Annual Report

1980 - 1

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
COCHIN
INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Annual Report

1980-81

Central Marine Fisheries Research Institute
COCHIN
INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Issued by
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Cover Photo:
Part of hatchery facilities
at Narakkal Prawn Culture Laboratory

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ANNUAL REPORT FOR 1980–81

DIRECTOR'S INTRODUCTION

During 1980-81, the Institute had undertaken 95 Research Projects/Problems under the existing Divisions; 10 Inter-Divisional Projects, 5 Inter-Institutional Projects, 4 Demonstration Projects and 6 Training Programmes. In addition to these the programmes under Sponsored Projects, Operational Research Projects, Lab-to-Land Programme, Centre of Advanced Studies in Mariculture and the Krishi Vigyan Kendra were in progress.

The various projects undertaken by the Institute in marine capture fisheries were oriented towards better understanding of the problems relating to the development of marine fisheries sector and monitoring of fish stocks for judicious exploitation and for advising suitable management policies in the small-scale and industrial sectors. The programmes in culture fisheries were necessarily aimed at developing simple low-cost technologies easy for adoption by coastal rural fishermen, small and marginal farmers and which would help them in augmenting the production of finfishes and shellfishes in low-lying saline and fallow coastal areas.

Considering the priorities proposed by the Institute during the Sixth Five Year Plan, advance action was taken during the year to complete certain projects on pelagic and demersal resources, crustacean fisheries, molluscan fisheries and on environmental studies so that emphasis could be placed in the coming year on projects aimed at exploratory surveys of the various resources of the Exclusive Economic Zone and the relevant fishery oriented environmental parameters.

Steady progress was maintained in the various projects and the highlights of the work done during the year may be summarised as follows:

Marine fish production during 1980 was provisionally estimated at 12.50 lakh tonnes showing a decline of about 10% when compared to the landings during 1979. Major part of the decline was noticed along the west coast.

During May–July 1980 the quinquennial census of marine fishing villages, fishermen population and other infrastructure facilities was successfully completed. In this well organised programme a number of scientific and technical staff participated and in all about 2130 marine fishing villages were covered and 2.93 lakh house-holds were visited. The census data are being analysed for the preparation of a detailed report.

At the Fishery Data Centre, the grouping of fishes has been revised to fall in line with FAO groupings and proper Codes have been assigned for computerisation of the data. The Data Centre receives and processes all types of exploratory fishery data from Government of India vessels and also private mechanised vessels. The resources data are regularly published in the Institute's publication—*Marine Fisheries Information Service, Technical and Extension Series* for dissemination to Central and State Departments, the industry and various other agencies.

Published information was made available during the year on the studies relating to the socio-economic status of fishermen community in Calicut area, coastal rural indebtedness in the Vizhinjam area and the impact of mechanisation on the socio-economic condition of fishermen in the Neendakara area.

An in-depth study of the purse-seine fishery that has developed in Goa, Kerala and Karnataka has been made. In the Mangalore–Malpe region, the purse-seine operations during the year landed heavy catches of horse mackerel, white bait and catfishes. Far example, unbridled catches of 72 tonnes of catfish (*Tachysurus tenuispinis*), carrying eggs in various stages in their mouth occurred during September 1980. The eggs alone amounted to 5 tonnes. This type of destructive fishing causes concern in respect of conservation of the resources. The removal of spawning stock in the case of other pelagic resources calls for exercising strict control and regulatory measures on the purse-seine fishery in these areas.

In the penaeid prawn fishery during the year, a decline in the catches was noticed at most of the centres except along Kerala coast where the catch as well as catch rates showed increase when compared to last year. At Neendakara, there was two fold increase in the landings of *Parapenaeopsis stylifera* (Karikkadi) but the sizes were comparatively smaller. An analysis of the data on the penaeid prawn fishery of this centre over the past ten years revealed economic overfishing taking place here, requiring proper management of the fishery.

Significant developments have taken place in crustacean culture fisheries. Experiments conducted in prawn culture fields showed that healthy growth of prawns was possible at a stocking density of 1 lakh prawns/ha. with supplementary feeds developed by the laboratory using cheap raw materials such as squilla, prawn head and shell wastes, groundnut oilcake and tapioca.

Remarkable success has been achieved in the artificial maturation of the prawns and spawning of the same under controlled conditions. This has lead to the process of complete domestication of the most important species, *Penaeus indicus* which is now running into the F–3 generation in the Prawn Culture Laboratory and Farm at Narakkal. This success has obviated the necessity of finding spawners from the open sea. It has also been found that a generation takes only about 98 days to complete an entire life cycle.

In the matter of larval rearing, 98% survival has been achieved from nauplius to post-larval stage. The development

of suitable live-feed cultures in large quantities was mainly instrumental for the success. The organisms which are mass cultured are the diatom (*Chaetoceros*), rotifer (*Brachionus*) and the cladoceran (*Moina* sp.).

During this period, the Narakkal Laboratory has supplied prawn seeds required for various experiments conducted in the Institute, in the lab-to-land programmes at various centres and also to private entrepreneurs from Goa and Tuticorin.

In edible oyster culture, spat collection was successful during the year and more than 6 lakh of spats were obtained. For large scale collection of spats several new areas were identified. Efforts have been made to process and can oyster meat in different media (in collaboration with CIFT). The canned oyster meat has received the attention of the industry.

An improvised hatchery system has been developed at Tuticorin for taking up experimental work on artificial production of seed of all cultivable molluscs.

Steady progress was maintained in the projects on fishery oceanography, primary productivity, secondary production, fish eggs and larvae, seaweed resources survey and culture, ecological studies, marine pollution and other aspects.

Under the project on 'Remote sensing and fisheries', the Institute has been working in collaboration with National Remote Sensing Agency, Hyderabad and Space Application Centre, Ahmedabad. With NRSA, mapping of productive areas in the sea off Cochin by remote sensing of the colour of the seawater was carried out in December 1980. A contour map showing horizontal distribution of chlorophyll has been prepared. In the joint experiment programme with SAC, aerial surveys was conducted in a test area off Karwar coast in January 1981 using Multi Spectral Scanner and camera systems coupled with collection of data in the sea. Through this modern technique it would be possible to correlate LANDSAT data with suspended sediments and fish schools.

In the field of extension, education and training a number of important events have taken place during the year. While detailed reports are given in the respective sections of this report, mention may be made of the following:

1. FAO/DANIDA sponsored Expert Consultation on Field Identification of Commercial Aquatic Organisms held at the Institute during January–February 1980.

2. Summer Institute on 'Culture of edible molluscs" organised at Tuticorin Research Centre during May–June 1980.

3. National Workshop on 'Mussel Farming.' organised by the Centre of Advanced Studies in Mariculture, CMFRI, at Madras during September 1980.

4. Seminar on Fisheries Extension jointly organised by CMFRI and other Fisheries Institutes under ICAR, at Cochin during December 1980.

5. Active participation of the scientists of the Institute in the Symposium on Coastal Aquaculture organised by the Marine Biological Association of India at Cochin during January, 1980.

Progress achieved in the Lab-to-Land Programmes, Operational Research Project at Kovalam, the Centre of Advanced Studies in Mariculture, Krishi Vigyan Kendra and other projects are given in the ensuing pages.

(E . G . Silas)
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 head quarters 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:

The various research projects/problems undertaken during the year 1980-81 were implemented by scientific and technical staff of the existing Divisions viz., Fishery Resources Assessment Division, Fishery Biology Division, Crustacean Fisheries Division, Molluscan Fisheries Division and Fishery Environment Management Division and the personnel engaged in the Inter-Divisional and Inter-Institutional projects, Demonstration projects, Operational Research Project, Krishi Vigyan Kendra, Training Programmes and Lab-to-Land Programmes.

Library:

The headquarters library was enriched with 525 books and 2,600 periodical reports/journals added during the year. In the libraries of the Regional Centre and Research Centres 425 books and a good number of periodicals were added. A separate book bank was started with the collection of text books and reference books for the benefit of the CAS in Mariculture. The library loan system with other libraries was continued and the headquarters library functioned as the Information Analysis Centre for the benefit of the whole institute. Reprographic facilities were strengthened, The library facilities were availed of by a wide cross section of researchers, scholars, students, institutions and organisations.

Facilities added:

1. R.V.SKIPJACK, the first 107' research vessel of CMFRI was launched at Calcutta on 7th November 1980. The vessel was built by M/s. Garden Reach Shipbuilders and Engineers, Calcutta. It has accommodation for 5 scientists and a crew of 11 members. The vessel is being equipped for fishery oceanography, purse-seining and trawling. Regular scientific cruises are expected to commence during the 3rd quarter of 1981.

2. A laboratory (attached to HQrs) at the Fishing Harbour Cochin, for monitoring the catches and for biological sampling of the various groups of fishes landed by mechanised vessels.

3. Pelagic Fisheries Laboratory at Cochin: The erstwhile Pelagic Fisheries Project of Govt. of India has transferred to CMFRI this laboratory accommodation along with some of the residual staff.

4. The Institute has acquired 500 acres of land and brackish water area at Mandapam Camp for mariculture farms; 90.45 acres of land at Muttucad to put up an International Centre for mariculture; 3.3 acres at Karwar for laboratory and administration buildings; 8 plots at Veraval for residential quarters.

5. Under the *Cadalmin* series of research boats, *Cadalmin* III, IV, V and IX have been launched.

Deputations abroad:

1. Dr. E.G. Silas, Director was deputed to attend the preliminary meeting of the 'Indian Ocean Alliance' and the seminar on Conservation in the Indian Ocean Area from 14–16 April 1980 at Mahe, Seychelles and was deputed as Expert Member of the Indian delegation to Copenhagen, Denmark, for discussions with DANIDA and Danish Shipyards concerning the construction of a fishery oceanography research vessel for the Dept. of Science and Technology, Govt. of India, 19–26 April 1980.

2. Shri K.V.N. Rao, Senior Scientist was deputed to Australia to participate in the FAO/IOFC/IPFC 6th Joint meeting of IOF committee on management of Indian Ocean tunas and the IPFC special committee on Indo-Pacific tunas; and the 6th session of the Indian Ocean Fisheries Commission held at Perth, from 20–29 February 1980.

3. Dr. M.J. George, Senior Scientist and **Dr. K.C. George, Scientist** were deputed to attend the Consultation on Stock Assessment for Small-scale Fisheries, Bay of Bengal Programme of the FAO at Chittagong, Bangaladesh from 16–21 June 1980.

4. Dr. E.G. Silas, Director and **Shri K.H. Mohamed, Senior Scientist** were deputed to Seychelles at the special invitation of the President of Seychelles to evaluate the possibilities of development of mariculture in the islands, from 15–29 November '80.

Advisory / Consultancy service provided:

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

1 ICAR representative on the Central Council and Executive Committee of the Kerala Agricultural University, Mannuthy, Trichur.

2 Member on the joint ICAR–ICSSR Scientific Panel for Social Sciences and Agricultural Extension.

3 Member, Programme Priorities and Cruise Committee for the National Institute of Oceanography, Goa.

4 Member, Research Advisory Committee of the Kerala Agricultural University, Trichur.

5 Member, Kerala State Fisheries Research Committee.

6 Member, Central Advisory Committee on Exploratory Survey of Marine Fisheries.

7 Member, Tamil Nadu State Fisheries Research Council.

8 Member, Regional Committee No. 8 (Constituted by the Governing Body, ICAR).

9 Member, Scientific Panel for Fisheries Research, ICAR.

10 Member, Kerala State Fishery Advisory Board.

11 Member, High Level Aquarium Committee–Construction of a Marine Aquarium at Cochin.

12 Member, in the Committee on Fisheries and other Aquatic Resources of the State Committee on Science and Technology, Kerala.

13 Member, Central Government Employees Co-ordination Committee, Cochin.

14 Member, Faculty of Marine Sciences, University of Cochin

15 Member, Technical Committee of the Marine Products Export Development Authority, Cochin.

16 Member, Expert Committee of the Madurai University, Madurai, constituted for framing the rules, regulations and syllabus for B.Sc., Marine Sciences.

17 Member, Editorial Committee for 'Indian Seafoods' of the Marine Products Export Development Authority.

18 Member, Professional Board of Studies for developing Curriculam on "Post Graduate" Diploma Course in Aquaculture, Fisheries Management and Fisheries Technology.

19 Member (ICAR representative), Management Committee, Krishi Vigyan Kendra, Pondicherry.

20 Member, Sub–Committee of the Indian Board of Wildlife.

21 Representative of the Department of Agricultural Research and Education to the MPEDA.

22 Member, Management Committee of Central Agricultural Research Institute, Andaman & Nicobar Group of Islands, Port Blair.

23 Member-Director of the Board of Directors of the Andhra Pradesh Fisheries Corporation Limited, Kakinada.

24 Member, Task Force for Preparation of Project-Operation Aquaculture Project—Ministry of Agriculture, New Delhi.

25 Member, Fishery Survey of India—Constitution of Central Co-ordinating Committee.

Important meetings attended/participation in advisory bodies, symposia, seminars, workshops in India*

Dr. E.G. Silas, Director

1 First meeting of the Central Co-ordination Committee Fisheries Survey at Delhi—1/80

2 Special meeting of the General Council of Kerala Agricultural University—1/80

3 Meeting of the working group on Marine Sciences—2/80

4 To chair the meeting on conservation of shrimps and other resources in the EEZ, Delhi—2/80

5 Meetings of the Indo—US Sub-commission on Science Technology, Delhi—2/80

6 Management committee meeting of KVK, Mitraniketan, Trivandrum—3/80

7 6th annual meeting of the General Council of KAU, Vellayini—3/80

8 Planning Commission meeting at Delhi on 'Ecology and Environment—7/80

9 Workshop on 'Mussel Farming' organised by CAS in mariculture—9/80

10 24th meeting of the MPEDA; Technical sessions of the IVth Indian Seafood Trade Fair, Madras—2/81

11 International meeting of the Convention on International Trade in Endangered Species of Wildlife Fauna and Flora, New Delhi—2-3/81

* List not exhaustive, Kindly see also separate section on Symposia and Seminars.

Dr. S.V. Bapat, Joint Director

1 Meeting of the ICAR Scientific Panel for Fisheries—8/80

2 First meeting of Evolution of work norms for posts at Class III and Class IV levels

Dr. P.S.B.R. James, Joint Director

1 Seminar on Coastal and Inland fish culture in Tamil Nadu, Fisheries College, Tuticorin—4/80

Dr. A.V.S. Murty, Scientist–S3, Dr. P.V.R. Nair, Scientist–S3, Shri V.K. Pillai, Scientist – S1 and Shri K.J. Mathew, Scientist–S1

1 Seminar on the Status of Environmental Studies in India, Trivandrum—3/81

Dr. H. Mohamed Kasim, Scientist–S1 and Shri Mohamed Zafar Khan, Scientist–S

1 Seminar on Recent Trends in teaching and research in aquatic biology, Bhavanagar—9/80

Dr. K. Radhakrishna, Dr. T. Appa Rao and Shri S. Reuben

1 Seminar on 'Inputs for development of Aquaculture, Dept. of Living Resources, Andhra University and Andhra Pradesh Fisheries Corporation, Waltair—3/81

Shri K.J. Mathew

1 Seminar organised by the Small Farmers Development Agency (SFDA), Quilon District in connection with the 10th annual celebrations—12/80

Dr. K. Satyanarayana Rao

1 Tenth Advisory Committee meeting of the Exploratory Survey of Marine Fisheries, Mangalore—6/80

Shri M.H. Dhulkhed

1 Advisory Committee of the Experimental Station of Central Food Technological Research Institute Mangalore—6/80

2 Inter-Institutional Research Project meeting of the University of Agri. Sciences, Bangalore—8/80

Dr. K. Radhakrishna, Shri P. Mojunder and Shri K.R.M. Nair

1 9th World Environment Day, Andhra University College of Science and Technology, Waltair.

Shri K.Y. Telang and Shri G. Nandakumar

1 Seminar on 'Some aspects of inland aquaculture in Karnataka' Fisheries College, Mangalore—7/80

Dr. S. Ramamurthy and Shri V.M. Deshmukh

1 Research Meeting on Agricultural Development for 1980, Western Zone, Bombay—4/80

2 Workshop on 'Reservoir Fisheries for Rural Development' CIFE, Bombay—4/80

Dr. S. Ramamurthy and Dr. N. Radhakrishnan

1 4th meeting of ICAR Regional Committee, No. 7, Goa—11/80

Dr. S. Ramamurthy

1 Meeting of State Level Committee for Co-ordination of Marine Fisheries work in Maharashtra, Bombay—8/80

Shri S.J. Rajan

1 Lab-to-Land Seminar, Tamil Nadu Board of Rural Development, Kilanalli

SYMPOSIA, SEMINARS, WORKSHOPS

FAO/DANIDA Expert Consultation on Field Identification of Commerical Aquatic Organisms of Western Indian Ocean:

This Expert Consultation programme was held at CMFRI from 21st January to 15th February 1980. The Experts drawn from 17 countries including India completed the identification of commercially important fishes of the Western Indian Ocean. 119 families of fishes comprising more than 495 species collected from coasts of India, Egypt, Aden, Kenya, Mozambique and Mauritius were dealt with. The bulk of the material for examination was provided by CMFRI.

Participation: *Dr. E.G. Silas,* Director—as Liaison Officer, Govt. of India.

Dr. P.S.B.R. James, Joint Director; *Shri K.V.N. Rao,* Scientist-S3; *Dr. G. Luther,* Scientist-S2; *Shri M. Kumaran,* Scientist-S2; *Shri R.S. Lal Mohan,* Scientist-S1 (as Experts)

A number of Scientists, Technical and other staff members of the Institute have rendered assistance and co-operation in the conduct of this programme.

Symposium on Coastal Aquaculture:

The scientists of this Institute took an active part in the various sessions of the Symposium on Coastal Aquaculture conducted at Cochin from 12-18 January 1980 under the auspices of the Marine Biological Association of India. The Symposium provided useful opportunities for discussing recent technologies developed in coastal aquaculture of many cultivable species and also the production, economics and development aspects. The Scientists had also an occasion to meet and discuss their findings with experts from abroad who came to attend the Symposium.

Summer Institute on 'Culture of Edible Molluscs'

The Summer Institute was organised at the Tuticorin Research Centre of CMFRI from 26th May to 24th June 1980. Research workers, extension workers and teachers drawn from different Universities, Research Institutions and State Fisheries Departments participated. The participants were educated on the proven technologies developed by the Institute in the aquaculture of edible oysters, mussels and clams. Suitable demonstration and field training were also given.

National Workshop on Mussel Farming:

This National Workshop on Mussel Farming was organised at Madras as a part of the objectives of the CAS in Mariculture, from 25th to 27th September 1980, to encounter and exchange information on the present status of research and development in mussel farming and to identify gaps in our knowledge and constraints encountered in propagating the technologies on a large scale. 46 delegates participated in the Workshop and an 'action plan' to facilitate research and joint programmes for accelerated development of mussel farming was formulated.

