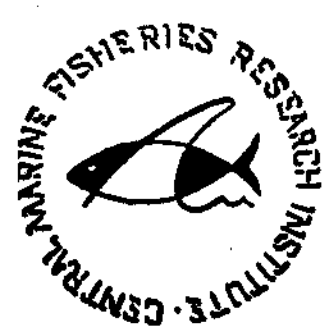
Annual Report

1985-86



Annual Report

1985-86

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
COCHIN
INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Issued by

Dr. P. S. B. R. JAMES

DIRECTOR

Central Marine Fisheries Research Institute

Post Box No. 2704, Cochin - 682 031

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CMFRI Headquarters Building, Cochin

DIRECTOR'S INTRODUCTION

Brief History, Organisational set up and Objectives

The Central Marine Fisheries Research Institute was established in 1947 by the Ministry of Agriculture and Irrigation. It was brought under the ICAR in 1967. The headquarters of the Institute is at Cochin. The Institute has one Regional Centre at Mandapam Camp, 11 Research Centres and 29 Field Centres along the East and West coasts of India. Experimental Field Stations are located at Narakkal, Kovalam/Muttukad, Karapad, Mandapam Camp and Calicut attached to the research centres.

The objectives of the Institute are to conduct research for assessing and monitoring the exploited marine fisheries resources leading to rational exploitation and conservation; to assess the underexploited and unexploited marine fisheries resources of the Exclusive Economic Zone; to understand the fluctuations in abundance of marine fisheries resources in relation to changes in the environment by conducting vessel-based programmes; to develop suitable mariculture technologies for finfish and shellfish in open sea to supplement marine fish productions; to conduct transfer of technology and post-graduate and specialised short-term training programme.

The Institute has 9 major Divisions for implementing its research projects.

1. Fishery Resources Assessment Division
2. Pelagic Fisheries Division
3. Demersal Fisheries Division
4. Crustacean Fisheries Division
5. Molluscan Fisheries Division
6. Fisheries Envronment Management Division
7. Physiology, Nutrition and Pathology Division.
8. Fishery Economics and Extension Division.
9. The Library and Documentation Division looks after the publications of the Institute and provides library services to the Scientists.

The Centre of Advanced Studies in Mariculture funded by FAO/UNDP and ICAR and affiliated to the Cochin University of Science and Technology is the educational wing of the Institute conducting M.Sc. and Ph.D. courses in Mariculture.

The Krishi Vigyan Kendra at Narakkal is the extension wing of the Institute imparting training to the marginal farmers in prawn and fish culture. A Trainers' Training Centre in Mariculture also has been recently sanctioned by the ICAR at Narakkal.

Physical target achievements :

The most important event during the year has been the shifting of the Institute's laboratories and offices of the headquarters at Cochin to its own permanent building which was duly inaugurated by Hon'ble Shri Buta Singh, former Union Minister for Agriculture and Rural Development on March 1, 1986. Since the shifting of the headquarters of the Institute in 1970 from Mandapam to Cochin, it was accommodated in several rented buildings. Now all the research laboratories and administrative sections have moved into the new building which has ground plus four storeys with a total plinth area of 8865 sq. m. With this facility, the Institute is organising well laid-out laboratories for different disciplines of research in fisheries, oceanography, mariculture, physiology, nutrition, pathology, electronics, remote sensing and laboratories for M.Sc. and Ph.D. students carrying out post-graduate research and education under the CAS in mariculture.

The purchase of an area of 5.02 acres of land at a cost of Rs. 105,40,677 from the Greater Cochin Development Authority in Ernakulam materialised during the year for the construction of residential quarters for the staff of the Institute at Cochin.

The Instiute has developed a prawn hatchery laboratory at Narakkal, shellfish hatchery laboratory at Tuticorin and shellfish breeding laboratory at Kovalam. The Institute has further developed the lagoon farm at Mandapam, open sea raft culture farms in Tuticorin, Calicut and Vizhinjam and pen and cage culture systems at Mandapam.

The scientific programme of FORV Sagar Sampada were managed by the Institute. The vessel made 15 research cruises during the year 1985-86 surveying a total area of over 9 lakhs sq. nautical miles in the EEZ and beyond including equatorial region. She cruised a total track distance of 28,000 nautical miles and the survey/researches, included, pelagic, demersal, mesopelagic and tuna live bait resources in addition to physical, chemical and biological oceanography. She logged 234 days of operation and occupied 425 stations.

The Institute's Research Vessel R/V Skipjack and the Cadalmin series research boats were engaged in the collection of fishery resources and oceanographic data in the inshore water along both the coasts.

Under the post-graduate research and education programme of CAS in Mariculture, the 5th and 6th batch of students were undergoing semester courses and 9 senior research fellows were admitted for the Ph.D. course and 12 students of the earlier batches had completed their work and their thesis were in various stages of completion. Three foreign experts visited to give consultancy service to the Centre. Eight scientists of the Institute have had advanced training abroad. A series of Workshops and Seminars were conducted at this Centre as per the objectives of the programme.

During 1985-86 the Krishi Vigyan Kendra conducted 42 training courses

in Mariculture and various other subjects to benefit 756 farmers which included 269 men and 517 women. Under the Trainers' Training Centre 4 different courses were conducted in subjects relating to mariculture of finfish and shellfishes.

Fishery resources information for planning, development, management and conservation was provided to all end-users on a regular basis. Transfer of technology was effected through various channels such as consultancy, training programmes, Lab-to-land programmes, Trainers' Training Centre and Krishi Vigyan Kendra (Farm Science Centre).

RESEARCH HIGHLIGHTS

Marine fish production :

Annual marine fish production in the country during the year 1985-'86 has been provisionally estimated at 1.57 million tonnes, registering a decline of 3.0% from 1984-'85.

Among the commercially important groups oil sardine accounted for 8.3% in the total landings as against 10.2% during 1984-'85. The contribution of penaeid prawns was 8.6% which was 0.5% more than the previous year. Bombay duck accounted for 6.7% as against 7.7% in the previous year. The contribution of non-penaeid prawns decreased from 4.6% during 1984-'85 to 4.1% during this year. A decline of about 0.5% was noticed in the contribution of *Stolephorus* spp. from the previous year.

Pelagic fisheries :

Stock assessment studies on tunas, mackerel oil saradine and anchovies were conducted during the year. Tuna fishery at Mangalore improved 10.6 times and at Vizhinjam 5.6 times during the year when compared to the catches of last year. The mackerel fishery showed a general improvement in 1985-86 with good fishery at Mangalore, but along the southwest coast the fishery lasted for a short season and the lower fishing mortality rate indicated better prospects for the next year. The yield per recruit analysis indicated that with the present size at first capture at 20 mm, the existing level of exploitation is just above the MSY level. Based on the resources data for 1975 to 1984 the MSY of Bombay Duck for Maharashtra was estimated at 80,000 tonnes and optimum effort as 1.6 million hauls. While oil sardine showed a general decline, its production in Mangalore showed over 50 per cent increase. In the case of lesser sardine, the stock estimated off Karwar, indicated that the catches could be substantially increased by increasing the fishing pressure.

Demersal fisheries :

Cat fishes in the inshore region pointed out that the species are being fished at maximum level in the present grounds and if the production has to be increased, the fishing areas have to be extended beyond the present limit i.e., in deeper waters. Studies on exploited population of threadfin breams have shown that fishing pressure in the Waltair-Kakinada region has been over the maximum sustainable level.

Crustacean fisheries :

Compared to the previous year, there was a decrease in the penaeid prawn catches on the west coast mainly due to decline in the catch of two dominant species *Parapenaeopsis stylifera* and *Metapeaneus dobsoni*. The stock assessment of *M. monoceros*, *P. stylifera* and *M. dobsoni* at Karwar, and Mangalore showed that the present level of exploitation does not adversely affect the stock. However, increasing the mesh size from the present 16-25 mm to 30 mm would be beneficial to the stock to maintain the MSY. Similar possibilities of increasing the yield through increasing mesh size of the trawl net was pointed out for *M. monoceros* off Kakinada.

Molluscan fisheries :

There has been a notable increase in the cephalopod production from the inshore waters over the previous year. The increase was 154 per cent in Bombay, 132 per cent in Madras, 81 per cent in Cochin and 55 per cent in Visakhapatnam. The average CPUE was highest in the Bombay region (240 to 250 kg/unit). During the cruises for FORV *Sagar Sampada* all cephalopod resources of EEZ was surveyed. Besides the common inshore species, oceanic squids such as *Symplectoteuthis oualaniensis* were collected at a number of stations in the eastern Arabian sea and Andaman Nicobar waters. Cephalopods such as *Cranchia* Sp., *Lysocranchia* sp. and *Abralia* sp. were also collected in the cruises.

Fishery environment :

Extensive monitoring of fishery oceanography parameters was carried out in the EEZ during the cruises of FORV *Sagar Sampada* to understand the mechanism of various physical chemical and biological process active in these areas and influencing the fisheries. The surface waters at a depth of 75 m. were found to be well mixed with a sharp thermocline between 75 m and 100 m in the seas around Andaman and Nicobar islands and well developed salinity maximum, characteristic of Bay was observed between 100 m and 300 m. Oxygen minimum layer (2 ml/l) corresponded with the salinity maximum layer. The pH values were less than 8 below 100 m depth. The zooplankton samples collected during the cruises are being sorted out for detailed analysis by the specialists. The work on seaweed resources, pollution monitoring, and ecological studies of specialised ecosystems such as corals, sponges and mangroves were showing good progress.

Mariculture :

At Narakkal prawn hatchery, the breeding and larval rearing technique for *P. indicus* have been further standardised and 1.3 million seed of *P. indicus* were distributed to local prawn farmers for stocking in their ponds. *P. japonicus* was reared at Kovalam for 3 successive generations. Monitoring the growth of post-larvae supplied by the Institute to the prawn farmers was done regularly and production rates ranged from 311 kg/ha/42 days in Ernakulam district to 577 kg/ha/5 month at Tuticorin.

In oyster culture, stake and ren culture techniques were experimented at Tuticorin farm with encouraging re-

sults and rates of production as compared to the previous raft culture methods were evaluated. Farm oysters from Tuticorin, yielding one tonne of meat were handed over to the Integrated Fisheries Project, Cochin for product development and marketing. At Tuticorin, experimental pearl oyster farming was staarted in Vantivu island besides maintaining the main farm at harbour basin. The commercial pearl oyster farm in Krusadi was monitored regularly for comparing yield potential under different ecological conditions. Experiments were taken up to understand the pearl-producing potential of different size groups with reference to size of nuclei implanted in them.

The shellfish hatchery laboratory at Tuticorin has become functional and mass production of spat of pearl oyster and edible oyster has been achieved through successive larval rearing experiments. Many techniques were evolved in improving the spat production rate.

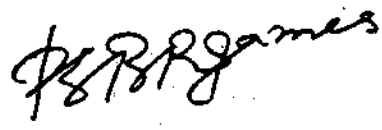
In finfish culture experiments on culture of selected species under different conditions of mono and poly culture systems in ponds, cages and pens were carried out at different centres of the Institute during the year, in order to bring in greater utilization of low lying coastal areas and extensive shallow lagoons.

Multi-displinary researchers on the physiological aspects of prawns, nutritional requirement of fry of *Chanos* and mullets and patho-biology of soft prawns in prawn culture fields were some of the important items undertaken by the concerned division.

Fishery Economics and Extension :

Socio-economic studies in four marine fishing villages of Gujarat and Maharashtra, socio-economic studies of fishermen house-holds in certain fishing villages of Tamil Nadu and the studies on the economics of operation of mechanised unit in Cochin and evaluation studies on the role of women were the important item of research undertaken by the Fishery Economic Extension Division.

Further details of progress made in the research projects of different Divisions and in the Education and Training programmes are given in the respective chapters.



(Dr P. S. B. R. JAMES)
Director

GENERAL INFORMATION

Advisory/Consultancy Service provided

Dr E. G. Silas, Director, served as :

1. Member of the Standing Committee on Ocean Resources of Department of Space, Bangalore.

2. Member in the Committee constituted by the Director General, ICAR for conducting research review of the Union Territory of Andaman and Nicobar under its National Agricultural Research Project.

Dr P. S. B. R. James, Director, served as :

1. ICAR Representative in MPEDA.

2 Member of the Committee on Productivity from Aquatic Resources constituted by the Department of Agriculture and Co-operation.

3. ICAR Representative in the Co-ordination Committee for Development and Conservation of Pelagic Resources constituted by the Department of Agriculture and Co-operation.

4. Member of Expert Committee to study and report on cropping pattern for Kuttanad area and Kole areas of Trichur and Ponnani.

5. Member in the High Power Committee on Management of Marine Fishery Resources constituted by Ministry of Agriculture.

6. ICAR representative in the Academic Council of Cochin University of Science and Technology.

7. Member in the Committee on Productivity from Aquatic Resources constituted by Ministry of Agriculture.

8. Member in ICAR Regional Committee No. 8 for 3 years from September 1985.

Shri M. Kumaran, Scientist S-3 served as :

1. Member in the Task Force for Implementation of recommendations of Steering Committee at district level, Calicut, constituted by Government of Kerala.

Dr P. Parameswaran Pillai, Scientist S-3 served as :

1. Member in Lakshadweep Wild Life Advisory Committee.

Engagements

Dr E. G. Silas, Director attended the following meetings :

International Conference on Fisheries Development 2000 AD sponsored

by the Ministry of Agriculture, Govt. of India, MPEDA and the Association of Indian Fishery Industries (AIFI) at New Delhi, 4-6 February.

33rd Meeting of the MPEDA at Bangalore, 7 February.

Meeting of the Research Advisory Panel of the Bombay Natural History Society and the Seminar on the Society's research projects at Indian Institute of Science, Bangalore, 11-12 March.

Meeting of the National Committee for SCOR at the Indian National Science Academy at New Delhi, 18 March.

12th Meeting of the Project Working Committee of the ICAR / UNDP aided projects at New Delhi, 26 April.

Dr A. V. S. Murty, Officiating Director attended the following meetings :

Meeting of the ICAR Director's Coordination Committee at CIFE, Bombay, 1 July.

Thirteenth meeting of the ICAR Scientific Panel for Fisheries at New Delhi, 6 August.

Second meeting of the ICAR Coordination Committee for *Sagar Sampada* at New Delhi, 7 August.

Dr P. S. B. R. James, Director attended the following meetings :

Meeting of the ICAR Regional Committee No. VIII at Trivandrum, 6-7 September.

Second meeting of the Tamil Nadu Fisheries Research Council at Madras, 16 September.

ICAR Director's Conference at New Delhi, 24-25 October.

Tripartite Meeting of the FAO/ UNDP Project on Intensification of Freshwater Aquaculture Research and Training at FARTC, Dhauli, 7 November.

Meeting of the Reorganisation Committee for CIFRI, Barrackpore, 8 November.

National Conference on Fisheries at New Delhi, 23 November.

Twelth meeting of the ICAR scientific Panel for Fisheries.

Divisional meeting of Institute's Seventh Plan proposal at ICAR Headquarters, New Delhi, 6 January.

Cruise Planning and Programme Priorities Committee Meeting for *Sagar Kanya* and *Sagar Sampada* at New Delhi, 14 January.

Inter-agency Preparatory Meeting for Futurology Workshop on Lakshadweep at Regional Research Laboratory, Trivandrum, 18 March.

World Conference on Trade in frog legs vis-a-vis Environmental Considerations organised by MPEDA in association with CIFRI at Calcutta, 10-11 April.

Dr K. Radhakrishna, Scientist S-3 participated in the Sixth Course on Designing Projects for Agricultural Development at Indian Institute of Management, Ahmedabad, 18 November — 19 January.

Shri Y. Appanna Sastry, Scientist S-1 underwent Eighteenth Agricultural Research Management Orientation

Smt. K. Pushkala, Emerald Heights College, Ooty.

Shri M. P. Vinabhah and R. Pandian, Department of Zoology, K.G.S. Arts College, Srivaikuntam.

Shri N. Arirthalengan, Deputy Director (Information) Govt. of Tamil Nadu.

Dr D. M. Thampy, Professor and Head of Depatrment of Aquaculture, College of Fisheries, Cochin.

Tuticorin

Miss G. Bernetin, Faith Academy, East Patel Nagar, New Delhi.

Smt. Valliammai Subramanian, President, SPIC Nagar Ladies Club, Tuticorin.

Shri P. V. Prabhu and Shri M. K. Kandoran, Scientists, CIFT, Cochin.

Smt. Uma Kumar, Department of Zoology, S. R. College, Trichy.

Dr. N. S. Murthy, Medical Superintendent, Railway Hospital, Madurai.

Shri R. S. Raman, Executive Director, Tuticorin Alkali Chemicals, Tuticorin.

Shri K. M. Veeranna, Anna University, Madras.

Dr T. Swaminathan, Assistant Professor, Civil Engineering, Anna University, Madras.

Students from the following Institutions visited CMFRI Headquarters/ Research Centres.

P. S. G. College, Coimbatore
St. Joseph's College, Alleppey.
Christ College, Irinjalakuda.
Department of Marine Biology, Karwar
Birla College, Kalyan.
C. M. S. College, Kottayam
N. S. S. College, Pandalam.
New Science College, Hyderabad.

Department of Zoology, University of Mysore.

Government College, Kasargod.

Minicoy

Study Group II of Estimates Committee of Lok Sabha visited on 21 January. The team consisted of Prof. Madhu Dhandawade, Shri M. R. Janardhanam, Shri G. L. Dogra, Shri N. N. Mehra, Shri J. C. Malhotra, Shri K. L. Anand and Shri N. C. Gupta.

Karwar

Dr M. R. Chandran, Professor and Head of Department of Zoology, Presidency College, Madras.

Prof. S. S. Mandal and Prof. V. B. Kattimani, S. B. Arts and Science College, Bijapur.

Prof. A. D. Marathe, Dr. D. Y. Joshi and Dr V. D. Ranade, Abasaher Garware College, Pune.

Kakinada

Shri Jagmohan and Chandrani, Japanese Business Service, Edogawa, Tokyo, Japan.

The students on study tour from the following colleges :

S.V.R.M. College, Guntur.
B. N. S. College, Hyderabad.
Noble College, Machilipatnam.
Fisheries Training Institute, Kakinada.

List of Scientists deputed abroad for Training during 1985-86

1.	Shri K. K. Prabhakara Panikkar Scientist S-1	:	Underwent training in Aquaculture Economics at University of Pertain, Malaysia, Kolalampur for 5 months from January.
2.	Shri E. V. Radhakrishnan Scientist S-2	:	Deputed for six months training in Lobster Culture at Tulane University USA.
3.	Shri M. Kathirvel Scientist S-1	:	Deputed to undergo training in the field of Integrated fisheries farming for four months in the Regional Leed Centre for Integrated Fish Farming, Wuxi, People's Republic of China from 9 April.
4.	Dr A. Laxminarayana Scientist S-2	:	Deputed to undergo Fellowship training on Reproductive physiology of marine prawns at Bodega Marine Laboratory Bodega, California, USA for a period of 4 months from 3 June
5.	Shri V. S. Rengaswamy Scientist S-1	:	Deputed to undergo fellowship training, in the field of Milkfish culture in the South East Asian Fisheries Development Centre, Illoilo city, Philippines for a period of 3 months from 14 June.
6.	Shri M. S. Rajagopalan Scientist S-3	:	Deputed to undergo training in Applied Ecology of mangroves at the Australian Institute of Marine Sciences, Townswille, Australia for 6 months from August.
7.	Shri T. S. Velayudhan	:	Underwent training in molluscan genetics at the Department of Biology Dalhousie University, Halifax, Novascotia, Canada for four months from August.

8. Shri P. Muthiah
Scientist S-2 : Deputed to undergo training in oyster hatchery at the Institute Franitair de Research, Pour Social Paris for four months from 9 September.

9. Shri S. Dharmaraj
Scientist S-2 : Deputed to undergo training in Invertebrate tissue culture in the National Institute of Fisheries Agency Tokyo, Japan for two months from 24 October.

10. Dr P. S. Kuriakose
Scientist S-2 : Deputed to undergo training in mussel culture at the Institute de Investigations Pesquares, Spain for 4 months from October.

Seminars and conferences

The Director and the Scientists of CMFRI participated in the ICAR cosponsored Seminar on Education and Training for Marine Fisheries Management and Development organised by CIFNET during 28-30 January. The Director presented a paper entitled "the potential marine fisheries resources and possibilities of exploiting the same to increase marine fish production".

The Director and Scientists of CMFRI participated in the Seminar on Mussel Watch at the School of Marine Sciences, Cochin, 13-14 February.

Dr Shyamal Banik, Scientist S-1 attended the 73rd session of Indian Science Congress at University of Delhi, New Delhi, from 3-8 January and presented a paper entitled 'Diazotrophic activity and ferric sulphate mineralizing ability by estuarine sulphate reducing bacteria'.

All India Industrial Trade Fair

Mandapam Regional Centre participated in the XIII All India Industrial & Tourist Trade Fair 1986 at Madras. An exhibition projecting fish culture activities was organised at the Ramanathapuram District Pavillion.

Flower show at Madurai

The Mandapam Regional Centre participated in the Annual flower show organised by the Madurai Horticultural Society at Madurai during 1-2 February. Cultured pearl, pearl oysters, edible oyster, fish and prawn were displayed in the exhibition held in this connection which attracted very large crowds. The Horticultural Society presented the stall with a certificate and a plaque.

C M F R I — OFFICIAL COMMITTEES

CMFRI Joint Council

The Joint Council of CMFRI has been constituted with the following members. The tenure of the Council will be for 3 years from 4 January, 1986.

Office side :

1.	Dr P. S. B. R. James, Director	:	Chairman
2.	Dr P. Vedavyasa Rao, S-3	:	Member
3.	Dr K. Radhakrishna, S-3	:	Member
4.	Dr K. C. George, S-3	:	Member
5.	Assistant Accounts Officer	:	Member
6.	Senior Administrative Officer/Administrative Officer	:	Secretary (Official side)

Staff side

(a) Technical Group :

1.	Shri K. Soman, Technical Assistant (T-II-3)	:	Member
2.	Shri M. Adul Nizar, Field Assistant (T-1)	:	Member
3.	Shri H. Kather Batcha, Technical Assistant (T-I-3)	:	Member
4.	Shri Joseph Andrews, Technical Assistant (T-II-3)	:	Member

(b) Administrative Group :

5.	Shri A. K. Balakrishna Pillai, Supdt.	:	Secretary (Staff side)
6.	Shri B. Vijayakumar, Senior Clerk	:	Member

(c) Supporting Group :

7.	Shri A. P. Sebastian, SS Grade II (peon)	:	Member
8.	Shri K. Muthuramalingam, SS Grade IV, Lab. Attendant	:	Member
9.	Shri K. Ganesan, SS Grade II (Watchman)	:	Member

Shri H. Kather Batcha has been elected as the Member to the Central Joint Staff Council at ICAR.

Vessel Management Cell

1. Dr K. C. George, S-3
2. Shri V. N. Bande, S-2
3. Smt. N. Yesodha, Jr. Steno

Management Committee for a tiffin room

1.	Dr M. J. George, J. D.	:	Chairman

Departmental Promotion Committee

1.	Dr P. S. B. R. James, Director	:	Chairman
2.	Shri T. Jacob, S-3	:	Member
3.	Shri P. T. Meenakshisundaram	:	Member
4.	Joint Director	:	Member Secretary in place of Sr. A. O.

Stores Committee

1.	Shri M. S. Muthu	:	Chairman
2.	Shri A. Noble	:	Member
3.	Shri Nandakumar	:	Member
4.	Shri K. K. Datta	:	Member
5.	Asst. Accounts Officer	:	Member
6.	Administrative Officer	:	Member

Committee for National Strategy for the Exploitation of Potential Marine Fisheries Resources — a 'feasibility study'

1.	Dr K. C. George	:	Convenor
2.	Shri T. Jacob	:	Member
3.	Shri M. S. Rajagopal	:	Member
4.	Dr V. Narayana Pillai	:	Member
5.	Dr K. J. Mathew	:	Member

Handbook Committe for Training Programme of the Institute

1.	Dr M. M. Thomas	:	Chairman
2.	Dr A. Laxminarayana	:	Member
3.	Mrs. Mary K. Mannissery	:	Member

PROGRESS OF RESEARCH

FISHERY RESOURCES ASSESSMENT DIVISION

The marine fish landings in India during 1985-'86 has been estimated at 1.57 million tonnes along with contributions of commercially important groups to facilitate stock assessment. Stock assessment of Indian Mackerel, *R. kanagurta*, Oil sardine, *S. longiceps* and certain species of penaeid prawns viz. *M. monoceros* and *P. stylifera* was carried out. Exploitation levels for realising maximum sustainable yields, standing stock and annual stock were estimated. Steps had been initiated to install a computer in the National Marine Living Resources Data Centre. A training programme of 10 days duration on the sampling design of CMFRI has been conducted for the benefit of the officials of State Fisheries Departments.

Aquisition of data on exploited marine fishery resources for stock assessment in Exclusive Economic Zone (FSS/FRA/1.1)

Annual Production of marine fish

Annual marine fish production in the country during the year 1985-'86 has been provisionally estimated at 1.57 million tonnes, registering a decline of 3.0% from 1984-'85.

Among the commercially important groups oil sardine accounted for 8.3% in the total landings as against 10.2% during 1984-'85. The contribution of penaeid prawns was 8.6% which was 0.5% more than the previous year. Bombay duck accounted for 6.7% as against 7.7% in the previous year. The contribution of non-penaeid prawns decreased from 4.6% during 1984-'85 to 4.1% during this year. A decline of about 0.5% was noticed in the contribution of *Stolephorus* spp. from the previous year.

Pelagic and demersal groups of fishes

The landings of pelagic fishes during 1985-'86 have been estimated at about 804,000 tonnes forming about 51.4% of the total landings while the remaining 48.6% of the total landings was accounted for by the demersal fishes including crustaceans. Table 1 shows the landings of these groups.

Table 1 : Marine fish landings in India (in tonnes)

	1985-'86	1984-'86
Pelagic	803,994	813,718
Demersal	761,899	801,204
TOTAL	1,565,893	1,614,922

Both the pelagic and demersal groups recorded lower landings during this year as compared to the previous year, the decrease being 1.2 and 4.9 per cent respectively.

Estimated landings of pelagic group are provided in Table 2(a).

Table 2(a) Estimated Pelagic Fish Landings in India (in tonnes)

Sy. No.	Pelagic fishes	1985-'86	1984-'85
1.	Clupeids		
a)	Wolf herring	17,006	18,418
b)	Oil sardine	128,724	165,291
c)	Other sardines	60,828	68,457
d)	Hilsa shad	5,543	9,607
e)	Other shads	11,981	14,962
f)	Anchovies		
	Coilia	28,043	24,272
	Setipinna	3,504	3,229
	Stolephorus	63,692	72,696
	Thryssa	27,372	20,202
g)	Other clupeids	32,945	42,987
2.	Bombay duck	103,419	124,947
3.	Half & Full beaks	2,637	1,710
4.	Flying fishes	669	2,705
5.	Ribbon fishes	94,305	52,318
6.	Carangids		
a)	Horse mackerel	3,534	4,316
b)	Scads	8,840	11,520
c)	Leather jackets	6,042	13,515
d)	Other carangids	36,763	28,015
7.	Mackerel		
a)	Indian Mackerel	65,152	40,331
b)	Other Mackerels	87	102
8.	Seer fishes	58	
a)	S. commerson	17,524	17,616
b)	S. guttatus	16,113	16,218
c)	S. lineolatus	30	186
d)	Acanthocybium spp.	—	44
9.	Tunnies		
a)	E. affinis	16,089	11,384
b)	Auxis spp.	3,448	1,525
c)	K. pelamis	3,643	3,624
d)	T. tonggol	1,090	186
e)	Other tunnies	6,233	3,216
10.	Bill fishes	838	1,479
11.	Barracudas	3,476	3,905
12.	Mullets	5,160	4,293
13.	Unicorn cod	405	2,569
14.	Miscellaneous	27,801	27,873
	TOTAL	803,994	813,718

Among the major pelagic fishes, oil sardine with 128,700 tonnes ranked first followed by Bombay duck (103,400 t), Ribbon fishes (94,000 t), Mackerel (65,100 t), stolephorus (63,700 t) and other sardines (61,000 t) contributing respectively 16.1, 12.9, 11.6, 8.1, 8.0 and 7.6 per cent to the total pelagic landings.

Oil sardine

Kerala and Karnataka together accounted for about 92% of the total oil sardine landings. The share of Kerala recorded a decline from 98% in 1984-'85 to 57% during this year, this is due to a reduction of about 54,900 tonnes from the landings during 1984-'85, which was about 128,000 tonnes, However, Karnataka recorded increase in landings from 32,000 tonnes during 1984-'85 to 45,600 tonnes in 1985-'86.

Bombay duck

A decrease of about 22,000 tonnes was observed in the landings of Bombay duck from 125,000 tonnes during 1984-'85 to 103,000 tonnes during 1985-'86. Maharashtra and Gujarat accounted 93% of the all India landings, Maharashtra alone accounting for about 61 per cent. Gujarat recorded a substantial decline of about 21,000 tonnes from the previous years' landings whereas in Maharashtra there was an increase of about 2,000 tonnes.

Stolephorus

The landings of *Stolephorus spp* declined from 73,000 tonnes during 1984-'85 to 64,000 tonnes during 1985-'86. Kerala accounted for 57.1% of the all India landings of this species. The landings in this state decreased by 11.2% from 1984-'85 landings of 41,000 tonnes. The landings of this species in Karnataka which constituted 16.1% of the all India landings decreased by about 1,300 tonnes.

Ribbon fishes

Landings of Ribbon fishes which accounted for 6% of total landings in India during 1985-'86 registered a substantial increase of about 41,000 tonnes from the landings of 52,000 tonnes during 1984-'85. This has been mainly due to higher landings in Kerala (25,000 tonnes), Gujarat (24,000 tonnes) and Maharashtra (21,000 tonnes).

Mackerel

There was an increase of about 25,000 tonnes in the landings of mackerel during 1985-'86 as compared to that of 1984-'85. Kerala and Karnataka together accounted for 69% of the all India landings, Karnataka ranking first. The landings of mackerel in Karnataka increased by 92% and in Kerala the increase was 58% over the landings during 1984-'85. In Tamil Nadu, the landings were 5600 tonnes declining by about 200 tonnes from the previous year. There has not been significant change in the landings in Andhra Pradesh. There has been increase of 3,000 tonnes in Goa during 1985-'86 (5700 tonnes) compared to those during 1985-'86.

Demersal species

Estimated landings of demersal species of fish and crustaceans are given in Table 2(b).

