



वार्षिक प्रतिवेदन
Annual Report
1989-'90



केन्द्रीय खारा जल जीव पालन अनुसंधान संस्थान
(भारतीय कृषि अनुसंधान परिषद)

१२, लीथ कैसल स्ट्रीट, सांथोम, मद्रास-६०००२८

CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
12, LEITH CASTLE STREET, SANTHOME, MADRAS-600 028



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12, LEITH CASTLE STREET, SANTHOME, MADRAS-600 028

Published by

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Cover Photo

Induced bred, hatchery reared
90 days old fingerlings of the
grey mullet, *Liza macrolepis*.

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ANNUAL REPORT 1989-90*

INTRODUCTION

Brief History

The Central Institute of Brackishwater Aquaculture (CIBA) was established on 1st April 1986 during the VII Five Year Plan as a part of the reorganization of the Fisheries Research Institutes of the Indian Council of Agricultural Research. Three Research Centres of the erstwhile Central Inland Fisheries Research Institute located at Kakdwip, Puri and Madras and the Prawn Hatchery Laboratory of the Central Marine Fisheries Research Institute located at Narakkal were transferred to the new Institute. While the above establishments formed the Non-Plan components, the Institute was provided with Plan components of additional staff, equipments and infrastructure.

The Council took the decision in 1989 to permanently locate the Headquarters of the Institute at Madras, accepting the offer of lands made by the Government of Tamil Nadu. An area of 53.51 ha at Mamallapuram was taken over for the establishment of the experimental farm. The allotment of lands at Adyar for the Headquarters, at Pallikaranai for staff quarters and at Muttukadu for the experimental hatchery was pursued with the Government of Tamil Nadu.

Mandate

The mandate of the Institute during the VII Plan was :

* The Report covers the period from 1-1-1989 to 31-3-1990

- to conduct multi-disciplinary, mission-oriented applied research to develop appropriate technologies for the culture of brackishwater finfish and shellfish to augment production,
- to provide information base for sustained growth and accelerated development of both industrial and artisanal culture fisheries in the brackishwater sector, and
- to provide development support through education, training, technology transfer and linkages.

Organisation and Facilities

The research programmes of the Institute were organised under three divisions. The Crustacean Culture Division looked after the programmes relating to development of technologies for the breeding and seed production of penaeid prawns, culture of prawns in grow-out systems, design and lay-out of hatcheries and *Artemia* cyst and biomass production. The Finfish Culture Division took up work on development of captive broodstock of brackishwater fishes, breeding and seed production, and culture of fish both in mono and polyculture systems. Resource and Technology Improvement Division worked on aspects of fish and prawn nutrition and feed technology. The Training, Extension and Information Division and Fish Farm Survey and Engineering Research Division could not be organised as yet at divisional level, due to lack of the

required number of scientists in the concerned disciplines. However, work under these divisions was carried out by the available scientists from other divisions. The Library and Documentation section was further strengthened with additions of books and periodicals. Co-ordination work was looked after by Technical Cell.

The Institute's headquarters continued to function from hired buildings at Madras while the work was carried out from Ennore Field Centre. The Pulicat Field Centre was closed down as the programmes taken up there had been completed. The Kakdwip Research Centre has a brackishwater farm, laboratory and administrative building and staff quarters. Puri Research Centre continued to function from hired building with field work at Chilka lake. Narakkal Research Centre has an experimental prawn hatchery and a nursery farm. The administrative control of the Krishi Vigyan Kendra at Kakdwip was transferred to Central Inland Capture Fisheries Research Institute, Barrackpore as per the decision of the Council with effect from 1st August 1989.

The administrative work of the Institute was carried out from the Headquarters and also with some minimum staff at the Research Centres.

Major achievements

Considerable progress was made in the research programmes of the Institute, especially in hatchery technology and culture of prawns, induced breeding and seed production of finfish, nutrition and development of feed technology for prawns and fish.

Further improvements in inducing maturation of *Penaeus monodon* under controlled conditions were made with water manage-

ment and feeding protocols. In a flow-through system with 200-300% exchange of seawater per day, *P. monodon* developed fully mature gonads 6-22 days after unilateral eye-stalk ablation. The prawns were fed with meat of mussel, squid, crab, polychaetes and goat liver in various combinations. The mature prawns spawned 3-4 times in a period of 45 days. In the breeding of the white prawn, *Penaeus indicus*, comparable results were obtained in egg production, fertilization and percentage of hatching both in second generation prawns obtained through *in vitro* fertilization and normally bred prawns. Better survival and growth of postlarvae of *P. monodon* was observed with *Artemia* biomass as food as compared to egg custard feed.

A detailed study of the confined prawn culture system in the fringe of Chilka lake in Orissa was conducted and data on soil and water quality, productivity and prawn production have been collected and analysed. Based on this study certain practices for pond management and feeding have been evolved for testing towards improving prawn production in this system operated by the economically weaker sections of the society.

The proximate composition of raw materials like prawn waste, squilla, fish meal, squid waste, groundnut oil cake, soy cake, wheat bran, rice bran and tapioca was studied. Squid waste has been found to have the highest percentage of protein (67.8%) and lipid (19.5%) and gave an FCR value of 1.3 in a 30 day experiment on *P. indicus* (16-40 mm TL).

The Institute developed its capability to produce adequate quantities of formulated feeds in pellet form for field trials using the simple feed processing equipment at Ennore. A total of 2.5 tonnes of pelleted prawn feed with a protein content of 35%

was prepared. The feed showed high acceptability by *P. monodon* in the ponds at Kakdwip and had a water stability for more than four hours. Feeding experiments with mullet fry of 30-35 mm with formulated feeds gave encouraging results. Feed II gave better survival (73%) and gain in weight (385%) than Feed I (67% and 246% respectively). Experiments conducted on the juveniles of pearlspot *Etroplus suratensis*, with six diet formulations indicated the protein requirement to be 37%. Studies were also conducted to evaluate their essential amino acid requirements.

Successful results in the induced breeding of *Mugil cephalus* and *Liza macrolepis* were obtained at Puri and at Ennore respectively. A total of 50,000 one-day old larvae of *M. cephalus* obtained by induced spawning

at Chilka lake mouth area were transported to Puri laboratory with oxygen packing and reared in water of 20 ppt salinity for a period of ten days. At Ennore, *L. macrolepis* was bred and 60,000 fertilized eggs were obtained. A survival rate of 37% was realised up to the fry stage. The fry have been further reared under hatchery conditions exclusively on pelleted feed.

The stock of *Liza tade* at Kakdwip farm was affected by ulcerative syndrome under low saline conditions during September 1989. *L. parsia* in the same farm was not affected. Treatment with potassium permanganate and water exchange enabled full recovery of the affected stock. The problem was investigated with the help of the Central Inland Capture Fisheries Research Institute.

K. ALAGARSWAMI,
Director.

GENERAL INFORMATION

Workshop

A workshop was organised by the Institute on Brackishwater Finfish Breeding and Seed Production at Madras on 6th and 7th December 1989, with an objective to make a critical review of the work done in India on the breeding of brackishwater finfishes, to identify the manpower, technical and infrastructure constraints and to consider and recommend future directions for basic and applied research in the field with prioritisation. The workshop was inaugurated by Dr. P. V. Dehadrai, Deputy Director General (Fisheries), Indian Council of Agricultural Research. The technical sessions of the workshop were attended by 58 scientists drawn from I.C.A.R. Headquarters, Central Institute of Brackishwater Aquaculture; Central Institute of Freshwater Aquaculture; Central Marine Fisheries Research Institute; Kerala Agricultural University; FAO Bay of Bengal Programme; University of Madras; Anna University; Zoological Survey of India; Viswa Bharati University; Post-graduate Institute of Basic Medical Sciences and Department of Fisheries, Government of Tamil Nadu as well as experts in the field. A total of 11 invited background papers on the subjects of broodstock development and management, reproductive physiology and endocrinology, induced maturation and breeding, nutritional requirements and seed production techniques were presented and discussed.

The recommendations of the Workshop, in brief, are as follows :

— *Lates calcarifer*, *Mugil cephalus* and *Etroplus suratensis* are identified as

priority species for strategic research in the next five years.

