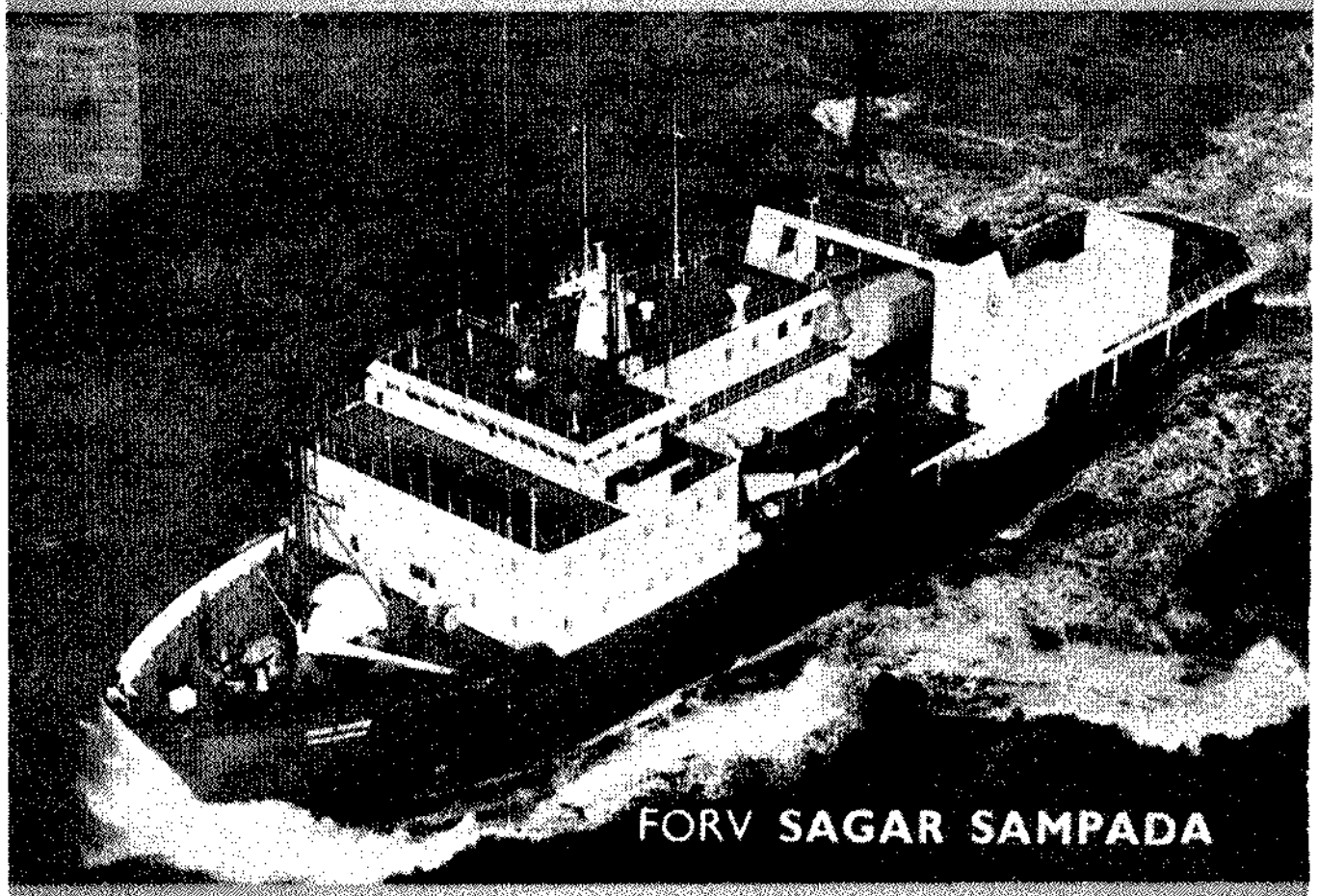
Annual Report

1984-85



FORV SAGAR SAMPADA

Annual Report

1984-85

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
COCHIN
INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Issued by
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Director
Central Marine Fisheries Research Institute
Post Box No. 2704, Cochin - 682 031
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Fishery Oceanographic Research Vessel "SAGAR SAMPADA",
Department of Ocean Development,
managed by Central Marine Fisheries Research Institute

ANNUAL REPORT (1984-'85)

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ANNUAL REPORT 1984-85 DIRECTOR'S INTRODUCTION

During 1984-85 the tempo of progress in both research and development activities of the Institute was maintained. The identification of CMFRI as the nodal contact Institute for planning and organising research cruises of FORV *Sagar Sampada* of the Department of Ocean Development is an important landmark. The Institute diverted its major effort in speedy construction of the headquarter's laboratory-cum-Administrative building and for developing facilities for installation of an Electron Microscope gifted by the UNDP for the Centre of Advanced Studies in Mariculture. Further, development in infrastructure facilities at various subordinate establishments of the Institute, career advancement of scientific and technical staff through 5 yearly assessment etc. where adequately taken care of through appropriate administrative actions. The Institute utilised Rs. 174.01 lakhs under Plan and Rs 176.11 lakhs under non-Plan. During the year the Institute has udertaken 112 Research Projeccts and maintained significant progress in education and training programmes of other projects such as CAS in Mariculture and K.V.K and T.T.C. in Narakkal. The various research projects were implemented by nine scientific divisions of the Institute.

Major highlights during 1984-85 were:

1. The all-India marine fish production during the year was estimated at 1,614,922 tonnes as against 1,583,211 tonnes of 1983-84. While the groups of pelagic fishes contributed 813,718 tonnes, the demersal groups yielded 801,204 tonnes. The contributions of major groups to production were as follows: prawns — 204,000 tonnes; oil-sardine — 165,000 tonnes; Bombay-duck — 125,000 tonnes and mackerel — 40,000 tonnes. The States of Kerala (23%), Maharashtra (19%), Gujarat (18%) and Tamil Nadu (14%) together accounted for 74% of all-India production. The fishery along the west coast had a share of 71% and that along the east coast 29% in the country's marine fish production.

2. Based on the marine fishery data collected in the past years, the population parameters of major exploited stocks for stock assessment was undertaken in respect of prawns, tunas, catfishes and cephalopods. These indicated that the present level of exploitation could be sufficiently increased in the case of tunas, catfishes and cephalopods and a marginal increase in the case of prawns on an all-India basis.

3. Stock assessment studies on oil-sardine, mackerel and anchovies, based on past data, have indicated high potentials and the possibilities of higher productcion from these stocks. Consequent on the large-scale introduction of the purse-seiners in the Karnataka waters and on a limited scale in Kerala, a detailed study was initiated to assess its impact on the artisanal fishery. The studies in Kerala have indicated that there is no tangible direct impact of purse-seining on the artisanal fishery for oil-sardine, at the present level of exploitation and availability.

Studies on the distribution and abundance of the juveniles of pelagic fish have yielded the spatial and temporal indices of their abundance.

Survey of the pelagic resources off West Bengal Coast have revealed fish concentrations between 20 and 50 m depth during September-October. Similar survey off the west coast has indicated that pelagic fish concentrations in January were dense in the area of 13° north and in depths between 40 and 75 metres.

Studies on the fishery and resources of the Indian shad off the West Bengal — Orissa coast were initiated. The fishery trends, biology of *Hilsa ilisha*, handling and storage facilities and the marketing of the catches were investigated.

Studies on the population parameters of *Nemipterus japonious*, the main species of threadfin-bream fishery of the east coast have been made. The estimated yield-per-recruit values have indicated that at Kakinada increased effort under present condition would result in less yield and that greater production from the present grounds is possible only with an increase in size at first capture. At Madras greater effort may be applied to get increased yield without adversely affecting the stock.

5. The average annual stocks of the prawns *Parapenaeopsis stylifera* at Neendakara and *Metapenaeus dobsoni* at Cochin have been assessed. The present status of the fishery shows differential fishing pressure for males and females of *P. stylifera* resulting in favourable recruitment of the species in the fishery, while this is not so in the case of *M. dobsoni*. The study suggests the necessity for reduction in fishing pressure in order to maintain the maximum sustainable yield levels. Stock assessment of important species of prawns in other centres such as Veraval, Bombay, Mangalore, Tuticorin, Madras and Puri has also been carried out.

6. A detailed analysis of the catch and biological data of deep-sea prawns from 100-450 m depth along the south-west coast of India between Cape Comorin and Bhatkal has been carried out during this period, based on 1187 bottom trawl hauls taken by the Government of India exploratory fishing vessels which surveyed this region during 1965-1979. A total of 22 species of prawns have been observed in the catches, of which five species of pandalids, two species of aristeids, two species of solenocerids and four species of penaeids are found to occur in commercial quantites. The pandalid *Heterocarpus woodmasoni* forms the mainstay of the fishery.

7. The potential resource of deep-sea prawns that could be commercially exploited from the 'Quilon Bank' and off Ponnani has been estimated to be about 5,300 tonnes from a productive area of about 5,000 sq. km. The winter season extending from December-February is found to be the peak period of abundance. The deep-sea prawn population in the area south of Cochin is predominantly constituted by pandalid species, while between Cochin and Bhatkal the penaeids and artisteids predominate.

8. Remote sensing in marine fisheries, using space technology, has been

successfully applied on the west coast. This will enable the estimate of the potential stocks through chlorophyll scanning from aircraft-mounted Ocean Color Radiometer (OCR), Coastal Zone Colour Scanner (CZCS) of American Satellite and also LANDSAT imageries available with NRSA coupled with sea truth measurements. A case study was conducted for Cochin Zone and it is observed that water columns having about 15 mg/m^2 chlorophyll can sustain an yield of over 250 kg/ha/year of fish inclusive of both demersal and pelagic resources.

9. Results of cruises of research vessels FORV *Sagar Sampada* and RV *Skipjack* have indicated the availability of juveniles of oceanic squid *Symplectoteuthis oualaniensis* and adult squids and cuttlefishes upto depths of about 300 m.

Cephalopod production from inshore waters amounted to 24,097 tonnes recording an increase of 30% over the previous year, the production being the highest so far. Kerala's cephalopod production increased by about 327% from previous year. Further data on stock assessment of important species of squid and cuttlefish were collected.

10. The screening of 40 organisms of echinoderms and algae for bioactivity was conducted for lethality, toxicity, hemolytic activity and antimicrobial activity. These assays revealed that *Holothuria atra, H. spinifera* and *Bahadshia marmorata* (both cuverian tubules and body wall) exhibited lethality and a high degree of toxicity to fish (*Chanos* and *Tilapia*) fingerlings and mice. These also showed strong hemolytic activity.

Isolation of the chemical constituents from *H. spinifera* and *H. scabra* has yielded microquantities of two crystalline compounds, the purification and identification of which is under progress. A total of 104 marine organisms of molluscs, sponges, corals and echinoderms are being assayed for the above bioactivities.

11. The geographic distribution and abundance of krill *(Euphausia superba)* of the Antarctic Ocean between 67°30' S and 68°30' S and longitudes 14°E and 20°E have been estimated. The average abundance for the area in the upper 150 m of water column has been found to be 212 numbers per 1000 m^3 of water. In the area investigated it has been observed that the krill swarmed at some places. Their distribution at the different stations varied between 10 and 1032 numbers per 1000 m^3 of water. The occurrence and abundance of other zooplankters of the above mentioned area have also been studied.

12. With the help of FORV *Sagar Sampada,* extensive data on fishery hydrographic parameters as well as the distribution of forage organisms both in space and time in the EEZ have been collected.

13. At the Narakkal Prawn Hatchery Laboratory, the hatchery technology for the production of marine prawn seed has been standardized and manual has been published on the subject, including details about hatchery site selection, hatchery equipment and layout, induced breeding techniques, larval rearing techniques, preparation of live and artificial feeds for the larvae and economics of operation of a commercial hatchery.

At the Kovalam/Muttukad field laboratories near Madras, the Japanese prawn *Penaeus japonicus* has been reared to adult size in the farm, induced to mature and spawn in captivity and the larvae successfully reared to juvenile stage, thus starting the second captive generation in the farm. This 'domestication' of *P. japonicus* in the farm is a major breakthrough.

Larval rearing techniques for *Penaeus semisulcatus* have been perfected at Mandapam Camp/Tuticorin and about 600,000 post-larvae produced were released into the Palk Bay under sea ranching programme. The necessity of providing a substratum of seaweeds for the successful survival of the post-larvae and juveniles of this species has come to light during the course of these researches.

A technique for artificial insemination of *P. indicus* and *P. monodon* has been developed. The improvements made in the technique during the year have increased the hatching rate of eggs from 3% to 90%.

14. In the culture of oyster, *Crassostrea madrasensis*, emphasis was given to development of low-cost technology for production. Stake culture and ren culture methods were introduced. Broadcasting of spat laden tiles was carried out. The average spat settlement was 15/tile and 5.9/oyster shell in the main spawning season (April-May) and 9/tile and 5.8/shell in the secondary season (August-October). Oyster culture programme was initiated at Karwar.

The natural population of pearl oyster *Pinctada fucata* in the 'paars' of Gulf of Mannar were monitored through sample survey. The shoreward 'paars' were more productive than the offshore ones. While *P. fucata* formed 87.6% of the population, the flat oysters formed the rest. The farm oysters showed growth in length only during November-March, while growth in thickness was observed to be continuous. Pearls produced at 5 m depth were found to be qualitatively better than those produced in the upper layers.

15. Further progress was achieved in standardising the hatchery technology for mass production of seed of pearl oyster *(P. fucata)* and edible oyster *(C. madrasensis)*. In two rearing of pearl oyster larvae 640,000 and 600,000 spat were produced. Spat setting rate was 16.7-34.2% at larval density 2/ml, 3.9-18.4% at 3/ml and 15.3-19.2% at 4/ml. Spat setting was achieved on day 14. During October-December larval rearing was not possible due to adverse environmental conditions brought about by a strong north-east monsoon.

16. Edible oyster spat production reached about 950,000 in an experiment. Spat settlement was obtained between days 13-25. Lime-coated tiles proved most successful as spat collectors. Oyster shells had a spot density of 40/shell. Induced maturation of pearl oyster and edible oyster was achieved through feed manipulation using *Chlorella* mixed phytoplankton and corn flour.

17. For the first time the cuttlefish *Sepia* sp. has been successfully reared from egg to adult. The hatchlings of size 5-8 mm had grown to 175 mm mantle length in about 6 months. Mating was observed among the laboratory reared adults and egg deposition by the female was noticed.

18. Feeding experiments to elucidate the optimum nutrient requirements for the fingerlings of *Liza macrolepis* showed that the diet containing 40% of protein, 40-50% of carbohydrate and 3% of lipid gave the optimum growth and survival. In the case of juvenile *Penaeus indicus*, however, 6% lipid content in the diet was found to be necessary for optimum growth. Increasing lipid level beyond this had no beneficial effect on the growth and food conversion ratio in this prawn.

19. The Institute has conducted several case studies on fishery economics. This indicated that in traditional paddy-cum-prawn culture in Kerala, the culture of selected species of prawns with improved techniques would help in enhancing prawn production and better remuneration. Socio-economic condition of fishermen in Kerala, Maharashtra and Gujarat pointed that adequate credit facilities to fishermen through Co-operative Societies and Rural Banks would help in reducing their dependence on local money-lenders for their credit needs towards operational cost.

20. Under the programme of Centre for Advanced Studies in Mariculture, in M.Sc. (Mariculture) 31 candidates were trained between 1980 and 1984, 18 candidates are currently undergoing the course. In the Ph.D. programme, 11 scholars completed the research work; two of them were awarded the degree. The works of other candidates are in the advanced stage of completion and finalisation of thesis. Twenty eight research scholars are currently working under the programme.

Under the Expert Consultancy programme, so far 11 experts, one each in the field of reproductive physiology, fish and shell-fish nutrition, invertebrate tissue culture, marine fish genetics, crustacean physiology, culture of live food organisms, oyster biology and culture, water quality management in aquaculture and environmental physiology and two experts in fish pathology visited the Centre utilising 11.5-man-months. In the programme of training of faculty members, 23 scientists were so far sponsored for training in as many subject matter areas utilising 99 man-months.

21. During the year the Institute has published the *Indian Journal of Fisheries* Vol. 31, *CMFRI Bulletin* No. 31 and four *CMFRI Special publications* on topics of current interest. Other publications include *Marine Fisheries Information Service*, T & E series and *CMFRI Newsletters*.

P. S. B. R. JAMES
Director

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 came under the control of ICAR in 1967. The headquarters of the Institute is at Cochin and it has a Regional Centre at Mandapam Camp, Tamil Nadu. Besides these the Institute has established 11 Research Centres and 29 Field Centres on both the coasts. Field experimental stations are located at Narakkal, Kovalam, Tuticorin, Mandapam, Vizhinjam and Calicut.

The *objectives* of the Institute are to conduct short-term and long-term multidisciplinary researches on the marine capture and culture fisheries of the country in order to provide *Research* support for the rational exploitation, conservation and management of the marine and brackishwater resources for stepping up production from the coastal water areas and the Exclusive Economic Zone and *Development* support for growth with stability of the industrial, artisanal and culture fisheries through transfer of technology, dissemination of information and *education, training* and *extension.*

Implementation of the projects :

With the new Divisions coming into being during 1982-83, the research projects/problems undertaken during the year were implemented by the following 9 Divisions :

1. Fishery Resources Assessment Division
2. Fishery Economic & Extension Division
3. Pelagic Fisheries Division
4. Demersal Fisheries Division
5. Crustacean Fisheries Division
6. Molluscan Fisheries Division
7. Fishery Environment Management Division
8. Physiology, Nutirtion and Pathology Division
9. Library & Documentation Division

Facilities added during the year

1. Acquisition of farms for mariculture, construction of laboratory buildings, hatcheries, procurement of equipment indigenously and from abroad.
2. Availability of FORV *'Sagar Sampada'* of the DOD for research cruises.

Finance :

The actual expenditure incurred by the Institute both under plan and Non-Plan during the financial years 1980-81 to 1984-85 are as follows:

Year	Non-plan	Plan
1980-81	1,02,65,008	68,64,072
1981-82	1,15,00,502	1,16,35,935
1982-83	1,33,08,785	1,85,07,185
1983-84	1,53,74,835	1,78,45,262
1984-85	1,76,11,062	1,74,01,123

Advisory/consultancy service provided :

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

1. Member on the joint ICAR-ICSSR Scientific panel for Social Science and Agricultural Extension.
2. Member, Programme Priorities and Cruise Committee for the National Institute of Oceanography, Goa.
3. Member, Research Advisory Committee of the Kerala Agricultural University, Trichur.
4. Member, Central Advisory Committee on Exploratory Survey of Marine Fisheries.
5. Member, Tamil Nadu State Fisheries Research Council.
6. Member, Regional Committee No. 8 (Constituted by the Governing Body, ICAR).
7. Member, Scientific Panel for Fisheries Research, ICAR.
8. Member, Kerala State Fishery Advisory Board.
9. Member, in the Committee on Fisheries and other Aquatic Resources of the State Committee on Science and Technology, Kerala.
10. Member, Central Government Employees Co-ordination Committee, Cochin.
11. Member, Technical Committee of the Marine Products Export Development Authority, Cochin.
12. Member, Editorial Committee for 'Indian Seafoods' of the Marine Products Export Development Authority.
13. Member, Sub-Committee of the Indian Board of Wildlife.
14. Member, Management Committee of Central Agricultural Research Institute, Andaman & Nicobar Group of Islands, Port Blair.
15. Member, Director of the Board of Directors of the Andhra Pradesh Fisheries Corporation Ltd., Kakinada.
16. Member, standing Scientific Evaluation and Implementation Committee for the Zoological Survey of India.
17. Member, Constitution of the Consultative Group of CIFNET.
18. Member, National Mangrove Committee constituted by the Department of Environment, Government of India.
19. Member of the Committee to consider the question of introduction of new species of fish into the country.
20. Member, Scientific Advisory Committee of Bombay Natural History Society.
21. Member of the Committee for Development of National Marine Park.
22. Convener of Standing Committee on Local Level Fishery Resources Survey constituted by the Department of Agriculture and Co-operation.
23. Member of the Cruise Planning and Programme Priorities Committee for ORV *Sagar Kanya* and and FORV *Sagar Sampada*.

24. Member of the Research and Advisory Council of National Institute of Oceanography, Goa.

25. Member of the Senate, University of Cochin.

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

27. Member of 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.

Engagements :

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

Meeting of the Secretary, Department of Ocean Development with the Director General, ICAR on FORV Sagar Sampada Programme, 11 April.

First meeting of the National Mangrove Committee at the Department of Environment, Government of India New Delhi, 17 May.

Meeting of the ICAR Panel for Fisheries at New Delhi, 3 July.

Meeting of the Directors of Fisheries Institutes and Project Co-ordinators under ICAR at New Delhi, 4 July.

First Meeting of the Research and Development Forum on Fisheries at ICAR, New Delhi, 5 July

Meeting of the Sea Turtle Specialist Group of the Department of Environment at New Delhi, 11 July.

Workshop on Reorientation of Zoology Programme at Madras University at the Christian College, Madras, 12 July.

Meeting convened by the Department of Ocean Development regarding finalization of national cruise programme of research vessels *Gaveshini, Sagar Sampada* and *Sagar Kanya* at New Delhi, 10 July.

Meeting of the ICAR Adhoc Committee to examine the norms of recurring contingencies during the VII Plan at New Delhi, 17 August.

First meeting of the Committee on Introduction of Exotic Fishes at CIFRI Barrackpur, 19 August.

Meeting of the Committee constituted by the Director General, ICAR under the chairmanship of Deputy Director General (Education) for formulation of policy for ICAR publications at Delhi, 25 August.

Meeting of the Director General, ICAR with the Secretary, Department of Agriculture regarding Pelagic Fisheries Laboratory at New Delhi, 10 September.

Meeting of the Standing Committee for co-ordinating the function of the Fisheries Istitutes under the Ministary and ICAR at New Delhi, 10 September.

Meeting of the Bureau of Fish Genetics Resources for deciding organizational set up at Allahabad, 10 September.

ICAR Directors' Conference, 26-27 October.

Meeting on establishment of Brackishwater Fisheries Research Institute and National Centre for Coldwater Fisheries Research at New Delhi, 14 November.

Meeting convened by the Secretary, Department of Agriculture regarding permitting pair trawling operation in EEZ by chartered foreign vessels and the feasibility of conducting bull trawling operations, at New Delhi, 27 November.

Meeting of the ICAR Scientific Panel for Fisheries, at New Delhi, 12 December.

Meeting of the Committee to suggest specific narrow disciplines on fisheries for inclusion in the Agricultural Research Service disciplines, at New Delhi, 13 November.

Dr. P. V. Ramachandran Nair, Scientist S-3 attended the Inter-Agency Workshop for preparing cruise plans of ORV *Sagar Kanya* and RV *Gaveshini*, 2-4 July.

Dr. K. Alagarswami has been nominated as a member, Board of Directors of the Tamil Nadu Pearls (Pvt.) Ltd.

Dr. S. Ramamurthy, Scientist S-3 attended the Meeting of Fishery Survey of India, Headquarters Consultative Group at Bombay, 10, October.

Dr. Ramamurthy also convened the meeting of the State Level Committee for Coordination of Marine Fisheries Work in Maharashtra, 21 December.

Dr. K. Radhakrishna, Scientist S-3 and Shri G. Sudhakara Rao, Scientist S-2 participated in the training programme organised by the Export Inspection Agency at Waltair and gave lectures on Oceanography and Fisheries of Andhra Pradesh, 27 June.

Dr. K. Satyanarayana Rao, Scientist S-3 participated in the management training at NAARM, Hyderabad, 18-28 September.

Dr. K. Satyanarayana Rao, Scientist S-3 participated in the workshop organized by ICAR on Operational Research Projects at the National Academy of Agricultural Research Management, Hyderabad, 29-31 October.

Shri G. Subbaraju, Scientist S-2 has been nominated to serve as member of Peer Group VI on Oceanography, Marine Resources and Coastal Engineering of National Natural Resources Management System (NNRMS).

Shri Subbaraju has also been nominated to serve as member of Planning Commission's Task force on Remote Sensing in Oceanograpl Marine Resources Management and Cost Studies.

Shri G. Sudhakara Rao, Scientist S-2 participated in the 5th meeting of the Consultative group for Calcutta Base, Fishery Survey of India, 14 May.

Smt. V. Chandrika, Scientist S-1 attended the Seminar on Pollution Problems organised by the Kerala State Pollution Control Board and Department of Forests, Kerala at FACT, Ambalamedu and presented a paper on Distribution and significance of faecal indicator organisms in bacterial pollution in and around Cochin, 5 April.

Distinguished visitors to the Institute Headquarters, Cochin

1. Union Minister of State for Rural Development Shri Chandulal Chandrarkar accompanied by Shri P.K. Velayudhan, Minister of Community Development, Kerala State vi-

sited CMFRI Headquarters at Cochin on 24th May, 1985.

2. Dr. Albert C.J. Tacon, Fish Feed Technologist, Aquaculture Development Co-ordination Programme of FAO.
3. Ms. Dina Vakil, Regional Information Officer for Asia and Pacific, UNDP, New York.
4. The FAO Evaluation Mission.
5. Dr. E. Bo. Jadziski, FAO Representative in India and Shri Radhakrishnan, Programme Asst., UNDP, New Delhi.
6. Mr. M.J. Priestly, UNDP representative in India.
7. Miss Marie — Helene Durand, Agro Economist, Orstom, Paris.
8. Cmde. K.M.V. Nair, Tata Oil Mills Co. Ltd., Madras.
9. Shri S. Seshadri, Branch Manager, S.T.C. of India, Tuticorin.
10. Shri Joy Ine Kurian, MPEDA, Tuticorin.
11. Shri M.R. Krishna, Chairman, National Shipping Board, Govt. of India, Madras.
12. Col. Iqbal Singh, Group Cdr., NCC, Madurai.
13. Capt. Mathew, Naval Base, Cochin
14. Shri K.N. Narayanaswamy, Processing Manager, Madura Coats, Amba Samudram and 100 Staff members of the Unit.
15. Dr. A. Sasidharan, M. G. College, Trivandrum.
16. Dr. R. Jindal, Dept. of Zoology, Punjab University, Chandigarh.
17. Mr. E. G. Sagoy, FAO Research Fellow, Federal Dept. of Fisheries Lagos, Nigeria.
18. Shri R. G. Nair, Scientist, CIFT, Cochin.
19. Capt. K.A. Ponnappa, Barber Ship Management, Hong Kong.
20. Shri C.R. Arasaraturam, Technical Manager, Indian Oil Corporation Ltd., Tuticorin.
21. Shri S. K. Venkataraman, Asst. Director of Fisheries, Staff Training Institute, Madras.
22. Shri R. Varadachari, Regional Manager, PTI, Madras.
23. Dr. S. Bandhopadhyay and Shri A. Mitra, Assistant Professors in Aquaculture Section at the Indian Institute of Technology, Kharagpur.
24. Dr. Amal Datta, Member of Parliament.
25. Shri B. R. Kalra, Deputy Commissioner (FE), Department of Agriculture, Government of India, in connection with collection of data for EEZ Mission to India.
26. Dr. A. G. Kalawar, Kerala Fisheries Expert Committee, "Ban on Trawling" — Kalawar Committee.
27. Mr. Wilfred Vogeler, Minister, Embassy of Federal Republic of Germany, New Delhi.
28. Dr. Pastor Torres, Director, Training and Extension, SEAFDEC Acquaculture Department, Iloilo, Philippines.
29. Dr. A. V. Raman, Dept. of Zoology, Andhra University, Waltair.
30. Dr. A. G. Statwal, Course Director 2nd UNDP / UNESCO Training Course on Mangrove Ecosystem.
31. Shri K. Thayaparan, Director, Inland Fisheries, Ministry of Fisheries, Sri Lanka.
32. Dr. S. D. Raj, Zonal Co-ordinator, Lab-to-Land Programme Zone VIII Bangalore.

Mangalore Research Centre :

1. Shri Rasheed A. Bolar, Bolar Fish Farms, Kankanady, Mangalore.
2. Shri N. V. Sripathy, Project Co-ordinator, CFTRI, Fish Technology Experiment Station, Mangalore.
3. Shri P. Sulochanan, Joint Director (Fisheries), Fishery Survey of India, Bombay.
4. Shri B. Laxman, Agriculture Project Officer, Syndicate Bank, Karnataka Regional Office, Mangalore.
5. Shri B. Venkatesh and Shri Raghavendra, Development Officers, NABARD, Bangalore.
6. Shri B. Jacob, Deputy Director, Export Inspection Agency, Mangalore.
7. Shri P. M.Madhusudhan, Professor and Head of Zoology Department, Shree Narayana College, Nattika.

Tuticorin Research Centre :

1. Shri A. Sambandamoorthy, Rural Development Officer, Tuticorin.
2. Shri S.A. Gani, Superintending Engineer, Tamil Nadu Electricity Board, Tirunelveli.
3. Ms. Tessa Sabright, Harley-on-Thames, U.K.
4. Mr. Daird Huggins, J & B Company, Glasgow, Scotland.
5. Shri K. K. E. Menon, Tata Oil Mills Ltd., Coimbatore.
6. Shri Sathyamoorthy, Assistant Director of Fisheries, Madras.
7. Shri V. Ramamoorthy, Assistant Director of Fisheries, Staff Training Institute, Madras.
8. Prof. Dr. S. C. Bargava, Indian Agricultural Research Institute, New Delhi.
9. Dr C. P. Wood, Tropical Development and Research Institute, London.
10. Professor S. Krishna Swamy, School of Biological Sciences, Madurai Kamaraj University, Madurai.
11. Shri R. Ananthapadmanabhan and Shri P.P. Siva Sankaran, Indian Oil Corporation, Madurai.
12. Shri K. Nair, Keltron, Trivandrum
13. Shri Jacob Cherian, Christian College, Chengannur, Kerala along with 30 students.

Mandapam Regional Centre :

1. Union Minister of State for Rural Development Shri Chandulal Chandrarkar visited the Mandapam Regional Centre on 12th June 1985.
2. Shri R. K. Trivedi, Chief Election Commissioner, Govt. of India.
3. Shri M. Krishnan, Consultant, Tamil Nadu National Wild Life Action Plan.
4. His Excellency the High Commissioner for Malaysia in India Mr. Razate bin Ismail.

Bombay Research Centre :

1. Mr. Boan Soung and his group, Livestock Department, Laos.
2. Mr. R.N. Morris, Hay St. East Perth, Western Australia.
3. Shri H. C. Hingaroni, Principal, Central Institute of Fisheries Education, Bombay.
4. Dr. (Mrs.) B. I. Maharajan, Indian Institute of Technology, Bombay.