Table 2 (b)

Estimated Demersal Fish landings in India (in tonnes)

Sl. No.	Demersal fishes	1985-'86	1984-'85
1.	Elasmobranchs		
a)	Sharks	31,415	34,205
b)	Skates	3,472	2,726
c)	Rays	16,148	18,051
2.	Eels	8,371	7,962
3.	Cat fishes	45,450	52,286
4.	Lizard fishes	13,202	14,870
5.	Perches		
a)	Rock cods	2,898	3,154
b)	Snappers	3,137	4,570
c)	Pig-face breams	2,643	1,769
d)	Threadfin breams	40,225	38,316
e)	Other perches	23,476	24,379
6.	Goat fishes	5,603	4,540
7.	Thread fins	7,070	8,509
8.	Croakers	102,623	108,670
9.	Silver bellies	54,940	52,113
10.	Big jawed jumper	23,567	18,656
11.	Pomfrets		
a)	Black pomfret	9,448	11,490
b)	Silver pomfret	19,084	34,641
c)	Chinese pomfret	158	446
12.	Flat fishes		
a)	Halibut	1,411	1,733
b)	Flounders	163	75
c)	Soles	25,870	42,651
13.	Crustaceans		
a)	Penaeid prawns	132,198	130,533
b)	Non-penaeid prawns	64,518	73,964
c)	Lobsters	4,328	3,250
d)	Crabs	21,010	26,488
e)	Stomatopods	39,503	29,616
14.	Cephalopods	33,622	24,097
15.	Miscellaneous	26,346	27,444
	TOTAL	761,899	801,204

Among the demersal species, penaeid prawns accounted for 17.4% of the total demersal landings. The share of pomfrets was 13.6% followed by non-penaeid prawns (8.6%), silver bellies (7.3%), elasmobranchs (6.7%) and cat fishes (6%).

Penaeid prawns

The estimated landings during 1985-'86 was about 132,200 tonnes as against 130,500 tonnes during 1984-'85 registering a marginal increase. Maharashtra (56,000 tonnes), Kerala (28,000 tonnes), Gujarat (13,000 tonnes) and Tamil Nadu (12,000 tonnes) together accounted for 83% of the all India penaeid prawn landings.

In Maharashtra, penaeid prawn landings increased by 11,000 tonnes from 45,000 tonnes during 1984-'85. Kerala registered a decline in the landings from 37,000 tonnes during 1984-'85 to 28,000 tonnes during 1985-'86. There is a decline of about 700 and 400 tonnes in the landings in Gujarat and Tamil Nadu respectively as compared to the landings during 1984-'85. The landings in Andhra Pradesh registered an increase of 22% over 1984-'85.

Non-penaeid prawns

The landings of non-penaeid prawns decreased from 74,000 tonnes during 1984-'85 to 64,500 tonnes during 1985-'86, the decline being 12.8%. Maharashtra and Gujarat accounted for 91% of all India landings of this group for this year, Maharashtra alone contributing 78.5%. Both these states registered decline in the landings as compared to that of 1984-'85, the decline being 1,200 and 2,400 tonnes respectively. The landings in West Bengal decreased from 8000 tonnes in 1984-'85 to 3,600 tonnes in 1985-'86.

Croackers

Croakers accounted for 6.6% of the all India total landings and declined by 5.6% from 109,000 tonnes during 1984-'85 to 102,600 tonnes during 1985-'86. Gujarat (30,200 tonnes), Maharashtra (24,800 tonnes), Orissa (19,400 tonnes), Tamil Nadu (8,100 tonnes), Kerala (7,600 tonnes) and Andhra Pradesh (6,800 tonnes) together accounted for 94% of the all India landings. All these states, except Maharashtra, recorded lower landings. The landings in Maharashtra increased by 23% in 1985-'86 when compared to the landings in 1984-'85.

Silver bellies

An increase of about 3,000 tonnes was observed in the landings in 1985-'86 as compared to 1984-'85. This has been mainly due to increased landings in Tamil Nadu during 1985-'86, the increase being 3,000 tonnes from 36,000 tonnes during 1984-'85. Tamil Nadu accounted for 71% of all India silver bellies landings followed by Andhra Pradesh (10.6%), Kerala (6.1%) and Karnataka (4.8%).

Perches

The landings of perches in 1984-'85 and 1985-'86 remained more or less at 71,000 tonnes. The contribution of Thread fin bream in the total perches

landings during 1984-'85 was 54.3% which increased to 55.7% during 1985-'86. The major portion (75%) of landings of perches was accounted for in Kerala.

Elasmobranchs

The estimated landings of elasmobranchs during 1985-'86 was 50,500 tonnes recording a decrease of about 4,500 tonnes as compared to 1984-'85. About 62% of the elasmobranchs landed during this year were sharks, the contribution of rays in the total elasmobranchs landings being 32%. Gujarat ranked first in the landings of elasmobranchs (12,700 tonnes) and registered an increase of about 6.3% over 1984-'85. The other major states in the order of landings are Maharashtra (10,500 tonnes), Tamil Nadu (8,200 tonnes), Andhra Pradesh (6,600 tonnes) and Kerala (5,800 tonnes).

Cat Fishes

The landings of cat fishes decreased from 52,000 tonnes during 1984-'85 to 45,000 tonnes during 1985-'86. The landings in Gujarat increased by 27% over 1984-'85. There has been a significant fall in the landings in Kerala from 10,500 tonnes during 1984-'85 to 4,600 tonnes during 1985-'86. There is an increase of about 1,000 tonnes in Maharashtra. All other states registered decrease. This along with steep fall in the landings in Kerala resulted in decreased landings in the All India level.

Pomfrets

A decrease of about 38% was observed during 1985-'86 in the landings as compared to 1984-'85, the landings during 1985-'86 being 29,000 tonnes. This has been mainly due to decreased landings in Maharashtra and Gujarat. The landings in Maharashtra during 1984-'85 (17,660 tonnes) decreased to 10,148 tonnes during 1985-'86. In Gujarat, the landings registered a fall from 14,700 tonnes during 1984-'85 to 9,600 tonnes during 1985-'86. The silver pomfret which accounted for 67% of the total pomfret landings during 1985-'86, declined from 34,600 tonnes during 1984-'85 to 19,300 tonnes in 1985-'86, its share during 1984-'85 being 74%. Andhra Pradesh too, recorded a fall in the landings from 5,000 tonnes during the previous year to 1,900 tonnes during the year under review.

Landings by mechanized/ non-mechanized vessels

The landings by mechanised and non-mechanised vessels are given in Table 3.

Table 3 : Landings by mechanized and non-mechanized vessels

(in tonnes)

	1985-'86	1984-'85
Mechanised	1,173,160	1,144,494
Non-mechanised	392,733	470,428
TOTAL	1,565,893	1,614,922

There is only a marginal increase in the landings by mechanised vessels. The landings by non-mechanised vessels, however, decreased by 16.5% from the previous year. The contribution of mechanised landings in the total landings was about 75% during

1985-'86 against 71% during 1984-'85. Thus, the over all decrease in the landings during 1985-86 was due to decreased landings of non-mechanised units.

LANDINGS IN DIFFERENT REGIONS

North east region

North east region comprising West Bengal, Orissa, Andhra Pradesh and Andaman & Nicobar islands accounted for 13% of the all India landings during 1985-'86 and the landings in this region declined by 7% from 1984-'85. Landings of *Stolephorus* spp increased by 3,100 tonnes from 4,100 tonnes during 1984-85. Elasmobranchs, non-penaeid prawns pomfrets and perches recorded a decline of 25, 45, 43 and 31 per cent respectively. Silver bellies recorded an increase of 23% from 5,700 tonnes during 1984-'85.

South east region

South east region comprising Tamil Nadu (including Pondicherry) contributed 14% to the all India landings and recorded a decrease of 30,000 tonnes from 248,000 tonnes during 1984-85. Silver bellies showed an increase of 11% from 36,700 tonnes during 1984-85 to 40,500 tonnes during 1985-'86. Significant decrease was noticed in the landings of elasmobranchs, other sardines, *Stolephorus* spp, ribbon fishes and croakers, the decrease being 2,800 tonnes, 5,000 t, 5,000 t, 4,600 t and 2,300 t respectively. There was a marginal decrease in penaeid prawn landings from 13,300 tonnes during 1984-'85 to 12,800 tonnes during 1985-'86.

South west region

The contribution of south west region consisting of the Kerala, Karnataka, Goa and Lakshadweep was 34% which was same as during the previous year. There was only a marginal decline of 2% from 1984-'85, the landings during 1984-'85 being 544,000 tonnes. There has been a significant increase in the landings of ribbon fish from 8,400 tonnes during 1984-'85 to 28,000 tonnes during 1985-'86. Mackerel also showed an increase of 79% from 28,000 tonnes during 1984-'85 to 51,000 tonnes in 1985-'86. However, the decreased landings of oil sardine, one of the commercially important fishes of this region from 162,000 tonnes during 1984-'85 to 122,000 tonnes during 1985-'86 together with the fall in the catches of cat fish, penaeid prawns, and croakers, resulted in the over-all decline in the landings of this region when compared to the previous year.

North west region

North west region comprising Maharashtra and Gujarat accounted for 39% of the all India landings. There has been no significant change in the landings from 1984-'85. In this region too, like the south west region, ribbon fish landings showed a significant increase of 24,400 tonnes from 19,600 tonnes during 1984-'85. Penaeid prawns increased from 59,000 tonnes during 1984-'85 to 69,000 tonnes during 1985-'86. There was a decline (39%) in the landings of pomfrets from 32,000 tonnes during 1984-'85 to 19,700 tonnes during the period under review. Bombay duck landings decreased from 121,700 tonnes during the previous year

PROGRESS OF RESEARCH

FISHERY RESOURCES ASSESSMENT DIVISION

The marine fish landings in India during 1985-'86 has been estimated at 1.57 million tonnes along with contributions of commercially important groups to facilitate stock assessment. Stock assessment of Indian Mackerel, *R. kanagurta,* Oil sardine, *S. longiceps* and certain species of penaeid prawns viz. *M. monoceros* and *P. stylifera* was carried out. Exploitation levels for realising maximum sustainable yields, standing stock and annual stock were estimated. Steps had been initiated to install a computer in the National Marine Living Resources Data Centre. A training programme of 10 days duration on the sampling design of CMFRI has been conducted for the benefit of the officials of State Fisheries Departments.

Aquisition of data on exploited marine fishery resources for stock assessment in Exclusive Economic Zone (FSS/FRA/1.1)

Annual Production of marine fish

Annual marine fish production in the country during the year 1985-'86 has been provisionally estimated at 1.57 million tonnes, registering a decline of 3.0% from 1984-'85.

Among the commercially important groups oil sardine accounted for 8.3% in the total landings as against 10.2% during 1984-'85. The contribution of penaeid prawns was 8.6% which was 0.5% more than the previous year. Bombay duck accounted for 6.7% as against 7.7% in the previous year. The contribution of non-penaeid prawns decreased from 4.6% during 1984-'85 to 4.1% during this year. A decline of about 0.5% was noticed in the contribution of *Stolephorus* spp. from the previous year.

Pelagic and demersal groups of fishes

The landings of pelagic fishes during 1985-'86 have been estimated at about 804,000 tonnes forming about 51.4% of the total landings while the remaining 48.6% of the total landings was accounted for by the demersal fishes including crustaceans. Table 1 shows the landings of these groups.

Table 1 : Marine fish landings in India (in tonnes)

	1985-'86	1984-'86
Pelagic	803,994	813,718
Demersal	761,899	801,204
TOTAL	1,565,893	1,614,922

Both the pelagic and demersal groups recorded lower landings during this year as compared to the previous year, the decrease being 1.2 and 4.9 per cent respectively.

Estimated landings of pelagic group are provided in Table 2(a).

to 101,400 tonnes during this year. Non-penaeid prawns declined by 6% during 1985-'86, from 62,500 tonnes during 1984-'85.

Stock assessment of commercially important fishes of the exploited zone (FSS/FRA/1.3)

During this year stock assessment of Mackerel *(Rastrelliger kanagurta)*, oil sardine *(Sardinella longiceps)* and certain species of penaeid prawns viz *M. dobsoni* and *P. stylifera* was carried out.

Mackerel

The growth parameters, mortality rates were estimated using the length frequency data collected during 1978-'83 at various centres viz., Calicut Cochin, Mangalore and Karwar. The exploitation rates for achieving maximum sustainable yields were determined. The analysis revealed that, for the present length at first capture, at all the centres considered for study the present level of exploitation is just below the MSY level and any further increase in exploitation may not yield significant increase in catches.

Oil sardine

Based on the length frequency data the growth parameter and mortality rates were estimated. The potential stock was estimated to be 4.4 lakh tonnes. In Kerala state, there appears to be a scope for increasing the fishing effort for realising higher catches.

Penaeid prawns

Stock assessment studies on *Parapenaeopsis stylifera* and *Metapenaeus monoceros* based on the data collected off Mangalore and Karwar coasts have clearly indicated that though the stocks have not been affected at the present level of exploitation, cod end mesh size of trawlers has to be increased atleast to 30 mm so as to increase MSY levels of these stocks.

National Marine Living Resources Data Centre (FSS/FRA/ST.1)

Data received in coded form from the field staff spread along the coast of India and also obtained from FSI vessels of Government of India were processed. The results were communicated to various organisations like State Fisheries Departments, Department of Agriculure, Government of India, ICAR and MPEDA. Zonal workshops of Scientific and technical personnel connected with sample survey programme were conducted at Calicut, Bombay, Madras and Kakinada, where extensive discussions took place and conclusions were arrived at for improving the formats of recording of data.

During this year decision has been taken about the model of the computer to be procured and accordingly orders have been placed with DGS & D. Management of EDP systems on board the Fishery Oceanographic Research Vessel 'Sagar Sampada' was continued. Intensive training was given to the field staff for recording the data in the restructured schedules.

Personnel associated with the various projects of the Division

T. Jacob, K. Alagaraja, S. K. Dharmaraja, K. Narayana Kurup, K. Balan, M. Srinath, K. S. Scariah, K. Vijayalakshmi, S. S. Dan, J. P. Karbhari, G. Balakrishnan, U. K. Satyavan, Varughese Philipose, K. C. Yohannan, P. K. Mahadevan Pillai, Varughese Jacob, G. Krishnankutty Nair, P. Sivaraman, V. Rajendran, V. P. Annam, P. Karunakaran Nair, Abha kant, Joseph Andrews, A. Kanakkan, S. Haja Najimudeen, C. J. Prasad, A. L. Ammini, K. P. George, M. B. Seynudeen, P. P. Pavithran, M. Ramachandran, K. Anandan, G. Subbaraman, P. T. Mani, M. R. Beena, Lata Thote, Pulin Behari Dey, Sapan Kumar Ghosh, Sukdev Bar, K. R. Somayajulu, K. Dhanaraju, V. Achutha Rao, M. Radhakrishnan, S. Satya Rao, M. Chandrasekhar, C. V. Seshagiri Rao, K. Chitti Babu, K. V. S. Seshagiri Rao, P. Ananda Rao, T. Chandrasekhara Rao, A. Hanumantha Rao, G. C. Lakshmaiah, A. Agastheesa Pillai Mudaliar, M. Mohamed Sultan, H. Kather Batcha, M. Bose, S. Manivasagam, L. Chidambaram, A. Srinivasan, M. Manivasagam, L. Jeyasankaran, R. Somu V. Thanapathi, V. Sivaswamy, A. Ganapathy, P. Palani, K. Muthaiah, Hameed Batcha, A. Kumar, K. Muniyandi, K. S. Krishnan, S. Sankaralingam, R. Subramaniam, C. Kasinathan, S. Subramani, O. M. M. J. Habeeb Mohamed, R. Gurusamy, K. Ramakrishnan Nair, N. Retnaswamy, J. P. Ebenezer, Jacob Jerald Joel, R. Bhaskaran Achari, M. Babu Philip, T. G. Vijaya Warrier, S. B. Chandrangathan, V. S. Gopal, A. A. Thankappan, K. Thulasidas, N. Palaniswamy, M. B. Renu Kumar, C. K. Krishnan, T. Girijavallabhan, K. Soman, T. Krishnankutty, B. Sreedhara, H. S. Mahadevaswamy, K. Chandran, Maruthi Sankar Naik, Ahamed Kamal Basha, T. B. Harikantra, Devidas Y. Naik, T. S. Balasubramaniam, A. Prosper, K. Ramdoss Gandhi, D. G. Jadhav, M. Shriram, J. L. Oza, K. B. Waghmare, C. J. Josekutty, Johny R. Dias, B. N. Katkar, S. D. Kamble, M. Chellappa, Y. D. Savaria, B. V. Makadia, S. S. Sugawekar, Zala Mangal Singh.

PELAGIC FISHERIES DIVISION

The major programmes of the Division were on capture fisheries carried out under 12 projects. The investigations carried out during 1985-'86 were concerned with monitoring and evaluation of resource characteristics and stock assessment of major exploited Pelagic fisheries. The scientists of the Division were also involved in inter-Divisional projects; besides being associated with the Teaching Programme at Post graduate level. They had also actively participated in several research cruises. Good progress has been achieved during the year under various projects.

The production from the mackerel, tuna & bill fish, seerfish, Indian shad, lesser sardine and carangid fisheries was comparatively better during the year than previous year. In others like oil sardine, anchovy, pomfret and Bombay duck it was lower. Two periods of abundance during March-May and September-December were observed for most of the pelagic fisheries. By increasing fishing pressure during the above periods, increased production from the fisheries could be realized. One of the significant features observed in the coastal pelagic species, during the current season, was the shift in their abundance from the southern grounds, to the northern grounds and also of the significant increase in the yields of scombroid species.

In most species generally two peak periods of spawning and recruitment were evident. Small meshed bag nets employed by the artisanal sector, shrimp trawl and purse seine by the mechanized sector took heavy toll of juveniles of Bombay duck, pomfret, oil sardine, lesser sardine, mackerel and whitebait from the nursery grounds.

Studies on the stock assessment and the effect of the fishery on the stocks of the exploited pelagic resources are in progress.

Resources of tunas and bill fishes (FB/PR/3.1)

E. G. Silas, G. Gopakumar, G. M. Kulkarni, C. Muthiah, T. M. Yohannan, P. P. Pillai, M. Srinath, A. A. Jayaprakash, Pon. Siraimeetan and S. Sreenivasa Rangan.

The research and technical programmes on the resources of tunas and bill fishes were continued at the observation centres during the year under report. Data on the biological characteristics and fishery trends were collected, analysed and studied.

There was a general increase in the trend of production and abundance of tunas and bill fishes during the year at the observation centres with an estimated landings of about 6275 tonnes in 1985-86 compared to 1936

tonnes in 1984-85. This increased trend in production was obvious at most of the centres, except at Waltair. The principal gear that contributed to the landings were drift gill net (39.3%), purse seine (39.2%) and Hooks & line (21.5%) at the mainland centres and pole and line (95.3%) at Minicoy.

Among the tunas and bill fishes landed at the mainland centres, tunas constituted 98.4% and the rest by bill fishes. The bulk of the tuna landings at these centres was sustained by *E. affinis* (49.7%), *A. thazard* (24.8%), *A. rochei* (17.7%) and *K. tonggol* (21.1%). In the oceanic region at Minicoy, the tuna fishery was supported by oceanic skipjack, *K. pelamis* (82.7%) and yellowfin tuna, *T. albacares* (16.8%). The peak abundance for the oceanic skipjack at Minicoy was observed during November-January and March-April; and for the *E. affinis* generally during May-August & October-December off the west coast and during June-August off the East-coast cenrtes of the mainland.

The size range and major modal sizes of tunas and bill fishes landed at different centres are presented in Fig. 1. Studies on maturity and spawning of *K. pelamis* were continued at Minicoy. Females dominated males in the landings. About 70% of the fish caught were in spawning and partially spent condition. The spawning period is protracted and species appears to spawn several times in a year.

The shoaling and feeding behaviour of the Oceanic skipjack was studied. The major types of shoals observed off Minicoy were mainly breeding and jumping shoals. The feeding response of the schools appears to be dependent on the state of hunger and on the availability of bait fishes outside the lagoon and on the edge of the reef.

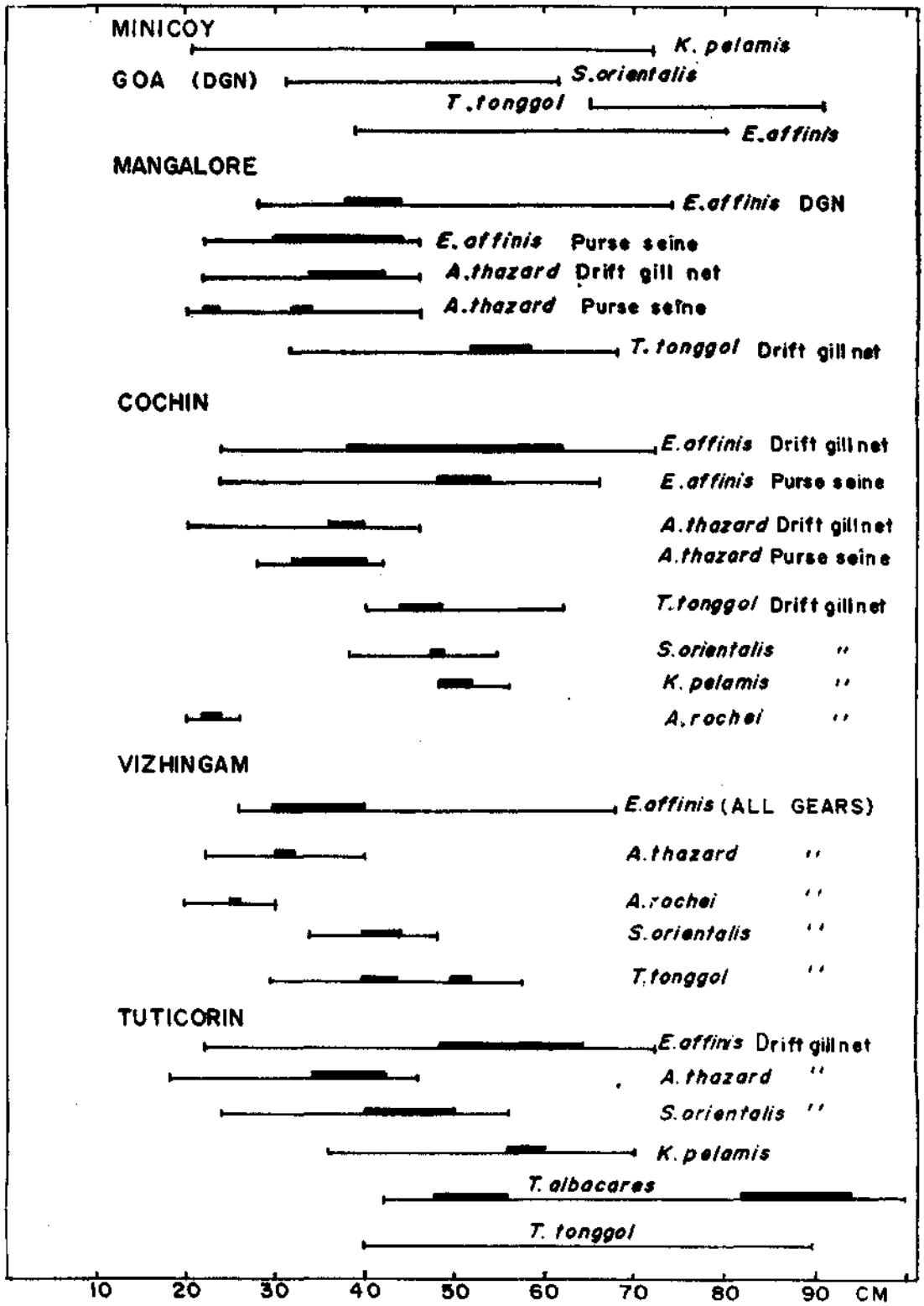
The quantity of bait fishes used for chumming tunas amounted to about 4.5 tonnes during the season. They consisted mainly of sprats (37.1%), Caesiodids (32.9%) and Apogonids (15.9%). They were generally abundant during October-January, March-April and December-March respectively. The most favoured bait fish 'Bureki', *Lepidozygus tapeinosma* which was abscent for a long time, was caught in good numbers during the year. Biological observations on the bait fishes were continued.

Studies on the stocks of *Euthynnus affinis* exploited by purse seine fishery off Cochin showed a total instantaneous mortality (Z) of 2.923 and fishing mortality (F) of 2.375 indicating an exploitation rate (E) of 0.81. For drift net caught fish the Z, F and E were respectively 0.966, 0.418 and 0.43 during the year against 1.90, 1.352 and 0.71 of 1984-85.

Resource characteristics of Pomfrets (FB/PR/5.4)

M. H. Dhulkhed, M. Zaffar Khan, V. M. Deshmukh, Madan Mohan, M. Kumaran A. A. Jayaprakash, T. Jacob, K. Balan and K. R. M. Nair.

Investigations on the resource characteristics of pomfrets were continued during 1985-86 season at the observation centres. The production from the



Size range and modes of Tunas at important centres

fishery declined at all centres during the year compared to previous season.

The pomfret fishery during the year yielded an estimated catch of about 191 tonnes by dol net at Bombay with a CPUE of 156 kg. The third quarter was most productive when 33.7% of the total catch was landed. At Satpati an estimated 683 tonnes of Pomfret were landed by drift net and dol net, the former gear accounting for 80.2% of the catch with a CPUE of 139 kg. The second quarter was more productive. The silver pomfret *(Pampus argenteus)* sustained the fishery at the above centres.

The fishery at Mangalore was poor with an estimated catch of 95 tonnes, recording a decline of 311 tonnes over the previous year. Purse seine, trawl and drift net accounted for 80.0%, 10.6% and 9.4% respectively of the production. The black pomfret *(Parastromateus niger)* in the purse seine and drift net catches and the silver pomfret *(P. argenteus)* in the trawl catches dominated. The production trend at Kaup with an estimated catch of about 11 tonnes was similar to that of Mangalore.

At Calicut the fishery was marginally increased during the year with an estimated landings of 33 tonnes showing an increase of 7 tonnes over the previous year. Drift gill net was the principal gear used. The black pomfret dominated (89.0%) the catches.

The pomfret fishery during the year was poor at Karwar with an estimated catch of 35 tonnes compared to 119 tonnes during the preceding year. The bulk of the catch was landed by purse seine.

A similar decreasing trend in the landings was observed at Cochin during the year with an estimated catch of 57 tonnes. The second quarter was the most productive. Drift gill net was the principal gear; and black pomfret dominated the landings (99%).

The silver Pomfret with commercial sizes ranging from 11 cm to 32 cm at Bombay, 11 cm to 23 cm at Karwar and from 11 cm to 25 cm at Mangalore supported the fishery. The black pomfret with sizes ranging from 13 cm to 23 cm at Karwar, 10 cm to 40 cm at Mangalore, 15 cm to 34 cm at Calicut and 14 cm to 43 cm at Cochin sustained the commercial fishery. Large quantities of young pomfrets with modal sizes ranging from 5 cm to 8 cm were caught by dol net at Bombay during October-January; by shrimp trawl nets at Karwar during March.

In the samples of black pomfret examined at Mangalore and Calicut sex-ratio was equal at the former and unequal at the latter centre with males dominating. Fishes with fully developed gonads were recorded in the catches during August to November indicating their breeding season.

Estimation of the fishery and resources of Oil sardine (FB/PR/9.1)

V. Balan, P. N. R. Nair, K. Narayana Kurup, T. Jacob, H. Kumaran, Madan Mohan, G. G. Annigeri and G. M. Kulkarni.

Monitoring of the fishery and resource characteristics of the oil sardine was continued at the observation centres.

The production (30,974 tonnes) from the oil sardine fishery during 1985-86 at the observation centres showed a marginal decline (8.7%) over that of previous year. The significant feature observed, however, was the shift in the increased production, during the current season, at the northern centres compared to the southern centres (Cochin). Thus the oil sardine landings at Mangalore (19468 tonnes) and Karwar (5123 tonnes) surpassed the landings at Cochin (2190 tonnes). The catch per unit per day by the purse seine fishery was also the highest (1.342 tonnes) at Mangalore followed by Karwar (0.902 tonnes).

At majority of the centres the species with modal size at 90 mm, 110-120 mm, 155-170 mm and 185-200 mm supported the fishery. The relative abundance of the different age classes in the fishery at the observation centres is presented in the following table No. 4.

Table : 4 Age composition of oil sardine (No./gear/day) in the non-selective gear at different centres during the fishing season 1985-86

Centre	*Gear*	*Age class*			Total
		0-year	1-year	2-year(+)	
Vizhinjam	Boat seine	1	0	0	1
Cochin	Purse seine	5,508	6,192	3,104	14,804
Calicut	Nethal vala	37,254	0	0	37,254
	Pattenkolli vala	9,060	6,639	2,593	18,292
Mangalore	Purse seine	23,800	16,138	5,989	45,927
Karwar	Purse seine	42,961	6,204	3,200	52,365
Goa	Purse seine	29,386	965	1,149	31,500
TOTAL	—	147,970	36,138	16,035	200,143
%	—	73.9	18.1	8.0	100.0

From the above data it is observed that the fishery during the year was mainly sustained by the 0-year class (73.9%), followed by 1-year class (18.1 %) and 2-year class (8.0%) at all centres, except at Cochin where 1-year class was dominant. Compared to the previous year, the relative contribution of 0-year class was lower by 7.3% (by numbers) during the current season which reflected in the productivity of the fishery. As in the previous season, large quantities of juveniles of oil sardine were caught by the purse seine at Goa, Karwar and Mangalore and the boat seine at Vizhinjam and Nethalvala at Calicut.

The sex-ratio indicated that males were dominant in the catches at Cochin and Karwar; females were predominant at Calicut, Mangalore and Goa. Gravid fish were generally caught during May-July at the southern Centres

and during August-September at the northern centres indicating the spawning period for the species.

The analysis of the biological and fishery data of the oil sardine collected at the major observation centres during the past years have been completed for the stock assessment and to study the impact of the fishery on the resource.

Evaluation of fishery and resources of Lesser sardines (FB/PR/9.2)

P. SAM BENNET, G. LUTHER, P. T. MEENAKSHISUNDARAM, S. SRINIVASA RANGAN, R. THIAGARAJAN, P. N. R. NAIR, K. NARAYANA KURUP, K. S. SCARIA MADAN MOHAN, G. G. ANNIGERI and K. M. KULKARNI.

The lesser sardine fishery during 1985-86 was fairly good at most of the observation centres on the East and West coast of India. Among the multifarious gears employed in the fishery, gill net at Vizhinjam, Tuticorin, Madras and boat seine at Visakhapatnam; and purse seine at Mangalore, Karwar and Goa were the principal gears.

During the current year an estimated 296 tonnes of lesser sardines were landed at Visakhapatnam of which gill net accounted for 50% and the rest by boat seine. The important species that supported the fishery were *Sardinella fimbriata* (54.7%), *S. gibbosa* (24.5%) and the rest by *S. longiceps*. The production from the fishery at Madras was estimated at 459 tonnes landed entirely by gill net. Peak period of abundance was observed during November. The fishery at this centre was sustained by *S. gibbosa* (79.2%), *S. sirm* (11.7%) and *S. fimbriata* (9.1%). The production from the fishery was good at Tuticorin with an estimated catch of 4223 tonnes landed entirely by gill net. Good landings were registered from August to December with peak in August when about 616 tonnes were landed. At this Centre, *S. gibbosa* (50.6%) and *S. sirm* (23.2%) were the principal species supporting the fishery.

At Mangalore the lesser sardine fishery yielded an estimated catch of 2222 tonnes. Purse seiners operating in 18-32 metre depth zone accounted for the catch. Peak landings were recorded in October with an estimated catch of 1449 tonnes. The bulk (99.9%) of the annual landings was accounted by *S. gibbosa*. There was a set back in the fishery at Karwar during the year with a production of 286 tonnes compared to the previous year when it amounted to 1256 tonnes. Purse seine was the principal gear employed and the predominant species were *S. gibbosa* (83.3%) and *S. dayi* (10.2%). The lesser sardine production at Goa amounted to 618 tonnes which were landed by purse seine. November was peak period for the fishery.

