 kg/ha in Kakinada and South Arcot respectively. Pelleted brand feeds both Indian and imported

were generally used in semi-intensive culture in all the districts surveyed. Pollution due to sugar and paper factory effluents and instances of diseases were also reported.

Primary and secondary data collected from the field are being compiled and tabulated in computer spread sheets. The analysis of cost-volume-profit with reference to Krishna Dist. was performed and results are presented in Table 10.

The extension requirements of the farmers were also recorded from the above said districts. The farmers expressed the need for short-term training programmes, simple scientific literature on shrimp culture technology, low-cost feed and hatchery seed for culture.

Table 10: Cost-volume-profits of brackishwater shrimp farms under different systems of operation in Krishna district of Andhra Pradesh.

System of operation	Fixed costs (Rs/ha)	Variable costs (Rs/tonne)	Break even output (kg)	Profits at break even output (Rs/ha)
Extensive	11,575	14,955	250	26,189
Improved extensive	18,376	56,840	750	90,756
Semi-intensive	27,735	1,60,509	1,000	11,755

EXTERNALLY FUNDED PROJECTS

Projects funded by Dept. of Biotechnology

1. 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 - D. Narayanaswamy
(Principal Investigator), M. Natarajan
and C. Gopal

The requirements of essential amino-acids was determined for *P. monodon* juveniles using purified experimental diets with casein, egg albumin and gelatin as the protein source. The protein level was kept at 40% and lipid at 8%, based on requirement studies of earlier experiments. The aminoacid composition of the feed ingredients viz., casein and gelatin was manipulated by adding free aminoacids so as to obtain the aminoacid profile similar to prawn tail muscle. Subsequently, graded levels of different aminoacids were added at different concentrations. Based on the growth, survival and FCR, the dietary requirements of the aminoacids viz., arginine, leucine, lysine, methionine and histidine were found to be 3.70, 1.03, 4.36, 1.64 and 1.43% of protein respectively. The requirement of polyunsaturated fatty acids viz., linoleic acid and linolenic acid in the diet was found to be 0.10 and 0.05% respectively.

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

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

Four test feeds were formulated using 14 different indigenous feed ingredients and further fortified with essential minerals, vitamins and permitted growth promoters and feed attractants. In each formulation, three grades of feeds viz., starter, grower and finisher were tested on postlarvae, juveniles and sub-adults of *P. monodon* in laboratory experiments. In a 60 day feeding trial, with one of the feed formulations which included fish meal, squid meal, squilla meal and soyabean cake as protein source, the prawns exhibited good growth, survival and FCR.

Water stability of pelleted feeds was tested using natural feed binders viz., wheat flour, maida, corn starch, rice flour and tapioca starch in combination with guar gum. The moisture content and the degree of steam-conditioning required with regard to the same was also worked out. The results indicated that a mixture of wheat flour and maida used in combination with 3% guar gum rendered 6 hours water stability of pellets.

Recent information on the nutritional requirements of *P. monodon* and *P. indicus* was compiled. A data file on feed ingredient profile with information on chemical composition and nutritional quality of 45 indigenous raw materials has been prepared.

Project funded by ICAR/National Agricultural Research Project (NARP/II/1 RD), Aquaculture: Basic research on pond bio-energetics, digestive enzymes and micro-flora 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. Alagarwami
Personnel - M. Natarajan (Project-in-Charge), N. Kalaimani, T.C. Santiago, K.K. Vijayan, S. Ahamad Ali, D. Narayanaswamy, S.V. Alavandi and S.S.Mishra

Isolation and identification of gut microflora with special reference to chitinolytic, cellulolytic and proteolytic activity and selection of bacteria with enhanced enzyme activity:-

The bacterial population did not show significant variation in the gut samples of captive and wild *P.monodon* (10^7 - 10^8 /g sample), whereas it showed wide fluctuation in both wild and captive *M.cephalus* (10^7 - 10^9 /g sample). The hindgut in fish harboured relatively larger number of bacteria than the foregut.

The gut bacterial flora of *P. monodon* was represented by *Vibrio*, *Aeromonas* and *Lucibacterium* spp. A gram positive bacterium *Bacillus* sp. was also recovered from wild prawns. The bacteria isolated from gut of *M. cephalus* had similar generic composition as observed in prawn. Other bacteria viz., *Pseudomonas*, *Alcaligenes*, *Moraxella* and a gram positive cocci, *Micrococcus* have also been isolated from fish. Twenty-two bacterial isolates from wild prawns and 20 from captive have been obtained. Similarly, 44 bacterial isolates from wild fish and 16 from captive, have been isolated.