- *Mugil cephalus* may be taken up as a model species for all basic studies on reproductive physiology and endocrinology.
- Specific identity of all grey mullets of India may be correctly established.
- Land-based hatchery systems at C.I.B.A. and sea-based breeding systems at C.M.F.R.I. may be established.
- In programmes on breeding and seed production of brackishwater fishes, collaboration with FAO Bay of Bengal Programme may be considered.
- C.I.B.A. may develop a model brackishwater finfish hatchery, obtaining design from outside the country, if required.
- Detailed studies on gonadotropin-releasing hormones, gonadotropin(s), steroids, prolactin and other hormones may be taken up on collaborative basis between ICAR Research Institutes and Universities.
- Techniques for short-term and long-term preservation of gametes may be developed.
- Use of hormones and their synthetic analogues for inducing maturation, vitellogenesis, ovulation/spermiation and spawning may be standardised.
- The role of environmental factors in regulating reproduction processes may be properly studied,

- The nutritional requirements of different stages in the life history of brackish-water fishes may be studied and formulated, balanced feeds for broodstock, larval stages, fry and fingerlings and grow-out culture may be developed.
- Research on live food culture of phytoplankton and zooplankton may be intensified with a wider species range for high density culture.
- The value of SCP, duckweeds, marine fungi and detritus in fish nutrition may be properly evaluated.
- *Artemia* cyst and biomass production programme may be expedited and techniques be developed within the time frame of about three years.
- C.I.B.A. may serve as nodal agency for brackishwater fish breeding information system and publish technical bulletins. C.I.B.A. may also develop technology packages for fish seed production.
- Standing Committee on Brackishwater Aquaculture Development, Government of India, Ministry of Agriculture, DOAC, New Delhi.
- DOD Committee for funding for Drought Relief Hi-Tech Aquaculture.
- Study Group on Fisheries, Ministry of Agriculture.
- Dr. M. S. Swaminathan Research Foundation, Madras.
- Governing Body of the Agency for Development of Aquaculture in Kerala.
- Technical Director of the Tamil Nadu Pearls (P) Ltd., Madras.
- Chairman, Expert Group to study removal of stake/Chinese nets from fishing in Brackishwaters of Kerala.

Shri Hardial Singh, Scientist SG, served as a member of the Research Committee on Sunderbans Biosphere Reserve.

Drs. L. Krishnan, S. M. Pillai and K. M. Das, Scientists (SG) served as members of Brackishwater Fish Farmers' Development Agency, Puri.

National Science Day

As part of the National Science Day celebrations, exhibition and group discussions with farmers were organised at the Headquarters and the Research Centres on 28th February 1989, 5th March 1989 and 7th March 1990.

Services in committees

Dr. K. Alagarwami, Director, served as a member of :

- DOD Steering Committee—S & T Programme on Poverty Alleviation, Government of India, New Delhi.
- Standing Committee of Government of Pondicherry on Brackishwater Aquaculture Development.

Training

The Institute organised a two-week training programme in prawn hatchery technology to Shri. Gangadhar V. Maddikere, Assistant Director of Fisheries, BFDA, Karwar, Karnataka from 21-8-1989 to 2-9-1989 at the Ennore field hatchery.

A training programme on prawn hatchery technology was organised at the Narakkal Research Centre from 22-1-1990 to 17-2-1990 and ten Fisheries officials from the maritime states of Gujarat, Karnataka, Kerala, Pondicherry, Orissa and West Bengal, participated in the training programme.

A batch of fisher-youth deputed by the Commissionerate of Fisheries, Government of Gujarat, underwent training for 45 days from 1-2-1990 to 17-3-1990 at the Kakdwip Research Centre. The training course included site selection, farm layout, design and construction of farm, collection and segregation of seed, pond preparation, culture systems, management, nutritional aspects etc.

Library and Documentation

The library of the Institute was strengthened further with the acquisition of 389 books during the period. To meet the reference needs and for updating the current knowledge of the scientists, subscriptions to 27 Indian and 30 foreign journals were also made. Establishment of exchange relationship with Indian, foreign and International Organisations and Institutions was made for publications of mutual interest. The library section catered to the needs of scientists, students/scholars of other organisations besides meeting the reference needs of the Institute's staff.

Publications

The following publications were brought out from the Institute during the year :

Special publication on the workshop on Brackishwater Finfish Breeding and Seed Production

Annual Report of the Institute for the year 1988.

Manpower Development

Shri S. Srinivasagam, Scientist (SG) after completion of the one year course for Senior Aquaculturists at SEAFDEC, Philippines under FAO/NACA fellowship, resumed his duties on 18th March 1989.

Smt. Munawar Sultana, Scientist (SG) underwent training in Integrated fish farming held at Wuxi, People's Republic of China between 12th April 1989 and 20th August 1989 under the FAO/NACA programme.

Dr. S. M. Pillai, Scientist (SG), underwent a training programme in 'Fish Nutrition' under the ICAR/INRA workplan at the Station d'Hydrobiologie, Saint Pee Sur Nivelle, France from 23rd September 1989 to 4th November 1989.

Shri K. N. Krishnamurthy, Principal Scientist, underwent a course on 'Human Resources Development' at NAARM, Hyderabad, from 22nd August 1989 to 2nd September 1989.

Seminars/Symposia/Workshops

The Director and the scientists of the Institute participated in the following symposia/seminars/workshops :

- Workshop on *Artemia* culture, organised by FAO/BOBP Madras, 4-5 May 1989; Shri A.V.P. Rao, Dr. L. H. Rao and Dr. S. Kulasekara Pandian.
- Workshop on Sagar Sampada at Central Marine Fisheries Research Institute, Cochin, 5-7 June 1989; Dr. K. Alagar-swami. The Director also chaired one Technical session.
- Third National Fish Seed Congress, Madras 8-9 July 1989; Dr. K. Alagar-swami, Dr. Mrs. T. Rajyalakshmi, Dr. K. V. Ramakrishna, Shri A. V. P. Rao and Shri K. N. Krishnamurthy.
- World Bank/UNDP/FAO/EEC Seminar on International Fisheries Research Needs for Developing Countries, Madras, 12-13 July 1989; Dr. K. Alagar-swami.

- National Workshop on Soil Resource Mapping of different states in India-Nagpur, 19-22 July 1989: Dr. B. P. Gupta.
- National Seminar on Livestock and Fisheries Production organised by Tamil Nadu Veterinary and Animal Sciences University, Madras, 21-22 September 1989: Dr. K. Alagarwami, Dr. S. K. Pandian, Dr. C. P. Rangaswamy and Smt. Munawar Sultana. The Director chaired a session.
- National Workshop on Coastal Zone Management of Tamil Nadu, organised by Centre for Water Resources, Anna University, Madras, 14 October 1989: Dr. K. Alagarwami and Shri K. N. Krishnamurthy.
- National Workshop on Brackishwater Prawn Farming for Higher Production, Bangalore 23-25 October 1989: Dr. K. Alagarwami, Shri A. V. P. Rao and Dr. L. H. Rao.
- National Workshop on Brackishwater Finfish Breeding and Seed Production organised by Central Institute of Brackishwater Aquaculture, Madras 6-7 December 1989: All the scientists of Central Institute of Brackishwater Aquaculture at headquarters, Dr. L. Krishnan, Dr. S. M. Pillai and Shri Hardial Singh from Research Centres.
- Regional Workshop on Aquaculture, organised by CIBA and M/s. Hindustan Lever Ltd., Visakhapatnam, 12 December 1989: Dr. R. D. Prasadam and Dr. K. Gopinathan.
- 77th session of the Indian Science Congress, Cochin, 4-9 February 1990: Dr. K. Alagarwami.
- National Workshop on Ulcerative Disease Syndrome in Fish, Calcutta, 6-7 March 1990: Dr. K. Alagarwami.

Meetings

Dr. K. Alagarwami, Director, attended the following meetings :

Specialists' Group Meeting on Developing Agriculture, Animal Husbandry and Fisheries in Goa, organised by CPCRI (ICAR) at Goa, 13-14 February 1989.