Seminar on Fisheries Extension:

Realising the immediate need to bring into focus fisheries extension, the CMFRI took initiative to organise a forum for discussing the subject by bringing together the different fisheries interest in the country. This resulted in the Seminar on Fisheries Extension jointly organised by the Fisheries Institutes under ICAR. The Seminar was conducted at the CIFT, Cochin from 8–10 December 1980. In all, 35 Status Reports/background papers were presented by the participating institutes, martitime state fisheries departments and other agencies. The Seminar had many useful recommendations which have been passed on to the concerned authorities/agencies for implementation. An exhibition on 'Fisheries Extension' was organised and field trips were also arranged.

Fourth Indian Seafood Trade Fair:

The Director and other scientists of the Institute took an active part in the 4th Indian Seafood Trade Fair organised by the MPEDA at Madras from February 7–8, 1981. Farm grown edible oysters canned in different media for the first time were exhibited at the Fair and this product has attracted the attention of the industry. The Institute had also projected its achievements in coastal aquaculture, in the exhibition organised at the fair.

Malsya Mela: A Malsya Mela and harvest festival was organised at Valappu near Cochin in March 1981 under the Lab-to-Land Programme of CMFRI.

List of distinguished visitors to the Institute
Headquarters laboratories, Cochin

1 His Excellency Mr. France Albert Rene, President of the Republic of Seychelles visited the Institute on 8–5–1980. He was accompanied by Mrs. Rene and his entourage.

2 Dr. O.P. Gautam, Director General, ICAR visited the Institute on 20–8–1980. This was his first visit after taking up the office of the Director General.

3 Shri Kalam Sarkar, Satya Bapuli, Md. Nizamuddin, Pralay Talukdar, Biren Bose, Sunil Basu Ray, Prabhin Sen Gupta,

Matish Ray, Jamini Saha, Nirmal Bose, Silen Chakraborthy and Kanai Mukerji Members of the West Bengal Legis-, lative Assembly visited on 7–2–80.

4 Mr. E.J. De Boer, Head Technical Research Dept. (Fishing vessel and gears), Netherlands Institute of Fisheries.

5 Mr. W. Lodder, Director of Royal Foundation for Shipping Education and Training, Amsterdam.

6 Mr. R.E. Wright, British Council Division, Madras.

7 Dr. Walter Fischer, Dr. B. Hutchins, Dr. R.J. Mackay, Dr. D.J. Woodland, Dr. R.L. Haedrich, Dr. J. Nielsen, Mr. M.R.M. Hegazy, Dr. M.L. Bauchot, Mr. A.L. Mauge, Mr. J.C. Miquel, Dr. M. Babu Rao, Dr. K.C.Jayaraman, Dr. P.K. Talwar, Dr. I. Nakamura, Dr. T. Sato, Mr. Zzioka, Mr. J. de B. Baisssac, Mrs. M.I. Sousa, Dr. P.H.J. Castle, Mr. M.A. Gadaffi, Dr. A.G.K. Menon, Mr. T. Wongratna, Dr. P.J.P. Whitehead, Dr. B.B. Collette, Dr. Heemstra, Dr. J.E. Randall, Dr. W.F. Smith–Vaniz (all participants to the FAO/DANIDA Expert Consultation on Field Identification of Commercial Aquatic Organisms of the Western Indian Ocean held at CMFRI)

8 A number of distinguished scientists who attended the Symposium on Coastal Aquaculture organised by the MBAI at Cochin in January 1980 visited the laboratories and farms of the Institute.

Prawn Culture Laboratory, Narakkal and Krishi Vigyan Kendra, Narakkal

1 Dr. D.J. Mehta, Central Salt and Marine Chemicals Research Institute, Bhavanagar.

2 Dr. David Kahn, Dept. of Zoology, Hebrew University, Jerusalem.

3 Dr. Patrick Sorgeloos, Artemia Reference Centre, State University, Belgium.

4 Mr. Takatsugu Kawamo, Kuwait Institute for Science.

5 Dr. Walter Fischer, Fisheries Dept., FAO, Rome.

6 M/s. Izumi Nakamura & Reiko Nakamura, Fisheries Research Station, Kyoto, Japan.

7 Dr. Bruce B. Collette, National Marine Fisheries Service, Washington.

8 Dr. Peter Whitehead, British Museum of Natural History, London.

9 Biauchi Gabiella, FAO, Rome.

10 Dr. R.L. Haedrich, St. Johns, New Foundland.

11 Dr. A.L. Maugi, Museum of Natural History, Paris.

12 Mr. T. Wongratna, Marine Fisheries Laboratory, Bangkok.

13 Mr. Basmy Hutchins, Western Australian Museum, Perth.

14 Mr. Jorgen Nielsen, Zoological Museum, Denmark.

15 Raphael Nzioha, Marine Fisheries Research Institute, Kenya.

16 Leslie Cobley, UNESCO, Paris.

17 H.K.F. Hoffman, FAO, Rome.

18 Cmdr. K.M.V. Nair, AVSM, Vr. C., Tata Oil Mills.

19 Shri V.G. Desai, Dy. Speaker, Goa Legislative Assembly and 8 other MLAs.

20 Dr. Mahmudul Karim, FAO/UNDP Project, Madras.

21 Dr. Thulja Ram Rao, Zonal Co-ordinator, Lab-to-Land Programme of ICAR.

22 Shri A.T. Dudani, ICAR, New Delhi.

23 Dr. O.P. Gautam, Director General, ICAR.

24 Shri M.A.K. Tayab, Joint Secretary, Ministry of Agriculture, New Delhi.

25 Shri George Joseph Mundackal, Member of Parliament with other MPs.

26 Shri Rasabehari Behere, Member of Parliament

27 Shri Chatur Bhuj "

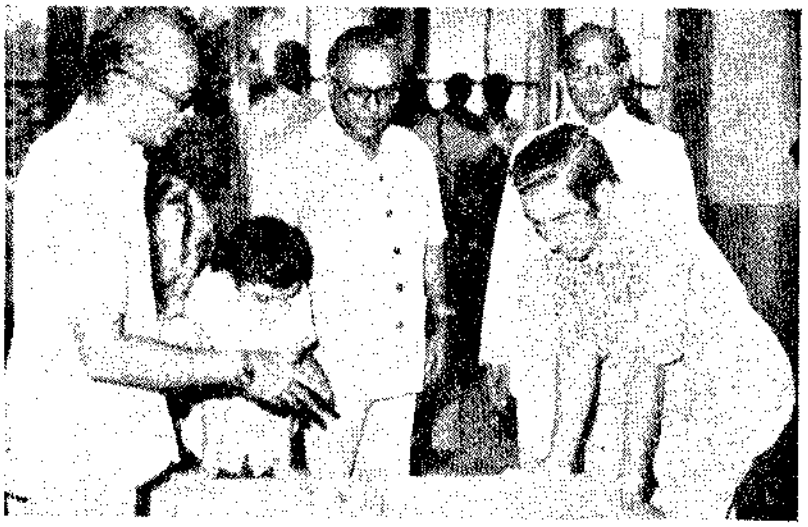
28 Shri Mukund Mandal "

29 Shri Shiv Sharan Sinha "

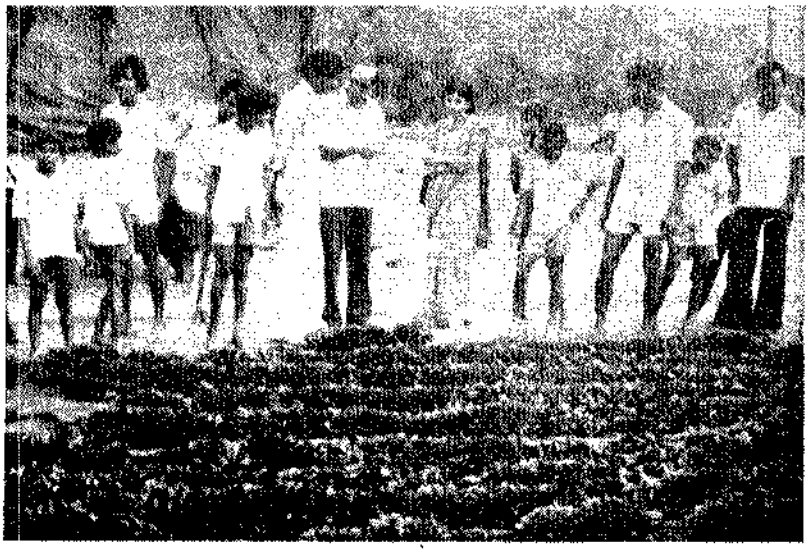
30 Shri Hukum Dev Narayan Yadav, Member, Parliament.

31 Dr. H.R. Arakere, Chairman, ASRB, New Delhi.

32 Dr. H.P.C. Shetty, Director of Instruction, College of Fisheries, Mangalore.



H.E. Mr. France Albert Rene, President of the Republic of Seychelles visisted CMFRI head-quarters laboratory at Cochin on 8-5-1980. Dr. E. G. Silas, Director, CMFRI and Shri K.H. Mohamed, Senior Scientist explain the prawn culture techniques.



Kumari Sobha Nambisan, IAS, Project Director, Dist. Rural Development Society, Karwar evinces interest in the harvest of cultured mussels.

Hatchery for molluscs at Tuticorin Research Centre.

Dr. R. Raghu Prasad, Asst. Director General (Fisheries), ICAR, delivering the presidential address at the national Workshop on Mussel Farming organised by the CAS in Mariculture.

(Madras, September 25 - 27, 1980)

33 Shri N.P. Singh, Tata Oil Mills, Bombay.

34 Mr. A.I. George, OFTC Regional Fisheries Adviser, Caribbean Is.

35 Mr. Akin Olaniawo, Federal Fisheries School, Nigeria.

36 Mr. Sadiqui Taha, Jordan News Agency, Amman.

37 Mr. A.E. Moustaffa, Middle East News Agency, Cairo.

38 Mr. Nelson Makwapaira, Malawi News Agency, Malawi.

39 Mr. Adam Zaki, Republic of Maldives.

40 Mr. M.L. Mwanangombe, ZANA, Zambia.

41 Alsafi Ezkhateer, Sudan News Agency.

42 Shri K.H. Venkatappa and Shri R. Krishnappa, University of Agricultural Sciences, Bangalore.

43 H.M. Nagabhushana & K.H. Hennumegowda, UAS, Bangalore.

Regional Centre, Mandapam Camp

1 Mr. Schurman, Ver Iddekingeweg, Groningen, Netherlands.

2 Mr. R. Rahe, GTZ, Germany.

3 Shri T.R. Nagarajan, Under Secretary, Dept. of Commerce, New Delhi.

4 Mr. A.K.M. Animol Haque, Bangaldesh Agricultural University, Mymensingh.

5 Shri V. Madhavan Nair, Dist. Collector, Ramnad.

6 Mr. R.K. Saxena, Jt. Secy., Ministry of Agriculture.

7 Dr. C. Kempanna, Dy. Dir. General, ICAR, New Delhi.

8 Shri G.S. Venkataraman, IARI, New Delhi.

9 Mr. Regene Thompson, Mauritius Is.

10 Shri R. Krishnappa, Registrar, UAS, Bangalore

11 Shri H.N. Nagabhushana, UAS, Bangalore.

Regional Centre, Bombay

1 Dr. V.S. Bhatt, Director (P & I) ICAR, New Delhi.

2 Dr. Swe Thwiw Dept. Mar. Biol., Manmein, Burma.

3 Dr. Nayan Taw, People's Pearl Fishing Company, Rangoon.

4 Shri C.S. Sharma, Addl. Secy., ICAR, New Delhi.

5 Prof. N.N. Murti, Mulund, Bombay.

6 Dr. D.V. Bal, Bombay.

7 Mr. A.K. Hamza, Oceanography and Fisheries Institute, Alexandria.

8 Dr. R. Raghu Prasad, Asst. Dir. General, ICAR, New Delhi.

9 Prof. P.C. George, Joint Commissioner (Fisheries), New Delhi.

10 Cmdr. C.L Sachdeva, Mazagon Docks, Bombay.

Research Centre, Karwar

1 Shri R.C. Choudhuri, Chairman, MPEDA, Cochin.

2 Dr. Gilbert Anderson, DANIDA, Consultant, Karnataka Land Army Corporation Limited.

3 Dr. V.V.R. Varadachari, Dy. Director, NIO, Goa.

4 Shri G.L. Rao, Former Director of Fisheries, Karnataka.

5 Shri Amol Karnad, Alacrity Consultants, Madras.

6 Shri H.N. Chandrasekaraiah, Mg. Director, Karanataka State Fisheries Development Corporation Ltd., Mangalore.

7 Shri M. Swaminath, Director, CIFNET, Cochin.

8 Dr. C. Kempanna, DDG (CS), ICAR, New Delhi.

9 Shri D.V. Waingankar, MLA, Karwar.

Research Centre, Mangalore

1 Dr. A. Antony, Dept. of Marine Sciences, University of Cochin, with a batch of 12 students.

2 Dr. C.V. Kurian, Emeritus Scientist, ICAR, Cochin.

Research Centre, Calicut

1 Dr. Nyan Taw, People's Pearl and Fishery Co., Rangoon.

2 Dr. Swe Theoin, Modelmein College, Modelmein, Burma.

3 Dr. A.W. Saadi, P.O.Box 3756, Damascus, Syria.

4 Dr. Mhd. Nizar Hamad, The Arab Co., for Livestock Development, Damascus, Syria.

5 Mr. Lars. O. Engiall, FAO, Bay of Bengal Programme, Madras.

6 Mr. M. Karim, Fisheries Adviser, "

7 Mr. Rolf Williman, Economist, "

8 Mr. Andrew Price, University College of Swansea, Waves Sassp, U.N.

Research Centre, Tuticorin

1 Shri R.V. Swaminathan, Hon'ble Minister of State for Agriculture visited the Research Centre on 26–10–1980.

Other visitors during the year:

2 Shri S.M. Prabhu, Chief Executive, New India Fisheries, Bombay.

3 Mr. Agustini D. Maligad, Mg. Director, Agro–Marine International Trading Co., Singapore.

4 Dr. Y. Krishnaswami Naidu, Manager, Tamil Nadu Dairy Development Corporation.

5 Mr. V. Valmeegi, MLA, Thirupattur.

6 Mr. C. Olbright Rimstino, W. Germany.

7 Maj. Kalu Wijeretne, Sri Lanka.

8 Shri A.G. Vasavan, Director of Fisheries, Kerala.

9 Dr. R. Subrahmaniam, School of Environmental Sciences, J.N.U., New Delhi.

10 Shri Sameervyas, Sub Collector, Tuticorin.

11 Shri S.T. Chari, Project Officer, Tamil Nadu Fisheries.

12 Shri A. Srinivasan, General Manager, Tamil Nadu Fisheries Development Corporation.

13 Shri R.D. Chakraborty, Project Co-ordinator, AICRP on Composite Fish Culture, CMFRI.

14 Dr. R. Natarajan, Director, CAS in Marine Biology, Port Novo.

15 Dr. H.R. Rabanlal, FAO South China Sea Programme.

16 Mr. M. Karim, Fisheries Adviser, Bay of Bengal Programme, FAO.

17 Dr. S. Jones, Former Director of CMFRI.

18 Mr. R. Sathiarajan, Director, IFP, Cochin,

19 Mr. M. Swaminath, Director, CIFNET, Cochin.

20 Mr. Sewis Coatanea (Aquacop) French Polynesia.

21 Mr. J.J. Schuurman, Netherlands.

22 Dr. Roglene K. Thompson, Mauritius.

23 Dr. Royden Nakamura, U.S.A.

24 Mr. Alfred, Norway.

25 Mr. J. Heiore, Brussels, Belgium.

Awards for film on 'Mariculture'

The colour film entitled 'Mariculture' was awarded the President's 'Rajat Kamal' award for the best instructional film and it also bagged the 'Silver Crayfish' award for the best short film at the IX International Naval & Sea Film Week held at Cartagana, Spain. The Film produced by the Films Division, Govt. of India, highlights the recent achievements of CMFRI in the mariculture of prawns, edible oyster, pearl oyster, mussel, sea weeds and eel and also the relevant technology transfer in the field. Dr. E.G. Silas, Director was the Technical Adviser to this film.

Sports

39 sportsmen represented CMFRI at the ICAR Zonal Sports meet held at Coimbatore in November 1980. The Institute was placed 4th on the basis of overall performance. Our athletes won 6 First positions in various events.

Finance:

The total 'actual expenditure' incurred by the Institute during the year 1980–81 was Rs. 102.65 lakhs under Non-plan and Rs. 68.61 lakhs under Plan.

PROGRESS OF RESEARCH

FISHERY RESOURCES ASSESSMENT DIVISION

Sample Survey for estimation of marine fish production and the effort expended (*FSS/FRA*/1.1)

Annual production of marine fish

The estimate of total marine fish landings in India during 1980 was about 12.50 lakh tonnes as against 13.88 lakh tonnes during 1979 thus showing a marginal decrease of about 10%. Excepting Andhra Pradesh, Gujarat and Andamans all maritime states recorded decreased landings in 1980. The reduction in the states of Kerala, Karnataka and Maharashtra in west coast has accounted for the major decline. (The statewise landing figures for 1979 and 1980 are given in Table-1). Among the commercially important species that contributed to the major decline were oil sardine, Bombay duck and mackerel the reduction in their landings being about 38,000, 31,000 and 16,000 tonnes respectively. Some of the other species that showed decline in their landings were ribbon fish, non penaeid prawns and sciaenids.

Table -- 1

State-wise total marine fish landings in India (in tonnes) during the years 1979 and 1980.

Sl. No.	State	1980	1979
1	West Bengal (Contai coast)	6,097	10,744
2	Orissa	39,375	51,808
3	Andhra Pradesh	1,16,013	91,426
4	Tamil Nadu	2,17,394	2,35,008

Sl. No.	State	1980	1979
5	Pondicherry*	9,390	10,068
6	Kerala	2,79,543	3,30,509
7	Karnataka	1,15,322	1,26,384
8	Goa**	24,490	25,388
9	Maharashtra	2,31,763	2,93,326
10	Gujarat	2,03,494	1,91,312
11	Andamans	1,803	1,721
12	Lakshadweep	2,909	3,846
13	Private trawlers***	2,244	16,840
	TOTAL	12,49,837	13,88,380

STATEWISE MARINE FISH PRODUCTION

West Bengal (Contai coast)

During 1980 the estimate of marine fish landings in West Bengal showed a decline of about 4,600 tonnes when compared to that of in 1979. This decrease was mainly due to lesser landings of other cluepids, Bombay duck, sciaenids, prawns and miscellaneous, the decline being about 800, 800, 600, 300 and 1800 tonnes respectively. However, the landings of catfishes showed an increase of about 600 tonnes.