In the commercial fishery, *S. fimbriata* ranging in size from 45 mm to 195 mm at Visakhapatnam and from 130 mm to 150 mm at Karwar; *S. gibbosa* ranging in size from 55 mm to 180 mm at Visakhapatnam, from 95 mm to 155 mm at Madras, from 105 mm to 180 mm at Tuticorin, from 140 mm to 190 mm at Mangalore and from 130 mm to 200 mm at Karwar; and *S. dayi*

ranging in size from 140 mm to 185 mm at Karwar were observed. Fairly good quantities of juveniles of *S. fimbriata* and *S. gibbosa* were landed by boat seines at Visakhapatnam.

Sex ratio of *S. fimbriata* showed that females out numbered males both at Visakhapatnam and Karwar. Adult fish with developing gonads were recorded only at latter centre. Similar data on *S. gibbosa* showed that females outnumbered males at Visakhapatnam, Mangalore and Karwar *vice versa* at Madras and Tuticorin. Gravid and spent fish were observed during February to April in abundance. At Karwar gravid fish were more predominant in the catches than at other centres. At this Centre, *S. dayi* was found to be in spent condition with males outnumbering females in the landings.

Based on the resources data collected (1979-83) at Karwar on the exploited stocks of *S. gibbosa* and *S. dayi*, the maximum sustainable yields (MSY) were estimated and the impact of the fishery on these stocks off Karwar and Karnataka coast was studied.

The estimated average annual yield-per-recruit for *S. gibbosa* showed that the MSY for the species obtained at the fishing mortality (F) of 1.0 in the existing fishery. Similar estimates for *S. dayi* showed that the MSY for this species was attained at 1.8 F. The estimated exploitation rates for these two species were in the order of 0.12 and 0.54 respectively. The mean annual stock of *S. gibbosa* off Karnataka and Karwar coast was in the order of 10,701 tonnes & 2,614 tonnes *vis-a-vis* the average yield of 1,965 tonnes and 352 tonnes for respective areas. The above data indicate that the present production from the two resources could be substantially increased without affecting the stocks off Karnataka by increasing the fishing pressure.

Similar studies on the impact of the present fishery on the lesser sardine stocks at different observation centres on the West and East ocast of India are in progress.

The fishery and resources characteristics of anchoives (FB/PR/9.3)

G. Luther, P. Devadoss, N. G. Pillai, K. Alagaraja, K. Balan, G. Syda Rao and K. V. Narayana Rao.

Investigations on the fishery and resource characteristics of anchovies were continued during 1985-86 season at five observation centres — two on the east coast and three on the West coast of India.

Purse seine fishery off Mangalore continued to yield the largest quantity of whitebait *(Stolephorus spp.)* landings along the Indian coast, although the fishery at this Centre experienced a set back this year. At Cochin also the whitebait fishery by purse seine was poor. At both the centres the purse seiners could not locate the whitebait schools in the normal fishing grounds. A change in migratory pattern of this fish along the northern Kerala and southern Karnataka coasts could have brought about this reduction in the purse seine landings.

An overall increase in the whitebait landings, however, was observed at Cochin and Vizhinjam. An increase was observed in these landings at Madras which is due to increase in fishing effort. A fall in the landings of these resources was observed at Visakhapatnam and this appears to be due to reduction in fishing effort.

Of the two major species of whitebait fishery, *S. devisi* and *S. bataviensis*, the former is dominant in gears operated at surface namely, purse seine and gill net (Netholivala) and the latter in the trawl net and boat seine. Nevertheless, the contribution of trawl net to the whitebait landings compared with that of purse seine, is only 5% at Mangalore, where these two gears were operated.

As the relative contributions of *S. devisi* and *S. bataviensis* are 47% and 31% respectively as observed in the artisanal fishery at Vizhinjam over the past several years, it would appear that these two species have differential vertical distributions, the schooling depth of *S. bataviensis* being in mid water and at lower depth than that of *S. devisi*. Hence employment of midwater trawl may help to harvest effectively the resource of *S. bataviensis* in the fishery season.

Studies on the spawning periodicity have indicated that the predominant species have protracted breeding period with peak breeding generally occuring during March-April and October-December months.

Past data on the resources of the two major species of *Stolephorus* are being analysed for stock assessment.

Evaluation of the fishery and resources of mackerel (FB/PR/9.4)

A. Noble, S. Reuben, N. S. Radhakrishnan, M. Sivadas, N. G. Pillai, M. Srinath, T. M. Yohannan, M. V. Pai, M. H. Dhulkhed and G. M. Kulkarni

The fishery showed a substantial increase in production during the year compared to previous year. This increase in production was mainly accounted by the unprecedented landings by purse seine at Mangalore.

At Panaji (Goa) the purse seine fishery yielded an estimated catch of 1714 tonnes of mackerel during the year compared to 1223 tonnes of last year. An increase of 1.3 times in fishing effort and 1.5 times in CPUE during the year was observed compared to preceding season. The bulk (95%) of the production was recorded during October-November. A significant increase in production was evident at Karwar and Mangalore during the year with estimated landings of 3360 tonnes and 11340 tonnes by purse seine compared to 1036 tonnes and 3434 tonnes of 1984-85 season. About 12% decrease in the fishing effort at Karwar and a substantial increase in the fishing effort and catch rate at Mangalore was observed during the year. The peak abundance for the species was observed during October at Karwar and during September-October at Mangalore. At Calicut the annual catch amounted to 351 tonnes, landed mainly by Pattenkolli (58%) and Nethelvala (24%) and showed improvement in production. The peak period of abundance was in September. There was also a substantial

improvement in the mackerel fishery by purse seine at Cochin with an estimated production of 5409 tonnes during the year compared to 2918 tonnes during previous season. Maximum catch (3245 tonnes) and catch rate (7.3 tonnes/boat day) were recorded in September. A significant reduction in the purse seine fishing effort was also observed during the year at this Centre. The mackerel landings at Vizhinjam, Mandapam Camp and Visakhapatnam amounted to 323 tonnes, 226 tonnes and 193 tonnes, showing marginal decrease over that of 1984-85 season.

Studies on the biology of the species were continued at most of the observation centres. On the West Coast mackerel ranging in size from 115 to 265 mm at Goa, 130 to 275 mm at Karwar, 75 to 275 mm at Mangalore, 65 to 155 mm at Calicut, 170 to 270 mm at Cochin and from 225 to 275 mm at Vizhinjam contributed to the fishery. On the east coast the fishery was sustained by the fishes ranging in size from 160 to 270 mm at Mandapam Camp and from 160 to 250 mm at Visakhapatnam. The growth of the dominant modal groups and the age composition of the species in the fishery were studied. From the relative abundance of different age classes that sustained the mackerel fishery at different centres on the West Coast, it is observed that 1-year olds were dominant in the fishery to the extent of 61.8%, followed by 2-year old fish (29.1%). The 0-year class contributed to the exent of 7.9%; their relative abundance being more pronounced during the year at Mangalore & Calicut (Vide: Table 5)

Table : 5 Age composition of mackerel (No./gear/day) in the non-selective gear at different centres during the fishing season 1985-86

Centre	*Gear*	*Age class*				
		0-year	1-year	2-year	3-year(+)	Total
Goa	Purse seine	540	2,950	715	0	4,205
Karwar	Purse seine	53	4,394	1,250	62	5,765
Mangalore	Purse seine	2,410	5,569	1,686	201	9,866
Calicut	Pattenkolli (Boat seine)	132	445	15	1	593
Cochin	Purse seine	0	10,996	7,788	221	19,005
Total	—		24,354	11,460	485	39,434
%	—		61.8	29.1	1.2	100.0

Studies on the sex-ratio and maturity condition of the species have indicated that female fishes were predominant in the catches at Goa, Cochin and Mandapam Camp and *vice-versa* at Mangalore and Vizhinjam. However, the sex-ratio was equal at Karwar. Adult fish with gravid gonads were

caught mainly at Vizhinjam and Cochin during April-May. At other centres the catches were dominated by spent and spent-recovering fish mainly during August-October months indicating the probable breeding period for the species.

At Waltair 16% of the fish examined had full stomachs and feeding mainly on Copepods.

The total instantaneous mortality (Z) of the exploited stocks during the year were in the order of 1.09, 2.63, 1.18, 1.52 and 2.12 at Panaji, Karwar, Mangalore, Calicut and Cochin respectively. On account of short season, the mackerel population had only limited exposure to fishing mortality. Chances of improvement of the fishery in the ensuing season are bright.

Based on the past data (1978-83) at Cochin, Calicut, Mangalore and Karwar the growth parameters like Loo and K of the species were estimated as 312.8 mm and 1.147 (annual) respectively. The Z calculated from average length frequency data using Pauly's method, was 4.78 at Cochin, 5.29 at Calicut, 5.03 at Mangalore and 4.36 at Karwar. With an estimate of natural mortality (M) at 1.76, the annual rates of exploitation (U) at the above centres were 0.62, 0.59, 0.65 and 0.67 respectively. Using Beverton and Holt yield model, the yield-per-recruit (Y/R) was calculated. It indicated that at the length of capture (Lc) as 200 mm and at the present rate of exploitation, any change in the length at first capture will not result in any increase in production. At all the above centres, the present level exploitation is just below that of MSY and further increase in fishing effort may not result in any significant increase in the yield.

Evaluation of the fishery and resources of seer fishes (FB/PR/9.5)

M. V. Pai, G. Luther, R. Thiagarajan, N. G. Pillai, M. Srinath, T. M. Yohannan, C. Muthiah and H. M. Kasim .

The yield from the seer fish fishery during the year under report showed improvement, over that of preceding season, with an estimated catch of 190 tonnes, 24 tonnes, 276 tonnes and 236 tonnes at Waltair, Mandapam Camp, Tuticorin and Vizhinjam respectively; and decrease at Calicut and Mangalore with estimated catch 102 tonnes and 486 tonnes. While the drift gill net was the principal gear at the west coast hook & line were important gears that landed the catches of the east coast centres. Off the west coast centres the fishery yielded the maximum catch and catch rates generally during October-December months. On the east coast centres, however, the maximum catch and catch rates were observed generally during April-August and October-December.

The seerfish fishery during the year was predominantly supported by *Scomberomonus commerson* (61.4% to 99.0%) on the west coast. The predominant species that supported the fishery on the east coast were *S. commerson* (90.3%), *S. guttatus* (5.0%) and *S. lineolatus* (4.7%) at Tuticorin and *S. guttatus* (62.3%) and *S. commerson* (37.7%) at Visakhapatnam.

S. commerson ranging in size from 24 to 119 cm with dominant modes between 42.5 cm and 82.5 cm at Mangalore, from 40 cm to 104 cm with modal sizes between 52.5 cm and 67.5 cm at Calicut and from 17.5 to 94.9 cm with dominant modal sizes at 22.4 - 27.4 cm, 40-47.5 cm, 50-62.5 cm and 87.5 to 95 cm at Tuticorin supported the commercial fishery during the year. Young ones of the species ranging in size from 17.5 to 27.5 cm were recruited to the fishery from September onwards.

Based on the past data the growth parameters of the predominant species, *S. commerson* were estimated for the stocks off Gulf of Mannar. The growth coefficient (K), Asymptotic length (Loo) were in the order of 0.342 (yearly) and 1419 mm respectively. The study showed that the species attains a mean length of 320 mm, 608 mm, 889 mm, 1054 mm and 1133 mm at 0-year, 1-year, 2-year, 3-year and 4-year of its life. Using Pauly's method the total instantaneous mortality coefficient (Z) and natural mortality coefficient (M) of the population were found to be in the order of 0.74 and 0.59. At the present level of fishing, the exploitation rate is 0.15. The studies indicate that there is scope for increased production from the fishery by stepping up fishing effort.

Similar studies on the predominant species at other centres are in progress.

Evaluation of the fishery and resources of Bombay duck (FB/PR/9.6)

V. M. Deshmukh, Alexander Kurien, M. Zaffar Khan, K. Alagaraja and S. K. Dharmaraja.

The monitoring of the fishery and resource characteristics of Bombay duck at Bombay were continued. The work at Veraval Centre was discontinued during the year due to lack of scientific man-power. The overall production from the fishery showed a significant decrease at Bombay with an estimated catch of 11,289 tonnes during the current season compared to 26,111 tonnes of previous year.

The fishery yielded an estimated catch of 6625 tonnes at Pachubunder (Bombay) during the year compared to 5960 tonnes of previous year, indicating a marginal increase. Maximum abundance at the Centre was observed in December with a catch rate of 148 kg per haul. The productive grounds were located in 21-30 metre depth. Fishes ranging in size from 30 mm to 360 mm with annual primary mode at 270 - 285 mm supported the fishery. Females dominated the catches; and gravid and spent fish contributing to 46% of the landings.

At Arnala (Bombay) the fishery was poor this year compared to previous year. The comparable production was 3067 tonnes and 18006 tonnes respectively. During the current year the catch rate (45 kg/haul) was also substantially lower than that of previous year (143 kg/haul). Productive grounds were located in 11-20 metre depth. The size ranged from 15 mm to 345 mm with primary mode at 165-180 mm. Females were predominant with gravid and spent ones forming 55% in the landings.

There was also a marginal decrease in the Bombay duck production at Ver-

375 mm. Adult fishes in spawning compared to the previous year with estimated catches at 1597 tonnes and 2145 tonnes respectively. During the current season better catches were obtained during April-June and October-December. As at the other centres, females were dominant in the catches. Spent and gravid fish formed high percentage.

The fishery at Satpati (Bombay) yielded an estimated catch of 2618 tonnes. The fishery was sustained by the fishes ranging in size from 45 m to 375 mm. Adult fishes in spawning condition were observed during January.

The population parameters of the stocks exploited by the fishery at Versova were studied. The values of Z, F and E during the year were in the order of 1.23, 0.79 and 0.64. Based on the past data (1975-84) of Bombay duck resources, the Maximum sustainable yield (MSY) for the stock off Maharashtra was estimated at 79,064 tonnes and optimum fishing effort at 1,584,286 hauls.

Evaluation of the fishery and resources of Carangids (FB/PR/9.7)

S. Reuben, N. S. Radhakrishnan, M. Sivadas, H. M. Kasim, P. N. R. Nair, K V. S. Nair and S. G. Raje

The estimated production totalled 260 tonnes at Waltair, 125 tonnes at Mandapam Camp, 957 tonnes at Tuticorin, 1120 tonnes at Vizhinjam, 363 tonnes at Cochin and 726 tonnes at Veraval. There was a significant increase in production during the year at Waltair (58%), Tuticorin (54.6%) and Veraval (57%) and decrease at Cochin (61%). A marginal increase (1.0%) in landings was also observed at Vizhinjam. Generally two peak periods of abundance in the fishery were observed. The observed productive periods were January-March and June at Waltair, January-February, June and November at Mandapam Camp, June-July and September-November at Tuticorin, April-June and August-October at both Vizhinjam and Cochin and January-March and September-October at Veraval. The principal gear operated at most of the centres for carangids was trawl, except at Vizhijam, where hooks and line was the most important gear. In addition, Drift gill net was another important gear employed in the fishery at Vizhinjam, Cochin and Veraval.

The most important species that contributed to the carangid fisheries were *Megalaspis cordyla, Alepes djedaba* and *Decapterus dayi* at Waltair; *Selaroides leptolepis* and *Carangoides malabaricus* at Mandapam Camp; *S. leptolepis* and *Caranx carangus* at Tuticorin; *Selar mate, D. dayi, S. crumenopthalmus* at Vizhinjam; *Alepes djeddaba* and *A. Kalla* at Cochin and *M. cordyla, D. dayi* and *Atropus atropus* at Veraval.

Size composition of the Principal species that sustained the fishery at the observation centres was monitored. *D. dayi* ranging in size from 55 to 185 mm at Waltair and from 135 to 229 mm at Vizhinjam; *M. cordyla* ranging in size from 220 to 335 mm at Waltair and from 100 to 474 mm at Veraval; *S. leptolepis* ranging in size from 80 to 199 mm at Tuticorin and from 85 to

168mm at Mandapam camp; *C. carangus* ranging in size from 80 to 469 mm at Tuticorin; *S. mate* ranging in size from 200 to 284 mm at Vizhinjam and *A. Kalla* ranging in size from 60 to 135 mm and *A. djeddaba* from 140 to 315 mm at Cochin contributed to the carangid landings.

The growth pattern of *D. dayi* at Waltair; *C. carangus* and *S. leptolepis* at Tuticorin were studied. Sex-ratio and gonad condition in some principal species were also investigated.

The average size attained by *D.* dayi at Waltair during first, second and third year of its life is 130 mm, 160 mm and 185 mm respectively. At Tuticorin besides establishing growth equations for *C. carangus* and *S. leptolepsis;* the instantaneous total mortality (Z), natural mortality (M), optimum age of exploitation (tc) and yield-per-recruit (Y/R) were also estimated. They are in the order of 4.38, 1.3, 1.18 years and 156 gm for *C. carangus* and 5.65, 1.4, 0.78 years and 28 gm for *S. leptolepsis* respectively.

Studies on the fishery and resource characteristics of the Indian Shad, Hilsa ilisha off West Bengal - Orissa Coast (FB/PR/10)

S. Reuben, S. S. Dan, P. T. Meenakshisundaram and S. K. Dharmaraja.

Observations on the marine fishery for *Hilsa* were carried out from three major fish landing centres in West Bengal, namely, Diamond Harbour, Frazer-gunj and Digha, during the year from June, 1985 to March, 1986. In addition to the above observations, the riverine landings of *Hilsa* at the Diamond Harbour were also monitored.

An estimated catch of about 300 tonnes were landed from the marine system and about 25 tonnes from the estuarine system during the current season. Out of the total production from the marine environment, about 624 tonnes at the Diamond Harbour, 244 tonnes at Digha and 32 tonnes at Frazer-gunj were landed. The fishing gears *Chandijal* (9-12 cm mesh) operated from mechanized boats, *Ilishajal* (5-8 cm mesh) operated from non-mechanised boats and *Jangal* (3.5 - 4.0 cm mesh) accounted for the landings from the marine environment. Peak catches during the year were recorded during August-November and February-March.

Clear migratory movements of this typical anadromus species into the Hooghly river were noticed. Migration into the river started in August and continued till March with peaks in September and February. Experiments to verify the migratory movements of hilsa from the Sea to the estuary/river and *vice-versa* were conducted. It was observed that the fish migrating from the sea was usually caught during the high tide, the point of gilling being at the top portion of the net. Fish returning to the sea was usually caught during low tide and were generally gilled at the bottom portion of the net. Usually spent fish had portions of mud in the guts.

During the year several samples of hilsa were examined for studying biological aspects, growth, coefficient, mortality and other population parameters. The range of length of the fish caught from the sea by mechanized gill nets varied from 160 mm to 580 mm, by non-mechanized gill nets from 210 mm to 550 mm and by shore-seine from

140 mm to 540 mm. The riverine hilsa had size range from 230 mm to 550 mm. It was observed that *Hilsa* enters the exploitation phase in the sea when it attains a total length of 160-190 mm. There were 4 to 5 modal groups in the fishery representing different year classes. The growth pattern of different size/age groups was studied to estimate the growth coefficient of the species. The fish enter the estuary for breeding migration when it attained a length of 230-250 mm.

Fishes in resting, developing and spent condition were encountered in the marine catches, whereas the fishes caught from the riverine system were found to be in all stages of maturity. The fish enters the estuary/river when they attained II-III stages of maturity. The size at first maturity (50% level) appeared to be 360 mm. The species appears to be a total spawner and has a facundity ranging from 3 to 13 lakhs depending on the size of the fish.

Informtion of the infrastructure facilities at different landing centres and the cost structure of hilsa at various points was also collected and studied.

Mesopelagic resources of the Exclusive Economic Zone (FB/PR/11)

M. KUMARAN, ALEXANDER KURIEN, MADAN MOHAN, P. P. PILLAI, A. A. JAYAPRAKASH, P. T. MEENAKSHISUNDARAM and S. REUBEN.

Studies on the Mesopelagic fish resources of the EEZ of India during 1985-86 were based on the catches landed by dol net at Sassoon docks (Bombay), shrimp trawl and bottom set gill net at Waltair and those obtained by different types of gear operated by FORV Sagar Sampada during its nine exploratory cruises both on the west and east coast of India. Their catch rates, species, composition, distribution and biological aspects were studied.

An estimated 56.6 tonnes of mesopelagic fishes *(Myctophum pterotum)* were landed at sasoon docks by Dol net during October-November with a catch rate of 2.3 tonnes per boat. At Waltair an estimated catch of about 108 tonnes *Psenes indicus* was landed by shrimp trawl during February-May and by bottom set gill nets during September-November. Peak catch rates by the former gear during March (0.76 kg/hr) and by the latter during November (1.4 kg/unit) were recorded.

Psenes indicus with modal sizes ranging from 145 mm to 185 mm contributed to the fishery at Waltair. The peak breeding season for the species appears to be January-March, as all the fishes during the period were found to be in fully mature and spawning condition.

The mesopelagic resources sampled at 254 stations during the Fishery and Oceanographic Research Cruises on board *Sagar Sampada* were also studied. The mesopelagic biomass, during the 6th cruise, sampled by Issac kid trawl (IKT) varied between 120 and 1555 ml/haul and by pelagic trawl from 2 to 400 kg. Mesopelagic fish catch was dominated by *Diaphus splendidus, Myctophum cocco, Vinciguerria lucetia* and *Diplophus taenia*. Other species recorded were *Polyipnus spinosus, Bregmaceros maclellandi, Stomias boa, Brama rai, Cubiceps natalensis, C. gracilis, Epinnula orientalis, Slytopthalmus paradoxus, Odonus niger* and *Trachypterus Woodi.*

The quantitative distribution of mesopelagics as sampled by the IKT during 9A cruise indicated that they were abundant in the neritic waters over the shelf (400 ml/haul) when compared to these from the shelf edge and oceanic waters. The biomas varied between 5 ml and 2000 ml/haul. The major fin fish constituents recorded were Myctophids *(M. cocco), D. splendidus, D. taenia* and Leptocephalli.

Good quantities of *C. natalensis* and *Psenes indicus* were caught by pelagic and bottom trawls during 12th cruise. The highest catch per haul was 34 kg. The analysis of the catches obtained by trawl showed that Myctophids formed 57% followed by other deep sea fishes (22%). Myctophids consisting of *Tripholurus* sp., *Ceratoscopelus* sp., *Diaphus elucens, Lampanyctus pusillus, Myctophum affinis, M. evermanni, M. spinosum* and *Nasolychnus* sp. were recorded in varying proportions.

Size distribution and maturity condition of some of the mesopelagic species studied during the above cruises are as follows:

Species	Size range (mm)	Dominant modal size (mm)
Diplophus splendidus	30-75	45 & 50
D. taenia	118-132	—
Diaphus splendidus	20-100	45 & 75
Myctophum cocco	47-100	70
M. dictum	40-85	70
Vinciguerria lucetia	35-50	42
V. sanzoi	28-41	35
Cubiceps natalensis	75-140	110 & 125
C. gracilis	82-142	—
Odonus niger	155-270	180
Psenes indicus	170-245	195 & 235

Wide variations in the sex-ratio between the species of mesopelagic fish was observed. In *C. natalensis* males were predominant (75%); while females dominated (80%) in *C. gracilis*. In *O. niger* the catch consisted of only males. In *Psenes indicus* males and females were in the proportion of 55% and 45%.

Population studies by mark release experiments on commercially important prawns and fishes (CMFRI/IDP/16).

P. VIJAYARAGAVAN, A. NOBLE, D. S. RAO, M. KUMARAN, M. H. DHULKHED, T. M. YOHANNAN and N. G. PILLAI

Due to various reasons the targetted work could not be achieved under the Project. However, the recovery of one drift bottle off Somalia coast (Mogadishu) in March, 1986 out of the lot released off Madras (East coast of India) is significant; indicating its probable drift by the prevailing coastal currents during the period.

DEMERSAL FISHERIES DIVISION

Assessment of catfish resources (DF/RE/11)

V. N. Bande, S. G. Raje, C. Muthiah, N. G. Menon, K. Alagaraja, Y. Appanna Sastry

Salient features :

There was marginal increase in the landings of catfishes at Veraval and substantial increase, nearly three-fold, at Mangalore, mainly from increased purse-seine effort. The catches declined at Calicut and Cochin, probably due to negligible effort by trawlers. At Waltair there was increased landing by artisanal fishermen, but less by trawlers. Though trawlers, driftnet and hooks and lines were the main gears, nearly 96% of the year's catfish catch at Mangalore was by purse-seine. Almost 849 tonnes of gestating males were caught by this gear in February-March.

Work done :

At Veraval 8,27,137 kg cat-fish were landed as against 7,39,620 kg in the previous year, showing a marginal increase. Out of the total catch, 72.79% was caught in trawl net and 27.21% by gillnet. The percentage of cat-fish in the total estimated landings was 1.94%. Trawl catches mostly consisted of *T. dussumieri*, (28.01%), *T. thalassinus* (27.61%) and *O. militaris* (12.02%). The gill net catches include *T. tenuispinis* (23.50%), *T. caelatus* (2.37%) and others (6.49%). CPUE, in case of trawls, had increased from 10.66 to 14.65 kg but in gill-net it had decreased from 9.11 kg to 7.98 kgs.

At Mangalore 2,300 tonnes of catfish was recorded, as against 519 tonnes last year — an increase of 343%. Unlike last year when 64% of the catch was landed by trawl, in the current year 2,204 tonnes (96%) was caught by purse-seine and the rest by trawl. As a consequence CPUE of purse-seine increased from 15.33 kg to 152 kg and CPUE of trawl had gone down from 6.43 kg to 2.26 kg; Purse-seine caught catfishes during September, October and December-March period unlike last year when they were available only in September and February, unlike the trawl fishery had the same season as of last year. *T. dussumieri* (71.82%), *T. serratus* (14.19%), *T. tenuispinis* (13.95%) and *T. thalassinus* (0.04%) were available in purse-seine; trawl catch comprised exclusively of *T. tenuispinis*.

An important observation during the year was the capture of gestating males of *T. dussumieri*. They were caught by purse seines in shoals (849 tonnes) in February and March.

At Calicut during the year 258.9 tonnes of catfish were landed. In the years 1983-84 and 1984-85 the figures

were 670.7 tonnes and 283.2 tonnes. Thus a declining trend in the catches is very much visible. The gears, hooks and line and gill nets contributed 67% and 33% respectively. Like last year there was no shoal movement along the coastal waters (as evident from the nil catches by trawl as well as boat seines). In both the gears *T. tenuispinis* was the major component followed by *T. dussumieri* and *T. serratus*. The CPUE for drift net and hooks and line were 22.1 kg and 127.5 kg respectively. Based on the data from 1979-1985 attempts were made to study the population parameters of *T. dussumieri*.

An estimated 64,087 kg of catfish were landed at Fisheries Harbour, Cochin, during the current year as against 8,80,944 kg during the last year. The decline in the catch was mainly due to poor landing by the trawlers. Unlike last year the trawl fishery was confined to only one month — June. Similarly drift nets which operated throughout last year were employed only up to December in the current year. Purse-seines did not land catfishes at all. The drift net contributed 53% of the catch and the trawl 47%.

Species-wise, *T. dussumieri* was totally absent in trawl catches, *T. thalassinus* and *T. tenuispinis* also showed downward trends. In drift net *T. thalassinus* and *T. tenuispinis* registered a marked increase but the other two species, *T. dussumieri* and *T. serratus*, were much less than in the previous year.

T. thalassinus and *T. tenuispinis* together accounted for 82% of the cat fish catch. A solitary gestating male of *T. thalassinus* was encountered in October.

At Waltair, the small commercial trawlers landed 69.7 tonnes of catfish, with CPUE 2.6 kg, as compared with 114.3 tonnes and CPUE 3.6 in the previous year. In the artisanal fishery the hooks and lines brought in 87.8 tonnes with C/E per boat 3.0 kg. Last year's landings by hook and line was 59.9 tonnes. Bottom-set gill nets caught 514 kg (C/E 0.04 kg) as against 777 kg in the previous year.

T. thalassinus was the most dominant species in the catches constituting 89.5% of the trawler landings and 86.2 per cent in hooks and lines. Females in spent condition were encountered during June and August. The majority of stomachs examined were half-full.

Stock assessment of threadfin-breams (DF/RE/12)

V. S. Murty, E. Vivekanandan, P. A. Thomas, K. V. S. Nair, M. Srinath, K. Balan, S. K. Chakraborty, S. G. Raje

Salient features :

Threadfin-bream catches increased at Waltair (despite decreased effort) and at Madras (with increased effort), while it declined at Cochin, Bombay and Veraval where there was fall in effort. Observations on the biology of *Nemipterus japonicus* were continued at the different centres. Gravid females were observed in all the months at Kakinada and Bombay and were restricted in occurrence at other centres.

Work done :

At Waltair, the private trawlers landed an estimated 846 tonnes of threadfin-breams which formed about 13% of the total trawl catch. The catches and catch rates were good during April 1985 and February and March 1986. When compared to the previous year the catches showed an increase of 58.1%, though there was a decline of about 15% in the effort.

The commercial trawlers at Kakinada landed an estimated 541 tonnes of nemipterids which formed aobut 2.7% of total trawl catch. The catch rates were good during November-March period. The threadfin bream catch showed a decline of 25% over that of previous year though there was a 9.9% increase in the effort.

At Madras, the trawlers landed an estimated 884 tonnes which formed about 10% of the total trawl catch. The catches and catch rates were good during August-September and February-March. When compared to the previous year the catches showed an increase of 123.5%, with a 65% increase in the effort.

At Vizhinjam, the hooks and lines landed an estimated 218.7 tonnes of threadfin breams which formed about 2.1% of total landings. Three peaks in abundance were noticed: July-August, December and March. Hooks and lines operated from mechanised units contributed about 62.5% of nemipterids landed.

At Cochin, the private trawlers landed an estimated 2,205 tonnes of threadfin breams. Maximum catches were obtained during June-August period, accounting for 86% of nemipterids landed during the year. When compared to the previous year the catches showed a decline of 59% This decline was mainly due to the reduced (56.8%) effort during June-August which is the peak period of abundance of threadfin breams.

At Bombay, new ferry Wharf and Sassoon Docks, the trawlers landed an estimated 2,456 tonnes of threadfin breams which formed 3.3% of total trawl catch. At Newferry Wharf the peak catches were obtained in April 85 and March 1986; at Sassoon Docks there was a peak in March 1986. When compared to previous year the nemipterid catch showed a decline of 4.8% along with 1.7% decline in the effort.

At Veraval, the private trawlers landed an estimated 1,304 tonnes of threadfin breams which formed 3.4% of total trawl catch. There were two peaks in abundance one in December and the other in March. The catches registered a decline of 55% over previous year, with a 10% decline in effort.

A total of five species contributed to the fishery along east-coast whereas 2-3 species contributed to the fishery along west coast. Along both coasts, however, two species, *N. japonicus* and *N. mesoprion*, were most abundant.

Biological observations on *N. japonicus* showed that at Waltair the length range was 80-269 mm; fishes of smaller modal length of 85 mm occurred in January, of 115 mm in June and January and of 125 mm in July, February

and March. At Kakinada the length range of catch was 80-288 mm; fishes of smaller modal length of 75 mm occurred in May. At Madras the length range of catch was 80-289 mm and fishes of smaller modal length of 95 mm occurred in June and September. At Cochin, the length range of catch was 70-229 mm and the same was 100-289 mm at Bombay and 50-319 mm at Veraval.