- In-House Review Meeting, Indian Council of Agricultural Research, New Delhi, 28-30 March 1989.
- As Expert Group Member of Marine Products Export Development Authority Shrimp Hatcheries at Gopalpur and Mangamaripeta, 3-7 March 1989.
- Indian Council of Agricultural Research Directors' meeting, New Delhi, 16-17, May 1989.
- Evaluation committee meeting of Tamil Nadu Pearls (P) Ltd., Tuticorin, 19-20, May 1989.
- Meeting of ICAR Directors, New Delhi, 26-27 May 1989.
- Meeting of Directors to discuss Draft Report of Working Group on Agricultural Research and Education, New Delhi, 8-10 July 1989.
- Working Group on Fisheries meeting of the Planning Commission, New Delhi, 25 July 1989.
- Indian Council of Agricultural Research Regional Committee No. VIII meeting Pondicherry, 7-8 August 1989.
- Steering Committee of the National Workshop on Prawn Farming—con-

- vened by the Ministry of Agriculture, Bangalore, 17 August 1989.
- Steering Committee of the National Workshop on Prawn Farming, New Delhi, 5 October 1989.
 - Central Institute of Fisheries Education Syllabus Committee, Bombay, 2-4 November 1989.
 - Central Institute of Fisheries Education Research Council Meeting, Bombay, 28-29 November 1989.
 - Agency for Development of Aquaculture with Kuwait Fund Assistance, Kerala, Trivandrum, 30 November and 1 December 1989.
 - Tamil Nadu Cauvery Delta Farmers' Association, meeting to discuss appropriate technologies in fish farming, Thanjavur, 14 March 1990.
 - ICAR Directors' conference, New Delhi, 27-28 March 1990.
 - Dr. K. V. Ramakrishna, Principal Scientist, attended the Research Review Meeting of CARI Port Blair, A & N Islands 22-24 September 1989.

Budget

		1989-90	
		(Rs. in lakhs)	
		Budget Estimate	Expenditure
Plan	...	48.00	47.89
Non-Plan	...	60.00	59.55

Visitors

The following dignitaries visited the Headquarters of the Institute and its Research Centres during the period :

- Dr. N. G. P. Rao, Chairman, ASRB, New Delhi.
- Dr. P. V. Dehadrai, Deputy Director General (Fisheries), I.C.A.R., New Delhi.
- Dr. K. Radhakrishna, Asst. Director General (Fisheries), I.C.A.R., New Delhi.
- Dr. P.S.B.R. James, Director, C.M.F.R.I., Cochin.
- Dr. V. R. P. Sinha, Director, C.I.F.E., Bombay.
- Dr. A. G. Jhingran, Director, C.I.C.F.R.I., Barrackpore.
- Dr. S. D. Tripathi, Director, C.I.F.A., Bhubaneswar.
- Dr. E. G. Silas, Vice-Chancellor, Kerala Agricultural University, Trichur.
- Dr. A. N. Bose, Retired Vice-Chancellor, Jadavpur University.
- Dr. M. Sakthivel, Director, M.P.E.D.A. Cochin.
- Shri S. Machendranathan, I.A.S., Director of Fisheries, Government of Tamil Nadu, Madras.
- Shri P. Krishnan, Joint Director of Fisheries, Government of Tamil Nadu, Madras.
- Dr. P. Govindarajulu, Professor of Endocrinology, Institute of Basic Medical Sciences, Taramani, Madras.
- Dr. T. Subramoniam, Professor of Zoology, University of Madras, Madras.
- Dr. Ronald Robert, Director, Institute of Aquaculture, University of Stirling, Stirling, Scotland, U.K.
- Dr. John F. Wood, ODNRI, London.
- Dr. Janet H. Brown, Institute of Aquaculture, University of Stirling, Stirling, Scotland, U.K.

Mr. Charles H. Antholt, Institute of Aquaculture, University of Stirling, Stirling, Scotland, U.K.

Shri A. D. Isaac Rajendran, Consultant, BOBP/ODA, Madras.

Oastug Lansen, Habyalirana Jean Baptiste, Mboneye Enlade, Uweerh Marie Jeanne, Officials, Department of Agriculture, Kigali, Rwanda.

Prof. R. Natarajan, Anna University, Madras.

Dr. A. K. Bandopadhyay, Director, C.A. R.I., Port Blair.

Dr. Pedini, F.A.O., World Bank Reconnaissance Team.

Prof. U. K. Srivastava, Indian Institute of Management, Ahmedabad.

Dr. B. K. Dholakia, Indian Institute of Management, Ahmedabad.

Shri C. V. S. Rama Rao, Director of Fisheries, Pondicherry.

A Team of Officials from the Australian Trade Commission.

Collaboration

A collaborative programme on the Development of water-stable feed for the shrimp *P. monodon* grown under artisanal aquaculture in India has been taken up between FAO/BOBP and CIBA with support from ODA Post-harvest Project of the Bay of Bengal Programme. Kakdwip Research Centre of CIBA is engaged in field testing of the feed formulated and manufactured as per ODA specifications, at its experi-

mental farm at Kakdwip. The project commenced work in March 1990.

Deputation

The services of Shri A. V. P. Rao, Principal Scientist, were lent to WAPCOS (Water and Power Consultancy Services India Ltd.), a Government of India undertaking, as Fisheries expert for their project in Indonesia, on improvement of water supply to Tambaks in South Sulawesi, during March 1989 for a period of three months in two spells.

Consultancy Services

The Institute took up a consultancy for Behavioural Science Centre, St. Xavier's Non-formal Education Society, Ahmedabad to do a feasibility study of Bhal area, Cambay Taluq, Kheda District, Gujarat, for brackish-water aquaculture. The study was completed by Dr. K. Alagarwami, Director, Dr. B. P. Gupta, Scientist SG and Shri K. O. Joseph, Scientist and a report was submitted.

Visits

Dr. K. V. Ramakrishna, Principal Scientist, visited Bangladesh under the ICAR/ BARC workplan 1987-88 in the field of Fresh and Brackishwater fish culture from 15 July 1989 to 5 August 1989.

Dr. A. Laxminarayana, Scientist (SG), visited Bangkok, Thailand, during 12-16 September 1989 to attend the FAO expert consultation group discussion on small scale prawn hatcheries.

PROGRESS OF RESEARCH

CRUSTACEAN CULTURE DIVISION

Breeding and Seed Production of *Penaeus monodon* (CCD/HT/1.1)

Madras : A. V. P. Rao (PL), K. Alagar-swami, L. H. Rao, S. Radhakrishnan, S. Srinivasagam, B. P. Gupta, S. Kulasekara-pandian and V. Sreekrishna.

Induced maturation of *Penaeus monodon*

During the year, improved results were obtained at the Ennore hatchery facility in induced maturation of prawns by employing a flow-through system with 200% exchange of water per day and experimenting with different combinations of natural foods. In 1.5 t capacity FRP tanks 4 to 6 ablated females with an equal number of males were held for 45 to 60 days. When fresh flesh of squid/mussel/crab was supplemented with goat liver and fresh polychaete worms, repeated spawnings (13 spawnings

in 60 days, 14 spawnings in 45 days and 16 spawnings in 50 days) were recorded, as compared to no spawning or delayed spawning with distorted eggs observed in tanks where goat liver and polychaete worms were not added (Table 1). In the above experiments flesh of squid/mussel/crab formed 12-15%, while goat liver and polychaete worms formed 1-2% of the body weight of the experimental prawns which were held in diffused light of 40-60 lux intensity.

Successful and repeated spawnings in the above experiment were observed at a salinity of 34-36 ppt, whereas there was no spawning at 30-31 ppt.

Larval rearing of *P. monodon*

The results of larval rearing from nauplii to PL 2-5 at a density of 100 nauplii/litre

TABLE 1. Effect of goat liver and polychaete worms as feed components on spawning of *Penaeus monodon*

Feed items	Level of feeding (%)	Feeding frequency	No. of		No. of spawnings recorded	No. of eggs (x10 ⁴)	Remarks
			♀	♂			
1. Fresh tissue of squid, Mytilus and crab	15.0	Thrice a day	4	4	2	13 spawnings in 60 days	5.2- Viable nauplii in 9 spawnings
Goat liver and polychaete worms	2.0	Once a day at 4-5 pm					
2. Fresh tissue of squid, Mytilus and crab	15.0	Thrice a day	4	4	2	No spawning	—

with conventional larval feeds (*Chaetoceros*+*Brachionus*+ egg yolk suspension/egg custard) showed a survival of 39%. In all, 34 trials were done in larval rearing. In 10 trials the survival at PL 5 ranged between 29% and 56.2% (average 44%). In 15 trials it was low (1.5% to 22.8%) due to non-synchronisation of culture of live food organisms with larval rearing and mechanical failure of aeration systems. In the remaining nine trials there was mortality at early stages. Addition of EDTA to seawater in 3 trials conferred only a marginal advantage in larval production over sea-

and Tamil Nadu and to the Nutrition Section of the Institute for experimental work.

Algal culture

The local strains of *Chaetoceros affinis* (both single-celled and chain forms), isolated from Ennore backwaters, were cultured in indoor and outdoor conditions. Under temperature-controlled conditions, the effect of light intensity on the growth kinetics of *Chaetoceros affinis* was studied and found that maximum multiplication takes place at light intensity of 1500-2200 lux (Table 2).