Veraval Research Centre :

1. Shri M. R. Nair, Director, CIFT, Cochin.

Particulars of Scientists deputed abroad from 1-4-1984 to 31-3-85 (1984—85)

Sl. No.	*Name and present Designation*	*Purpose*	*Period*
1.	Shri V. Kunjukrishna Pillai, Scientist S-2	To undergo training in the field of 'Water quality Management' under UNDP fellowship at Alabama, U.S.A.	6 months from 26-3-84
2.	Shri M. Vijayakumaran, Scientist S-2	To undergo training in the field of 'Aquatic Patho-Biology' under FAO/UNDP programme in Stirling, U.K.	5½ months from Sept. 84.
3.	Shri Madan Mohan Scientist S-2	To undergo training in 'Fishery Biologist Course under FORV Programme in Denmark.	2 months from Oct. 84.
4.	Shri T. E. George Augustine, Bosun (T.II.3)	To undergo training in Master Fisherman Course in Denmark under FORV Programme.	" "
5.	Dr. A. Geethanand Ponnaiah , Scientist S-2	For training in the field of Marine Fish Genetics at the Fisheries Lab. Lowestoft, England under FAO/ UNDP Programme.	6 months from 10-10-84
6.	Dr. K. Alagarswami Scientist S-3	Deputed abroad as leader of the cruise FORV Sagar Sampada form Denmark to India.	7-11-84 to 30-12-84
7.	Shri K. K. Prabhakara Panicker, Scientist S-2	For training in the field of 'Aquaculture Economics' in the University Pertanian Malaysia under FAO/ UNDP Programme	From Jan. to May 85
8.	Shri E. V. Radhakrishnan, Scientist S-2	To undergo training in Lobster Culture in the Tulane University, New Orleans, USA under FAO/ UNDP Programme.	6 months from 10-1-85

PROGRESS OF RESEARCH

FISHERY RESOURCES ASSESSMENT DIVISION

Estimates of annual marine fish production during 1984-'85 stood at 1.61 million tonnes. Contribution from commercially important groups on regional basis has been estimated for use in stock assessment studies. Levels of maximum sustainable yields for *Parapeneopsis stylifera* and *Metapenaeus dobsoni* for Sakthikulangara and Cochin regions have been worked out. Steps have been taken 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.

Acquisition 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 1984-85 has been provisionally estimated at 1.61 million tonnes. Compared to the landings of 1.58 million tonnes in 1983-'84, the landings during the period under report has recorded a marginal increase of about 2%.

Among the commercially important varieties of fish, oil sardine accounted for 10.2% of the whole landings in 1984-'85 against 11.4% of 1983-'84. Penaeid prawns landings contributed 8.1% against 7.4% of previous year. Bombay duck accounted for 7.7% against 6.0% of previous year. 4.6% of landings was accounted for by non-penaeid prawns which was 3.2% in 1983-'84. *Stolephorus spp.* contributed 4.5% against 5.7% of previous year.

Pelagic and Demersal groups of fishes :

During 1984-'85 palegic species contributed to about 814,000 tonnes accounting for 50.4% of the total landings while 49.6% came from demersal fishes including crustaceans. Table I shows the landings of palegic and demersal fishes.

Table 1: Marine fish landings in India

	1984-'85	1983-'84
Pelagic	813,718	779,977
Demersal	901,204	803,234
TOTAL	1,614,922	1,583,211

The landings of pelagic species has increased by about 34,000 tonnes (4.3%) while the contribution from demersal species declined marginally by 2,000 tonnes.

Estimated landings of various pelagic species are provided in Table-II (a).

Table II a. Estimated Landings of various Pelagic Species

Sl. No.	*Pelagic fishes*	1984-'85	1983-'84
1.	Clupeids		
a)	Wolf herring	18,418	16,635
b)	Oil sardine	165,291	180,081
c)	Other sardines	68,457	76,841
d)	Hilsa shad	9,607	4,023
e)	Other shads	14,962	21,256
f)	Anchovies		
	Coilia	24,272	18,090
	Setipinna	3,229	3,382
	Stolephorus	72,696	89,802
	Thryssa	20,202	17,887
g)	Other clupeids	42,987	35,208
2.	Bombay duck	124,947	95,441
3.	Half beaks & Full beaks	1,710	2,603
4.	Flying fish	2,705	1,483
5.	Ribbon fishes	52,318	39,488
6.	Carangids		
a)	Horse mackerel	4,316	3,093
b)	Scads	11,520	9,160
c)	Leather-Jackets	13,515	9,577
d)	Other carangids	28,015	29,099
7.	Mackerel		
a)	Indian mackerel	40,331	33,516
b)	Other mackerel	102	89
8.	Seer fishes		
a)	*S. commerson*	17,616	13,433
b)	*S. cuttatus*	16,218	21,900
c)	*S. lineolatus*	186	286
d)	Acanthocybium ssp.	44	201
9.	Tunnies		
a)	*E. affinis*	11,384	11,079
b)	*Auxis* ssp.	1,525	2,596
c)	*K. pelamis*	3,624	2,651
d)	*T. tonggol*	186	11
e)	Other tunnies	3,216	2,692
10.	Bill fishes	1,479	758
11.	Barracudas	3,905	3,598
12.	Mullets	4,293	3,408
13.	Unicorn Cod	2,569	452
14.	Miscellaneous	27,873	30,158
	TOTAL	813,718	779,977

Among the major pelagic fishes, oil sardine contributed 165,000 tonnes accounting to 20.3% of the whole pelagic fish landings. Bombay duck accounted for 15.4%; *Stolephorus ssp.* for 8.9%; other sardines for 8.4%; carangids for 7.0%; ribbon fishes for 6.4% and mackerel for 5.0%.

Oil sardine :

About 98% of the whole landings of this species was accounted for by its landings in Kerala, Karnataka and Goa coasts. The landings of oil sardine showed a reduction by about 15,000 tonnes from its landings of 180,000 tonnes of 1983-'84.

In Kerala landings reduced by about 22,000 tonnes — from 150,000 tonnes of 1983-'84, it declined to 128,000 tonnes in 1984-'85. But, in Karnataka the landings of oil sardine increased substantially by about 8,000 tonnes — from 24,000 tonnes of 1983-'84, the landings in 1984-'85 increased to 32,000 tonnes.

Oil sardine landings has been recorded in Andhra Pradesh and Orissa coasts also during the year 1984-'85, in addition to Tamil Nadu and Pondicherry on the east coast of India.

Bombay duck :

The landings of Bombay duck increased by about 30,000 tonnes to 125,000 tonnes in 1984-'85 and 95,000 tonnes in 1983-'84. Maharashtra and Gujarat together accounted for 97.4% of the landings of this fish in the country. In Maharashtra the landings of Bombay duck increased from about 40,000 tonnes of 1983-'84 to 61,000 tonnes showing an increase of about 54.7% In Gujarat the landings increased to 60,000 tonnes in the reported year from 50,000 tonnes, the previous year's landings (21.2%).

Stolephorus :

Landings of *Stolephorus spp.* decreased by about 17,000 tonnes during the year 1984-'85 compared to the landings of previous year. From 90,000 tonnes of 1983-'84 the landings declined to 73,000 tonnes registering a reduction in the landings by about 19.0%. Kerala accounted for 56.9% of the total landings of *Stolephorus spp.* in the country. The landings from that state during the year under report, however, reduced by about 26.3% compared to previous year's figure of 56,000 tonnes, the landings decreasing to 41,000 tonnes. Tamil Nadu (including Pondicherry) accounted for 20.8% of the landings of this species where its landings increased by 4,500 tonnes compared to previous year. The landings of Karnataka accounted for 16.1% where the landings increased by about 200 tonnes from 11,500 tonnes of previous year. The landings of *Stolephorus spp.* is recorded in the entire coast line except in Gujarat and Lakshadweep.

Ribbon fishes :

Landings of ribbon fishes increased by 13,000 tonnes from the previous year's landings of 39,000 tonnes. 23.4% of the landings of this fish is accounted for by the landings in Tamil Nadu under report increased by about 6,600 tonnes from 5,600 of 1983-'84 to 12,200 tonnes in 1984-'85. Maharashtra contributed 20% of the landings where they decreased marginally by 6.8% from 11,200 tonnes of 1983-'84, to 10,500 tonnes. Considerable landings of this fish are recorded in Gujarat (9,100 tonnes, 17.5%), Kerala (6,600 tonnes, 12.5%) and Andhra Pradesh (6,000 tonnes, 11.4%). In Gujarat the landings increased by about 24.8% and in Kerala the landings increased considerably compared to 1,100 tonnes of the previous year. However, in Andhra Pradesh, 29.7% decrease was observed in their landings.

Mackerel :

The landings of mackerel (40,000 tonnes) showed an increase of about 6,800 tonnes in 1984-'85 compared to the landings of 33,500 of 1983-'84. Kerala contributed 31.9% of the total mackeral landings, the level of landings in that state remained the same as that of previous year with a marginal increase of 1.3%. Karnataka also accounted for a similar proportion of landings, the landings (12,800 tonnes, 31.7%) showing an increase of about 10,300 tonnes from 2,500 tonnes of '83-'84. Tamil Nadu coast accounted for 14.4% of the total mackeral landings where the landings declined by 3,100 tonnes compared to previous year's landings. Andhra Pradesh accounted for 11.2% of the landings of this fish where it registered a decline in the landings by about 2,200 tonnes. Landings of mackeral in Goa increased by 2,500 tonnes and accounted for 6.7% of the landings of mackeral in the country.

Demersal Species

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

Among the demersal species, penaeid prawns accounted for 16.3% of the total landings of this group. Croakers contributed 13.6% followed by non-penaeid prawns (9.2%), perches (9.0%), elasmobranchs (6.9%), silver bellies (6.5%), cat fishes (6.5%) and pomfrets (5.8%).

Penaeid prawns :

The landings of penaeid prawns in 1984-'85 recorded an increase of 14,000 tonnes. The landings increased from 117,000 tonnes of 1983-'84 to 131,000 tonnes of 1984-'85 showing an increase of about 11.9%. The landings in Maharashtra (45,000 tonnes) accounted for 34.8% of the total panaeid prawns landings in the country. Other regions which contributed considerably to the landings of penaeid prawns are Kerala (37,000 tonnes, 28.5%) Gujarat (14,000 tonnes, 10.6%) Tamil Nadu (13,000 tonnes, 9.6%), Andhra Pradesh (8,000 tonnes, 5.9%) and Karnataka (6,000 tonnes, 4.2%).

In Maharashtra the landings of penaeid prawns increased by about 7,000 tonnes from 37,000 tonnes of 1983-'84. In Kerala the landings increased by 11,000 tonnes from 26,000 tonnes of 1983-'84. In Gujarat also the landings of penaeid prawns registered an increase in the landings; it increased by about 4,000 tonnes from the landings of 9,000 tonnes of 1983-'84. However, the landings in Andhra Pradesh decreased by about 4,000 tonnes. Similarly the landings in Tamil Nadu decreased by 2,000 tonnes and in Karnataka also a decrease of about 1,000 tonnes was observed. In Goa, the landings of penaeid prawns decreased by 2,000 tonnes from about 6,000 tonnes of 1983-'84 to about 4,000 tonnes of '84-'85.

Croakers :

The landings of croakers in the country during the year under report remained more or less at the same level as that of previous year, the landings being 109,000 tonnes. The landings in Gujarat which accounted for 33.5% of the whole landings of croakers in the country registered an increase of about 18.4% in the year under report where it increased from 31,000 tonnes of 1983-'84 to the order of 36,000 tonnes in the year 1984-'85. Maharashtra accounted for 18.6% of the landings where a marginal increase was observed in the landings — from about 18,000 tonnes of 1983-'84 to

Table 2 a. Estimated landings

Sl. No.	Demersal fishes	1984-'85	1983-'84
1.	Elasmobranchs		
a)	Sharks	34,205	39,019
b)	Skates	2,726	4,066
c)	Rays	18,051	27,802
2.	Eels	7,962	7,707
3.	Cat fishes	52,286	64,365
4.	Lizard fishes	14,870	15,613
5.	Perches		
a)	Rock cods	3,154	2,635
b)	Snappers	4,570	3,793
c)	Pig-face breams	1,769	2,201
d)	Threadfin breams	38,316	27,447
e)	Other perches	24,379	20,426
6.	Goat fishes	4,540	5,646
7.	Thread fins	8,509	7,412
8.	Croakers	108,670	108,572
9.	Silver bellies	52,113	87,772
10.	Big-jawed jumper	18,656	19,432
11.	Pomfrets		
a)	Black pomfret	11,490	16,524
b)	Silver pomfret	34,641	40,605
c)	Chinese pomfret	446	260
12.	Flat fishes		
a)	Halibut	1,733	1,718
b)	Flounders	75	289
c)	Soles	42,651	25,653
13.	Crustaceans		
a)	Panaeid prawns	130,533	116,619
b)	Non-penaeid prawns	73,964	50,633
c)	Lobsters	3,250	2,253
d)	Crabs	26,488	26,461
e)	Stomatopods	29,616	28,678
14.	Cephalopods	24,097	18,575
15.	Miscellaneous	27,444	31,058
TOTAL		801,204	803,234

about 20,000 in 1984-'85. In Orissa, the landings registered an increase of about 2,000 tonnes compared to previous year. The landings in Orissa of about 18,000 tonnes accounts for 17% of the whole landings of this fish in the country. Other regions which contributed considerably are Tamil Nadu (10,000 tonnes, 9.2%), Kerala (9,800 tonnes, 9.0%) and Andhra Pradesh (7,700 tonnes, 7.0%). In Kerala the landings increased by about 2,400 tonnes as compared to the landings of previous year. The landings decreased by about 4,100 tonnes in Andhra Pradesh and by 2,300 tonnes in Tamil Nadu.

Non-penaeid prawns :

The landings increased from 51,000 tonnes in 1983-'84 to 74,000 tonnes in 1984-'85 showing an increase of about 23,000 tonnes. Maharashtra and Gujarat together accounted for 84.5% of the total landings in the country. The landings in Maharashtra increased by about 19,000 tonnes in the year under report from 33,000 tonnes of the previous year. Similarly the landings showed an increase of about 3,000 tonnes in Gujarat from about 8,000 tonnes of 1983-'84 In the east coast, non-penaeid prawns are recorded in substantial quantities in West Bengal and Andhra Pradesh. The landings in West Bengal increased by about 4,000 tonnes in 1984-'85 from about 4,000 tonnes of 1983-'84. However in Andhra Pradesh the considerable decrease was seen in the landings where it declined from about 6,000 tonnes in 1983'84 to the order of 1,000 tonnes in 1984-'85.

Silver bellies :

A steep decline of about 36,000 tonnes is observed in the landings of silver bellies in the year 1984-'85; from 88,000 tonnes of 1983-'84 the landings decreased to 52,000 tonnes in 1984-'85. Tamil Nadu coast which accounted for 68.7% of the landings of silver bellies suffered a reduction in its landings by about 26,000 tonnes, from 63,000 tonnes of 1983-'84 to 37,000 tonnes in 1984-'85. Andhra Pradesh which accounted for 8.9% of the landings of silver bellies, suffered a decrease of about 2,000 tonnes. The landings in Andhra Pradesh decreased from about 7,000 tonnes of 1983-'84 to about 5,000 tonnes of 1984-'85. Kerala which accounted for 7.3% of the landings sustained a decrease of about 5,000 tonnes where the landings declined from 9,000 tonnes of 1983-'84 to about 4,000 of 1984-'85. In Karnataka landings of silver bellies showed a reduction of about 2,000 tonnes from about 5,000 tonnes of 1983-'84 to about 3,000 tonnes of 1984-'85.

Perches :

The landings of perches in the year 1984-'85 showed an increase of about 16,000 tonnes over about 57,000 tonnes of previous year. Threadfin breams constituting 46.6% of the perches increased by about 11,000 tonnes from previous year's landings of 27,000 tonnes. Major contribution to the landings of perches came from Kerala (about 29,000 tonnes) accounting for 39.8% of the whole landings in the country followed by Tamil Nadu (11,600 tonnes, 16.0%), Andhra Pradesh (11,500 tonnes, 15.9%), Gujarat (9,500 tonnes, 13.2%) and Maharashtra (5,200 tonnes, 7.1%).

Elasmobranchs :

A decrease of about 16,000 tonnes is observed in the landings of elasmobranchs, the landings in 1983-'84 and 1984-'85 being about 71,000 tonnes and 55,000 tonnes respectively. Gujarat accounted for 21.7% of the total elasmobranchs landings in the country. Landings in Gujarat remained in the year

1984-'85 at the same level of 1983-'84 the landings being about 12,000 tonnes. Tamil Nadu which accounted for 20.2% of the country's landings suffered a decline of about 39.3% from about 19,000 tonnes of 1983-84, to about 11,000 tonnes in 1984-'85. In Andhra Pradesh the landings in both the years remaied at about 10,000 tonnes which accounted for about 19.1% of the landings of elasmobranchs in the country. Kerala which accounted for 11.8% of the landings suffered a decline of about 3,300 tonnes from 9,800 tonnes in 1983-'84 to 6,500 tonnes in 1984-'85.

Cat fishes :

The landings of cat fishes decreased from 64,000 tonnes of 1983-'84 to 52,000 tonnes of 1984-'85 showing a reduction of about 12,000 tonnes. Maharashtra which accounted for 21.2% of the landings in the country suffered a decline of about 2,000 tonnes from about 13,000 tonnes of '83-'84 to 11,000 tonnes of '84-'85. Kerala which accounted for 20.1% of the landings sustained a reduction of about 6,000 tonnes from 16,000 tonnes of 1983-'84 to about 10,000 tonnes of 1984-'85. Similarly the landings in Gujarat which accounted for 18.4% showed a decline of about 1,000 tonnes from 11,0000 tonnes of 1983-'84 to 10,000 tonnes of 1984-'85. Other regions which contributed substantially to the landings of cat fishes are Orissa (6000 tonnes, 11.3%), Andhra Pradesh (5,500 tonnes, 10.5%), Tamil Nadu (about 3,000 tonnes, 5.7%) and Karnataka about 3,000 tonnes, 5.6%). The landings decreased by about 2,000 tonnes in Tamil Nadu and by 3,000 tonnes in Karnataka compared to previous year's landings while in Andhra Pradesh, the landings increased by about 2,000 tonnes.

Pomfrets :

The landings of pomfrets decreased from about 57,000 tonnes of 1983 '84 to 46,000 tonnes of 1984-'85 showing a reduction of about 11,000 tonnes. Maharashtra which accounted for 37.9 % of the landings suffered a decline of about 6,000 tonnes where the landings of 24,000 tonnes in 1983-'84 reduced to 18,000 tonnes of 1984-'85 But Gujarat which accounted for 31.6 per cent of the landings registered an increase in its landings by over 5,000 tonnes from its landings in 1983-'84, the landings in 1984-'85 being about 15,000 tonnes. In east coast Andhra Pradesh which accounted for 10.9% of the landings suffered a decline of 5,000 tonnes from 10,000 tonnes in 1983-'84 to 5,000 tonnes in 1984-'85. The landings in West Bengal also showed a considerable decline of about 4,000 tonnes where the landings declined from 6,000 tonnes of 1983-'84 to about 2,000 tonnes of 1984-'85.

Landings by mechanised/non-mechanised crafts

Table-3 gives the landings by mechanised and non-mechanised vessels in 1984-'85 compared to the corresponding landings during 1983-'84.

Table 3 : Landings by mechanised and non-mechanised vessels

	1984-'85	1983-84
Mechanised	11,44,494	9,17,654
Non-mechanised	4,70,428	6,65,557
Total	16,14,922	15,83,211

Landings by mechanised vessels have shown considerable increase in 1984-'85 over that of 1983-'84; the landings increased by 227,000 tonnes

nised vessels however, suffered a decrease of about 195,000 tonnes (29.3%) The mechanised landings accounted for 70.9% of the total landings in 1984-'85, while the same was only 58% in 1983-'84. The contribution from non-mechanised vessels which was 42% in 1983-'84 has reduced to 29.1% in 1984-'85.

LANDINGS IN DIFFERENT REGIONS

North East region :

North east region comprising West Bengal, Orissa, Andhra Pradesh and Andaman & Nicobar Islands contributed 14% of the landings in the country in 1984-'85. The landings of 224,000 tonnes during 1984-'85 showed a decline of about 32,000 tonnes from the landings of previous year in this region. Among the commercially important varieties of fish panaeid prawns and croakers registered reduction in the landings by 4,400 tonnes each and Bombay duck landings reduced by 2,700 tonnes.

South east region :

South east region comprising Tamil Nadu coast (including Pondicherry) accounted for 15% of the landings in the country as a whole. This region also registered a decline in the annual landings by about 45,000 tonnes from 292,000 tonnes of previous year. Among the commercially important varieties, silver bellies declined by 26,000 tonnes from the previous year's landings of 63,000 tonnes. Similarly landings of other sardines reduced by about 9,000 tonnes from 37,000 tonnes of 1983-'84. However, *Stolephorus* spp. showed an increase in the landings by 4,500 tonnes.

South West region :

South west region comprising Kerala, Karnataka, Goa and Lakshadweep contributed 34% of the marine fish landings in the country which showed a marginal increase of about 7,000 tonnes in 1984-'85 over the landings of 537,000 tonnes of the previous year. Among the important species in this region, oil sardines showed a reduction in the landings by 15,000 tonnes from 177,000 tonnes of previous year. Similarly *Stolephorus* spp. also reduced in its landings by about 15,000 tonnes. However, perches registered an increase in the landings by about 16,000 tonnes; mackerel by 13,000 tonnes and penaeid prawns by 8,000 tonnes.

North west region :

North west region comprising Maharashtra and Gujarat accounted for 37% of the landings in the country. Landings in this region during 1984-'85 registered a substantial increase of about 101,000 tonnes over the previous year's landings of 489,000 tonnes. Among the major species that accounted for this steep increase were Bombay duck which increased by 232,000 tonnes, penaeid prawns which increased by 13,000 tonnes and non-penaeid prawns which increased by 22,000 tonnes. However, elasmobranchs reduced in its landings by 3,000 tonnes.

Stock assessment and estimation of potential yield of commercially important species (CMFRI/IDP/15)

Levels of maximum sustainable yield at the present rate of effort expended have been estimated for *parapenaeopsis stylifera* and *Metapenaeus dobsoni* in the Sakthikulangara and Cochin regions. The analysis has clearly indicated that effort pressure has to be reduced to sustain the stocks for obtaining MSY. An interesting result was that males are more exploited than females in the adult stage and thus females are put to relatively less

effort pressure resulting in favourable recruitment to the fishery in the case of *P. stylifera.*

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

Standardised proformae for collection of data on catch, effort and other related characters, separately for purse-seiners, trawlers, other mechanised crafts and also for non-mechanised boats were finalised. Codes for items such as species, crafts, gears and landing centres were allotted and self-coding data entry formats were introduced at the field level. The coded proformae received from the field investigators were thoroughly scrutinised and the data analysed for estimates of catch and effort.

During the year, two meetings of the technical committee for establishment of computer centre were organised at Delhi. Final recommendations were made and submitted to Director General, I.C.A.R. The approved specifications were sent to DGS & D for procurement of the computer.

Survey of estuarine fisheries (FSS/FRA/1.5)

The pilot studies intended to be taken up during the year could not be undertaken due to lack of personnel.

Evaluation of change in the pattern of catch and composition in the artisanal and mechanised units in Tamil Nadu (FSS/FRA/1.16).

Catch statistics of marine fish by mechanised and non-mechanised units in different districts of Tamil Nadu durig 1982-'83, 1983-'84 and 1984-'85 have been studied. In Madras district the landings by mechanised crafts accounted for 75-80% of the total landings while 20-25% came from non-mechanised units. The landings in Chengalput district is found to have come totally from non-mechanised crafts. In south Arcot district 20-25% of the landings was contributed by mechanised units while 75-80% came from non-mechanised units. Mechanised landings accounted for 50-60% of total landings in Tanjore district and non-mechanised landings for 40-50%. Landings in Pudukottai district varied from 80 to 95% in mechanised sector and from 5 to 20% in the non-mechanised sector. Landings in Tirunelveli district varied from 30 to 40% in the mechanised sector where as non-mechanised landings accounted for 60-70%. Mechanised landings accounted for 5-10% in Kanyakumari district and non-mechanised landings for 90-95%.

Training in Fisheries Resources Assessment including population dynamics (CMFRI/TR/6)

A training programme running for a period of 10 days from 18th to 28th July 1984 was conducted for the benefit of personnel from Fisheries Departments of maritime states. 20 officers from various maritime states were given training on the sampling methodology adopted by CMFRI for estimating marine fish landings in the country. This programme consisted of lectures on theory and field trips and group discussions.

PELAGIC FISHERIES DIVISION

The major programmes of research activities under the Division were mainly on capture fisheries carried out under eleven projects. The investigations conducted during the year were concerned with the monitoring and evaluation of resource characteristics and stock assessment of the tunas, mackeral, oil sardine, Bombay duck, lesser sardines, whitebait, pomfrets, seerfishes, hilsa shad and carangids. Good progress has been achieved during the year under various projects.

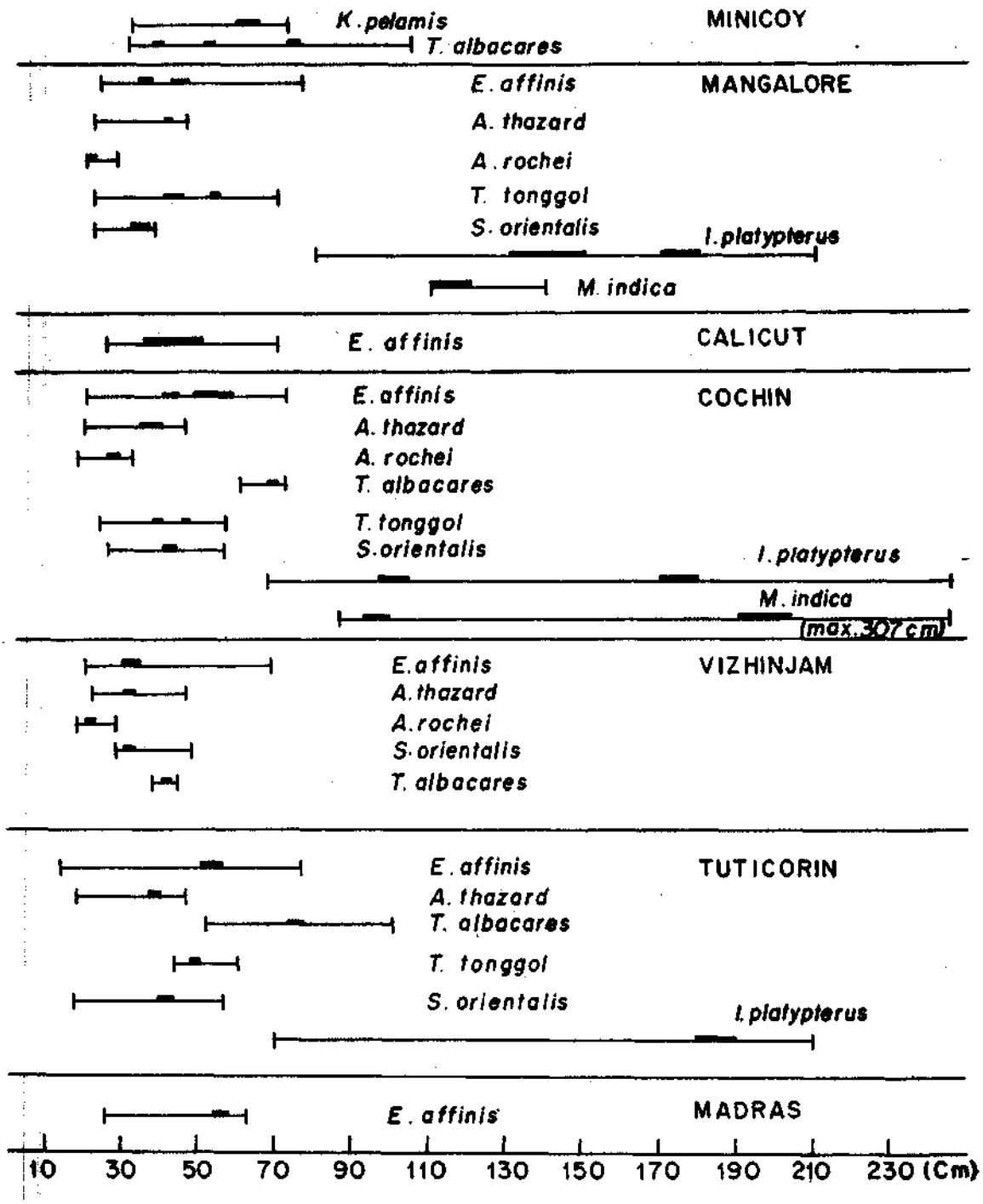
The yield from the tunas, mackerel, seerfishes, Bombay duck, oil sardine, pomfrets and lesser sardines was higher during the year than previous year. Lower production was reported in other resources. Two peak periods of abundance during March-May and October-December were observed for most of the pelagic species. By increasing fishing pressure, during the above two periods of abundance, increased production from these fisheries could be realised.

In most of the species two periods of spawning and recruitment were evident. Small-meshed bag nets employed by the artisanal sector, and purse seines and shrimp trawls by the mechanised sector took heavy toll of juveniles of oil sardine, mackerel, Bombay duck and pomfrets from the inshore nursery grounds. Fishing the juveniles, before their full growth, is a wasteful utilisation of the resources and calls for appropriate management measures.

Based on the time series resources data, studies on the stock assessment and the effect of the fishery on the monitored pelagic resources are in progress. The following are highlights of the results obtained thus far.

Time series resource data covering the period 1979-'82 for *Euthynnus affinis* and *Auxis thazard* and for the period 1976-'82 for *Katsuwonus pelamis* and *Thunnus albacares* were studied and the estimates of their average annual stock size and the present rate of their exploitation were obtained. In the case of *E.affinis* and *A.thazard*, the average annual stocks were in the order of 206 and 7.7 thousand tonnes and their exploitation rates were 0.5 and 0.5 respectively, indicating that both the species are under-exploited and a substantial increase in their production is possible by increased fishing pressure. In the case of skipjack *(K.pelamis)* and yellowfin *(T.albacares)* their exploitation rates were estimated at 0.64 and 0.85 and total mortality rates (z) at 2.065 and 3.168 respectively. In view of the low exploitation rates as compared with high rates of total mortality, it is emphasized that further exploitation of these two oceanic resources is possible by employing increased fishing effort.

Based on the data collected on the exploited resources of silver pomfret, *Pampus argenteus* from Saurashtra coast during 1980-84, the growth parameters of the species were estimated. The growth coefficient (K), the asym-



Size range of species of tunas and billfishes at different centres observed during 1984-'85

ptoic length ($L\infty$) and t_0 for the exploited stock were 0.0877, 317 mm and — 0.297 months respectively. The spe-cices was found to grow to an average size of 207 mm, 279 mm and 304 mm at the end of one, two and three years of its life.