Orissa

In Orissa also, there was a decline of about 12,400 tonnes in the total marine fish landings in 1980 when compared to that of 1979. The fall in the catch was mainly due to the lesser landings of *Hilsa ilisha*, sciaenids, prawns, pomfrets, seer fish and elasmobranchs, the decline being about 4,900, 2,500, 1,900, 1,000, 900 and 600 tonnes respectively. However, other cluepids and cat fishes recorded an increase of about 1,100 and 900 tonnes respectively.

Andhra Pradesh

The total marine fish production in Andhra Pradesh showed an increase of about 24,600 tonnes (27%) as compared to 1979. The landings of ribbon fish, lesser sardines *Thrissocles*

* Excluding Mahe and Yenam which are included in Kerala and Andra Pradesh respectively.

** Excluding Daman and Diu which are included in Gujarat.

*** Partial coverage of larger trawlers.

and mackerel showed an increase of about 9,300, 7,800, 3,900 and 3,600 tonnes respectively. A decline in the catch of penaeid prawns, seer fish and elasmobranchs to the extent of 3,000, 2,600 and 2,200 tonnes, however, was noticed.

Tamil Nadu

In Tamil Nadu, the total landings showed a decline of about 17,600 tonnes (7.5%). This decrease was mainly due to reduced landings of ribbon fish, *Leiognathus*, lesser sardines and penaeid prawns, the decline being 13,200, 4,700, 3,300 and 1,100 tonnes respectively. The landings of mackerel, *Anchoviella* and sciaenids, however, showed an increase of about 3,700, 2,100 and 600 tonnes respectively.

Pondicherry

The total landings in Pondicherry showed a decrease of about 700 tonnes (6.7%). The landings of flying fish and perches declined by about 850 and 340 tonnes respectively. An increase of about 740 tonnes in the landings of lesser sardines was also noticed.

Kerala

A decline of about 51,000 tonnes (15.4%) in the total landings was noticed in Kerala as compared to that of 1979. The decline was mainly due to reduced landings of oil sardine, ribbon fish, *Caranx*, lesser sardines, tunnies, seer fish and perches, the decrease being 47,200, 12,800, 7,900, 4,900, 4,800, 2,500 and 2,400 tonnes respectively. The landings of penaeid prawns, cat fish and non penaeid prawns, however, showed an increase of about 23,100, 2,600, and 1,700 tonnes respectively.

A scrutiny of the catch of oil sardine showed that there was a substantial fall in the regions Alleppey to Ponnani and Quilandy to Manjeswar. In Alleppey to Ponnani region (excluding Cochin Fisheries Harbour) the catch decreased to 17,300 tonnes in 1980, the fall being about 39,000 tonnes and in Quilandy–Manjeswar region the catch declined to 14,100 tonnes the fall being about 22,000 tonnes. The cause is being investigated.

As stated earlier, an increase of about 23,100 tonnes in the catch of penaeid prawns was noticed. This was mainly due to substantial increase in the catch in the Sakthikulangara area

where the landings came to 14,500 tonnes and 36,000 tonnes respectively during the years 1979 and 1980.

Karnataka

In Karnataka, the total landings decreased by about 11,100 tonnes (8.8%) as compared to 1979. This was mainly due to the fall in the landings of mackerel, cat fishes and penaeid prawns, the decline being about 20,500, 4,600 and 1,600 tonnes respectively. The landings of oil sardine *Anchoviella* and *leiognathus*, however, showed an increase of about 9,600, 3,900 and 3,100 tonnes respectively.

Goa

A marginal decline of about 900 tonnes (3.5%) in the total landings was noticed in Goa during 1980 as compared to 1979. This was mainly brought out by the decrease in the landings of mackerel and oil sardine, the decline in their landings being 1,900 and 700 tonnes respectively. The landings of *Leiognathus*, however, showed an increase of about 800 tonnes.

Maharashtra

The estimate of total marine fish production during 1980 was 231,763 tonnes. The broad indications are that Bombay duck, penaeid and non penaeid prawns showed a decline.

Gujarat

A marginal increase of about 12,200 tonnes (6.4%) in the total landings was noticed in Gujarat over that of 1979. The landings of elasmobranchs, ribbon fish, penaeid prawns, eels, sciaenids and pomfrets showed an increase of about 9,600, 6,400, 5,900, 5,800, 3,400 and 3,300 tonnes respectively. The catch of *Harpodon nehereus*, however, showed a decline of about 27,300 tonnes.

Andamans

The total landings in Andamans remained more or less same. The species-wise composition did not show much variation.

Lakshadweep

A decline of about 940 tonnes in the total landings of Lakshadweep was noticed during 1980 as compared to 1979. This was mainly due to reduced landings of tunnies to the tune of about 1,030 tonnes.

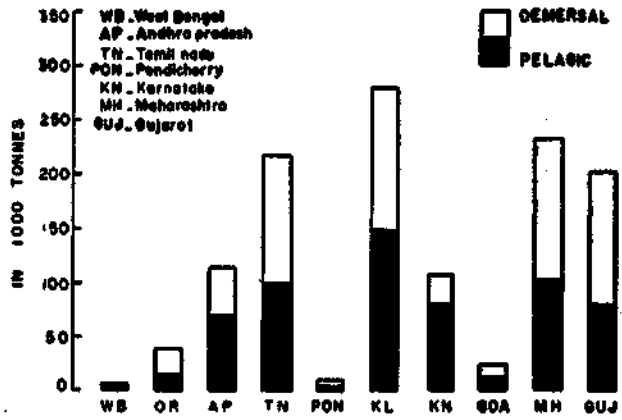


Fig. 1: *Distribution pattern of pelagic and demersal group of fishes in different martitime States of India.*

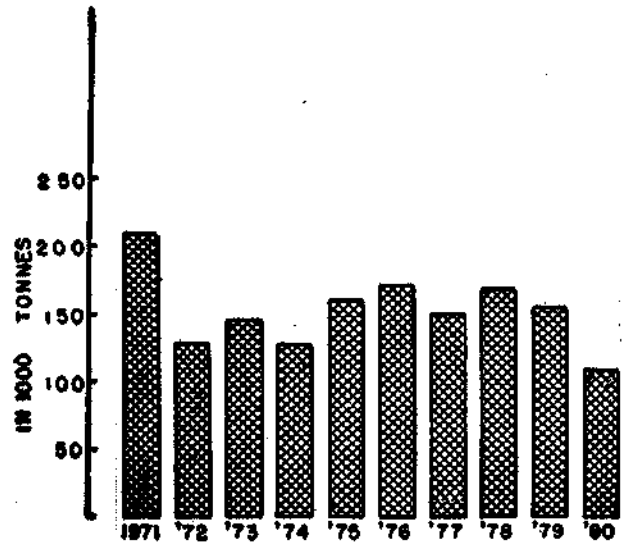


Fig. 2: *Landings of oilsardine during* 1971 *to* 1980.

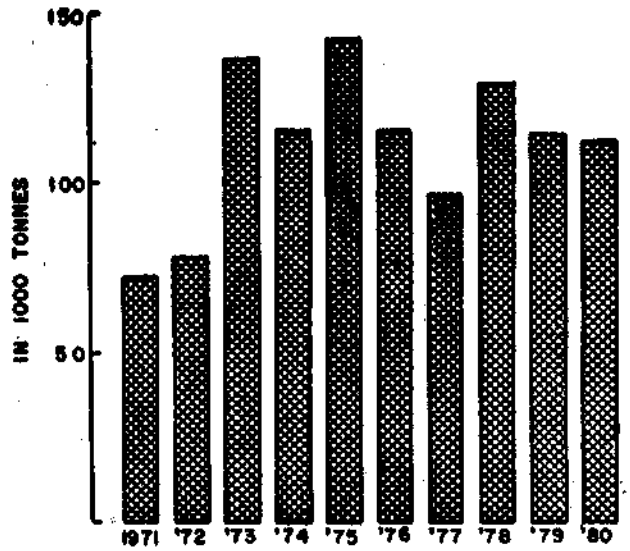


Fig. 3: Landings of Penaeid prawns during 1971 *to* 1980.

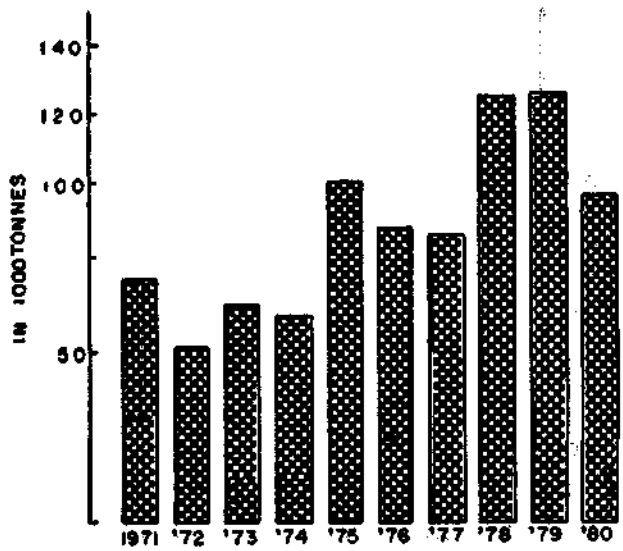


Fig. 4: Landings of Harpodon nehereus during 1971 *to* 1980.

Table – 2

Composition of marine fish catch in India during 1979 and 1980 (in tonnes)

Sl. No.		*Name of fish*	1980	1979
1		Elasmobranchs	57,862	52,843
2		Eels	12,082	7,155
3		Cat fishes	43,745	48,817
4		*Chirocentrus*	12,805	10,274
5	(a)	Oil sardine	115,744	153,971
	(b)	Lesser sardines	67,053	68,351
	(c)	*Hilsa ilisha*	6,996	12,068
	(d)	Other *Hilsa*	9,127	8,672
	(e)	*Anchoviella*	33,684	26,588
	(f)	*Thrissocles*	19,342	16,628
	(g)	Other clupeids	38,270	33,965
6	(a)	*Harpodon nehereus*	95,505	126,044
	(b)	*Saurida & Saurus*	11,332	11,154
7		*Hemirhamphus & Belone*	1,653	1,577
8		Flying fish	1,255	2,546
9		Perches	38,541	35,657
10		Red mullets	2,416	3,130
11		Polynemids	6,056	5,809
12		Sciaenids	89,360	93,018
13		Ribbon fish	62,690	71,349
14	(a)	*Caranx*	24,265	28,942
	(b)	*Chorinemus*	4,182	3,307
	(c)	*Trachynotus*	40	195
	(d)	Other carangids	945	465
	(e)	*Coryphaena*	302	146
	(f)	*Elacate*	379	880
15	(a)	*Leiognathus*	54,400	55,266
	(b)	*Gazza*	186	197

Table-2 (cond.)

Sl. No.		Name of fish	1980	1979
16		*Lactarius*	7,415	4,474
17		Pomfrets	38,231	40,427
18		Mackerel	55,279	71,514
19		Seer fish	25,986	29,547
20		Tunnies	20,371	26,595
21		*Sphyraena*	1,782	2,265
22		*Mugil*	2,030	1,400
23		*Bregmaceros*	916	638
24		Soles	13,633	12,203
25	(a)	Penaeid prawns	112,037	113,665
	(b)	Non-penaeid prawns	58,700	63,917
	(c)	Lobsters	679	1,135
	(d)	Other curstaceans	25,386	20,304
26		Cephalopods	11,335	15,032
27		Miscellaneous	65,840	106,250
		TOTAL	12,49,837	13,88,380

Pelagic and demersal group of fishes:

While the pelagic catch declined to 631,115 tonnes in 1980 from 748,353 tonnes in 1979, the demersal catch likewise declined to 618,722 tonnes in 1980 from 640,027 tonnes in 1979, the decline being 16% and 3% respectively.

PELAGIC GROUP OF FISHES

Oil Sardine

The catch of oil sardine declined by about 38,000 tonnes during 1980 as compared to 1979. This was mainly due to reduced landings in the states of Kerala, Tamil Nadu and Goa.

Mackerel

A decline to the extent of 16,000 tonnes in the landings of mackerel was noticed during 1980. Lower landings in the states of Karnataka and Goa accounted for the decline in the catch of mackerel.

Bombay duck

The landings of Bombay duck showed a decline of about 31,000 tonnes during 1980 as compared to 1979. Both Maharashtra and Gujarat recorded lower landings.

Lesser Sardines

A marginal decrease of about 1,300 tonnes in the catch of lesser sardines was noticed during 1980. While Andhra Pradesh, Pondicherry and Maharashtra recorded higher landings, Tamil Nadu, Kerala and Karnataka recorded lower landings of lesser sardines.

Anchoviella

The landings of *Anchoviella* registered an increase of about 7,100 tonnes. Higher landings in the states of Andhra Pradesh, Tamil Nadu, Kerala and Karnataka were responsible for the increase in the total catch.

DEMERSAL GROUP OF FISHES

Penaeid Prawns

The landings of penaeid prawns showed a marginal decline of about 1,600 tonnes during 1980 as compared to 1979. Except in Kerala, Goa and Gujarat, the catch of penaeid prawns declined in all the maritime states of India. In Kerala the landings of penaeid prawns showed a substantial increase of about 23,000 tonnes.

Non–Penaeid prawns

A decline to the extent of 5,200 tonnes was noticed in the landings of non–penaeid prawns during 1980 as compared to 1979. This was mainly due to decreased landings in the state of Maharashtra.

Sciaenids

The landings of sciaenids showed a decline of about 3,700 tonnes during 1980. While Maharashtra, West Bengal and Orissa recorded comparatively lower yield of sciaenids, Andhra Pradesh, Tamil Nadu, Pondicherry, Kerala, Karnataka and Goa recorded higher landings.

Cat fishes

The total catch of cat fishes showed a decline of about 5,000 tonnes mainly due to lesser landings in the states of Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Gujarat.

Marine fish production during the first quarter of 1981

Marine fish production in India is provisionally estimated at 3.5 lakh tonnes during the first quarter of 1981. This excludes the catches from Kutch, Andamans, and Lakshadweep. This estimate shows an increase of 41,000 tonnes (11.5%) over that of the corresponding period of 1980.

Frame Survey (FSS/FRA/FS 1.2)

All India census on marine fishermen population and infrastructure facilities was carried out during May–July 1980 in all the maritime states of India except Maharashtra, Andamans and Lakshadweep. About 165 scientific and technical personnel from the different divisions of this Institute were involved in organising, conducting and supervising the census operations. About 1,500 persons were engaged at the village level for house to house enumeration. In all about 2,130 marine fishing villages were covered and about 3,33,000 households visited for this purpose. The total fishermen population was about 18.9 lakhs. About 18% of them were engaged in full time fishing. The detailed report on this is under publication.

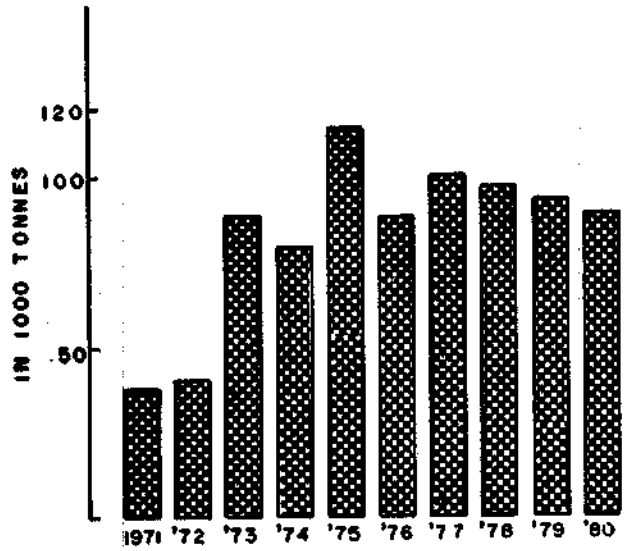


Fig. 5: Landings of Sciaenids during 1971 *to* 1980.

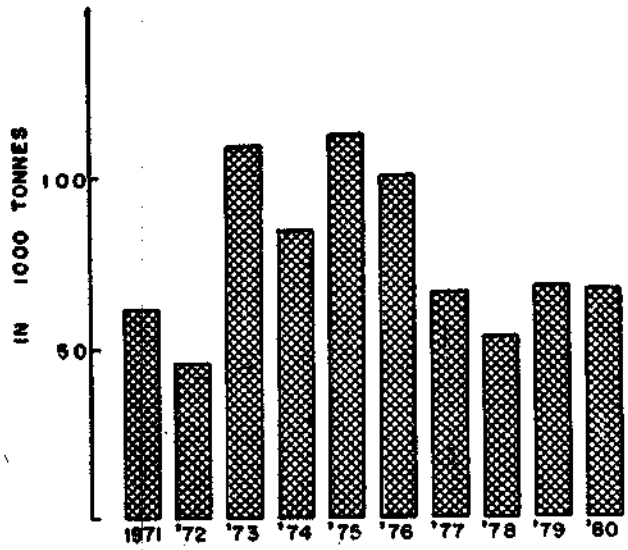


Fig. 6: Landings of lesser sardines during 1971 *to* 1980.

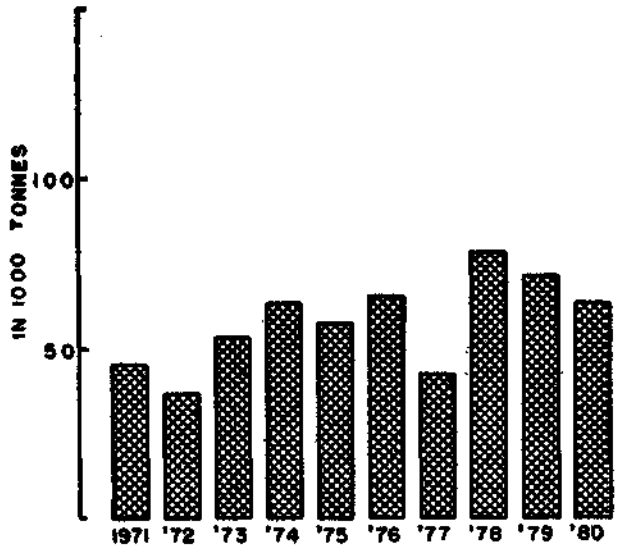


Fig. 7: Landings of ribbon fish during 1971 *to* 1980.

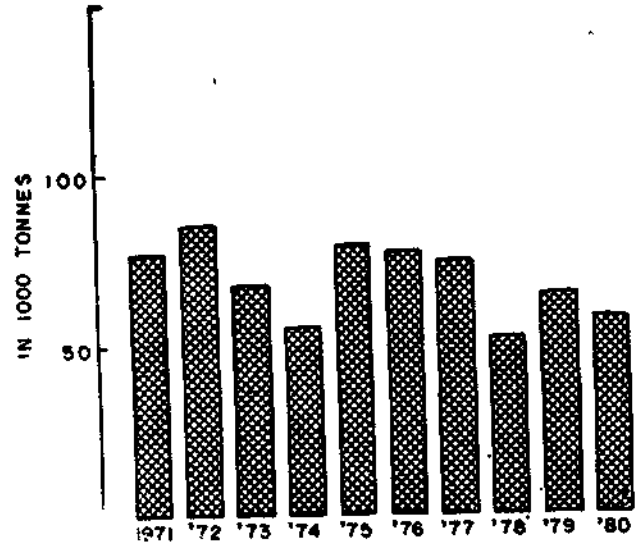


Fig. 8: Landings of Non-peaneid prawns during 1971 *to* 1980.