TABLE 2. Effect of light intensity on growth kinetics of *Chaetoceros affinis* in 2 l Haffkin flasks in air-conditioned laboratory

Light intensity (lux)	Initial density (cells/ml)	Final density (cells/ml)	Period of growth (hours)	pH
500-800	0.5×10^5	$1.4-2.2 \times 10^5$	72	8.5-8.8
1000-1500	0.5×10^5	$4.0-5.8 \times 10^5$	72	8.5-9.0
1500-2200	0.5×10^5	$6.2-7.6 \times 10^5$	72	8.5-9.0

water not treated with EDTA (24% and 19.8% respectively). The results obtained with different experimental larval feeds were not conclusive.

Postlarval rearing

In the experiment to test *Artemia* biomass as food on the growth and survival of *P. monodon* postlarvae from PL 5 to PL 20, the maximum average length recorded was 14.4 mm as against 11.7 mm obtained in the control where egg custard was given as feed. The average survival in the replicates with *Artemia* biomass as food was 63% (range 51-81%) as compared to 59% in the control.

The project supplied in all 85,570 post-larvae to Departments of Fisheries of Goa

Table 3 gives the comparative production levels of *Chaetoceros affinis* under outdoor and indoor light conditions. The indoor cultures could be maintained in 200 l perspex tanks for a longer period (48-60 hr) under controlled light intensity of 2500-3000 lux as compared to the 24-30 hr period for outdoor cultures, where the light intensity ranged between 10,300 and 1,32,000 lux.

In outdoor cultures of *Chaetoceros*, addition of bakers' yeast at 10 ppm to the modified 'F' medium treated seawater at 1 ml/l yielded higher cell densities ($6.3-10.3 \times 10^5$ cells/ml) as compared to their multiplication in the control without baker's yeast ($4.3-5.0 \times 10^5$ cells/ml).

TABLE 3. Comparison of production rates of *Chaetoceros affinis* in outdoor and indoor light conditions (Chain form and single cell form)

Tank Volume : 200 l

Period	Outdoor/ indoor	Light intensity (lux) (10^3)	Production (cells/ml $\times 10^6$)	
			range	Average
April-June	Outdoor	41.5-120.0	1.5-7.0	3.4
July-September	Do.	10.3-132.0	1.1-5.2	3.8
October-December	Do.	25.5-128.0	1.4-3.4	2.8
January-March	Indoor	2.5-3.0	4.4-8.8	6.5

TABLE 4. Production of *Brachionus plicatilis* using different feeds and with different levels of inoculum

Culture duration (days)	Rotifer inoculum size (no./ml)	Feed*	Final density of rotifer (no./ml)
14	10	A	90
	10	B	138
	10	C	120
14	20	A	98
	20	B	157 (av. of 2 trials)
	20	C	126 (av. of 2 trials)
15	15	A	96
	15	B	140
	15	C	126
9	20	A	98
	20	B	142
	20	C	128
8	15	A	90
	15	B	140
	15	C	105

* A—*Chaetoceros affinis* @ 15×10^4 cells/rotifer/day

B—*Chlorella* sp @ 15×10^3 cells/rotifer/day

C—Baker's yeast @1 g/one million rotifers/day

Rotifer culture

Mass culture of *Brachionus plicatilis* was carried out in plastic pools (90 cm and 120 cm dia and 60 cm height) kept outdoor using saline water (20-30.5 ppt) enriched with Yashima medium. The rotifers were fed with *Chlorella* at 1,50,000 cells/individual per day along with Baker's yeast at 1g/million rotifers/day. The population density increased from the initial 5-18 individuals per ml to 42 to 156 individuals per ml in 5-6 days.

Further experimentation was carried out using different levels of inoculum and for different durations using different feeds with two replicates for each treatment (Table 4). The results indicate short duration culture of 8 days with an inoculum size of 15 rotifers per ml and feeding with *Chlorella* sp. gives a better result than cultures for longer period of 14 or 15 days.

Tolerance of larvae to NH₃-N

Two experiments were conducted to find out the tolerance levels of protozoa II and mysis II stages of *P. monodon* to ammonia. The water quality parameters in this experiment were, salinity 32-34 ppt, total alkalinity 140-141 ppm, Nitrite-N 16-18 g/l. After a 24 hour exposure to ammonia, it was noticed that total mortality of protozoa II took place at concentrations of 14.42 mg/l and above. At 6.69 mg/l the survival was 66.6%. Estimated LC 50 value was 8.60 mg/l which is equivalent to 0.8058 mg/l of unionised ammonia. In the case of mysis II, total mortality was observed at 61.2 mg/l of total ammonia. At 29.66 mg/l the survival rate was 26.6%. The estimated LC 50 value was 17.90 mg/l which is equivalent to 1.9161 mg/l of unionised ammonia.

Breeding and larval rearing of *Penaeus japonicus*

Four spawners of *P. japonicus* were collected from the wild. These were 175 mm/70 g, 210 mm/85 g, 210 mm/85 g and 245 mm/105 g and produced respectively, 23,000, 460,000, 64,000 and 445,000 eggs. The hatching rates ranged from 43.5% to 63.8%. Due to poor survival in different stages of larval rearing, only 31,428 PL2 could be produced from the first, third and fourth spawners above and the larvae from the third spawner suffered total mortality at mysis stage. From the fourth spawner, 6118 PL20 were obtained. The rearing was done with the feed of *Chaetoceros* (20,000 cells/ml), egg yolk (10-15 particles/ml) and rotifer (10/ml) upto PL2 stage and green mussel tissues and whole egg custard at 10-15 g/day/t of water from PL2 to PL20. These were raised to juveniles (50-80 mm) with mussel meat as food.

Maturity was induced in three females (50-85 g) through unilateral ablation of eyestalk. Though maturity was recorded in 5-9 days after ablation, the females did not spawn.

Breeding and seed production of *Penaeus indicus* (CCD/HT/1.2)

Narakkal: A. Laxminarayana (PL), S. Kulasekarapandian (upto 4 July 1989), S. M. Pillai (from 3 July 1989) and K. V. George.

In induced maturation experiments on *Penaeus indicus* at Narakkal the effect of three natural foods, viz., flesh of *Metapenaeus dobsoni*, clams *Villorita cyprinoides* and *Sunetta scripta*, was studied. It was observed that while the latency period between ablation and maturation was four days in the case of prawns fed with *M. dobsoni* and *S. scripta*, it was 5-6 days with flesh of *V. cyprinoides*. The percentage of

females which matured was 75.0 with *S. scripta*, 62.5 with *M. dobsoni* and 42.2 with *V. cyprinoides*.

Larval rearing of *P. indicus* done at four naupliar densities viz., 75, 80, 90 and 100 per litre gave a maximum survival rate of 62.3 for 75/l and minimum 43.0% for 90/l to PL5 stage. During the larval rearing, water was not changed till PL1 stage was reached. Nursery rearing of postlarvae from PL5 to PL20 at different stocking densities of 2, 3, 4, 6 and 8 per litre gave the highest survival of 80.5% at a density of 3 PL5 per litre.

Mixed culture of diatoms was done in one tonne capacity rectangular tanks using modified 'F' medium. At a temperature and salinity range of 24-32°C and 31-32 ppt respectively, the cell density varied between $1.0-1.25 \times 10^5$ cells/ml.

Layout, systems and design of small scale prawn hatchery (CCD/HT/1.4)

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

During the year the associates visited both the commercial hatcheries at Visakhapatnam and Gopalpur and studied in detail the various integrated systems for maturation, larval and postlarval rearing and live food cultures.

At Ennore hatchery the methods of algal and rotifer culture were further refined through experimentation and higher production of rotifers was obtained by feeding them with baker's yeast and of *Chaetoceros* by controlling the light intensity and temperature.

By tagging the broodstock prawns it was possible to follow the spawning cycles of individual prawns. The products of the

first three spawnings were better in respect of fertilization and hatching rates. Each prawn was found to spawn 3 to 5 times during 50 days.

Design for a small-scale prawn hatchery (2 million PL 20 per annum) was prepared for the Department of Fisheries, Pondicherry, incorporating all the systems and water-treatment methods. This hatchery design is meant for multi-species seed production. Also the design for a backyard hatchery for rearing PL5 to PL20 to be managed by groups of trained fishermen was given to the above Department.

Semi-intensive culture of *P. monodon* in tide-fed ponds (CCD/CP/1.1)

Kakdwip : Hardial Singh (PL), R. K. Chakraborti and H. S. Majumdar.