The stock assessment of the Bombay duck resource off Nawabunder, Saurashtra coast were made based on the data collected during 1976-'79. The estimated average population parameters of the species were in the order of $Z = 2.679$, $M = 1.533$ and $F = 1.146$ during the period of investigation. Based on these parameters, the average annual stock and the MSY were found to be 9,015 tonnes and 4,181 tonnes respectively for the area under study. The average yield from the existing fishery was 3561 tonnes. This indicates that the present level of exploitation is close to the maximum sustainable yield (MSY) and that only marginal increase in landings is possible by increased fishig.

Resources of tunas and billfishes (FB/PR/3.1)

Research and technical programmes carried out during the year were mainly centred around the collection of data on the resources, present trend of exploitation of the fishery and biological parameters such as size composition, growth and mortality of different species from the observation centres.

All India tuna landings in 1984 have been estimated at 19,413 tonnes which showed an increase of 9.9% when compared with 1983 production. During the present season increased trend in production was observed in all the maritime states, except in Karnataka, Tamilnadu and Pondcherry. To the tuna landings, Kerala contributed maximum (30.6%), followed by Lakshadweep (21.1%), Maharashtra (14.5%), Tamilnadu (13.2%) and Gujarat (8.3%). The remaining was shared by the other states. The coastal tunas constituted 82% and the oceanic tunas 18% of the country's tuna production.

Among the observation centres, the highest landings (679t.) were recorded at Cochin and the lowest (18t.) at Madras. However, maximum catch rate (235.2 kg) was observed at Minicoy with an estimated catch of 570 tonnes. Among the tunas and billfishes landed at different centres, tunas constituted the bulk (85%) of the catch. At Minicoy the fishery was mainly sustained by *K.pelamis* (93.1%) and yellofin tuna (6.4%). At other centres *E. affinis* contributed to the bulk (about 62%) of the tuna landings. The peak abundance for the oceanic skipjack *(K.pelamis)* at Minicoy was observed during October-December and March-April; and for the mackerel tuna *(E. affinis)* generally during February-June at the southern centres and during August-October at the northern centres along the mainland. The principal gear employed in the fishery were pole and line at Minicoy and drift gill net at the other centres.

The size range and major modes of tunas and billfishes landed at different centres are presented in Fig. 1. At Minicoy, about 54% of the skipjack landed was constituted by larger size group (59-65 cm). *T.albacares* ranged in fork length between 31 cm and 104 cm. Small tunas (below 30 cm) of several species were recorded in the laddings generally during May-October at many centres on the west coast.

Studies on the maturity and spawning of *K.pelamis* have been conducted at Minicoy. Gravid fish (St. V — VI) were abundant during October-March indicating that the species was spawning in the area during above months. A significant feature noted, during the period under report, was that about 73.7% of the skipjack caught were spawners.

The magnitude of the tuna live-bait fishery was studied. During the year an estimated 4.3 tonnes of live-bait fishes were caught for chumming tuna. The major component species of live-bait fishery were *Spratelloides delicatulus (30.9%). S.japonicus (22.0%) Caesio chrysozona* (16.9%) and *C.Caerulareus* (12.0%). Studies on the distribution and biology of *Spratelloides* spp. revealed that *S.delicatulus* was found both in the shallower and deeper waters; and *S.japonicus* in deeper waters of the Minicoy lagoon. Both the species breed inside the lagoon. Whereas the caesiodids breed outside the lagoon and the young ones are recruited to the lagoon with faourable currents. Most of the live-bait species were fished from the lagoon during October-March.

Time series resource data covering the period 1979-82 for *E.affinis* and *A. thazard;* and for the period 1976-82 for *K.pelamis* and *T.albacares* were studied and estimates for their average annual stocks and the present rates of their exploitation were obtained. In the cacse of *E.affinis* and A. *thazard,* the average annual stocks were in the order of 206 and 7.7 thousand tonnes and their exploitation rates were 0.5 and 0.5 respectively, indicating that both the specices are under-exploited at present and a substantial increase in their production is possible by increase in fishing pressure. In the case of skipjack *(K.pelamis)* and yellowfin *(T.albacares),* the exploitation rates and total mortality rates (z) were estimated at 0.64 & 0.85 and 2.06 & 3.17 respectively. In view of the low exploitation rates as compared with high rates of total mortality, it is emphasised that further exploitation of these for oceanic resources is possible by employing increased fishing effort.

Resource characteristics of pomfrets (FB/PR/5.4)

Studies on the fishery and resource characteristics were continued during 1980-84 season at all the observation centres. Except at Veraval and Bombay, the fishery for pomfret showed a decline in production compared to previous season.

The production from the pomfret fishery at Veraval was better with an estimated catch of 447 tonnes, than last year's. Gill net and trawl were the principal gear operated and landed respectively 42.3% and 57.7% of the catch. In the gill nets the share of silver and black pomfret was 36.5% and 63.5% respectively. Second and third quarters were more productive. Silver pomfret constituted 93.8% of the trawl catch. Third quarter yielded more catch amounting to 56.4 tonnes of its annual landings. At Rajapra (Veraval) dol nets landed 167 tonnes exclusively of silver pomfret. The second quarter accounted for 71.8% of its catch. At Bombay only *P.argenteus* were landed by gill net with an estimated catch and catch rate of 668 tonnes and 243 kg respectively. The most productive period was October-December when 34% of the annual catch was landed. At Pachubunder, the dol net landings

totalled 419 tonnes, the third quarter accounting as much as 60.8% of the catch. The catch per boat per day ranged from 139 kg to 738 kg.

At Karwar, the fishery was better than previous year recording a two-fold increase. Purse seiners hauled up exclusively the black species amounting to 116 tonnes forming 97.7% of the annual catch. The most productive period was July-September when 61.5% of this gear's catch was landed with a catch rate of 86 kg. On the other hand trawl landed only 2.7 tonnes of silver pomfret. The landings of pomfret at Mangalore declined by 50% over the previous year. Drift gill net and trawl accounted for 48.2% and 51.8% of the estimated annual catch (40.5 t). In the gill net catches, black pomfret and in the trawl catches catches silver pomfret were predominant, accounting for 79% and 85.6% of the respective gear's landings. At kaup drift gill net landed an estimated catch of 20.4 tonnes. Black predominated in the catches.

The fishery was exceedingly poor at Calicut with an estimated catch of 25.3 tonnes; and recording a shortfall of 21.6 tonnes over the previous year. Drift gill net and bag net accocunted for the landings. Both the gear landed the black pomfret *(Parastromateus niger)* exclusively. At Cochin Fisheries Harbour, the pomfret fishery landed an estimated catch of 125.9 tonnes during the present season showing a decline of 36.1% over the previous season. The drift gill net and purse seine accounted for 81.3% and 19.7% of the annual catch. The black species dominated in both the gear (96.5% & 70.9%). The most productive period was August-October.

At Puri the fishery was poor though the fishing effort expended was slightly more than in the previous year. An estimated catch of 31 tonnes was landed by gill net during the current year compared to 45 tonnes of previous year. The silver (83.7%) and black species (16.2%) sustained the fishery. The Chinese pomfret *(P.chinensis)* landed occasionally in limited quantities. The first quarter was the productive period.

The silver pomfret *(P.argenteus)* with dominant sizes ranging from 130 mm to 270 mm at Veraval, 150 mm to 299 mm (Furcal length) at Bombay, 150 mm to 210 mm at Karwar, 170 mm to 230 mm at Mangalore, 140 mm to 250 mm at Cochin and from 160 mm to 190 mm at Puri supported the fishery during the year. On the other hand the black species (*Parastromateus niger*) with predominant sizes ranging from 150 mm to 260 mm, 150 mm to 270 mm and 140 mm to 330 mm sustained the fishery for this species at Karwar, Mangalore and Cochin respectively. Large quantities of pomfrets ranging in size from 40 to 99 mm at Veraval and from 30 to 99 mm at Bombay were landed by dol net during November-March and April respectively.

In the samples of silver pomfret examined at Puri, on the east coast, males were more in number than females during April and September while female fish predominated males during May, July and August. Most of the adult fish examined during May September were found to be mainly in maturing, mature and spent condition. About 66.7% of the gut contents of silver pomfret studied at Puri consisted of pulpy matter. Other itmes were salps, hydromedusae and crustacean remains.

The processing of the data collected during 1980-84 was completed and the study of the stock assessment of the predominant species is in progress. The population parameters of the silver pomfret, *Pampus argenteus* at Veraval were estimated as follows: Growth coefficient K = 0.0877, asymtotic length L_∞ = 317 mm and t_o = —0.297 months. The speceis grew to a size of 207 mm, 279 mm and 304 mm at the end of the first, second and third years respectively.

The processing of resources data of the earlier years at other centres is completed and the studies on the stock assessment of the species are in progress.

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

Investigations on the fishery and resource characteristics of the oil sardine were continued at the observation centres.

The oil sardine fishery during the year under report showed marked increase (21.1%) in production compared to the previous year. The landings at Cochin (14,721 tonnes) surpassed remarkably those at Mangalore (12,197 t), Karwar (4283 t.), Calicut (1987t) and Goa (389t) regions. The increase in the oil sardine production at the major centres like Cochin, Mangalore and Karwar was in the order of 26.6%, 60.8% and 31.0 per cent respectively compared to the previous year. The maximum abundance of the species on the west coast was observed during September-December. The principal gear employed at Cochin, Mangalore, Karwar and Goa was the purse seine and at Calicut Pottenkollivala. The highest annual catch rate 2.5 t. per boat/per day) was recorded at Cochin, followed by Mangalore (1.0 t) and Karwar (0.66 t.)

The size and age composition of the species that sustained the fishery during the year was studied. The species wih modal sizes ranging from 160 to 215 mm at Vizhinjam, 125 to 180 mm at Cochin, 105 to 200 mm at Calicut, 140 to 180 mm at Mangalore, 105 to 175 mm at Karwar and 110 to 190 mm at Goa dominated the landings. Large quantities of young oil sardine with modal size ranging from 75 to 95 mm were also caught mainly at Cochin, Calicut, Mangalore, Karwar and Goa centres. The relative abundance of different age classes in the fishery at the observation centres are presented in table-1. From the data it is observed that the fishery was mainly sustained by the 0-year class to the extent of 81.2% (by numbers); followed by 1-year class (10.0%) and 2-year class (9.8%). The conribution of 0-year class to the fishery during the current season was significantly higher by 30.6% compared with that of previous seasons. The positive effect of this was evident in the fishery by increased production during the present season.

The sex-ratio and spawning season of the species was studied. Females at Cochin, Calicut, Mangalore and Karwar dominated in the landings. Adult fish in spawning codition were generally found to be abundant during April-September in the catches at most of the centres.

The processing of the resource data of the earlier years was completed and the stock assessment studies on the species are in progress.

Investigations on the fishery and resource characteristics of lesser sardines were continued during the year under report at the observation centres.

TABLE — 1

Age composition of Oil sardine (No/gear/day) in the non selective gear at different centres during the fishing season 1984-85

Centre	*Gear*	*AGE CLASS* 0-*year*	1-*year*	2-*year*(+)	*Total*
Vizhinjam	Shore seine	84	251	145	480
Cochin	Purse seine	39289	21071	22963	83323
Calicut	Pottenkolli vala	2092	1147	2565	5804
	Nethal vala	147800	111	0	147911
Mangalore	Purse seine	54806	5450	3636	63892
Karwar	Purse seine	28848	5181	3550	37579
Goa	Purse seine	1275	857	662	2794
TOTAL	—	274194	34068	33521	341783
%	—	80.2	10.0	9.8	100.0

The fishery for lesser sardines was betterr with an estimated catch of 9552 tonnes during the current year compared to the previous year at most of the centres. Special mention may be made of the good fishery at Mandapam and Tuticorin, where lesser sardines formed the major contributors. Most of the commercial landings came from 6-10 fathom depth zone.

The lesser sardine fishery at Waltair yielded an estimated catch of 306 tonnes of which 9 tonnes at the Lawson's Bay and 222 tonnes at the Outer Harbour were landed. Gill net was the principal gear accountings for 70% of the lesser sardine catch; followed by boat seine. Off this coast, *Sardinella fimbriata* and *S. gibbosa* were the principal species of which the former species formed 82% of the lesser sardine landings.

Total estimated lesser sardine landings at Madras was in the order of 137.5 tonnes. Good landings were recorded from October to March. Of the three species, *S. gibbosa, S. sirm* and *S. dayi* which contributed to the fisery. *S. gibbosa* formed the bulk (86.9%) of the catch. Gill net was the principal gear accounting for the whole catch.

Gill nets operating in the Palk Bay landed an estimated 2745 tonnes of lesser sardine catch at Mandapam. The peak abundance of this resource in the Palk Bay was observed during May-June. The principal species that sustained the fishery were *S. albella* and *S. gibbosa* of which the former species contributed to 71.2% of the production. Productive grounds were located, during the year, in 6 to 10 fathom depth.

The fishery for lesser sardines at Tuticorin was fairly good with an estimated production of 4164 tonnes landed entirely by the gill nets. Fishing was done mainly in 6-10 fathoms depth zone in the Gulf of Mannar. Highest monthly production (650 t.) was recorded in October. Major portion (54.4%) of the annual catch was contributed by *S. gibbosa*. Next in importance were *S. sirm* (26.5%), *S. albella* (13.8%) and *S. dayi* (9.3%).

At Vizhinjam the fishery landed 111 tonnes of lesser sardines forming about 2.0% of the total fish landings. Principal gear employed in the lesser sardine fishery were the gill net, (88.6%), boat seine (6.9%) and Hooks & line (3.4%). *S. gibbosa* was the predominant species (68.6%) followed by *S. sirm* (23.1%) *S. sindensis* (3.3%) and *S. fimbriata* (2.8%). The peak abundance of these resources in the local waters was observed during October-November and May.

The lesser sardine fishery at Mangalore was quite erratic. During the year an estimated 831 tonnes of lesser sardines were landed by purse seine. These species were mainly caught from 6 to 10 fathoms depth zone. Predominant species was *S. brachysoma* (96.6%), followed by *S. jussieui* (3.4%).

The production of lesser sardine fishery at Karwar during the year was estimated at 1258 tonnes; landed mainly by purse seine (99.8%). The fishery was supported by four species, viz. *S. fimbriata, S. gibbosa, S. albella* and *S. dayi.* Among them the predominant species was *S. fimbriata* contributing to 32.8% of the lesser sardine landings. The peak abundance of the resource was observed off Karwar during October.

In the commercial landings, *S. gibbosa* ranging in size from 5 to 19.5 cm and with dominant size groups at 12.0—14.5 cm supported the fishery at the East coast centres. In the purse seine catches at Mangalore and Karwar, fishes having dominant sizes at 9.0—13.5 cm and 15.0—19.0 cm were recorded. Sex-ratio varied considerably in different meshed gill net catches. While males were dominant in the landing at Madras; females were more in number at Tuticorin, Vizhinjam, and Karwar. Gravid and spent fish were abundant during February-April at Waltair; during several months at Tuticorin, during March-May & August-November at Vizhinjam and during September-November at Karwar.

S. fimbriata having sizes from 4.5 cm to 18.0 cm at Waltair, 10.0 to 17.5 cm at Karwar were observed in the landings. Sex-ratio was equal in boat seine samples, whereas as females predominated in the catches by gill net and purse seine landings. Fish with spent gonads were observed in July at Waltair. Fishes of *S. albellla* havig size range from 12.5 cm to 16.5 cm supported the fishery at Karwar. Females were dominant in the catches. Most of the catch composed of fish with developing gonads. Some spent fish were observed during September. *S. dayi* with size ranging from 14 to 17 cm contributed to the catches at Karwar. Males were more in number. Only gravid and spent fish were observed in the catches; with gravid fish dominating during October-November.

S. sirm having size ranging from 11.5 to 21.9 cm and with dominant modes at 13.5 cm, 16.0 cm, 18.0 cm and 20.0 cm contributed to the fishery at Vizhinjam. Females were predominant. Fishes with developing and gravid gonads were abundant generally durig March-May and November. Partially spawned fish were recorded only in April.

During the year, processing of the resource data of the earlier years was completed and studies on the stock assessment are in progress.

The fishery and resource characteristics of anchovies (FB/PR/9.3)

Anchovy resources were investigated at observation centres. Whitebait *(Stolephorus)* continued to be the dominant category in the anchovy landings. A general decline in the whitebait fishery was noticed during this year. The catch, catch rates as well as the percentage composition of whitebait in the total fish catch were adversely affected. The long-jaw anchovy *(Thryssa)* landings improved at Madras.

At Mangalore, the annual whitebait landings were 8021 t, which is 186 t less than that of last year. This is due to poor purse seine catches during the first and last quarters and poor trawl catches, in general. To the total whitebait catch, purse seine contributed 96.3% with a catch rate of 647 kg/net and trawl 3.7% with a catch rate of 5.4 kg/net. The purse seine during the year was operated for whitebait in 10-30 m depth compared with 10-20 m depth last year. The peak abundance off this coast was observed during April-May and October-February. The entire purse seine catch composed of *S. devisi;* whereas *S. bataviensis* (69%), *S. devisi* (28%) and *S. macrops* (3%), contributed to the trawl landings. Fishes of *S. devisi* ranging in size from 65 to 95 mm and *S. bataviensis* from 70 to 100 mm supported the fishery. In both the species peak periods of breeding were observed during April-May and November-February. In *S. devisi* males were dominant; whereas in *S. bataviensis* sex-ratio was equal.

The anchovy production at Cochin showed decline with estimated catch of 300 t; of which purse seine landed 90.7% and shrimp trawl 9.3%. To the total anchovy landings, whitebait *(Stolephorus)* contributed 98.7% and the long-jaw anchovy *(Thryssa)* 1.3%. The latter was landed by shrimp trawl. The catch rate of whitebait by purse seine and shrimp trawl were in the order of 92 kg and 0.6 kg respectively. The fishery was erratic in occurence. The peak abundance was observed during May and October. *S. devisi* mainly sustained the purse seine catches (99%), followed by *S. bataviensis* (1.0%). But in the trawl catches predominant species were *S. bataviensis* (77%), followed by *S. devisi* (18%) and others. In both the species, fishes ranging in size from 50 to 100 mm contributed to the catches. In the case of *S. devisi* females, whereas in *S. bataviensis* males dominated the catches. Fishes with developing and gravid gonads were dominant.

The fishery showed a declining trend at Vizhinjam; the production during the present season being 1/3 of the previous season. The catch rate was also lower. An estimated 430 t of whitebait were landed by boat seine (86.7%), 'Nethalivala' (11.7%) and shore seine (1.6%). Bulk of the annual catch (92%) was landed during June-September, with peak landings during June-July. The catch rates obtained by the principal gear in the order of their importance were 13.3 kg, 23.5 kg and 13.8 kg respectively. *S. devisi* accounted for 69.5% of the whitebait landings, followed by *S. bataviensis* (24.9%), *S. buccaneeri* (5.1%) and *S. indicus* (0.5%). Fishes of the first two species ranging in size from 30 to 95 mm and from 35 to 95 mm respectively contributed to the landings. In both species sex-ratio

was equal except in boat-seine catches where females of *S. devisi* predominated. While the gravid fish of *S. devisi* were abundant during most part of the year; those of *S. bataviensis* were met with only during August-September.

At Madras anchovy fishery showed an improvement during the current year with an estimated catch of 101t. To the total anchovy catch, whitebait contributed 39.6%; while long-jaw anchovy 60.4%. The bulk of the catches were landed by shrimp trawl. The peak abundance for both the whitebait and long-jaw anchovies was recorded during May-September. *S. bataviensis* was the dominant species accounting for 72% of the whitebait landings and *S. devisi* formed the rest. Fishes of the former species ranging in size from 40 to 115 mm and of the latter species from 45 to 100 mm sustained the landings. In the predominant species, however, juveniles formed 44% of the catch and were abundant during February-May and September-October. In both the species females dominated and fishes in advanced stages of maturity were observed mainly during April-September, indicating their probable spawning season in the area.

The anchovy fishery at Waltair landed an estimated catch of 381t of which whitebait *(Stolephorus)* formed 65.4% and the rest (34.6%) by the long-jaw anchovy *(Thryssa)*. Compared to the previous season, the landings of whitebait decreased and of longjaw anchovy increased during the year. Principal gear employed in the fishery were the shrimp trawl and shore seine. Off this coast, peak periods of abundance for the white bait during January-March and August-September and for the long-jaw anchovy during June-October were observed. In the anchovy landings, *S. devisi, S. bataviensis* and *T. mystax* were the predominant species. Fishes of the two former species ranging in size from 55 to 90 mm and from 45 to 105 mm respectively sustained the fisheries. Sex-ratio was equal and gravid fishes were abundant generally during February-March and July-September.

The data collected during the earlier years was processed and studied for the trends in the fishery, growths, age and maturity cycle of the dominant species of whitebait. The processing of the resources data of whitebait was completed and studies on population parameters like Asymptotic length, growth coefficient, mortality coefficient and exploitation rates are in progress.

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

The mackerel fishery showed a substantial improvement in the production during the year under report compared with previous season at all the observation centres.

At Goa the purse seine fishery yielded an estimated catch of 1223 tonnes of mackerel, showing an elevenfold increase over the previous season. A significant increase in the fishery was also observed at Karwar and Mangalore with estimated landings of 1036 tonnes and 3434 tonnes by purse seine Productive grounds for mackerel at these centres were located in 11-20 fathom depth. Similar trends in production were evident at Cochin, Vizhinjam, Mandapam and Waltair

with estimated landing, during the present season, amounting to 250 tonnes, 2918 tonnes, 399 tonnes and 185 tonnes at Calicut, Cochin, Vizhinjam and Waltair respectively. The bulk of the annual catch was landed by purse seine at Cochin and the indigenous gear like boat seine drift gill net and shore seine at the other centres. The peak abundance of mackerel at Cochin was observed during October; consisting mainly of 1-year and 2-year old fish.

Studies on the biology of the species were continued at most of the observation centres. Fishes ranging in size from 105 to 250 mm with minor and major modes at 135 mm and 210 mm respectively at Goa from 150 to 275 mm with minor and major modes at 165 mm and 240 mm respectively at Karwar; from 70 to 270 mm with minor and major modes at 115 mm and 235 mm respectively at Mangalore; from 210 to 260 mm with a dominant mode at 240 mm at Calicut; from 100 to 285 mm at Vizhinjam; from 150 to 275 at Mandapam and from 70 to 240 mm with a dominant mode at 225 mm at Waltair contributed to the fishery. The purse seine fishery for mackerel at Cochin was mainly sustained by the 1-year old fish, followed by 2-year olds. Good quantities of young mackerel with modal sizes ranging from 70 to 130 mm were also landed by purse seine between Goa and Mangalore, by boat seines at Calicut and Vizhinjam and by shrimp trawl at Mangalore and Waltair. They were landed generally during April-June and August-October.

From the relative abundance of different age classes that sustained the mackerel fishery at different centres, it is observed that 1-year class sustained the fishery to the extent of 57.6%, followed by 2-year class (37.7%) at all centres (Table-1). However, 2-year old fish dominated the landings at Mangalore and Calicut during the current year.

TABLE-1

Age composition of mackeral (No/gear/day) in the non-selective gear at different centres during the fishing season 1984-85

Centre	*Gear*	*AGE CLASS*				
		0-year	*1-year*	*2-year*	*3-year(+)*	*Total*
Goa	Purse seine	237	2124	390	0	2751
Karwar	Purse seine	46	1018	857	1	1922
Mangalore	Purse seine	80	537	917	2	1536
Calicut	Pattenkolli	1	49	166	0	216
Cochin	Purse seine	149	2634	1832	2	4617
TOTAL		513	6362	4162	5	11042
%		4.6	57.6	37.7	0.1	100.0

Age class: 0-year (< 159mm); 1-year (160—229mm); 2-year (230—269mm) & 3-year (270mm+)

Sexes were equal in the landing at most centres of observation; except at Calicut where male fish and at Mamdapam female fish dominated. Adult fish in Gravid and spent condition were generally found to be abundant during February-April and August-October. The feeding intensity of mackerel at Waltair was moderate. Copepods and *Coscinodiscuss* were important item present in the stomach.

The accumulated data on the biology of the species, its fishery and resources have been analysed and studied during the year for the estimation of co-efficients of growth, mortality and longivity of the population; and work on the stock assessment of the species is in progress.

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

Investigations on the fishery and resources of seer fish were continued at Mangalore, Calicut, Cochin, Vizhinjam, Tuticorin, Mandapam Camp and Waltair. The landings of seerfish improved in all centres this year except at Waltair. The bulk of the catch was landed by drift gill net in all centres except Waltair where hooks & line accounted for 83% of the landings. King seer *(S. commerson)* dominated the landings at all the centres except Waltair where *S. guttatus* dominated. Peak catches were recorded during October-December in all centres except Waltair where April-June was most productive.

Drift gill net at Mangalore landed 985 t of seer fish at a catch rate of 30.1 kg/unit. The present catches showed an increase of 15.5% over those of last year. Peak landings (92.3%) of the annual catch were recorded during October-December. Seer fish landings as incidental catch, by purse seines this year (432t) showed manifold improvement as compared to those of last year (7t). The bulk of the landings were contributed by the king seer, *Scomberomorus commerson* (54.2%) and spotted seer, *S. guttatus (45.8%)*, with peak catches during November-December. The size ranges of king seer and spotted seer were 37-117 cm and 33.5-53.0 cm with dominant modes located at 57.5 cm, 72.5 cm and 45.0 cm respectively.

The catches of seer fishes by drift gill nets in Calicut totalled 113 t registering an increase of 54.7% over those of last year. The catch rate nearly doubled from 22.9 kg/unit during last year to 42.6 kg/unit during the present year. Peak landings of seer fishes were reported in October. As usual the bulk of the catch (84.2%) comprised King seer which ranged in size from 40 cm to 109 cm with dominant modal groups at 62.5 cm and 8.25 cm.

A total of 651 t of seerfish was landed at Cochin at the rate of 30.1 kg/unit. The catches improved by 48.8% over those of last year. The bulk of the catch (96.4%) was contributed by the King seer. Peak catches of King seer and spotted seer were reported in October and November, respectively. The size of King seer ranged from 32.5 cm to 147.5 cm with dominated modal groups at 62.5 and 82.5 cm. The spotted seer ranged from 27.5 cm to 67.5 cm with a modal group at 42.5 cm.

At Vizhinjam a total catch of 141 t was landed showing an increase of

36.6% over that of last year. The bulk of the catch (97%) was landed by drift nets. Peak catches were landed in October. King seer dominated the catches.

At Tuticorin an estimated catch of 257.6 t. was landed. Drift nets (63%) and trawlers (26.6%) accounted for the bulk of the catch. The size range of king seer which was the most dominant was 15.0-107.4 cm.

The catches of seer fish at Mandapam totalled 22t. with a peak catch dated in November. King seer was the dominant species which ranged from 10 cm to 120 cm with dominant modes at 55 cm and 100 cm. Based on the catch rates of drift gill net during 1964-76, the MSY of the seer fish for the Tamil Nadu coast was estimated at 4921 tonnes.

At Waltair the seerfish catches totalled 103 t as against 130 t last year. Hooks and lines landed the bulk (83%) of the catch while drift gill nets contributed the rest: while the former gear returned a catch rate of 3.8 kg/unit, the latter yielded a catch rate of 1.1 kg/unit. The bulk of the catch was landed during April-June. The spotted seer was the only seer fish landed by gill nets. The King seer and spotted seer contributed 45.2% and 54.8%, respectively, of the hook and line catches.

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

Bombay duck landings along Saurashtra coast totalled 20,411 t which were landed at a catch rate of 101 kg/haul. The present landings improved by 65.8% over those of last year. Good catch rates of 188 kg/haul and 161 kg/haul were recorded in December and November respectively.

The size of the fish ranged from 30 mm to 330 mm. The fishery was mainly supported by the 0-year class as the small sized 30-45 mm and 60-75 mm size group dominated in the fishery. Females out numbered males in all the months except October. Resting and maturing females were predominant. Gravid specimens were met with in December.

The present landings of Bombay duck at Arnala (18,006 t), Pachubunder (5,960 t) and Versova (2,066t) along Maharashtra coast showed vast improvement over those of last year. A catch rate 14319/haul at Arnala, 65 kg/haul at Pachubunder and 13 kg/haul at Versova was recorded this year. Peak catch rates along Maharashtra coast were obtained during October-November.

The length of Bombay duck in the fishery ranged from 15 mm to 345 mm with four dominant modal groups at 90-105 mm, 210-225 mm, 255-270 mm and 270-285 mm. 1 + year class dominated the fishery. Females always outnumbered males. Gravid and spent females were predominant.

The stock assessment of the Bombay duck resource off Nawabunder, Saurashtra coast were made based on the data collected during 1976-79. The estimated average population parameters, Z, M and F of the species were in the order of 2.679, 1.533 and 1.146 respectively during the period of investigation. Based on these parameters, the average annual stock and the Maximum sustainable yield (MSY) were found to be 9,015 tonnes and 4181 ton-

nes respectively for the area under study. The average yield from the existing fishery was 3,561 tonnes. This indicates that the present level of exploitation, is close to the maximum sustainable yield (MSY) and that only marginal increase in landings is possible by increased fishing.

Similar study on the stock assessment of the resources and the impact of the fishery on the Bombay duck catch is in progress at the other centres.

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

Carangid investigations were continued at Waltair, Mandapam, Tuticorin, Vizhinjam, Cochin, Mangalore and Veraval. The estimated landings totalled to 165 t at Wailtair, 174.2 t at Mandapam, 2110 t at Tuticorin, 1109 t at Vizhinjam, 1932 t at Cochin, 955.5 t at Mangalore and 463.4 t at Veraval. The catches during this year improved at Cochin (30.7%), Mangalore (46.8%) and Veraval (22.4%) while they declined at Mandapam (11.5%), Vizhinjam (26.3%) and Waltair (59.5%) when compared to those of last year. The overall trend was one of marginal increase. Two peak periods of abundance during April-June and July-October were noticed. The principal gears operated for carangids were: purse seine at Cochin and Mangalore; trawl net at Waltair, Mandapam, Tuticorin and Veraval; gillnets at Waltair, Vizhinjam and Veraval and hooks and lines at Waltair and Vizhinjam.

Megalaspis cordyla in the landings of drift gillnet at Waltair and Veraval, *Decapterus dayi* in the catches of hooks and lines at Vizhinjam and purse seines at Mangalore and trawl net at Waltair; *Selaroides leptolepis* in the landings of trawl net at Mandapam and Tuticorin; *Selar mate* in the landings of hooks and lines at Vizhinjam; *Alepes Kalla* in the trawl net at Mangalore; *A. para* and *A. djeadaba* in the catches of purse seine at Cochin were some of the important carangids that contributed to the fishery.