At Kakinada, mature and gravid adults occurred in all months. At Madras gravid adults occurred in May, July August and November. At Cochin fishes with developing ovaries occurred during monsoon months. At Bombay, gravid adults occurred in almost all months and at Veraval they occurred in April, October to December and in March.

Resource characteristics of perches (FB/DR/1.8.2)

P. Sam Bennet, H. M. Kasim, K. M. S. Ameer Hamsa, P. A. Thomas, Grace Mathew, S. K. Chakraborty.

Salient features :

The perch fishery was good at all centres, the mechanization of indigenous craft being of increasing significance at many centres like Tuticorin and Vizhinjam. Hooks and line and drift nets were the main gear landing larger perches, while smaller perches were caught from near-shore areas by traps and occassionally shore-seine. Biological studies were continued on *Lethrinus nebulosus.*

Work done :

At Mandapam (Keelakarai) perch traps and hook and lines were operated from non-mechanised boats. They landed a total of 42.7 tonnes of perch during the year; 33.1 tonnes were caught by the perch traps and hooks and line units brought 9.6 tonnes. A number of species were landed by perch traps, the more important ones being *Lethrinus nebulosus, Lutjanus fulviflamma, Epinephelus spp, Plectorhynchus* spp, *Siganus* spp., *Callyodon* spp. The major portion of the hook and line catch consisted of *Lethrinus nebulosus.*

At Tuticorin the significant feature noticed in the perch fishery was the increasing mechanization of indigenous craft. Hooks and line and drift-net fishing benefited by this mechanization. An estimated 938 tonnes of perch were landed by indigenous gears. Of the total 448.4 tonnes were landed by non-mechanized units, 426.2 tonnes by mechanized units and 63.4 tonnes by non-mechanized units at Tharuvaikulam. Drift nets, hooks and lines, gill nets and olaivalai (Shore seines) were employed in the perch fishery. Hooks and line was the leading gear, landing 688.3 tonnes of larger perches. *Lethrinus nebulosus, Lates calcarifer, Serranus, Lutianus rivulatus* and *Diagramma* were landed by hook and line units. Drift nets landed *Lethrinus nebulosus, Serranus* spp. and *Diagramma* spp. Small sized perches were landed in large numbers by Olai valai at Tharuvaikulam. The species included *Lethrinus nebulosus, Psammoperca waigiensis, Lates calcarifer* and *Serranus, Lutianus, Diagramma* species.

Trawl nets landed good quantities of perches at Tuticorin fishing harbour. October and January were the peak period. *Lethrinus nebulosus* was the dominant species in the trawl landings, followed by *Epinephilus, Scolopsis, Lutianus* and *Serranus.*

Good perch landings were recorded from Vizhinjam during the year. There was marked increase in the use of mechanized indigenous crafts for operating hooks and line and drift nets. These two gears landed the maximum perch catch at Vizhinjam. Other gears in operation included non-mechanised hook and line, drift net and boat seine. The major portion of the catch was composed of *Priacanthidae, Nemipteridae, Lethrinidae* and *Serranidae,* while others caught included *lutianids, Theraponidae, Siganids* and *Ambassids.*

At Cochin fishing harbour, the estimated perch landings during the year came to 285.7 tonnes, mainly by hooks and lines operated from November to March by migratory fishermen. They landed large-sized perches. Smaller perches were landed by trawlers operating from the fishing harbour. There was marked increase in the catch of perches during the year when compared with 1984-85. The major portion of the catch consisted of *Epinephilus tauvina, E. diacanthus, E. areolatus, E. chlorostigma, Pristipomoides typus* and *Lutjanus* spp.

The total perch landings at Vizhinjam was estimated at 522.1 tonnes and this formed 5.05% of the total fish landing. When compared with the 277 tonnes of 1984-85 the present year's landing is higher by 93%. The hike in landing during the current year was contributed by almost all families. Of these Nemipterids ranked first with 218.7 tonnes (41.9%), Priacanthids (91.9 tonnes or 17.6%).

Two peaks in the landings of perch could be noted this year: that of July/August formed the major one, the other being in December.

Hooks and line operated from mechanised vessels contributed the bulk of landings (223.8 tonnes or 42.8%) while those operated from non-mechanised vessels accounted for 98.2 tonnes or 18.8%. The other gears were Drift net (mechanised) (68.5 tonnes or 13.12 per cent) and Drift net (non-mechanised) (24.9 tonnes or 4.7%). The rest of the catch 106.7 tonnes or 20.4%, was contributed by gears such as shore seine, boat seine and Konchu vala.

Landing of Siganids, Nemipterids, Serranids, was very good during the first half of the year while that of priacanthids during the 3rd quarter and of lethrinids, during the 4th quarter.

Observations on biological parameters were taken on *Lethrinus nebulosus.* The size range was from 6.0 to 30.0 cm at Mandapam with the dominant size at 11.0 cm. The fishes were immature. At Tuticorin fish from 4.0 cm to 75.0 cm caught by indigenous gears were recorded. Small-sized fish from 4.0 cm to 16.0 cm were caught by olaivalai (Shore seine). Also smaller fish from 7.0 to 45.0 cm were recorded by small meshed drift net. Larger fish

from 20.0 to 75.0 cm were caught by hook and line and large-meshed drift nets. The smaller fish were immature. Attempts have been made to study the growth rate, mortality rate, optimum age of exploitation and yield per recruit by using statistical methods.

Assessment of sciaenid resources (FB/DR/1.8.4)

T. Appa Rao, V. S. R. Murty, P. Devadoss, E. Vivekanandan, K. V. S. Nair, S. K. Chakraborty, S. G. Raje

Salient features :

There was generally a slight decline in the sciaenid landings at most centres. Trawlers made the bulk of the catches while other gears, like gill-nets at Veraval, contributed to a slight extent. Studies on the biology of *Otolithus cuvieri* and *Johnius carutta* were continued.

Work done :

At Waltair, the private trawlers landed an estimated catch of 497.2 tonnes of sciaenids and they contributed 7.6% of the total catches. Peak landings were obtained during the period October-December 1985. The minimum C/E of 1.95 kg and maximum of 67.5 kg were recorded in April and December respectively. When compared to the corresponding period of previous year, the sciaenid catches decreased by 10.1 per cent of the total catches and the effort put forth was also less by 15.5%. Out of 12 species that occurred at Waltair, *K. axillaris, J. carutta* and *J. vogleri* contributed 36.2%, 23.3% and 18.0% respectively.

The length frequency studies on *J. carutta* showed the range in total length from 85 to 205 mm with modes at 125, 135 and 145 mm.

At Kakinada, from the private trawlers an estimated catch of 1305 tonnes of sciaenids was landed, contributing to 6.5% of total catches. Peak landings were recorded during January-April. Even though the effort increased by 10.1%, the catches decreased by 11.5% as compared with the catches of previous year. *A. nibe, J. vogleri, O. ruber, J. carutta, J. dussumieri* were the important species, as they together contributed 58% of total landings. When compared to the catches of previous year, *J. vogleri, O. ruber* and *J. dussumieri* showed a decline but *A. nibe* and *J. carutta* increased by 1.1% and 100% respectively.

J. carutta ranged in total length from 100 to 228 mm. The maximum sustainable yield with the present year was estimated as at F = 1.8, but the present F is 4.0. There is however, scope for increasing the yield by increasing the age of first capture to 1.7 from the present 1.1.

At Madras from Kasimode landing centre an estimated catch of 243 tonnes of sciaenids was landed which contributed to 2.8% of total catches. Peak landings were obtained during November 1985. The annual average CPUE of 5.1 kg/hr was recorded as against the value of 7.4 kg of previous year. Out of 12 species that contributed to the sciaenid fishery, *J. carutta* contributed 25.7% of sciaenid catch, followed by *O. argenteus* (21.1%), *J. sina* (9.5%) and *P. aneus* 9.4%.

About 379 specimens of *J. carutta* measuring 50 to 209 mm were analysed for the study of the biology of the species. A mode was observed at 120-129 mm. Specimens with ripe ovaries were observed during June, July and September. The food components consisted of prawns, fish and *Squilla* sp.

At Bombay, from Sassoon Docks 2583 tonnes of sciaenids were landed, contributing to 8.8% of total landings, with an average catch per hour of 5.52 kg. Peak landings were observed in October 1985 and January 1986. From New Ferry Wharf, a total catch of 2886 tonnes of sciaenids was estimated, with an average annual c.p.h. of 6.36 kg. Here the sciaenids contributed 6.6 per cent of total landings. In October and November 85 and January 86 peak landings were noticed. *J. macrorhyncus, J. vogleri* and *O. cuvieri* were the most important species landed.

Length frequency studies were made on *J. macrorhyncus, J. vogleri* and *O. cuvieri.*

At Cochin, estimated landings of 431 tonnes with C/E value of 13.8 kg were obtained. Peak catches, with highest catch rates, were recorded during the period of March-April. The lean period for the fishery was during July-August.

The important species in the landings were *J. sina, O. ruber* and *K. axillaris.* Biological studies were made on *J. sina.*

At Veraval, an estimated total catch of 6712.959 kgs of Sciaenids, which contributed to 17.6% of total catches, was landed. The gill nets landed 154.3 tonnes while the remaining catch came from trawlers. The sciaenid catches this year were less by 38.5 per cent when compared with the catches of the previous year. Maximum C/E value of 1624 and minimum C/E of 3.00 were recorded in February and May respectively. The more important species landed were *O. cuvieri, S. brunneus, P. diacanthus.*

Biological studies on *O. cuvieri* showed that fishes measuring 75-362 mm contributed to the fishery. Modal lengths were at 145 (in October), 165 (in November) 215 (in December), 145 (in January), 175 (in Februaury), 175 (in March) and 245 (in May).

Resource characteristics of silver bellies (FB/DR/1.8.5)

V. S. R. Murty, Y. Appanna Sastry, S. Srinivasa Rangan, P. Livingston, N. G. Menon.

Salient features :

Better landings of silver-bellies were reported from all centres, with increases of 7 to 12% over last year's figures. Biological observations were continued on *Leiognathus bindus* and *Secutor insidiator* at Kakinada and Madras, and *Leiognathus dussumieri* and *L. jonesi* at Mandapam.

Work done :

At Kakinada, the private trawlers landed an estimated 1,708 tonnes of silver-bellies which formed 8.5% of total trawl catch. Peaks in the catches were

observed during May, October and February. The catches showed an increase of 6.7% over those of previous year these *L. bindus* and *S. insidiator* were the most abundant together forming along with a 9.9% increase in effort. 10 species contributed to the fishery; of about 70% of silver belly landings.

At Madras, an estimated 628 tonnes of silver bellies were landed by private trawlers, which formed about 6.7% of total trawl catches. Peak catches were obtained in May, August and February, whereas peak catch rates were obtained during April, August and March. When compared to the previous year, the catches showed an increase of only 12.3% though there was an increase of 64.3% in the effort. A total of 11 species contributed to the landings and here also *L. bindus* and S. insidiator together formed about 67% of silverbelly landing.

In the Mandapam area, the private trawlers operating in the Gulf of Mannar and Palk bay landed an estimated 11,416 tonnes of silverbellies. In the Gulf of Mannar the peak returns were obtained in May, August, November and February. In the Palk Bay, off Mandapam, peak catches were obtained in June, September, December, and March and off Rameswaram in June, November and February. A total of 14 species contributed to the catches. In the Palk bay *L. jonesi* was most dominant accounting for 62.2% of silverbellies landed from this area. In the Gulf of Mannar, *L. dussumieri* was the most dominant species and forms about 47% of silverbelly catch in the area. In the entire Mandapam region *L. jonesi* is the most dominant species forming 52.1% of silverbelly catches followed by *L. brevirostris* (15.6%), *L. bindus* (11.8%), *L. dussumieri* (1.8%) and others.

Studies on the length composition of the main species at different centres showed:

For *L. bindus*, at Kakinada the length range of the catch was 16-124 mm and fishes with smaller modal length of 32 mm occurred in August, September and November. At Madras, the length range of the catch was 30-119 mm and fishes of smaller modal length of 32 mm occurred in February, of 42 mm in October and of 47 mm in February.

For *S. insidiator*, at Kakinada, the length range of catch was 35-114 mm and fishes of smaller modal lengths of 42 mm occurred in July and September. At Madras, the length range of catch was 40-114 mm and fishes of smaller modal length of 62 mm occurred in September and October.

For *L. dussumieri*, in the Gulf of Mannar off Mandapam the length range of catch was 55-164 mm and fishes of smaller modal length of 62 mm occurred in September.

For *L. jonesi;* at Rameswaram the length range of the catch was 30-135 mm and smaller fishes of modal length of 37 mm occurred in December and of 42 mm in June and July.

Gonadal studies showed that, for *L. bindus*, at Madras, fishes with developing gonads occurred in all months;

gravid adults however occurred in May July, August, November and December 1985 and January 1986. In *S. insidiator*, off Madras, while developing fish occurred in all months those with mature gonads occurred in May, August, September and December 1985 and January-March 1986. In *L. dussumieri* in the Gulf of Mannar, gravid adults occurred in May, June, October, December, January and March though fishes with developing gonads occurred in almost all months. In *L. jonesi* of the Palk bay, gravid adults occurred in all the months.

Survey and monitoring of major demersal fisheries (FB/DR/1.9.1)

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Salient features :

Monitoring the exploratory and commercial trawl landings at selected centres, the pattern of distribution and abundance of the ground fish categories were studied. An attempt was also made at Kakinada at an over-all assessment of the demersal resources in the area, using standardised effort and population parameter values for the major constituent species.

Work done :

At Kakinada, data were collected from the commercial trawlers. An estimated 20,037 tonnes of fish (including 4458 tonnes of prawns which formed 22.2% of total catch) were landed by the trawlers at Kakinada. There was an increase of 25.3% in the total catch when compared to previous year, while the effort showed a 13.8% decline in *Pablo* units, 39.1% increase in *Pomfret — Royya* units and 25.9% increase in *Sorrah* units. The maximum catch of 3334 tonnes was obtained in March and the minimum of 703 tonnes in November. Sciaenids and threadfin-breams registered a decline of 11.5% and 24.7% over the previous year whereas all other important demersal groups showed considerable increase.

A comparison of the effort and catch data during the five year period (1981-82-1985-86) shows that the effort declined in alternate years. Lizard fish formed the one group which showed considerable increase in landings in each succeeding year, irrespective of fluctuations in effort. Similarly the total catch, total demersal catch and prawn catch showed increase in succeeding years except during 1984-85, when there was considerable decline.

With the *Pomfret — Royya* category of boats as standard unit, effort standardisation was attempted, with all demersal groups together taken as one group. This showed an annual total standard effort of 44138 units landing 20,037 tonnes of fish, of which demersal fishes made up 68% (monthly values ranging from 59% in March to 78% in December). The dominant groups were silver bellies 39%, sciaenids 30% and perches 22%.

Peak catch rates were obtained during different months for the different demersal groups, but most showed

peak abundance in January, May and July.

At Cochin, an estimated total of 6720 tonnes was landed by the trawlers for an effort of 28179 units (120486 hours), at the catch rate of 238.5 kg/unit (55.8 kg/h). The prawn catch was 1389 tonnes, forming over 20% of the total catch at a catch rate of 49 kg/unit, and the main species were *Metapenaeus dobsoni* followed by *Parapenaeopsis stylifera* and *P. indicus*. The fish catch was 4672 tonnes at the rate of 165.8 kg/unit, the constituent species being nemipterids *(Nemipterus japonicus* and *N. mesoprion)*, sciaenids *(Johnius sina, Otolithes ruber* and *O. cuvieri)*, sharks *(Rhizopriniodon* and *Carcharinus* spp), *carangids, Alepes para, Decapterus russelli* and *D. macrosoma)*, soles *(Cynoglossus macrostomus, Psettodes erumei,* and *Pseudorhombus arsius)*, barracuda *(Sphyraena barracuda, S. Jella)* and ribbonfish *(Trichiurus lepturus)*. Crabs *Squilla* and *Thenus* made up nearly 405 tonnes and cephalopods 193 tonnes.

At Waltair, an estimated 6,512 tonnes of all-fish catch, including 622 tonnes of prawns, were recorded. When compared to previous year the present catch showed an increase of 134 tonnes. The present annual catch rate of all-fish (22.0 kg/h) has shown an increase when compared to previous year (18.2 kg/h) but the prawn catch rate had fallen from 2.7 kg to 2.25 in the present year. *Nemipterus mesoprion* and *Upeneus*, that were in sixth and seventh rank in order of abundance during 1984-85 came upto the first and second rank respectively in 85-86.

At Madras, the two trawlers 'Matsyajeevan' and 'Matsyaharani' of the Fishery Survey of India fished for 8 months during the year landing 35,824 kg of fish in 751.11 hours of fishing. The catch rate worked out to 47.69 kg/h. 'Matsyaharani' also carried out long-lining for 5 months, catching 9,107 kg of fish. The highest trawl yield of 416.2 kg/h was obtained from 10-80/5C in September, while 12-80/68 proved the best ground for sharks and sail-fish by long-line. The departmental boat 'Cadalmin III' doing experimental fishing off Madras, caught good quanties of Nemipterus and silver-bellies from 13-80/IC and12-80/6B in May and September.

At Veraval an estimated 25,252 tonnes of demersal fishes were landed by private commercial mechanised boats operating trawls and gill-nets and this formed nearly 60% of the total fish catch by these gears. The contribution of the trawlers was 23,567 tonnes, at a catch rate of 44.07 kg/hour, and that of gill-nets 1,686 tonnes at 7.54 kg/hour. This year's fishery marked a fall by nearly 40% of last year's demersal fish landings. The decline was observed in the catch and the catch rate by the trawls, while the gill-net catch rate by the trawls, while the gill-net catch and rate showed a slight increase. Among the component groups, sceiaenids formed the largest part 23%, followed by Lactarius 15%, prawns 14%, thread-fin-breams and eels 5% each, shark and rays 4% each and catfish 3.5%.

Pond culture of marine fishes (DF/CUL/1.3)

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Salient features :

Experimental culture of marine fish was carried out with different rates of stocking and feeding in the coastal ponds at Tuticorin, Mandapam and Madras. Mullet and milkfish were reared at all centres; additionally, the culture of *Lates calcarifer* was tried at Tuticorin. Aspects of site choice and management that require improvement were identified.

Work done :

Marine fish culture experiments were carried out in the coastal ponds developed close to the sea shore at Tuticorin, Mandapam and Madras. Among mullets, *Mugil cephalus, Liza macrolepis, L. cunnesius, Valamugil seheli* were stocked. The grounds for the collection of milkfish seed were identified adjacent to the culture centres. *Lates calcarifer* young ones were gathered near the culture site and stocked in pond, in monoculture system. Suitable methods were devised for the transportation of the seed of these cultivable species.

Different sets of experiments, under monuculture and polyculture systems, were carried out under varying, stocking and feeding conditions. Supplementary feeds, made up with rice bran and groundnut oil cake, were supplied to mullets and milk fish. The growth of *M. cephalus* was highly varying, in the range 20 mm/13 g. to 39.8 mm/12.4 g/month and it may be due to environmental conditions and the availability natural food in ponds. The growth rates of other mullets and milkfish were poor, although the hydrological conditions were in the normal range in the ponds at Muttukad. It obviously indicated that supplementary feeding is a must in the experiments. The survival and production rates were low, 20-38% and 114-240 kg/ha respectively in the first round of experiments at Madras and the loss of stock was mainly due to poaching as reported. The second set of experiments were damaged by heavy monsoon during November 1985. At Mandapam *Chanos* showed varying growth rates at 18 to 31 mm and the better growth and production was noticed at the stocking intensity of 500/ha. The growth rate of *Chanos* in most of the experiments were poor and around 22 mm/month, although the environmental conditions were in the normal range. It may be due to the low productivity of the culture area. At Tuticorin *Chanos* indicated a growth rate at 22 mm/21 gr/month and mullet in monoculture system showed the growth at 25 mm/17 gr./month. Survival and productions were low, due to loss of stock by poaching. The culture site needs improvement and the arrangements for better farm management are under progress.

Cage culture of marine fishes (DF/CUL/1.4)

K. M. S. Ameer Hamsa, Sampson Manikkam

Salient features :

Attempts to culture *Epinephelus tauvina* in net-cages in coastal waters

of Mandapam have given encouarging results; with a mortality rate of less than 10% and average growth rate of 16 mm/month.

Work done :

In an effort to investigate a suitable method for culturing groupers, experiments were conducted to study the growth of *Epinephelus tauvina* in the coastal waters of Mandapam (Gulf of Mannar) using net-cages of size 5 x 5 M of HDPE fish-netting of mesh size 20 mm.

Juveniles of *Epinephelus tauvina* were collected alive by drag nets and by special perch-traps. They were kept in aquarium condition and acclimatized for 2-3 weeks and later stocked in the net cages at the rate of 100 juveniles (150-250 mm) per cage.

The fishes were fed with chopped trash fish at the rate of 10% of their body weight at 48-hour intervals.

The fishes showed an increase in size of 16 mm (total length) per month per fish. This growth rate of *E. tauvina* appears satisfactory and comparable to the results achieved in some of the south-east Asian countries. The mortality rate varied from 3 to 10%.

Juveniles of *Epinephelus tauvina* were also reared in floating net cages of size 1.5 x 1.1 x 1.3 M. The fishes showed a growth of 15 mm per month per fish. The mortality was very high due to skin abrasions caused by synthetic net material.

The major draw-back in the cage culture of finfishes in the coastal waters of Mandapam (Gulf of Mannar) is that the culture cages are subjected to the fury of strong south-west monsoon winds from May to September every year, which often restricts the period available for culture.

Culture of marine fishes in polythene-lined ponds (DF/CUL/1.5)

Salient features :

Milkfish and mullets were cultured in polythene film-lined ponds at Calicut and production of over 900 kg/ha for *chanos* and 600 kg/ha for *Mugil cephalus* were obtained. Experiments with *Sillago sihama* and *Megalops cyprinoides* gave growth rates of 12-17 mm and 5 mm/month respectively.

Work done :

Studies were made on the growth, survival and production of *Chanos chanos, Mugil cephalus, Sillago sihama* and *Polynemus tetradactylus* in the polyethylene film-lined ponds at Calicut during the year, in addition to the observations continued on *Megalops cyprinoides* stocked during the previous year.

Tidal pools provided good supply of seeds. Seeds were found normally in salinities ranging from 3.3 to 7.1 ppt. A total of 3170 fry of *M. cephalus* and 577 of *C. chanos* were collected during the period. After some mortality during the transit and acclimatisation, 526 *chanos* and 1263 *M. cephalus* were stocked in 8 ponds. In addition to this seeds of the whiting, *Sillago sihama*, and the threadfin, *Polynemus tetradactylus*, were also collected for the first time from the surf of Konnad

beach in the Calicut area during November-January months and utilised for culture experiments.

Four ponds in which *Chanos* and Mugil were stocked were fertilized with NPK (12:14:8) at the rate of 400 kg/ha for the first time to promote natural feed in the ponds. In the remaining four identical ponds the fishes were fed with an artificial feed made out of groundnut oil cake, tapioca waste and prawn-head powder. The whiting and threadfin were fed with minced mussel meat. Environmental parameters of the culture system and growth of the fishes were monitored regularly.

The best production of *Chanos* was in pond 4, which gave 1015 kg/ha with 85.7% survival and in pond 3 with 933 kg/ha and 66.3% survival. The low survival rate in pond 3 has influenced the remaining stock to grow faster leading to a higher size at harvest (159.9 g) when compared to pond 4 in which it was 134.7 g only. For *Mugil cephalus*, out of these two ponds, the pond treated with chemical fertilizer gave a production of 606 kg/ha and survival of 93.3%, while pond 13, with artificial feed, gave only 288 kg/ha production even though it had 97.7% survival. This difference was found in the growth rate also. Fishes in pond 7 registered a daily growth increment of 0.83 mm and 0.40 g; whereas in pond 13 they were respectively 0.61 mm and 0.18 g.

For *Sillago sihama* a total of 906 fry, in the size range 36.2-42.0 mm, was stocked in four ponds in January 1986. In three of the ponds they were stocked at the rate of 1.5M^2 and in one it was 1/M^2. A daily increase in the growth of 0.4 mm was observed for the fish in ponds 3 and 5. In pond 4, it was 0.5 mm and in 8 it was 0.7 mm during the period.

Polynemous tetradactylus, in the size range 15-23 mm and numbering 600, was stocked in two ponds on 29.11.85. The young ones were found very active for about two months and afterwards gradually the entire stock perished. The reason could not be ascertained.

Observations were continued on the growth of *Megalops cyprionoides* stocked on 17.7.84 at a rate of 1.4/M^2. Without giving any supplementary feed, the fish was cultured for about 300 days. It showed a monthly growth of 5.4 mm and 1.08% g.

Pen culture of marine fish (DF/CUL/1.6)

R. S. Lal Mohan

Salient features :

Culture of milkfish and mullets in two pens of 0.5 and 1 ha size at Mandapam gave a production of 221 kg from the former and 390 kg from latter; with average growth rates of 0.73 and 0.75 g/day respectively. An experiment with *Chanos* seed from a secondary spawning and at a higher stocking size in November was found to yield a better growth rate.

Work done :

Two pens of area 0.5 ha. and 1 ha were webbed with HDPE webbing of

20 mm mesh. The bar diameter of the webbing was 0.5 mm.

The 0.5 ha. pen was stocked with 4,000 fingerlings of *Chanos* of average length 68.8 mm and weight 2.06 gr. It attained a length of 259 mm, weighing 136 gr. when harvested after 184 days. The recovery rate was 51%. 221 kg of fishes were obtained from the pen. The average increment in weight per day was 0.73 g.

The One-ha. pen was stocked on 1.7.85 with 10,000 fingerlings of *Chanos* measuring 112.5 mm and weighing 4.7g. The stock attained the size of 317 mm/213 g. in a period of 268 days. A total of 390 kg of fish was harvested from this pen. The recovery rate was 21%, as 2,136 fishes were recovered from the pens. The average growth was 0.75 g. per day. The period of the experiment was 268 days from 1.7.85 to 25.3.86.

During the year under report, one more experiment was conducted from 19.11.84 to 19.4.85. 300 numbers of *Chanos* were collected from the secondary spawning and were utilised for this experiment. The seed measurement was 145 mm, weighing 18 g. The fish attained a length of 346.5 mm and 289. 3g. in a period of 150 days. The average weight increment per day was 1.8 g. The growth was very good during this experiment.

The observations on the barnacle attachment which shortens the life of the pen structures, was continued. It was observed that the barnacle attachment was maximum during December, January and February — about 3 kg/ M^2. No attachment was observed during October when the salinity was 46.4 ppt. During the high infestation period the salinity was 25-28 ppt.

Salinity in the pen-culture site ranged from 25.4 to 48.5 ppt. The maximum salinity was observed during August and the lowest in December. The dissolved oxygen ranged from 3.2 to 6.2 ml/1; the lowest value was observed during March.

CRUSTACEAN FISHERIES DIVISION

The salient features of the capture fisheries for crustaceans during 1985-86 are as follows: Kerala and Karnataka coasts witnessed severe decline in the production of the penaeid prawn *Parapenaeopsis stylifera* ('Karikkadi') which forms traditionally the mainstay of the shrimp fishery of the region. As observed on earlier occasions, sizable quantities of prawns were also landed by purse seiners on the south Canara coast. Juvenile recruitment in the nursery areas was comparatively poor for the estuary-dependent species at Mangalore, Calicut and Madras. Among non-penaeids the *Acetes* fishery of the northwest coast is found to be multispecies in character. Bombay continued to be the leading centre for lobster landings. At Kovalam (Madras), heavy catches of the juveniles of *Panulirus homarus* was noticed in the newly introduced trammel net. The stomatopod landings declined at most of the centres, and the highest yields were recorded along the Karnataka coast.

Under culture fisheries, the technique of artificial insemination of *Penaeus indicus* and *P. monodon* was further refined and perfected. A hatching rate of 95% was obtained when the spermatophores were implanted in females after making 3 to 4 prickings. Experiments conducted to retain the larvae of *Penaeus indicus* in the rearing tanks itself, until they become stockable size seed yielded some good results. 35.9% survival was obtained in some experiments when the larvae were retained in the rearing tanks until they became PL 20. At Tuticorin studies made on the field culture of *P. indicus* and *P. semisulcatus* in recently excavated ponds in a salt pan area, revealed that even when the salinity varied from 31 to 45 ppt *P. indicus* is better suited for field culture than *P. semisulcatus*. Hatchery produced seeds of *P. japonicus* stocked in the ponds at Kovalam, Madras, got impregnated and the ovary started developing within eight months. After eye-stalk ablation they became mature and spawned in captivity giving viable eggs. A temporary hatchery established at Mandapam Camp for the seed production of *P. semisulcatus* yielded good results. Within 28 days 5.8 lakhs of PL 1 and 2 were produced, from which 3.04 lakhs were released in the Palk Bay area.

Assessment of penaeid prawn resources (CF/RE/1.1.1)

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The penaeid prawn production (Table 7) showed decrease at most of the centres except at Madras, Kakinada

Table 7: Penaeid prawn fishery at various centres 1985-'86 (1984-85 figures in brackets)

	GUJARAT	MAHARASHTRA		KARNATAKA			KERALA	
	Veraval	Sassoon Dock	Karwar	Malpe	Mangalore	Calicut	Cochin F.H.	Sakthi-kulangara
Gear: *Trawl*								
Catch in tonnes	2621 (3245)	9121	932	433 (1508)	1645 (2142)	112 (214)	1462 (2357)	10068 (14576)
C/E kg/unit	67.3 (73.0)	489.7	114.5	14.9 (30.3)	39.5 (37.8)	...	...	...
C/E kg/hr.	5.2 (5.4)	24.5*	...	2.8 (5.3)	5.7 (5.1)	4.9 (9.9)	10.7 (16.2)	14.6 (19.4)
Productive months**	3,2,4,10	...	8,4,5,3	5,3,4,2	4,2,3,1	4,3,1,12	1,4,12,2	6,7,8,5
Important species†	h,f,g,c	f,a,b,i e,h	d,f,b	d,f,b	d,f,b,j	f,d,j,b	d,f,j	f,d,j
Gear: *Purse seine*								
Catch in tonnes			2.0		23.0		1.3	
Productive months			2,3		2,3		5	
Important species			d		d,j		d	
Indigenous gear								
Catch in tonnes					62.0	35.0 (gill net)		
C/E kg/unit					...	9.8		
Productive months					7,8	6,7		
Percentage in all fish						13,0		
Important species					d	d		

Table 7 (Cont.)