Three ponds in Sector B at Kakdwip Farm (Pond No. 6, 7 and 8 measuring 0.09, 0.275 and 0.375 ha respectively) were prepared by drying the pond and ploughing the pond bed. After treatment with lime, a basal dose of poultry manure at 500 kg/ha was applied. Tiger prawn seed (10-12 mm size) collected from nature were stocked during April-May 1989 at a stocking density of 96,000 no/ha and initially the stock was maintained only on natural food. However, to maintain a sustained production of natural food organisms poultry manure at 75 kg/ha was applied at monthly intervals. From middle of June 1989, pelleted feed with 38.9% crude protein was given to the stock and continued upto September. The experiment got vitiated due to entry of miscellaneous species and the survival and production of *P. monodon* was affected. Due to the monsoon, the salinity in the ponds was reduced from 26.3 ppt in May to 5.3 ppt in September, resulting in soft shelled condition of the 30% of the stock. Between July and September 1989, 122.5 cm

rainfall was recorded. The average values of physicochemical parameters of the water and soil in the ponds are presented in Table 5.

Monitoring of prawn culture in the Chilka lagoon under ERRP, ADAP and BFDA Schemes* (CCD/CP/1.2)

Puri: S. M. Pillai (upto 30 June 1989)
L. Krishnan (PL) (from 30 June 1989),
P. K. Ghosh and B. P. Gupta.

under the antipoverty schemes of the Government. The production of prawns has been low in the range of 100-592 kg/ha/year. In an attempt to understand the reasons for such low production, the ecological parameters of 12 ponds in Mudiratha, Deynai and Khandualpur clusters were studied in all the three seasons—summer, monsoon and winter of 1989-90.

Very low values of redox potential (—210 to —1600 mv) were recorded in all the ponds

TABLE 5. *Average hydrological conditions of P. monodon culture ponds in Sector B at Kakdwip farm during 1989*

Parameter	April	May	June	July	August	September
<i>Water phase</i>						
Depth (cm) ..	120.0	100.00	127.00	105.00	105.00	113.00
Temperature (°C) ..	30.9	31.40	30.80	29.90	31.50	30.50
Transparency (Secchi disc, cm) ..	28.0	29.00	34.00	29.00	29.00	28.00
Salinity (ppt) ..	21.5	26.30	22.00	10.30	6.70	5.30
pH ..	8.4	8.40	8.60	8.50	8.50	8.30
D.O. at 7 am (ppm) ..	7.2	6.80	5.20	6.70	8.10	6.90
Alkalinity (ppm) ..	142.0	152.00	142.00	92.00	74.00	68.00
Av. N (mg/l) ..	3.2	2.60	0.90	4.80	5.30	4.90
Av. P (mg/l) ..	0.4	0.36	0.06	0.20	0.25	0.18
<i>Soil phase</i>						
pH ..	8.00	8.20	8.50	8.35	8.75	8.30
Org. C (%) ..	0.36	0.44	0.27	0.36	0.30	0.42
Av. N (mg/100 g) ..	13.40	15.20	11.20	10.60	12.80	16.90
Av. P. (mg/100 g) ..	2.80	2.30	3.10	4.10	3.90	2.80
E.c. (mmhos/cm) ..	15.90	17.80	10.00	7.90	2.30	1.80

In Chilka lagoon in the confined rain-fed ponds, prawn farming has been in vogue since 1983, raising two crops per annum

* ERRP—Economic Rehabilitation of Rural Poor; ADAP—Area Development Approach Programme; BFDA—Brackishwater Fish Farmers Development Agency.

and especially during monsoon and winter (August and November) indicating conditions unfavourable to aerobic bacteria leading to poor mineralisation of organic matter. The organic carbon of the soil is low (0.17-0.75%). Available nitrogen and available phosphorus in the soil are low, as also the

C_aCO_3 . Higher level of iron in the soil (0.68-1.28%) and water (0.46-1.90 ppm) interfere with the phosphorus release and indirectly affect the production of prawns. Though liming is practised in all the ponds the dosage is highly variable.

The biological productivity of benthos and plankton has been low to medium. Among the three schemes, the ponds under ERRP scheme have comparatively low benthos and plankton. While the monsoon crop production ranges 35-500 kg per ha, the winter crop from ADAP scheme ponds was reported to be between 40-75 kg/ha. Details of production obtained in monsoon crop are given in Table 6. Flesh of *Pila*

the productivity of the soil and water has been suggested.

Prawn and fish production in perennial ponds (CCD/CP/1.4)

Narakkal : S. Kulasekarapandian, (PL upto 4th July 1989), A. Laxminarayana (PL from 5th July 1989), M. K. George (upto 31st Aug. 1989), Syed Ahmad Ali and K. V. George.

The 0.6 ha perennial pond at Narakkal Farm was treated with 252 kg quicklime on 1-4-1989 and was stocked with 30,570 hatchery-reared PL20 seed of *Penaeus indicus* of average size 29.4 mm/132mg on 12-4-1989.

TABLE 6. Production data of *P. monodon* from the confined ponds in the Chilka lagoon during the monsoon crop of 1989

Scheme	Pond No. and (area in ha)	Stocking density (No./ha)	Survival (%)	Culture period (No. of days)	Av. weight at harvest (g)	Production rate kg/ha/crop
BFDA	1 (0.40)	10,000	80.0	180	27.0	202.5
	2 (0.16)	15,000	80.0	210	30.0	315.0
	3 (0.16)	15,000	96.0	180	30.0	480.0
	4 (0.18)	25,000	60.0	210	30.0	500.0
ADAP	1 (0.50)	15,500	64.5	180	30.0	250.0
	5 (0.50)	6,000	93.3	195	27.0	154.0
	13 (0.50)	10,000	47.2	195	27.0	136.0
	16 (0.50)	22,000	32.1	105	45.0	404.6
ERRP	31 (0.20)	20,000	7.5	143	25.0	35.0
	32 (0.20)	10,000	95.0	150	27.0	282.5
	33 (0.20)	10,000	66.5	150	28.0	180.0
	34 (0.20)	10,000	90.5	150	30.0	300.0

globosa is the only feed given to prawns and the quantity and frequency of feeding are dependent on the availability of material. Based on the results of this detailed study a set of recommendations for improving

Supplementary feeding with a formulated pelleted feed composed of prawn head waste, fish meal, groundnut cake and tapioca, and fortified with vitamin and mineral mix was done from 22-4-1989 to 22-6-1989 at

the rate of 10% of the biomass of prawns. During the 72 days culture period the temperature, salinity and dissolved oxygen were in the ranges of 29°-32°C, 4.5-17.4 ppt and 2.14-6.8 mg/l, respectively.

The pond was again stocked with 5,000 fry of *Liza parsia* of average size 18.3 mm/1.0 g and 300 fry of *Mugil cephalus* of average size 21.4 mm/1.5 g at an overall stocking density of 8,800 mullets per ha on 10th August 1989.

Colonisation of the pond by the clam *Villorita cyprinoides* in large numbers resulted in poor growth of shrimp as well as fish. This has become a major problem in the region and a study of *Villorita* occurrence was initiated. An area of 1050 ha of Pōkkali fields and 150 ha of perennial fields are under prawn culture in Vypeen island. The presence of *Villorita cyprinoides* is restricted to the perennial fields. The absence of *Villorita* in seasonal fields may be attributed to the fact that these are dried and raked for paddy cultivation every year during the summer months of April and May. These fields are generally shallow (about 0.5 m depth) compared to perennial fields which are deeper (1.2 m depth).

Artemia biomass and cyst production in the laboratory and salt-pans (CCD/AC/1.1)

Madras : S. Kulasekarapandian (PL).

This new project on *Artemia* production was initiated during August 1989 in a pond of 0.1 ha made available for experiment by a salt factory at Kelambakkam, near Madras. The water depth was 60 cm. The soil was composed of 60.5% sand, 12.5% silt and 27.0% clay and was found to be low in available phosphorus (1.75 mg/100 g), available nitrogen (15.8 mg/100 g) and organic carbon (0.11%). The PO₄-P and the NO₃-N in the water phase have low ranges

of 0.006 to 0.040 ppm and 0.212 to 0.320 ppm respectively. Total alkalinity was 96-106 ppm. The temperature ranged between 31.2°C to 36.4°C. The gross primary production ranged from 0.187 to 0.900 gC/m³/day. *Navicula* and *Chlorella* formed the phytoplankton components of the pond.