The bacterial isolates from wild prawns were found to be active degraders of chitin and protein, whereas those from captive prawns exhibited high proteolytic and lipolytic activity. The bacterial isolates from wild fish gut samples exhibited proteolytic and lipolytic activity, while those from captive fish showed only high proteolytic activity.

Identification of digestive enzymes viz., proteases, lipases, carbohydrases and chitinases in digestive tract, changes in

enzyme profile and activity at different stages of growth and studies on factors such as substrate concentration, pH and temperatures which alter enzyme activity:-

Standard enzyme assay techniques were used to analyse the enzyme activity in the digestive tract tissues of both captive and wild prawn/fish.

The α -amylase activity in *P. monodon* (PL 32) ranged from 14-1,505 μ mol/min/g tissue at 37°C (pH 6.9) and was active in the temperature range of 20-50°C with highest activity at 40°C. With regard to pH, maximum activity was recorded at pH 6.9, with detectable enzyme activity over a pH range of 6-8.

A linear relationship was observed between amylase activity and size of animal, smaller animals exhibited low activity than the larger ones. Amylase activity in hepatopancreas and intestinal tissues of captive adult prawns was relatively low.

α -glucosidase activity in the hepatopancreas, stomach and intestinal tissues of juvenile captive prawns was in the range of 3,044-20,522, 708-6,521 and 562-2,470 μ g glucose/min/g tissue at 37°C (pH 6.0) respectively. The hepatopancreas of wild adult prawn recorded an activity of 3,381 μ g glucose/min/g tissue.

α -glucosidase activity in the liver and intestinal tissue of *M. cephalus* (8-13 g) was in the range of 1,436-2,019 μ g and 555-581 μ g glucose/min/g tissue respectively at 37°C and pH 6. The wild fish exhibited an activity of 432-1,255 μ g glucose/min/g of liver tissue.

Trypsin activity ranged from 9,940-14,295 Units/g tissue at pH 7.8 in the hepatopancreatic tissue of captive *P. monodon* (PL 32). The liver sample of wild mullet recorded chymotrypsin activity of 32 Units/g tissue.

Activity levels of enzyme in relation to starvation and environmental parameters viz., temperature, salinity and pH:-

P. monodon (60-100 mm/2-8 g) were exposed to different salinities viz., 5, 15, 25, 35 and 45 ppt for a period of 30 days under controlled conditions (pH 8 ± 0.2 ; temperature 27-29°C). Tissue samples were collected on day 0, 10, 20 and 30 and analysed for activity levels of various enzymes.

In another experiment, the prawns were exposed to different pH levels viz., 6, 8, and 10 with salinity maintained at 25-28 ppt and temperature between 27-29°C for a period of 30 days. Tissue samples were collected as above and activity levels of various enzymes recorded. Studies are in progress.

Similar experiments on the effect of starvation and temperature on digestive enzyme activity in *P. monodon* are in progress.

Analysis of selected feed ingredients for proximate composition and determination of apparent digestibility coefficient in the post-larvae, juvenile and adult *P. monodon*, determination of ammonia excretion in relation to quality of feed ingredient:-

Feed ingredients representing protein (both plant and animal), carbohydrate and lipid sources, cellulose, single cell proteins and chitin were selected and their proximate composition analysed. The results are presented in Table 11.

The digestibility coefficient of live feed ingredients viz., fish meal, squid meal, soybean meal, prawn head waste and squilla meal was determined by feeding standard diets containing 65% of each ingredient to three size groups of *P. monodon* (group I

1 g; group II 4-5 g and group III 10-12 g) for a period of 20 days, using chromium oxide as an inert marker. In general, the digestibility of these ingredients appears to be better in smaller prawns (group I) and tends to be lower in larger-sized prawns. Between the feed ingredients tested, squid meal and squilla meal had higher dry matter content and protein digestibility followed by soybean meal, fish meal and prawn head waste in all the three size groups of prawns.

Project funded from AP Cess Fund

Impact of brackishwater aquaculture on the environment

Coordinator - Dr. K. Alagaraswami
Principal Investigator - K.O. Joseph
Personnel- B.P.Gupta, S.V. Alavandi and P.S. Sudheesh

The study on the impact of brackish-water aquaculture on the environment was continued. Three farms at Pudiparthi village (Nellore Dt.) practising semi-intensive culture, one farm at Krishnapatnam (Nellore Dt.) practising improved extensive culture and one farm at Tuticorin practising intensive shrimp farming, were selected for detailed study.