The length ranges and modal groups of important carangids were as follows:

Name of the species	*Length range*	*Modal groups*
Selaroides leptolepis	70-169 mm	127 mm, 137 mm and 147 mm
Decapterus dayi	135-224 mm	150 mm and 190 mm
Selar mata	100-284 mm	165 mm, 175 mm and 185 mm
Alepes djeddaba	105-275 mm	120 mm, 160 mm and 190 mm 215 mm and 230 mm
A. kalla	80-130 mm	90 mm, 105 mm and 120 mm
Megalaspis cordyla	20-349 mm	175 mm and 425 mm

Assessment of the major pelagic fish resources (FB/PR/9.9) *

The extent and pattern of exploitation of the coastal pelagic resources of the west and east coast of India have been studied by monitoring the pelagic fish landings from the artisanal drift net and purse seine fisheries at the observation centres.

The production from the pelagic fish resources at Veraval increased by 22.3% during the present season, over the previous year's, with an estimated catch of 15,578 tonnes. Drift net fishery contributed to 14.1% and trawl fishery to 85.9% of the total pelagic fish landings. The maximum catch and catch rate were observed generally during March-May and October-December. Along this coast the major component species that sustained pelagic fisheries in the order of abundance were ribbon fish (24.6%), big-jawed jumper (21.2%), other clupeids (7.9%), shark (5.9%), *Ilisha sp.* (5.9%), squid (5.6%), *Hilsa spp.* (5.4%), seerfish (3.8%) and *Chirocentrus* spp. (3.3%). Maximum abundance for ribbon fish, big jawed jumper, other clupeids, sharks and *Chirocentrus* sp were observed during March-May and September-December; for *Ilisha spp.* during April and November-January; for squid during January-April; for Indian shad *(Hilsa* spp) during November-February and for seerfish during January-March and September-November.

At Bombay an estimated pelagic fish catch of 4519 tonnes were landed at New Ferry Warf by trawl. Maximum catch and catch rate for the pelagic resources were observed during February-April and September-December. Along this coast, the predominant component species were clupeids (40.6%), ribbon fish (36.1%), carangids (8.8%), tuna (8.6%) and pomfret (5.8%). Maximum concentration of Clupeids was recorded during January-March and September-November; ribbon fish during February-May and September-October; carangids during February and November-December; tuna during October-December; and pomfret during February and September-October.

The fishery for pelagic species landed an estimated catch of about 6796 tonnes at Karwar. Purse seine fishery contributed to the bulk (98.4%) of the catch. The major component pelagic species in the purse seine landings were oil sardine (63.0%), lesser sardine (18.5%), mackerel (15.2%) and pomfret (1.8%). Along this coast maximum abundance for oil sardine was observed during November-April; lesser sardine during October-November; mackerel during July-September and January-March and for pomfret during July-September.

At Mangalore with an estimated catch of 26,184 tonnes, there was a considerable increase (11.4%) in the pelagic fish landings during the present season. The principal gear that accounted for the bulk (98.8%) of the landings was purse seine. The rest of the catch was landed by the drift gill net. The principal species in the purse seine landings were oil sardine (47.3%) anchovies (28.3%), mackerel (13.3%), lesser sardines (3.2%) and carangids (3.2%); while in the drift gill net catch seer fish (64.4%), tuna (10.9%), sharks (7.8%) and pomfret (6.2%) were the

* Project completed

major species. Along this coast the peak abundance for most of the species was observed during September-December.

The artisanal fishery at Calicut landed an estimated catch of 2451 tonnes of pelagic fish by Pottenkolli vala (51.3%), Nethalvala (38.1%) drift net (8.2%) and gill net (2.4%). The dominant species in the catches were oil sardine (81.0%), mackerel (10.2%), seerfishes (4.6%) and tuna (3.1%). Off this coast the maximum abundance was observed for oil sardine during May and October-January, mackerel during September-November, for seerfish during September-October and for tuna during August-October and February-March.

At the fisheries harbour, Cochin, an estimated 19,452 tonnes of pelagic fish were landed mainly by purse seine (92.0%) and drift gill net (7.8%). The dominant resources that contributed to the fisheries were oil sardine (75.7%) mackerel (15.0%), tuna (3.4%), seerfish (3.3%) and whitebait (1.5%). Their peak abundance during the year was observed during December-April, September-October, June-August, October-December and in October respectively.

The artisanal fishery at Vizhinjam landed an estimated catch of 4500 tonnes of pelagic fish by several types of gear. The bulk of the pelagic species was landed, however, by boat seine (34.6%), hooks and line (33.6%) and drift gill net (25.6%). The major resources that contributed to pelagic fisheries during the year in the order of abundance were carangids (24.8%) tuna (21.7%), ribbon fish (17.8%), anchovy (10.0%), mackerel (8.9%), rainbow sardine (5.8%), seerfish (3.1%) and lesser sardine (2.5%). The peak periods of abundance for carangids during March- May, July-August and October-December; for tuna during March-May and September-October; for ribbon fish and anchovy during June-July; for mackerel during February-April and July-October for seerfish during April-May and September-October; and for lesser sardines during May and October-November were observed.

The pelagic fisheries off Tuticorin have yielded an estimated catch of about 2104 tonnes. The principal gear that landed the catches were gill net (71.0%), drift net (19.3%) and hooks and line (6.4%). Along the coast, the bulk of the catch was constituted by lesser sardine (71.0%), seerfish (12.3%) carangids (11.2%) and tuna (5.5%).

The peak period of abundance for lesser sardine was observed during November-January; seer fishes during September-November; carangids during February-March and for tuna during May-August.

At Mandapam gill nets (30 mm — mesh) operating in the Palk Bay landed an estimated catch of 2745 tonnes. Lesser sardines (dominated by *Sardinella albella)* contributed to the bulk (97.2%) of these landings. Two types of drift gill nets (60 mm & 140 mm mesh) operating in the Gulf of Mannar landed an estimated 158 and 10 tonnes of pelagic fish respectively at Keelakkarai. In the former, *Hilsa kelee, Chirocentrus spp,* belonids, bardacuda, seerfish, mackerel; and in the latter, seerfish, tune, shark and *Caranx spp* were the principal species caught. Off this coast peak abundance for sardines during May-June and for the other resources generally during April-June and December-February were observed.

The pelagic fish landings at Madras were estimated at 472 tonnes; of which 55.7% at Kasimedu and 44.3% at Nochikuppam were landed by four types of gear. The foremost among them being gill net (42.8%), followed by drift gill net (29.8%); bag net (19.4%) and hooks and line (8.9%) with an average catch rates of 24.2, 21.9, 84.0 and 12.5 kg respectively. Important species that contributed to the catches in the order of abundance were *Sardinella spp* (36.7%), seerfish (17.6%), *Hilsa* sp (9.9%), Shark (8.0%), anchovy (6.1%), mackerel (5.9%), *Caranx* spp (4.9%) and tuna (4.7%). Along this coast, the abundance of lesser sardine was found during May-July and September-December; seerfish mackerel and tuna during February-June; *Hilsa* sp during February-April; sharks during May-June and December-January; anchovy during November-January and June, and *Caranx* spp during March-June.

At Waltair, the pelagic fish production showed improvement with an estimated catch of 1746 tonnes of which 42.0% landed at Lawson's Bay and 58.0% at Fishing Harbour. Several types of gear were operated during the year. However, the principal gear that accounted for the pelagic fish landings was the shrimp trawl (56.4%), followed by hooks and line (17.3%), bottom set gill net (15.1%), shoreseine (6.1%) and gill net (5.0%). The highest catch rates by the artisanal units were recorded generally during February-May and during August-October; and by the shrimp trawl during July-September. The important pelagic species that contributed to the pelagic component were mackerel (10.7%), carangids (10.1%), ribbon fish (9.4%), anchovies (6.3%), seerfish (6.0%), sardine (4.8%) and shark (4.8%). Along this coast the maximum abundance of *Sardinella* spp was observed during January-March and July; seerfish during July-September and December-January; mackerel during February-June; carangids during January-April and August-October; anchovies during June-November; ribbon fish during July-December and shark during April-July.

Studies on the fishery and resource characteristics of the Indian shad, *Hilsa illisha* off the West Bengal-Orissa coast (FB/PR/10)

The project which was initiated in September 1984 envisages detailed study of the peak fishery by the scientist and technical assistant teams at the major fish landing centres, namely, Diamond Harbour, Kakdwip, Beguakhali Namkhana, Kalistan, Fraser Gunj, Junput and Digha in West Bengal. Accordingly, a special survey of the hilsa fishery during October-December, 1984 was carried out.

Gearwise data on catch, fishing effort, species composition and size composition were collected. A total of 565.5 tonnes of *Hilsa* was landed from different centres during the period of survey. The bulk of the catch (65.0%) was landed at Diamond Harbour followed by Digha (20.0%), Kakdwip (8.0%) and Namkhana (5.0%). The landings at Junput (2.0%), Fraser Gunj (0.8%) and Kalistan (0.4%) were poor.

The contribution of the drift gillnets, namely, *Chandijal* and *Ilishjal* to the catch was highest (53.3%) as compared to that of encircling seine nets, namely, *Jangal* and *Kachal* (46.7%): peak landings of 255.0 mt were recorded in October which then declined to 243.0 tonnes in November and then to 67.6 tonnes in December. The fishery

from the marine environment appears to start in July and continue till March.

A total of 10,376 fish ranging from 170 mm to 570 mm were examined for length frequency. An examination of the data pooled for the period of survey shows five modes at 285 mm, 325 mm, 385 mm, 430 mm and 490 mm probably representing different age classes that sustained the fishery. The size composition of *Hilsa* taken from Jangal, a non-selective gear, showed that 1) there was recruitment of smaller size groups into the fishery in November and December 2) there was significant addition to the size group about 312 mm in November as compared to October, 3) a marked depletion of the size groups above 312 mm in the month of December as compared to November and 4) a general phenomenon of systematic additions to and removals from the size groups indicative of organised movement of fishes from and to the fishing grounds.

Examination of scales revealed the presence of radii and growth checks and otoliths the presence of growth checks. The number of radii and growth checks increased with the size of the fish. The sex ratio of male and female was 1:1.27. Males ranged in size from 190 mm to 410 mm while females varied between 200 mm and 560 mm. Majority of males (91.5%) and females (48.8%) were immature. Maturing (17.6%) and spent (32.8%) females were also met with in the catches. Fishes in advanced stages of maturity (stages V and VI) were landed from Hooghly river in February at Diamond Harbour. The size at first maturity for females was observed to be at 360 mm. The analysis of ova diameter frequency has shown that a single dominant group gradually progresses from immature to mature stage indicating a single spawning each year in *Hilsa*. The fecundity ranged from 4,67,060 to 13,69,450 in fishes of the length range 360 mm to 495 mm.

The relationship between length and weight, length and depth and total length and standard length were estimated as follows:

Length - weight relationship

a) Log W = 9.3555 + 2.7530 Log standard length, r = 0.9782.

b) Log W = 10.2064 + 2.8053 Log Total length, r = 0.9789.

Total length - depth relationship

Depth = 1.964 + 0.2546 total length, r = 0.9906.

Total length - standard lentgh relationship

Standard length = —8.0302 + 0.8438 × total length r = 0.9965

Based on the experience gained in the survey of the winter fishery for hilsa shad in West Bengal, a similar survey of monsoon fishery from June to October is suggested. Studies on age structure, rate of exploitation and mortality will be continued to assess the stock size and maximum sustainable yield.

The catches of demersal resources of catfish, perches, threadfinbream, sciaenid and silverbellies were monitored and the biology of various species was studied. Analysis of catch and effort data from the operations of exploratory trawls and commercial trawls carried out at different centres and the pattern of distribution and relative abundance of the groundfish categories are described.

Silverbelly fishery showed considerable decline at most centres, though it still formed a significant part of the demersal fish landings. Population parameters/yield per recruitment studies indicated that an increased effort could bring in larger catches at Madras, while increased effort will reduce the yield at capture is increased. Small size perches were also caught by shore seines and traps. Absence of mature females of catfish in Cochin waters was a significant observation.

Estimation of the stocks of catfish (FB/DR/1.8.1)

An estimated 739620 kg cat fish was landed at Veraval of which 47363 kg (64.04%) by trawl gear and 265989 kg (35.96%) by drift nets respectively. The percentage of cat-fish in the total fish catch during the year was 1.23. The dominant species in trawl catches were *Tachysurus tenuispinis, T. thalassinus, T. dussumieri* and *O. militaris,* whereas in the drift nets the only mafor species was *T. dussumieri* (95.55%).

The total catfish catch at Calicut was 283.2 tonnes as against 670.7 tonnes during the last year. The catches were brought by two gears mainly, hook and line—235.9 tonnes and drift net 47.4 tonnes respectively. The sudden drop in the catches during the current year was attributed to the disappearance of *T. tenuispinis* shoals from the near shore waters, which were usually caught in Pottenkolli vala. The drift net catches comprised mostly *T. dussumieri* (23.7 tonnes) and *T. serratus* (14.9 tonnes), whereas *T. tenuispinis* was the sole contributor for the hook and line catches. In *T. dussumieri* fish in maturity stages V and VI were dominant in July and August and stage VII in October. In *T. tenuispinis* V, VI and VII stages were common in August-September months.

An estimated 8,80,944 kg catfish was landed at the Fisheries Harbour, Cochin. The landings were 57% more than the previous year, which was mainly due to improved trawl landings. The trawl gear contributed 69.90% (563.5 tonnes) of the total catch and drift net 39.09% (344.4 tonnes) and purse seine catches were negligible. In the order of abundance the species *T. seratus* (139.8 tonnes) *T. dussumieri* (82.9 tonnes), *T. thalassinus* (62.4 tonnes) and *T. tenuispinis* (59.3 tonnes) contributed to the drift net catches. In trawl gear major contribution was by *T. thalassinus* and *T. tenuispinis* 265.4 tonnes and 252.6 tonnes respectively. An interesting observation is that during the last 4 years mature and gravid females of the species *T. tenuispinis* and *T. thalassinus* were not encountered in Cochin waters.

At Waltair the cat-fish data analysgenous gears at Lawson's Bay. The mercial trawlers operating from Visakhapatnam Fishery Harbour and indigenous gears at Lawson's Bay. The

trawl gear landed 114.3 tonnes, hook and line 59.0 tonnes and bottom-set gill nets 0.8 tonnes. Only two species namely *T. thalassinus* 110.07 tonnes (96.3%) and *T. tenuispinis* 4.28 tonnes (3.7%) contributed to the trawl fishery. Whereas in hook and line the composition was 96.7% and 3.3% and in bottom-set gill nets the two species made up 87.1% and 12.9% respectively.

Females of both the species were encountered during November and December, indicating the spawning probably in the month of October or so.

Resources characteristics of perches (FR/DR/1.8.2)

During the year a good fishery for perch was reported from all the centres. Indigenous gear like hooks and lines landed good quantities of perches along with other fish. Main gear employed to catch perches were hooks and lines, drift nets of different mesh sizes, gill net, shore seine, boat seine and perch traps. The hooks and lines appears to be more popular than other gears for catching perches. Small-sized perches were caught by shore seine called *Olai valai* operated close to shore in shallower waters.

Centre of observation	*Total landings of perches in tonnes*	*Gears employed*
Tuticorin	803.8	Hooks and lines, drift net, gill net, shore seine.
Vizhinjam	270.6	Hooks and lines, boat seine, drift net and *Konchu vala.*
Mandapam	35.0	Perch traps, Hooks and lines.

Lethrinus, Serranus, Lutjanus, Diagramma, Lates calearifex, Nemipterus, Priacanthus, Siganus, Callyodon and *Psammoperca* were the important groups of fishes caught at the different centres. *Lethrinus nebulosus* from 4.0 to 80.0 cm were observed in the landings. Smaller fish were caught by shore-seine and larger fish by hooks and lines and large-meshed drift net.

At Tuticorin 803.8 tonnes of perches were landed. Hooks and line was the most widely used gear to catch large-sized perch. The next important gear was *Paru Valai* (wide-meshed drift net). Small perches from 4.0 to 17.0 cm were caught by *Olai valai,* a sort of shore seine. *Lethrinus, Serranus, Lutjanus, Diagramma, Lates* and *Psamoperca* were the important groups of perches caught at Tuticorin. October was the peak season for perch at Tuticorin. *Lethrinus* formed 43.1% of the perch catch. *Lethrinus nebulosus* from 4.0 to 80.0 cm were observed in the fishery.

During the year the estimated perch landing at Vizhinjam came to 270.6 tonnes which was 4.6% of the total fish landed there. Over 50% of the perch caught were by hooks and lines. Drift nets, boat seine and *Konchu vala* were also used in the perch fishery at Vizhinjam. Nemipteridae

formed the major group followed by Priacantharidae, Lutjanidae, Lethrinidae and Siganidae. Two peaks in the perch landings were observed at Vizhinjam, one during August-September and the other during January-February.

Indigenous traps and hooks and lines were employed in the perch fishery at Mandapam. The total perch landings during the year at Mandapam came to 35.0 tonnes, of which 29.4 tonnes were landed by perch traps and 5.5 tonnes by hooks and lines. *Lethrinus nebulosus* formed the important group. Other species that supported the fishery at Mandapam were *Lutjanus fulviflamma, Epinephilus, Plectorhynchus, Siganus* and *Callyodon. Lehtrinus nebulosus* from 9.0 to 30.0 cm were observed in the catches at Mandapam.

Resources characteristics of threadfinbream (FB/DR/1.8.3)

At Waltair, the private trawlers landed an estimated 535 tonnes of threadfinbreams which formed 8.4% of total trawl landings. Better catches and catch rates were obtained during April and January. There was a decline of 63.1% in the nemipterid catches when compared to the previous year, along with a 5.1% decline in the effort.

At Kakinada, an estimated 719 tonnes of nemipterids were landed by private trawlers, forming 4.5% of total trawl catch. The catches were good during December-February period; the catches during these three months together accounted for 74% of threadfin-breams landed during the period under report. The catches showed a decline of 34% over the previous year along with about 27% decline in the effort. The catch per unit effort also showed a decline of about 9%.

At Madras, an estimated 396 tonnes of threadfinbreams were landed by private trawlers, which formed 8.9% of total trawl catch. The catch and catch rate were high during August. The landings of these fishes showed a decline of about 57% over previous year along with a 12.5% decline in the effort.

At Cochin, the private trawlers landed an estimated 5366 tonnes of threadfinbreams. Peak catch and catch rates were obtained in August. The nemipterid catches at this center showed an increase of 426% when compared to the previous year, though there was a decline of 25% in the effort.

At Calicut the estimated landings of threadfinbreams were 43 tonnes, as during the previous year.

At Bombay, at the two landing centres, Sasoon Docks and New Ferry Whay together, an estimated 2580 tonnes of threadfinbreams were landed. Highest landings were obtained during October - November. When compared to previous year, the landings showed a decline of 14% with about 2% decline in effort.

At Veraval, an estimated 2884 tonnes of threadfinbreams were landed by private trawlers which formed about 5.2% of total trawl catches. Peak catches and catch rates were obtained during April and January.

Five species contributed to the fishery at Waltair, Kakinada and Madras whereas only three species con-

tributed at Cochin, Bombay and Veraval and only one species at Calicut. *Nemipterus japonicus* and *N. mesoprion* were the most abundant species at different centers and *N. japonicus* was the only species at Calicut. At Waltair, *N. japonicus* and *N. mesoprion* contributed to the fishery more or less equally; at Kakinada *N. japonicus* formed 28.2% and *N. mesoprion* 60.3% of nemipterid catches. At Madras these two species formed 39.4% and 16.8% respectively. At Cochin *N. mesoprion* was most abundant and formed 69% of nemipterid catches. At Bombay and Veraval, *N. japonicus* was most abundant and formed 63.4% and 84.3% respectively.

Detailed studies were carried out on *N. japonicus.*

At Waltair the length range of catch was 95-265 mm; smaller fishes with a modal length of 115 mm occurred in April and August. At Kakinada the length range of the catch was 75-275 mm; fishes of smaller lengths forming modes at 75 and 85 mm occurred in April and December respectively. At Madras, the length range of catch was 75-295 mm; smaller fishes forming a mode at 95 mm occurred in July, December and January. At Cochin, the length range of catch was 105-245 mm; smaller fishes forming a mode at 105 mm occurred in June. At Bombay, the length range of catch was 85-245 mm; smaller fishes forming a mode at 105 mm occurred in February. At Veraval, the length range of catch was 35-305 mm; smaller fishes forming modes at 65 mm and 85 mm occurred in December and January respectively.

Fishes with ripe gonads were observed during July, October and November at Madras. At Cochin, all the specimens examined were in immature and early maturing stages. At Bombay, gravid adults were observed in October and December-February periods. At Veraval, gravid adults were observed during October and December-February periods. At Veraval, gravid adults were observed during October-March period.

The population parameters for *Nemipterus japonicus* were estimated at Kakinada and Madras and the results are under publication.

It is seen that, at Kakinada, under the present age at first capture, increase in effort will result only in reduced yield per recruit, and that increased yield per recruit can be obtained by increasing the cod-end mesh size. At Madras, effort can be increased to get increased yield without adversely affecting the stock.

Assessment of Sciaenid resources (FR/DR/1.8.4)

At Waltair, from the private trawlers, an estimated total catch of 557.3 tonnes of sciaenids (which contributed to 8.7% of total catches) was landed. It was observed that the catch per hour values were increased more or less from month to month up to December '84. Thereafter there was a decrease in the catches. Peak landings were recorded during September-December '84.

From Fishery Survey of India trawlers, namely, M. V. 'Matsyashikari' and 'Matsyadarshini' about 9 tonnes of sciaenids were caught from the bottom trawls and purse seiners.

J. carutta (28.4%) *J. vogleri (14.2%), K. axillaris, N. maculata* (17.2%) and *P. macropthalmus* (7.5% are the species that mainly montributed to the catches.

At Kakinada, an estimated catch of 1475 tonnes of sciaenids was landed, which contributed to 9.2% of total catches. Peak landings were recorded in April '84, August '84 and January '85. There was an increase in sciaenid catches by 8.3%, when compared to previous year, with a corresponding increase of 36% in catch per hour values.

Atrobucca nibe, Jhonius dussumieri, J. vogleri, O. ruber and *N. maculata* dominated in the catches and these species contributed to 62% altogether. Excepting for *N. maculata* other species showed an increasing trend in the catches annually. It was observed that there was a significant decrease in the catches of *J. carutta* by 81% when compared to last year. *J. carutta* measuring 85-235 mm were taken for biological studies.

At Madras an estimated total catch of 215 tonnes of sciaenids was landed by private trawlers. Sciaenids contributed about 4.8% of total catches. Peak landings were recorded in May '84. It was observed that there was a decrease in the catches by 60.8% when compared to the catches of previous year.

J. carutta (19.0%), *O. argenteus* (14.2%), *K. axillaris* (13.0%) and *Pennahia aneus* (11.7%) dominated among sciaenid catches.

J. carutta measuring 80-229 mm were taken for biological studies. Females with ripe gonads were observed in April, June, July and November. Prawns and Squilla were the main items of food.

At Veravel an estimated 10,920 tonnes of sciaenids were landed by the trawlers and gill netters. But more than 90% of the catches were realised by trawlers. When compared to the catches of previous year, there was an increase by 16.6% in the sciaenid catches.

For *O. cuvieri,* peak landings were recorded during January-March '85. *O. brunneus* and *P. diacanthus* also contributed to the fishery and peak landings were recorded during the period December '84 to February '85.

O. cuvieri, ranging in size from 90-340 mm were obtained and I year and II year age groups mainly contributed to the fishery.

Acetes sp, *Solenocera* sp, and *Hippolytes* sp mainly contributed to the food of this species.

Mature females were obtained during September '84-January '85 and specimens with running ovaries were observed during November-January. Spent fishes were seen during January-March '85.

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

Fishery: At Kakinada, an estimated 1600 tonnes of silverbellies were landed by private trawlers, which formed 10% of total trawl catches. Better returns were obtained in April, August and December-March periods. The silverbelly catch showed a decline of 24% over that of previous year along with about 27% decline in the effort.

At Madras, an estimated 560 tonnes of silver bellies were landed forming 12.6% of total trawl catch. Peak catches and catch rates were obtained in June, October and February. When compared to the previous year, the silver belly catch showed a decline of 26.5% along with a decline of 11.2% in the effort.

At Kakinada, a total of nine species contributed to the fishery, of these *Leiognathus bindus* was most dominant, followed by *Secutor insidiator* and these two species together forming 70% of silver belly catches. The catches of these two species showed considerable decrease over prevous year (13.7 and 54.1% respectively). At Madras thirteen species contributed to the fishery. Of these *L. bindus, L. splendens* and *S. insidiator* were most abundant, together forming about 70% of silver belly species landed. When compared to the landings of previous year, the catches of *L. bindus* increased by 111.4% whereas those of *L. splendens* and *S. insidiator* showed a decrease of 23.6 and 2% respectively.

Biology of L. bindus: At Kakinada, the length range was 22-127 mm; fishes of smaller lengths forming a mode at 27 mm occurred in February and at 32 mm in May and November.

At Madras, the length range of catch was 52-122 mm, fishes of smaller lengths, forming modes at 57 mm, occurred in October, February and March and at 62 m in January.

Gravid adults occurred in almost all months at Madras.

Biology of S. Insidiator: At Kakinada, the length range of catch was 42-117 mm and smaller fishes forming a mode at 47 mm occurred in April and July. At Madras, the length range of catch was 32-117 mm; smaller fishes forming a mode at 47 mm occurred in December.

At Madras gravid adults occurred in almost all months, with peaks in March and December.

Estimation of major demersal fish resources (FB/DR/1.9)

The demersal fishes made up 73% of the estimated total fish landed at Veraval. Of the 43652 tonnes of demersal fish caught, 42267 tonnes were by trawl and 1385 tonnes by gill nets at catch rates of 70.32 and 6.01 kg/hr respectively. Sceaenids made up the major part of the geared fish landed (9532 tonnes) and nemipterus made up 2885 tonnes and prawns 2560 tonnes. Other groups that contributed significantly included crabs 5529 tonnes and cephalopods 6647 tonnes.

At Cochin the estimated demersal fish catch in the commercial shrimp trawlers was 11,027 tonnes at an annual catch rate of 326 kg/unit, for an effort of 33,825 units.

The total catch was the highest in August (3422 tonnes) for an effort of 4,239 units at a catch rate of 807 kg/unit. In October, November and December the effort expended was very little and the catch was also very poor. However in October the catch rate was found to be the highest 1,649 kg/unit. Prawns constituted 21.37% of the total catch (2547 tonnes) at an annual average catch rate of 70 kg/unit. The *Parapenaeopsis stylifera* fishery was at its peak in April-July '84 and March '85 with the highest catch and catch rate (615 tonnes at a catch rate of 215 kg/unit) in July. The *Metapenaeus dobsoni* fishery was

in April-May and February-March at its with the highest catch and catch rate (210 tonnes at catch rate of 60 kg/unit) in February.

Among fin fishes the threadfin breams were the major constituents (5348 tonnes) forming 48% of the fin fish catch at an annual average catch rate of 158 kg/hr. The main species contributing to the fishery was *Nemipterus mesoprion* and *N. japonicus)* with negligible quantities of *N. delagoae.* The nemipterid landing was the highest in June-July, with nil landings in October-November and January. The cat fishes constituted mainly by juveniles of *Arius tenuispinis, A. thalassinus* and *A. maculatus* was another important component of the demersal fin fish catch forming 10.36%, the total landings being 889 tonnes.

The annual landings of the Malabar Cole *Cynoglossus macrostomus* was 419 tonnes at an average annual catch rate of 12.40 kg/unit. The highest catch and catch rate was in July 50 kg/unit, whereas in September-November the catch was negligible. Other main groups landed were sciaenids, barracudas, perches and cephalopods.

An estimated 4654.5 tonnes of demersal fish was landed at Tuticorin at the catch rate of 157.2 kg/unit by 29,602 units of trawlers. The catches were poor during the last quarter, and the effort input was also the least during February and March 1985. The important perches caught were sciaenids, 1344.1 tonnes (28.9%), prawns, 886.9 tonnes (19.1%), nemipterids 823.3 tonnes (17.7%), other perches 322.7 tonnes (6.9%), *Saudira spp* 200.1 tonnes (4.3%) rays, 180.6 tonnes (3.9%), catfish 131.3 tonnes (2.8%) and crabs 11.9 tonnes (2.4%).

At Madras, 'Matsyajeevan' operated trawlnet during all the months of the year and landed 41,861 kg of fish spending 997.88 trawling hours. The catch rate was 41.94 kg/hr. 'Matsyaharini' did purse seining throughout the year but the fishing was effective only during 3 months of the year, the total catch being 648 kg of fish. The CPH was 28.35 kg.

Bottom trawling was done in 38 fishing areas in degree squares 10-79, 10-80, 11-79, 11-80, 12-80 and 13.80. No catch was obtained from 11-79/1F and 6F. The highest yield of 215. 5 kg/hr was obtained from 10-79/5F in the month of June. The catch consisted of silver bellies and carangids.

M.L. 'CADALMIN — III' operated trawl net from August '84 to January '85 covering areas 12-80/5B, 6B, 5C, 6C and 13-80/1C, 2C. Silver bellies constituted the major catch. The best yield came from 12-80/5B (CPH:28.51 kg) in August followed by 13-80/1C (CPH: 18.07 kg) in September.

An estimated 15989 tonnes of fish (including 3348 tonnes of prawns which formed about 21% of total catch) were landed by the trawlers at Kakinada. The catch showed a decline of about 24% over that of previous year along with about 20% decline in Pablo units, 26% decline in Pomfret units and 15% decline in Sorrah units. All the important demersal groups showed considerable decline except sciaendis which showed an increase of 8.3%, lizard fish which increased by 30% and cat fish by 8%.

As during previous years effort standardisation was made taking

pomfret as standard unit and considering all demersal groups together as one group.

In all months as well as in total annual catch, the demersal component was considerably high, the percentage ranging from 65.5 in February to 79.1 in October. Among the major demersal finfish resources, peak returns of nemipterids were obtained in December-February period when fishing takes place in relatively deeper waters beyond 50 m. In sciaenids returns were obtained in April, August and December-February periods; in in silverbellies during April, July, August, December-March; in lizard fish durng July, December and February; in catfish during December-March; in flat fish duriing April and January-March.

An attempt to study the MSY of all demersal fish as one group, with all effort standardisation terms of pomfret units, instead that the demersal fish population in the sea off Kakinada is on the verge of being overfished and any increase in the effort without changing the fishing ground or without modifying the trawl net may result in over exploitation of the demersal resources.

At Waltair an estiated 5378 tonnes of all fish inclusive of 938 tonnes of prawns were caught by the trawlers (OAL 30'-37' with 40-90 H.P. engines). A fall of 2050 tonnes of catch is observed whic is mainly due to fall in catch rates. The catch rates during 1983-1984 from 26 kg fallen to 18.2 kg in the current year under report.