	KERALA		TAMIL NADU		ANDHRA PRADESH		ORISSA	
	Munam-bam	Ponnani@	Tuticorin	Madras	Kakinada	Waltair	Puri	Paradeep
Gear: *Trawl*								
Catch in tonnes	360	79	531 (961)	605 (443)	3986 (2715)	600 (897)		1388 (757)
C/E kg/unit	32.0	14.8	24.0	12.6	91.9 (65.2)	22.0 (27.9)		51.3 (43.2)
C/E kg/hr	8.0	2.97	4.8	2.5	12.7 (9.5)	2.0 (2.6)		8.4 (6.8)
Productive months **	2,3	2,3	8,6,7,5	3,2,11,1	3,2,9,5	10,8,12,3		12,10,1
Important species†	f,d,b	f,d,j,b	l,j,f,d	d,j,h	b,d,j,e,f	b,i,j,d,h		b,f,a,d,k,h
Gear: *Purse seine*								
Catch in tonnes								
Productive months								
Important species								
Indigenous gear								
Catch in tonnes			107 (gill net)				64 (gill net & boat seine)	
C/E kg/unit			5.3				1.1	
Productive months			7,9,6				4,10,11	
Percentage in all fish								
Important species			j				a,m	

* Calculated at 20 hrs per unit. ** Calendar month @ October-March data

† a. *M. affinis*
b. *M. monoceros*
c. *M. kutchensis*
d. *M. dobsoni*
e. *M. brevicornis*
f. *P. stylifera*
g. *P. hardwickii*
h. *S. crassicornis*
i. *Metapenaeopsis* sp.
j. *P. indicus*
k. *P. monodon*
l. *P. latisulcatus*
m. *P. merguiensis*

& Paradeep where it improved as compared to the previous year. At centres in Karnataka and Kerala the decline was severe on account of lower landings of *Parapenaeopsis stylifera*. Yet this species remained the dominant constituent at all the centres in Kerala except at Cochin Fisheries Harbour, where *Metapenaeus dobsoni* replaced it. The latter species formed the predominant one thoughout the Karnataka coast because of the failure of *P. stylifera*. At centres of Gujarat and Maharashtra the decline in the fishery was to a lesser extent than in the south west coast. On the east coast, while Madras, Kakinada and Paradeep registered an upward trend, Tuticorin and Waltair witnessed the reverse. The catch rate of prawns was maximum at Bombay and Kakinada, where as the lowest was recorded at Malpe and Waltair. Prawns were most abundant during January-May between Veraval and Calicut, May-August between Cochin and Tuticorin, February-March at Madras and Kakinada and August-December at Waltair and Paradeep.

While the trawlers accounted for the bulk of the fishery, indigenous gear landed prawns in appreciable magnitude especially during June-September at Mangalore, Calicut and Tuticorin and April, October and November at Puri. Purse seines also brought sizeable quantity of prawns during February-March at Mangalore.

The catch composition of the trawl fishery at the various centres (Table 8) indicates that *M. affinis* was an important constituent at Bombay, *M. monoceros* at Bombay, Mangalore, Kakinada and Puri, *M. dobsoni* throughout the Kerala and Karnataka coasts and at Madras, *P. stylifera* at Bombay and along the southwest and south east coasts upto Tuticorin, *P. hardwickii* and *Solenocera crassicornis* at Veraval, *Metapenaeopsis* sp. at Bombay & Waltair, *Penaeus indicus* at the centres of the south east coasts and *P. semisulcatus* at Tuticorin. The indigenous gears landed predominantly *M. dobsoni* at Calicut and Mangalore, *P. indicus* at Tuticorin and *M. affinis* and *P. merguiensis* at Puri. The purse seines landed *M. dobsoni* and *P. indicus* in the order of abundance.

The price structure of prawns in the landing place at selected centres is shown in Table 9.

The exploited population of most of the species was found to be more or less of the same sizes at the different centres (Table 10). However, in the case of *M. dobsoni* larger sizes were caught in the Karnataka region compared to Kerala, Tamilnadu and Andhra coasts. The size of *P. indicus* was comparatively larger on the east coast. At most of the centres female prawns dominated in the fishery for the major species. Peak spawning was observed in most of the species during December-May on the west coast and May-September on the east coast. A secondary peak was also noticed during October-December on the upper east coast.

Table 8: Percentage of penaeid prawn species at different centres in the trawl fishery

SPECIES	Veraval	Sassoon Dock	Karwar	Malpe	Manga-lore	Calicut	Cochin F.H.	Sakthi-kulangara	Munam-bam	Ponnani	Tuti-corin	Madras	Kaki-nada	Waltair	Paradeep
M. affinis	1.0	20.5	0.7	2.0	1.0	0.2	0.2	1.0	...	...	...	...	3.1	1.4	18.3
M. monoceros	4.1	12.8	5.0	6.2	17.7	5.9	2.4	3.2	6.4	24.0	2.8	7.0	20.3	42.5	21.2
M. kutchensis	7.1	...	...	...	...	...	...	...	...	...	...	...	...	...	...
M. dobsoni	...	...	86.2	59.8	39.5	30.5	62.4	16.0	35.6	8.4	10.7	63.1	13.4	5.9	15.3
M. brevicornis	...	8.3	...	...	...	...	...	...	...	...	...	...	8.6	...	...
P. stylifera	12.3	20.8	7.3	27.5	28.7	54.4	23.7	67.6	52.2	41.5	16.2	...	6.1	...	19.3
P. hardwickii	11.9	...	...	...	...	...	...	...	...	...	...	...	2.8	...	3.8
S. crassicornis	53.7	8.0	...	...	...	...	...	...	...	...	...	...	...	5.0	7.2
Metapenaeopsis sp	...	10.0	...	...	...	...	...	...	...	...	...	...	...	17.5	...
P. indicus	...	...	...	4.4	10.2	9.0	10.9	8.2	4.6	20.4	17.3	25.6	11.1	12.8	...
P. penicillatus	1.6	4.1	...	...	...	...	...	...	...	...	...	...	...	...	...
P. merguiensus	...	...	0.6	...	...	...	...	...	...	...	...	...	4.5	...	1.1
P. monodon	...	...	0.2	...	...	...	0.3	...	...	...	...	2.8	9.6	3.7	7.7
P. semisulcatus	2.2	...	...	...	...	...	...	0.1	1.2	5.0	46.2	1.5	4.4	2.6	...
P. latisulcatus	...	...	...	...	...	...	...	...	...	...	2.8	...	...	...	...
Others	6.1	15.5	...	0.1	2.9	...	0.1	3.9	...	0.7	0.7	...	16.1	8.6	6.1

Table 9: Price structure (Rs./1 kg) of penaeid prawns at selected centres

Category	Mangalore	Cochin Sakthi-kulangara	Ponnani	Cochin Fisheries Harbour	Kakinada
Large	50-90	60-80	66-85	50-75	50-80
Medium	20-40	30-45	30-35	22-45	16-30
Small	10-20	10-18	10-18	10-18	8-12
Tiny	...	5-8	...	5-7	...

Assessment of non-penaeid prawn resources (CF/RE/1.1.2)

S. RAMAMURTHY, V. D. DESHMUKH, M. ARAVINDAKSHAN and S. LALITHA DEVI

The non-penaeid fishery (Table 11 & 12) declined considerably at Veraval and Kakinada, while at Bombay it remained more or less in the same magnitude as in the previous year. A notable observation was the multispecies nature of the *Acetes* fishery in the north west coast. *A. indicus* and *A. johni* were found to constitute the fishery, of which the latter formed almost the entire catch during October-November. *A. japonicus* was of lesser fishery significance.

At Veraval, the fishery accounted 12.2% of the dol net catch, with peak landings in November. The catch, effort and C/E showed decline. *Acetes* spp. constituted 46.1% followed by *N. tenuipes* (29.6%) and *E. ensirostris* (24.3%) *N. tenuipes* had the dominant mode at 33-54 mm and peak spawning was observed during October. In *E. ensirostris*, 68-83 mm size formed the mainstay of the fishery, with maximum percentage of ovigerous females occurring in September and January. The growth parameters worked out for the species were $L\infty$ — 107.2 mm, K — 0.196/month and t_o — 0.041. Total mortality was estimated to be 10.36 for the year and the exploitation rate 0.77. At Bombay, *A. indicus* had a size range of 20-38 mm *A. johni* 17-25 mm, *A. japonicus* 15-22 mm and *N. tenuipes* 26-65 mm. Females occurred in more numbers during November and March. The non-penaeids at Kakinada constituted 2.4% the total trawler landings with peak production in September followed by October and May *E. ensirostris* and *N. tenuipes* had modal sizes at 60-64 mm. Females predominated with highest breeding activities during September. The non-penaeids accounted 5.1% of the total backwater catch at B. V. Palem. *Macrobrachium* spp. and *E. styliferus* constituted the fishery with peak catches during January-February.

Table 10 : Size range (dominant modal size in parenthesis) in mm of the important species in the trawl fishery at various centres

(A: All sexes; M: Male; F: Female)

SPECIES	GUJARAT Veraval	MAHARASHTRA Sassoon Dock	KARNATAKA Karwar	KARNATAKA Malpe	KARNATAKA Mangalore	KERALA Calicut	KERALA Cochin Fisheries Harbour
M. affinis	...	A 88-148	...	...	...	...	...
M. monoceros	...	M 108-138 F 108-158	M 73-138 F 78-163 (118)	... ...	...	A 93-168 (113)	...
M. dobsoni	...	... ...	M 48-93 F 53-113 (113)	M 48-88 F 48-108 (93)	M 53-93 F 53-108 (88)	A 43-118 (73)	A 48-108 (63; 73)
M. kutchensis	M 68-143 (108) F 73-173 (108)	...	...	...	...	...	...
M. brevicornis	...	...	...	...	...	...	...
P. hardwickii	M 48-78 (63) F 48-128 (93)	...	...	...	...	...	...

P. stylifera	M 53-103 (78) F 48-153 (93)	M 58-98 F 78-118	M 53-403 (73) F 68-128 (88)	M 53-88 (68) F 53-118 (83)	M 53-103 (73) F 48-128 (83)	A 48-108 (73)	A 48-118 (83)
P. indicus	...	...	...	...	... ...	A 73-153 (93)	A 93-183 (113;148)
P. penicillatus	M 98-178 (163) F 108-248 (173)	...	...	...	...	...	...
P. semisulcatus	...	...	...	...	...	...	...
P. monodon	...	...	...	...	...	...	...
S. crassicornis	M 28-88 (68) F 23-118 (93	M 53-73 F 68-118	...	...	...	...	...

SPECIES	KERALA			TAMIL NADU		ANDHRA PRADESH		ORISSA
	Sakthikulangara	Munambam	Ponnani	Tuticorin	Madras	Kakinada	Waltair	Paradeep
M. affinis	...	...	...	...	...	A 60-129	...	A 78-173
M. monoceros	...	...	A 68-178 (133)	... ...	M 108-208 F 103-203	A 60-194 (148) ...	M 63-178 (123) F 68-188 (143)	A 63-173 ...

M. dobsoni	A 38-118 (73)	A 48-113 (63)	A 58-93 (73)	... ...	M 53-108 (73) F 53-108 (78)	A 38-108 (83) ...	... ...	A 58-113 ...
M. kutchensis	...	...	...	...	...	...	...	...
M. brevicornis	...	...	...	...	...	A 78-138 (83)	...	...
P. stylifera	A 38-118 (83)	A 48-123 (78)	A 58-125 (93)	...	...	...	...	A 68-123
P. hardwickii	...	...	...	...	...	...	...	...
P. indicus	A 93-183 (128;153)	... ...	... ...	M 108-198 (148;123) F 98-213 (148;178)	M 103-193 F 103-193	A 83-203 ...	M 88-183 (143;153) F 93-193 (153;168)	... ...
P. penicillatus	...	...	...	...	...	...	...	...
P. semisulcatus	...	... ...	... ...	M 88-198 (133) F 93-208 (138;168)	M 113-183 F 113-178	... ...	M 98-198 (153) F 98-248 (183)	... ...
P. monodon	...	... ...	... ...	... ...	M 123-268 F 123-263	A 103-298 (228)	M 133-238 F 153-308 (233)	... A 53-103
S. crassicornis	...	...	...	...	...	...	...	...

Table 11 : Non-penaeid catch in tonnes and C/E in kg during 1985-86 and 1984-85

Centre	Gear	1985-86 Catch	1985-86 C/E	1984-85 Catch	1984-85 C/E
Veraval (Navambunder)	*Dol*	919.6	45.6	1847.1	62.8
Bombay					
i) Versova	*Dol*	5030.8	291.5	5441.7	377.0
ii) Sassoon Dock	*Dol*	705.5	44.6	316.6	25.2
"	Trawl				
Total		100.4	12.7	51.7	10.8
Kakinada					
i) Fishing Harbour	Trawl	5836.7	...	5810.0	...
ii) Backwaters	Drag nets/	472.3	10.9	632.3	15.2
(B. V. Palem)	Stake nets	11.3	0.6(DN) 0.7(SN)	16.6	0.8(DN) 1.0(SN)

Table 12 : Species composition of non-penaeid catch in tonnes (% in parenthesis) during 1985-86

Species	Veraval	Bombay	Kakinada Marine	Kakinada Backwaters
Acetes spp.	424.0	4563	336.9	...
	(46.1)	(78.2)	(71.4)	...
N. tenuipes	272.4	1244	75.2	...
	(29.6)	(21.3)	(15.9)	...
E. ensirostris	223.2	...	22.1	...
	(24.3)	...	(4.7)	...
Others	...	29	38.1	11.3
		(10.5)	(8.0)	(100.0)
TOTAL	919.6	5836	472.3	11.3

Table 13: Estuarine fishery for juvenile prawns at selected centres during 1985-86

	Karwar	Mangalore	Calicut	Cochin	Madras	Kakinada	Puri
Estimated catch in tonnes	75.9	8.9	91.8	1160.1	19.0	189.8	
CPUE in kg/net	4.47	0.01*	2.7	1.6	...	9.8	
Fishing gears	Sluice nets	Cast nets & seines	Stake nets	Stake nets	Stake nets, seines, cast nets	Stake nets & drag nets	
Important species	*M. dobsoni* *M. monoceros*	*M. dobsoni* *P. indicus* *M. moyebi*	*M. dobsoni* *P. indicus* *M. monoceros*	*M. dobsoni* *M. monoceros* *P. indicus*	*P. indicus...* *M. dobsoni* *M. monoceros*	*M. monoceros* *P. indicus* *P. monodon*	
Peak fishing season	Oct.-Dec.	June	April-May & October	April-June & December	April-May, Dec. & Feb.	September & January-February	

* For cast nets

Assessment of prawn resources in the nursery grounds (CF/RE/1.1.3)

C. Suseelan, K. R. Manmadan Nair, S. Lalitha Devi, D. B. James, V. S. Kakati, N. S. Kurup, K. K. Sukumaran and K. Y. Telang

The resource characteristics of marine prawns from their estuarine habitats were monitored from Karwar, Mangalore, Calicut, Cochin, Madras, Kakinada and Puri. The year witnessed severe decline in the abundance of penaeids in the nursery grounds at Mangalore, Calicut and Madras although slight improvement was noticed at the other centres as compared to the previous year. The failure of the fishery was mainly due to the poor recruitment of *Metapenaeus dobsoni* and *Penaeus indicus* on the west coast centres and *P. indicus* at Madras. This set back in juvenile abundance suggests low production of prawns in the marine environment of the respective centres during 1986-87.

Commercial fishery for prawns in the nursery areas (Table 13) was active throughout the year with peak catches during October-December at Karwar, June at Mangalore, April-May and October at Calicut, April-June and December at Cochin, April-May, December and February at Kakinada. In general, the fishery was predominantly constituted by *M. dobsoni* on the southwest coast, *P. indicus* on Tamilnadu and Orissa coasts and *M. monoceros* in Andhra Pradesh. An improvement in shrimp catch over that of the previous year was observed for *M. dobsoni* and *M. monoceros* at Karwar, *M. moyebi* at Mangalore, *M. dobsoni* at Cochin and Madras and *M. monoceros*, *P. monodon* and *P. indicus* at Kakinada. The estuarine fishery was entirely supported by juveniles of varying sizes except at Kakinada where maturing females were also recorded in the catches. The major size groups of *M. dobsoni* were 31-50 mm at Mangalore, 41-50 mm at Cochin and 46-55 mm at Madras. In Korapuzha the annual mean size varied from 38.3 to 60.2 mm. *M. monoceros* was mainly represented by 45-64 mm size at Kakinada, while at the other centres slightly larger sizes (66-100) dominated in the catch. The important sizes of *P. indicus* were 46-75 mm at Mangalore, 65-109 mm at Kakinada, 81-110 mm at Calicut and 86-100 mm at Madras. *P. monodon* in Kakinada backwaters showed a size range of 30-254 mm, but majority belonged to 105-174 mm size group. At most of the centres the major species showed preponderance of females as observed in the previous year.

Assessment of lobster and crab resources (CF/RE/1.3)

P. V. Kagwade, E. V. Radhakrishnan, K. Y. Telang and V. D. Deshmukh

The lobster landings increased at Bombay (695 t) and Madras (23 t), but decreased at Veraval (184 t) when compared to the landings of the previous year. Moderate quantities of the lobster landings were also recorded at Calicut (3.4 t) and Tuticorin (16.6 t). The catch increase at Madras was almost 3-fold in the trawlers. The CPUE increased from 14.2 kg to 15.9 kg this year at Bombay while at Veraval it decreased from 0.5 kg to 0.4 kg. Peak catches were recorded during November-January at Veraval, October at

Bombay, March-May at Calicut, May and September at Tuticorin and July-August at Madras. While *Panulirus polyphagus* (45-68 %) and *Thenus orientalis* (32-55%) constituted the fishery of the northwest coast, *P. homarus* predominated in the landings at Calicut and Tuticorin and *T. orientalis* in the trawl fishery at Madras. In the indigenous fishery at Kovalam (Madras), a substantial increase in the landings of *P. homarus* was reported as a result of the heavy occurrence of juveniles of the species in the trammel net (Mani valai) during March. The occurrence of large quantities of juvenile lobsters in this newly introduced net calls for conservation measures.

The crab landing during this year was considerably higher at Mangalore, Madras and Kakinada while at Veraval it got reduced to 1/6 from the previous year's estimate. *Portunus sanguinolentus* (70-98%) consituted the bulk of the catches on the west coast centres and at Madras (49%), where as at Kakinada *P. pelagicus* (60%) was the dominant species.

Assessment of stomatopod resources (CE/RE/1.7)

K. K. Sukumaran, D. B. James, G. Sudhakara Rao, N. S. Kurup and K. Y. Telang

At all the centres except at Madras the stomatopod landing declined in varying degrees when compared to the landings of the previous year. Maximum concentration of the resources was observed along the coasts of Karnataka where the catch rate in trawlers varied from 10 to 15 kg/hr with the estimated annual productions amounting to 401 t at Karwar, 2282 t at Malpe and 4379 t at Mangalore. The landings at the other observation centres were much less and varied between 24 t at Madras and 94 t at Waltair. While the fishery along the west coast was entirely supported by a single species *Oratosquilla nepa*, with modal sizes ranging 48-118 mm, the same along the east coast was multispecies in nature. In the case of O. *nepa*, active recruitment of fresh entrants into the fishery was observed during November-December at Mangalore and Malpe. Females outnumbered the males in all the species. *O. nepa* was found to breed intensively during March-April on the west coast and in January at Madras.

Field culture of marine prawns (CF/Cul/1.1.1)

M. Kathirvel, K. Devarajan, M. Rajagopalan, S. Lazarus, M. Rajamani, S. Shanmugham and Syed Ahamed Ali

Calicut: Studies were carried out on the growth, survival and production of *P. indicus* in polyethylene sheet lined ponds. Hatchery reared seed were used for the experiments. They were fed with pellatised feed. *P. indicus* recorded a growth of 1.0 mm, 0.8 mm, and 0.6 mm per day at the stocking densities of 50,000, 70,000 and 1,00,000 per ha during 81-118 days culture respectively, indicating the maximum growth at 50,000/ha.

Tuticorin: Hatchery produced seed of *P. indicus* (20,000 numbers of 10-13 size) and *P. semisulcatus* (12,200 numbers of 10-13 mm size) were released together in a newly constructed ½ ha.

pond in the Veppalodai salt pan area. In an adjacent pond of the same size *P. indicus* seeds (22,820 numbers of 28 mm average size) collected from the wild were stocked. Regular observations on the growth of prawns, temperature, salinity oxygen and pH of pond water were made from both the ponds. Salinity varied from 31-45 ppt and dissolved Oxygen from 2.8-5.8 ml/l respectively. Prawns were fed with pelletized feed (7-10% of body weight). After a period of five months the prawns were harvested. In the pond stocked with hatchery reared prawns, 85% of *P. indicus* were recovered. The rate of growth of *P. indicus* for the five months was 25 mm/3.8 gr/month. Total yield at the end of 5 months 562 kg/ha. *P. semisulcatus* was almost absent at the time of harvest. In the other pond, stocked with seed of *P. indicus* from the wild the survival was 66% and growth rate was 22.1 mm/3.8 gr/month. These experiments clearly showed that laboratory reared *P. indicus* are as good as the seed collected from the wild. Moreover, laboratory reared seed showed a slightly faster growth rate. Compared to *P. semisulcatus*, *P. indicus* showed a better survival rate in the salt pan area even when the salinity varied from 31-45 ppt. The mortality of *P. semisulcatus* in the ponds may be due to the ecosystem, particularly the clayey bottom which may not be suitable for this species. Moreover this species may require sandy bottom with sea weed or grass for clinging. Further experiments on these lines are in progress.

Madras: Hatchery reared seed of *P. japonicus* of average size 14.8 mm were released inside a velon screen enclosure kept in one of the culture ponds. After 45 days the average size of the prawn became 50.4 mm. They were stocked in a pond at the rate of 5,000/ha. The prawns were fed with the meat of *Meretrix casta* at the rate of 5% of the body weight of stocked biomass. A growth rate of 0.69 mm/day was observed during the first 180 days. When the culture period was extended to 255 days, the overall growth became 0.51 mm per day. Females of above 130 mm in total length were found to be impregnated. Developing ovaries were noticed after 8 months growth in the ponds. Ten mature females and males collected from the pond were subjected to eye stalk ablation experiments. They matured and spawned viable eggs, and the hatched out larvae were reared through various stages upto PL 1.

Hatchery production of marine prawn seed (CF/Cul/1.1.2)

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Good success was achieved in the maturation of *Penaeus indicus*. All the larvae produced in the hatchery at Narakkal were from spawners induced to mature by unilateral eyestalk ablation. No wild spawners were used. Out of the 516 females that were ablated, 447 (86.6%) spawned viable eggs.

During this year, the main objective was to study the feasibility of rearing the larvae of *P. indicus* from PL-1 to PL-25 in the larval rearing tank itself, and thus trying to eliminate the separate rearing of post-

larvae in the nurseries. 95 successful experiments were carried out for rearing the nauplii of *P. indicus* to PL-1 and again upto PL 25. Two ton capacity containers, both plastic pools and cylindro-conical fibreglass tanks, were used as larval rearing containers. These tanks were kept inside the glass house. Mixed diatoms cultures dominated by *Chaetoceros* spp were used as larval feed upto last mysis and there after particulated artificial feed was used. A few experiments were terminated when the larvae reached the PL 1-2 stage. Different experiments were carried out by retaining the larvae in the rearing tanks until they reached PL 3-7, PL 8-12, PL 20 and PL 25. When the larvae were reared in the tank until they became PL 3-7, the survival was 16.8% with a range of 2.2%-58.6%. When they were reared until PL 20 the average survival was 22.9% with a range of 8.0-35.9%. Although a lot of fluctuations are seen in the results, the fact that in some experiments a survival of 35.9% was obtained when the larvae were reared in the larval rearing tank itself until they became PL 20, clearly indicate the possibility of rearing the larvae, in the rearing tanks itself until, they develop to stockable seed size (PL 15-20). During this period, the salinity of the water in the rearing tanks varied from 29.5 to 30.5 ppt, temperature from 29.5 to 30°C and pH from 8.1 to 8.4. The ammonia content level was between 0.025 *ug*.at NH_3-N/1 and 0.07 *ug* at NH_3-N/1. A total of 2125.10 thousand seed of *P. indicus* were produced during this period.

18 experiments on the nursery rearing of PL 5 were carried out during this period. Cement tanks of 4 tonne capacity were used for the purpose. Larvae were fed with artificial feed and salinity of water was slowly reduced by replacing 1/3 water with brackish water every 3 to 4 days. Larvae were retained in the nursery tanks for a period of 7 to 38 days. Average survival in the nursery was 49.9%.

Experiments were also carried out to study the feasibility of using the grow-out pond itself, for the nursery rearing of post-larvae. A brackish water pond of 0.02 ha. was selected for this purpose. The pond was stocked with PL 6 at the rate of 17,86,000/ha. After 18 days the average total length and weight of the seed became 34.88 mm and 0.03 gr respectively. 40.89% survival was obtained. They were then used for stocking the ponds.

Seed of *P. indicus* reared at the Narakkal Laboratory were used for conducting experiments at the Institute's ponds and in the farmers' fields. 1.32 million prawn seed were given to 17 farmers, co-operative societies, and to the KVK. Follow up studies on the seeds supplied to various farmers were carried out. Details regarding the growth, production potential and economics of eight observations made are given below:

No.	Area (ha)	No. of seeds stocked	No. of days	Average wt. gr.)	Total catch (Kgs)	Catch/ ha.	Net amount Rs.	Expen- diture in Rs.	Profit in Rs.
1	1.34	74500	80	14.7	441.30	329.3	17432	9320	8112
2	0.20	16200	105	7.8	12.65	63.25	798	250	548
3	6.01	150000	88	8.0	195.50	32.53	7000	3000	4000
4	0.20	10000	53	5.56	25.00	125.00	625	...	...
5	1.00	56000	42	8.33	135.00	135.00	4450	3450	1000
6	0.20	7950	78	8.77	14.80	74.00			
7	0.34	7000	52	13.69	88.90	261.47	6375	1854	4521
8	0.80	40000	53	11.76	41.65	52.00			

A series of experiments on the mass production of seeds of *P. semisulcatus* were also conducted. 106.11 thousand PL were produced. Using these post larvae, experiments were carried out to study the effect of sudden transfer of postlarvae acclimatised to 30 ppt. to water having a lower or higher salinities. Experiments showed that early stage postlarvae up to PL 51 could not survive sudden transfer to salinities less than 20 ppt. Same thing holds good for PL 45, whereas PL 20-25 showed a tolerance upto 15 ppt indicating their ability to adapt to lower salinity. The experiments indicated that sudden increase or decrease in the salinity will lead to mortality of *P. semisulcatus* in the culture ponds.

Attempts were also made to develop a suitable substitute for phytoplankton feed for the rearing of *P. indicus* larvae. Chicken egg and clam meat in 1:5 ratio were mixed, minced and cooked to get a custard. This was broken into smaller particles seived and used as feed for the rearing of larvae. This gave very good results from mysis stage onwards.

Artificial propagation of green crabs (CF/Cul/1.1.3)

R. MARICHAMY

Polyculture of *Scylla serrata* with *Liza macrolepis* was carried out at Tuticorin. 820 seed of *Scylla serrata* (37 mm) and 1000 seed of *Liza macrolepis* (38 mm) were released together in a pond. Within a period of nine months the crab attained a size of 137 mm (CW) and 408 gr in weight. The rate of growth was 12 mm/48 gr/month. *Liza macrolepis* attained a size of 193 mm/79 gr and the monthly growth rate was 19 mm/9 gr.

Experiments were carried out on the seed production of *Portunus pelagicus.*

Twenty days were needed for completion of the five zoeal stages and one megalopa stage. Newly hatched artemia nauplii were used as food. Development from the 2nd to the 9th crab instar took 46 days, the time interval between each moult was 3-5 days.

Artificial insemination and breeding of prawns (CF/Cul/1.1.5)

M. S. Muthu and A. Laxminarayana

The technique of artificial insemination of *P. indicus* was further improved. Females with a carapace length of 39-41 mm, were collected, and using electrocautery apparatus their eye stalks were unilaterally ablated. They were kept individually in pools. The salinity, temperature and pH of the water in the pools were maintained at 33 ppt, 26-28°C and 8.2 respectively. They were fed with clam meat *ad libitum*. When the females moulted after 4-5 hours they were implanted with spermatophores obtained from males by electro-ejaculation. Experiments conducted revealed that whenever these spermatophores were implanted after pricking them 3 to 4 times with a fine sterilized needle, the hatching rate of eggs laid was found to be very high (86.1-94.29%) whereas when the spermatophores were used without pricking the hatching rate of eggs was low (25.3-28.5%).

Culture of spiny lobsters (Panulirus sp.) (CF/Cul/1.5)

E V. Radhakrishnan and M. Vijayakumar

Experiments were carried out to study the effect of thoracic ganglation extracts on the moult cycle of lobsters. Thoracic ganglion from female *Panulirus homarus* were found to accelerate moulting in male lobsters, when 0.2 ml extract of the ganglion was injected in the intermoult stage three times at intervals of 3 days. While the injected males completed the moult in an average of 7.5 days the males in the control group took 28.5 days to complete the moult.

Five breeding experiments were carried out with *P. homarus* collected from the wild. 3000 phyllosoma larvae were reared in a running sea-water system. They were fed with chopped clam meat (0.4 mm size particles). Although the larvae readily accepted this food, due to epibiont infestation, larvae did not surive after five days. For the purpose of controlling the growth of epibionts the toxicity of malachite green, potassium permanganate and formalin on newly hatched phyllosoma larvae was studied.

Sea ranching of marine prawns (CF/Cul/1.1.7)

N. N. Pillai, M. S. Muthu, K. V. George, A. Laxminarayana, S. K. Pandian, Syed Ahamed Ali, A. R. Thirunavakkarasu, M. Rajamani, M. Kathirvel and K. Devarajan

A temporary hatchery for the production of postlarvae *P. semisulcatus* was established at Mandapam Camp. Two trial runs for the production of PL 1 & 2 were carried out during a period of 28 days. 5.84 lakhs of PL 1 & 2 were produced. 3.09 lakhs were released into the sea in the Palk Bay area.

1.07 lakhs of postlarvae of *P. indicus* and 0.8 lakhs of post-larvae of *P. semisulcatus* reared at MPHL, Narakkal were transported to Mandapam Camp in connection with this programme.

MOLLUSCAN FISHERIES DIVISION

Survey of Cephalopod Resources in the Exclusive Economic Zone (MOL/RE/1.2.1)

E. G. SILAS, K. ALAGARSWAMI, KUBER VIDYASAGAR, G. SYDA RAO, M. M. MEIYAPPAN, P. V. SREENIVASAN, K. PRABHAKARAN NAIR, K. SATYANARAYANA RAO, R. SARVESAN and G. RADHAKRISHNA

FORV *Sagar Sampada* had undertaken 15 cruises in the EEZ during 1985-86 and invariably caught cephalopods in various fishing gears and plankton nets and IKMT. In cruise No. 8, surveying the Eastern Arabian Sea, cuttle fishes *Sepia pharaonis* (53 kg) and *S. elliptica* (253 kg) were caught in the demersal net at 22°0.8'N, 68°33'E at the depth of 68 m. The species ranged in size (DML) 165-286 mm and 65-120 mm respectively.

Cruise No. 9 which was oriented towards the survey of cephalopod resources in the Eastern Arabian Sea — Northern sector (Lat. 15°30'N-23°30'N Long. 65°00'E-72°30'E) revealed the availability of oceanic squid *Symplectoteuthis oualaniensis* in the area. The oceanic squids were attracted by the ship's lights at night and one female (268 mm DML) was taken at position 17°30'N, 71°00'E by hand jigging. The demersal fishing at positions 21°30'N 69°00'E and 23°30'N, 67°00'E yielded small quantities of *Sepia pharaonis, S. trygonina* and *S. elliptica*. Pelagic octopods and *Abralia* sp. were observed in mesopelagic collections.