Water, sediment, plankton, benthos and bacteriological samples collected periodically from inflow and effluent channels, culture ponds and adjoining creek/sea during culture period (March/April to July 1993) were analysed. The wastes discharged during the harvest period (August 1993) and the heavy metals and pesticide residues in water were also analysed.

Increased COD levels and formation of noxious H₂S were observed at the end of the culture period in farms at Nellore, whereas this was not the case at Tuticorin, due to the presence of an effective central drainage system with a relatively higher water exchange rate (30-35% per day as against 5% per day at Nellore).

Table 11 : Proximate composition (%) of selected feed ingredients

Name of ingredient	Moisture	Crude protein	Crude fat	Nitrogen free extract / Carbohydrate	Crude fibre	Ash
A. Protein-rich material						
Plant origin						
Soybean cake	10.45	51.50	1.00	19.70	8.85	8.50
Sunflower cake	7.00	26.69	2.04	26.44	30.13	7.70
Gingelly cake	9.76	38.71	6.00	25.82	10.69	19.02
Groundnut cake	13.85	46.93	5.00	17.23	8.90	8.09
Animal origin						
Fish meal	10.80	48.02	5.40	3.27	1.73	30.78
Squid meal	8.40	46.58	4.40	15.83	3.98	30.81
Silk worm pupae (Defatted)	7.30	62.17	1.75	8.40	ND	5.59
B. Chitin-rich material						
Prawn head waste	9.91	39.83	9.60	4.14	16.34	20.18
Squilla meal	15.70	33.23	4.40	4.34	5.69	36.64
C. Carbohydrate-rich material						
Wheat flour	12.50	12.50	2.00	70.00	1.75	1.25
Maida	12.26	11.07	0.33	75.19	trace	1.15
Corn flour	13.20	1.78	0.40	82.62	1.00	1.00
Tapioca	4.80	2.00	0.54	87.41	3.80	1.45
D. Non-conventional material						
Bagasse	6.93	3.02	5.85	54.32	26.88	3.00
Alfalfa	10.10	17.00	3.00	34.17	24.00	11.73
Ipil-ipil	11.54	31.07	7.02	33.42	7.47	9.48
Duckweed	6.80	13.13	7.32	ND	ND	15.50
E. Single cell protein						
<i>Spirulina</i>	6.89	60.89	9.00	10.22	trace	13.00
Yeast	10.53	35.45	6.00	43.04	trace	4.98

ND - Not determined

Increased levels of COD, turbidity, nitrate, ammonia, phosphate and total suspended solids were recorded in the effluent than influent water (Table 12). In contrast, nitrite levels were lower or equal in effluent water. Similarly DO was also lower. Further increase in concentrations of above mentioned parameters in effluent water was observed during the harvest period (Table 12).

Recovery in levels of DO, ammonia and total suspended solids to desired water quality was not achieved even at a distance of 500 m from the effluent outfall area at Kandaleru creek (DO 3.0 ppm, ammonia 1.8 ppm and total suspended solids 3,528 ppm). However at Tuticorin, near seawater characteristics were observed at a similar distance from the effluent outfall area (DO 5.4 ppm, ammonia 0.16 ppm and total suspended solids 68.6 ppm).

The concentrations of most heavy metals were below detection levels. However, zinc was detected in borewell water (0.38 mg/l) and creek (1.35 mg/l) in Kandaleru. Low levels of mercury (0.0003 mg/l) were observed in influent seawater at Tuticorin. The pesticide concentrations were also below detection level except for BHC residue (0.032 mg/l) detected at Kandaleru creek.

An increase in organic carbon content (0.31 to 1.2%) and development of highly reducing conditions (Eh -200 mV) was noted

in the pond soils at Nellore at the end of the culture period. A similar trend was observed in the effluent channel and creek sediments. At Tuticorin, organic carbon did not show much increase (0.12 and 0.38%).

Phyto- and zoo-plankton showed a more or less uniform species composition in all samples. The major phyto-groups observed were *Pleurosigma* sp., *Nitzschia* sp. and filamentous green algae.

Benthic organisms were dominated by gastropods, polychaetes and amphipods. The species diversity and abundance was more in extensive culture systems than in semi-intensive farms. In general, sampling points at the effluent discharge area in all ponds, showed a relatively abundant population of macrobenthos.