The most abundant group/species that caught were penaeid prawns 888 tonnes (13.9%), ribbon fish 565 tonnes (8.9%), crabs 544 tonnes (8.5%) *Saurida* sp 536 tonnes (8.4%), *Leiognathids* 333 tonnes (5.2%), *Nemipterus mesoprion* 330 tonnes (5.2%), *Uveneus* sp. 304 tonnes (4.8%), *Kathala* axillaries 292 tonnes (3.6%), stomatopods 228 tonnes (3.6%) and *Johnius carutta* 181 tonnes (2.9%).

Pond culture of marine fishes (FB/CUL/1.1)

Experiments on the culture of marine fishes were carried out in the coastal ponds developed at Tuticorin, Mandapam Camp and Madras-Muttukad. Seeds of mullets and milkfish were collected from estuarine area. tidal pools, lagoons and intertidal zones. The grounds for the collection of *Chanos* seeds in April-May are the Velinekkam tidal flats at Tuticorin, Manali Island, Thoni Thurai and Pillaimadam at Mandapam and Adyar estuarne region in Madras. Young ones of *Lates calcarifer* were gathered at culture site at Tuticorin and stocked in pond. Mullet seeds are available in different seasons of the year, *Valamugil seheli, Liza macrolepis, L. cunnesius* and *Mugil cephalus* being the species stocked.

The hydrological factors of culture site were regularly monitored. The high saline condition in ponds became a hindrance for the growth of mullets and milkfish. The growth rate and production rate differ according to seasons and systems of culture in different centres. At Tuticorn, better survval and growth rate was found in *Lates calcarifer*, 17 mm/80 g/month. *Chanos chanos* showed a rate of 26 mm/22 g/month and *Liza macrolepis* of 18 mm/7 g/month.

At Mandapam Chanos showed growth rate up to 25.1 mm/18.3 g per month without additional feeding and up to 42.1 mm and 31.1 g per month with feed, while mullets gave a monthly rate of 16.7 mm and 6.71 g without feed. At Madras mullets showed a growth rate of 36 mm and 25 g per month and chanos 36 mm and/ 28 g per month.

Culture of marine fish in cages (DF/CUL/1.4)

Net cages measuring 5 x 5 m were used for rearing groupers *(Epnepheles* spp) and snappers (species of *Lutjanus* and *Lethrinus).*

Juveniles of *Epinepheles tauvina* 150-250 mm in total length were stocked in the cages, their mean length and weight were 184 mm and 92 g respectively. After a period of eleven months their mean size increased to 363 mm, registering a growth of 16 mm per month per fish. The mean weight increased from 92 to 770 g at the rate of 62 g per month. In the other experiment after a period of four months the mean size increased from 146 to 205 mm, showing an increase of 15 mm per month per fish and the mean weight from 23 to 75 g, an increase of 13 g per month per fish.

During the last quarter under report juveniles of *Epinepheles tauvi*na (70-140 mm) were collected alive from trap catches and by drag nets. They are kept in acquaria in running water for later stocking.

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

Milk fish, mullets, *Megalops* were cultured in Polythene-lined ponds. The seed availability in the wild showed a different pattern this year, the seed of *M. cephalus* being more abundant over a longer period, while those of milk fish and *M. cypinodes,* which are usually plenty, were obtained in small numbers only.

Chanos gave a growth rate of 1.05-1.35 g per day, depending on stocking rate. A stocking density of 1.5/m^2 gave the maximum production obtained, 2133 kg per ha. *M. cephalus* showed a growth rate of 0.8 to 1.1 mm (0.5 to 0.7 g) per day at the stocking rate of 1/m^2. The production obtained amounted to 1100 kg/ha. Megalops, stocked at 1.4/m^2, gave a monthly growth rate of 17 m and 7.6 g and a production rate of m1170 kg/ha

Attempts at laboratory breeding of flat fishes could not succeed for want of mature fish or spawners.

Culture of marine fish in pens (DF/CUL/1.6)

The pens were stocked with milk fish fingerlings at rates of 10,000-20,000 per ha and periods of 180-200 days were available for culture. The 0.25/ha pens gave growth rates ranging from 0.26 to 0.42 g per day and production rates of 114-194 kg/ha. The 0.5/ha pen was stocked at rate of 286 kg/ha for a culture period of 168 days. The 1-ha pen, stocked at 20,000/ha, was harvested in three stages in December, March and April and gave growth rates of 0.31 g/day during the first 3½ month period, 0.98 g/day during the next 3 months and 4.3 g/day in the final 1½month period. An experiment of restocking the 0.5/ha pen in December and harvesting it in April gave growth rates of 1.81 g/day.

There was an increase in the penaeid landings at Sakthikulangara, Bombay, Veraval, Tuticorin and Puri. While the non-penaeid landings improved considerably at Bombay and Veraval they declined drastically at Kakinada. The lobster landing increased at Veraval and Bombay during the year. Unusually heavy landings of the crab *Charybdis cruciata* was recorded at Veraval.

The prawn hatchery techniques were further simplified and standardized. 4.78 million postlarvae of *P. indicus* were produced at the Narakkal laboratory. 1.84 million seed-sized prawns were supplied free of cost to the local farmers. For the first time in India *Penaeus japonicus* was induced to mature and spawn in capitivity by eyestalk ablation and the larvae were successfully reared to postlarval stage and beyond. Sea-ranching programme for prawn has been initiated. Larvae of *Scylla serrata* and *Portunus pelagicus* have been successfully reared to the crab stage at Tuticorin.

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

Detailed investigations on the resources characteristics, exploitation and biological features of important species of penaeid prawns were carried out from twelve centres namely, Veraval, Bombay, Karwar, Mangalore, Calicut and Cochin on the west coast, and Puri, Waltair, Kakinada, Madras and Tuticorin on the east coast. Trawling was the major gear employed in the fishery. The salient features of the fishery as observed at the different centres are summarised in Table — 1. The year witnessed an increase in total catch as well as catch rates at Veraval, Bombay, Sakthikulangara, Tuticorin and Puri, while in the other centres the fishery declined to different degrees when compared to previous year.

At Veraval a two-fold increase in catch and catch rate was registered mainly on account of the heavy landings of *Solenocera crassicornis* during April-May and February-March. *Penaeus semisulcatus*, which has been a major constituent of this fishery in recent years, suffered a set back. The prawn production increased by 29% at Sasoon Dock and 26% at New Ferry Wharf as a result of considerable improvement in the landings of *Parapenaeopsis stylifera* and *Metapenaeus affinis* at both the centres. The maximum catch as well as CPUE was registered in September. A similar increase in the landings of *P. stylifera* was also recorded at Malpe in Karnataka and Sakthikulangara in Kerala (+78%) the monsoon months being the most productive period for the latter centre. At all the other centres on the west coast, except Mangalore the fishery suffered a set back. Even at Mangalore, though a marked increase in the total landings was registered, the catch/hr decreased from 5.3 kg of the previous year to 5.1 kg this year. The failure in the fishery of all these centres was mainly brought about by a general decline in the abundance of *P. stylifera*, a widely distributed species along the coast.

Table — 1 : Penaeid prawn fishery at various centres during 1984-85

	Veraval	Sasoon Dock	New Ferry Wharf	Karwar	Mangalore	Calicut
MECHANISED FISHERY						
a) Catch in tonnes	3245.000	13223.871	12291	383.405	2142.400	213.600
b) Catch/effort in kg	5.4	64.9/trip	520/trip	4.8	5.1	9.9
c) Important species	l, j, k, m b, i, e	j, b, c, n d, l, f	j, b, c, l n, d	j, a, c b, g	j, a, c, f h, b	j, c, f, h, b
d) Productive months	4-5 ('84) & 2-3 ('85)	9-10	9-10	5 & 3	12 & 1	11 & 3
INDIGENOUS FISHERY						
a) Catch in tonnes	—	—	—	10.700	—	73.51
b) Catch/effort in kg	—	—	—	20.5	—	15.3
c) Important species	—	—	—	j, b	—	a, j, f,
d) Productive months	—	—	—	4, 5, 3	—	7, 8, 9
PRICE STRUCTURE						
a) Jumbo	—	—	—	—	—	—
b) Large	—	—	60-85	—	18-74	85
c) Medium	—	—	18-50	—	21-40	40
d) Small	—	—	4-18	—	7-16	20
e) Tiny	Rs. 2/kg	—	4-6	—	10-21	—

	Cochin	Sakti-kulangara	Tuti-corin	Madras	Kakinada	Waltair	Puri
MECHANISED FISHERY							
a) Catch in tonnes	2357.068	14574.978	961.000	443.000	2715.300	897.600	784.140
b) Catch/effort in kg	16.23	19.4		2.90	9.54	2.57	6.3
c) Important species	b,h,j,a f, c	p,j,f,a,c b,o,p,i	f,j,i,a	a,f,c i, h	c,a,f,j h, b, k	c,f,h a, i	a,h,c,k j, g, l
d) Productive months	4-7	6-8	6-8, 12	7, 12,1	8-9, 1-4	11, 10,9,4	9, 12,1
INDIGENOUS FISHERY							
a) Catch in tonnes	—	—	—	—	—	—	112.642
b) Catch/effort in kg	—	—	—	—	—	—	0.271
c) Important species	—	—	—	—	—	—	g,b,f,h,a
d) Productive months	—	—	—	—	—	—	9, 10,11
PRICE STRUCTURE							
a) Jumbo	—	60-80	—	—	110(headless)	—	—
b) Large	30-60	35-75	—	—	90 "	65-70	—
c) Medium	15-25	15-25	—	—	18-45	60-75	—
d) Small	10-15	6-20	—	—	10-18	30-50	—
e) Tiny	7-15	6-15	—	—	10	47	—

a — *M. dobsoni*, b — *M. affinis*, c — *M. monoceros*, d — *M. brevicornis*, e — *M. kutchensis*, f — *P. indicus*, g — *P. merguiensis*, h — *P. monodon*, i — *P. semisulcatus*, j — *P. stylifera*, k — *P. hardwickii*, l — *S. crassicornis*, m — *P. penicillatus*, n — *M. stridulans*, o — *P. acclivirostris* and p — *Trachypenaeus* spp.

The landings of estuary-dependant species such as *Metapenaeus dobsoni* and *M. monoceros* showed a general improvement in these waters except at Cochin where it declined considerably from the previous years landings.

On the east coast, prawn landings increased, with *Penaeus indicus* as the major species at Tuticorin by trawl nets and at Puri by gill nets. At Paradeep (Orissa) also, higher landings as well as catch rates were recorded by trawlers as compared to the previous year, the predominant species being *M. dobsoni*, *P. monodon* and *M. monoceros*. With *M. dobsoni* as the principal species at Madras and M. *monoceros* at Kakinada and Waltair, the prawn production in the Coromandel and Andhra coasts declined markedly this year from that of the previous year. At Waltair, the failure in the fishery was mainly due to the drastic reduction in the landings of *M. dobsoni*.

No significant change was noticed in the size composition of the major species in the fishery during this year. The dominant size group of *P. stylifera* was 61-85 mm along Kerala and 71-115 mm along Karnataka coasts. In Bombay waters the species was represented by slightly larger sizes (86-130 mm). The dominant size group of *M. dobsoni* was 51-90 mm at most of the centres, while at Paradeep it was slightly higher ranging 76-100 mm. Among the other major species, the predominant sizes were 126-165 mm for *P. indicus* along Tamilnadu coast, 191-260 mm for *P. monodon* at Paradeep, 105-144 mm and 115-175 mm for *M. monoceros* at Kakinada and Waltair respectively, and 61-75 mm for *S. crassicornis* at Veraval.

Peak spawning of *P. stylifera* was observed during April and December-February at most of the centres on the southwest coast, and during September-November in Bombay waters. *M. dobsoni* bred actively during the postmonsoon period (October-January) along the southwest coast and during September-October and March at Madras and January at Paradeep. *P. indicus* showed peak breeding along the Tamilnadu coast during August-September, while *M. monoceros* was seen to breed actively along the coasts of Andhra Pradesh almost throughout the year. At Veraval, *S. crassiocornis* had peak breeding during January-February.

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

The non-penaeid prawn landings at the various centres of observation are given in Table-2. The fishery witnessed improved landings at Veraval and Bombay to the extent of 225 and 120% respectively compared to 1983-84. The dol nets of Versova and New Ferry Wharf accounted for the success of the fishery in Bombay. At Kakinada there was a considerable decline in the nonpenaeid catch during this year. The marine catch was only 40% of that of 1983-84.

Acetes indicus was the major constituent at Bombay. At Kakinada also *Acetes* spp was dominant in the marine fishery. At Veraval this species was relegated to a second place *Nematopalaemon tenuipes* being predominant. The latter species and *Exhippolysmata ensirostris* were respectively next in importance at the other marine landing centres. In the backwaters of Kakinada *Macrobrachiun* ssp was most common.

Table — 2 : Catch in tonnes & C/E in Kg.

Centre	Gear	1984-85		1983-84	
		Catch	C/F	Catch	C/E
VERAVAL					
(Nawabunder)	Dol	1847.1	62.8	807.0	36.0
BOMBAY					
i) Versova	Dol	5441.7	377.0	4077.8	315.9
ii) Sasoon Dock	Dol	316.6	25.2	747.4	70.1
—do—	Trawl	51.7	10.8	240.1	11.8
iii) New Ferry Wharf	Dol	123.3	87.1	76.2	57.3
—do—	Trawl	407.2	17.2	124.6	4.8
TOTAL (Bombay)		6340.5		5266.1	
KAKINADA					
i) Fishing Harbour	Trawl	632.3	15.2	1588.0	29.0
ii) Uppada	Seine	—	—	44.3	0.7
iii) Backwaters	Drag/Stake				
(B.V. Palem)	nets	16.6	1.0(SN) 0.8(DN)	59.8	2.4(SN) 1.9 DN)

Percentage of berried individuals among *N. tenuipes* was high during April-May at Bombay and during April-May and October-November at Veraval. At Kakinada it was high in June. In the case of *E. ensirostris* the maximum period of occurrence of berried individuals was more or less the same at Veraval and Kakinada. Mature specimens of *Acetes indicus* were noticed to occur in May at Bombay.

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

Resources characteristics and biology of marine prawns with reference to their estuarine habitats were studied from Karwar, Mangalore, Calicut, Cochin, Quilon, Madras, Kakinada and Puri. It was observed that the abundance of penaeid prawns in these nursery areas was relatively less this year at Mangalore, Madras and Kakinada, while in all the other centres an improvement in the same was observed as compared to the previous year. This suggests a similar trend in abundance of prawns in the inshore waters off the respective centres for the ensuing season.

Juvenile prawns supported commercial fisheries in varying magnitudes (Table 3), with peak catches during February-March at Karwar and Puri, November-January at Mangalore April-

May and October-November at Calicut, April, October and December-January at Cochin, November at Madras and July-August at Kakinada. As usual, *Metapenaeus dobsoni* predominated the catch throughout the southwest coast. In the east coast, while *P. indicus* formed the mainstay of the fishery at Madras, *M. monoceros* was the chief constituent of the juvenile prawn population at Kakinada and Puri. In Ennore Estuary (Madras) the immigration of post larvae of *P. indicus* and *M. dobsoni* was found to take place more intensively during night than in the day time. *P. mondon* occurred in appreciable quantities in Kakinada backwaters and Chilka Lake. The size composition of most of the species in the exploited fishery showed similarities in the different estuasine systems. In Chilka Lake however, the trap fishery exhibited relatively wider size range and occurrence of larger individuals in sizeable quantities. The major size groups in the fishery were 36-89 mm for *M. dobsoni*, 45-105 mm for *M. monoceros*, 61-150 mm for *P. indicus* and 90-200 mm for *P. monodon*. The maximum sizes attained by these species in this environment were respectively 100 mm, 120 mm, 169 mm, and 244 mm in total length. All the major species exhibited preponderance of females in most of the centres studied.

Table — 3 : Estuarine prawn fishery at selected centres during the year 1984-85

	Karwar	Mangalore	Calicut	Cochin	Madras	Kakinada	Puri
Estimated catch in tonnes	67.2	18.0	132.0	1036	36.4	179.3	64.6
CPUE in Kg/net	3.5	2.2*	3.2†	1.4	—	3.9	0.04
Fishing gears	Sluice nets	Mini-otter trawl, shore seins, cast nets	Stake nets	Stake nets	Stake nets, Seines, Cast nets	Stake nets, Drag nets	Trap
Important species	*M. dobsoni, M. monoceros, P. indicus, P. merguiensis*	*M. dobsoni, P. indicus*	*M. dobsoni M. monoceros, P.indicus*	*M. dobsoni M. monoceros, P. indicus*	*P.indicus M.dobsoni M.monoceros*	*M.monoceros, P.mondon, P.Indicus*	*M.monoceros, P.indicus,M.dobsoni, P.monodon*
Peak fishing period	February-March	February-March	November-December	April-May, October-November	November	July-August	February-March

† catch/hour

* For mini otter trawl

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

The estimated catch of lobsters registered improvement at Veraval and Bombay whereas it exhibited a declining trend at Madras (Table-4). The catch per unit effort also decreased or increased accordingly. Higher yields were recorded during December, October and February at Veraval, April-June at Bombay, September at Madras and November-March at Tuticorin.

Table — 4 : Lobsters landings 1984-85

Centres of observation	*Catch in tonnes 1983-84 with C/E in kg/unit*	*Catch in tonnes 1984-85 with C/E in kg/unit*
Veraval	200.600 (0.29)	283.600 (0.47)
Bombay	315.000 (6.95)	633.800 (14.18)
Madras	9.900 (—)	7.200 (0.25)
Tuticorin	—	15.118 (5.46)

At Bombay *Thenus orientalis* which was dominant over *P. polyphagus* during the previous year was landed in equal quantity during the reported year. This species decreased at Veraval compared to its previous years landing. At Tuticorin *Panulirus homarus* and *P. ornatus* were landed and were well represented during November-March period.

Berried females of *P. homarus* were abundantly represented during August-September at Tuticorin. Berried females of *P. ornatus* were not represented at this centre. More number of females than males of *P. homarus* were abundantly present during April, January-March and similarly, females of *P. ornatus* were present during April and October.

In *P. homarus* recruitment took place during November-December period, and young females grew upto 165 mm till April, and beyond up to September-October. These females appeared to have spawned in November-December and after the spawning the larger females probably moved down to deeper waters from rocky areas of shallow waters. It appears that *P. ornatus* bred during December-January and the juveniles reached 205 mm till April, '84 thus contributing to the fishery.

P. polyphagus at Bombay exhibited prolonged breeding period over the year. At Veraval, February-March period appeared to be the spawning season as evidenced by the occurrence of berried females. Young ones of *P. polyphagus* contributed to the fishery during April-May period.

The crab fishery was good during April at Veraval whereas during February at Madras Kakinada (Table-5). At Veraval *Charybdis cruciata* and at Madras *P. sanguinolentus* were domi-

nant whereas at Kakinada *P. pelagicus* was the leading species. The size range of males and females of *P. sanguinolentus* was 24-60 mm.

Table — 5 : Crab landings 1984-85

	1983-84	1984-85
Veraval	4410 (6.43 kg/unit)	5833 (8.06 kg/unit)
Madras	167.200 (4.84 kg/unit)	74.300 (2.5 kg/unit)
Kakinada	795.000 —	498.000 —

In general, the crab fishery improved at Veraval but decreased at Madras and Kakinada.

Prawn Fishery Atlas (CF/RE/1.4)

Data on prawn landings by Fishery Survey of India and Integrated Fisheries Project vessels along the Indian coast for the year 1981 has been analysed for the preparation of the prawn atlas.

Assessment of stomatopod resources (CF/RE/1.7)

The estimated total landings of stomatopods by mechanised vessels from Karwar, Mangalore, Malpe, Calicut, Cochin, Madras and Visakhapatnam during the year 1984-85 was 11069.670 tonnes against 5447.577 tonnes in the previous year. The fishery was constituted mainly by a single species viz., *Oratosquilla nepa* except at Madras and Visakhapatnam where 3 or 4 other species also contributed to the fishery. The dominant species of stomatopods in order of abundance at Madras were *O. nepa, O. woodmasoni O. holochista* and *Harpiosquilla harpax* whereas at Visakhapatnam *O. interrupta, H. harpax* and *O. woodmasoni* were the important ones. The obvious increase in landings by two-and three-fold at Mangalore and Malpe respectively, compared to the previous year, was the main feature of the fishery. At Karwar the fishery has declined by 331 tonnes from the previous year. The dominant species of all centres *O. nepa* ranged in size between 38 mm to 145 mm in the overall fishery. The catch per unit effort was higher at Karwar and Calicut, but the highest landing was at Mangalore followed closely by Malpe, whereas Karwar occuppied the third place (Table-6). This pattern of abundance was similar to that of the previous year. The regular fishery season fell between December and April at all centres except east coast centres. The peak breeding season was March, sometimes extending up to April-May.

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

Experiments on the culture of *Penaeus indicus, P. monodon, P. semisulcatus* and *P. japonicus* in earthern grow-out ponds at Muttukadu (Madras) and Tuticorin and polyethylene

Table — 6 : Stomatopod fishery at various centres during 1984-85

Centre	Catch (kg)	Catch/effort kg.	Species composition	Fishery season	Size range (mm)	Breeding season	Gear
Karwar	1036260	17.36/hour	*O. nepa*	12-4	51-120	12,3,4	Trawl
Malpe	4563400	16.03/hour	*O. nepa*	1, 12	48-118	3	Trawl
Mangalore	5023000	12.04/hour	*O. nepa*	1, 12	38-128	3	Trawl
Calicut	13403	5.24/hour	*O. nepa*	4, 1-3	48-118	3	Trawl
Cochin	191000	0.44/hour	*O. nepa*	4	51-145	4-5	Trawl
Madras	11987	0.10/hour	4 species	2-12,1	48-108	3	Trawl
Visakhapatnam	228620	0.65/hour	4 species	6.9.10	—	—	Trawl

sheet-lined ponds at Calicut were carried out. At Tuticorin, *P. indicus* stocked at a rate of 20,000/ha exhibited a growth of 0.4 to 0.6 mm/day in 5-6 month rearing, when the reared prawns were fed with artificial pelletised feed. The survival rate varied from 27 to 29%. In the experiments with higher densities (1 lakh/ha) and pelletised feeding carried out at Calicut, an increased growth of 0.8 to 1.0 mm/day was noticed in the same species with a higher survival rate of 52 to 78% during 82-83 days rearing. The higher growth and survival obtained at Calicut was due to the lesser saline range of rearing medium and smaller size of the ponds (0.03-0.1/ha), where the pond management could have been easier than the larger ponds (0.2-0.25/ha) at Tuticorin.

P. monodon stocked at a rate of 20,000/ha in a 0.5/ha pond at Muttukadu was reared without supplementary feeding for a period of 185 days, during which time, a growth rate of 0.66 mm/day was recorded. Tiger prawn numbering 100 stocked in a 0.02/ha pond at Calicut was found to grow at a rate of 1.17 mm/day with artificial feeding.

Hatchery-raised advanced post-larvae (PL-15 stage) of *P. semisulcatus* having an average size of 13.9 mm in length were stocked at a rate of 20,000 to 36,500/ha in 0.4 ha ponds at Muttukadu, where the salinity ranged from 24 to 27‰ during 90 days of rearing. Though the growth rate was appreciable (0.85 to 1.1 mm/day), the survival of reared prawns was severely affected by the sudden depletion of dissolved oxygen level in the culture ponds.

At a stocking density of 5,000/ha *P. japonicus* showed poor growth of 0.36 mm/day in 6 months of rearing at Muttukadu. When about 100 animals having an average size of 109.7 mm were reared for a further period of 5

months, they attained an average size of 154.0 mm. Most of the females were found with developing ovaries. This is the first time that the cultured Kuruma prawn attained maturity in confined waters.

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

Experiments carried out during this period at Nararkkal helped to simplify the techniques of induced maturation and spawning of commercially important penaeid prawns in captivity, as well as the mass production of prawn seeds. Studies were also made to overcome the difficulties in the rearing of larvae of *Penaeus indicus* and *P. monodon* from postlarvae to stockable seed size in the nursery ponds.

At the Narakkal laboratory of the CMFRI, a series of experiments were carried out on the induced maturation and spawning of *P. indicus*. During this period, a total of 418 females of this species were collected, during different periods from the departmental brackishwater ponds. The eyes of these prawns were unilaterally ablated using electrocautery apparatus and kept in the broodstock pools. 92.3% of the prawns thus treated, matured and spawned in captivity showing that the methods used for ablation, water management and feeding the animals, at the Narakkal laboratory have almost become perfect. Adult prawns kept in captivity in the broodstock tanks were induced to mature and spawn as and when the larvae were required for experiments. During this period, 90.7% of the total requirements of nauplii for the hatchery were obtained from the spawners obtained from the broodstock tanks.

Work was carried out to study the influence of various types of feed and different salinity ranges on ablated prawns of *P. indicus*. Of the various types of feed used for experiments, clam meat proved to be the best for the maturation and spawning of this species. Another interesting observation was that this species when ablated, matured and spawned in captivity even when the salinity of the water was only 18 ppt.

Investigations were also carried out to bring down the cost of production of seed of *P. indicus* by perfecting the water management procedures as well as identifying the specific feed at different larval stages. Thus only mixed culture of diatoms dominated by *Chaetoceros* sp. was given to the larvae until they reached the last mysis stage. From postlarvae 1 onwards artificially prepared powdered feed was also used. Water change in the rearing pools was carried out only from the mysis stage onwards. Only 1/3 to 1/4th of the total volume was replaced every day until the larvae metamorphosed to postlarvae. 129 experiments were carried out during this period for the mass production of *P .indicus* seeds using different types of containers. 17.66 million nauplii were used for different types of experiments. Average survival rate from nauplii to first postlarvae was 30.34% and nauplii to fifth postlarvae was 20%, although in some experiments 90.5% survival was obtained. 4.78 million postlarvae were produced and they were further reared in different types of nurseries. In nurseries, larvae were stocked either in the first postlarval stage or fifth postlarval stage and fed thrice daily with artificial feed developed in this laboratory. From fifth postlarvae onwards salinity of the rearing medium was slowly reduced by adding brackishwater. In the nursery

tanks an average survival of 44.3% was obtained. Experiments conducted showed that mortality of postlarvae was more between postlarvae 1 to 5 stages. When postlarvae 5 were stocked in nurseries average survival was 64.9% during final harvesting at seed size.

During this period 1.84 million seeds of *P. indicus* were supplied to various agencies, such as co-operative societies engaged in prawn farming, farmers adopted under lab-to-land programme, and thirty individual farmers engaged in scientific prawn farming and to the Marine Products Export Development Authority. In addition to these, seeds were also used to stock the Departmental ponds at Narakkal and Calicut, and also for the research work of the scientists and research fellows of CAS in Mariculture.

Experiments were also carried out on the larval rearing of *P. monodon*. Seven trials were made. An average survival of 11.8% was obtained from nauplii to first postlarvae. They were further transferred to nursery tanks and experiments were continued. Few trials made to transport the nauplii of this species from Madras to Narakkal were not very successful. Experiments on this line are in *progress*.

Experiments were conducted on the biomass production of *Artemia* sp. The nauplii obtained from 6g cyst were stocked at the rate of 930 numbers per litre. Rice bran was used as food at intervals of two hours to maintain the transparency of 35 cm. pH was maintained at 7.8 to 8.0. A biomass production of 260 g (wet weight) was obtained in 24 days in one tonne of water.

MADRAS : For the first time in India, *Penaeus japonicus* kept in captivity and induced to mature by unilateral eye stalk ablation, matured and spawned in the laboratory.

19 experiments on spawning and larval production of *P. monodon, P. indicus* and *P. japonicus* were carried out. A total of 230,000 postlarvae 1 were obtained. They were further reared for 20-35 days in nurseries and then stocked in the departmental ponds at Muttukadu for further studies.

Sixty specimens of *P. japonicus* obtained from the departmental ponds at Muttukadu, were maintained in the indoor broodstock tanks. Their growth was not appreciable. They were further reared in the earthen ponds where their growth was fast and females with different stages of maturity were obtained. When these females were transferred to the laboratory, absorption of ovary was noticed. Then seven females were subjected to unilateral ablation, of which two matured and spawned giving viable egs after a period of 37-44 days. From 1.3 lakhs of nauplii obtained, two trials were made and they were reared through various stages up to first postlarvae. 65,500 postlarvae were obtained. 2000 early juveniles were stocked in the departmental ponds for further observations.

TUTICORIN: Experiments were carried out on the spawning and rearing of commercially important species of prawn *P. semisulcatus*. Spawners for the experiments were collected from the sea. Larvae were fed with phytoplankton culture dominated by *Chaetoceros* sp. until they reached mysis 3 stage. Afterwards they were fed

with freshly hatched nauplii of *Artemia* sp. From two experiments a total of 5,500 postlarvae were produced.

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

Experiments on the culture of *Scylla serrata* were continued in the coastal ponds developed at the intertidal swampy lands at Toticorin. Hatchery-produced seeds stocked at the size of 19 mm carapace width (CW) during November 1984 have grown to 137 mm CW/378 g weight by July 1984 showing a monthly growth rate of 17 mm/47 g. Spawner crabs were obtained from the brood stock containing the matured specimens and the subsequent spawning was noticed in an interval of 2 months without the precopulatory moult or mating. Hatchery techniques were improved for the better production of crab seeds. *S. serrata* reached 20 mm size (carapace width) in 2 months after hatching whereas *N. pelagicus* attained the same size in 40 days after hatching. Promising results were obtained in the production of seeds of *N. pelagicus*, and the observations reveal the scope for large-scale hatchery operations.

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

The technique of artificial insemination developed for penaeid prawns was further improved and perfected. This method has helped to improve the hatching rate. In the case of *P. monodon* the hatching rate obtained was 99.47% and in the case of *P. indicus* the hatching rate obtained was 94.7%. Survival of the larvae of artificially inseminated *P. indicus* was 79.48% from nauplius to postlarvae 1 stage. One of the artificially inseminated *P. indicus* rematured and spawned for the second time after artificial insemination producing viable eggs that hatched into normal healthy nauplii.

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

Effect of eyestalk ablation and eyestalk extract injection on ovarian development of maturing and mature lobsters were studied. In mature lobsters, one injection (0.2 ml/2 eyestalks/lobster) did not show much inhibiting effect on gonad development. The gonad index (GI) of ablated lobsters was almost three-fold (0.8) when compared to the control group. The hepatic index (HI) in experimental lobsters (2.5) when compared to normal lobsters (1.1) was high, evidently due to water accumulation. The higher per cent dry matter in gonad of ablated lobsters shows real tissue synthesis. The comparable values of per cent dry matter in hepatopancreas and muscle in control and eyestalk ablated and extract-injected lobsters shows the probable role of eyestalk factors in hepatopancreas and muscle metabolism. Almost same results were obtained in experiment with maturing lobsters. The dosage (concentration) of extract may not be sufficient to inhibit the accelerated ovarian activity. Standardization of eyestalk injections have to be carried out.