Stock assessment and estimation of potential yield of commercially important fishes (FSS/FRA/FS 1.3)

Gear-wise length frequency data on commercially important fishes namely oil sardine, mackerel, Bombay duck and penaeid prawns were collected. Statistical analysis of marine fish landings in India during 1969 to 1977 was taken up. Estimates of mortality rates using length-frequency data has also been taken up.

National Fishery Data Centre (FSS/FRA/ST. 1)

Coding and punching of fishery data continued. Part of the survey data pertaining to 1978 was transferred to punch cards. The data collected under the socio-economic enquiry at Pudiappa were coded for punching.

Standardisation of fishing effort (FSS/FRA/1.4)

The data on gear-wise estimates of catch and effort of marine fish landings in Karnataka for the years 1977 to 1980 were analysed.

Survey of estuarine fisheries (FSS/FRA/1.5)

This survey work could not be taken up for want of adequate staff.

Exploited marine fisheries resources of maritime states (FSS/FRA/1.6)

A detailed report on statewise districtwise and gearwise estimates of catch and effort in India for the year 1977 was finalised.

Socio-economic surveys of small scale fisheries at selected centres (FSS/FRA/1.7)

Data relating to the indebtedness of coastal fishermen at Vizhinjam were collected, processed and the results were published (MFIS. No. 18). Out of 404 fishermen families covered under the study, 83% were in debt. The average outstanding debt per household worked out to Rs. 2,160/- whereas the average annual income of such family was only Rs. 1241/-. Money

lenders were the major source of borrowings. They accounted for 87% of the total credits. Institutional credit was only 5.2%. Only 24.8% of the total debt was utilised for productive purposes. Maximum amount was spent for construction and repairing of house buildings.

Socio-economic survey has been conducted at Alanthalai & Uvary fishing villages (Thirunelveli District, Tamil Nadu) covering about 500 fishermen households. Data have been collected for the study of cost and earning of catamarans in this area.

Impact of purse-seine operations on the socio-economic conditions of traditional fishermen (FSS/FRA/1.8)

A survey was conducted to study the impact of purse-seine operation in the Kerala coast visiting the landing centres from Munambam to Thottappally. It was observed that the indigenous sector has been affected both from the production and marketing sides. Further investigations are in progress.

Impact of mechanised fishing on the socio-economic conditions of fishermen in Sakthikulangara—Neendakara area (FSS/FRA/1.9)

Detailed information to study the impact of mechanisation on the socio-economic conditions of fishermen at Sakthikulangara area was collected and the data are being processed. The study showed that about 50% of the fishermen families have only an annual income of Rs. 3,600 or less. Employment potential has generally increased in the area. A detailed report covering all the important aspects is under preparation.

Training in fishery resources assessment inclduing population dynamics (CMFRI/TR/6)

The training programme could not be taken up due to preoccupation with census work.

Economics of marine fisheries in the Calicut area (IIP/4)

The detailed report on the first phase of the survey is completed.

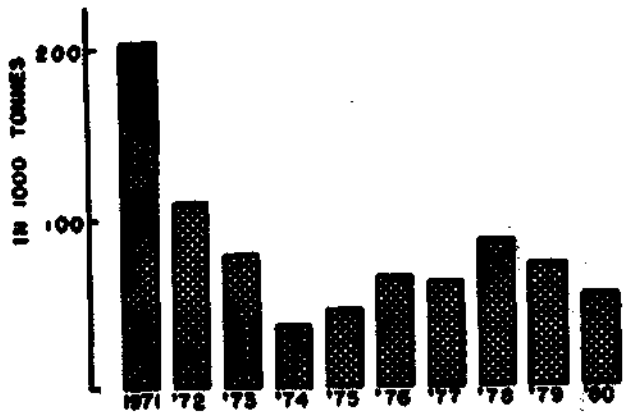


Fig. 9: *Landings of mackerel during* 1971 *to* 1980.

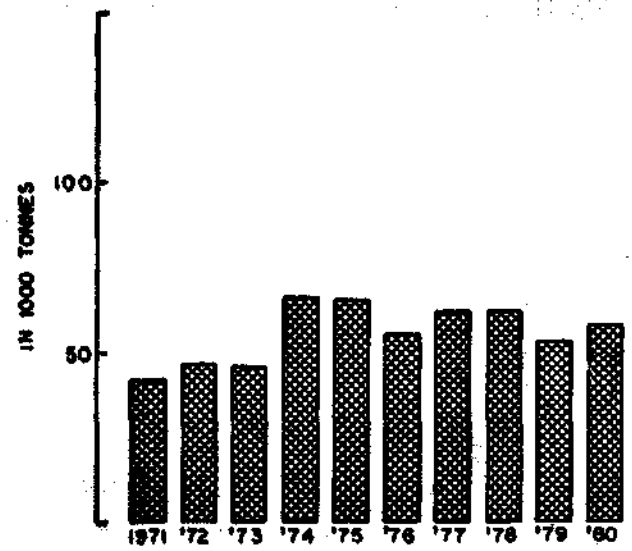


Fig. 10: *Landings of Elasmobranchs during* 1971 *to* 1980.

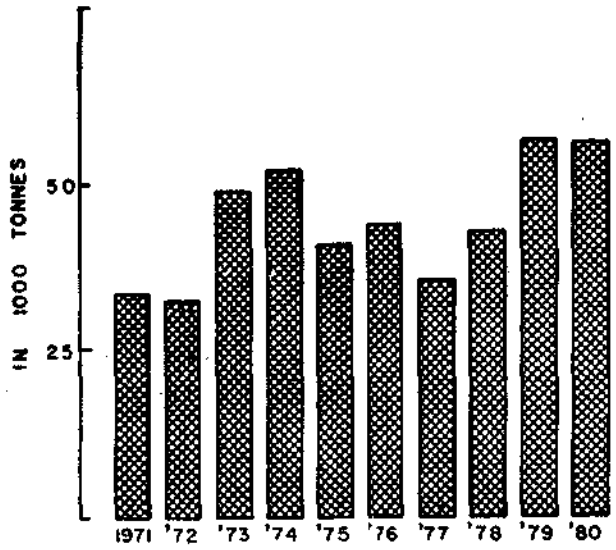


Fig. 11: *Landings of silver bellies during* 1971 *to* 1980.

All India Census of marine fishermen, craft and gear 1980. *Enumeration work in progress.*

Personnel associated with the various projects of the Division

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FISHERY BIOLOGY DIVISION

a. Pelagic Fisheries

*The fishery and resources characteristics of oil sardine (FB/PR/1.1)**

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During the year under report, the purse seine landings of oil sardine indicated almost a three-fold increase at Cochin, those at Mangalore and Goa recorded only a marginal improvement compared to the preceding year. At Karwar, the purse seine catches slightly dwindled during the year. Though the catches of the indigenous gears declined markedly at Cochin, Mangalore and Karwar regions, perhaps as a consequence of heavy purse seine fishery, those at Calicut indicated only a marginal decrease. The highest average catch per purse seine was made at Cochin (1847 Kg.); the average catch per purse seine at Mangalore was also quite good compared to the below-average figures of Karwar and Goa.

Of the different total-length modes, the predominant ones observed at the majority of the centres were: at 30, 90, 105, 120–125, 140, 160–170, 180–185 and 200 mm.

The age composition in the catch per unit effort of oil sardine at different centres are given in accompanying table.

At Cochin the females were dominant (57.0%). While the III–IV stages were dominant only in May, the spent and spent-recovering ones preponderated during most of the months. At Calicut females dominated during January, February, June- August and November. The partly-spent fish dominated during June to

* Projects completed during 1980-81

AGE COMPOSITION IN THE CATCH PER UNIT EFFORT OF OIL SARDINE AT DIFFERENT CENTRES DURING 1979 AND 1980

Place & Gears		1979			1980		
		O-year	1-year	2-year & above	O-year	1-year	2-year & above
Goa	P.S.	13912	1854	4114	17759	654	32
Karwar	R.P.	4737	406	515	4012	116	97
	P.S.	42309	19844	1786	66077	469	197
Mangalore	P.S.	22122	13358	3383	62780	12857	2539
Calicut	P.K.	7316	6473	3542	7193	5726	3617
Cochin	T.V.	14230	2910	777	13727	4167	464
	P.S.	123708	19950	11707	48927	10675	8967
TOTAL		228334	64795	25824	220475	34664	15922

P.S.—Purse seine, R.P. Rampani P.K. Pattenkollivala T.V.—Thangu vala
Age: 0-year (<149mm), 1-year (150–179mm), 2-year (180mm+)

August among the adult fish indicating early spawning. The male to female ratio was almost equal at Mangalore. While stage II was dominant during the first quarter, the stage V dominated in May. The partly-spent ones were dominant in September. The occurrence of appreciable quantities of spent fish in May indicated early spawning. At Karwar the males dominated. Among the adults, appreciable quantities of spent and partly-spent fish were observed in September. In Yendi and gill net the partly-spent fish dominated in July.

Evaluation of the resources of lesser sardines (FB/PR/1.3.1)*

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The fishery for the lesser sardines was fairly good during the year. Estimated total landings being 20 tonnes at Waltair, 198 tonnes at Madras, 999 tonnes at Mandapam (Palk Bay) 4385 tonnes at Tuticorin, 173 tonnes at Vizhinjam, 3 tonnes at Cochin, 640 tonnes at Karwar and 1298 tonnes at Goa.

At Karwar the catch was considerably lower than that of the previous year. *Sardinella fimbriata, S. gibbosa, S. albella, S. dayi, S. sirm, S. clupeoides and S. sindensis* were recorded in the fishery. During the year both seine nets and gill nets were employed in the lesser sardine fishery.

Sardinella fimbriata from 4.0 cm to 18.5 cm total length were recorded in the fishery. All fish examined at Waltair were immature. At Cochin and Karwar females were more in number than males. At the other centres fish in various stages of maturity were encountered.

Commercial landings of *Sardinella gibbosa* at different centres contained fish from 7.0 to 17.5cm. Females were more in number than males at Waltair and Tuticorin. Whereas, at Madras and Karwar males were more abundant than females in the catches. Maturity stages varied at different centres.

Biological observations on *Sardinella albella* were carried out at Cochin and Karwar. Fish from 13.5 to 16.0 cm were

* Project completed

observed with the mode at 14.5cm. Females outnumbered males at Cochin whereas, at Karwar males were more in number than females. At Cochin the purse seine catch composed of fish with mature and spent gonads. Gravid fish were noticed during September to November. Mature fish dominated the Karwar fishery during February.

Sardinella dayi from 12.0 to 17.5cm were observed in the catches. At Madras the 12.0 to 16.0 cm size groups entered into the fishery with 14.0cm and 14.5cm size groups dominant in the catches. At Karwar fish from 13.0 to 17.5 cm were observed in the catches. The 14.5cm group was more or less dominant. At Madras females formed a higher percentage than males. On the other hand at Karwar males were more in number than females.

Mature fish dominated the Madras Fishery during January and February. During the other months only immature fish formed the fishery. Spent fish dominated the catch at Karwar. Mature fish were seen during March and April.

Sardinella sindensis was available only at Vizhinjam. Fish in the size range from 3.0 to 18.0cm were available in the fishery with modal size at 5.0 and 15.0cm. Females were slightly more in number than males. Fish with resting and developing gonads were common in the commercial fishery.

Evaluation of the resources of anchovies (FB/PR/1.3.2)*

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An outstanding feature of the fishery during this year has been the huge purse seine landings of *Stolephorus* at Mangalore during October–November amounting to 4320 tonnes, as a result of the active purse seine operations during the season. However, during these two months *Stolephorus* landings by purse seines at Karwar, north of Mangalore, were poor.

A record catch of 4649 t. on *Stolephrorus* was observed at Mangalore this year, compared with the catch of 759t. of last year. Pruse seines landed bulk (98.7%) of the catch and trawls

landed the rest. Peak landings occurred during October–November for purse seine accouting for 94.3% of the annual catch. *S. devisi* formed the bulk (90%) of purse seine catch followed by *S. bataviensis* (7.4%), whereas *S. bataviensis and S. macrops* forming 56.9% and 40.1% respectively accounted for bulk of trawl catches. *S. devisi* ranged in length between 50 and 99mm with common sizes at 57–82mm during January–April, and at 82–87mm during October–December. Gravid fish were common during January and February, while spent fish during October–December. Sexes were generally equal. *S. bataviensis* occurred in a size of 45–104mm total length with the common size at 67–97mm. During Feburary–May and October, bulk of the fish was with either resting or developing gonads and during January, November–December bulk of the fish had spent gonads. Gravid fish were rare in the catches, sexes were generally inequal; male being more than females. *S. macrops* in the catches had a size of 45–79mm. Gravid fish were available during January, April and November–December, and spent fish during January, May and December. Males outnumberd females in the samples.

The fishery for whitebait at Cochin landed an estimated catch of 277t. during the year with maximum catch (175t.) and catch rate (145 kg) occurring during October. *Stolephorus bataviensis* (58.5%), *S. heterolobus* (33.5%) and *S. macrops* (5.4%) were the dominant species. The above three species with length ranges from 65 to 95 mm, 45 to 95mm and 50 to 75mm with modes at 70, 80 and 60mm respectively contributed to the catches. They were found breeding over a number of months with peak spawning coinciding with October–December and March–May months.

At Vizhinjam *Stolephorus* landings of about 193t. during 1980 were about five times more than that of the previous year. This multispecies fishery had two peak seasons as usual: One during April–July and another during September–November. Gill nets landed bulk (51.5%) of the catch followed by boat seine (43%) and shores seine (5.5%) with the catch per net at 35.8kg, 3.7 kg. and 7.1 kg. respectively. *S. devisi and S. bataviensis* continued to be the two most important species in the fishery accounting for 61.8% and 25.2% of the annual catch.

Adult fish of 0-year class comprised bulk of the catches of *S. devisi* and *S. bataviensis* as well as of *S. buccaneeri* which contributed to 3.1% of the *Stolephorus* fishery. Juvenile fish was most common in the catches for *S. indicus* which accounted for 8.3% of the *Stolephorus* catch.

Spawning season of *S. devisi extended for almost* throughout the year with intense activity during March-July and November. But fish of *S. bataviensis* in advanced stages of maturity were available during January, April-May, November and December. Sex ratio of these two species was generally equal in the population sampled from non-selective gear. On the other hand bulk of the catches of *S. buccaneeri* comprised fish in advanced stages of maturity with intense spawning activity during February, June-July and October, and males dominated with a ratio of 1 : 2 M in boat seine where bulk of this species was landed. *S. indicus* with gonads in advanced stages of maturity were met with during January-March and September-December.

T. mystax and *T. setirostris* accounted for 90% of the *Thryssa* landings of 31 t. The other species met with were *T. dussumieri, T. vitrirostris* and *T. malabaricus.* Boat seine landed bulk of this fish. Good catches were obtained during August-October during this year. Juveniles formed bulk of the catches. Spawning season extended from July to December for *T. setirostris* and from March to Setpember for *T. mystax.*

Anchovy catches at two observation centres in Palk Bay amounted to 17.5 t. by gill nets and 3.9 t. by shore seine. *Tyryssa* (49.85%) and *Stolephorus* (41.71%) formed bulk of the gill net anchovy catch followed by *Setipinna* (7.47%) and *Coilia* (0.98%). *S. bataviensis* was the dominant species contributing to 41% of the *Stolephorus* catch, followed by S. *indicus* (22%) and *S. devisi* (20%). The common size in the fishery ranged between 45 and 80mm for *S. bataviensis.* between 40 and 130mm for *S. indicus,* between 60 and 75mm for *S. devisi. T. setirostris* (31%), *T. vitrirostris* (26%), *T. hamiltonii*(22%) and *T. malabaricus* (21%) were the constituent species of *Thryssa* catches.

Anchovy landings at Madras amounted to 131.3 t. of which *Stolephorus* accounted for 68.8% and *Thryssa* for 31.2% of the catch. Trawl net accounted for bulk (66.7%) of the anchovy

landings followed by gill net (25.9%) and shore seine (7.4%). *S. bataviensis* accounted for bulk (73.95%) of *Stolephorus* catches followed by *S. commersonii* (14.21%), *S. devisi* (10.98%), and *S. indicus* (0.86%), while *T. dussumieri* (51.12%) and *T. mystax* (47.04%) accounted together for 98.16% of the *Thryssa* catches.

S. bataviensis ranged in length between 20 and 130 mm with common sizes ranging between 55 and 80 mm in shore seine and between 60 and 95 mm in trawl net. Fish with mature gonads were rare in the catches and were observed in March, June and July, Males outnumbered females with a ratio of 68:32. *S. devisi* ranged in length between 35 and 95 mm with common sizes ranging between 55 and 75 mm in shore seine and between 70 and 90 mm in trawl net. Fish with mature and ripe gonads were met with from February to July. Males outnumbered females with a ratio of 67:33.

Anchovy landings at Uppada, near Kakinada, amounted to 65.5 tonnes. January–March, June and November—December witnessed good landings. *Thryssa* accounted for bulk (90%) of the anchovy catch followed by *Stolephorus* (7%), *Setipinna* (2%) and *Coilia* (1%), Gill net and shore seine together accounted for about 96% of the anchovy catch. In both these gear *Thryssa* formed about 90% of the anchovy catch. *T. mystax* and *T. dussumieri* were the important species accounting together for about 85% of the landings of this genus. About 85% of the *Stolephorus* catch was formed by *S. commersonii, Setipinna* and *Coilia dussumieri* were the other species met with in the catches. The size of *T. mystax* in gillnet catches ranged between 80 and 259 mm with common sizes ranging between 120 and 219 mm, whereas in shore seine it ranged between 80 and 139.

An estimated anchovy catch of 23.9 t. by indigenous gear and 208.4 t. by trawl were landed at Waltair this year, compared with 6.16 t. and 323.8 t. landed respectively in preceding year. About 76% of the catch by indigenous gear was contributed by shore seine, the share of the other two gear being 19% and 5% respectively. Bulk of the anchovy catch was landed during July October and December. Two species of *Stolephorus* and three species of *Thryssa* were noted in the catches. *S. heterolobus* was the dominant species of anchovy in shore seine and gill net, where-

as *S. bataviensis* was dominant in boat seine and trawl net. *Stolephorus* and *Thryssa* accounted for 54% and 46% respectively of the anchovy catch in trawl landings, where *T. mystax* and *T. setirostris* represented by adults and *T. dussumieri* represented by juveniles were available. Juvenile fish were common in March for *S, heterolobus,* and in September and November and *S. bataviensis;* whereas adults were common during September, October and December for *S. heterolobus* and in January and October for *S. bataviensis.*

The fishery and resource characteristics of the mackerel (FB/PR/2.1)*

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The purse seine landings of the mackerel with an estimated catch of 983 t. at Goa were, better in 1980 in comparison to the landings of the previous year. This increase was due to increased fishing effort and due to higher catch rate (273 kg) compared to the previous year.