Local strain *Artemia* cysts earlier collected from the salt pans were hatched in 35-40 ppt salinity (hatching rate 48.6%) and the pond was stocked at 10.3 nauplii/l. The salinity of the pond was maintained between 70-100 ppt. In 25 days, the *Artemia* population in the pond increased to a density of 78/l, comprised by adults, pre-adults, juveniles and nauplii. On 7th October, oviparity was observed in 25% of the adult population. However, total mortality of the entire population occurred on 19th October, presumably due to a sudden drop in salinity. Cyst production experiment was resumed in March 1990 in a set of 3 ponds each of 230 m².

In a laboratory experiment on *Artemia* biomass production, at a stocking density of 160 nauplii/l, using aged clear solutions of pig manure and cattle dung as fertilizers, biomass of 140 g and 55 g (wet weight) was obtained respectively in 20 days. While in the tank with pig manure, 68% of the *Artemia* population became mature with formation of ovisac, the whole population in the tank with cattle manure remained immature.

Monitoring of traditional brackishwater aquaculture system for improving the productivity (CCD/TF/1.1)

Kakdwip : R. K. Chakraborti (P.L.) S.R. Das and Ashis Choudhury.

Narakkal : K. V. George.

Under this project, work was carried out at Kakdwip and Narakkal. Due to reasons

of logistics, a farm adjacent to Kakdwip Research Centre was selected out of the five farms surveyed. In the selected farm the water and soil conditions and macrobenthos were studied to understand the productivity. The data on the above are furnished in Table 7. The ponds were low in organic carbon, available phosphorus and available nitrogen. The macrobenthos

TABLE 7. Ecological conditions of a newly-constructed brackishwater farm at Kakdwip during April 1989 to September 1989

Parameter	Range
<i>Water</i>	
Depth (cm)	.. 50.0 - 80.0
Temperature (°C)	.. 29.2 - 31.5
Transparency (cm) (Secchi disc)	.. 23.0 - 31.0
Dissolved oxygen (ppm)	.. 6.9 - 7.8
pH	.. 8.4 - 8.7
Total alkalinity (ppm)	.. 90.0 - 133.0
Salinity (ppt)	.. 3.80 - 13.2
<i>Soil</i>	
pH	.. 8.35 - 8.75
Organic carbon (%)	.. 0.51 - 0.69
Electrical conductivity/ m/mhos/cm	.. 5.20 - 21.30
Salinity (ppt)	.. 3.00 - 19.20
Available P (mg/100 g)	.. 0.42 - 0.68
Available N (mg/100 g)	.. 8.2 - 12.30
Carbonate+bicarbonate (ppm)	160.00-280.00
<i>Macrobenthos (No./m²)</i>	
Amphipods	.. 361
Tanaeids	.. 298
Polychaetes	.. 21

was poor both qualitatively and quantitatively

The ponds were stocked with *P. monodon* at 55,000/ha between April and July. Poultry manure was applied at 25-40 kg/ha per month. In three months the weight increased to 15-20 g. Continuous harvesting at fortnightly intervals was conducted during July-October. At the time of harvesting, prawns of 25-60 g were removed. Details on harvested quantities were not available. Softshell syndrome in *P. monodon* was of common occurrence. Experiments with soft-shelled prawns (109-114.5 mm/9.5-11.5 g) indicated that such prawns are sensitive to changes in salinity. As compared to normal prawns, the intake of supplementary food is very low, being only 1 to 1.5% of the body weight.

The macrovegetation of bheries was studied. The common forms are *Ruppia maritima*, *Paspalum scorbiculatum* and *Enteromorpha* sp.

During November 1989 to March 1990 a perennial prawn field near Narakkal (5 ha in area) was monitored. The ranges for some of the parameters of water and soil quality are: salinity 2.91 to 18.08 ppt, temperature 29.8°C-35°C, dissolved oxygen 3.8-8.2 ppm, water pH 7.2-8.6, soil pH 6.80-7.4 and redox potential—300 to +51 mv. The prawn field had mostly reducing conditions at the soil-water phase, indicating poor mineralisation of nutrients. A total of 4952 kg of prawns were harvested with the following species-wise break-up: *M. dobsoni* 58.4%, *P. indicus* 35.8%, *M. monoceros* 5.6% and *Penaeus monodon* 0.2%.

FINFISH CULTURE DIVISION

Broodstock development, management, breeding and seed production of *Lates calcarifer* (FCD/BS/1.1)

Madras : K. N. Krishnamurthy (PL), K. Alagaraswami, Mathew Abraham, K. Gopinathan, Munawar Sultana, K. O. Joseph and V. Sreekrishna.

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

At Ennore near Madras, two velon net cages (50 m² each) fixed in the backwater were stocked with 51 numbers of *L. calcarifer* ranging 125-250 mm in total length and 60-100 g in weight. These were collected and transported from Pulicat lake. They were reared feeding them with live trash fish and prawns.

The range of hydrographic parameters of ambient water were: temperature 24.2-30.2°C; transparency 9-28.0 cm; salinity 10.0-34.0 ppt; pH 7.1-8.4; dissolved oxygen trace to 6.8 mg/l, total alkalinity 100-128.0 mg/l; phosphates 0.008-0.08 mg/l; nitrates 0.01-0.04 mg/l and silicates 1.22-1.82 mg/l.

Under tank culture, two females of *L. calcarifer* (350 mm/8 kg and 365 mm/9 kg) in stage III of maturity collected from the sea near Ennore barmouth were acclimatised and reared in two 10'×2' circular plastic tanks individually during April 1989. The fish were given dip treatment with potassium dichromate for 2 minutes and administered oxytetracycline intramuscularly. However, both the fish did not survive beyond 10 days due to fungal infection and loss of scales. One *L. calcarifer* 1200 g in immature condition collected during November 1989 was reared in the plastic tank feeding with live prawns and fish at 20% of the body weight.

Under the pond system of raising the broodstock at Kakdwip, a rearing pond of 0.132 ha area was stocked with 25 numbers of two-year old fish of average size 410 mm/950 g during June 1989. The pond was flushed with tidal water at fortnightly intervals. The fish fed mainly on the forage fish and prawns brought in by the tide. By March 1990, the fish had grown to an average 486 mm/1400 g. All the fishes remained immature.

Broodstock development, management, breeding and seed production of grey mullets (FCD/BS/1.2)

Madras : K. V. Ramakrishna (PL), T. Rajyalakshmi (upto 30 September 1989), R. D. Prasadam, Mathew Abraham, K. Gopinathan, Munawar Sultana, K. O. Joseph and V. Sreekrishna.

Puri : L. Krishnan and P. K. Ghosh.

Kakdwip : Hardial Singh, S. R. Das and Ashis Chowdhury.

Narakkal : S. M. Pillai and M. K. George.

Broodstock development

Significant success has been achieved in the breeding of grey mullets, specifically of *Liza macrolepis* at Ennore and *Mugil cephalus* at Puri. Thirty adult fish of *L. macrolepis* were introduced in a 10'×2' plastic pool in October 1989, of which 14 survived after 15 days of rearing. They were fed with a newly developed pelleted diet consisting of algae (25%), rice bran (30%), groundnut oil cake (25%), soya-bean (20%), Vitamin E (30 mg/kg), Vitamin K (30 mg/kg) and mineral mix (5g/kg) at 5% of the body weight of the fish. The average size of the fish was 187.3 mm/62.0 g. Another batch of 19 fish were

acclimatised during December 1989 and maintained in a separate pool. Calcium hypochlorite treated seawater was used. An *in situ* biological filter was installed in the pool. The salinity ranged 31.0-32.5 ppt, pH ranged from 8.1-8.3 and water temperature 24.9-29.0°C during the period.

Liza macrolepis collected from commercial catches ranging in length from 185 mm to 246 mm and weight from 70 g to 130 g in different (I, II, V and VII) stages of maturity were analysed for their biochemical constituents *viz.*, protein, glycogen, total free sugars and lipid levels in gonad, liver and muscle.

Induced breeding

As many as 70 trials were made on *L. macrolepis* for induced spawning using carp pituitary, HCG and GnRH in varying doses under different salinity conditions. Among the fishes treated only thirteen females showed positive response. Eight females spawned naturally; however, there was no fertilisation as the males did not show any response. Four females were stripped and fertilization was noticed at 50-70%. However, in all the cases the development continued only for 2-7 hours. Another female (225 mm/110 g) was stripped on 22-2-1990 at 0015 h and about 60,000 fertilized eggs were obtained. With 50% hatching rate about 30,000 hatchlings were obtained 16 h after fertilisation.