Weekly doses of brain and thoracic ganglion extracts were administered in group of juvenile lobsters (0.2 ml/lobster i.e. two ganglia in 0.8 ml saline) for three weeks and the moult cycle was compared to the control group, which was given saline injection. The lobsters which were given thoracic ganglion injection in inter-

moult stage spent an average of 16 days in D_0 stage whereas those injected in D_0 stage spent only 8 days in this stage. The lobsters which were given brain extract injection spent an average of 11.5 days in D_0 stage whereas the control group spent an average of 15 days in the same stage.

The moult cycle of 17 juvenile *P. homarus* was followed. Three types of premoult curves were obtained. Type I spent an average of 33.3 days, type II 20 days and type III 9.4 days in D_0. Eyestalk ablation accelerated moult cycle in D_0 stage. The experiment showed that ablated lobsters spent an average of 5 days in D_0 when the control ones spent an average of 18 days. Ablation accelerated D_1-E period also.

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

1,07,250 numbers of hatchery reared seed of *Penaeus indicus* from the Narakkal laboratory (Cochin) were transported by departmental van, to Pillaimadam lagoon at Mandapam Camp, on Palk Bay side.

16,500 seeds of average size 18.11 mm were released into the lagoon of Pillaimadam. 3,690 seeds of 18.11 mm average size and 25,250 seeds of 7.79 mm average size were released into two nurseries constructed in the lagoon for further observations on their growth and survival.

While transporting the seeds of P. indicus from Cochin to Mandapam Camp by van, a series of experiments were conducted on the transportation of prawn seed. In one set of experiments, ten rounded plastic containers of 50 litre capacity (40 cm diameter at the base with 11 cm mouth opening) were used. These containers were filled with 40 litres of seawater of 31 ppt salinity. Prawn seeds with 7.79 mm average size were released into 6 containers at densities of 375 number/litre, 300 n/l, 187 n/l and 135 n/l. In four containers seeds of 18.11 mm size group were released in densities of 175 n/l and 56 n/l. Seawater in these containers was aerated for 15 miutes, at one hour intervals. Totally 24 hours were taken for the transportation of seeds from Cochin to Mandapam Camp. After 24 hours, the average survival rates for seeds of 7.79 mm size were 30.3% for 375 n/l, 43.7% for 300 n/l and 74.1% for 135 n/l. In the case of seeds with average size of 18.11 mm, 7.5% survival was observed when the rate of stocking was 175 n/l and 74.4% at the stocking density of 56 n/l.

18.11 mm size group seeds of *P. indicus* were also transported using cylindrical transportation bags (base diameter 19 cms) of 18 litre capacity. These bags were filled with 6 litres of seawater with 31 ppt salinity. Seeds were introduced into these bags at different stocking densities. Oxygen was bubbled through the water for two seconds. Then the space inside the bag above the water was filled with oxygen. Seeds at the rate of 83 n/l, 92 n/l and 117 n/l were packed in these bags. After 24 hours of transportation, the survival rates were 80%, 64.7% and 67.1% respectively.

In another set of experiments, plastic bins of 100 litre capacity, having a base diameter of 38 cm and mouth diameter of 49 cm were used for the transportation of prawn seeds. Six litres of seawater of 31 ppt salinity were poured into these bins and 500 numbers of seeds with an average size of 18.11 mm were released into these bins. No aeration was given. While the van was moving, the water in these bins was shaken well and thus got oxygenated. 99% of the seeds survived after 24 hours. The prawn seeds were found to be in healthy condition.

Success was achieved in laboratory rearing of the cuttlefish from egg capsule to adult stage. Based on past data an attempt was made for the first time on stock assessment of three important species of cephalopods and the standing stock and average annual stocks in the traditional fishing grounds off Cochin, Madras and Vizhinjam have been estimated.

Survey of cephalopod resources in the Exclusive Economic Zone (Mol/Re/1.2.1)

FORV Sagar Sampada, the newly acquired Fishery and Oceanographic Research Vessel of Government of India started her research cruises during the last quarter of the year. The vessel caught 31 kg of cuttlefish *Sepia pharaonis* in bottom trawl in January, '85 in the depth range of 61-98 m at positions 09°46'N/75°46'E, 09°45'N/75°41.6'E and 10°22'N/75°41.2'E. The size range was 54-275 mm and most of them were males in mature or spent condition. In February, 129 kg of *S. pharaonis* (150-292 mm size) were caught in the depth range 54-250 m at positions 10°31'N/55°40.5'E, 11°40.2'N/74°56.2'E, 12°26'N/74°26'E, 13°31'N/73°35.8'E, 13°36'N/73°25'E and 14°31'N/73°24.1'E. Other species of cephalopods were in negligible quantities. Pelagic trawling in areas 11°29.6N/70°54'E, 12°31'N/72°22'E, 12°29'N/72°55'E, 13°28'N/69°25'E and 14°25'N/71°59.5'E yielded small quantities of juvenile oceanic squids and loliginids. During February-March, the vessel caught 13 kg of *Loligo duvaucelii* in bottom trawling at the depth of 47 m in area 21°02'N/69°38'E. In March '85, 152 kg of squids were caught in bottom trawl operations in the depth range of 70-114 metre in areas 10°30'N/75°32'E, 09°30.5'N/75°53.2'E and 08°26.2'N/76°32.2'E.

R.V. Skipjack operating bottom trawl in the area 09°36'N/75°51.6'E caught 100 kg of the squid *Loligo duvaucelii* in August. The squids were of the size range of 30-115 mm and all were immature. In the other cruises she caught only very small quantities of cephalopods.

Three vessels of the Fishery Survey of India operating from Bombay base caught about 18 tonnes of cephalopods at the rate of 4.3 kg/hr from areas 17-72, 17-73, 18-71, 18-72, 19-71 and 19-72 in bottom trawling. Better yields were obtained in area 17-72 where the catch rate was 6.4 kg/hr as in last year. Area 19-72 produced 4.4 kg/hr. But maximum effort was spent in area 18-72 which yielded only 3.8 kg/hr. Vessels of the Cochin base caught about 18 tonnes of cephalopods mostly in bottom trawling operations in areas 8-76, 9-75, 9-76, 10-75, 11-75 and 12-75 in the depth range of 20-80 m. Area 9-76 where most of the effort was spent yielded 0.1 to 14.7 kg/hr. Area 9-75 yielded maximum catch (2.3 tonnes) at the rate of 24.2 kg/hr in October. In the same month, area 8-76 yielded 33.3 kg/hr. Pelagic trawling operations in the area 9-76 in the month of September yielded 0.6 tonnes of squids at the rate of 36.2 kg/hr, the catch constituting about 12% of the total catch.

Stock assessment of cephalopod resources of inshore waters (Mol./Re/1.2.2)

The cephalopod production from the inshore waters amounted to 24,196 tonnes (provisional) during this year recording an increase of about 30% over the previous year, the production being the highest so far. Maharashtra ranked first accounting for about 35% of the production, followed by Kerala (30%). Gujarat (16%) and Tamilnadu (14%) were the other two important cephalopod producing States. The production in Kerala recorded about 327% increase. The mechanised boats at Neendakara-Sakthikulangara recorded an increase of 316% in cephalopod landings for an increase of 20% fishing effort. The traditional small-scale sector also contributed higher catch as seen from an 345% increase in the Trivandrum zone for an increase of 64% in effort. Except for West Bengal and Orissa, cephalopod landings in all other maritime States showed an increase over the previous year.

For the first time, an attempt was made to estimate the stocks of major cephalopod species in the traditional fishing grounds (upto 50 m depth) off some of the centres based on 1978-'80 data. The estimated average annual stocks of the species are as follows: *Loligo duvaucelii* off Madras 104 tonnes and off Cochin 250 tonnes; *Sepia aculeata* off Madras 168 tonnes; *Sepia pharaonis* off Vizhinjam 636 tonnes. There are possibilities of increasing production of cuttlefish from Vizhinjam area. Assuming that the density of population and rate of exploitation of the three species are uniform in the inshore fishing grounds along the entire coastline, the average annual stocks of the species on an all-India basis have been estimated as follows, based on 1978-1980 figures: *L. duvaucelii* 18,203 tonnes; *S. aculeata* 23,536 tonnes and *S. pharaonis* 15,245 tonnes The estimated annual average landings of the same period for the three species have, respectively, been 5142 tonnes, 4483 tonnes and 2397 tonnes. The stock assessment work is being continued for subsequent years .

The 1984-85 production estimates, catch per unit of effort, catch composition and size ranges of different species at important centres are furnished in Table 1. At Bombay New Ferry Wharf, the cephalopod landings declined from 3060 tonnes to 2373 tonnes although the decrease in effort was only nominal (4%). The average CPUE also decreased from 126 kg to 102 kg with the monthly CPUE ranging from less than 1 kg to 207 kg. Cephalopods' contribution to the total landings ranged from less than 1% to 13.5%. In contrast, at Bombay Sassoon Docks the production increased by 108% with only 18% increase in effort. The average CPUE also increased from 124 kg to 218 kg .The monthly CPUE and percentage contribution to the total landings were from 4.2 kg to 722.3 kg (December) and from less than 1 to 42% (December) respectively. At Mangalore the landings increased from 516 tonnes to 676 tonnes (31%) with 26% increase in effort. There was not much change in the CPUE which ranged from 3 kg to 17 kg. The average percentage contribution increased from 3 to 5%. Landings at Cochin recovered remarkably with 155% increase in production from 46 tonnes to 117 tonnes although the effort decreased by about 18%. The CPUE ranged from less than 1 kg to 7 kg. The cephalopods constituted 0.1 to 2.7% of the total landings.

Table — 1 Estimated Cephalopod landings by trawlers at different centres during 1984-85

Centre	Total cephalopod landings (t)	CPUE (Kg)	*L. duvaucelii* %	size range (mm)	*S. aculeata* %	size range (mm)	*S. pharaonis* %	size range (mm)	*S. elliptica* %	size range (mm)	Others %	% of cephalopods in all fish catch
BOMBAY												
— New Ferry Wharf	2373	102.0	58	30-309	36	40-229	6	110-349				0.1
— Sassoon Docks	4728	217.7	36	45-220	—	60-180	—	180-315				13.8
MANGALORE	676	13.6	74	20-369	25	60-199	1	—				5.1
COCHIN	117	3.2	44	50-249	18	70-140	14	90-229	14	50-119	10	1.1
VISAKHAPATNAM	139	—	41	40-139	22	50-199	18	50-259			19	—

At Visakhapatnam the landings had decreased by about 42%.

Cephalopods were caught almost throughout the year at all important centres except Mangalore where there was no fishery during monsoon period. Better yields were obtained during October-March at Bombay, April, May and November-February at Mangalore; and January, March, June and August at Cochin.

Experiments in transport of molluscan seed (Mol/Re/1.7)

Seed of brown mussel *Perna indica*, of size 5-15 mm, collected during July-September, remained without any mortality for 24 hours in wet gunny bags. In 72 hrs mortality was 50%. Seed of 15-30 mm size, collected during October-December, and held under similar conditions suffered mortality within 24 hours which reached 50% at 48 hours. These results have indicated the ideal season and seed size of transportation.

Recruitment studies in the clam population (Mol/Re/1.8)

The population density of blood clam *Anadara granosa* in Kakinada Bay ranged from 4.17 no./m^2 in January to 11.33 no./m^2 in October. The overall size range was 3-62 mm and seed clams of 3-4 mm size occurred throughout the year. Based on the von Bertalanffy growth equation estimated earlier (where t_0 = — 0.4088 yr; K = 0.5816 on an annual basis; L_∞ = 73.4 mm) and the age composition of clams in the commercial fishery it is observed that recruitment to the fishery takes place at 15 mm (age 0.29 yr), length at first capture is 41

mm (age 1 yr) and the maximum length attained is 71.2 mm (age 5.62 yrs). The instantaneous coefficient of natural mortality (M) has been estimated at 1.3. Environmental parameters were continued to be collected. At Karwar, data on size range and population density in different months for the species *Meretrix casta*, *M. meretrix* and *V. cyprinoides* were collected and observations on spatfall have been made. Environmental data were also collected.

Atlas of clam resources of Kerala and Karnataka (Mol/Re/1.9)

The data collected on the clam resources from the estuaries in Karnataka were analysed and a final drarft of the resource atlas for this area of study was prepared. In Kerala, 14 estuaries from Cochin to Manjeswaram were surveyed and the data analysed. The data from the rest of the estuaries/lakes which were collected earlier were analysed. The clam resources atlas will be finalised shortly.

Culture of edible oyster (Mol/Cul/1.1)

In the experiments on spat collection in Tuticorin, 20,000 tiles and 270 shell-rens were used during the major spawning season (April-May) and 2,500 tiles and 130 shell-rens during the secondary spawning season (August-September). The average spat settlement was 15/tile and 5.9/shell and total spat collection was 94,600 in the main season. The average spat density was 9/tile and 5.8/shell in the secondary season. In the farming system, in addition to the rack-tray method, stake culture was introduced for the first time with 270 stakes. Broadcasting of spatladen shells was also done. Work on culture biology of *Crassostrea madrasensis* was continued to be studied. Infection of oyster in the wild by *Dermocystidium marinum* was noticed in 10-50% cases. Trematode *(Bucephalopsis hymaena)* infection ranged 1.3-1.8% during November-December and March.

An oyster culture programme was initiated at Karwar during the year and preliminary investigation was carried out.

Culture of green mussel in saltwater lagoon (Mol/Cul/1.2.1)

The project was started during this year as an offshoot of an earlier project, specially to concentrate on utilisation of saltwater lagoons along the coastal area for mussel production. Experimental work on pole culture and raft culture was intensified. Mussels produced from the farm at Muttukadu were supplied to Tamil Nadu Fisheries Development Corporation for popularisation in their marketing stalls.

Since the seed source for this work is from Ennore, the reproductive biology of the mussel population from the area was studied. Contrary to the observation of an all-male population in the farm oysters in the earlier seasons, both males and females were present. Occurrence of partially spent males and females indicated spawning in the lagoon. Environmental parameters and plankton were collected for understanding the dynamics of this semi-enclosed lagoon system in relation to mussel biology and production.

Investigations on mussel spat settlement and seed slipping on transplantation (Mol/Cul/1.2.2)

The project was initiated this year for understanding the optimal environmental and substratum conditions rerequired for settlement of mussel spat and also to investigate the phenomenon of seed loss in rope culture in the farm. At Vizhinjam, spawning of the brown mussel *Perna indica* commenced in the first week of June. Experiments with spat of 1-12 mm size with various cultch materials were carried out in the laboratory for understanding factors such as primary settlement detachment and reattachment of mussel spat. Planktonic larvae collected from the coastal waters and introduced into experimental tanks showed preference to smooth surface for attachment. Although these larvae temporarily set on the tank surfaces with byssal threads, they did not show firm attachment. The experiments indicated that although the young spat would primarily settle on filaments, algae and smooth surfaces, they would subsequently prefer hard substratum. Seed of 5-15 mm size collected from the mussel beds in October, when transplanted to ropes showed a slipping rate of 50-75% in 5-7 days. However, seed of 20-25 mm and above collected from submerged rocks in November, when transplanted to ropes showed only 5-10% slipping. Observations were made on byssal thread secretion of young mussels over an 18 hr period and it was found that those of 5-15 mm size secrete fewer threads, whereas those of 26-35 mm size secrete a larger number.

Pilot project on mussel culture (Mol/Cul/1.2.3)

Since there was delay in procuring floats and other materials for culture of green mussels, the work could not be taken up during this season. Regular observations were carried out from 6 centres around Calicut, on the settlement and growth of mussel seed in natural beds. Seed samples were also collected from the commercial catches and analysed.

Culture of clams and windowpane oyster (Mol/Cul/1.3)

Windowpane oyster culture faced the same problem of paucity of seed as in the previous year. Heavy predation of clams *(M. casta)* by crabs u set the results of clam culture in Mulki estuary. Clam biology was studied at Karwar.

Replenishment and monitoring of Villorita spp. production of estuarine system (Mol/Cul/1.3.1)

Clam production in the Vembanad lake suffered a setback and it reached a level of 9,402 tonnes against 16,222 tonnes in 1983-84. While there was reduction in all the 4 zones, it was drastic in Zone-III. Mass mortality of clams in the southern zones due to lowering of pH during May-June, 1983 appears to have been responsible for the decrease in production. In Zone-I, small clams (less than 10 mm accounted for 44% of production. The ecology of area around the dredging zone was studied in detail based on salinity, pH, sediments in suspension, light penetration and clam population.

Pearl Culture (Mol/Cul/1.4)

On seven sea trips to the pearl banks of Gulf of Mannar, a total of 6,600 pearl oysters were collected, of which 87.6% was *Pinctada fucata* and

the rest flat oysters. The survey covered the paars named Fernando, Devi, Vantivu, Arubagam, Tholayiram. Nagarai, Pulipondu and Paduthamarikan. The shoreward paars were more productive than the offshore ones. The size of *P. fucata* was small with the mean dorso-ventral range of 28.4-31.8 mm and mean weight range of 4.2-8.7 grams during the period. The oysters were reared in the harbour basin farm. The FRP-floatation blocks developed under the inter-institutional project with Vikram Sarabhai Space Centre were tested for the rafts at Veppalodai and improvements were suggested.

Monitoring the growth of pearl oyster in the farm on the breakwater slope as well as rafts, it was seen that while increase in length was perceptible only during November-March, increase in thickness was observed throughout the year. Nucleus implantation work could be carried out only on a moderate scale. Growth of cultured pearls at different depths (1-5m) of culture was observed. Environmental parameters and fouling rate were monitored.

Development of hatchery system for edible oyster seed production (Mol/Cul/1.5)

Induced spawning of oyster *Crassostrea madrasensis* was carried out successfully by conditioning the animals for 3-10 days in the laboratory and applying thermal induction. Five sets of larval rearing were done and spat settlement took place at the end of 13-25 days from spawning. Of the three materials used for spat setting lime-coated title was the most successful with 100-spat/tile, rollowed by oyster-shell with 40 spat/tile and polythene sheet with 4 spat/sq. cm. The maximum spat production achieved was 950,000 in January and the minimum was 74 in September. Experiments on induced maturation were continued using different diets. Mixed phytoplankton and corn flour were found effective and the treated oysters were spawned by thermal stimulation or hydrogen peroxide induction. The spat were produced. Spat setting rate rack-tray and stake culture methods.

Development of hatchery system for mussel seed production (Mol/Cul/1.6)

Four spawning experiments were conducted on *Perna viridis* at Kovalam laboratory. Thermal stimulation by lowering temperature to 18.5 deg. C and sudden raising to 28.5 deg. C induced the ripe males and females to spawn. Environmetal factors as well as algal food rearing conditions were not favourable and progress in larval rearing and spat production received a set back. In the case of *P. indica*, breeding work carried out in July was successful. Detailed observations were made on larval density, algal cell concentration, growth of larvae, setting and metamorphosis. Spat of size over 4 mm were transplanted in the farm and growth observed. Subsequent to July, spawning did not take place in the laboratory.

Experimental pearl oyster hatchery for mass production of spat (Mol/Cul/1.7.1)

Four sets of pearl oyster larval rearing were carried out during the year. In the first experiment, 6.4 lakh spat were reared in the oyster farm by ranged 16.7-34.2% at larval density 2/ml, 3.9-18.4% at 3/ml and 15.3-19.2% at 4/ml. Feeding was done with *Isochrysis galbana* at 5,000 cells/larva/

day upto umbo stage and double that thereafter. In the second experiment, 22,000 spat were produced. During October-December, larval rearing was not possible due to non-maturation of oyster and adverse environmental conditions brought about by a strong north east monsoon. In the third rearing, 6 lakh spat were produced in a single tank of 1 tonne capacity. The fourth experiment commenced by end of March and continued into April. In one of the experiments spat setting was achieved on day-14 which is an improvement over previous results. Induced maturation experiments were carried out using mixed algal culture and rice flour adding vitamins and aminoacids. Growth of hatchery produced pearl oysters was monitored in the farm. The growth data showed an increase from 7.2 mm to 47.2 mm (12 months), from 20.1 mm to 51.7 mm (12 months), from 36.6 mm to 56.9 mm (11 months), from 47.3 mm to 57.3 mm (11 months) and from 50.9 mm to 59.9 mm (11 months).

Culture of cephalopods (Mol/Cul/1.8)

The project made an important contribution in the rearing of cuttle fish from egg to adult. Two clutches of eggs of *Sepia* sp. were collected from the spawning grounds and brought to the laboratory. Out of a total 1050 eggs, each of 15 mm diameter, more than 90% hatched between 10-19 days in the rearing tanks. The hatchlings measured 5-8 mm in mantle length. The hatchlings were initially fed with live mysids and later, after they reached juvenile stage, with live fish fry (mullets, *Gerres* sp etc.) of 10-15 mm size. In 6 months, the cuttlefish had grown to a mean size of about 175 mm mantle length. Mating was observed among the laboratory reared adults and egg deposition by the female was noticed. The investigations are being intensified.

Development of hatchery system for clam seed production Mol/Cul/1.9)

Larval development of *Anadara granosa* was worked out upto straight-hinge stage.

Breeding and experimental sea-ranching of commercially important gastropods (Mol/Cul/1.10)

Thermal and chemical stimulation on mature *Trochus* did not evoke any spawning response. But keeping them in darkness and well aerated condition led to release of gametes and fertilisation. Larval growth was followed upto trochophore stage beyond which they did not survive. Egg cases of *Thais* collected from the wild dehisced in the laboratory. The veligers were fed with microalgae and observed for 14 days. Contamination of the rearing medium led to total mortality of the veligers. Observations on the breeding cycle of gastropods in the natural environment were made.

Training in pearl culture (CMFRI/TR/2)

The third short-term Training Course in Pearl Culture was organised from 8 October to 2 November 1984. The training course was conducted as per the curriculum followed during the earlier short-term courses. The following candidates received training:

1. Shri R. Soundararajan, Scientist S-2, Central Agricultural Research Institute (ICAR), Port Blair.
2. Shri M. I. Patel, Research Officer, Department of Fisheries, Govt. of Gujarat.
3. Kum. Mini Thomas, Senior Research Fellow, CAS in Mariculture, CMFRI.

FISHERY ENVIRONMENT MANAGEMENT DIVISION

The pysical, chemical and planktological conditions including eggs and larvae of the Exclusive Economic Zone of the waters around India were studied. Aquatic conditions including pesticide residues of selected industrial areas were monitored. Under marine pollution studies, heavy metals studies were initiated for the first time in the sea as well as in bivalves. The mangrove ecosystems around Cochin were monitored. Observations were made on the nesting behaviour of marine turtles and the hatching success of eggs in the nests was studied. It was estimated that about 8.3 million hatchlings would have emerged successfully from the first arribada of 1985 season where 2,79,600 turtles were estimated to have nested over a 16 days period.

Aquaculture systems were monitored. Agar-yielding seaweed *Gracilaria edulis* and algin-yielding seaweed Hormophsa triquetra were cultured in the field and progress was made in genetical engineering studies of *G. verrucosa, G. edulis* and *G. sjoestedtir.* Bacteriological studies of mangrove sediments were carried out. Progress was made in designing, fabricating and developing of electronic/electric equip ments useful for fisheries.

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

Cochin

During early May typical summer conditions were prevalent in the region off Cochin. The surface temperature in the offshore region (20 m depth) was as high as 32 deg. C. But late May indicated characteristics of the approach of monsoon. A representative station at 10 m depth off Cochin contained only 1.31 ml/L of dissolved oxygen at the bottom and temperature was nearly 26.6 deg C only, which was less by about 4 deg. C than the surface. This year, August could be considered as the period when maximum upwelling occurred in the region off Cochin. The thermocline was very near to the surface.

Calicut

Temperature, salinity, dissolved oxygen, nitrate, nitrite, silicate and phosphate were the parameters determined from the samples. Appreciable changes were not noticed in the post monsoon conditions from the premonsoon with respect to the salinity and dissolved oxygen of the waters, while a tremendous increase was noticed in nutrient conditions.

Vizhinjam

Salinity of the inshore waters ranged from 31.77‰ to 34.50‰. Dissolved oxygen content values were within the range of 3.47 ml/L to 5.30 ml/L. The inorganic phosphate values showed variation from 0.82/ μg at/L to 2.21 μg at/L. Nitrite values ranged from 0.18 μg at/L to 0.92 μg at/L Nitrate values ranged from 1.05 μg at/L to 2.74 μg at/L. The silicate content of the inshore waters ranged from 6.60 μg at/L to 15.08 μg at/L.

Tuticorin

The salinity showed a single peak, i.e. 34.75‰ in June 1984 and the lowest 32.12‰ in December '84. This

trend was unusual when compared to the earlier years. Normally, the fluctuations of salinity follow the course of temperature. Dissolved oxygen content of the coastal water was varying in a narrow range mostly around 5.0 ml/L. pH of the surface water varied from 7.46 to 7.95. Bottom samples did not differ much from this. Inorganic phosphate and nitrite was present in negligible percentages or was absent in June-July '84.

Mandapam Camp

The salinity in Gulf of Mannar ranged from 29.29‰ (December) to 35.42‰ (August) while in Palk Bay it ranged from 29.90‰ (December) to 35.51‰ (August). The bottom salinity in Gulf of Mannar ranged from 29.21‰ to 35.75‰ (July) while in Palk Bay it ranged from 28.94‰ (December) to 35.24‰ (August). The dissolved oxygen content in Gulf of Mannar ranged from 3.93‰ ml/L (January) 5.27 ml/L (August), while in Palk Bay it ranged from 3.25 ml/L (March) to 5.23 ml/L (July). Among the nutrients the phosphate values were higher in Palk Bay and silicate values and nitrate values were higher in Gulf of Mannar when compared with Palk Bay waters.

Kakinada

Salinity values were highest in summer (about 34‰) and there was a sharp fall through monsoon period to the lowest (about 13‰) in November. The lowest salinity in the winter might be on account of the combined effect of the Bay of Bengal depressions and run off from the land. The fluctuations of nutrients, namely phosphates, nitrates and silicates are erratic.

Madras

Surface water temperature came down on either side of the September maxima (30 deg. C) to attain minima in June (28 deg C) and in December (27.5 deg C). The minima of temperature in June and December were due to the two monsoonal systems. The salinity was high during southwest monsoon (about 34‰) and lowest in December-January (about 28‰) The winter minimum might be due to influx of fresh water through the rivers Adyar, Coovum and Kortaliyar.

Phytoplankton and primary productivity of the EEZ (MBO/PP/1.1)

Primary production is being estimated mostly by light and dark bottle — Oxygen method. Very often the dark values are higher than the light values. It, therefore, becomes imperative to discontinue the oxygen method and switch over to C14 method.

At Calicut, two stations, one of 5 metre depth and the other of 10 metre depth, were sampled. Surface and near bottom samples were analysed.

In the period 1984-85 surface production/day varied from 224 mgC/m^3 to 550 mgC/m^3 in 5 m station and from 83 mgC/m^3 to 596 mgC/m^3 in 5 m. bottom. In 10 m bottom production varied from 18 mgC/m^3 to 1410 mgC/m^3. Highest production was obtained in April which was 1410 mgC/m^3 and lowest in January and March.

Daily column production varied from 1417 to 248 mgC/m^2 in 5 m and from 1091 mgC/m^2 to 4538 mgC/m^2 in 10 m. Generally high production was observed in April and October.

At Vizhinjam gross productivity varied from 143 mgC/m^3/day (July) to 343mgC/m^3/day (December) and net production from 86 mgC/m^3/day (July) to 264 mgC (August). Production (gross and net) was relatively low in February which is an impoverished month.

Gross production varied widely from 64 (April) to 432 mgC/m^3/day (March), net production from 36 (April) to 364 mgC/m^3/day (March).

At Tuticorin highest productivity was recorded in June, 1984 followed by January, 1985. During the rest of the months productivity was relatively low.

At Madras surface gross productivity was estimated on 3 days in the year and the net productivity was nil.

A Kakinada daily gross productivity (896 mgC/m^3) and net productivity (302 mgC/m^3) were high during January-March '85.

At Waltair, water samples were collected from 5/6 discrete depths from 2 stations. C14 method was employed for estimating primary production near the surface. Samples were incubated for 6 hours. Chlorophyll samples from the surface were collected. Temperature, salinity and dissolved oxygen were measured and tabulated. Macronutrients were estimated.

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

Cochin

Regular sampling for zooplankton was carried out in the fishing grounds off Cochin. The zooplankton volume ranged between 11.22 ml in August to 51.3 ml in September per 100 m^3 of water which indicated a sudden increase during the post monsoon season. The zooplankton presented a normal composition with copepods, chaetognaths, lucifers, siphonophores, decapod larvae and polychaete larvae as the dominant forms in the order of their abundance.

Vizhinjam

Zooplankton sampling was carried out regularly in the Vizhinjam Bay and open sea. The displacement volume for the bay station fluctuated between 3.11 ml in March and 19.1 ml in September per 100 m^3 of water while for the sea stn. it ranged between 2.83 ml in April and 40.33 ml in November per 100 m^3 of water. The zooplankton production in the bay was comparatively more than in the previous year which indicated a more congenial situation for the living organisms.

Madras

The zooplankton production was found to be very low during the year and found to vary from 0.25 ml in July to 2 ml in January per 10 minutes haul in the shallow station. In the deeper station the same was found to be a little more being 0.5 ml in June to 2.5 ml in January per 10 minutes haul. In the samples the copepods dominated except when the swarming of cladecerans took place in April. While the fish eggs were common in April and May fish larvae were abundant in December and January.

Tuticorin

Sampling for zooplankton was carried out every month at Tuticorin

in the fishing grounds where the depth range was from 6 to 15 m. The lowest biomass of zooplankton obtained was 4.8 ml in January and the highest value was 32.4 ml per 10 minutes haul. Fish eggs were seen in all the samples collected during the year while the fish larvae were present in February and March only.

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

Work under this project was carried out at Cochin, Vizhinjam, Mandapam and Tuticorin.

Cochin

Contrary to previous year, the offshore station had more fish eggs, 69% of the total and the nearshore station 31%. This accounted for an average annual number of 139/m^2 at the offshore station and 55/m^2 at the inshore station. At the nearshore station, August and November had very good numbers of fish eggs but at the offshore station in addition to these, April, May and January were also good months with the peak at the offshore station in April (631/m^2). Of the total eggs, elliptical eggs (*Stolephorus* eggs) made up 25% of the total, mainly caught in April from the offshore station and the rest was caught during September to January. Of the round eggs, the smallest had a diameter of 0.55 mm and they made up 8% of total eggs mainly caught from the inshore waters. 51% of all eggs had a diameter range between 0.6 and 0.7 mm, equally abundant at both the stations throughout the year. 6% of all eggs were with a diameter between 0.7 - 0.8 mm, 5% of all eggs between 0.8 - 0.9 mm and 3% of all eggs between 0.9 - 1.0 mm. Only 2% of the total eggs were above 1 mm in diameter. The biggest round egg met within the collection had a diameter of 1.5 mm.