In the survey of the Laccadive Archipelago (Lat. 08°00'N - 17°00'N; Long. 70°00'E-75°00'E), pelagic fishing yielded squids from 24 out of 40 operations.

Cruise 14 around Andaman-Nicobar Archipelago had brought to light the availability of oceanic squid resources in the area. During this cruise 26 out of 31 pelagic fishing and 3 demersal fishing operations yielded juveniles and adults of cephalopods. *S. oualaniensis* was caught in many stations. Another important oceanic squid *Thysanoteuthis* sp. was recorded in the station 12°00'N, 92°00'E in the pelagic trawl operation. The mature female measured 585 mm in DML and weighed 5.3 kg. Collection of squid eggs and developing embryos in appreciable quantities in areas 12°00'N 92°00'E, 10°30'N 94°00'E, 11°29'N 95°00'E and 11°00'N 96°00'E indicate their breeding grounds. Other oceanic species recorded were *Cranchia* sp., *Lysocranchia* sp. and *Abralia* sp, *Sepia pharaonis*, S. *aculeata* and *Doryteuthis* sp. were also observed.

Cruise 16 surveying the mesopelagic resources in the Southern Bay of Bengal (Lat. 07°00'N-13°00'N; Long. 83°00'E-91°00'E) caught oceanic squids in almost all the 22 pelagic fishing and 8 midwater trawl operations.

R. V. Skipjack caught small quantities of *Loligo duvaucelii* in demersal

fishing operation at 09°30'N 76°16.8'E in september. Squid shoals were often noticed attracted towards ship's lights at night.

Detailed biological studies on cephalopod collections of the Research Vessels have been made.

Three vessels of Fishery Survey of India (Bombay base) caught about 2 t of cephalopods during the first quarter at the rate of 2.5 kg/hour.

Four vessels of Integrated Fisheries Project and one vessel of Fishery Survey of India based at Cochin together caught about 17.7 t of cephalopods at the rate of 9.7 kg/hour for the period April-December. About 76% of the catch had come from the major area 9-76 followed by 8-76 and 10-75. Production from other areas was negligible. April and May accounted for about 74% of the catch and catch per hour was about 21 kg. *Matsya Varshini* caught about 1.2 t of cephalopods at the rate of 248 kg/hour from the area 10-75 in shallow waters (depth 42 m) during December and cephalopods formed 47% of the total catch.

Stock assessment of cephalopod resources of the inshore waters (MOL/RE/1.2.2)

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Monitoring the fishery for cephalopods, a notable increase in production was observed in all the major centres. The increase over the previous year was marked at New Ferry Wharf-Bombay (154%), Madras (132%), Cochin (81%) and Visakhapatnam (55%). The production estimates, catch per unit of effort, species composition and size ranges of important species at different centres are given in Table 15).

At Veraval the catch had increased by 10% from 1673 t to 1844 t with a catch rate of 48 kg per unit. Squids forming 64% were dominant in the catches. Good landings were recorded throughout the year except during June-September when there was no fishing.

At New Ferry Wharf-Bombay with only 4% increase in effort the catch rose 2.5 times giving an average CPUE of 250 kg, with the range from 3 kg in July to 1473 kg in December. The cuttlefish landings had increased by 415% but the squids declined by 37%. At Sassoon Docks — Bombay with 7% decrease in effort the catch had increased marginally with a catch rate of 240 kg per unit. The cephalopods accounted for 15% of the total landings and in Decemebr they formed as much as 54%. The CPUE ranged between 6 kg in July and 1245 kg in December. There was no fishing during June July.

At Mangalore, in spite of about 15% decline in effort the production increased by 30%. The CPUE also increased from 14 kg to 25 kg. The squids were dominant (81%). There was no fishing during July-August.

The production continued to show increasing trend at Cochin where the catch increased by 81% against a decrease in effort by 18% with a catch

rate of 7 kg per unit. Squid production increased by 240% but that of cuttlefishes decreased by 44%. Due to poor shrimp yields there was no fishing during September-October period.

At Tuticorin an estimated 192 t of cephalopods were landed at the rate of 5 kg in February to 10 kg in September and the cephalopods formed from less than 1% to 4% of the total landings. 62% of the production was obtained during July-October.

At Madras centre against a 30% increase in effort, 132% increase in production was observed. The catch rate and contribution to total fish landings were 8 kg per unit and 4% respectively. Better yields were obtained during July-October period which accounted for 84% of the production.

At Visakhapatnam, the production had risen from 139 t to 215 t in spite of about 16% decrease in effort. The catch rate and contribution of cephalopods to all fish production were 8 kg per unit and 3%. Cuttlefishes were dominant forming 58%.

Vizhinjam, the only centre where the entire cephalopod production comes from indigenous gears, recorded about 36% increase in landings. Production from boat seines increased by 72% and there was a marginal decrease (2%) in hooks and lines catch. 65% of the production came from boat seines and the rest from hooks and lines. The CPUE of boat seines and hooks and lines were 8 kg and 3 kg respectively. Catamarans fitted with out board engines operating hooks and lines had a higher CPUE at 4 kg than the ones without engines at 2 kg. 95% of the squids were caught by boat seines and the entire cuttlefish production was obtained from hooks and lines.

Boat seines did not yield any cephalopods during October-November period and hooks and lines during February-March and May-July periods.

Recruitment studies in clam populations (MOL/RE/1.8)

G. Syda Rao, N. Ramachandran

Two sampling centres were chosen in the Mulky estuary for monitoring the clam populations. At Bappanadu centre, *Meretrix casta* population was thin. The average density of seed clams ranged 119-132/sq. m. during November-December. At Sasihitlu centre, *M. casta* density was 592/sq. m in December, 1329/sq. m in January, 1236/sq. m in February and 1127/sq. m in March. While the size group range 20-24 mm dominated the Bappanadu samples, 15-19 mm was dominant at Sasihitlu. In March, an estimated 33 t of seed clams were exploited from the latter centre primarily for lime purpose. The ecological parameters were monitored.

The populations of *Meretrix meretrix, M. casta* and *Villorita cyprinoides* were monitored at Kodibag-Kadwad and Kinnar areas at Karwar. Data on size composition, biomass and landings by the sustenance fishery were collected.

Table 15 : Estimated Cephalopod landings by trawlers at different centres during 1985-86.

Centre	Total Cephalopod landings (t)	CPUE (Kg)	*L. duvaucelii*		*S. aculeata*		*S. pharaonis*		Others	Cephalopods in all fish landings
			%	size range (mm)	%	size range (mm)	%	size range (mm)	%	
VERAVAL	1844	48	64	30 - 269	...	...	...	...	36	5
BOMBAY										
— New Ferry Wharf	6021	250	14	30 - 269	42	30 - 239	44	160 - 359	...	14
— Sassoon Docks	4838	240	27	40 - 229	...	40 - 209	...	175 - 309	...	15
MANGALORE	1064	25	81	40 - 269	14	70 - 209	5	...	...	10
COCHIN	211	7	83	50 - 239	4	70 - 129	7	100 - 209	6	3
TUTICORIN	192	5	37	...	9	...	36	...	...	...
MADRAS	382	8	42	...	20	...	25	...	13	...
VISAKHAPATNAM	215	8	42	50 - 259	30	60 - 189	16	50 - 219	12	3
VIZHINJAM (Indigenous gears)										
— Boat Seines	313	8	89	40 - 269	...	...	...	...	11	7
— Hooks & Lines	168	3	8	...	...	...	92	160 - 369	...	7

Culture of edible oysters (MOL/CUL/1.1)

K. NAGAPPAN NAYAR, K. SATYANARAYANA RAO, P MUTHIAH, M. E. RAJA PANDIYAN, K. A. NARASIMHAM and N. RAMACHANDRAN

Natural spatfall was poor in the Tuticorin farm area during the April-May spawning season. To augment the oyster population in the creek, the spat collected were restocked in the same area. Hatchery-produced oyster spat of February 1985 origin had growth to a mean size of 75.2 mm by March 1986.

Studies on culture biology of *Crassostrea madrasensis* were continued. The reproductive cycle of the oyster population in Tuticorin Bay was followed. The major spawning took place during April-May and the secondary spawning in September. However, as noted earlier, spat settlement on the cultch was poor in both seasons. Hydrographical parameters of the bay and Pinnakayal estuary oyster beds were monitored.

Farm oysters, yielding one tonne of meat, were sold to the Government of India's Integrated Fisheries Project at Cochin in August for their experimental programme on product development and marketing.

Oyster collections from different parts of the Indian coasts were examined for species identification. Monitoring for toxic dinoflagellates in the plankton in Tuticorin Bay showed their absence.

Oyster biology was studied at Kakinada. The condition index was high during April-June and low during September-December. The sex ratio showed consistent dominance of female over males at 2.5 : 1.0. Spawning activity in the oyster population was high during April-June 1985 and again during January-March 1986. Hydrographical parameters of Kakinada canal were monitored concurrently.

Experiment on the culture of *Saccostrea cucullata* was initiated at Karwar. The experimental plot at Sadashivgad on Kalinadi was stocked with spat of 15-20 mm size. Survival rate was poor due to heavy silting. Culture biology of the species was studied and the environmental parameters were monitored.

Pilot project in oyester culture (MOL/CUL/1.1.1)

K SATYANARAYANA RAO and P. MUTHIAH

Spat of *Crassostrea madrasensis* produced in the hatchery unit were reared in the oyster farm in Tuticorin Bay under stake culture system and the oysters attained a mean size of 75.2 mm by end of the year. About 5000 young oysters were broadcast in the creek. In November '85, 90,000 hatchery spat were reared in the farm under cage culture and pen culture systems.

Culture of green mussel in saltwater lagoon (MOL/CUL/1.2.1)

K. RANGARAJAN

The green mussel seed collected from Ennore were transplanted to poles in the mussel farm in the lagoon of Muttukadu. The seed of average

size 27.9 mm and 0.13 g in July 1985 had grown to 90.7 mm and 40.8 g in March 1986. Due to flooding of the lagoon in November-December, heavy mortality of mussel was observed in the farm. There was no self propagation of mussel in the lagoon, as the gonads which appeared ripe externally were resorbed without going through the process of spawning.

Investigations on mussel spat settlement and seed slipping on transplantation (MOL/CUL/1.2.2)

K. K. APPUKUTTAN and P. S. KURIAKOSE

Spawning of the brown mussel *Perna indica*, which was poor as indicated in another section, commenced by late June and primary settlement were conducted with mussel spat of 0.4-3.5 mm length. Settlement was good on brown seaweeds and pieces of tiles. On glass plates of different colours, the spat settlement was almost equal, indicating absence of colour preference. The number of byssal threads secreted by the spat ranged 1-5. Studies on byssogenesis of mussel showed that, in 18 hours time, the number of threads secreted ranged 1-18 (mode 6-9) in size group 10-24 mm, 1-20 (mode 3-7) in size group 25-34 mm and 3-29 (mode 6-8) in size group 40-60 mm.

Pilot project in mussel culture (MOL/CUL/1.2.3)

P. S. KURIAKOSE

The project could not be carried out during the year as the scientist was on deputation during the mussel farming season. Routine observations on mussel exploitation were made along the Malabar coast. Mussel landings in this sector have been estimated at 2560 t during the season September-March.

Culture of clams and windowpane oyster (MOL/CUL/1.3)

K. A. NARASIMHAM, G. SYDA RAO and N. RAMACHANDRAN

The progress has not been up to expectations due to lack of controllable clam farming facilities with the Institute. The experiment on *Meretrix casta* in Mulky estuary did not prove successful due to total mortality of transplanted clams on account of crab predation. Culture biology of *M. casta* and *M. meretrix* was studied at Karwar. The culture of windowpane oyster could not be taken up due to non-availability of seed.

Investigations on ecophysiological factors influencing developmental biology of clams (MOL/CUL/1.3.2)

G. P. K. ACHARI

This is a new project and work commenced towards the end of the year. Clams of species *Villorita cyprinoides* from Vizhinjam area, and *Katelysia opima, Paphia malabarica, Meretrix casta, Mactra* sp. and *Sanguinolaria* sp. from Neendakara have been maintained in the laboratory for observations. Live food culture for euryhaline species was initiated.

Pearl Culture (MOL/CUL/1.4)

K. ALAGARSWAMI, A. CHELLAM, S. DHARMARAJ T. S. VELAYUDHAN and A. C. C. VICTOR

The monitoring of pearl oyster beds was continued. Seven sea trips

during April-May '85 to Kurichan, Devi and Fernando "pars" yielded a total of 3137 oysters, of which 86.5% was *Pinctada fucata* and the rest flat pearl oysters. The October '85-March '86 season which was less productive, yielded only 243 oysters from 7 sea trips to Kurichan, Fernando and Vantivu Arubagam "paar". The average pearl oyster size was 27.5 mm in the former season and 27.5-30.0 mm (different paars) in the latter season.

Pearl oyster farming was continued in the harbour basin farm. To choose alternate sites, experimental work was carried out maintaining pearl oysters in waters adjacent to Vantivu island off Tuticorin, after carrying out a quick survey of the area. Pearl oysters under farming by the commercial venture at Krusadai island were also monitored for comparing growth potential under different ecological conditions. Improvements were effected in the farming materials such as the floatation barrels — and spat rearing cages.

On the surgical techniques, an experiment was carried out to understand the pearl producing potential of different sizes of oysters for standardising oyster size — nucleus size / load relationship. Pearl oysters were divided into the following groups (dvm): 40-50 mm, 50-60 mm, 60-70 mm, and 70-80 mm. Nuclei of diameters 3 mm, 4 mm and 5 mm were used. A total of 2131 oysters was used in this work. The implanted oysters will be examined in due course.

During the year, the following growth rates of hatchery-produced oysters were recorded in the harbour farm: April 83 batch — 0.45 mm/month; November '83 batch — 1.28 mm/month; May '84 batch — 1.60 mm/month; January '85 batch — 3.52 mm/month; and August '85 batch — 7.35 mm/month. Three year-old oysters grew at 0.27 mm/month in the raft and at 0.35 mm/month on the breakwater slope.

The environmental parameters of the harbour farm were monitored. While the different parameters followed the susual annual pattern, dissolved oxygen was found to be high at 8.49 ml/l in September '85. The experiment on control of fouling with shading of rafts did not prove positive in the first instance. On the other hand, rearing oysters at 5 m depth was more successful in control of barnacle fouling.

Mass production of edible oyster seed in hatchery system (MOL/CUL/1.5.1)

K. Nagappan Nayar, K. Satyanarayana Rao
P. Muthiah and M. E. Rajapandiyan

Wild oysters collected from Karapad creek, Tuticorin harbour and Pinnakayal estuary formed the broodstock for the hatchery work. The oysters were conditioned for maturation by control of temperature and feeding them with a rich supply of mixed phytoplankton or boiled corn flour. Sixteen batches attained maturity by the above process and spawning was attempted by thermal stimulation at 32°C. Eight batches spawned successfully during April-June, September-October, December and March and the oyster larvae were reared to spat setting. A total of 890,000 spat was produced during the year.

Larval rearing density was 3 larvae/ml but reduced to 0.5/ml towards setting stage. Better results were obtained at a salinity of 20 ppt than at 25 ppt, 30 ppt and 35 ppt. Rate of settling was good among larvae fed on the local strain of *Isochrysis galbana* and *Dicrateria*. Oyster shell, shell grit and polythene sheet were provided as spat collectors. The hatchery-produced spat were reared in the oyster farm.

Development of hatchery system for mussel seed production (MOL/CUL/1.6)

K. RANGARAJAN and K. K. APPUKUTTAN

There appeared to have been a spawning failure of the brown mussel *Perna indica* of Vizhinjam area during the normal spawning season of the species. The poor spawning in the populations seemed to have been caused by the prolonged south-west monsoon during June-September 1985 and the low temperature and salinity of the coastal waters of the area. Examination of the gonad of the female revealed that yolk deposition was subnormal in the ova by mid-July and even this material was resorbed by end-July. Repeated attempts to induce spawning by thermal stimulation, a technique which has worked in earlier seasons, did not result in spawning and, therefore, larval rearing work could not be pursued. Even the natural settlement of mussel spat in the rocky stretches of the coast was found to be poor. The growth of the hatchery-produced spat of the previous season was monitored from April to March and the average growth was found to be 2.5 mm/month in length and 2.5 g/month in weight.

During the year, eight attempts at induced spawning of the green mussel during July-September were not successful. Rearing of larvae resulting from February 1985 spawning was continued and small number of spats were obtained.

Experimental pearl oyster hatchery for mass production of spat (MOL/CUL/1.7.1)

K ALAGARSWAMI, S. DHARMARAJ, A. CHELLAM and T. S. VELAYUDHAN

During the year, the experimental molluscan hatchery programme was fully shifted to the new hatchery premises and facilities were established.

The pearl oyster spat of February and March 1985 spawnings were reared further in the laboratory until they were transferred to the farm. Five larval rearings were carried out resulting from the spawnings obtained on 24th April, 23rd June, 28th August, 27th November and 11th December 1985. These yielded, respectively, 760,000, 5,000, 400,000, 70,000 and 600,000 spat. Wide variations in results have been noticed and these were examined for standardisation. The spat were subsequently transferred to the farm at various stages to study the survival rate and growth. Juvenile rearing procedure was improved with a three-stage change of screen of the cages.

Besides attempting mass production of seed, several experimental aspects of larval rearing were pursued. Aeration during larval phase yielded poor spatfall (1.1%). Addition of antibiotics to the rearing medium enhanced settlement to 31% from the 22% in

control. Larvae could be reared successfully to settlement (on day-19) on a diet of mixed phytoplankton although the growth rate was less as compared to the standard det of *Isochrysis galbana*. Open culture of *I. galbana* was feasible. Culling the larvae at sizes of 100μm, 150μm and 180μm enhanced settlement to 9.3% as compared to 0.5% for the control. Spat settlement was 57% at the tank bottom, 10% on the sides of the tank and 33% on spat collectors.

Young spat of pearl oyster thrived on a pure diet of *Chaetoceros* with a growth rate of 0.085 μm/day, as compared 0.060 μm/day growth obtained with *Isochrysis*. A mixture of the two species enhanced the growth further to 0.088 μum/day.

Induced maturation experiments were continued. Feeding a mixed diet of ricebran and algae reinforced with vitamins enabled 26.7% of spent oysters and 40% of the maturing oysters to attain full maturity. A male *Pinctada* fucata was bred with a female *P. sugillata* producing hybrid spat (on day-21)

A programme of far-reaching implications was initiated during the year. A sea ranching programme which might give scope for repopulating the natural pearl banks of the Gulf of Mannar was inaugurated by release of about 600,000 young spat of *P. fucata*, raised in the experimental hatchery, on Vantivu Arubagam paar in December. A second batch of 70,000 spat was released subsequently.

As an extension education strategy in favour of the technology, a consignment of 50,000 hatchery-produced pearl oyster spat was handed over in December to the joint commercial venture of pearl culture of Govt. of Tamil Nadu.

Culture of cephalopods (MOL/CUL/1.8)

D SIVALINGAM

Three batches of egg capsules of the cuuttlefish *Sepia pharaonis*, collected during February, March and July 1985, were used in the experimental culture of cephalopods. The hatching rate was 100% in the first batch, 40% in the second and 44% in the third. Hatching was completed in 4 days, 2 days and 26 days from date of collection of the above batches of eggs. Growth of hatchlings was similar during the first month, but the second batch showed a faster growth subsequently. The survival rates which were 36.5%, 55.7% and 10.6% respectively, at the end of first month of life got reduced to 1.6%, 6.3% and 3.2% by the end of the fourth month. With subsequent mortality, the lone animal (of the first batch) survived to 220 days. The maximum size recorded was 13 cm at 180 days.

Among the cuttlefish of the third batch, 4 females and 2 males attained maturity and mating behaviour was observed. These laboratory reared animals laid a total number of 653 eggs in February 1986, but none was viable. More knowledge has been gained on the food requirements and behaviour of the hatchlings, juveniles and adults which would be useful in the culture of cephalopods.

Development of hatchery system for clam seed production (MOL/CUL/1.9)

K. A. NARASIMHAM

The hatchery facilities could not be established at the Kakinada Research Centre and consequently, the project continued to suffer with the minimum facilities available, spawning and larval rearing of *Anadara granosa* was carried out. The larval population perished on day 13 due to heavy ciliate attack.

Breeding and experimental sea-ranching of commercially important gastropods (MOL/CUL/1.10)

S. MAHADEVAN, K. RAMADAS and K. K. APPUKUTTAN

The experimental breeding of *Thais* sp. at Vizhinjam led to initial success of larval metamorphosis although the percentage of young ones obtained was very low. Each egg cluster had 50-60 capsules, and each capsule had 650-750 embryos. The veligers hatched from the capsules within 3-7 days of maintaining them in the laboratory. *Isochrysis* and *Chlorella* were not fed upon by the veligers which showed preference to detritus as food. Mortality was high at various stages of development. The larval life of veliger was 12-15 days before they metamorphosed into young gastropod.

The work on *Trochus radiatus* at Mandapam was only partly successful. Repeated efforts to induce the gastropod to breed under captive condition using thermal or photic stimulation resulted in extrusion of gametes and fertilisation. But the eggs perished shortly thereafter. The constraints of water quality and larval nutrition have been examined.

FISHERY ENVIRONMENT MANAGEMENT DIVISION

Physical and chemical aspects of the waters of the Exclusive Economic Zone (MBO/ES/1.1)

A. V. S. Murty, C. P. Ramamirtham, D. S. Rao, S. Muthusamy, K. G. Girijavallabhan, S. Krishna Pillai, R. Marichamy and C. V. Mathew

Observations off Cochin on the general oceanographic condition of the southwest coast of India showed that the monsoon features of the waters started early June itself, as judged by the cooling of water layers and a strong halocline from surface downwards as a result of the monsoon dilution of the surface waters. The thermocline could be inferred at a very shallow depth. The shift of thermocline to a depth less than 10m during monsoon from a depth of about 75 to 100 m during summer helped much for the fertility of the waters. Further, the presence of upwelled water at the bottom layers could be confirmed from the very low oxygen values at the bottom strata of the nearshore waters.

At Calicut, during the year higher water temperature was noted in April (30.2°C). The maximum salinity was 34.37‰ and the minimum was 30.35‰. Dissolved oxygen was found high in January which was 6.95 ml/l. Of nutrients, the Phosphate values were more or less steady during the period. The silicate values ranged between a minimum of 9.80/μ g at/l to a maximum of 18.71/μg at/l. The nitrate content was found to give a maximum value of 3.8 mg/l in October and a minimum value of 1.99 mg/l in April 1985. The nitrate values did not show much variation.

At Vizhinjam in the inshore environment surface Temperature values were within the range from 23.00°C to 30.00°C. The surface salinity showed a decreasing trend during the monsoon. The minimum value for salinity was 30.77‰ and the maximum was 35.23‰. Dissolved oxygen content values varied from 4.00 ml/l to 4.92 ml/l. The inorganic Phosphate showed higher values in August to October. The nitrate and nitrite factors did not vary much during the period. The silicate values ranged from 7.52 μg at/l to 12.80/ μg at/l. The pH in October was constant at 8.2.

At Mandapam, hydrological studies were continued in the inshore waters of Gulf of Mannar and Palk Bay. The water samples were analysed for salinity, dissolved oxygen, pH and nutrients. Bottom samples at three meters depth were also collected. Atmospheric and sea surface temperature were also recorded at the place of collection.

The salinity in Gulf of Mannar ranged from 29.00‰ (Feb) to 35.68‰ (Aug.) while in Palk Bay it ranged from

28.85‰ (Jan.) to 35.43‰ (July). The bottom salinity in Gulf of Mannar varied 28.19‰ (Jan.) to 35.74‰ (June).

The Dissolved oxygen content in Gulf of Mannar ranged from 4.28 ml/l (Sept.) to 5.70 ml/l (Nov) while in Palk Bay 4.16 ml/l (May) to 5.45 ml/l (Mar.).

The pH was 8.0 in both places.

The sea surface temperature in Gulf of Mannar showed variation from 26.6°C (Jan.) to 31.0°C (April), while in Palk Bay it varied from 26.8°C (Jan.) to 30.2°C (April).

Among the nutrients the phosphate values were higher in Palk Bay after the North East monsoon (Jan.-Mar.) as compared with Gulf of Mannar.

Silicate values were higher in bottom samples than surface water in both the places and values are higher during October to December in both the places.

There was not much variation in nitrate concentrations in both the places.

The surface waters off Kakinada showed the highest temperature (32.9° C) during May and lowest temperature (22.0°C) in June. Treating March, April and May as summer, June, July and August as monsoon season and November, December and January as Winter, the average values of temperature during the three seasons were 31.9°C, 26.0°C and 24.8°C respectively. The salinity values were highest during summer, moderate during monsoon and minimum during winter.

At Minicoy, the work was started in November 1985. Three stations were selected for observation. First and Second stations are in the lagoon, the first at jetty and second in the middle of the lagoon. The third station is in the open sea. Depthwise samples were collected from second and third stations. Samples were collected for the analysis pH, Temperature, salinity and dissolved oxygen.

Temperature showed a variation from 27°C to 29.1°C. The lowest temperature recorded at the surface was 27°C in the lagoon during January and February. Highest temperature was recorded in March. At the 5m depth the lowest temperature recorded was in station III. Higher temperature values were observed in all stations and at different depths.

Minimum salinity values were recorded in November (32.12‰) lower salinity values were recorded in station I in January also. In station II also the salinity value was less at the surface during January. Generally higher values were observed in February and March.

Dissolved oxygen showed a variation from 4.19 ml/l. Highest value was observed at the surface samples generally in all other stations the dissolved oxygen values were around 46 ml/l.

The pH values in the surface at I station varied from 8.25 to 8.50. In the second and third station the pH

values were slightly higher at 5 M depth higher pH values were observed in station III (Open Sea). Highest pH value was observed in the 15 M depth at station III.

Eggs and larvae of commercially important fishes from the shelf and adjacent waters EEZ (MBO/FEL/1.1)

K. C. George, Rani Mary Jacob, P. Bensam, Pon Siraimeetan and Geetha Antony

Cochin: Plankton samples were collected during the year from one nearshore station at 15 m depth and one offshore station at 30 m depth. The fortnightly collections were made by continuous oblique hauls covering the entire depth column using a Bongo-20 net of 0.5 mm, square mesh. On an average plankton valume was moderate for both the stations with maximum (2.37 ml/m^3) at the nearshore station in July. Excepting July and August the plankton biomass was very poor in both the stations with the minimum value during February-March at the inshore station. (0.01 ml/m^3). As usual, comparatively the nearshore station had more plankton. In July there was a bloom of *Fragilaria oceanica* and in November there was a swarm of *Penilia avirostris.*

Fish eggs as well as larvae were less than one third the number observed in the previous year. On an average the offshore station had more fish eggs and larvae than the nearshore station. But the maximum number of eggs were recorded from the nearshore station in August (189/m^2) and larvae from the offshore station in January (49/m^2). Of the total fish larvae caught 26.7% belonged to *Stolephorus* spp. the maximum number caught in January from offshore station. Just two *Sardinella* larvae were present in December and two Mackerel larvae in August. Other larval groups met with in the collection in order of their abundance were Ambassids, Carangids, Gobids, Mugilids, Sciaenids, Leiognathids, Lutianids and larvae of *Bregmaceros.*

As was the case in the previous year, the offshore station was relatively warmer, more saline and better aerated than the near shore station. Maximum and minimum surface temperature recorded were 28.5°C and 25.3°C. Surface salainity was highest in March 33.32‰ and lowest in July 10.56‰. Dissolved oxygen ranged between 2.78 to 5.93 ml/l.

Vizhinjam

Total displacement volume of plankton showed two peaks, one in June-August and the other in October-November and it reached its lowest level in September. The first peak was due to a bloom of phytoplankton such as *Fragilaria oceanica, Rhizosolenia* sp. *Thalassionema* sp. and *Bellorochea* sp. and the second peak was due to a swarm of medusae. Fish eggs were more than in the prevous year but fish larvae were less. Eggs showed a distinct peak in August which was mainly composed of flat fish eggs. Eggs of *Stolephorus* spp. were recorded in June. Larval forms of carangids and sardines were observed in April but their numbers were few.

In the open sea station maximum and minimum surface temperatures

were 30°C and 23°C respectively. The surface salinity was highest in March (35.23‰)and lowest in July (30.78‰) The monthly average for dissolved oxygen values ranged between 4.00 ml/l to 4.90 ml/l.

Mandapam

Regular weekly collections of plankton were made from trawling grounds. Most of the eggs collected were those of grey mullets. One type was identified as those of *Valamugil seheli*. Post larval stages of the shad *Hilsa kelee* and the silver belly *Gerres oyena* were identified. Eggs and post larvae of *Sardinella* and *Thryssa* were available in the collection.

Phytoplankton and Primary Productivity of EEZ (MBO/PP/1.1)

K RADHAKRISHNA, G. S. DANIEL SELVARAJ, K. G. GIRIJAVALLABHAN, C. P. GOPINATHAN, C. V. MATHEW, RANI MARY JACOB and P. V. RAMACHANDRAN NAIR

During the year, the observations on Phytoplankton and Primary productivity was continued at Calicut, Vizhinjam, Tuticorin, Madras and Visakhapatnam. At Calicut, consequent upon the transfer of the scientist, the technical assistant handled the project independently. The project was discontinued at Cochin and Kakinada due to shortage of scientists.

Primary productivity experiments were conducted on board FORV *Sagar Sampada* in the Arabian Sea and Central Equatorial Indian Ocean.

Gross primary productivity was estimated near the surface and near the bottom at the first station of 5 m depth and additionally from the mid-depth at the second station of 10 m depth. The study revealed that the inshore waters off Calicut are generally fertile.

At Vizhinjam, surface primary productivity (gross and net) by the oxygen method was estimated at one station in the open sea from April '85 to Sept. 1985 -- for the first half of the year only. Very high rates (over 1 gm /m^3/day) were recorded in June 1985. This is attributed to a mixed bloom of *Fragilaria, Rhizosolenia* and *Bellerochea*. Productivity was low in July followed by September. Surface hydrographic data relating to temperature, salinity, dissolved oxygen and micronutrients, for the entire year, are also recorded.

The productivity rate in the inshore area off Tuticorin was moderate to high during April-May, October and January to March. During the south west monsoon period (June-September) as well as North East monsoon (November-December) it was less and could be due to high turbidity. Diatoms dominated the phytoplankton populations round the year. *Chaetoceros* bloom was observed in September.

At Madras, gross productivity was reported since net productivity tended to be negative.

At Vizakhapatnam, from January, 1986, sampling within the fishing harbour and just outside the harbour had to be resorted to. Surface samples alone could be taken.

Analysis of primary productivity samples collected during the cruises of FORV *Sagar Sampada* in the Bay of Bengal and Central Equatorial Indian Ocean is in progress.

Zooplankton in relation to productivity recruitment and fisheries (MBO/PL/1)

K. J. Mathew, T. S. Naomi, K. Rengarajan, C. V. Mathew, P. A. Thomas, Rani Mary Jacob, Pon. Siraimeetan, S. Krishna Pillai, and K. G. Girijavallabhan

Work on the monitoring of zooplankters was carried out at seven research centres. The biomass and relative abundance of different groups of zooplankters were as normal as in the previous years which shows that there has been no major disturbances in the environment.