The water used for the incubation of eggs and rearing of hatchlings was pre-treated with calcium hypochlorite and filtered. Salinity was maintained around 30 ppt. The daily observations on the temperature, salinity and pH were recorded and the data for the first 15 days showed that the water temperature ranged from 27.4 to 29.8°C, salinity ranged from 29.0 to 30.5 ppt while pH ranged from 7.7 to 8.2.

The hatchlings were released in two FRP tanks of 500 l capacity in equal numbers. Green water consisting of *Chlorella* sp. was given as larval food for the first 2 days. From day 3 *Chaetoceros* and *Brachionus* were given. The hatchlings were found to feed well on *Brachionus*. Artificial feed of groundnut oil cake and rice bran in powdered form was given from day 15 when the estimated number of fry was 11,000, showing a survival rate of 36.4%. On day 28 the fry were transferred to 1.75 t tanks and the rearing was continued further successfully.

During the breeding camps set up at Arkhakuda near Puri between November 1989 and January 1990, mature females and males of *M. cephalus* were collected from Chilka lake mouth area. Mature and fully ripe females were given oxytetracycline at 25 to 50 mg/kg body weight of fish. Nine females of *M. cephalus* in the size range of 420 mm/750 g and 510 mm/1200 g were treated with carp pituitary extract, mullet pituitary extract and pimozone. The doses ranged 4-72 mg/kg for mullet pituitary gland and 8-40 mg for pimozone. The size of males used in these experiments ranged between 327 mm/300 g and 345 mm/350 g. Of the nine, six females responded to the hormones and four spawned. Even though fertilization and development was observed in all the four cases, hatching took place only in one case (490 mm/1.2 kg female). The treatment on this successful fish was a mixture of MPG (26 mg/kg) and pimozone (17 mg) given in two injections. The eggs hatched after 48 h. The temperature and salinity of ambient water ranged from 20-29.5°C and 20-30 ppt respectively.

The one-day old larvae, about 50,000, were transported from Arkhakuda to the Puri laboratory under oxygen packing. The larvae were reared in two rectangular tanks of 2 t capacity filled with seawater.

The salinity was maintained at 20 ppt by diluting with freshwater. Water temperature ranged from 20-24°C. From second day onwards the larvae were fed with rotifers and copepods. The mouth formation was observed on third day. However, the larvae survived for 10 days only under laboratory conditions. Live feed cultures were continued at Puri under outdoor and indoor conditions.

At Kakdwip 30 numbers of *Liza tade* with an average size of 350 mm/750 g were stocked in 0.12 ha pond during August 1989. They were fed twice daily with powdered mixture of rice bran and fish meal (60 : 40) at 3% body weight. By March 1990, the fish had grown to an average size of 497mm/1307g. Full gonadial maturation was not observed in the fish.

Broodstock development, management, breeding and seed production of *Etroplus suratensis* (FCD/BS/1.3)

Narakkal : S. M. Pillai (PL) and M. K. George.

Kakdwip : Hardial Singh and B. K. Banerjee.

At Narakkal ten *Etroplus suratensis* (152-180 mm/105-150 g) were stocked in a cement cistern. A layer of mud was spread on the bottom of the cistern and nesting materials for attachment of eggs were provided. The fishes were fed on a formulated diet and on alternate days 50% water was exchanged.

At Kakdwip, broodstock of pearlspot was maintained in a pond of 0.02 ha area. The size of the fishes ranged 42-80 g and they were fed with rice bran and fish meal (1 : 1) at the rate of 3% body weight. During May-June natural breeding was observed in the pond and a total of 1000 fry were obtained. Subsequently 25 fishes having average weight of 85 g were released in a

pond (0.08 ha) for breeding, but natural breeding was not observed.

Monoculture of brackishwater fishes in tide-fed ponds (FCD/FC/1.1)

Kakdwip : B. K. Banerjee (PL), Hardial Singh, H. S. Majumdar and A. Chowdhury.

Collection of seed of *Liza parsia* was made from the tidal pits during February-March 1989. About 90,000 seed, ranging in size from 15-22 mm were collected. The seed were reared in two ponds (0.067 ha and 0.196 ha) at a stocking density of 72,000/ha. They were fed with powdered mixture of rice bran, fish meal and oil cake (2 : 1 : 1) daily at 5% of the fish biomass. Flushing of pond water was done at fortnightly interval with the tidal cycle. The rate of survival in the nursery phase of two months was 70% and the average size attained was 32 mm.

The nursery reared seed of *L. parsia* were stocked in 3 ponds of 0.067 ha each and another of 0.184 ha during April-May 1989. The stocking density was 35,000/ha. Before stocking, poultry manure was applied in a single dose of 1000 kg/ha to enhance natural productivity of food. Supplementary diet was also continued at 4-5% of the fish biomass. The production from these four ponds worked out to be 395.5, 323.8, 318.4 and 415.0 kg/ha/yr.

Monoculture of *L. tade*

Two hundred yearlings of *L. tade* (average 200 mm/100 g) collected from farm ponds were stocked in a pond (0.196 ha) in April 1989. The fish were fed with artificial diet of rice bran, fish meal and oil cake at 5% of body weight daily. The size recorded at harvest was in the range of 225-330 mm (average 282 mm/219 g) for the slow growers and 335-425 mm (average

376 mm/555 g) for the fast growers. A total of 69.5 kg was harvested and the catch composed of *L. tade* (60kg) and miscellaneous species (9.5 kg).

During November 1989, heavy infection of disease was noticed in almost 80% of the stocked fish. Patches of deep red lesions of various intensity were found on the body of affected fishes. Lot of slime secretion was found in the lesions and the fish were extremely sluggish. While *L. tade* was affected, other species in the pond were not affected. The disease was provisionally diagnosed as the epizootic ulcerative syndrome (?). Investigations on pathogens, carried out by the Fish Disease Group of the Central Inland Capture Fisheries Research Institute at our instance, revealed the presence of *Micrococcus* sp. from the ulcers and *Trichodina* sp. from the gills. The environmental parameters of the pond water were as below :

TABLE 8. Environmental parameters in affected pond at Kakdwip

Date of observation	1-12-89	11-1-90
pH	.. 8.3	8.3
Dissolved Oxygen (ppm)	.. 6.9-9.3	11.0
Alkalinity (HCO ₃) (ppm)	.. 110.0	139.0
Alkalinity (CO) (ppm)	—	120.0
Hardness (ppm)	.. 1030.0	1179.0
Free CO ₂ (ppm)	.. —	—
Salinity (ppt)	.. 5.1	6.0

As a precautionary measure all the fishes were netted out and the infected ones were segregated. Non-infected fishes were released back in pond while the infected fishes

were given a bath of KMnO₄ at 10 ppm after which they were released in a different pond. Periodical examination of the infected stock of *L. tade* revealed almost cent per cent recovery within a period of three weeks.

Seed collection and nursery rearing of *L. tade*

Seed collections of *L. tade* were made from tidal pits during the period from July to September. About 20,000 seed of *L. tade* were collected which were reared in two nursery ponds of 0.08 ha and 0.07 ha. All possible measures were taken to prevent the entry of predatory fishes like *Lates calcarifer* and *Eleutheronema tetradactylum*. The stocking density was 1,80,000/ha. The seed of *L. tade* were fed with powdered mixture of rice bran, fish meal and mustard oil cake at 2 : 1 : 1 at 5% of biomass daily. The average size recorded in March 1990 was 90 mm/7 g.

Monoculture of *L. calcarifer*

Monoculture of *L. calcarifer* was carried out in a pond of 0.087 ha. As the availability of *L. calcarifer* was extremely poor, the experiment was initiated with 15 fish collected from farm ponds and canals. The size range was 150-205 mm and stocking was done in September 1989. After 7 months rearing, the average growth was 275 mm/250 g.

Ecological parameters

Bottom fauna of the ponds consisted of tanaids, *Gammarus* sp., polychaetes and mysids. Their numerical abundance ranged from 220-5280 units/m². Tanaids formed 90%, followed by *Gammarus* 8%, polychaetes 1.5% and mysids 0.5%. The common zooplankton was represented by *Diatomus*, *Brachionus*, *Moina*, *Keratella* and their nauplii

and mysids. The phytoplankters were mainly represented by species of *Navicula*, *Oscillatoria* and *Anabaena*. Physico-chemical parameters of the ponds were in the following ranges : water temperature 22.5-32°C, depth 47.5-100 cm, transparency 20-32 cm, D.O. 6-10 ppm, pH 8.2-8.6 and salinity 2.5-21 ppt.