As in the previous years, the offshore station was richer in fish larvae contributing to 72% of total larvae with an annual average value of 70/m^2 as against 33/m^2 during 1983-84. As usual fish larvae were comparatively more during the latter half of the year and the peak was in December at the offshore station (240/m^2).

On the whole the offshore station was relatively warmer, more saline and better aerated than the nearshore station.

Vizhinjam

Fish eggs were more in the Bay than in the open sea station with the peak during August (1305/100m^3). Carangid eggs formed the dominant group with the maximum number in January (430/100m^3). Eggs of flat fishes, lizard fishes, and eels were also recorded in fairly good numbers.

Fish larvae were also more in the bay with the peak in September (494/100 m^3). Among the Clupeoids, *Sardinella* larva was present in the bay in April, May and November and in the open sea station in May and January. *Anchoviella* larva was present only once in both bay and open sea stations in May and September respectively. Mackerel larva also was present in November at the bay station and in May at the open sea station. Carangid larvae were the most abundant group, more at the bay station with the maximum number in December. Larvae of flat fishes, eels, gobids and Ambassids were also observed at both the stations.

Mandapam

Thirty nine samples each were collected from the Gulf of Mannar and Palk Bay area. On an average plankton volume was more in the Palk Bay area, but as in the previous years fish eggs and larvae were comparatively more in the Gulf of Mannar area.

Tuticorin

Fish eggs were recorded in all the samples throughout the period but fish larvae were very poor and were recorded only in February and March 1985.

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

Field culture of the agar-yielding seaweed *Gracilaria edulis* and algin-yielding seaweed *Hormophysa triquetra* were carried out in an area of 0.1 hectare at Hare Island using monofilament nylon lines for the first time. There was gradual increase in growth of *Gracilaria edulis* upto 100 days while in *Hormophysa triquetra* there was no increase in growth and decline in growth was observed after 70 days. Seedlings of *Gracilaria edulis* with an average length of 13.8 cm introduced grew to an average length of 26.1 cm after 100 days.

Attempt was made for the first time to transplant the agarophyte *Gracilaria verrucosa* to Mandapam from Muttukadu backwaters. At Pillaimadam lagoon, young plants of *Gracilaria verrucosa* with the mean length of 5.2 cm grown from the spores liberated by the cultured plants were found attached to the velon screen covering of the cage.

Culture of the edible algae *Caulerpa racemosa* and *C. racemosa* var *laetevirens* and the agarophyte *Gracilaria crassa* was conducted in pens and cages in the ponds at fish farm. Attempt was also made to culture *Caulerpa racemosa, Gracilaria crassa* and *Acanthophora spicifera* near the pen culture site at Pillaimadam lagoon and *Caulerpa racemosa* var *laetevirens, Gracilaria edulis, G. crassa* and *Acanthophora spicifera* near the river mouth of Pillaimadam lagoon.

Experimental culture of *Gracilaria verrucosa* was carried out in the fish farm area at Muttukadu Mariculture Centre, Madras following 3 methods namely pond culture, cage culture and rope culture. Cage culture was carried out in the open canal area and in the ponds.

Plants of *Gracilaria edulis* collected at Mandapam were successfully transported by train to the field laboratory at Kovalam. The plants were healthy and showed regeneration although the salinity was low (19‰ salinity). But heavy silting was observed over the plants. The growth rate over 53 days period was 1.42%/day which doubled in 70 days.

Environmental monitoring in the industrial and adjacent areas of the Cochin backwater system (MBO/EE/1.4)

Under this project the investigations in the Cochin-Azhikode and Cochin-FACT areas were continued.

Actual monsoon features could be said to be observed by mid July only, in the backwater system.

By October, complete changeover in the hydrographic conditions were perceptible in both the branches of the estuary. The waters have become warmer especially at the bottom layers.

The influence of upwelling in the Arabian Sea, over the estuarine system have mostly disappeared and there was a noticeable increase in salinity values also.

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

Heavy metal studies were initiated for the first time in the sea as well as in bivalves. Samples analysed by Atomic Absorption Spectrophotometer were for Co, Cu, Fe, Pb, Ni and Zn. Among the metals analysed Cobalt, Nickel and Zinc showed higher values when compared to copper, iron and lead. In order to assess the effect of dumping of ammonia by FACT in the offshore waters laboratory trials were carried out in simulated micro ecosystems and it was found that the ammonia at 1 ppm level completely inhibits the processes of primary productivity while at .01 ppm it enhances.

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

Madras

Regular environmental monitoring was carried out from stations in the ponds as well as from the open canal. Organic carbon contents were estimated from a few sediment samples. Apart from these, the qualitative estimation of dominant zooplankton components were also carried out.

Gross productivity — showed a highly fluctuating trend. In general, the open area had low values in July-August and again in November, on an average productivity rates did not go beyond 550 mgC/m^3/day. This was much lower than the average values in the ponds where maximum productivity recorded was 1100 mgC/m^3/day.

Chlorophyll 'a' and pheophytin: During October-November period when the chlorophyll content was rather high a swarm of *Ceratium* was found; a second bloom was recorded in November which supported an intense swarm of mysids in the farm area. In the ponds, the chlorophyll 'a' maxima were recorded in May. The minimum recorded in April was associated with very high values of pheophytin. It is of interest to note that very high values of pheophytin recorded in October in the bottom waters of the canal was associated with very low values of dissolved oxygen, indicating a high rate of decay at the bottom layers.

Fish mortality: Two instances of fish mortality were recorded during the period under report.

1) April 1984: Large-scale mortality of finfish *Sarotherodon mossambica* was observed during this period mainly in the B-series of ponds which were without exchange of water. A bloom occurred in the ponds dominated by *Chroococcus turgidum.*

2) February-March 1985: Sporadic mortality of *S. mossambica* was observed during this period. A bloom dominated by *Perridinium* was recorded with prevailing oxygen levels of 0.89 to 2.17 ml/L.

Mandapam :

Environmental monitoring were carried out from 9 ponds at the pen culture area in the Pillaimadam lagoon and the Palk Bay area.

Primary productivity showed the highest values in August-September (the highest value recorded was

3143.96 mgC/m^3/day in Pond 16) and the lowest being 77.18 mgC/m^3/day in June in Pond No. 1. It was also observed that the trend of primary productivity was very high in earthern ponds when compared to concrete ponds as well as at the stations located in the open waters.

Investigations on the pesticide residues and heavy metals in the environment and living resources of the estuarine and inshore waters (MBO/MP/1.3)

Baseline studies and survey to identify the level of pesticide residue in the aquatic environment and in commercially important organisms were carried out.

Ecology of the mangrove swamps and their associated fauna and flora (MBO/MS/1.1)

Collection of the field data on the mangrove ecosystems around Cochin was continued during the year. Mangrove areas in the Vypeen island were studied in detail with reference to biomass production in different habitats. The standing crop in Station A ranged from 8.4 to 13.2 kg/m^2, 3.34 to 4.8 in B and 2.93 kg/m^2 in C. Soil pH in the different habitats ranged from 6.3 to 7.45. Total nitrogen varied from 0.29 to 0.87 and total phosphorus from .0043 to .013. Seasonal fluctuation were noticed in the exchangeable cations and chloride.

Investigations on the biology of marine turtles, cetaceans and the dugong in relation to their conservation and management (MBO/MM/1.1)

Data were collected on the carcasses of olive ridley washed ashore and about 694 carcasses in different status of decomposition were counted in a stretch of 10 km. The details of number of destroyed nests by predators and successive nesters, freshly noticed tracks and dead carcasses were observed in January 1985 at Gahirmatha Orissa.

Data were collected on the size and weight of eggs during first and second arribada in 1985 season.

Details of estimated number of nesting females nesting area, size of nesting females, depth of nest, clutch size, distance of pit from high water mark, incubation duration, hatching success, nest temperature and ambient atmospheric temperature at night during the nesting period were collected.

Studied the hatching success of eggs in the nests in 23 clutches. In each case the number of eggs laid, live hatchlings emerged, live hatchlings in pipping stage, dead hatchlings in pipping stage, spoilt and unfertilized eggs were noticed.

During 1985 after an interval of 58 days of the completion of first arribada, the second arribada commenced on 13.3.1985. Unlike previous years 8083 olive ridley came ashore for nesting over a period of 10 days. In 1984 season the number of turtles came to shore for second arribada was around 200,000.

It was observed that an average of 115 hatchlings successfully emerged from each clutch. On this basis it is estimated that about 8.3 million hatchlings would have emerged successfully from the first arribada of 1985

season where 2,79,600 turtles were estimated to have nested over a 16 days period in January 1985.

Attraction of fishes by acoustic methods (FED/Misc/3)

Procured Hydrophone and precision Amplifier. The project work could not be carried out as scheduled since the set of instruments could not be imported so far.

Designing, developing and fabricating electronic instruments — Mile marker circuit in Acoustic system, flowmeters and power supply system for larval counter (FED/IT/1)

Designing, developing and fabricating the following:

1. Electrical ruddar indicator
2. AC/DC automatic aerator
3. Electronic Larval counter with power supply unit.

Single Cell Protein (SCP) production from micro-algae (FED/BT/1)

During the period under review macro-algae collected from Rameswaram, Pamban, Thonithurai, Seemiappa Darga, Pudumadam and Kilakarai from August 1984 to March 1985 were analysed for protein estimation.

The protein values estimated in the macro-algae ranged from 0.35 to 16.28%. Over 10% protein value was observed in the following species, viz. *Cladophoropsis zoolingeri, Stoechospermum marginatum, Sargassum wightii, Turbinaria conoides, Hormophysa triquetra, Cystophyllum muricatum, Grateloupia lithophila, Hypnea musciformis, Centeroceras clavulatum* and *L. poitei.*

Development of suitable digestor for coastal villages (FED/BT/2)

An attempt was made to enlist the whole range of methanogenic halophilic bacteria from mangrove sediments. Totally 4 types of morphologically different and physiologically active methylotrophs were encountered from marine sediments:

1. Rod shaped cells, sporulating — eg. *Methanobacillus* 2. Rod shaped cells, non-sporulating eg. *Methanobacterium* 3. Spherical cells in sarcina arrangement eg. *Methanosarcina,* 4. Spherical cells not in sarcina arrangement eg. *Methanococcus,* Methanobacillus and Methanococcus found to be prominent in marine sediments.

Selection and Genetic Improvement of Seaweeds (FED/SW/1.4)

Collection and screening of material: Different populations of the two species — *G. verrucosa* and *G. edulis* were sampled as part of the attempt to understand diversity in this genus. Herbarium specimens of these have been preserved, and some are being cultured for analysis.

Screening for variation in growth of *G. edulis* was done in two experiments conducted at Mandapam. Preliminary observations revealed no significant variation in the growth of three populations collected from different areas around Mandapam.

Study of Chromosomes: Attempts were made to study the chromosomes, as part of the programme to under-

stand the genetic structure of *Gracilaria*. Improvements were made in the staining technique.

Genetic analysis: The first step towards genetic analysis has to be the reliable completion, *in vitro*, of the life cycle of the study organism. Progress in this direction has been made for *G. verrucosa*, *G. edulis* and, to some extent, in *G. sjoestedtii*.

Investigations on Krill resources of the Antarctic waters (FED/PL/2)

The material collected during the third Indian Antarctic Research Expedition was analysed for zooplankton in general and for euphausiids in particular. While only 3 species of euphausiids including krill (*Euphausia superba*) were present in samples from within the Antarctic circle, 8 species were found to occur between 20 deg S up to the Antarctic circle. The zooplankton appeared to be more in the colder waters.

Detailed studies of distribution and abundance of zooplankton and krill resources of the area within latitudes 67°30'S and 68°30'S and longitudes14°E and 20°E have been studied and a paper incorporating the results has been presented and discussed at the symposium on Antarctica at Delhi in October.

Evaluation of macro and micro nutrients in the sediment and fertility of culture systems (FED/Misc./7)

During the period under review investigations of mud samples from mud bank area, perennial and seasonal prawn fields between Ernakulam-Azhikode (6 fields in Ernakulam and 4 fields in Eloor area), altogether consisting of 67 samples were analysed for the different environmental parameters. In addition, with the aid of Mobile Laboratory a team was sent to Orissa for investigating clusters of ponds around Chilka Lake developed under ERRP scheme. The investigations have revealed the lime requirements which is in the range of 280-8000 kg/ha and the available potash was in the range of 28 to 174 ppm. These investigations on sediment fertility will considerably enhance the scope of artificial enrichment and thereby increase the general productivity of the ponds for undertaking aquaculture activities.

Bio-active agents from Marine organisms (FED/Misc./8)

Preliminary chemical investigations on the flagellate, Dunaliella salina, which was found to be toxic to edible oyster were conducted which yielded 0·05 g of reddish sticky residue, 100 mg of oily deep greenish mass and 135 mg of a colourless amorphous substance. Further investigations are in progress.

A preliminary screening of 10 species of echinoderm collected from Gulf of Mannar area for toxicity to fishes, mice and also for hemolytic activity was conducted. These studies showed that *Holothuria atra*, *H. spinifera* and *Bahadschia marmorata* exhibited high degree of toxicity to the fish fingerlings, *Chanos* and *Tilapia*, mices also showed strong action on the erythrocite cells. The cuverian tubules of *B. marmorata* is highly toxic to all. The gradation of toxicity is brought out by these assays. The gradation strongest to weak toxic species is *H. atra* (body

wall and viscera), *B. marmorata* (body wall and cuverian tubules), *H. spinifera* (body wall and viscera), *H. scabra* (body wall), *Pentoceraster regulus* (body wall), *Actinocucumis typicus* (body wall), *Astropecten indicus, H. scabra* (viscera), *Goniodiscaster scaber, Tropiometra carinata, A. typicus* (viscera), *P. regulus* (viscera), *Stomopneustes variolaris* (viscera).

Chemical investigation of *H. spinifera* yielded 20 mg of colourless microcrystalline powder m.p. 239-242°C and *H. scabra*, 30 mg of crystalline sticky mass m.p. 249-252°C. As the yields of the compounds were very less, further collection of the material and extraction are being carried out.

A series of trial experiments were made to extract nematocyst toxin of jelly fishes with various reagents and simultaneous biotests for toxicity on fish, mice and hemolytic activity. The results were not satisfactory and further studies are being planned.

About 30 species of marine algae from Gulf of Mannar, Palk Bay and Mandapam Camp were examined for their hemolytic activity and anti-microbial activity. Only one test organism namely *Sargassum myriocystem* alone showed inactivity as far as hemolytic activity and anti-microbial actvities are concerned. *Enteromorpha compressa, Caulerpa racemosa, Cystoseria trinoides, Sargassum myriocystum, Amphiroa fragilissima* and *Acanthophora specifera* have exhibited no hemolytic activity, whereas *Cladophosis zoolangeri, Grateloupia lithophilla, Caulerpa peltata, Avrainvillea erecta, Halimeda gracilis, Stocchiospermum marginatum, Padina gymnospora, Turbinaria conoides, Gelidiella acerosa, Cheilosporum spectable, Ulva lactuca, U. reticulata, Bropsis pulmosa, Hormophysa triquetra, Sargassum wightii, Jania rubens, Gracilaria corticata, G. cressa, G. edulis, Hypnea musciformis, Centeroceras clavulatum* and *Laurencia papillosa* exhibited hemolytic activity. In the anti-microbial tests none of the thirty species showed any action on *Salmonella typhii.* All the species show antibiosis against both gram —ve microbes. *E. compressa, C. zoolangeri, P. gymnospora, S. wightii* and *G. cortica* show action against gram +ve cultures of Bacillus. Strong anti-microbial activity against gram —ve *Vibrio alginolyticus* is shown by *U. lactuca, C. peltata* and *G. acerosa. A. erecta* and *G. cressa* show inhibition of *Vibrio parahemolyticus. C. peltata, S. marginatum* and *G. acerosa* exhibit strong antimicrobial activity against *Staphylococcus aureus.*

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

Chlorophyll scanning from aircraft by OCR together with the sea truth data collected off Cochin were correlated for a highly exploited zone off Cochin to test the validity of using chlorophyll values for estimating fish production. It has been indicated that chlorophyll values for water columns approximating to 15 mg/sq. m. can sustain an yield of over 250 kg/ha/year of fish inclusive of both demersal and pelagic resources. Perhaps this could be used as a sort of general guideline in the estimation of resources based on chlorophyll data for a larger area in future studies involving the application of remote sensing technology in intensely fished waters of our coasts.

Landsat MSS data has also been found useful in mapping algal blooms

off Goa. A ratio of Landsat MSS band 4/5 enabled to understand the distribution pattern of suspended sediments. Enhanced False Colour Composite (FCC) generated with combination of band 4 (assigned red), 6 (assigned green) and ratio of 4/5 (assigned blue) proved most suitable in distinguishing the areas under suspended sediments from those under algal bloom. This would be helpful in locating large patches *Trichodesmium* blooms which adversely affect our pelagic fisheries.

Identification and isolation of suitable planktonic micro-organisms as mass culture (CMFRI/IDP/20)

During the year, the isolation, identifiation and mass culture programme of the nannoplankters for the purpose of feeding the oyster larvae at the Field Laboratory at Karapad was continued. The newly isolated phytoflagellates representing the Classes Haptophyceae, Chrysophyceae and Chlorophyceae were once again tried as food for the oyster larvae and confirmed its acceptability by the larvae especially the forms under Haptophyceae. The results showed that 3 strains of *Isochrysis galbana,* species of *Pavlova, Dicrateria* and *Chromulina* are good feeds compared to other nannoplankters.

Training Programme in Bacteriology (CMFRI/TR/7)

A training manual namely Laboratory Experiments for Isolation and Identification of Marine Bacteria was prepared.

Training in application and operation of underwater Acoustic equipment in fisheries (CMFRI/TR/9)

The training programme was organised during 12-25 September 1984. 19 scientists/teaching staff of 6 organisations such as fisheries Institutes, Maritime Universities associated with fisheries research and teaching participated.

FISHERY ECONOMICS AND EXTENSION DIVISION

Studies on the socio-economic status of fishermen were conducted in selected fishing villages of Tamil Nadu, Maharashtra and Gujarat and the earnings of fishermen families in various categories based on means of production were estimated. Net income over operating cost was found to be highest in families owning/sharing mechanised boats. In majority of villages, private agencies were the major source of finance for the fishermen. A study on the cost and earnings of trawlers, gillnetters and purse-seiners operating off Cochin Fisheries Harbour showed that the average gross revenue was highest for purse-seiners and lowest for gillnetters. Average fuel expenditure per day worked out to Rs. 650/-, 420/- and 130/- for purse-seiners, trawlers and gillnetters respectively.

An awareness and attitude study revealed that about 80% of the fish farmers were aware of the scientific prawn farming practices. The study evaluated the constraints fish-farmers faced during the implementation stage.

The Institute put up a stall in All India Exhibition held at Cochin 1984 and visuals including live specimens were exhibited. The Institute's fishery research activities were projected in an impressive manner. About 5 lakh people visited the stall during the exhibition period.

Surveys of small scale fisheries in southern region of India to study the socio-economics of coastal rural sector (FE & E/1) .

Data collected from Thiruvottiyoorkuppam and Pudumanikuppam fishing villages were analysed and a preliminary report about the socio-economic conditions of these two villages were prepared. Samples of households representing different categories such as (i) boat owners (ii) wage earners and (iii) families depending on fishery related activities were drawn from the preliminary survey for continuous observation with regard to different socio-economic parameters for a period of one year.

20 units of catamarans operating at Thiruvottiyoorkuppam was selected to study the "Economics of catamaran fishing units". Data on daily basis with regard to cost and returns were collected from April 1984 onwards and the same was completed by March 1985.

Preliminary analysis showed that the average initial investment for a catamaran unit was about Rs. 5300. The average number of fishing days was about 215. The annual gross income of a catamaran at Thiruvottiyoorkuppam was found to be about Rs. 9000/- as against Rs. 13,000 at Pudumanikuppam. A fishing labourer at Thiruvottiyoorkuppam was earning an annual income of Rs. 3,000/- whereas at Pudumanikuppam it was Rs. 4,300/- The net profit of a catamaran unit at Thiruvottiyoorkuppam was Rs 445/- and at Pudumanikuppam it was Rs. 1,545/-. This is in addition to his own wages.

Price spread at selected fish markets (E & FE 3)

Data on fish prices at Cochin Fisheries Harbour and at some of the ma-

jor consumer markets, transportation charges and marketing costs have been collected during the period 1983-84 and analysed. It was observed that fisherman's share in consumer's rupee was 35 to 45 paise per rupee for comparatively cheaper varieties of fish and more than 55% for quality fishes like pomfret, seer fish etc. Transportation costs worked to 5 to 8 paise.

A similar type of study has been taken up at Pudumanikuppam landing centre (Madras) which was selected as primary market and five centres as consumer markets. Seasonwise data at various points of the marketing channel were collected and the same are being analysed.

Economics of mechanised fishing units (E & FE 4)

Cost and earnings data have been collected from trawlers, gillnetters and purse seiners from Cochin Fisheries Harbour on a sample basis during 1983-84. The data thus obtained have been analysed.

Average gross revenue worked out to Rs. 4192/- for purse-seiners, Rs. 932/- for trawlers and Rs. 775/- for gillnetters per day. The average fuel expenditure worked out to Rs. 650/-, Rs. 420/- and Rs. 130/- respectively. Daily earnings of a crew member worked out to Rs. 50/- for purse-seiners, Rs. 33/- for trawlers and Rs. 39/- for gillnetters.

Study on income, consumption and employment pattern and credit facilities available to fishermen in north west coast (FE & E/9)

Three fishing villages in Maharashtra and four in Gujarat were covered under this study. Fishermen families in these villages were categorised on the basis of means of production and data were collected from sample families during 1983-84. The results revealed that number of annual fishing days ranged from 200 to 244 for different categories. October-December quarter is the peak fishing season contributing 34-42% of annual catch in these villages. Crew wages is the biggest expenditure for boat operating families forming 45-75% of fishing expenditure. For mechanised group fuel is the second biggest expenditure (23-39% of the expenditure). Among all the categories, annual net fishery income over operating cost is maximum for the families owning/sharing mechanised boats, averaging Rs. 10199 in Maharashtra and Rs. 12042 in Gujarat. Household expenditure per day for different categories comes to be Rs 16-18 in Maharashtra and Rs .15-20 in Gujarat. Propensity to consume ranges from 0.57 to 1.01 in Maharashtra and 0.55 to 0.96 in Gujarat.

Annual investment for different categories ranges from Rs. 360 to Rs. 4383 in Maharashtra and Rs. 425 to Rs. 5474 in Gujarat. There is significant difference in annual investment within categories. About 60-84% of families among different categories in Maharashtra and 58-78% in Gujarat are availing loan from different agencies. In majority of villages private agencies are main sources of finance for the fishermen. Financing through fishermen co-operative society is found to be comparatively better in Maharashtra. Outstanding loan ranges from Rs. 3389 to Rs. 4206 per indebted family in Maharashtra and Rs. 1,040 to Rs. 5827 in Gujarat. One per cent change in income brings 0.12 per cent

change in consumption in Maharashtra and 0.22 per cent change in Gujarat. Among earners (49-59% of population) majority have fishing or fishery related activities as the main occupation.

Costs and returns of doinet fishery in north west coast (FE & E/13)

Data collection in two villages of Maharashtra and one village in Gujarat is in progress.

Comparative economics of artisanal and mechanised fishing units in West Bengal and Orissa coast (FE & E/10)

The work of collection of cost and earnings data from selected fishing centres was taken up. The field work is in progress.

Design and evaluation of teaching aids for mariculture extension (FE & E/11)

The procurement of basic materials namely photographs and slides on the various aspects of capture and culture fisheries was continued. Colour photographs were taken covering the activities including hatchery technology for edible and pearl oysters at Tuticorin Research Centre and negative, slides and prints were prepared.

The Institute participated in the Cochin 1984 All India Exhibition where visuals on Institute's activities were produced and displayed. An evaluation conducted showed that about 5 lakh people visited the exhibition. The live specimens of hatchery produced prawn, translites and specimens on Third Indian Antarctic Expedition and photographs and posters on conservation of marine turtles were identified as the most attractive exhibits.

Mariculture practices — an awareness and attitude study (FE & E/12)

A study on the awareness and attitudes towards scientific prawn farming among the fish farmers around Cochin was made by collecting appropriate data from a sample of farmers and analysing the same. Eighty per cent of the fish farmers considered for the study were aware of the scentific prawn farming practice. They tended to have favourable attitude towards the practice. Extent and ownership of holding, experience in traditional farming and training in the new practice influenced the attitude favourably. The rank order of the constraints was lack of detailed knowledge about the practice, paucity of seed, time lag involved in accruing income from the enterprise, risk involved due to leased in holdings and ignorance about availability of credit for the purpose.

PHYSIOLOGY, NUTRITION AND PATHOLOGY DIVISION

Induced breeding experiments were conducted on *Mugil cephalus* using H.C.G. harmone along with pituitory gland extract. The eggs recorded 90% maturity on the second day after the administration of the harmone. Histological studies revealed that there were six different cell types in the pituitory gland. Studies on the correlation between the gonadotraps and different maturity stages are in progress. Experiments revealed that moderately moist diets containing 20 to 30% moisture were more suitable for feeding fry of *Liza parsia* and a feeding frequency of twice daily resulted in maximum growth and survival of the fry. Experiments were also conducted to evaluate the optimum lipid requirements of the fingerlings of *L. macrolepis*. Diet containing 40% protein and 40 to 50% carbohydrate provided more efficient growth rate and survival rate of *L. macrolepis* fry. Laboratory analysis indicated that sardine oil and prawn oil had high levels of polyunsaturated fatty acids, licosapentaeonic and docosahexaenoic acids, but shark liver oil had much lower level of the above two fatty acids. It was further observed that 6% liquid content in the diet is adequate for *P. indicus*. Increasing liquid levels in the diet above this level had no beneficial effect on the growth and food conversion ratio. The ratio of the total bodyweight to hepatopancreas of the females of *P. semisulcatus* was found to show an inverse relationship with the maturation of the overy.

The Division, during the year carried out researches on eleven projects, one each dealing with Physiology and pathology of penaeid prawns, three on inducing maturation and reproductive physiology of finfishes such as grey mullet, milkfish and *Etroplus suratensis* and six on nutritional requirements of fry and fingerlings of mullets and milk fish, penaeid prawn larvae, spiny lobsters and of the mud crab larvae. Of these two projects, one relating to the reproductive physiology of *Etroplus suratensis* and the other on cataloguing of chemical and biological data on feed ingredients were completed. The salient features of observations and conclusions made in the above projects are given below.

Controlled breeding of Grey mullets and Siganus spp .

Live *Mugil cephalus* breeders caught by Chinese dip nets were procured from Cochin Barmouth for induced breeding experiments. As the transportation and handling stress were found to affect greatly the survivability of breeders in the hatchery, an anti-shock cage was fabricated to hold the breeders in the spawning tank and during the experiments. The cage consisted of a rectangular frame of thick PVC pipe fitted inside an oval 1.2 tonne fibreglass tank. A hapa made of soft nylon netting was attached to the PVC frame and kept suspended in such a way that a clearance of 5 to 6" on all sides of the tank was ensured. A top cover was also provided to the cage. During the reporting period, although 17 breeders were procured, induced breeding experiments were conducted only on 2 specimens using the commercially available H.C.G. hormone along with pituitary gland ex-

tract. In both the cases, the eggs, after the administration of the hormone in 2 dosages to one fish and in 3 dosages to the other, recorded 90% maturity on the second day. However, they failed to liberate eggs. Further experiments in a closed running sea water system are being planned.

Correlation between the structure of the pituitary and changes in the gonad of pearl spot, Etroplus

The histological studies of the gonads of *Etroplus suratensis* showed that the peak breeding season of the fish was in December-January. A secondary peak was also observed in June-July. Different stages of ova development were identified on the basis of histological changes of oocytes during maturation. Enormous amount of fully matured spermatozoa thickly packed in the testicular himen was observed in December and again in June.

The histological studies on the pituitary gland have revealed six different cell types in the gland. The gonadotrops wich are responsible for maturation events have been located in the proximal pars distalis portion of the pituitary gland. Studies on the correlation between the gonadotrops and different maturity stages are in progress.

Nutritional requirements of fry and fingerlings of the milkfish, Chanos chanos, and mullets (Mugil spp.)

The results of the experiments carried out to study the relative efficiency of dry, moist and semi-moist diets for *Liza parsia* fry, with a view to identifying a suitable form of diet, indicated that the semi-moist diets containing 20 to 30% moisture were more suitable for feeding the fry as compared to dry and moist diets. The moist diets showed poor water stability and disintegrated fast, while the dry diets were poorly accepted by the fry. In another experiment to evaluate the effect of feeding frequencies on the growth and survival of *L. parsia* fry, they were fed on a purified diet once daily, twice daily, once on alternate days and twice on alternate days at a constant feeding level. The results showed that feeding twice daily provided the maximum growth and survival of the fry.

Feeding experiments were also conducted to elucidate the optimum lipid requirements of the fingerlings of *L. macrolepis* using isonitrogenous purified diets. Diets containing graded levels of lipids ranging from 1 to 11% were fed to triplicate groups of finger lings in each treatment. The data obtained showed that the diet containing 3% lipid gave the optimum growth and survival.

The main aim of the experiments carried out at Tuticorin on *L. macrolepis* fry was to determine protein and carbohydrate requirements and the results indicated that the diet containing 40% protein and 40-50% carbohydrate provided more efficient growth rate, protein uptake and survival rate.

Cataloguing of chemical and biological data on conventional and non-conventional feed ingredients suitable for cultivable marine organisms in India

Continuing the project during the period under report, data were collected on the proximate composition and

amino acid profiles of proteins, minerals, trace elements and vitamin contents of various feed ingredients and on the composition of live food organisms. Amino acid profiles of six ingredients were analysed in LKB amino acid analyser. Besides, fatty acids profile of 17 lipid sources were studied using a gas liquid chromatography fitted with a Flame Ionization Detector. Preliminary observations indicated that none of the 14 vegetable oil sources analysed had licosapentaenoic and docosahexaenoic fatty acids essential for the crustaceans. Most of the vegetable oils had high content of linoleic acid. Among the marine lipid sources, cod liver oil, sardine oil and prawn oil had high levels of polyunsaturated fatty acids, licosapentaeonic and docosahexaenoic acids. However, the shark liver oil had much lower level of the above two fatty acids.