At Karwar, during the first half of the year the catch was only 45 tonnes against 374 tonnes of the corresponding period of 1979. The carry over of the1979 season was thus very poor here.

In Mangalore the mackerel landings at Baikampady in 1980 was 30 tonnes ot which 12 tonnes were landed by Kantha balae as against 20 t. during the preceding year. The Rampan landings, effort and cpue were 2625 kg, 14 numbers and 187.5 kg respectively in 1979 and 15964 kg, 40 numbers and 399.1 kg respectively for 1980. The purse seine landings and its cpue here were estimated at 4039 t. and 451 kg which were lower than the comparable figures in 1979.

There was an increase in the Rampan operations and their catches. However, the number of purse seine operations and their catch and cpue decreased in 1980. At Ullal, the catch fell down to 3 tonnes in 1980 from 9 tonnes of 1979. The cpue of Kantha balae was 5.3 kg in 1980 against 11.3 kg of 1979.

* Indicates projects completed during 1980–81.

The comparative catch, effort and cpue at Calicut for 1979 and 1980 were as follows: The total landings in the 2 years were almost the same. The Patton Kolli and its landings were slightly more but the cpue was less. The landings of the gill nets and the drift nets were also less with less cpue. There was a remarkable three fold increase in the trawler landings with a higher cpue even though the number of trawlers were more or less the same (see table).

	1979			1980		
Units	C (kg)	E	cpue (kg)	C (kg)	E	cpue (kg)
Pattenkolli	341980	9869	34.7	351550	10924	32.18
Ayilavala	244138	5065	54.1	116118	3215	36.12
Mathivala	918	2793	0.3	246	3382	0.07
Trawlnet	53892	8559	6.3	185799	8729	21.29
Driftnet	26354	3596	7.3	25314	3819	6.63
TOTAL	697282			679027		

At Cochin, the number of Thangu vala and Ayila vala and their mackerel landings were less in 1980 against that of 1979 with an estimated catch of 206 and 387 t. respectively. The cpue (48.2 kg) of Thangu vala in 1980 was better than in 1979. At Fisheries harbour the estimated landing of mackerel for the year was 3903 tonnes. Out of this 95% were landed by the purse seiners.

The mackerel landings at Vizhinjam doubled this year over that of 1979. The catch details show that the drift net and the Konchu vala as the major gears landing mackerel here. There was a substantial increase in the number of drift nets in this year. The number of Konchu vala was almost the same in the 2 years. But there was almost 100% increase in its cpue.

Around Mandapam a total of 117 tonnes of mackerel were landed in 1979 and it has fallen to 85 tonnes in 1980. Both the fishing effort and the catch rate during 1980 season registered similar decrease compared to 1979. A total of 60.0 tonnes of mackerel were landed around Madras. Eda Valai (Bag net) landed the maximum mackerel of 34.0 tonnes at a cpue of 20.5 kg.

Vizhinjam had the smallest fish along the west coast as it used to be in the previous years. Maximum size up to 299 mm were, however, seen this time at Cochin in the drift net landings. At most of the centres of study the species showed comparatively faster growth rate over different sizes. This fast growth is peculiar to the year 1980. These fish were healthy and at the same time very immature in their gonadial development in comparison to the conditions in the preceding years. Such healthy fish in the stock may lead to good spawning in the season and a good future for the fishery if all the fishery independent factors turn out to be favourable for their breeding and rearing.

The older fish of 1979 season carried over the 1980 were advancing in their gonadial maturity, and the conditions indicate a spawning in January–March and another one in July–October at Cochin. There were indications of probable spawning in April–June and August–October at Calicut and September October at Vizhinjam. The spawning at Mangalore was recorded during August–September.

Age composition in the commercial landings by major gear at different centres are also given in the table. The commercially exploited stock falls mainly in 0 and 1 year old groups. Two year olds are comparatively more at Vizhinjam where some 3 year olds are also encountered. The age composition in both the indigenous and mechanised fishing units was more or less the same. The overall average total instantaneous mortality coefficient in 1980 for the mackerel along the west coast is estimated to be 2.3629 (provisional) indicating a survival of 9.42% of fish in the stock for future propagation and support to the stock. Faster growth in the fish with higher rate of survival in the year are good indications of a better fishery in the future.

AGE COMPOSITION IN THE CATCH PER UNIT EFFORT OF MACKEREL AT DIFFERENT CENTRES DURING 1979 AND 1980

Centre & Gears		1979				1980			
		0-year	1-year	2-year	3-year	0-year	1-year	2-year	3-year
Keelakarai	D.N.	—	37	108	—	—	15	1	—
Vizhinjam	B.S.	18	—	—	—	2	1	—	—
Cochin	B.S.	1	200	24	—	891	77	1	—
Calicut	B.S.	26	239	53	—	63	234	40	—
Baikampady	R.P.	3284	1841	—	—	—	3431	230	—
"	I.S.	219	2613	672	—	49	4302	385	—
Karwar	R.P.	141	34643	11867	—	296	27988	326	21
"	I.S.	185	5094	3722	—	27	1509	105	—
Goa	P.S.	6240	3857	—	—	743	3090	210	—
TOTAL		10114	48524	16446	—	2071	40467	1298	21

D.N.—Drift Net B.S.—Boat Seine R.P.—Rampan P.S.—Purse Seine
Age groups: 0-year (<159mm), 1-year (160–229mm) 2-year (230–269mm), 3-year (270mm+)

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

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Major part of the research activities under the project was concentrated on collecting information on the resources, present trend of exploitation, products, utilisation and biology of tunas and billfishes landed by various gears from the coastal waters of the mainland of India and from around Minicoy Island.

All India tuna landings in 1980 have been provisionally estimated as 20,264 tonnes which indicate a decline of about 6,333 tonnes from the landings during 1979. Except in Tamil Nadu, where 78.7% increase in tuna landings were recorded, in all the other states the catches showed declining trend.

The estimated total effort and catch of tunas and bill fishes by different gears and the CPUE for tunas and billfishes at the centres where monitoring of the landings was carried out are presented in accompanying table.

Estimated total effort, catch and CPUE for tunas and bill fishes at different centres

	Total catch (kg.)		Effort (units)	CPUE
Minicoy	15,565	: TR	110	141.5
	6,61,160	: PL	1,267	521.8
Goa	10,906	: DGN	4,256	2.6
Mangalore	2,09,410	: DGN	52,014	2.1
	11,34,692	: PS	92,673	12.4
Calicut	96,150	: DGN	3,787	25.4
Cochin	8,60,612	: DGN	22,711	29.2
	1,20,000	: PS	9,356	13.0
Vizhinjam	4,70,613	: DGN	18,457	25.5
	1,70,661	: HL	87,470	2.0
	12,014	: KV	8,565	1.4
	459	: SS	317	1.5
Tuticorin	28,19,309	: DGN	9,867	285.5
	1,402	: TR	458	3.1
Visakhapatnam	30,200	: HL	—	—

DGN—Drift gill net; PL—Pole and Line; TR—Surface trolling; PS—Purse seining; HL—Hooks and Line; KV—Kochuvala; SS—shore seine.

Pre-monsoon months (March–April) and Post-monsoon months (November) were found to be the productive periods for tuna fishery at Minicoy. High rates of CPUE for tunas were recorded during the monsoon months (May–August) at Calicut, Cochin, Vizhinjam, Tuticorin and Waltair. At Mangalore maximum values of CPUE for tunas were recorded in March and April mainly due to the operation of purse seiners. Relatively high CPUE for these fishes were recorded at Goa during November.

At most of the centres where observations were made, fresh tunas landed were transported to the interior markets under refrigeration or packed with ice. In the Lakshadweep, fishery products such as salted and sundried fish (33.50%) are prepared mainly from skipjack tuna. Canning is also done during the tuna fishing season at Minicoy. At Goa, private canning companies process tuna in refined soyabeen oil and it has been estimated that about 50,000 numbers of tunas are canned during the tuna fishing season every year. At Cochin, tunas are canned on a limited scale by private firms for marketing to cities in North India.

The percentage composition of different species of tunas and billfishes at the centres where observations were made indicated that at Minicoy' *K. pelamis* formed 80% followed by *T. albacares* which contributed to 19.4% of the total tuna catch. In all the other centres, except at Tuticorin, *E. affinis* formed the major species in the tuna landings ranging from 55.2% at Vizhinjam to 4.98% at Calicut followed by *Auxis* spp.

At Tuticorin, *A. Thazard* formed 86.9% of the total tuna catch followed by *E. affinis* (11.6%). *E. affinis* contributed 78% of the total tuna catch at Visakhapatnam followed by *T. tonggol* (10%) and skipjack (8%).

Observed ranges in the size (in cm) of different species and the dominant modes are presented in Fig. 2. Small sized

Specimens of the major species of tunas appeared in the fishery at different centres in the following months:

Area (Centre)	Species						
	E. affinis	A. thazard	T. tonggol	T. albacares	K. pelamis	S. orientalis	A. rocheii
Minicoy	—	—	—	Feb. (30.0)	May (30.0)	—	—
Mangalore	Oct. (20.5)	Sept. (21.0)	Oct. (34.5)	—	—	June (28.0)	Nov. (20.2)
Calicut	Oct. (34.0)	Sept. (32.0)	—	Aug. (54.0)	—	—	—
Cochin	Aug. (22.0)	June (28.0)	Feb. (36.0)	Nov. (50.0)	—	June (36.0)	Aug. (20.0)
Vizhinjam	Aug. (30.0)	March (24.0)	—	Feb. (60.0)	—	—	—
Tuticorin	Sept. (12.0)	Sept. (12.0)	June (44.0)	July (60.0)	—	July (14.0)	—

The occurrence of small-sized specimens of *E. affinis* at Tuticorin (September) and Cochin (August) has been found to be recurrent feature every year.

Investigations on the other biological parameters such as the sex ratio and maturity stages of tunas were also carried out at Minicoy, Mangalore and Calicut. At Minicoy, the percentage of developing females of *K. pelamis* and *T. albacares* were maximum in March and the gravid females of the former species were relatively numerous in November. The percentage composition of developing and spent specimens of *E. affinis* was high at Mangalore in September. At Calicut maximum number of *E. affinis* in the developing stages was observed during November–December period.

At Minicoy investigations were conducted on the distribution pattern and availability of tuna live baits. Culture of *Tilapia* and substitute tuna live bait has been attempted. Onboard observations were also made to collect data on tuna hydrography.

Total species-wise production of tunas and billfishes from the Indian Ocean for 1978 has been computed based on the catch statistics published by the FAO, Taiwan and Japan.

Culture of anchovies as live bait for tuna (FB/PR/3.4)*

G. LUTHER, G. GOPAKUMAR AND MADAN MOHAN.

Stolephorus devisi, S. bataviensis, S. buccaneeri and S. indicus were stocked this year in a cage of 62800 litre cpacity in the proportion of 58%, 37%, 4% and 1% respectively. The length ranges with the average given in parenthesis for the four species were: 58–92mm (72mm), 52–94,mm (77mm), 65–75mm (71mm) and 112–118mm (115mm). In an attempt to reduce the mortality of fish during transportation to rearing cages, the fish were carried in less saline water of 21‰–28‰ salinity. This method brought down the mortality to 1/5 of that in normal (100%) sea water where the mortality ranged between 45% and 50% for *S. devisi and S. buccaneeri,* but had no effect on *S. batavienesis and S. indicus* which sustained 85–90% mortality during the period of transportation lasting for half an hour to an hour. The last two species survived in the cage for only a few hours. *S. devisi* and *S. buccaneeri* on the other hand, were quite active in captivity in the cage for about a month. Thereafter, a gradual decline in their number took place and by the end of the second month of captivity not a single fish was alive in the cage.

Studies reveal that *S. devisi* and *S. buccaneeri* are the two hardy species of *Stolephorus* that could be kept in captivity for use as live bait and they together account for about 60% of the *Stolephorus* catches along the West coast. Problems relating to capture and transfer of fish from net to transporting equipments, transfer of fish into the cages, presence of predators in the collections, mortality of the different species of *Stolephorus* during the above operations, preparation of artificial feed and feeding of fish, upkeep and maintenance of rafts and cages have been fairly understood.

Capturing fish by encircling nets such as purse seine, adoption of methods that would reduce mortality at different stages of handling of fish, and aiming to stock fish only for shorter dura-

* Project completed.

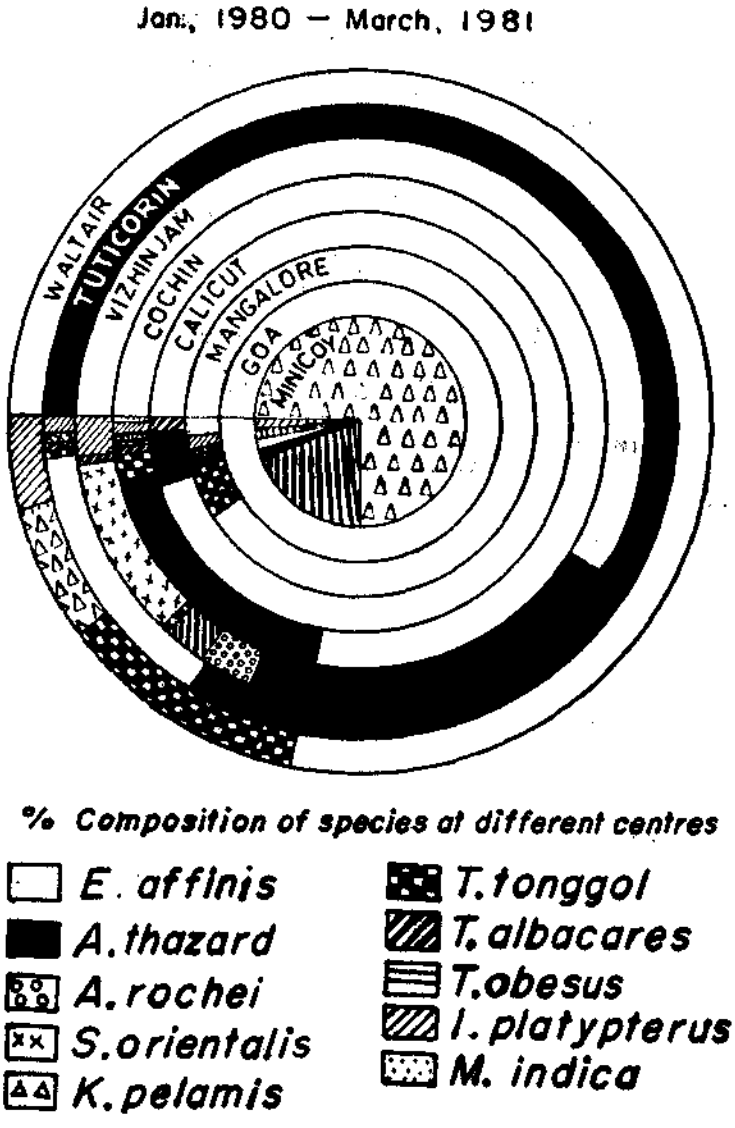


Fig. 12: Percentage composition of different species of tunas and billfishes at different centres.

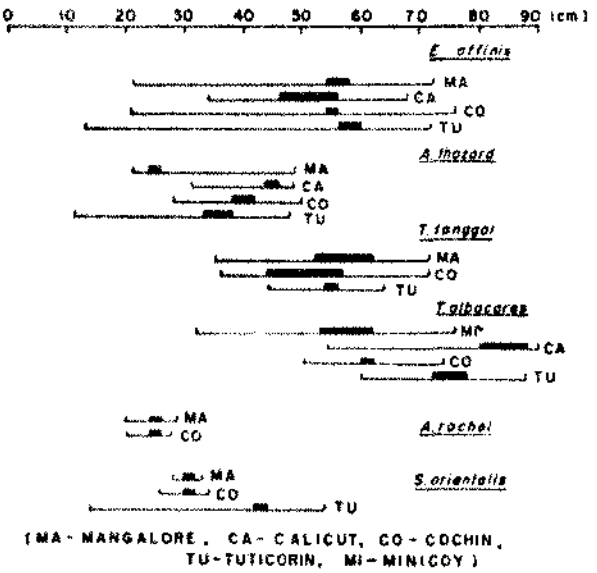
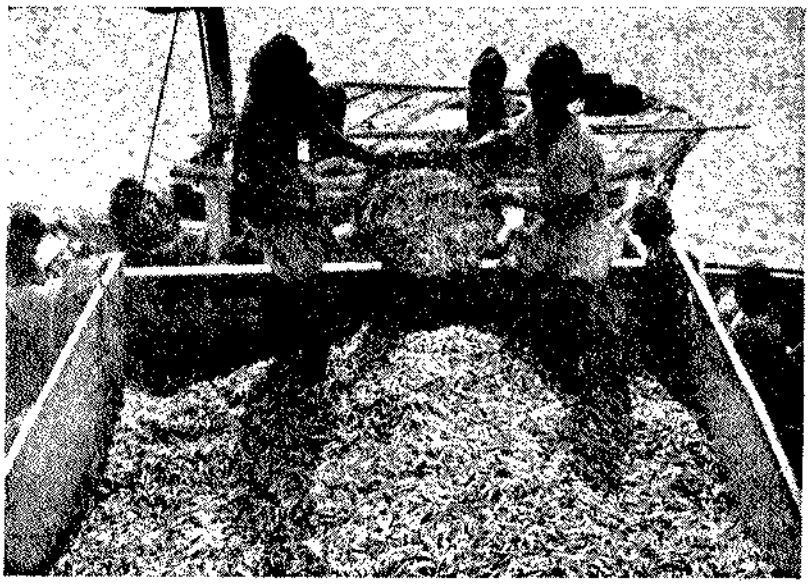


Fig. 13: Size ranges of different species of tunas at various centres. Major modes are also indicated.



Bumper catch of Anchovies at Mangalore

tions of 1 or 2 months would seem to facilitate utilizing the *Stolephorus* resources as live bait for tunas.

The fishery and resource characteristics of Bombay duck (FB/PR/4.1)*

V.M. DESHMUKH, ALEXANDER KURIAN AND M. ZAFAR KHAN

Along the Saurashtra coast the Bombay duck fishery at fishing centres, Navabundar, Rajpara and Jaffrabad yielded an estimated catch of 5581, 18721 and 11882 tonnes with the annual catch rate of 86 kg; 95 kg and 151 kg per haul respectively for the year 1980. For the previous year the estimated catch from these centres was 5640, 14870 and 11808 tonnes respectively. The highest catch per haul was recorded during September 1980 (244 kg) while the lowest was in March 1980 (14 kg) at Navabunder. At Rajapara the highest catch per haul was recorded in May (226 kg), while at Jaffrabad the catch per haul was highest in October (174 kg).