At Cochin work on the analysis of zooplankton collected on board FORV *Sagar Sampada* has been started with the help of Institute's technical hands and some qualified hands taken on contract basis from outside. During the period unuder report, a total of 100 zooplankton have been sorted out into 15 to 20 major taxa which in urn will be studied by subject experts.

A detailed report of the work done during the 3rd Indian Antarctic Expedition especially on zooplankton has been prepared.

Culture of economically important seaweeds (MBO/SW/1.2)

N. Kaliaperumal and Geetha Bharathan

Field cultivation of agarophytes *Gracilaria edulis* and *G. arcuata var. arcuata;* alginophytes *Sargassum ilicifollum, S. wightii, Turbinaria conoides, Hormophysa triquetra* and *Cystoseira trinodis* and agaroidophytes *Hypnea musciformis, H. valentiae* and *Acanthophora spicifera* was carried out at Hare Island using monofilament nylon lines. For an initial seed material of 4.85 kg introduced, an yield of 12.85 kg crop was obtained and it was found to be 2.6 fold increase over the seed material.

During July-September, *G. edulis* (38.35 kg) in 21 lines. *A. spicifera* (15.40 kg) in 16 lines, *H. valentiee* (5.90 kg) in 10 lines, *H. triquetra* (20.55 kg) in 13 lines, *G. trinodis* (2.15 kg) in 2 lines and *T. conoides* (13.45 kg) 9 lines were introduced at Hare Island.

During October-December *G. edulis* (11.17 kg) in 16 lines, *H. valentiae* (6.90 kg) in 8 lines, *H. musciformis* (3.80 kg) in 4 lines, *A. spicifera* (5.40 kg) in 6 lines, *H. triquetra* (5.05 kg) in 2 lines and *G. trinodis* (0.65 kg) in 1 line were introduced. The yield was found to be 5.3 fold increase over the seed material introduced. *G. edulis* introduced in November and December and *Hypnea, Acanthophora, Hormophysa* and *Cystoseira* introduced during October-December did not grow.

Marine Pollution in relation to protection of living resources (MBO/MP/1.1)

P. V. Ramachandran Nair, V. Kunjukrishna Pillai, A. G. Ponniah, S. Muthuswamy, R. Marichamy, I. David Raj

The project work was carried out at Cochin and Tuticorin.

At Cochin, trace metal levels in bivalves were investigated.

Four types of bivalve molluscs, *Perna viridis* from Calicut, *Villorita cyprinoides* from Cochin, *Perna indica* from Vizhinjam and *Crassostrea madrasensis* from Tuticorin were collected for a period of three months (October, November and December) and the trace metal levels were estimaed. At Cochin, the clams were collected from three stations to have a comparative study of the heavy metal load in the different parts of the estuarine environment. The soft parts were digested with nitric and perchloric acid and analysed for trace metals viz: Zn, Fe, Cd, Pb, Ni and Co using Atomic Absorption Assay. A total of 43 samples were analysed.

Within the period of study, the data revealed a seasonal trend for some of the metals. At Cochin in *V. cyprinoides* Zn and Cu levels showed a decreasing trend from October to December in all the three stations. The metal load in *P. viridis* at Calicut also showed similar trends for Zn, Pb and Cu. In *P. indica* at Vizhinjam only Pb and Cu showed a seasonal variation in the same pattern. However, in the oyster, *C. madrasensis* at Tuticorin no definite trend of seasonal variation for any of the metal could be observed. But a positive correlation between size of the animal and Cu level were observed ($r = 0.92$).

At Tuticorin, environmental changes due to industrial wastes were observed in selected centres. Five centres were regularly visited. Apart from measuring mercury content, the other essential water characteristics such as salinity, oxygen and pH were also determined and found much variations among different discharging points.

Mercury was in normal levels and low percentage in industrial areas around SPIC and TAC. But the Dharangadhara Chemical Works and Plastic Resin Centre which discharges the industrial wastes contain mercury at higher levels varying from 18 to 200 ng/ml in October 1985. No fish or any fauna were seen inside the lagoon in this month. A fall in pH, fluctuating from 1.20 0to 1.50 was noticed in this month.

Environmental monitoring of aquaculture systems (MBO/MP/1.2)

V. Kunjukrishna Pillai, V. Chandrika, Geetha Bharathan, M. Rajagopalan, K. G. Girijavallabhan, I. David Raj, and S. Alavandi

Regular monitoring of environmental parameters were carried out at the grow out ponds at Muttukkadu Mariculture Centre, Madras. Data were collected for water temperature, dissolved oxygen, salinity, productivity, water transparency, chlorophyll 'a' and pheophytin and nutrients.

Very high temperatures were recorded in the months of April and May (range 31.97 — 33.43). A significant drop of nearly 2°C occurred during June with the onset of South west monsoon. pH of the canal water showed a lot of fluctuation (8.4 to 8.6 during April-May) and 7.7 in September. The pond water did not show much variation except a slight rise in May. Study of diurnal variation in dissolved

oxygen during April-May revealed depletion during early hours of the morning in some ponds. (0.25 to 0.96 ml/l). Salinity in all stations rose in May and dropped in June following rains. Productivity of the waters were very high during April-May but dropped during June and thereafter. Chlorophyll 'a' level was very high during April-May, but low during June and a decreasing trend prevailed until September when an increase occurred. Regarding nutrients, fluctuations in NO_3 and PO_4 trend prevailed during the early part of the period with a peak during August.

There was some drastic environmental changes during November due to cyclonic weather prevailing in the area. There was flooding of the farm during the first half of November. These conditions led to extensive breaching/submergence of most ponds and a drastic drop in salinity. This led to the loss of much of fish stocked.

The rains during November led to a sudden reduction in salinity (from an average of 21 ppt to 10 ppt). This was accompanied by an increase in nutrient levels and by the second half of November very dense blooms of phytoplankton were observed. By the month of December the salinity recorded the normal level and the values for nutrents, productivity and chlorophyll also dropped.

Investigations on pesticide residue analysis in the environment and living resources (MBO/MP/1.3)

V. KUNJUKRISHNA PILLAI, D. VINCENT and K. K. VALSALA

Since both the reporting integrator and the chart recorder were out of order, the Gas Chromatograph unit could not be put into operation for the analysis of the samples. All efforts were made to repair the units. Action has already been taken to import the necessary spares for the reporting integrator. It is expected that the recorder will be repaired by the local representative of the company and available shortly and the work will be continued as early as possible.

Investigations of algal proteins, carbohydrates, lipids, polysaccharides and other chemical constituents (FED/BT/1)

V. S. K. CHENNUBHOTLA and S. MUTHUSWAMI

During this period collection of macro algae were made from six collection centres in and around Mandapam namely Rameswaram, Pamban, Thonithurai, Seeniappa Dharga, Pudumadam and Kilakarai. Totally 32 algae comprising 13 green algae, 7 brown algae and 12 algae were collected. The collected algae were washed in fresh water and sun dried. The dried samples were powdered and used for analysis of carbohydrate, lipid and protein.

In green algae the highest amount of carbohydrate was found in *Ulva reticulata* as 11.26% and the lowest in *Valenciopsis pachynema* as 1.89%. The highest amount of lipid was recorded in *Enteromorpha compressa* as 6.4% and the lowest amount in *Bryopsis plumosa* as 0.04%. The protein content was found to be more in *Cladophora* sp. as 10.8% and the lowest in *Bryopsis plumosa* as 1.97%.

Among the brown algae the carbohydrate was found to be more in *Stachoespermum marginatum* as 6.0% and less in *Padina gymnospora* as 2.74%. The lipid was found to be more in *Stachoespermum marginatum* as 4.9% and less in *Sargassum myriocystum* as 0.36%. In *Sargassum wightii* the concentration of protein was found to be more as 12.54% and less in *Padina gymnospora* as 2.98%.

In red algae *Grateloupia lithophila* showed more concentration of carbohydrate as 16.72% and lesser concentration in *Jania rubens* as 1.6%. The lipid was found to be more in *Acanthophora spicifera* as 4.22% and less in *Jania rubens* as 0.39%. The protein was more in *Grateloupia filicina* as 9.9% and less in *Hypnea valentiae* as 0.97%.

Selection and Genetic improvement of seaweeds (FED/SW/1.4)

N. KALIAPERUMAL, GEETHA BHARATHAN and PRABHAKAR

The life-history of *Gracilaria* sp. has been completed *in vitro*. This is of major significance for future breeding programmes and genetic studies.

The life cycle was completed within 210 days in the first instance. Improving the culture conditions, particularly light, can bring this total time period to 120 days. Tetrasporophytes were found to mature earlier than gametophytes.

Green ~~mutant arose~~ spontaneously as a branch from a normal, red-brown tetraporophyte. Tetra spores from this germinated and developed into male and cystocarpic plants. Study of the inheritance of this trait would add to our basic knowledge of this taxon.

Plants of *G. verrucosa* and *G. edulis* which germinated from carpospores, have not matured in the laboratory. Preliminary experiments varying the salinity regime in *G. verucosa* did not reveal any effect of reproductive maturation in this species. Further work needs to be done in these economically important species.

Experiments conducted on *G. edulis* to study variation in growth revealed no significant individual variations. However, it was observed that plants collected from Thonithurai showed slightly higher rate of growth (0.4% day) than plants obtained from either Krusadai of Hare Islands (0.2 to 0.3% day). These observations need to be followed up to see whether they are of any genetic significance.

Investigation on sediment fertility (FED/Misc./7)

P. V. RAMACHANDRAN NAIR, C. P. RAMAMIRTHAM, A. G. PONNIAH, R. V. SINGH, I. DAVID RAJ, and S. BANIK

Nitrogen, phosphorus and potash were analysed in the samples collected from the Ernakulam — Azhikode, Ernakulam to FACT and Ernakulam to Thykkattussery regions.

On analysing the available nutrients it was observed that the area covered by the project seems to be very fertile and may be considered very

good for undertaking aquaculture activities. Available nutrients — Nitrogen, Potash and Prosphorus analysed were in the range of 39 to 179 kg/ha. 63 to 300 kg/ha. and 9 to 49 kg/ha. respectively.

Under E. R. R. Programme of Orissa: Soil samples were collected from the culture ponds of Brackish water Fisheries Development Agency (Puri-Ganjum Districts of Orissa) were analysed for heavy metals using Atomic Absorption Spectrophotometer. On analysing different values were observed for different clusters. The range for observed values of different heavy metals was 1 to 65 ppm for copper, 19 to 576 ppm for Zinc, 5 to 31 ppm for Manganese and non-detectable to 0.5 ppm for cadmium. This information will be helpful in assessing the inputs required for the ponds around Chilka Lake for undertaking successful culture operation by farmers.

Bioactive Agents from Marine organisms (FED/Misc. 8)

D. Sadananda Rao, R. Sarvesan, D. B. James, K G. Girijavallabhan, C. S. Gopinatha Pillai, P. A. Thomas, K. K. Appukuttan, C. P. Gopinathan and S. Muthuswamy

During the period under review 105 marine organisms were collected from inshore regions of Vizhinjam, Tuticorin and Mandapam in order to screen these organisms for bio-activity. The organisms were identified and they belonged to sponges, alcyonairians, corals, molluscs, echinoderms and flagellates, the following is the list of organisms collected.

All the organisms were cleaned and weighed quantities of parts of these were preserved in ethanol for further extraction prior to bioassays. The extraction of these has been recently completed.

All the organisms, in bioassay on mice, did not exhibit lethality. However, Alcyoniarian and *Trochus radiata* caused initially a slight loss of balance and finally paralysis of the left hind legs of the mice.

Strongest hemolytic activity was shown by *Pocillopora damicornis* (Linn) where as *Dunaliella salina* (red variety), Chromulina Echinoderm brown No. 2 exhibited good hemolytic activity. Mild hemolytic activity was shown by *Pocillopora eudouxii, Nerita, Tertadon* sp. and *D. salira* yellow variety. Hemolytic activity was not at all shown by sea lilly alcyoniarian, *Cellaria radiats* and *Trochus.*

Experiments were conducted at Tuticorin hatchery to study the toxic effect of *D. saline* on the just settled spat of edible oyster and mortality was noticed after 48 hours, revealing the toxic nature of the flagellate, on edible oyster spat. Another test on the fingerlings of mullet and adult edible oysters indicated no harmful effects of *D. salina* even after 96 hours. In the pearl oyster hatchery, larvae of pearl oysters in one rearing tank had mortality due to the blooming of a toxic dinoflagellate which was identified as *Oxytoxum* sp. Attempts were made to isolate and culture this toxic organisms by making use of the inoculum from the rearing tank. Attempts were also made to culture the *Gymnodinium* sp.

found in the "red tide" in the inshore waters of Tuticorin in May 1985.

Manuring/Fertilization of ponds for production of Lab-Lab composed of blue-green algae (FEMD/LL/1)

P. BENSAM

This project newly started at Mandapam, the constituents of Lab-Lab in the natural state in unused ponds was assessed. This has shown that Lab-Lab at Mandapam is chiefly composed of *Phormidium* and Nematodes.

Two experiments were conducted on increasing the production of Lab-Lab, in 800 sq. m ponds. In the first one with cowdung at a manuring rate of 1,500 kg/ha, formation of Lab-Lab was observed after one month.

The increase in formation of *Phormidium* in the first experiment was about 21 times more than in the natural state; and in the second experiment the increase was about two times more than in the first. The increase in the number of nematodes in the natural state and in the second one a little above five times.

Mass culture of micro-algae for use as feed for the bivalve larvae in hatcheries (CMFRI/IDP/20)

C. P. GOPINATHAN, P. MUTHIAH, A. CHELLAM, S. DHARMARAJ, K. RAMACHANDRAN NAIR and J. X. RODRIGO

During the year, the isolation procedure for getting suitable forms of phytoflagellates and other nannoplankters for feeding the larvae of oysters from the waters of Tuticorin Bay was in progress. The serial dilution culture technique employed for the isolation of required species of flagellates. The culture tubes inoculated with less than 10 μ organisms, showed the presence of species of *Nitzschia, Thalassiosira* and few phytoflagellates. From these tubes, one golden yellow coloured flagellate, measuring 8 μ, could be separated out of which *Cryptochrysis fulva*, a member of *Chrysophyceae* is being developed as a pure culture.

The mass culture programme of the Haptophycean flagellate, *Isochrysis galbana* was in progress. During the year, daily 250-300 litres of the pure culture of this flagellate has been supplied to the hatchery for the rearing operation of both edible and pearl oyster larvae. Feeding this flagellate alone, millions of spat settlement occurred in both the hatcheries.

Already isolated phytoflagellates other than *Isochrysis*, such as species of *Pavlova, Dicrateria* and *Chromulina* were tried once again as feed in the case of edible oyster larvae and good results were obtained at the time of settlement of spat.

Application of Remote Sensing Technology in Marine Fisheries (CMFRI/IDP/17)

G. SUBBARAJU, P. V. R. NAIR and A. G. PONNAIH

During April and October, 1985 two sea truth data collection trips were undertaken deploying two research vessels *Matsya Varshini* and

Skipjack from Off Mangalore to off Quilon. 380 samples were drawn from different stations of various depths and analysed for chlorophyll *a*, pheophytin *a*, organic productivity by 14C and particulate matter. Radiance values, and light visibility were also measured by using Quanta Spectrometer and Sechi disc respectively.

Landsat (MSS) imageries were analysed by digital method which enabled to identify algal bloom off west coast of India.

Ecological studies on mangroves (MBO/MS/1.1)

M S. RAJAGOPALAN, G. S. DANIEL SELVARAJ and A. KANAGAM

Ecological studies carried out at Kakinada showed that hydrological parameters in the mangrove areas were chiefly influenced by seasonal rainfall and tidal factors. Estimates of primary productivity showed close relation to the values of Nitrate and Nitrites than to inorganic phosphates — which is derived from land drainage. It was observed that variations in dissolved oxygen and the rate of conversion of organic nitrogen into inorganic nitrogen was rapid during monsoon and post monsoon months and the rate of regeneration slowed down when the suspended load in water was higher than 100 mg/l. It was also observed that organic carton content in the soil and sediments of Godavari mangroves was higher than the Pitchavaram (Tamil Nadu) mangrove areas.

At Cochin ecological studies on mangroves were continued with emphasis on the habitats dominated by *Avicennia officinalis*. The germination of Avicennia seeds and the establishment of seedlings were studied in relation to changes in salinity and tidal inundation factors.

PHYSIOLOGY, NUTRITION AND PATHOLOGY DIVISION

During the year under report, the work was carried out on thirteen projects, which includes seven in nutrition, three in general physiology, two in reproductive physiology and one in pathology. The two projects in nutrition have been completed. The four projects were newly initiated during the year from the month of October, 1985. The findings and conclusions are as under.

PNP/3 — Controlled breeding of grey mullets and *Siganus* species

L. KRISHNAN, M. K. GEORGE and
G. MOHAN RAJ

Emphasis was mainly given to the induced breeding and standardization of techniques especially pertaining to *Mugil cephalus* using spawners. A survey made on the availability of *Mugil cephalus*, spawners in areas around Cochin, showed the occurrence of fairly good number of spawners in Chinese dip-net catches during October to April and June-July period. During the year, 13 breeders of *Mugil cephalus* comprising of 10 males and 3 females were procured alive and transported to the laboratory. Three induced breeding expermeints were carried out. Of these, in the third experiment 95% of the ova attained maturity, eventhough spawning was not achieved. An anti-shock cage designed and developed in the laboratory proved useful in rearing the breeders under hormone treatment and in reducing the stress.

One of the important achievements during the period under report is the successful production of a hybrid between *Liza macrolepis* female and *Liza parsia* male. A total of 1.2 lakh hybrid larvae were produced. The larvae were reared in different salinity media and fed with live feed. A pure bred *Liza parsia* brood was also reared at the same time for comparison. From one batch of hybrid larvae reared in a 2 tonne plastic pool in 10 ppt salinity, nearly 35% survived beyond stocking stage of 40 days. Comparative studies are in progress on the morphology of the hybrid larvae and *Liza parsia* larvae.

PNP/6 — Nutritional requirements of fry and fingerlings of the milkfish *Chanos chanos* and mullets

R. PAUL RAJ. D. C. V. EASTERSON and
D. KANDASAMI

Two experiments were conducted during the year. In the first experiment the effects of selected salinity levels on the food intake, growth and food conversion efficiency in the mullet, *Liza parsia* fry were studied. Salinity levels of water used for the experiment were 5, 10, 15, 20, 25, 30 and 35‰. *Liza parsia* fry were acclimated to the experimental salinities, gradually. The experiment was conducted for a period of seven weeks. A total of 45

fish fry were reared at each salinity level with 15 fish in each replicate. The fish were fed Halvers H-440 test diet, with a moisture level of about 40% at a feeding rate of 8% of the body weight, twice daily. Data on food intake, growth (rate of Gain) and food conversion ratio were recorded for each treatment. The experiment showed that salinity has considerable influence on the growth and feed utilization in *Liza parsia* fry. Among the salinity levels, salinity ranging from 15 to 25‰ produced significantly greater growth rate (119 to 147% mean live weight gain) in *Liza parsia* fry than other salinity levels. The percentage conversion efficiency was also relatively high at the above salinity ranges. However, food intake was relatively less in fish at 5, 30 and 35‰ salinities than fish reared at other salinities. Mortality rates were also found to be relatively high at higher salinities of 30 and 35‰ (30 and 20% respectively). In other treatments, mortality rates varied between 9 to 19%. Thus the experiments showed that salinity levels ranging from 15 to 25‰ are preferable for optimum food intake, growth and conversion efficiency in *Liza parsia* fry.

The second set of experiments was conducted to determine the essentiality to three water soluble vitamins, namely ascorbic acid, choline and inositol in the diets of milkfish fry. Milkfish fry obtained from the Vypeen Island were acclimated on a vitamin free Halvers' H-440 diet for finfiish, prior to the commencement of the experiment. Four isonitrogenous and isocaloric, diets were prepared using purified ingredients. The diets included one control, which had all the essential vitamins and from each of the remaining three diets one of the test vitamin was deleted. The diets were prepared to contain about 40 to 50% moisture and fed to the fish, once daily in the morning. Each of the diet was fed to triplicate groups of fish. The experiment was conducted for a period of over 150 days.

From the results it is evident that all the three vitamins are esential in the diet of the milkfish, *Chanos chanos*. Among these, ascorbic acid deficiency induced a heavy mortality rate of 43%, which was followed by choline deficiency (35%). While the inositol deficient diet produced the mortality rate of 19%, the control produced the lowest mortality rate of 10%. Growth of fish was also significantly affected by the deficiency of the test vitamins.

PNP/9 — Nutritional requirements of penaeid prawn larvae

SYED AHAMED ALI and M. VIJAYAKUMARAN

With a view to evolving a purified formula diet for understanding the dietary nutritional requirements of early stages of penaeid prawn larvae a modified test diet designated as PD-9 was prepared. In this diet a mixture of protein sources consisting of egg albumin, casein, gelatin and fibrin was used in equal proportions. Similarly for the carbohydrates, a mixture of sucrose, maltose and starch was used in equal proportions. The diet was prepared as pellets and dried in vacuum oven at 40 ± 2°C for 24 hours. It was powdered in a pulverizer and sieved through a 37 micron sieve using a sieve shaker.

The microparticulated diet was enriched with two different lipid mixtures. In one of the diets, cod-liver oil, lecithin and sardine oil were used in the ratio 1:1:1. The total percentage of lipid was maintained at 9%. In the second diet cod-liver oil, lacithin, sardine oil and prawn-head oil were used in the ratio 1:1:1:1 at 9% level. These diets are yet to be tested for their biological value in larvae.

Experiments conducted to determine the protein requirement of juvenile *P. monodon* showed that the dietary protein requirement may be about 25% in the dry diet.

PNP/10 — Nutritional requirements of spiny lobsters (*Panulirus* spp)

M. VIJAYAKUMARAN and E. V. RADHAKRISHNAN

The project was initiated in April 1982. In the first experiment a comparative study was made to determine the suitability of a moist and a dry pellet to juvenile *P. homarus*. The observations indicated that the lobsters prefer moist pellets when compared to dry pellets.

In the second set of experiments two test diets were prepared using caseien, glucose, starch, agar-agar, cellulose, cholesterol, shark liver-oil, mineral mixture, vitamin mixture and trisodium citrate. The two test diets were similar in composition but differred in the methods of preparation. For preparing test diet-1, starch and agar agar were dissolved in water and heated for 10 minutes at 80°C in a water bath. All other ingredients were added and mixed thoroughly as the temperature came down to 40°C. The feed was then stored in deep-freeze. For test diet 2, all the ingredients were mixed with hand and heated in an autoclave without pressure for ten minutes. The feed was taken out mixed well again and autoclaved for further 10 minutes. After cooling the feed was stored in deep freeze. Each of the test diets was fed to juvenile lobsters. The results indicated that diet 2 (cooked food) was superior to diet —1. All the subsequent experiment were conducted using cooked food.

With a view to determining the protein requirement of the lobster, five synthetic diets containing protein levels ranging from 0 to 60% were prepared. Biological evaluation of these feeds and a control diet (mussel meat) was carried out by setting up feeding experiments in 40 l plastic containers each with one male and a female juvenile lobster. Since normal lobsters took longer period to complete moult, bilaterally eye-stalk ablated lobsters were also used in the study. The experiment however, was concluded prematurely due to frequent power cut and subsequent mortality of lobsters. Observations made indicated the poor acceptability of the test diets, especially the high protein ones. Besides high protein diets (45 and 60% protein) had poor water stability. Feed acceptance was relatively poor in ablated lobsters, when compared to normal lobsters. Among the test diets those with (45 and 60% protein) gave slightly better results in both normal and ablated lobsters.

Since experiments with purified test diets were not successful as envisaged, it was decided to evaluate the nutritional requirements with semi-synthetic test diets. The semi-synthetic test diets with full supplementation of beef extract and yeast extract powder did not give better performance. But partial supplementation with 25% Squilla meal to casein based diets provided encouraging results.

The project was concluded in December, 1985 due to various constraints.

PNP/11 — Development of artificial diet for rearing of bivalve larvae and spat

D KANDASAMI, P. MUTHIAH and S. DHARMARAJ

Microencapsulated diets were prepared using gelatin as the coating substance. The artificial diets of particle size 2 to 3 micron were prepared. The diet ingredients used were fresh prawn head, trash fish, fish waste and waste from edible oyster and pearl oyster. The diet extracts were used for the preparation of micro-encapsulated diet. The diets were fed to edible oyster and pearl oyster spats at the rate of 80,000 to 120,000 cells per day per spat. Preliminary observations indicated that by using these diets the hatchery rearing period can be reduced by about three days.

PNP/14 — Studies on the pathobiology of soft prawns

P. VEDAVYASA RAO, M. S. MUTHU, N. NEELAKANTA PILLAI, A. LAXMINARAYANA and V. S. KAKATI

The concentrations of copper and protein in the haemolymph of male and female *Penaeus indicus* was recorded. It was observed that in the males of size groups 100 to 120 mm, the copper concentration was varying between 65.45 and 124.55 µg/ml and the protein concentration from 61.7 to 87.1 mg/ml. In the slightly larger size-group males (121-130 mm), the copper concentration was relatively higher (73.9 to 136.4 µg/ml), whereas the protein concentration was low (33.3 to 82.1 mg/ml). In females belonging to the size group 100-146 mm the copper concentration was observed to be between 59.1 and 140.9 µg/ml and protein from 40 to 101.5 mg/ml. There was no appreciable difference in the distribution of these parameters in different size-groups as observed in the males. The ratio of copper to protein was found to be varying between 0.86 and 0.234.

Earlier studies showed that soft-prawns occur in ponds when the ecological conditions of the pond got deteriorated. Following these observations, studies on the distribution of redox potential and occurrence of soft prawns were taken up in Narakkal ponds.

Two ponds stocked with the hatchery reared seed were monitored during June to September 1985. In pond 1, the redox potential ranged from —270 to —341 with an average value of —311.3, in early July when the prawns were in a healthy state. In mid August, when symptoms of 'soft' condition in the stocked ponds were observed, the average Eh value was —294.

The pond II was stocked with *P. indicus* on 20-3-1985. Till the end of

May, the stocked prawns were in healthy condition. On 3-6-1985, the 'soft' condition was observed the Eh of the pond soil varied from —274 to —404 with an average value of —335.6. The higher value was recorded in the middle of the pond. This deteriorated condition of the pond and the occurrence of 'soft' prawns, which varied from 26.3% to 92.5%, continued till September 1985.

In one more pond (Pond 3) a similar pattern in the distribution of redox potential and occurrence of 'soft' prawns was observed. The Eh value remained above —300, when the 'soft' prawns occurred.

The above data were compared with those recorded in different fields during the previous two years.

PNP/15 — Studies on the hepatopancreas of penaeids

D. C. V. EASTERSON and D. KANDASAMI

Variations in the glycogen content associated with the maturation in the hepatopancreas of *P. indicus* and *P. semisulcatus* were studied. In *P. indicus* females, the hepatopancreas constituted 4.13%, 5.47%, 5.05% and 5.15 per cent of the body weight in spent, early maturing, late maturing and matured individuals. The glycogen content was observed to increase during the early maturing stage for its use in the subsequent stages. In males the glycogen much higher than those of females. In content, in the hepatopancreas, was *P. semisulcatus* the glycogen contents recorded in the hepatopancreas were 3.72, 5.39, 6.83 and 4.65 in the maturing, late maturing, matured and spent stages.

PNP/19 — Nutritional requirements of the mud-crab (*Scylla serrata*) larvae and juveniles

D. KANDASAMI and R. MARICHAMI

Test diets composed of chemically semipurified ingredients such as casein, dextrin, fish and vegetable oils (2:1), vitamins and minerals were prepared, using carrageenan as the binder. Diets containing protein levels ranging from 20% to 70% were prepared. The diets were freeze dried, powdered and sieved to obtain particle sizes ranging from 75 to 125 microns. Since the larvae of the mud-crab were not available the experiment could not be conducted. Meanwhile, the project has been suspended due to other priorities of research work assigned to the associates.

PNP/20 — Controlled breeding of milk fish

M. K. GEORGE and A. R. THIRUNAVUKKARASU

Large milk fish caught from pond water were stocked in plastic pools containing sea water for conducting studies on gonad development and maturation by administering a low dose of HCG hormone and fed on a protein rich food.

Fresh stocks of milk fish fingerlings brought from Pamban area of Mandapam were successfully transported with 80% survival rate and are reared in Narakkal ponds.

PNP/21 — Studies on the effect of food additives or attractants for larvae, juvenile and adult prawns

R. Paul Raj, N. N. Pillai and
A. R. Thirunavukkarasu

The project was approved in October, 1985. Some of the essential biochemicals and feed ingredients were procured. Six feeds were formulated using casein, egg-albumin and gelatin as protein source; sardine oil, sunflower oil and soy lecithin as lipid source; sucrose, glucose and starch as carbohydrate source; vitamin and mineral mixture were added as supplements. The amino acid glycine was used in graded levels in these diets. The diets were prepared as pellets, freeze dried and stored in freezer for conducting feeding experiments with post-larvae and juveniles of *P. indicus*.

PNP/22 — Acceleration of maturation of penaeid prawn by nutritional improvement and appropriate feeding strategies.

Syed Ahamed Ali, M. S. Muthu and
A. Laxminarayana

Mantis shrimp, prawn head, clam meat, wheat flour (Maida), fish oil (sardine), prawn head extract, soya bean lecithin, vitamins and minerals were selected for formulation of feeds to feed broodstock of *Penaeus indicus*. Four feeds were formulated and prepared. Feeding experiments on brood stock prawns are being planned. Preliminary experiments indicated that a good binding material is essential in the feed to prevent leaching of nutrients. Some of the binding materials are being evaluated for this purpose.

PNP/23 — A comparison of the capabilities of juvenile and adult *Penaeus monodon* to regulate osmolality concentration in the haemolymph.

A. D. Diwan, A. Laxminarayana and
V. S. Kakati

Experiments were conducted in the laboratory to study the osmotic regulation in adult *Penaeus monodon* exposed to various hypo and hypersaline media. Adult live specimens of *P. monodon* of total length ranging between 180 mm and 220 mm were collected regularly and acclimated to the laboratory conditions for 48 hrs before initiation of experiments. The prawns were exposed to salinity levels ranging from 0% to 45% for 24 hours and 48 hours duration to find out changes occurring in the osmolality concentration of the haemolymph. Simultaneously osmolality concentration of different saline media survived during the experiment and showed significant changes in their osmolality capabilities both for 24 and 48 hours duration. A significant increase in the osmolality of the haemolymph was observed associated with the increase in osmolality of the medium. Thus these results showed that adult *P. monodon* are highly efficient osmoregulators. However, when they were exposed to freshwater, they died within 24 hours. The iso-osmotic point for 24 and 48 hours duration was found to be around $\approx$s. 18.5‰ and $\approx$s. 21.0‰ respectively.

PNP/24 — Distribution of Phenol oxidase enzyme and its role in hardening of the cuticle in penaeid prawns.

A. D. DIWAN and N. SRIDHAR

The project was approved in October, 1985. Some of the chemicals essential for the work were procured. Live specimens of prawns were brought to the laboratory from Marine Prawn Hatchery, Narakkal. Haemolymph was collected using trisodium citrate as anticoagulant and preserved in frozen condition. Tissue extracts of different parts of exoskeleton and hepatopancreas were prepared in phosphate buffer in cold and then used for the estimation of phenol-oxidase activity. The different enzyme substrates used were catechol, phenol and adrenaline. Experiment is in progress.