Nutritional requirement of penaeid prawn larvae and juveniles

The experiments carried out under the project during the period were directed to determine the qualitative and quantitative lipid requirements for the juvenile *Penaeis indicus*. Five types of diets with different lipid sources such as cod liver oil, sardine oil, prawn head oil, lecithin and a mixture of all the four lipids were formulated with other ingredients comprising of Caesin (vitamin free), sucrose, starch, cholesterol, glucosamine HCl, sodium citrate, sodium succinate, Inositol, choline chloride, vitamin and mineral mix (Roche), cellulose and PVA (Binder), and feeding experiments in replicates were conducted. The diet containing the mixed lipids showed significant growth both in terms of size and weight. It was further observed that *P. indicus* has specific qualitative requirement for lipids. The fact that the diet having the four lipids in equal proportion produced highest growth showed that the prawns require a proper blend of fatty acids for healthy and faster growth. The growth obtained in prawns by feeding the diet with prawn head oil (which contains rich polyunsaturated fatty acids of W3 series) was very near to that recorded in feeding experiments with the diet having mixed lipids. On the basis of this result, experiments were conducted to determine the quantitative requirement of lipid with six isocaloric diets formulated with lipid mixture in increasing levels of 1, 3, 6, 9, 12 and 18%. The results of these experiments indicated that a 6% lipid content in the diet to be adequate for *P. indicus*. Increasing lipid levels in the diet above this level had no beneficial effect on the growth and food conversion ratio.

Nutritional requirements of spiny lobsters (Panulirus spp.)

Earlier experiments with synthetic test diets on the spiny lobster, *Panulirus homarus* had shown that the acceptability of such diets was not good, resulting in wastage of food as well as poor rate of growth. Hence it was decided to test whether the palatability could be increased by offering semi-synthetic diets. For this purpose, three diets were prepared with casein as the main protein source and incorporating wheat floor, crab meal, and prawn peelings in the diets. Both moist and pellets were prepared and feeding experiments were conducted initially with dry pelleted feed. The study was being continued.

Development of artificial and processed natural diet for rearing bivalve larvae.

Gelatin coated micronarticulate diet of 2 to 3 micron size using edible oyster extract, pearl oyster extract and clam extract was prepared. Feeding experiments were conducted using this micropartculate diet as supplementary feed along with the natural diet with edible oyster larvae. The microparticulate diet was given at rates varying from 20,000 to 40,000 capsules per day/larva. The results indicated that the larvae fed with gelatin coated microparticulate diet showed higher setting rate than those fed with only algal diet. Further experiments are in progress to confirm this observation.

Studies on the hepatopancreas of penaeids

The studies on chemical composition of hepatopancreas of *P. semisulcatus* were continued. The glycogen content of the hepatopancreas showed an increase along with the maturation process of the ovary from the immature to mature stage, the percentage glycogen content in terms of weight of hepatopancreas being 4.56 at stage II, gradually increasing to 7.64% in stage IV. The glycogen content in males, however, did not show any significant change. The ratio between the weight of total body and hepatopancreas was found to show an inverse relationship with the maturation of the ovary, as it was found decreasing from the immature to mature stage.

The carotein content in relation to maturation of the female followed a similar trend as that of glycogen content, it was 4.57% in total body weight in the mature prawns and only 1.06% in the maturing females; in terms of weight of hepatopancreas, it was 9.4% and 3.8% respectively.

The hepatopancreas and muscle tissue of *Penaeus indicus* were also analysed for trace metals for calcium, zinc, iron, copper, nickel and cobalt. The latter two trace metals were found to be absent in these tissues in the prawn. In the hepatopancreas, calcium, zinc, iron and copper were 1256.7μg/g, 167.3 μg/g, 163.6 μg/g and 14.9 μg/g dry tissue, whereas, the values of the trace metals recorded in the muscle was 379.7 μg/g, 80.5 μg/g, 20.1 μg/g and 78.6 μg/g respectively.

Studies on pathology of 'soft' prawns

An interim review of the progress of the project during its operational period from 1982 to 1984 was made. Physiologically, an imbalance in the calcium distribution in the haemolymph, muscles and exoskeleton between the 'soft' and normal prawns was noticed. Although the calcium content was found at a relatively higher level in the haemolymph and muscles, it was lower in the exoskeleton in 'soft' prawns. Histologically, the hepatopancreas of the 'soft' prawns showed a degenerated condition, whereas the muscle and the hind gut tissues were normal. Further studies and comparisons of the histology of the hepatopancreas of the 'soft' and starved prawns are in progress.

The data collected on the stocking density and the occurrence of 'soft' prawns showed no correlation between these parameters. The analysis of the gut content of the 'soft' prawns indicated that the gut of 90% of prawns observed were in gorged condition. It was pointed out that one of the contributing reasons for the oc-

currence of soft prawns might be the toxic effects of the plankton blooms which were often seen when such condition developed in the prawns.

Another observation made on 'soft' prawns related to the distribution levels of Free Amino Acid and protein in 'soft' prawns. These were found to be relatively low in the 'soft' prawns However, it was opined that these parameters could serve as only secondary index. The environmenal conditions such as dissolved oxygen of the pond water, salinity and pH did not show any significant correlation with softness of prawns.

The results of feeding experiments carried out on 'soft' prawns indicated that 'soft' prawns fed with protein rich diet were found to recover, while the diets deficient in nutrients such as calcium, phosphorus and vitamin had no effect on 'soft' prawns.

One of the studies on the effect of H_2S on prawns revealed that the characteristics similar to that of soft prawn were developed when the H_2S build up in the environment in which the prawns were cultured, goes beyond certain level. Following this, further studies on the eH distribution in the culture pond and occurrence of 'soft' prawns were being planned.

Nutritional requirements of the mud crab, Scylla serrata larvae and juveniles

This project was started in April, 1984. Microparticulate (less than 53 μ in size) test diets with protein content ranging from 25% to 65% were prepared with a view to find out the protein requirement of the larvae. Designs of the feeding experiments were finalised to undertake the same during the ensuing rearing of crab larvae in the laboratory.

Controlled breeding of milkfish

Initiating the project during the period, the infrastructural facilities to carry out the breeding experiments were built up. A few specimens of milk fish reared during the last four years in the brackish water pond were maintained separately for observation on the behaviour of the fish under controlled conditions of the laboratory.

PHYSIOLOGY, NUTRITION AND PATHOLOGY DIVISION

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amino acid profiles of proteins, minerals, trace elements and vitamin contents of various feed ingredients and on the composition of live food organisms. Amino acid profiles of six ingredients were analysed in LKB amino acid analyser. Besides, fatty acids profile of 17 lipid sources were studied using a gas liquid chromatography fitted with a Flame Ionization Detector. Preliminary observations indicated that none of the 14 vegetable oil sources analysed had licosapentaenoic and docosahexaenoic fatty acids essential for the crustaceans. Most of the vegetable oils had high content of linoleic acid. Among the marine lipid sources, cod liver oil, sardine oil and prawn oil had high levels of polyunsaturated fatty acids, licosapentaeonic and docosahexaenoic acids. However, the shark liver oil had much lower level of the above two fatty acids.

Nutritional requirement of penaeid prawn larvae and juveniles

The experiments carried out under the project during the period were directed to determine the qualitative and quantitative lipid requirements for the juvenile *Penaeis indicus*. Five types of diets with different lipid sources such as cod liver oil, sardine oil, prawn head oil, lecithin and a mixture of all the four lipids were formulated with other ingredients comprising of Caesin (vitamin free), sucrose, starch, cholesterol, glucosamine HCl, sodium citrate, sodium succinate, Inositol, choline chloride, vitamin and mineral mix (Roche), cellulose and PVA (Binder), and feeding experiments in replicates were conducted. The diet containing the mixed lipids showed significant growth both in terms of size and weight. It was further observed that *P. indicus* has specific qualitative requirement for lipids. The fact that the diet having the four lipids in equal proportion produced highest growth showed that the prawns require a proper blend of fatty acids for healthy and faster growth. The growth obtained in prawns by feeding the diet with prawn head oil (which contains rich polyunsaturated fatty acids of W3 series) was very near to that recorded in feeding experiments with the diet having mixed lipids. On the basis of this result, experiments were conducted to determine the quantitative requirement of lipid with six isocaloric diets formulated with lipid mixture in increasing levels of 1, 3, 6, 9, 12 and 18%. The results of these experiments indicated that a 6% lipid content in the diet to be adequate for *P. indicus*. Increasing lipid levels in the diet above this level had no beneficial effect on the growth and food conversion ratio.

Nutritional requirements of spiny lobsters (Panulirus spp.)

Earlier experiments with synthetic test diets on the spiny lobster, *Panulirus homarus* had shown that the acceptability of such diets was not good, resulting in wastage of food as well as poor rate of growth. Hence it was decided to test whether the palatability could be increased by offering semi-synthetic diets. For this purpose, three diets were prepared with casein as the main protein source and incorporating wheat floor, crab meal, and prawn peelings in the diets. Both moist and pellets were prepared and feeding experiments were conducted initially with dry pelleted feed. The study was being continued.

Development of artificial and processed natural diet for rearing bivalve larvae.

Gelatin coated micronarticulate diet of 2 to 3 micron size using edible oyster extract, pearl oyster extract and clam extract was prepared. Feeding experiments were conducted using this micropartculate diet as supplementary feed along with the natural diet with edible oyster larvae. The microparticulate diet was given at rates varying from 20,000 to 40,000 capsules per day/larva. The results indicated that the larvae fed with gelatin coated microparticulate diet showed higher setting rate than those fed with only algal diet. Further experiments are in progress to confirm this observation.

Studies on the hepatopancreas of penaeids

The studies on chemical composition of hepatopancreas of *P. semisulcatus* were continued. The glycogen content of the hepatopancreas showed an increase along with the maturation process of the ovary from the immature to mature stage, the percentage glycogen content in terms of weight of hepatopancreas being 4.56 at stage II, gradually increasing to 7.64% in stage IV. The glycogen content in males, however, did not show any significant change. The ratio between the weight of total body and hepatopancreas was found to show an inverse relationship with the maturation of the ovary, as it was found decreasing from the immature to mature stage.

The carotein content in relation to maturation of the female followed a similar trend as that of glycogen content, it was 4.57% in total body weight in the mature prawns and only 1.06% in the maturing females; in terms of weight of hepatopancreas, it was 9.4% and 3.8% respectively.

The hepatopancreas and muscle tissue of *Penaeus indicus* were also analysed for trace metals for calcium, zinc, iron, copper, nickel and cobalt. The latter two trace metals were found to be absent in these tissues in the prawn. In the hepatopancreas, calcium, zinc, iron and copper were 1256.7μg/g, 167.3 μg/g, 163.6 μg/g and 14.9 μg/g dry tissue, whereas, the values of the trace metals recorded in the muscle was 379.7 μg/g, 80.5 μg/g, 20.1 μg/g and 78.6 μg/g respectively.

Studies on pathology of 'soft' prawns

An interim review of the progress of the project during its operational period from 1982 to 1984 was made. Physiologically, an imbalance in the calcium distribution in the haemolymph, muscles and exoskeleton between the 'soft' and normal prawns was noticed. Although the calcium content was found at a relatively higher level in the haemolymph and muscles, it was lower in the exoskeleton in 'soft' prawns. Histologically, the hepatopancreas of the 'soft' prawns showed a degenerated condition, whereas the muscle and the hind gut tissues were normal. Further studies and comparisons of the histology of the hepatopancreas of the 'soft' and starved prawns are in progress.

The data collected on the stocking density and the occurrence of 'soft' prawns showed no correlation between these parameters. The analysis of the gut content of the 'soft' prawns indicated that the gut of 90% of prawns observed were in gorged condition. It was pointed out that one of the contributing reasons for the oc-

currence of soft prawns might be the toxic effects of the plankton blooms which were often seen when such condition developed in the prawns.

Another observation made on 'soft' prawns related to the distribution levels of Free Amino Acid and protein in 'soft' prawns. These were found to be relatively low in the 'soft' prawns However, it was opined that these parameters could serve as only secondary index. The environmenal conditions such as dissolved oxygen of the pond water, salinity and pH did not show any significant correlation with softness of prawns.

The results of feeding experiments carried out on 'soft' prawns indicated that 'soft' prawns fed with protein rich diet were found to recover, while the diets deficient in nutrients such as calcium, phosphorus and vitamin had no effect on 'soft' prawns.

One of the studies on the effect of H_2S on prawns revealed that the characteristics similar to that of soft prawn were developed when the H_2S build up in the environment in which the prawns were cultured, goes beyond certain level. Following this, further studies on the eH distribution in the culture pond and occurrence of 'soft' prawns were being planned.

Nutritional requirements of the mud crab, Scylla serrata larvae and juveniles

This project was started in April, 1984. Microparticulate (less than 53 μ in size) test diets with protein content ranging from 25% to 65% were prepared with a view to find out the protein requirement of the larvae. Designs of the feeding experiments were finalised to undertake the same during the ensuing rearing of crab larvae in the laboratory.

Controlled breeding of milkfish

Initiating the project during the period, the infrastructural facilities to carry out the breeding experiments were built up. A few specimens of milk fish reared during the last four years in the brackish water pond were maintained separately for observation on the behaviour of the fish under controlled conditions of the laboratory.

LIBRARY AND DOCUMENTATION DIVISION

LIBRARY

During the year 407 books, 920 volumes of periodicals and 140 non-book materials were added to the Headquarters library. The essentially required books and periodicals were also procured for the sectoral libraries at the Regional Centre and Research Centres of the Institute. The library was doing the sales and distribution of the publications of the Institute and printing of 'forms etc. for the Institute in the offset printing machine & photocopiers.

The inter-library loan and collaboration were provided as usual to various institutions, Universities and government departments in the country and abroad.

Further the following services were also provided by the library.

1) Current Awareness Service (Monthly)
2) S. D. I. Service (Manual)

PUBLICATIONS

The following publications were issued by the Institute

1) *Indian Journal of Fisheries*
   Vol. 31 — No. 1, 2 and 3 and Volume 32 — No. 1
2) *CMFRI Bulletin* No. 31 Coastal zone management: Mud banks of Kerala coast.
3) *Marine Fisheries Information Service: Technical and Extension Series* Nos. 51, 52, 53, 54, 55 and 56.
4) *CMFRI Special Publication*: Nos. 15, 16, 17, 18, 19, 20 and 22.
5) *CMFRI Newsletter:* Nos. 23 to 26

CENTRE OF ADVANCED STUDIES IN MARICULTURE

In the M.Sc. in Mariculture teaching programme eighteen students have undergone the course, 10 belonging to the Fourth Batch (seniors) and 8 to the Fifth Batch (juniors). In the Ph.D in Mariculture programme eleven scholars completed their research work; two among them have been awarded the Ph.D. Degree by the University of Cochin. Twentyeight Research Scholars belonging to the Third, Fourth and Fifth batches are currently working under the programme. Two experts of mariculture visited the Centre and imparted training in various methodologies of research and practice in mariculture based on their own experiences and knowledge.

The educational activities, individual training of faculty members, expert consultancy and equipment procurement programme of the centre were continued during the period as per the work plan of the project.

In the M.Sc. (Mariculture) Programme, 18 candidates are undergoing the course, 10 belonging to the fourth batch and 8 to the fifth. The fourth batch is in the third semester of the course which is devoted to different culture systems in the second semester. Earlier, the 9 candidates belonging to the third batch succensfully completed the course and passed the University examination.

In the Ph.D. Programme, eleven scholars completed the research work, two among them have been awarded the Ph.D. degree by the University of Cochin. Twenty eight research scholars belonging to the third, fourth and fifth batches are currently working under the programme.

Nine experts, one each in the field of reproductive physiology, nutrition, tissue culture, genetics, crustacean physiology, culture of live food organisms and oyster biology and culture and two experts in fish and shellfish pathology visited the centre during 1980-84. During the reported period, Dr. Sammy M. Ray, Dean, Mody College, Texas A & M University, USA, an expert in oyster biology and culture and Dr. Claude E. Boyd, Professor in Water quality, Auburn University, USA, offered consultancies. Besides organising group discussions and seminars, the experts conducted workshops training the scientists and scholars in the research methodology. Dr. Sammy M. Ray, organised a workshop in 'Marine toxins in bivalve molluscs and general consideration of shellfish sanitation; while Dr Boyd dealt with 'water Quality management in Aquaculture.'

Training programme in identified priority areas where adequate expertise is not available in the country, to enhance the professional competency of scientists/faculty members were continued. During the period, 6 scientists one each in the field of fish seed production, water quality management, aquatic pathobiology, marine fish genetics, aquaculture economics and lobster culture underwent training.

Through the UNDP assistance, need-based major equipments were procured for strengthening the physiology, nutrition, pathology, endocrinology and water quality researches. During 1984-85, One Hitachi-14, 600 Transmission-cum-Scanning Electron Microscope, and an Ultra Microtome were procured. With these equipments, 26 different items of major laboratory equipments were added to strengthen and augment the research facilities.

KRISHI VIGYAN KENDRA, NARAKKAL

1. About 150 families of Ernakulam District have been surveyed so as to arrange specific training programmes of practical value according to the needs of the farmers and also survey work was conducted to identify the beneficiaries of the Lab-to-Land Programme of the Institute and inter-action between the farmers and the KVK staff was developed. KVK also developed functional linkage with other organisations like Block Development Office, Land Development Bank, Forest and Fisheries Department of Kerala State and All India Radio.

2. Training Courses organised :

Area	*Duration in days*	*Type of training*	*No. of courses*	*No. of Trainees*			*No. of trainee days occupied*
				*FM**	*FW**	*Total*	
Scientific farming of prawn and fin fishes	5	90% Off and 10% On Campus	19	94	238	332	1660
Post harvest technology of prawn & fishes	3	On Campus	1	—	30	30	90
Prawn/fish seed collection	1	Off Campus	1	—	30	30	30
Financing for prawn and fish farming	1	On Campus	1	22	—	22	22
Live stock sterility in cattle & some remedial measures	1	On Campus	1	33	—	33	33
Calf care	1	On Campus	1	—	35	35	35
Poultry farming (Broilers)	2	On Campus	2	56	—	56	56
Poultry farming (Layers)	1	On Campus	1	—	35	35	35
Vegetable cultivation	1	Off Campus	2	—	78	78	78
Social forestry	1	Off Campus	3	28	114	142	142
Food preservation	1	On Campus	1	—	44	44	44
		TOTAL	33	233	604	837	2225

* *FM = Farm Men*

* *FW = Farm Women*

3. Work analysis of scientific staff :

A. *Training Courses*

Sl. No.	*Designation of staff*	*No. of courses taken during current year*		*No. of days spent in taking/developing courses during the year*	
		Off Campus	*On Campus*	*Off Campus*	*On Campus*
1.	Senior Scientist (Scientist S-3) — 1	20 (90% Off & 10% on campus)		1575 (Trainee days)	175
2.	Senior Training Asst. (T-6) — 4	6		250 (Trainee days)	
3.	Training Asst. (T-4) — 3*	7			225 (Trainee days)
	TOTAL	33		1825	400

* *One post vacant at present*

B. *Training-cum-Extension Activities :—*

Sl. No.	*Designation of staff*	*No. of days spent during the year on*		
		Training	*Extension*	*Survey work*
1.	Senior Scientist — 1	33 Trainee days	120 Man days	—
2.	Senior Training Asst. (T-6) — 4	1252 "	480 Man days	240 Man days
3.	Training Asst. (T-4) — 3	940 "	360 Man days	180 Man days
	TOTAL	2225	960	420

C. *Survey work:*

About 150 families belonging to Cochin, Kanayannur and North Parur taluks (all in Ernakulam Dist.) have been covered under the preliminary survey programme so as to arrange specific training programmes as per the need of the farmer.

4. Conducted tours of farmers/farm women/other trainees :

The trainees were regularly taken to prawn and fish seed collection centres in Vypeen Island for imparting practical training in seed collection. The trainees were also taken to the Marine Prawn Hatchery Laboratory of CMFRI, Narakkal.

5. Survey work :

i) A preliminary survey of 300 trained farmers of Vypeen Island was conducted to identify the beneficiaries of Phase III of the LLP of the Institute.

ii) 100 families identified as the proposed beneficiaries under the III phase of LLP have been contacted again to collect the bench mark survey.

iii) Out of 2330 farmers trained in the Kendra till December 1984, 1303 farmers (55.9%) were contacted personally to assess the impact of the training programme and its utility among the farmers.

A brief result of the survey is given below:—

I. *Trainees who have utilised the training:*

a)	Selective stocking — scientific farming	11.98%
b)	Seed collection and survey	10.44%
c)	Supplementary stocking — Semi-scientific	6.91%
d)	Employed in prawn farm	1.69%
		31.02%

II. *Trainees who have not utilised the training due to:*

a)	Lack of own land/finance	49.26%
b)	Continuing studies	1.38%
c)	Otherwise employed	17.88%
d)	Continuing traditional filtration	0.46%
		68.98%

6. A. Publications :

1) "A Guide to prawn farming" prepared by Shri K. Ashokakumaran Unnithan will be brought out as a special publication of CMFRI and the same is in press.

2) A popular article entitled 'Krishi Vigyan Kendra' prepared by Dr. M. M. Thomas and Sri K A K Unnithan was published in 'Kerala Karshakan', a publication of Farm Information Bureau of the Govt. of Kerala.

3) "Role of Krishi Vigyan Kendra in mariculture training" prepared by Dr. M. M. Thomas, P. K. Nair, K. A. K. Unnithan, P. K. Martin Thompson, A. N. Mohanan, P. Radhakrishnan and K. Purushothama Kani for publication in the Institute's Bulletin on Prawn culture.

B. Articles and Journals published by KVK :

The K V K publishes articles of fisheries interest as "KVK Patrikas" and "KVK Leaflets".

7. Innovative/New ideas tried in training :

a) Though there are various agencies to finance prawn/fish farming project, the farmers do not have a free 'know how' on the norms and conditions to avail these facilities. So a one-day training course on this subject was arranged by making available of the services of Agricultural Officer, Kanayannur Taluk Land Mortgage Bank.

b) With the help of the subject matter specialists from Central Institute of Fisheries Technology a three day training course was arranged for women in the KVK campus on "Post Harvest Technology of prawn and fishes". The trainees were given practical training in the preparation of soup powder, wafers and pickles from cheap fish.

c) The Agricultural Officer, Kuzhupilly was invited to take an on campus training programme on vegetable cultivation in which the women farmers were trained in the scientific methods of vegetable cultivation including the use of chemical fertilizers and pesticides.

d) The 'Vanamahotsava' of Vypeen NES block was arranged at the KVK Campus. The local public and the farmers who underwent training in social forestry participated in the programme. Sri P. K. Velayudhan, Hon'ble Minister for Community Development, Govt. of Kerala, inaugurated the function by distributing seedlings to the trainees. As part of this programme a one-day training on social forestry was arranged. The DFO gave lectures to the trainees.

8. A. Other aspects of KVK working and management :

a) Measurements / Methods evolved and / or used to assess the impact of the training:

Considering the importance of assessing the impact of the KVK training programme on the target group the regular training courses were suspended at the instance of the Director, CMFRI and a follow up survey was conducted to assess the post training activities of the trainees during September — December '84 to assess the impact of the training programme. About 1303 trainees were contacted in person. It was found that 31.02% of the trainees have utilised the training in the following lines viz., Scientific farming, semi-scientific farming, prawn seed trade and employment in prawn farms.

b) Studies / research taken with a view to understand the achievement and needs for training:

A village-wise family survey was undertaken to find out the needs for training .Also bio-data of each trainee is collected in the first day of the training course. Based on these data the training courses are conducted. Training course on poultry farming, duck farming, horticulture and agriculture are arranged separately. Courses on Integrated farming system like prawn / fish / vegetable cultivation are also arranged for the trainees based on primary survey.

c) Specific literature developed for farmers:

A publicaition entitled 'A guide to prawn farming' has been prepared. This will be brought out by CMFRI as a special publication.

d) Outstanding achievements:

Since there is plenty of raw material available in the form of prawn and thrash fish, a three day training course was organised for farm women on post harvest technology on prawn and fish with the help of the staff of CIFT, Cochin. Practical work experience was given to the trainees in making prawn wafers, fish soup powder and fish pickles.

Film shows arranged:

a) No. of film shows ... 43

b) Progressive total of shows during the year under report ... 43

c) No. of documentaries shown to KVK trainees ... 97

Teaching aids developed:

i) Training activities have been photographed for making slides.

ii) New farming techniques/operation introduced:

Polyculture of prawns and fishes integrating vegetable cultivation along the bunds have been advocated during the monsoon.

RADIO TALK/DISCUSSIONS/SEMINARS ETC.

1. **Radio talk :**

Sl. No.	*Title of talk*	*Person who gave the talk*
1.	Scientific prawn farming — a more profitable alternative to the conventional filtration system	Shri K A K Unnithan, Sr. Training Asst. (T-6) ...
2.	Training in fish farming	Dr. M. M. Thomas Officer-in-charge ...

2. Seminars :

1. Brackish water fish farming organised by Department of Fisheries, Kerala.

Shri P Karunakaran Nair, Sr. Training Asst. (T-6) presented a paper on traditional prawn farming in Kerala, its merits and demerits.

3. Meetings :

1. Shri K.N. Rasachandra Kartha, Sr. Training Asst. (T-6) attended the Regional Committee Meeting of the Lab-to-Land programme held at CTCRI, Trivandrum.

2. Dr. M. M. Thomas, Scientist (S-3) and Officer-in-Charge, Shri P. Karunakaran Nair, Sr. Training Asst. (T-6), Shri K.N. Rasachandra Kartha, Sr. Training Assistant (T-6) attended the Evaluation Committee meeting of the Lab-to-Land Programme held at CIFT., Cochin.

4. Discussions :

A discussion programme is conducted regularly on the last day of each training programme. Also all the film shows are followed by a discussion on Mariculture.

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Shri S. Dharmaraj
Shri K. Narayana Kurup
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Shri R. Sathiadas
Shri Syed Ahamadali
Shri Alexandar Kurian

Scientist S-1

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Shri G.P. Kumaraswamy Achary
Shri K. Y. Telang
Shri P.V. Sreenivasan
Miss R. Padmini
Mrs. Gracy Mathew
Shri V. Thangaraj Subramanian
Dr. V. S. Kakati
Dr. N. Ramachandran
Shri S.K. Chakraborthy
Shri Vinay D. Deshmukh
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Miss Jancy Jacob
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Shri D. Sivalingam
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Shri P. Natarajan
Shri Mohamed Zafar Khan
Shri T.S. Velayudhan
Shri G. Radhakrishnan
Shri V.S. Rengaswamy
Shri I. David Raj
Shri S. Sreenivasa Rengan
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Shri Kamal Kumar Dutta

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(Not a gradation list)

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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

Curator (T-5)

Shri A. Bastian Fernando

Senior Technical Assistant (T-5)

Shri Varughese Philipose
Shri T. Prabhakaran Nair
Shri W. Venugopalan

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
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Shri S. Kandasamy
Shri G. Gurusamy
Shri M. Babu Phlip
Shri M. Mohamed Sultan
Shri Jacob Jerold Joel
Shri S.G. Vincent
Shri P.M. Aboobaker
Shri E.K. Raveendran (on deputation to A & N Admn.)
Shri C.G. Lakshmiah
Shri R. Reghu
Shri P. Karunakaran Nair
Shri A. Agastheesapillai Mudaliar
Shri K.K. Balasubramanian
Shri K.V.S. Seshagiri Rao

Technical Assistant (T-II-3)

Shri T. Girijavallabhan
Shri A.A. Thankappan
Shri N.P. Kunhikrishnan
Shri P. Ananda Rao
Shri T.G. Vijaya Warrier
Shri A. Hanumantha Rao
Shri I.P. Ebenizer
Shri C.K. Krishnan
Shri K.S. Krishnan
Smt. K. Kamumudi Menon
Shri P. Ramadas
Shri C.T. Rajan
Smt. S. Lakshmi
Shri S. Manivasagam
Shri K.K. Kunhikoya
Shri V. Suresh
Shri K. Soman
Shri M. Shriram
Shri S.K. Balakumar
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Shri A. Ganapathi
Shri C. Kasinathan
Shri J.R. Ramalingam
Shri M. Najumuddin
Shri K.B. Wagmare
Shri Y.D. Savaria
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Shri Joseph Andrews
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Dr. N. Jayabalan
Shri K. Dhanaraju
Shri V.A. Narayanankutty
Shri K. Muniyandi
Shri Z. Jayasankaran
Shri N. Sundaram (now on other duty as Ad. Officer, CIGR, Mathura, U.P.)
Shri K. Balachandran
Smt. A. Kanagam
Shri D. Sundararajan
Shri D. Vincent
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Shr V. Rangacharyalu

Jr. Technical Assistant (T-2)

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Shri K. Muthiah
Shri K. Ramadas Gandhi
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Shri K. Chandran
Shri Mathew Joseph
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Shri J. Bhavaneshwara Varma
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Shri B.P. Thumber
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Field Assistant (T-1)

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Shri S.D. Kamble
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Shri Devidas Y. Naik
Shri T.B. Harikantara
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Senior Technical Assistant (T-4) (Computors)

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Shri G. Krishnankutty Nair
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Shri V. Rajendran
Smt. V.P. Annam

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

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Shri A. Pathrose
Shri S.G. Kalgutkar

Driver (Boat) (T-2)

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Driver (Boat) (T-1)

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Shri James George

Serang (T-I-3)

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Shri O.M. Jainulabdeen

Serang (T-1)

Shri H. Vasu

Bosun (T-II-3)

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Shri T.E. George Augustine
Shri Thomas Teles
Shri Nirmal Mathews

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Shri A. Muniyandi

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Shri T.P. Haridasan

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Shri S. Enasteen
Shri R. Arokiaswamy
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Shri P.J. Joshy Jacob

Mate (T-6)

Shri P.K. Velayudhan

Bosun (T-4)

Shri B. Ramesh

Engine Driver (T-II-3)

Shri Johnson K. Kuriakose

Deckhand Sr. (T-2)

Shr P. Bhaskaran
Shri T.K. Sudhakaran
Shri S. Moideen Meerasa
Shri V. Maria Alwaris
Shri K.P. Vijayan

Oilman (T-2)

Shri T.R. Sreekumaran

Oilman-cum-Deckhand (T-2)

Shri P.D. Chidambaram
Shri L. Jobai Fernando

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

Bosun (T-II-3)

Shri N.B. Gopalakrishna Menon

Driver (Boat) (T-1)
Shri K.K. Bose

Cook (Boat) (T-1)

Shri K. Raju

Operational Research Project, Kovalam

Technical Assistant (T-I-3)

Shri V. Selvaraj

Motor Driver (T-2)

Shri K. Pandi

Administrative Staff

Administrative Officer

Shri V.K. Sridhar
Shri P.C. Jacob

Asst. Administrative Officer

Shri K. Dorairaj

Asst. Accounts Officer

Shri M.P. Chandrasekharan
(transferred to CTCRI)
Shri S.P. Nair

Superintendents

Shri S.P.L. Sethu
Shri S. Subramanian
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 N. Rajamunnaswamy

P.A. to Director

Shri L. Krishnaswamy
Shri K. M. Surendran