Polyculture of fishes and prawns in coastal tide fed ponds (FCD/FC/1.2)

Kakdwip : S. R. Das (PL), from July 1989 and A. Chowdhury.

At Kakdwip, during September 1989, one pond (0.08 ha) was stocked with *L. parsia* (31,250 no/ha, *L. tade* (18,750 no./ha) and *P. monodon* (50,000 no./ha). The average initial sizes were 28 mm, 16 mm and 18 mm for *L. parsia*, *L. tade*, and *P. monodon* respectively. *P. monodon* had grown to an average size of 80 mm/4.5 g in 4 months while *L. parsia* and *L. tade* registered a size of 117.3 mm/25.0 g and 158.2 mm/42.5 g respectively in seven months. Data on natural production of phyto and zooplankton in the pond were collected.

RESOURCE AND TECHNOLOGY IMPROVEMENT DIVISION

Compounded feed formulation and feed technology for penaeid prawns (RTD/NT/1.1)

Narakkal : Syed Ahmad Ali (PL) and A. Laxminarayana.

Madras : C.P. Rangaswamy, D. Narayanaswamy and N. Kalaimani.

Kakdwip : R. K. Chakraborti.

Narakkal

Two formulated feeds for *P. indicus* which were being used at the Narakkal Research Centre were improved by addition of squid waste, alfalfa (as growth promoting agent), antioxidant and preservative. The improved feed gave better growth, survival (80%) and food conversion ratio (2.3) in 90-day rearing experiments conducted in 1 tonne capacity fibreglass tanks. With the original feed formulation, an FCR of 2.2 was obtained at the end of two month rearing period, after which the prawn (*Pendaeus indicus*) became soft-shelled indicating that the original formula does not provide adequate nutrition for the older juveniles (70 mm size) although it is good for the nursery and early juvenile phase.

Cuttlefish waste with and without ink glands were both equally acceptable to the prawns. Squid mantle and squid waste when incorporated in the feed gave FCR of 1.1 and 1.3 respectively in 30-day rearing experiments with *P. indicus* (16-40 mm). Catfish waste and tuna waste were substituted for fish meal in the feed formula with good results.

The temperature at which the prawn head waste was dried before powdering had an effect on product quality. Sun drying and oven drying at 60°-70°C yielded the best flavour and colour to the dried products.

The proximate composition of raw materials such as prawn waste, squilla, fish meal, squid waste, groundnut oil cake, soy cake, wheat bran, rice bran and tapioca was estimated. Squid waste contained the highest percentage of protein (67.8%) and lipid (19.5%).

A total quantity of 41 kg of particulate feed (protein 36.5 to 38.5%) for feeding PL 1 to PL 25 of *P. indicus* was prepared and supplied to the prawn hatchery project of Narakkal Research Centre. The survival rate from PL 1 to PL 20 was between 50% and 80% and the larvae were healthy. The ingredients were prawn waste, squilla, fish meal, G.O.C., tapioca, vitamin and mineral mix.

Madras

Using the feed processing equipment installed at the Ennore Field Centre, 2.5 tonnes of pelleted feed (protein 35%) was prepared for field trials of *P. monodon* grow-out culture at the Kakdwip Research Centre. For the first time preparation and supply of large quantities of shrimp feed was successfully accomplished this year. The ingredients were, fish meal (32%), prawn head waste (8%), soy cake (25%),

rice polish (15%), starch (16%), vitamin-mineral mix (2%) and shark liver oil (2%).

In feeding trials with PL 25 of *P. monodon* at Ennore, this feed gave very good growth and survival at a stocking density of 25 PL per 100 litre. At the end of 30 days (salinity 20-22 ppt), the survival was 100% and the average weight was 159 mg (initial weight 5 mg). The experiment is continuing.

Short-term experiments (10-25 days) using PL 10 of *P. monodon* were conducted using two different feeds: Feed I consisting of squid, soy cake and rice polish and Feed II consisting of fish meal, prawn waste and soy cake. Feed II gave better results in terms of survival rate and growth. The control, fed only with squid mantle, gave very poor survival and growth.

Field trials at Kakdwip

The feed sent from Madras was tested on *P. monodon* juveniles (6 g size) reared in cement cisterns and FRP tanks. In 15-day experiments FCR varied from 1.9 to 2.7 in 18 to 23 ppt salinity.

Another feed locally prepared in dough form consisted of fish meal (48%), mustard cake (28%) and wheat flour (24%) and gave FCR of 2.3 to 3.75 in 60-day experiments using *P. monodon* (0.4 g in size) kept in cement cisterns containing brackishwater of 20 ppt.

Soft shelled prawns fed to satiation on pellets sent from Madras showed no gain in weight although they survived for 40 days.

Compounded feed formulation and development of feed technology for finfishes (RTD/NT/1.2)

Madras: T. Rajyalakshmi (PL, upto September 1989), C. P. Rangaswamy (PL,

from October 1989), R. D. Prasad and V. Sreekrishna.

Narakkal: Syed Ahmed Ali and S. M. Pillai.

Kakdwip: B. K. Banerji.

At Madras

Experimental evaluation of formulated feeds for Liza macrolepis

Feeding experiments using two formulated feeds for the fry of *L. macrolepis* were conducted in 100 litre FRP tanks. The ingredients in Feed I were squid, soya cake, rice polish, starch, fish oil, vitamins and minerals (protein 37.7%). Feed II (protein 40.0%) differs from Feed I in that squid was replaced by fish meal and prawn waste. The duration of the experiment was 30 days and the stocking density 50 fry/100 l; the salinity was 28-30 ppt. Feed II gave better survival rate and percentage increase in weight (73% and 385% respectively) than Feed I (67% and 246% respectively).

At Narakkal

Protein requirement of Pearlsplit

A feed base consisting of fish meal (76%), groundnut cake (12.6%) and wheat bran (11.4%) was evolved to prepare diets to understand the nutrient requirements of *Etroplus suratensis*. Six diets were prepared (ES 6-ES 11) using the above - mentioned feed base containing different protein levels. The diets were made almost isocaloric by adding tapioca in graded levels. The crude protein of the diets varied from 25.83 to 53.84% and the digestible energy from 320.0 to 345.6 KCal/100 g.

Juveniles of *E. suratensis* were fed with the diets to satiation in 40-day experiment conducted in plastic pools (3'x2' dia)

TABLE 9. Results of feed trials on Pearlsport

Particulars	Diets					
	ES6	ES7	ES8	ES9	ES10	ES11
Protein %	.. 53.80	46.00	41.60	37.20	32.30	25.80
Av. initial weight (g)	.. 8.60	7.60	7.60	6.10	6.00	4.70
Av. final wt. (g)	.. 9.69	8.53	8.13	8.33	7.00	5.00
Relative growth rate %	.. 12.60	12.20	6.90	36.60	16.70	6.40
Feed conversion ratio	.. 2.09	1.75	4.95	1.25	3.68	—

having 300 l brackishwater. Each pool was stocked with 15 fishes. The results are given in Table 9.

The highest growth rate and low FCR were recorded by diet ES 9 having 37.2% protein. Diets having crude protein above and below this level showed low growth and high FCR. The crude protein requirement of the pearlspot is indicated to be 37%.

Essential Amino acid requirements of Pearlsport

Juveniles of *E. suratensis* were fed with diet ES 5 having 32% protein to study the quantitative essential amino acid requirements. Twenty fishes were held in 3'x2' plastic pools in triplicate and fed to satiation for 20 days. The fish showed specific growth rate of 0.8024% which is considered to be good. The protein and energy retention efficiencies were 30.87% and 22.45% respectively. The diet and initial and final samples of the fishes were analysed for total amino acid composition at the Fish Nutrition Laboratory, INRA, Saint Pee Sur-Nivelle, France. It was found from the data that there was positive protein depo-

sition in the fishes. From the data the quantitative requirements of essential amino acids were determined as follows :

Amino acid	Requirement (% protein)
Arginine	.. 3.44
Lysine	.. 9.79
Histidine	.. 2.12
Isoleucine	.. 1.40
Leucine	.. 3.57
Valine	.. 2.13
Methionine	.. 2.04
Phenylalanine	.. 2.24
Threonine	.. 2.04
Tyrosine	.. 3.04

At Kakdwip

Fry of *Lates calcarifer* (20-40 mm) were reared in glass jars containing 2 ppt pond water for about 1 1/2 months by feeding them with live mysids and prawn seed collected from the canals. They attained a size of 50-80 mm.

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(Not a gradation list)

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Shri B. B. Roy, T-2
Shri P. C. Mohanty, T-1
Shri K. Paranthaman, T-1

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