In the Bombay duck catch at Navabunder, the minimum size group 15–30 mm and maximum size group 345–360 mm were noticed. In most of the months the catches were dominated by 60–75 mm size but in May a bigger size group 180–195 mm dominated the catches. At Rajapara the Bombay duck in the catches ranged from 30-45 mm size group to 360-375 mm size group and the catches ranged from 30-45mm size group and the catches were mostly dominated by small size fish of 45–60 mm and 60-75 mm size groups except in May where 90-105 mm size group predominated the catch. Similarly at Jaffrabad the size of the fish in the catches ranged from 30–45 mm length to 360–375 mm length. Here also it was seen that the catches were supported by 45–60 mm and 60–75 mm size groups but in the month of January they were dominated by bigger fish of 225–240 mm size group.

At these three centres sex ratio for Bombay duck males to females was 52 : 48. Male fish was dominant during October and December and female in February. A few gravid specimens were observed particularly during December–January.

At Arnala on the Maharashtra coast, the Bombay duck fishery was reported poor as an estimated catch of 854 tonnes

was landed during the year as against 4785 tonnes of last year. The annual catch rate per haul has come down to 62.05 kg from 139 kg of the last year. Similarly the catch per haul in number has dropped down from 2513 to 754. The average length has gone up from 223 mm of last year to 233 mm of this year. The mean survival was estimated as 53.21% and actual mortality 46.79% while exploitation rate was 37.30%.

At Arnala the size of the fish ranged from 15 mm to 390 mm in the catches. In most of the months catches were dominated by bigger size groups 225–240 mm; The ratio of females to males during the period was 1 : 1.7 and in larger size groups females dominated. The spawners and spent individuals occurred in all the months. Food analysis showed that with the reappearance of *Bregmaceros maclellandi* dependence on non-penaeid prawns was reduced.

At Versova in Maharashtra Bombay duck fishery was reported poor this year with an estimated catch of 1152 tonnes for 1980. The fishery was good during the first quarter. The catch per haul for the year was 10.56 kg and the maximum catch rate of 16.19 kg was reported during January 1980 and the number of fish per haul for the year was 312. The annual average size of Bombay duck has come down to 167 mm from 178 mm of the previous year. The maximum average length 192 mm was noted in January 1980.

At Versova the minimum size group seen in the catches was at 30-45 mm and maximum at 360-375 mm. In most months the catches were dominated by 210-225 mm size group or smaller ones; while in October bigger size group 270–285 mm was predominant in the catches. The percentage of juveniles was high in most of months while in January and October the percentage of adults was high in the catches.

Fishery and resource characteristics Carangids (FB/PR/5.1)*

S. Reuben, V. Sreeramachandra Murthy, P.N. Radhakrishnan Nair, T. Prabhakaran Nair, N.S. Radhakrishnan and Alexander Kurian.

Carangid fishery landed an estimated quantity of 24.1 tonnes by the indigenous gear at the Lawson's Bay, 33.2 tonnes by the trawlers of the Exploratory Fisheries Project and 860.7 tonnes by the commercial trawlers during the year forming 9.0,

11.0 and 10.5% of the total catch in the respective gear. *Scomberoides commersonianus* and *Decapterus dayi* dominated the carangid landings at the Lawson's Bay while *D. dayi, M. cordyla* and *C. malabaricus* were dominant carrangids landed by the trawlers.

The length of *M. cordyla,* measured for growth studies, ranged from 190 to 380 mm while that of *D. dayi* ranged from 55 to 199 mm. Fresh broods of *M. cordyla* appeared in the fishery during September while *D. dayi* entered the fishery in March. Males of *M. cordyla* slightly dominated in numbers. Resting and developing females were more during January and September while spent individuals dominated in March and August. 51% of the fishes had half-full stomachs while 45% of them were empty. Crustaceans dominated the food components during first half-year while fish remains were observed during the second half-year.

At Kakinada an estimated 493.8 tonnes of carangids were landed by the commercial trawlers. These formed 5.0% of the catches. *D. dayi* contributed to the bulk (77.7%) of the carangid catch. March/April and September were peak months for carangid landings.

D. dayi was recruited into the fishery during March. The length of this species ranged from 55–205 mm. Males dominated over females. Gravid and spent females predominated during February; majority of the fishes had empty stomach.

The fishery at Vizhinjam landed an estimated catch of 571 tonnes of carangids by the indigenous gear. This formed 13.21% of the total landings. The bulk of this catch was contributed by hooks and line (48.7%) and drift nets (23.5%). Post-monsoon period appeared to be best for carangid landings. The bulk of the carangid catch was contributed by *Decapterus* spp. *M. cordyla* examined for length frequency, ranged from 130 to 374 mm. There seemed to be initial recruitment into the fishery during May. Males dominated during May, September and October while female in other months. Majority of the females examined were in resting condition. While all the stomachs examined in May had gorged stomach; majority of those examined in later month were empty.

The sizes of *D. dayi* measured ranged from 75 to 294 mm. There was an indication of fresh brood entering into the fishery during November–December period. Preponderance of males was noticed in June, October and December while females in other months. Majority of the ovaries examined during May to October period were in advanced and spent condition.

At Mangalore Carangids landings from the purse seine totalled 515 tonnes which formed 2.4% of total catch. The bulk of the catch (75.0%) was contributed by *M. cordyla*. Peak catches of carangids were noticed during November.

The length of *Selar kalla* examined ranged from 80 to 164 mm. Juveniles of this species were found in most of the months; while maturing and mature fish were encountered in October. *M. cordyla* observed in the fishery ranged from 215–374 mm in length during September to November. While immature fish dominated during September, maturing fish were dominant in October and November.

The coverage of the landings at Bombay was rather poor. An estimated 92 tonnes of *M. cordyla* was landed at Sasoon Docks. The catch rate was better in January (2.7 kg/hr) and October (1.74 kg/hr) than in other months. All the specimens examined were immature. 73.0% of the fish examined for food habits showed no food in their stomachs. Sciaenids, *Coilia* and *Acetes* were the common food components encountered in the stomachs.

The resource characteristics of ribbon fishes (FB/PR/5.2)*

P.T. MEENAKSHISUNDARAM, Y. APPANNA SASTRY, S. LAZARUS AND S.K. CHAKRABORTY.

At Madras an estimated total of 1,21,735 kg of trichiurids was landed at Kasimedu by the commercial trawlers occupying 5.97% of the total trawl landings for the period January–December 1980. The maximum ribbon fish landing (33,264 kg) was recorded during November and the minimum (43 kg) during March. Similarly the maximum catch return (22.95 kg) for a unit of effort was recorded during November and the minimum (0.06 kg) during March. At Triplicane boat-seines landed 16461 kg of ribbon fishes between January and December, 1980 forming

50.01% of the fish caught by this gear. During July and October the landings as well as the catch per-unit-effort were found to be higher than the rest of the months.

The size range of *Trichiurus* found in the trawl landings was between 160 mm and 1019 mm of total catch. It is evident from the data that the individuals measuring upto the length of 559 mm are commonly entering into the fishery. Fish of the size above that were rarely encountered during the period of present observation. The maximum size of the fish recorded in the boat-seine catch was 559 mm and the smallest specimen measured 160 mm.

The specimens obtained from trawl catches revealed the presence of immature and maturing females along with immature, maturing and mature males in good percentages during January-May. During June and July mature individuals of both the sexes were encountered. All the specimens examined during October were found to be in immature condition. Throughout the period of present investigation, ribbon fishes occurred with gorged, full, 1/2 full and empty stomachs. Excepting June, moderate feeding was noticed in more numbers of individuals during rest of the months.

An estimated 787·3 tonnes of ribbonfish were landed by the commercial trawlers at Kakinada and 399 tonnes by the inshore fishing gear at Uppada centre. The ribbonfish catch from off-shore are less by 626 tonnes when viewed from the previous year. They formed 7.9% in trawlers and 13.1% in inshore gear. *T. lepturus* was most common species in both the inshore and offshore landings. Boat-seines and shore-seines are proved to be the efficient gear for obtaining the ribbon fish among the all inshore gear. Individuals of *T. lepturus* measured in commercial trawlers contained 3-4 old fish also, and they were below 3 year age in the inshore landings studied. During August specimens of above one meter length were measured in trawl net landings.

Unlike the previous year, this year the *Trichirus* fishery commenced very late at Vizhinjam. The hairtails started appearing in the catches by June only; whereas in the previous year it was available in the catches from April onwards. So also in the last year the season lasted for 9 months upto December, but

this year it was there for only 4 months and it came to a close by September. Good landings were observed in the month of July. An estimated total of 583 t. of trichiurids were landed at Vizhinjam and it formed 15.34% of the local landings. For the corresponding period of the previous year it was 3429 tonnes and it formed 58.73% of the total landings. Thus a drastic reduction in the catch of trichiruids was noticed this year in this area.

The fishery was exploited by boat seine, hooks and line, gill net and drift net and their respective contribution being 94.7%, 5.1%, 0.1% and 0.1%. Like the previous year this year also the bulk of the catch was by boat seine. The monthly CPUE varied from 0.53 to 40.72 kg for boat seine, 0.02 to 4.14 kg for hooks and line and less than a kg for gill net and drift net. *Trichiurus lepturus* was the only species which formed the fishery. Minimum and maximum sizes of the fish recorded in boat seine during the year were resepctively 12.1 cm and 110 cm. The modes were observed at 54.1 cm size groups during June; 16.1, 22.1 and 64.1 cm size groups during July, 26.1 cm size group during September. The size range found in the hooks and line catches was between 62.1 and 106.0 cm and a prominent mode was found at 70.1 cm size group during the month of September.

Fish with resting, developing, gravid and spent individuals were present and their representation being 57.4%, 25.9%, 13.9% and 2.8% respectively. Resting and developing individuals were found in the months June, July and September; gravids were seen only in July and spent ones were observed in June and September. In all the months the females were found to dominate the catches and the overall male–female ratio was 45.1 : 54.9.

The fishery at Bombay in general was good and showed marked improvement compared to that of last year catch. At Sassoon Docks a total of 1535 tonnes of ribbon fish was landed by trawlers. The landing of ribbon fish last year was 768 tonnes. This year's landing is 49% higher than that of previous year. The 'dol' net landing at Sassoon docks was 172 tonnes about 48.1% more compared to last year's figure of 91 tonnes. At New Ferry Wharf, estimated landing of ribbon fish was 2103 tonnes about 64% more than the last year catch of 769 tonnes.

At New Ferry Wharf where only trawlers are landed the catch comprised exclusively of *T. lepturus*. At Sassoon docks also the trawl catch comprised of *T. lepturus* as in the dol net catch. It was observed that about 50% of the catch comprised of *T. savala* and another 50% *T. lepturus*. The ribbon fishes landed by trawlers were generally of medium size ranging from 650 mm to 950 mm; whereas those landed by 'dol' net were of smaller size 250-350 mm size range.

The fishery and resource characteristics of Sharks (FB/PR/5.3)*

M.D.K. KUTHALINGAM, M.E. RAJAPANDIAN, P. DEVADOSS AND H. MOHAMMED KASIM.

The study on the fishery and resource characteristics of sharks at the major centres was carried out during the year under report.

An estimated catch of 722 t. of sharks were landed at Veraval by gillneters and trawlers. Of the total, the share of gillnets was 362 t. and that of trawlers 360 t. The shark landings at this centre were generally high from January to May than in other months. The catch rates were also generally higher during the above periods ranging from 8.5 to 13.6 kg for the trawl and from 12.8 to 65.3 kg for the gill net.

The bulk of the gill net catch was contributed by *Scoliodon sorrakowah* (39.3%), *S. palasorrah* (25.8%) and *Carcharhinus melanoptera* (19.2%). In the trawl landings, *S. sorrakowah* (68.6%) and *S. palasorrah* (20.2%) were the predominant species.

The biology of the two most dominant species was studied. The recruitment ot young ones of *S. sorrackowah* into the fishery was observed at 30 cm during December. The size of the species in the commercial landings ranged from 25 to 65 cm with modal sizes at 30 cm and 45-50 cm; the latter forming the most dominant size. In *S. palasorrah* the recruitment was observed at a minimum size of 40 cm during December/January. The size of the species in the catches ranged from 40 to 90 cm with three dominant modes at 55, 65, and 75 cm.

The sex ratio of the samples of *S. sorrakowah* examined was in the order of 64F : 30 M. Most of the adult fish exa-

mined during January/March were in gravid stages IV–VI) and in spent (stage VII) condition. The species was feeding during the above period on squilla, cephalopods, Crabs and fish.

At Calicut the fishery for sharks during the year landed an estimated catch of 248 t. which is the highest over the previous three years and is two and half times that of 1979 catch. Drift nets, hooks and line and trawls were employed in the fishery. Highest catches and catch rates were recorded during March/ May and September/November periods. Among the gear Drift net obtained the maximum catch (86.6%) and catch rate (40.1kg). Like-wise the genus *Carcharhinus* formed majority in all the months of the year. At Elathur the same group contributed to a little over 90% in the catches being composed of *C. limbatus* (63.1‰), *C. melanoptera* (23.9%) and *C. sorrah* (5.9%).

Recruitment of young fish in large numbers was recorded during July to December/January period. Female fish in pregnant condition were recorded over an extended period. Mating takes place during monsoon months. Prawns are mostly preferred during all months and the other food items devoured are Crabs, Squilla, squids, soles and other bottom fishes.

The landings of sharks at Tuticorin during the year were generally better than that of previous year. The catches were mainly landed by drift nets and Hooks and line. As at other centres maximum catch and catch rate was obtained by the former. Among the sharks the predominant species were *Rhizoprionodon acutus* and *Loxodon macrorhinus*. The size of the former varied from 55 to 89 cm with dominant size at 78–79 cm and 84–85 cm and that of the latter from 76 to 89 cm with dominant sizes at 82–85 cm.

At Madras an estimated catch of about 250 t. of sharks were landed as compared with 41 t. during the previous year. The catch was obtained mainly by Trawlers, Gill nets and Hooks and Lines. While the highest catches were obtained by trawl, highest catch rate was recorded by gill net. In the landings, *S. sorrakowah* (83‰) and *S. palasorrah* (12.3%) were the predominant species.

The size of *S. sorrakowah* in the landings ranged from 37 to 59 cm with dominant sizes at 39–40 cm, 51–53 cm and 58–59 cm. The species *Eulamis melanoptera* and *S. palasorrah* with dominant sizes ranging from 27 to 31 cm and 29 to 46 cm respectively contributed to the major portion of the landings. The species *S. sorrakowah* was feeding moderately during the period and mainly on fish, prawn, *Acetes* and Cephalopods.

Resource characteristics of pomfrets (FB/PR/5.4)

M.H. DHULKHED, M. ZAFAR KHAN, V.M. DESHMUKH, M. KUMARAN, A.A. JAYAPRAKASH, MADAN MOHAN, G. GOPAKUMAR AND K.N. RAJAN.

Investigations on the resource characteristics of pomfrets were continued at centres Veraval, Bombay, Mangalore, Cochin, Vizhinjam and Puri. Fairly good amount of work was carried out at all these centres and that threw light on the pattern of their resources i.e., the commonest species being *P. chinensis* was observed in the catches at the former centre only. The estimated pomfret catch at Veraval, Bombay, Mangalore, Cochin, Vizhinjam and Puri amounted to 468, 583, 29, 103, 6 and 10 t. respectively the highest cpue being 196 kg at Bombay.

At Veraval, third quarter (53.1%) was the most productive, whereas at Bombay it was the first quarter (30.8%). However, at Cochin during the third quarter and at Mangalore, Vizhinjam and Puri in the last quarter better catches were recorded.

The entry of new recruits of *P. argenteus* measuring from 20 mm onwards were observed at Navabunder (Veraval) in January and March. Entry of yet another brood of this species was noted at the centre during September and October. At Versova (Bombay) young ones of white pomfret (50 mm onwards) were observed in the "dol" net catches from the middle of March. The dominant group 70 mm observed in March shifted to 120 mm by October registering a growth of 120 mm in seven months time. At Mangalore also, small-sized *P. argenteus* were observed in the trawl catches from February to April, which indicate as to the probable period of their spawning. At Mangalore small sized (40 mm onwards) *P. chinensis* were noted during March.

Juveniles of *Parastromateus niger* were observed in the trawl catches during February and April.

Length range and modal sizes for various species for different centres were studied which indicated a wide range of sizes and dominant modes during different months of the year.

At Vizhinjam, *P. argenteus* in stages III and VI were observed during September. At Pentakota (Puri) white pomfret in resting stage were observed in January and developing stages from February and September. The period from March to May witnessed this fish in gravid condition. With regard to the sex ratio at Puri the females dominated (66.7%) the catches during the first quarter whereas in the second quarter the proportion males and females was 15.9% and 85.0% which coincided with their breeding season. The stomachs of *P. argenteus* were rather empty. The stomach contents included salpa and hydromedusae.

Unit stocks of oil sardine, mackerel and Bombay duck (FB/PR/6.1)

M.K. GEORGE, ALEXANDER KURIEN AND S. MUTHUSWAMY.

Experiments were conducted mainly to find out a suitable gel medium and a standard electrophoretic procedure to detect and resolve some of the isozymes in oil sardine collected from Worli landing centre at Bombay. Initial studies showed that both starch and acrylamide gel are suitable to detect lactate dehydrogenase and esterase isozymes tested that is, devoid of LDH ospzyme polymorphism. Further experimental improvements in all respects may throw some light on the genetic patterns of various isozymes in oil sardine.

Evaluation of the distribution and abundance of spawners and young fish (FB/PR/7.1)

K.V. NARAYANA RAO, G. GOPAKUMAR, A.A. JAYAPRAKASH, P.T. MEENAKSHI SUNDARAM AND S. REUBEN.

The work under the project was continued during the year at Vizhinjam, Madras, Waltair and Cochin observation centres. During the year an estimated 21044 kg of young fish were landed which is about 1243 kg less than that of previous

year's. About 91.8% of the catch was landed by the boat seines with an average cpue of 1.02 kg and the rest (8.2%) was by shore seines with an average cpue of 1.14 kg. From the month-wise catch rates of various species it was observed that the young fish were abundant during November/December, February/April and July/August period.

Among the pelagic groups *Stolephorus, Sardinella, Rastrelliger, Chorinemus, Dussumieria, Decepterus, Trichiurus, Sphyraena* and mullets were the predominant elements contributing to 0.15, 0.69, 0.01, 0.12, 1.54, 26.58, 28.75, 0.99 and 0.57% of the landings by weight.