The bacterial population in the effluent water and soil samples was generally higher than in the inflow area and general pond system. The bacterial population of soil was relatively lower during the culture phase. However, difference in their levels during culture and harvest periods was not evident in the improved extensive farms. At Tuticorin, the bacterial load in pond water, discharge water and effluent water during the culture period was heavy when compared to the inflow water. The enteropathogenic bacterium *Salmonella* sp. was not encountered in any of the farms. The bacterial flora were chiefly represented by the following genera: *Pseudomonas*, *Aeromonas*, *Vibrio*, *Flavobacterium*, *Moraxella*, *Acinetobacter* and *Bacillus*.

Table 12: Water quality characteristics of influent and effluent water during culture and harvest periods in semi-intensive shrimp culture systems in Nellore district, A.P.

Parameters	Culture period		Harvest period
	Influent	Effluent	Effluent
DO (ppm)	5.8	4.5	Trace
Turbidity (NTU)	6.0	20.8	280.0
Total suspended solids (ppm)	49.0	68.8	11,760.0
Phosphate (ppm)	0.006	0.1	14
Nitrate (ppm)	0.11	0.16	0.3
COD (ppm)	17.2	22.8	210.0
Ammonia (ppm)	0.06	0.19	2.9
Nitrite (ppm)	0.04	0.04	0.05

LIST OF PUBLICATIONS 1993-94*

Alagaraswami, K. 1994. 'Environmental Planning for Aquaculture'. Paper presented at the Seminar on Shrimp/ Prawn Aquaculture - A management perspective, organised by Aquastride Biotech Pvt. (Ltd.), at Madras on 6-8 January 1994.

S. Ahamad Ali, D. Narayanaswamy, C. Gopal and K. Alagaraswami 1993. 'Nutrition and Feed Technology for Cultured Prawns.' Paper presented at the Symposium on Aquatic Resources Conservation and Reservoir Fisheries, 23-24 December 1993, at Bhopal.

Gopinath, M., M. Krishnan and T. Ravisankar. 1993. Trends in exports of agricultural and agro-based products exports from India in the light of the New Economic Policy. *Proc. Agri. Econ. Res. Review*, IARI, New Delhi, February 24-25, pp 51-52.

James, D.B., M. Kathirvel, K. Ramadoss and A. Chellam. 1993. The spawning of the holothurian *Actinopyga mauritiana* (Quoy and Gaimard) on board FORV *Sagar Sampada*. *J. mar. biol. Ass. India*, **35**: 220-221.

Joseph, K.O. and J.P. Srivastava. 1993. Heavy metal load in edible oyster, *Crassostrea madrasensis* (Preston) from Ennore estuary in Madras. *J. Environ. Biol.*, **14**(2): 119-125.

Joseph, K.O. and J.P. Srivastava. 1993. Pollution of estuarine systems: Heavy

metal contamination in the sediments of estuarine systems around Madras. *J. Indian Soc. Soil Sci.*, **41**(1): 79-81.

Joseph, K.O. and J.P. Srivastava. 1993. Mercury in finfishes and shellfishes inhabiting Ennore estuary. *Fishery Technology*, **30**(2): 115-118.

Joseph, K.O., J.P. Srivastava and P.M.A. Kadir. 1993. Acute toxicity of five heavy metals to the prawn, *Penaeus indicus* (H. Milne Edwards) in brackishwater medium. *J. Inland Fish. Soc. India*, **24**(2): 82-84.

Mohamed, K.S., K.K. Vijayan and A.D. Diwan. 1993. Histomorphology of the neurosecretory system in the Indian white prawn, *Penaeus indicus* H. Milne Edwards. *Bull. Inst. Zool., Academia Sinica*, **32**(1): 39-53.

Rajendran, K.V. and K.P. Janardanan. 1993. Studies on the life-cycle of *Tremiorchis ranarum*. *J. Helminthol.* (U. K.), **67**: 95-101.

Vijayan K.K. S.K. Mohamed and A.D. Diwan. 1993. On the structure and molt controlling function of the Y-organ in the prawn, *Penaeus indicus*. *J. World Aquacult. Soc.*, **24**(4): 516-521.

Vijayan K.K. and A.D. Diwan. 1994. The mandibular organ of the prawn, *Penaeus indicus* H. Milne Edwards and its inconsequential role in moulting process. *J. Aqua. Biol.*, **9** (1 & 2): 45-46.