FISHERY ECONOMICS AND EXTENSIONS DIVISION

Socio-economics of fishermen households and economics of indigenous fishing units at Vizhinjam and Calicut areas of Kerala State (FE & E/1.1)

R. SATHIADHAS and K. K. P. PANIKKAR

Data on fixed cost components of catamarans and canoes along with the gears were collected from 150 units at Poonthura fish landing centre at Vizhinjam area. 20 catamaran units and 20 canoes fitted with outboard motors were selected for detailed study. Information on items like craft-gear combinations, operational cost, landings and value has been collected on day-today basis covering the 3 seasons. The data collection will be completed by July 1986.

In-depth analysis of data collected under a similar scheme at Pudumanikuppam and Thiruvottiyoorkuppam villages was completed. To study the input-output relationship in catamaran operation, a Cobb-Duglas function was fitted with gross income (Y) as dependent and initial investment (X_1) and operational cost (X_2) as independent variables. The fitted function is

$$Y = 36.28 \times {}^{0.15}_{1\ (0.054)} \times {}^{0.61}_{2\ (0.094)}$$

Marginal product with respect to initial investment worked out to 0.32. The acquisition price (interest) of the initial investment of Rs. 100 being Rs. 15, a higher initial investment is found to be profitable.

In the Calicut region, Quilandy fishing village has been selected for a comprehensive survey of small-scale fishery. The survey has been initiated with a complete enumeration of all fishermen households and 20 units each of different craft-gear combinations have been selected for the collection of data relating to costs and earnings on daily basis covering all the seasons.

Economics of mechanised fishing units in Tuticorin and Mangalore areas (FE & E/4.1)

K. K. P. PANIKKAR, T. JACOB and R. SATHIADHAS

The study has been initiated at Tuticorin, Mangalore and Malpe. At Tuticorin, information on daily catch, value and operational costs have been collected from 40 trawlers selected on a sample basis covering 30, 32 and 34-36 footers. The data collection for the first three quarters of the year has been completed. Similar data collection work has been initiated at Mangalore and Malpe from sample units of purse-seiners, trawlers and gillnetters. The field work is in progress.

Economics of different fishing units in Orissa (FE & E/10.1)

K. K. DATTA

A pilot enquiry was conducted in the fishing villages of Orissa to identify the predominant crafts and gears

used as well as the available infrastructure. Four landing centres, two in Balasore district and two in Cuttack district were selected for detailed study.

The major gears in the two districts were trawlnets and gillnets. In Paradweep in Cuttack district which is an important landing centre, over 200 trawlers operate. There are 3 ice plants near the landing centre to cater to the fishermen's needs. The system of payment to the crew vary between regions and within regions. In most of the centres the crew are paid on the basis of daily catches after deducting the owners' share. The disposal of catches are generally done through middlemen.

Data on day-to-day costs and earnings were collected from selected units. The field work has been completed and the data are being analysed.

An evaluative study on the extent of utilization of knowledge gained by women through training programmes in prawn/fish culture (FE & E/12.1)

KRISHNA SRINATH

To assess the extent of utilization of knowledge by women trained in prawn cultuure through the training programmes of the Krishi Vigyan Kendra of CMFRI a study was taken up in March 1985 and the collection, tabulation and analysis of data were completed. The trained women showed favourable attitude towards the KVK and the prawn culture technology, the average attitude scores being 4.3 and 4.15 on a 5-point scale. The constraints involved in the utilization of knowledge were non-possession of suitable holdings, lack of opportunity to work in other's holdings and lack of finance. In general, the trained women felt that the courses being of short duration of 5-10 days was not sufficient to give enough confidence to try the technology.

Cost and returns of dolnet fishery in northwest coast (FE & E/13)

D. B. S. SEHARA

The study on the dolnet fishery economics was undertaken in two marine fishing villages of Maharashtra and one village of Gujarat. In Navagaon (Maharashtra) 'Khamba' system prevails. Wooden logs of different sizes are fixed at 3-4 places at different fathoms for tieing the base ropes and nets. Generally one owner fixes 9-12 logs which cost about Rs. 1 lakh and last for 4-5 years. In Mudh (Maharashtra) 2-3 metres of wooden logs are fixed in mud and floats are arranged with the help of ropes for net tieing. This system is called 'Sus' costing about Rs. 50,000 per unit. At Navabunder (Gujarat) stones are piled at different fathoms and floats are fixed with base ropes. The net is tied with two ends of the rope. This is also called 'sus' system and each sus costs about Rs. 4,000. From each of the three villages costs and returns data were collected from 20 sample units to study the returns to capital and labour. The field survey was completed and the data analysis is in progress.

A study of the role of women in prawn peeling and the infrastructure existing in centralised and decentralised units in Cochin (FE & E/14)

JANCY JACOB

From 200 selected prawn peeling units around Cochin detailed data on the socio-economic level and the working conditions of the women engaged in peeling and extent of infrastructure available were collected. Preliminary results indicated that the infrastructural facilities in centralised units were well above the average score and those of decentralised units were found significantly below average score. Significant differences between centralised and decentralised units were observed in all parameters related with quality control. The analysis of the socio-personal data collected from women revealed their low socio-economic status, medium status of health and hygiene, low motivation and low working climate.

Content analysis of fisheries news in national and regional dailies (FE & E/15)

A. REGUNATHAN

During the period under report, work of collection of data pertaining to three major categories as nature, presentation and subject matter areas of news relating to fisheries under twentyone sub-heads from the selected national and regional dailies, in English, Tamil and Malayalam was initiated.

LIBRARY & DOCUMENTATION DIVISION

Library :

250 books, 1020 periodicals and 150 non-book materials were added to the library at Headquarters during the year. Essentially required books and periodicals were added to the Sectoral libraries at the Regional Centre and Research Centres.

The CAS and SDI Services were continued gaining greater user value. The reprography programme was continued.

Publications :

The following publications were issued during the year :

1. Indian Journal of Fisheries. Vol. 32; Nos. 1, 2, 3, & 4.
2. Annual Reports 1982-83, 1983-84 and 1984-85.
3. Special Publications Nos. 21, 23, 24, & 27.
4. R & D Series for Marine Fishery Resources Management (Hand-outs) Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9 & 10.
5. Marine Fisheries Information Service. T & E Series. Nos. 58, 59, 60, 61 & 62.
6. Newsletter Nos. 27 & 28 and 29 & 30.
7. Research Highlights 1984-85.
8. Souvenir (on the occasion of the inauguration of the permanent buildings of the Institute's Headquarters).

KRISHI VIGYAN KENDRA, NARAKKAL

Dr M. M. THOMAS (Officer-in-Charge),
P. KARUNAKARAN NAIR, K. A. UNNITHAN,
P. K. MARTIN THOMSON, K. N. R. KARTHA,
A. N. MOHANAN, P. RADHAKRISHNAN and
K. PURUSHOTTAMAN

The Krishi Vigyan Kendra of CMFRI continued to function as the vocational training centre at the grass root level conducting need based training courses to small and marginal farmers, landless labourers and unemployed youth to enable them to get acquainted with modern methods of farming.

The main theme of the training has been prawn and fish farming in coastal areas. However, short term training courses were imparted in other subjects such as agriculture, animal husbandry and home science, health and hygiene to create an awareness about the recent developments in these fields.

During the year a total of 786 (269 men and 517 women) benefitted from these courses, the details of which are given in table 16.

Table 16 : Details of training courses organised in 1985-86

Subject	Duration (days)	No. of Courses	No. of trainees Male	Female	Total
Scientific farming of prawns and fishes	5-10	20	156	161	317
Post harvest training	3	2	...	52	52
Integration of prawn culture with paddy	2	1	...	22	22
Eradication of predators, pond construction, fixing, sluice gates, farm management, prawn and fish seed collection and transport, prawn and fish harvesting, marketing etc.	1- 2	7	79	27	106
Other agriculture and animal husbandry subjects	1	12	34	255	289
Total	...	42	269	517	786

II. Other activities :

a. **Survey work :** 293 familities belonging to Cochin, Kanayannoor and North-Parur Taluka of Ernakulam District have been covered under the preliminary survey programme so as to arrange specific training programmes taking into account the training needs of the farmers.

b. **Lab-to-Land programme :**

Bench mark survey of 65 farmers, the beneficiaries of phase III of Lab-to-Land programme of the Institute, was conducted. Prawn/Fish farming integrating Coconut cultivation was implemented in their fields.

c. **Karshaka sammelanam :**

A Karshaka sammelanam was organised on 26th March 1986 participating all the beneficiaries of LLP — Phase III and other interested farmers of the locality.

d. **Film shows :** In all 74 film shows were arranged for the benefit of farmer trainees of KVK at Narakkal and neighbouring villages.

e. **Radio talks :** Four Radio talks were broadcast by the Trichur Station of All India Radio.

f. **Seminar :** The staff of KVK participated in the following seminars:

1) Aquaculture Engineering at CMFRI

2) World Food Day organised by the Nutrition board of Malippuram Village.

3) Brackish water Prawn farming at Tropical Aquaculture Company, Kodungalloore.

4) Functional Literacy programme organised by the NES Block Development Office, Vypeen.

5) Farmers' meet organised by MPEDA at Edavanakkad.

6) Workshop on KVK convened by the Director, CMFRI.

g. **Adoption of schools :** In order to create an awareness among the school children on the farming technology of Prawns and Fin fishes, ten schools of Vypeen island were adopted by the KVK. Screening of films of mariculture interest, free supply of relevant literature and conducting science camps are some of the activities undertaken by the KVK.

h. **Publications :** Four publications (one in English and three in Malayalam) were brought out by KVK.

i. **Meetings :** The Officer in-Charge and staff of KVK attended six meetings at various places.

j. **Exhibition :** Guidance given to St. Mary's High School, Narakkal in arranging exhibition in Prawn culture. Also participated in the All India Exhibition held at Cochin and in the Exhibition organised in connection with the inauguration of new building of CMFRI.

Details of Training Courses conducted under the TTC, Narakkal

Sl. No	Area/ Type of training	Duration	No. of courses	No. of trainees	No. of trainee days	Remarks
1	Hatchery production of edible oyster seed (Tuticorin)	17.2-28.2.86	1	11	132	Conducted at CMFRI Tuticorin
2	Farming of edible oysters (Tuticorin)	12.3-20.3.86	1	7	63	at CMFRI, Tuticorin
3	Sea Weed Culture (Mandapam Camp)	10.2-20.2.86	1	2	22	at CMFRI, Mandapam Camp
4	Hatchery production of marine prawn seeds (Narakkal)	17.2-28.2.86	1	5	60	at Narakkal Prawn Culture Lab. of CMFRI
5	Prawn farming (Narakkal)	10.3-22.3.86	1	4	52	Prawn Cult. Lab. of CMFRI, Narakkal & KVK/TTC Narakkal.

POST-GRADUATE RESEARCH AND EDUCATION

Nine Junior Research Fellows joined the Sixth batch of Mariculture course in the year under the ICAR/ UNDP/FAO Centre of Advanced Studies in Mariculture at this Institute. Nine out of the 10 candidates in the Fourth batch passed the M.Sc., Mariculture Examination conducted by the University of Cochin. All of them had first class and one of them got distinction.

Under the Ph.D. programme 9 Senior Research Fellows in the Fifth batch were admitted. Twelve students belonging to the Second and Third batches have completed their work and the thesis are in various stages of completion. Two students of the earlier batch have submitted their thesis to the Cochin University of Science and Technology for Ph.D. in the year.

Three foreign experts offered consultancy service at the Centre, and 8 scientists had advanced training abroad. Two workshops were organised. FAO Consultants and our scientists on return from foreign training gave a total number of 16 seminars. Besides, 4 special lectures by eminent visiting scientists were held.

Eight Fellows under the CAS Mariculture programme got selection in the Agriculture Research Service Examination held in 1985.

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STAFF POSITION AS ON 31-3-1986

I. Scientists
(Not a gradation list)

Dr. P.S.B.R. James — Director

Scientist S-5

Dr E.G. Silas
(Director upto 24-6-1985)

Scientist S-3 (Rs. 1800-2250)

Dr A.V.S. Murty (Officiating Director 25-6-'85 – 2-9-'85)
Shri T. Jacob
Dr P.V. Ramachandran Nair (Joint Director)
Shri K. Nagappan Nayar
Dr K. Alagarswami
Dr P. Vedavyasa Rao

Scientist S-3 (Rs. 1500-2000)

Shri K. V. Narayana Rao
Dr S. Ramamurthy
Dr M.D.K. Kuthalingam
Shri M. S. Muthu
Shri S. Mahadevan
Dr K. Radhakrishna
Shri K. Rangarajan
Dr K.C. George
Dr G. Luther
Dr K. Satyanarayana Rao
Shri M.S. Rajagopalan
Shri A. Noble
Dr K. Alagaraja
Dr M.M. Thomas
Dr M. Vasudeva Pai
Shri M.H. Dhulkhed
Shri S.K. Dharmaraja
Shri M. Kumaran
Shri V. Balan
Dr (Mrs) P.V. Kagwade
Shri D. Sadananda Rao
Shri P.T. Meenakshisundaram
Dr V.S.K. Chennubhotla
Shri G. Subbaraju
Shri K.A. Narasimham
Shri K.N. Krishna Kartha
Dr C.S. Gopinatha Pillai
Shri V.N. Bande
Dr P. Parameswaran Pillai
Dr K.J. Eapen
Dr V. Narayana Pillai
Dr S.C. Mukherjee
Dr Peer Mohamed

Scientist S-2

Dr K. Venketasubba Rao*
Shri C.P. Ramamirtham
Dr P. Bensam
Shri V.M. Deshmukh
Shri C. Mukundan
Shri G.G. Annigiri
Shri K. Dorairaj*
Dr T. Appa Rao
Dr R.S. Lal Mohan
Shri R. Marichamy
Dr P.S. Kuriakose
Shri P. Sam Bennet
Shri S. Reuban
Dr A.D. Diwan
Shri D.C.V. Easterson

Dr R. Paul Raj
Shri N. Neelakanta Pillai
Shri G. Sudhakara Rao
Dr P.A. Thomas
Shri C. Suseelan
Shri V. Kunjukrishna Pillai
Shri C.P. Gopinathan
Dr K. J. Mathew
Shri R. Sarvesan
Dr V. Sriramachandra Murthy
Dr K. Devarajan
Shri T.M. Yohannan
Shri A.C.C. Victor
Dr P. Nammalwar
Dr K. Rengarajan
Shri C. Muthiah
Dr N. Kaliaperumal
Shri A. Chellam
Shri E.V. Radhakrishnan
Dr (Mrs) S. Sivakami
Dr D.B. James
Dr P. Devadoss
Shri K.K. Appukuttan
Shri K. Narayana Kurup
Shri N.S. Radhakrishnan
Shri J.C. Gnanamuthu
Shri Kuber Vidyasagar
Shri S. Lazarus
Shri A.A. Jayaprakash
Shri G. Nandakumar
Dr E. Vivekanandan
Mrs. Mary K. Manisseri
Dr G. Syda Rao
Dr A. Laxminarayana
Shri P. Muthiah
Dr S. Kulasekhara Pandian
Shri G. Mohanraj
Shri M. Vijayakumaran
Mrs. Rani Mary George
Shri G.S. Daniel Selvaraj
Shri Alexander Kurian
Shri M. Kathirvel
Shri Y. Appannasastry
Shri Pon. Siraimeetan
Shri D.B.S. Sehara
Dr L. Krishnan
Shri A.R. Thirunavukkarasu
Shri Syed Ahamed Ali
Dr M.K. George
Shri K.V. Somasekharan Nair
Shri K.K. Sukumaran
Shri K. Prabhakaran Nair
Shri K. Ramadoss
Dr N. Gopinatha Menon
Dr P. N. Radhakrishnan Nair
Shri K.N. Rajan
Shri R. Thiagarajan
Shri M. Rajagopalan
Shri M.E. Rajapandian
Dr (Mrs.) V. Chandrika
Shri S. Dharmaraj
Shri K.S. Scariah
Shri N. Surendranatha Kurup
Shri G.P. Kumaraswamy Achary
Dr V.S. Kakati
Shri P. Livingston
Shri P.V. Sreenivasan
Shri S. Shanmugham
Shri K. Balan
Shri A. Regunathan
Shri K.G. Girijavallabhan
Shri K.M.S. Ameer Hamsa
Dr M. Rajamani
Shri G. Gopakumar
Shri Madan Mohan
Dr (Mrs) Lalitha Devi
Dr H. Mohamed Kasim
Shri R. Sathiadas
Shri K.K.P. Panikkar
Dr N. Gopalakrishna Pillai
Dr A. Geethanand Ponnaiah
Shri V. Gandhi
Shri A. Raju
Shri M. Srinath
Shri A.P. Lipton
Smt. Geetha Bharathan
Dr George John
Dr K.C. George

Scientist S-1

Shri K.Y. Telang
Shri V. Thangaraj Subramanian
Dr M. Devaraj
Shri K.S. Sundaram
Shri S. Muthusamy
Shri R. Soundarajan
Shri K.R. Manmadan Nair
Mrs. R. Padmini
Mrs. Gracy Mathew
Dr N. Ramachandran
Shri S.K. Chakraborthy
Shri Vinay D. Deshmukh
Shri P.E. Sampson Manickam
Shri S. Krishna Pillai
Mrs. Krishna Srinath
Shri D. Kandasami
Shri D. Sivalingam
Shri M.M. Meiyappan
Shri P. Natarajan
Shri Mohamed Jafar Khan
Shri G. Radhakrishnan
Shri T.S. Velayudhan
Shri V. S. Rengaswamy
Shri I. David Raj
Shri P. Karuppaswamy*
Shri S. Srinivarangan
Shri S.G. Raje
Shri K.K. Datta
Shri M. Sivadas
Shri G.M. Kulkarni
Smt. T.S. Naomi
Smt. K. Vijayalakshmi
Shri M. Aravindakshan
Shri C.V. Mathew
Dr Shyamal Banik*
Shri P. Kaladharan
Miss Jancy Jacob
Shri Mohan K. Zachariah
Shri N. Sridhar
Shri S.V. Alavandi
Shri Prabhakar
Shri P.K. Krishnakumar
Shri P.U. Jachariah
Miss P.M. Molly
Miss Puthran Prathibha
Shri C. Gopal
Shri Veerendra Veer Singh
Shri K.K. Philipose
Miss P.T. Sarada
Shri M. Feroz Khan
Mrs. V. Kripa
Shri Sunil Kumar Mohamad K.
Shri M. Karthikeyan
Shri Abhay Kant Pathak
Shri Bipin Bihari
Shri K. Vijayakumar
Shri P. Jayasankar
Miss M.K. Sanhotra
Miss Jasmine
Shri Ajay Kumar Pandey

Scientist 'S'

Shri P. Dandapani*

II Technical Staff

Field Officer (T-7)

Shri Syed Basheeruddin
Shri S. S. Dan
Shri J. P. Karbari

Field Officer (T-6)

Shri G. Balakrishnan
Shri S. Natarajan
Shri U. K. Sathyavan
Shri R. V. Singh
Shri Varughese Philipose

Curator (T-5)

Shri A. Bastin Fernando

Senior Technical Assistant (T-5)

Shri T. Prabhakaran Nair
Shri W. Venugopalan

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* On lien or deputation to other Institutes.

Senior Technical Assistant (T-4)

Shri K. Ramachandran Nair
Shri A. C. Sekhar
Shri P. S. Sadasiva Sarma
Shri P. K. Mahadevan Pillai
Shri K. Ramakrishnan Nair
Shri R. Bhaskaran Achari
Shri N. Ratnasami
Shri K. C. Yohannan
Shri K. Nandakuamaran
Shri M. Ayyappan Pillai
Shri M. Badruddin
Shri V. K. Balachandran
Shri C. V. Seshagiri Rao
Shri S. Kalimuthu
Shri K. N. Gopalakrishnan
Shri S. B. Chandrangathan
Shri M. V. Somaraju
Shri S. Kandasamy
Shri R. Gurusamy
Shri M. Babu Philip
Shri M. Mohamed Sultan
Shri Jacob Jerold Joel
Shri S. G. Vincent
Shri P. M. Aboobaker
Shri G. C. Lakshmiah
Shri R. Reghu
Shri P. Karunakaran Nair
Shri A. Agastheesapillai Mudaliar
Shri K. K. Balasubramanian
Shri K. P. S. Seshagiri Rao
Shri T. Girijavallabhan
Shri A. A. Thankappan
Shri P. Ananda Rao
Shri T. G. Vijajya Warrier
Smt. K. Koumudi Menon
Shri P. Ramadas
Shri C. T. Rajan
Smt. S. Lakshmi
Shri S. Manivasagam
Shri K. K. Kunjikoya
Shri M. Shriram
Shri S. K. Balakumar
Smt. Geetha Antony

Technical Assistant (T-II-3)

Shri N. P. Kunhikrishnan
Shri A. Hanumantha Rao
Shri C. K. Krishnan
Shri K. S. Krishnan
Shri V. Suresh
Shri K. Soman
Smt. C. Nalini
Shri R. Vasanthakumar
Shri P. Ramalingam
Smt. Abha Kant
Shri B. Narayana Rao
Shri K. Thulasidoss
Shri T. S. Balasubramanian
Shri A. Ganapathi
Shri C. Kasinathan
Shri Joseph Xavier Rodrigo
Shri K. Ramasomyajulu
Dr C. Thankappan Pillai
Shri Joseph Andrews
Shri K. Chittibabu

Technical Assistant (T-I-3)

Shri S. Siddalingaiah
Shri J. R. Ramalingam
Shri M. Najumuddin
Shri K. B. Wagmare
Shri Y. D. Savaria
Shri G. Subramanya Bhat
Shri K. Dhanaraju
Shri V. A. Narayanankutty
Dr K. Muniyandi
Shri L. Jayasankaran
Shri K. Balachandran
Smt. A. Kanagam
Shri D. Sundararajan
Shri D. Vincent
Shri K. P. Viswanathan
Shri V. Sivasami
Shri N. Palaniswamy
Shri T. Chandrasekhara Rao
Shri L. Chidambaram
Smt. Alli C. Gupta

Shri O. M. M. J. Habeeb Mohamed
Shri M. Selvaraj
Dr R. Thangavelu
Shri A. Srinivasan
Shri V. Thanapathi
Shri H. Kather Batcha
Shri S. Palanichamy
Smt. Uma S. Bhat
Shri Sapan Kumar Ghosh
Shri S. Subramani
Shri M. Manickaraja
Shri A. Devendra Gandhi
Shri M. R. Arputha Raj
Shri Hameed Batcha
Shri V. Rangacharyalu
Shri J. L. Oza

Junior Technical Assistant (T-2)

Shri K. Muthiah
Shri K. Ramadas Gandhi
Shri T. Krishnankutty
Shri K. Chellappan
Smt. K. K. Valsala
Shri K. Chandran
Shri Mathew Joseph
Shri M. N. Kesavan Elayathu
Shri K. K. Surendran
Miss T. A. Omana
Shri K. Narayana Rao
Shri M. Chandrasekharan
Shri C. S. Sasidharan
Shri V. Achutha Rao
Shri C. Manimaran
Shri N. Vaithianathan
Shri G. Arumugham
Shri S. Rajapackiam
Smt. P. Swarnalatha
Shri G. Srinivasan
Shri R. Somu
Shri M. Radhakrishnan
Shri M. Chellappa
Shri A. Ramakrishnan
Shri T. Dhandapani
Shri M. Bose
Smt. V. K. Janaki
Shri V. G. Surendranathan
Shri M. P. Sivadasan
Shri J. Narayanaswami
Shri K. T. Thomas
Shri S. Sathya Rao
Shri A. K. Velayudhan
Shri P. Poovannan
Shri P. Venkatakrishna Rao
Shri A. Prosper
Shri C. J. Josekutty
Shri K. Srinivasagam
Shri K. Sahul Hameed
Shri H. Ramachandra
Shri C. K. Dinesh
Shri S. Hanumantharaya
Shri B. Sridhara
Shri D. Nagaraja
Shri J. Bhuvaneshwara Varma
Shri C. H. Ellithathayya
Shri H. K. Dokia
Shri B. P. Thumber
Shri S. S. Chandrasekhar
Shri M. Manivasagam
Shri S. Sankaralingam
Shri N. Chennappa Gowda
Shri H. S. Shivanna
Shri L. R. Khambadkar
Shri M. G. Sivadasan
Shri M. Abdul Nizar
Shri A. Nandakumar

Field Assistant (T-1)

Shri P. Palani
Shri S. Kemparaju
Shri Pulin Behari Dev
Shri A. Ahamed Kamal Basha
Shri S. S. Sugawekar
Shri R. Dias Johny
Shri A. Y. Mestry
Shri O. Thippaswamy
Shri D. G. Jadhav
Shri V. S. Gopal
Shri M. S. Sumithrudu

Shri A. D. Sawant
Shri P. Thirumilu
Shri S. Mohan
Shri H. S. Mahadevaswamy
Shri R. Subramanian
Shri P. Thillairajan
Shri B. B. Chavan
Shri M. Enose
Shri A. Kumar
Shri M. S. Sankar Naik
Smt. Lalitha Sekharan
Shri Sukudev Bar
Shri Y. Muniappa
Shri M. Prasada Rao
Shri J. D. Sareng
Shri S. D. Kamble
Shri B. N. Katkar
Shri T. B. Harikantra
Shri M. S. Suraj Singh Sula
Shri Athipandian
Shri R. Anilkumar
Shri K. Shanmugasundaram
Shri K. Sasidharan Pillai

Senior Technical Assistant (T-4)

Shri Varghese Jacob
Shri G. Krishnankutty Nair
Shri P. Sivaraman
Shri V. Rajendran
Smt. V. P. Annam

Computor (T-I-3)

Shri A. Kanakkan
Shri S. Haja Najeemuddin
Shri C. J. Prasad
Smt. P. L. Ammini

Punch Card Operator (T-2)

Shri K. P. George
Shri M. B. Seynudeen
Shri P. P. Pavithran
Smt. M. R. Beena
Smt. P. T. Mani

Punch Card Operator (T-1)

Shri M. Ramachandran
Shri K. Anandan
Smt. Latha Govind Rao Thote
Shri G. Subbaraman

Motor Driver (T-I-3)

Shri K. Karuppian
Shri P. Krishnan
Shri C. D. Davis

Motor Driver (T-2)

Shri O. Muthukaruppan
Shri G. Natarajan
Shri V. Varadaiah
Shri K. Dharma Rao
Shri K. Ratnakumar
Shri M. Gopinathan Nair
Shri S. Yadavayya
Shri K. Pandi
Shri K. J. Mathew
Shri S. Ramachandran Nair
Shri K. Narayanan Nair
Shri M. N. Appukuttan Nair

Motor Driver (T-1)

Shri P. Pasupathi Rao
Shri K. K. Soman
Shri C. S. Xavier
Shri Govind Nath Chudasama
Shri Xavier Mohandas
Shri K. Alagirisamy

Sr. Library-cum-Documentation Assistant (T-5)

Shri K. Kanakasabapathi

Sr. Library Assistant (T-4)

Shri E. Johnson

Sr. Library Assistant (T-II-3)

Shri V. Edwin Joseph

Library Assistant (T-I-3)
Smt. Girijakumari

Jr. Library Assistant (T-2)
Smt. P. Geetha

Driver (Boat) (T-2)
Shri M. A. Vincent
Shri M. Mohideen Abdul Kader

Driver (Boat) (T-1)
Shri D. Padmanabhan
Shri James George

Serang (T-I-3)
Shri C. K. Dhandapani

Serang (T-1)
Shri H. Vasu

Bosun (T-II-3)
Shri Thomas Teles
Shri Nirmal Mathews

Senior Artist (T-4)
Shri K. L. K. Kesavan

Arstist (T-I-3)
Shri A. Muniyandi

Artist (T-1)
Shri K. K. Sankaran

Photographer (T-5)
Shri P. Raghavan

Driver (Boat) (T-I-3)
Shri M. Mustaffa
Shri S. G. Kalgutkar

Painter-cum-Polisher
Shri R. Marimuthu

Cook (Boat) (T-2)
Shri A. K. Unnikrishnan
Shri K. K. Prabhakaran
Shri E. Sivanandan

Cook (Boat) (T-1)
Shri M. Rengan
Shri Vali Mohamed
Shri K. C. Gopalan

Carpenter (T-1)
Shri T. P. Haridasan

Skin Diver (T-I-3)
Shri A. Dasman Fernando
Shri F. Soosai V. Rayan

Projector Operator
Shri K. Chacko

Deckhand (T-2)
Shri M. K. Gopalakrishnan
Shri K. S. Leon
Shri V. Vedanayagam
Shri P. Munisamy
Shri M. Ibrahim

Deckhand (T-1)
Shri D. Bosco Fernando
Shri D. Anandan
Shri S. Enasteen
Shri R. Arokiaswamy
Shri K. Parasuraman
Shri C. Manibal
Shir S. Kesavan
Shri S. Ganesan
Shri P. M. Abdul Muheedu
Shri R. Sekar
Shri U. Alagamalai
Shri K. C. Devassy
Shri P. M. Hariharan
Shri V. B. Benziger
Shri P. Hillary

Skipper (T-7)
Shri P. R. Leopold

Chief Engineer (T-6)
Shri P. J. Joshy Jacob

Mate (T-6)
Shri P. K. Velayudhan

Bosun (T-4)
Shri P. Ferozhkhan

Shri T. E. George Augustine
Shri B. Ramesh

Deckhand Senor (T-2)
Shri P. Bhaskaran
Shri T. K. Sudhakaran
Shri S .Moideen Meerasa
Shri V. Maria Alwaris
Shir K. P. Vijayan

Oilman (T-2)
Shri T. R. Sreekumaran

Oilman-cum-Deckhand (T-2)
Shri P. D. Chidambaram

Foreman (T-II-3)
Shri P. Thankappan

Technical Officer (T-7) - CAS
Shri K. V. George

Farm Engineer (T-7) - (CAS)
Shri B. S. Ramachandrudu

KRISHI VIGYAN KENDRA, Narakkal

Senior Training Assistant (T-6)
Shri P. Karunakaran Nair
Shri K. Ashokakumaran Unnithan
Dr Martin Thompson
Shri N. Rasachandra Kartha

Training Assistant (T-5)
Shri A. N. Mohanan
Shri P. Radhakrishnan

Training Assistant (T-4)
Shri K. Purushothaman Kani

Bosun (T-II-3)
Shri N. B. Gopalakrishna Menon

Driver (Boat) (T-1)
Shri K. K. Bose

Cook (Boat) (T-1)
Shri K. Raju

Administrative Staff
Administrative Officer
Shri V. K. Sridhar
Shri P. C. Jacob

Asst. Administrative Officer
Shri K. Dorairaj

Asst. Accounts Officer
Shri T. Gopinathan

Superintendents
Shri S. P. L. Sethu
Shri M. P. Lakshmanan
Shri A. Sethubhaskaran
Shri P. Aithappa Naik
Shri M. Subbiah
Shri G. V. Padnekar
Shri A. K. Balakrishna Pillai
Shri S. R. Narayanan
Shri S. Subramanian
Shri N. Rajamuniswamy

P.A. to Director
Shri K. M. Surendran
Shri C. Yohannan