Compared to the previous year, this year's landings were lower by about 1243 kgs. Shore seines contributed only 8% of the total young fish landings this year compared to 33% during previous year. Similarly the contribution of *Sardinella* and *Sphyraena* this year was about 0.7% and 1% in contrast to last year when they contributed 16% and 8.7% respectively. *Stolephorus* also showed similar decrease in abundance. The landings of *Trichiurus* and *Decapterus* increased during this year (28.7% and 26.6% respectively when compared to previous year (4.2% and 1%).

During the year an estimated catch of 73.1 tonnes of young fish was recorded at Tengapatnam south of Vizhinjam. Boat seines and shore seines contributed to 57% and 43% of the landings. At this centre species like *Caranx* (11.8%), *Sphyraena* (7.7%) mackerel 5.4%), *Sardinella* (2.4%), *Stolephorus* (2.5%) and *Scomberomorus* (0.8%) contributed to the bulk of the pelagic component.

The size of the predominant species in the landings varied from 25 to 44 mm for *Stolephorus bataviensis*, 15–49 mm for *S. devisi*, 35 to 54 mm for mackerel 20 to 119 mm for *Sphyraena*, 15 to 75 mm for *Sardinella gibbosa*, 125 to 310 mm for *Trichiurus haumela*, 35 to 79 mm for *Decapterus* 80 to 99 mm for *Dussumieria* and 7 to 79 mm for Mullet.

During the year about 23% of mackerel, 76.5% of *Stolephorus devisi*, 19.1% of *S. bataviensis*, 34.1% of *S. indicus* and 83.8% of *S. buccaneeri* were in mature and spawning condition (IV–VII) stages among the adult fish samples.

At Madras mature fish of *Sardinella gibbosa* were commonly occurring during January–April period along with young fish measuring 100–115 mm. During July–September juveniles of this species occurred in lesser quantities. In November the size of the juveniles varied between 50 mm and 70 mm. Adult fish of *S. dayi* in advanced stages of maturity were recorded during January–April and in November. Young ones of this species of the size 60–80 mm were found to occur in stray number during July–September. Mature fish of *Stolephorus bataviensis* occurred in stray numbers in July and in good numbers during August–September; and that of *S. heterolobus* from January to September. Fish measuring 40–50 mm and 30 mm and above of these two species were common during January–March months. Mature and spent fish of *Thryssa* and *Trichurus lepturus* were common during July–September. Juveniles of mackerel measuring 90–115 mm and of *Scomberomorus* measuring 180–230 mm were recorded during August–September and June respectively.

At Lawsons Bay (Waltair) an estimated catch of 47211 kg of young fish was landed by the non-selective gear like shore seiners and boat seines. Of the total, shore seines contributed to 67.7% and the rest by the boat seines. The peak abundance of the young fish at this centre was during February–March and during October–December months. The maximum catches and the catch rates by both the gear also coincide with the above two periods. The highest catch rate (57.8 kg) by the shore-seine and (42.8 kg) by the boat seine, however, was recorded during March and October respectively.

Among the pelagic groups *Rastrelliger kanagurta, Stolephorus bataviensis, S. hetatolobus, Sardinella fimbriata, S. gibbosa, Megalaspis cordyla, Decepterus dayi, Trichiurus* and *Dussumieria acuta* were the predominant elements contributing to 27.1, 20.1, 12·9, 2.6, 8.0, 0.3, 16.7, 2.9 and 6.1% respectively of the landings by weight. Among these, *R. kanagurta, S. fimbriata, S. bataviensis, S. heterolobus, Caranx, malabaricus, D. davi Dussumieria acuta* and *Trichiurus* with dominant size groups at 85–100, 45–75, 35–45, 45–55, 40–55, 65–70, 90–110 and 210–240 mm respectively contributed to the landings.

At Cochin young fish were recorded mainly in shrimp trawlers. During the year as estimated catch of 42.1 tonnes

was landed by the trawl amounting to same magnitude as in the previous year (42.2 t.) Maximum catch rates were recorded in March and July. Among the pelagic species *Pampus argenteus* (3.04%), *Pampus chinensis* (0.26%), *Lactarius* (26.29%) and *Caranx kalla* (21.87%) were the main contributors. *Pampus argenteus* with the size ranging from 40 to 110 mm, *Caranx kalla* from 70 to 130 mm *L. lactarius* from 60 to 130 mm, *S. heterolobus* and *S. bataviensis* from 40–45 mm contributed to the young fish landings. Mature fishes of *Stolephorus spp.* were observed during March, April May and June. Mature specimens of black pomfrets (*P. niger*) were observed during June and July.

Survey and evaluation of the pelagic fish resources of the Tamil Nadu and Andhra Coast (FB/PR/8.1)*

M.D.K. KUTHALINGAM, K. RADHAKRISHNA, S. REUBEN AND S. SRINIVASARANGAN.

Due to unanticipated delays in the supply of the R/V CADALMIN both at Madras and Waltair bases, no resources survey work could be done. The vessel to Madras centre was commissioned in middle of October 1980 and the other to Waltair centre is yet to be supplied. The vessel based at Madras conducted 28 hrs. of bottom trawling and obtained a total catch of 719 kg of fish. Silver bellies, sciaenids, sea bream and ribbon fish were the major component in the catch.

The Project was discontinued.

Addendum Division: **FISHERY BIOLOGY—Pelagic Fisheries**

Fishery and resource characteristics of mackerel (FB/PR/2.1)

Karwar

At Karwar, a steep fall in Rampan and rise in purse seine operations were noticed in 1980 as compared to the previous year. Mackerel catches of both the gears declined considerably in the current year. As against 2631 tonnes of mackerel landed in 1979, current year's total production was 707 tonnes. The particulars of catch, effort and cpue of different gears during 1979 and 1980 are as under:

Purse seine	Catch (kg)	Effort (nos.)		c.p.u.e.	(kg)
		Units	Hauls	/unit	/haul
1979	1534593	1506	2979	1018.99	515.14
1980	525866	2543	4881	206.78	107.73
Rampan:	Catch (kg)		Effort (nos.)		c.p.u.e. (kg)
1979	1095537		197		5561.10
1980	178957		70		2565.28
Yendi:					
1979	146		1075		0.14
1980	1839		1207		1.52
Beesubale:					
1979	150		22		6.82
1980	No landings		—		—
Pattebale:					
1979	176		82		2.15
1980	No landings		—		—

Resources of seer fishes (FB/PR/3.3)*

M.V. PAI, C. MUTHIAH, T.M. YOHANNAN, A. NOBLE, P. P. PILLAI, P.N. RADHAKRISHNAN NAIR, GRACY MATHEW AND K. RADHAKRISHNA.

Investigations on the resources of seer fishes were continued at Karwar, Mangalore, Calicut and Tuticorin and initiated at Cochin, Vizhinjam and Waltair during the year.

At Karwar 131 tonnes of seer fishes landed by bottom set gill nets and at Gobitwada 85 tonnes by drift nets. *Scomberomorus commerson* dominated the catches at the latter centre and *S. lineolatus* at the former with 425–975 and 425–525 mm modal size groups during the year. At Karwar the spotted seer *S. guttatus* (modal size 425–625mm) formed 35.8% of the catch.

At Mangalore, out of an estimated catch of 928 t. drift nets operated by indigenous craft accounted for 619 t. *S. commerson* (68.8%) in modal lengths 410–450 & 901–950 mm mainly supported the fishery. The dominant size groups in the case of spotted seer were 301–330 & 481–510 mm.

At Calicut drift nets mainly accounted for the landings of seer fishes with an estimated catch of 119 tonnes. *S. commerson*

dominated the landings (91.9%) with annual modes at 670 & 870 mm. Peak catches were in January.

At the fishing harbour, Cochin drift gill nets landed 258 tonnes of seer fishes. Small quantities were also landed by purse seines and trawlers. Here also the king seer dominated the catches. Maximum catches were recorded in November. Stray catches of *Acanthocybium solandri* were also observed. King seer had modal size groups 500-540 to 700-740 mm and spotted seer, 400-440 mm. In the purse seines the size of king seer ranged from 550-740 mm. In the trawl catches the sizes were usually less than 300 mm.

At Vizhinjam the landings were estimated as 112 t. Here also the drift nets accounted for the bulk of the catches with peak landings during November.

At Tuticorin 161 t. of seer fishes landed upto September 1980. Hook and lines and drift nets accounted for the major share of the catch. *S. commerson* dominating the fishery had modal sizes 500-550 to 950-1000 and *S. guttatus* 550-600 to 850-900 mm.

At Waltair out of an estimated total catch of 77 t. hook and lines accounted for 73 t. where *S. guttatus* had a higher percentage composition. April was the peak period of landings. The spotted seer dominated the catches from EFP vessels also.

B. DEMERSAL FISHERIES

1. The fishery and resource characteristics of cat fishes (FB/DR/1.1.1)*

B. KRISHNAMOORTHI, E. VIVEKANANDAN, V.N. BANDE, N. GOPINATHA MENON, M.K. GEORGE AND H. MOHAMED KASIM.

At Waltair: A total of 43 tonnes of cat fish was landed by the five Govt. of India vessels operating off Andhra–Orissa coasts, *Tachysurus thalassinus* (38 tonnes) and *T. tenuispinis* (5 tonnes) being the main constituents. From the inshore regions an estimated yield of 17 tonnes was realised, hooks and line yielding 16 tonnes and bottom set gill nets 1 tonne. While *T. thalassinus* was the main catch of hooks-and-line, the gill nets caught mainly *T. tenuispinis*. Biological observations on the

two species showed a size-range of 100-559 mm in *T. thalassinus* with 3 modes at 710, 370 and 470 mm. Fish of 120-240 mm were immature, 360-450 mm. mature. Feeding intensity was greatest in February/March and October/November. Gravid (stages V and VI) and spent (VII) specimens were obtained from March to August for *T. tenuispinis* the size-range was 170-419 mm, with modes at 230 and 350 mm. Fishes of 180-280 mm, which were immature, were dominant. September to November marked the period of intensive feeding. Gravid and spent specimens were obtained in October/November.

At Madras: An estimated catch of 18 tonnes was landed by trawlers at Kasimode/Pudu manikuppam centres. Indigenous gear brought no landings at Triplicans, and only 2 kg at Nochikuppam. *T. thalassinus* was the major contituent, forming 55%. The size-range was 125-326 mm in trawler catches, 253-455 mm in gill-nets. Gonads at V, VI stages were observed in May. Feeding was maximum in January and July.

At Cochin: The fishery was constituted by *T. dussumieri, T. tensuispinis, T, thalassinus* and *T. serratus* in that order of abundance. While *T. dussumieri* and *T. serratus* were landed by drift-nets only and *T. tenuispinis* by trawls only, *T. thalassinus* was caught by both gears. Because of several constraints in obtaining cat fish for examination, biological observation could not be carried out satisfactorily.

At Calicut: The estimated catch was 924 tonnes at a catch rate of 50 kg/unit, which was a considerable improvement over the previous year's 632 tonnes and 46 kg/unit. The hooks and line contributed most to the fishery (479 tonnes, 168 kg/unit) the drift nets being next important (168 tonnes, 56 kg/u.) The trawl yielded 175 tonnes at 20.3 kg/u. *T. dussumieri* was the dominant species in drift nets while *T. tenusipinis* was dominant in both hooks and line and trawl. *T. dussumieri* ranged in size 32-82 cm in drift net catches and 44-84 cm in hooks and line, while *T. tenuspinis* ranged 28-56 cm in drift nets and 30-46 cm in hooks and line. Specimens in maturity stage VI and VII were obtained in July-November.

At Bombay: The estimated catch was 3039 tonnes from landings at Sassoon Docks, Ferry Wharf and Versova. January-

April formed the period of peak abundance. The best fishing grounds were 17–72–E2 and 17–72/D5, off Ratnagiri, where the EFP trawlers obtained catch rates of 2088 kg/u and 732 kg/u respectively. *T. sona T. thalassinus* and *T. maculatus* were the chief contributors, and came in size-ranges of 52–85 cm, 24–42, 5 cm and 30–46.5 cm respectively.

At Veraval: With estimated catches of 156 tonnes by gill-nets and 422 tonnes by trawls, the total catch was 578 tonnes. While trawler catches were uniformly good, gill net catches were better in April and October. *T. dussumieri,* constituting 56% of the catches, dominated among the 6 species landed, and had a size-range 15–35 cm in trawler catches and 35–75 cm in gill-net catches. *T. tenuispinis* was similar to *T. dussumieri.* The size range of *O. militaris* both in gill nets and trawls, was 15–45 cm *T. dussumieri* fed mainly on *Squilla.*

2. Resource characteristics of perches (FB/DR/1.1.2)*

GRACY MATHEW, K.S. SUNDARAM, P.A. THOMAS, MADAN MOHAN, P. SAM BENNET, K.M.S. AMEER HAMSA, N. GOPALAKRISHNA PILLAI.

*At Bombay:*An estimated catch of 251 tonnes of perches was landed. Though this showed an overall increase, compared to previous year, there was a declining trend of perch landings at Mazagoon jetty. At Sassoon Docks the landings were greater this year (138 tonnes as against 27 t of last year's) mainly due to bumper landings of species of *Epinephelus, Pomadasys, Apogon* and *Priacanthus,* which did not land last year. Biological observations on *Epinephelus tauvina* showed a progressive shifting of mode and the entry of the next year-class into the fishery from March to December in the samples from Sassoon Docks.

At Vizhinjam: 318 tonnes of perches were estimated to have been landed, which is a notable increase compared with last year's. Nemipterids formed the bulk (73%), other groups being lethrinids (8%) theraponids (6%) lutjanids (4%) and Epinephelus (3%). Hooks and line were the major gear contributing 273 tonnes (86%) of the perch catch. Other gears used were boat seines, konchu vala, shore seines. There was fishing for perches throughout the year. Biological studies were made

on a few dominant specie viz. *Nemipterus bleekeri, N. delagoeaei, N. tolu* and *N mesoprion.*

At Tuticorin: A total of 424 tonnes of perches was estimated to have been caught; about 8% of fish landed here. The maximum landings were in July–September and the minimum in January–March. *Lethrinus nebulosus* constituted the maximum of 189 tonnes (45%) followed by serranids 95 tonnes (22%), *Diagramma* 52 tonnes (12%) *Nemipterids* 34 tonnes (8%) and *lutijanids* 34 tonnes (8%). Hooks and line were the major gear used, bringing in 57% of the perch catches, while driftnets caught 30%. Only length measurement were possible in the field as the fish were directly auctioned and disposed of immediately after landing. With the consequent difficulty in getting adequate samples of the large-sized commercially important species. *Lutjanus liniolatus* had a size-range of 45–225 mm.

At Mandapam: It was a comparatively poor year for perches, as only about 19 tonnes were landed at Kilakkarai. Perch-traps and drift-net brought in about 11 tonnes. *Lethrinus nubulosus* dominated the catches. Traps also caught *Siganus, Lutjanus* and *Scarus spp. L; nebulosus* had a size-range of 110–260 mm with a mode at 230 mm in the drift net samples; and 80–345 mm in the trap specimens with two modes at 110 mm and 120 mm. *Lutjanus fulvifiama* from traps ranged 85–200 mm with a mode at 120 mm. The food consisted mostly of partially digested young crabs, prawns, fishes and bivalves.

3. Resource characteristics of threadfin-breams (FB/DR/1.1.3)*

V. SRIRAMACHANDRA MURTHY, T. APPA RAO, D.B. JAMES, M.K. GEORGE, A.A. JAYAPRAKASH AND K.V.SOMASEKHARAN NAIR.

At Waltair: An estimated 1360 tonnes were landed with catch rates of 3.9 kg/h for EFP trawlers and 5.7 kg/h for commercial trawlers. *N. japonicus* and *N. mesoprion* made up over 99% of the catch. *N. japonicus* had a size range of 75–235 mm (an 85 mm mode appeared in May) Gravid fish were obtained in October–December and mature adults in April–May and August–November.

At Kakinada: an estimated 584 tonnes were landed by commercial trawlers (forming 6% of total trawler catches). Which

showed a 115% increase over previous year's catches. The increase was mainly due to a remarkable fivefold increase in catches of *N. mesoprion*. Also, *N. delagoae* occurred for the first time here. Biological studies on *N. japonicus* showed a size-range of 55–295 mm. Males out-numbered females in all months except November–December. Gravid fish occurred during January March and August–December, with peak in November–January.

At Madras: An estimated 224 tonnes were landed by commercial trawlers. In *N. japonicus* the size-range was 85–225 mm. Males were dominant in almost all months. Gravid adults occurred in July–August and February and spent ones in February March, while mature adults occurred during February. March and July–December.

At Bombay: An estimated 1768 tonnes were landed, about 8% of total catch. Regular fishery for these fishes was there only at Sassoon Docks centre. *N. japonicus* showed a length range of 130–299 mm.

At Cochin: The fishery was constituted by the single species *N. japonicus*. The estimated catch by trawlers operating from fisheries Harbour was 910 tonnes, at 19.7 kg/h; as against 2748 tonnes and 62.7 kg/h during previous year. The highest catches were in July—September. The size-range was 55—285 mm. Females outnumbered males except in July–October, when males dominated. Females at Stage VI were observed in September–October. The food consisted of small prawns, *squilla* and small fishes.

At Calicut: The estimated landing at Vellayil centre was 145 tonnes, the entire landings coming in the first half-year. The fishery was constituted by *N. japonicus*. The size-range was 60-215 females outnumbered males in February–March. In April samples were exclusively of males. No gravid or spent individuals were obtained, the fishes caught being at resting II or developing stages. Feeding was poor except in March, the food items were mainly echiuroids, taleosts, prawns, amphipods and detritus.

4. Sciaenid resources of the east and west coast of India (FB/DR/1.2)*

T. THOLASILINGAM, E. VIVEKANANDAN, V. SRIRAMACHANDRA MURTHY, S.K. CHAIRABORTHY, K.V. SOMASEIHARAN NAIR AND T. APPA RAO.

At Waltair: The five EFP trawlers caught 9.9. tonnes of sciaenids, which is about 50% more than last year's catch. The private trawlers landed 926 tonnes. Maximum sciaenid catches were in July–September. *Johnius carutta* in the length range of 70–195 mm., *Pennahia macropthalmus* and *Kathala axillaris* in the length range of 60–145 mm formed the main catch.

At Kakinada: An estimated 1193 tonnes of sciaenids were landed by private trawlers, forming 12% of the total trawl catch. Peak catches were during January–March, August–September and December. When compared to previous year, the catch this year showed an increase of 71%, with a decline in the effort. Of the 16 species recorded *J. carutta, J. vlogleri* and *J. dussumieri* formed the main catch. Biological observation on *J. carutta* showed a size-range of 85–225 mm fishes of 120–179 mm dominating. Gravid specimens were obtained in January–April and July–August. The majority of specimens examined had everted or empty stomachs. The main food items were fishes, prawns, small crabs and stomatopods.