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

PERSONNEL
(Not a Gradation List)

DIRECTOR
Dr. K. ALAGARSWAMI

SCIENTISTS

Principal Scientist

Dr. K.V. Ramakrishna
Shri A.V.P. Rao
(Voluntary retirement on 5.4.1993)
Shri K.N. Krishnamurthy

Scientist S-3

Dr. R.D. Prasadam

Senior Scientist

Dr. L. Hanumantha Rao
Dr. Mathew Abraham
Dr. A. Laxminarayana
Dr. S. Kulasekarapandian
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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
(Joined the Institute on 1.10.93 after
the completion of the deputation at
Jadavpur University)
Dr.(Smt.) Munawar Sultana
Dr. M. Natarajan

Scientist (Selection Grade)

Shri K. Devarajan
Shri Hardial Singh
(On deputation to Punjab Agro-In-
dustrial Corporation w.e.f. 1.3.1994)

Shri S.R. Das
Dr. P. Ravichandran
Shri M. Kathirvel
Dr. A.R. Thirunavukkarasu
Shri R.K. Chakraborti
Shri S. Srinivasagam
Shri D. Narayanaswamy
Shri N. Kalaimani

Scientist (Senior Scale)

Shri B.K. Banerjee (w.e.f. 1.7.1987)
Dr. M. Krishnan (w.e.f. 29.3.90)
Dr. K.O. Joseph (w.e.f. 1.7.1990)
Dr. C. Gopal (w.e.f. 22.2.1991)
Shri S.V. Alavandi (w.e.f. 29.4.1993)

Scientist

Dr. K.K. Vijayan
Shri T. Ravisankar
Kum. D. Deboral Vimala
Dr. (Kum) Shiranee Periera
Dr. S.S. Mishra
Dr. J.V. Ramana
Dr. P.S.P. Gupta
Dr. P. Kishore Chandra
Shri. V. Chellapandian
Shri P.S. Sudheesh
Dr. K.V. Rajendran
Smt. Imelda Joseph
Dr. K. K. Krishnani
(Joined the Institute on 30.3.1994)

Technical Officer

Shri P. Lakshmanadoss, T-7
(Engineer)

Dr. V. Sreekrishna, T-6
(Resigned on 13.4.1993)
Shri Ashish Chowdhury, T-5
Shri P.M.A. Kadir, T-5

Technical Assistant

Shri R. Elangovan, T-4
Shri N. Venugopal, T-4
Shri S. Krishnan, T-4
(Promoted to T-4 from 1.1.1993)
Shri S. Sivagnanam, T-II-3
Shri S. Gopalakrishnan, T-II-3
Shri R. Puthiavan, T-II-3
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Asst. Finance & Accounts Officer

Shri S. Krishnaswamy

Senior Stenographer

Shri N. Raghavan

Assistant

Smt.S. Bhagirathi
Shri R. Palaniswamy
(deputation from CICR w.e.f. 2.7.1992)

Senior Clerk

Shri A.B. Mondal
Shri K. Baburajan
(Reversion to CMFRI
w.e.f. 13.11.1993)

Shri P. N. Rajasekharan Nair
(Reverted to Junior clerk
w.e.f. 7.11.1993)

Junior Stenographer

Shri P. Prasad
(Transferred to CICRI,
Kasargod w.e.f. 30.4.1993)
Shri S.K. Halder

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
Shri S. Pari

AUXILIARY PERSONNEL

Driver

Shri M.G. Subramani, T-I-3
Shri M. Gopinathan Nair, T-2
(Promoted to T-I-3 w.e.f. 1.1.1989)
Shri B.B. Roy, T-I-3
(Promoted to T-I-3 w.e.f. 1.7.1989)
Shri P.C. Mohanty
Shri K. Paranthaman

SUPPORTING STAFF

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S.S.Gr. III

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Shri Sita Ram Das
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Shri Gunadar Das

Shri L.C. Manna
Shri Prakash Chandra Saha

S.S.Gr. II

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Shri Dhaneswar Das
Shri R.K. Behera
Shri Shyam Bhoi
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Shri P. Arumugam
Shri Baman Jally
Shri N. Mani
Shri R. Subramani
Shri Sasadar Betal
Shri R.B. Das
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Shri Krishna Pada Naskar
Smt S. Santhi
Shri Premanda Bisoi
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Shri K. Nityanandam
Shri M. Subramani
Smt Lakshmi Rani Bhuiya
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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