At Madras: The EFP trawlers caught 14 tonnes of sciaenids, which was 18% of total trawl catch, the second largest catch (after silver bellies). Private trawlers landed 99 tonnes, about 5% of total trawl catch. Peak sciaenid catch was in January–March. Of the 13 species recorded *Otolithus argenteus J. carutta, K. axillaris* and *J. aneus* made up the major part subject observations on *J. aneus* showed a size-range of 96–225, the size 155–164 and 185–194 mm dominating. Gravid specimens were prawns, fish and crab.

At Calicut: The estimated sciaenid catch from trawler landings was 348 tonnes, which was 50% more than last year's. Maximum catch was in January. Of the 11 species recorded, *Johnius sina, O. ruber* and *O. cuvieri* made up the main catches. Biological studies were made on *J. sina* and *O. ruber. J.* sina had

a length range of 50–194 mm, 115–154 dominating. Gravid females were available in almost all months. Most of the stomach were found empty. The dominant food items observed were fishes, prawns and *echiuroids*. In *O. ruber* the legnth range was 40–304 mm, with 100–109 size dominating. The fishery was almost exclusively of fish of indeterminate stage of maturity, though spent individuals were obtained in May. The items of food were mainly prawns and teleosts.

At Bombay: The estimated landings were 2788 tonnes at New Ferry Wharf (which was 39% higher than lastyear's catch) and 2575 tonnes at Sassoon docks 28% higher). The fishery was better in October–December and January–March *J. vogleri* was the dominant species, followed by *J. macrorhyuus* and *O. cuvieri*. *J. vogleri* had a size-range of 115–309 mm with a dominant range of 180-234 mm. and mature specimens were obtained throughout the year. *J. macrorhymcus* had a range of 95–299 mm with 190–194 mm dominating and mature and spent fish were observed in all months. For *O. cuvieri* the length ranges were 110–359 mm, with 180-229 mm dominating.

5. Fishery and resource characteristics of silver-bellies (FB/DR/1.3)*

J.C. GNANAMUTHU, N. GOPALAIRISHNA PILLAI, V. SRIRAMACHANDRA MURTHY AND M. BADRUDEEN.

At Mandapam Camp: The total catch of silver-bellies at Mandapam, Rameswaram and Pamban has been estimated as 11637 tonnes. This showed a decline as compared with last year's landings, possibly due to the reduced fishing effort expended this year. *Leiognathus jonesi* was the dominant species at Mandapam and Rameswaram The species had a size-range of 25–115 mm, the major size groups being 45–75 and 80–95 mm at Mandapam and 40–55, 60–75 and 80–85 at Rameswaram. Though mature fish were observed almost all through the year, the main spawning period was January–May. Females outnumbered the males. In Pamban *L. dussumieri* was the dominant species in the size range of 65–146 mm the bulk being in groups of 80–95 and 100–125 mm. Females were more abundant here also, and mature fish were available in good-numbers from February to July.

At Kakinada: An estimated 569 tonnes were landed by the trawlers (nearly 6% of the trawler landings) peak catch and rate were obtained in February–March and September–October. *L. bindus* and *S. insidiator* were most abundant, these two species together making up about 76% of the silver-bellies catch. *L. bindus* had a range of 22–122 mm, the bulk of the catch being in 32–92 mm. Smaller juveniles at 27 mm occurred in February and July. While mature fish were available in May, July, September and January–March, gravid females occurred July, August and January. Peak feeding was in January–March and June–August. *S. insidiator* (in the sizer range of 47–117 mm) was abundant in 67–97 mm size. From the availability of gravid females the spawning period of the species appears to be September–March. Peak feeding was in January–March, as also October–November.

At Madras: The estimated catch of 214 tonnes (at the rate of 14.6 kg/h from the trawler landing was an improvement over the previous year's figures. This formed nearly 11% of the landing by mechanised boats. The highest catches came in October–December. *L. bindus* and *S. insidiator* were the dominant species, contributing over 50% of the catches. *L. bindus* had a range of 20–125 mm though the bulk of the commercial catch was in 60–100 mm. Mature fish occurred in all months, but they formed a high percentage in February, April, May. The peak spawning appeared to be in February–May.

6. Evaluation of the demersal resources at selected centre (FB/DR/1.4)*

C. MUKUNDAN, S.K. CHAKRABORTHY, M.K. GEORGE, M.M. MEIYYAPPAN, A.A. JAYAPRAKASH, P. SAM BENNET, GRACY MATHEW, K.M.S. AMEER HAMSA, N. GOPALAKRISHNA PILLAI, P.T. MEENAKSHI SUNDARAM, E. VIVEKANANDAN, Y. APPANNA SASTRY AND K. RADHAKRISHNA.

At Bombay: Of the 3 EFP vessels that operated from this centre *Meena Sangrahak* fished from January to April and again in December. *Matsya varshani* during March, May, June, August, September, October and December and *Meena Bharati* in January–March, May and October–December. The areas fished were 13–74, 16–72, 18–70, 18–71, 18–72, 19–70, 19–71, 20–68,

20–70, 21–68 and 21–69 at depths 24–136 m, and an estimated total of 163 tonnes was landed. The highest catch was by *Meena Bharati* in 16–73/4B, landing 1600 kg of catfish at a rate of 640 kg/h. Other rich areas were 16–72/6E (cph. 403.6) and 16–72/2F (cph. 109) catfish was the dominant part of the catch followed by "Miscellaneous" and sciaenids. In addition to bottom trawling *Matsya Varshani* also operated purse seine and mid-water trawl. The latter, in areas 20–69 and 21–68 and 38–55 m depth brought catches of 1303 kg of ribbon fish and 151 kg *Nemipterus* in 27 hours.

At Cochin: Data from the EFP and IFP vessels available during the year, viz; those of (a) last quarter of last year and (b & c) the first 2 quarters of this year and (d) part of the 3rd quarter were analysed, as also the landing data, for the year, of the private fishing boats operating from this base. The details are given below:

EFP Vessels	(a)	20–90	166.34	22,330	134–24
	(b)	14–150	360.15	33,796	93–84
	(c)	10–48	279.98	27,798	92–28
	(d)	12–40	106.50	2,017	18–94
IFP Vessels					
Trawling	(a)	16–60	299.86	60,104	200–44
	(b)	21–52	547.30	132,480	242–06
	(c)	26–49	158.07	50,187	317–50
	(d)	14–58	149.84	18,274	121–96

The catches were mainly of elasmobranchs, catfishes Nemipterus, perches and carangids.

In addition IFP vessels also operated traps at depths 80–93 m in areas 9–75, 9–76, 10–75, 10–76, 11–75 and 12–74 to catch 4710 kg of perches.

The landings at the Cochin Fishing Harbour by privately owned mechanised trawlers gave the following:

I Quarter	122,864	3232,913	26.31
II Quarter	92,615	2869,415	30.98
III Quarter	19,164	1062,885	55.46
IV Quarter	32,039	752,186	23.47
	266,682	7917,399	29.68

The major components were, in order of abundance, prawns, *Nemipterus*, sciaenids, catfishes, flatfishes, *Saurida* and carangids.

At Tuticorin: Of the 3 EFP vessels Jheenga fished off Tuticorin only during first half year, Square 8–78 was the area fished and only the 24 m trawl was used. The catch and effort figures are:

Meena Saudagar	494	44,109	98.82
Meena Niryantak	543	47,004	36.56
Jheenga	248	13,726	55.35

Perches, rays, perchlets and carangids made up the greater part of the landings. The highest catch rate was by Meena Saudagar in 8.78/4C in July, viz. 269 kg/h.

At Mandapam Camp: Exploratory fishing by cadalmin II in Gulf of Mannar and Palk Bay brought in a total catch of 19,416 kg at the rate of 52.12 kg/hr. of which the catch from Palk Bay was 11,820 in 208 hours at the rate of 56.83 and from Gulf of Mannar 7.596 kg in 164.5 hours at 46.18 kg/h. The bulk of the catch was of silver-bellies (81.75%) and miscellaneous (17.84%).

At Madras: The two EFP vessels Meena Gaveshak and Meena Stara fished in areas 12–80/5c, 6c; 13–80/4B, 1c, 2c, 3c, 4c, 5c and 14–80/1A, 1B, 2B, 3B, 4B, 3c, 4c, 5c, and landed a total of 77,247 kg in 1105 hours at the rate of 69.94 kg/h. The best catch rate of 354 kg/h was obtained from 14–80/1B in February and the lowest 2.40 kg/h from 13–80/2c in March. The catches consisted of silver-bellies, Gerrids, sciaenids and nemipterids. In addition to the analysis of catch data, biological observations of *Leiognathus bindus, Otolithoides argenteus Tachysurus thalassinus, Nemipterus japonicus* and *N. tolu* and *Saurida tumbil* were also carried out.

At Kakinada: The three types of trawlers gave an estimated total catch of 9910.6 tonnes (including 2579.8 of prawns) in 324,628 hours, the catch rate working out to 30.5 kg/h. This marked an increase of 557 tonnes in catch compared to last year's

figures.

Pablos	44,746	1263,115	28.2
Pomfrets & Royyas	248,298	7640,113	30.6
Sorrah	30,584	1007,445	32.9
	324,628	9910,673	30.52

Peak catches were obtained in February–March and August December. Prawns ranked first in abundance (26%) followed by sciaenids (12%) and ribbonfish (9%).

At Waltair: Five EFP vessels, operating from this base, landed 289 tonnes of fish with an effort of 1699.5 hours giving a catch rate of 169.93 kg/h. Matsya darsani and shikari undertook 15–20 day cruises in deeper waters 30–180 (and one at 612 m); others fished at 20–60 m.

Matzya Shikari	621.27	151,816	244.36
" darshani	397.75	100,462	252.57
Meena shodhak	255.52	12,134	47.48
" Jawahar	149.58	3,718	24,85
Meena Pradata	276.01	20,668	74.88
	1699.5	288.798	169.93

Private fishing boats during this period caught 8181,801 kg in 237,696 hours, giving a catch rate of 34.42 kg/h "Miscellaneous fish" formed the larger part of the trawler landings. Of the rest catfish, sharks and rays were the more important items.

7). Resources characteristics of rays and skates (FB/DR/1.6)*

M.D.K. KUTHALINGAM, S.G. VINCENT, P. DEVADOSS AND S. SRINIVASARENGAN.

At Vizhinjam: Estimated totals of 40 tonnes of rays and 860 kg of skates were landed. The maximum catches of rays were in January. The main species were *Gymnura poecilura, G. macrura, Himantura, bleekeri, Amphotistus kuhlii A. imbricatus, Dasyatis sephen* and *Aetobatus narinari.* Driftnets landed the maximum catch (over 20 tonnes), followed by boat-seines (7 tonnes), Konchuvala (1 tonne) and hooks and line (5 tonnes).

At Calicut: An estimated total of 10 tonnes of rays and skates was landed at Calicut by mechanized boats, drift, nets and hooks and lines. There was a reduction in the catches, as compared with last year's. Machanised boats operated for only about five months and contributed over 88% of the total catch. *Dasyatis spp. Aetobatus narinari, Rhinoptera javanica* and *Rhyncobatus djiddensis* were the main species caught. *Dasyatis* spp. formed over 63% of the landings.

At Madras: An estimated 180 tonnes of rays were caught at Pudumanaikuppam/Kasimode landing centre by trawl and *Amphotistus imbricatus* was the dominant species. Skates formed a catch of 19 tonnes, mainly spp. of *Rhyncobatus*. Other gears at this centre brought 54 tonnes of rays by gill net, 428 kg of rays and 155 kg of skates by hooks and line, and 9 tonnes of rays by edavalai. At Nochikuppam, irukka valai operated by non-mechanized vessels caught over 1 tonne of rays. At Triplicane aravalai from non-mechanized craft caught 141 kg of rays, and thoorivalai caught 47 kg. Biological studies were carried out on *Amphotistus imbricatus* and *Rhyncobatus djiddensis*. The former had a size range of 170-299 mm and was found to feed on fish, *Acetes* crab and prawns. The latter had a length range of 200-750 mm; females were more abundant. The food items in the stomach were fish and prawns.

8. Fishery and resources characteristics of lizard fishes (RB/DF 1.7)*

S.V. Bapat, D.B. James, K.M.S. Ameer Hamsa, P.N. Radhakrishnan Nair, P.A. Thomas, V.N. Bande and N. Gopinatha Menon.

At Kakinada: 213 tonnes of lizard fishes were landed by trawlers at the rate of 0.66 kg/hr. Though this rate was better than last year's, the total catch was less by nearly 19 tonnes. The main species were *Saurida tumbil* (in the size range of 148-350 mm) and *S. undosquamis* (in the range ot 140-295 mm).

At Madras: 225 tonnes were landed by trawlers at 17.15 kg/h. The maximum catch of 40 tonnes was in June, the maximum rate of 38.71 kg/h was in August. *S. undosquamis* had a range of 80-360 mm. Partially spent females was found in

higher percentages in January-March. Sexes were equally distributed. Feeding was low, 69–88% of stomachs were empty. *Stolephorus* was the main food item.

At Mandapam Camp: 125 tonnes of lizard fish were landed, over 123 being at Rameswaram centre. The maximum catch of 26 tonnes was in December, at 3.3 kg/h. *S. tumbil* had a size range of 105–370 mm with mode at 248 mm. Sardines, anchovies, silver bellies and gobiids were the main food items.

At Vizhinjam: A total of 28 tonnes was landed, comprising *S. tumbil, S. undosquanis S. myops* and small quantities of *Saurus variegatus* and *Synodus indicus.* The bulk of the catches was by hooks and line (79%) The size range were 130–340 mm. for *S. tumbil,* 50–329 for *S. undosquamus,* 100–249 m for *Saurus myops.* Maturing and mature specimens of all other species were observed in August–September.

At Cochin: A drastic decline in catch was observed due to suspension of trawling operations in October–December, as most trawlers were working as carrier boats for purse–seiners. The lizard fish catch amounted only to 200 tonnes (as against 417 last year). The maximum catch of 74 tonnes at the rate of 40.88 kg/h was in August. *S. tumbil* in the range of 120–400 mm and *S. undosquamis* in 90–250 mm formed to fishery. Spent and resting *S. tumbil* were observed in May and April, *S. undosqunmis* in stage III–IV in November. Feeding activity was moderate, nearly 50% of stomach being found empty. *Stolephorus* was the main food item, others being prawns, silver–bellies, *Tripauchen,* soles and squids.

At Calicut: A total of 10 tonnes of *S. tumbil* was landed by trawlers at the rate of 1.16/h. This was an improvement over last year's 6 tonnes of this over 8 tonnes was landed in February at the rate of 4.7 kg/h. The size range was 80–335 mm. Mature and spent fish were observed in October–December.

9. Culture of marine fishes (FB/CUL/1.1.1)

P.S.B.R. JAMES, A. RAJU, R. SOUNDARA RAJAN, D. KANDASWAMY, V.S. RENGASWAMY, R. MARICHAMY, S. SHANMUGHAM, R.S. LAL MOHAN AND M.H. DHULKHED.

At Mandapam: Culture of fin-fishes in ponds as well as net enclosures in coastal waters was carried out, as also studies on the availability and abundance of *Sillago* fry and fingerlings.

In pond culture, polyculture experiments were carried out with mullets (*L. macrolepis, V. seheli*) milkfish (*Chanos chanos*) and prawns (*P. indicus*). At harvest time, after 14 months growth, these had shown monthly growth rates of 10.7 mm (6.4 g), 13.6 mm (8.6 g), 20.1 mm (15.6 g) and 10.5 mm (2.3 g) respectively, with survival rates of 69.7%, 26%, 13.8% and 14.3% in that order. Experiments with *V. seheli, Chanos chanos* and *Sillago sihama* showed, after a 12-month period, monthly growth rates of 10.2 mm (4.3 g), 17.3 mm (0.5 g) and 9.2 mm (2.0g), and survival rates of 64.4%, 67.7%, and 6.7%. Experiments with fertilised and unfertilised ponds for rearing *Chanos* and *V. seheli* showed monthly growth rates, for *chanos*, of 31.5 mm (10.8 g) in unfertilised and 27.7 mm (12.4 g) in fertilised ponds, and for mullets a growth rate of 24.4 mm (6.8 g) in unfertilised and 14.2 mm (3.2g) in fertilised. The stocks in both the ponds were fed with rice bran and groundnut oil cake in equal proportion at the rate of 5% of the body weight of fish.

In Net Impoundment experiments, net enclosures of 10x 10x3m, in coastal Palk Bay were stocked with *V. sehili Chanos*, and *Sillago* at the rate of 140, 300 and 60/100 s.m. The experiments could not be continued after October because of damage by cyclonic storm. The growth recorded till then gave the monthly rates as 26.9 mm (10.5 g) for mullets, 22.7 mm (10.3 g) for *Chanos* and 16.8 mm 8.1 g) for *Sillago*.

Studies on availability and distribution of *Sillago* fry revealed that the fry occurred throughout the year except in February in the inshore Palk Bay at Pullamodom, but its abundance varied. The peak abundance was in March-May and a secondary season in September-October. The majority size groups were 16 mm and 45 mm. Thus *Sillago* is a continuous breeder with 2 peak breeding seasons in a year. Considered in relation to the phases of the moon, the abundance of fry varied, with an average 46/haul in the New Moon phase, 11/haul during the first quarter, 42/haul in the Full Moon phase and 42/haul in the last quarter. Generally the fry was found to be more abundant in day time collections than in the night.

Feeding experiments were also conducted, using 4 types of artificial feed prepared with locally available cheap materials, such as ground nut oil cake, rice bran, fish meal, silver belly powder, tapioca powder, multi-vitamin tablet yeast tablets etc., with the alga *Bhizoclonium* sp. as control. The conversion ratios and survival rates of the fry of chanos and mullets of different size groups and at different density levels were also studied.

At Tuticorin: Polyculture and monoculture experiments were conducted on marine fishes in four coastal aquaculture ponds, developed in the swampy intertidal zone at Tuticorin. Stocked at size 35–50 mm and density 3350 for mullets and 25 mm and 8700 for chanos, the fishes gave a production figure of 802 kg/ha/year. The mullets showed a monthly growth rate of 14.2 mm (9.9g) and milk fish 24 mm (22.9g). The mullets showed a better survival rate. In mono culture experiments *L. macrolepis* stocked at 20 mm size, showed, during a 10 month period, a monthly growth rate of 21 mm (9.4g) and chanos stocked at 16 mm showed, during an 8 months period, a monthly growth rate of 34 mm (27 g). In general, it can be inferred that growth and survival period was better in mono culture system than in poly culture.

At Calicut: Culture of fishes and prawns in Polythene-lined ponds gave good results. They were reared to commercial size and two harvests could be had in one year. In a 6.1 ha pond, *P. indicus* gave a production rate of 1600 kg/ha in 105 days, gaining a length of 109 mm and weight of 8.3 g. Also fishes like *Chanos, E troplus, Mugil* and *Megalops* were cultured along with prawns. In one instance *Etroplus suratensis* spawned after one year of stocking and the juveniles were reared.

At Mangalore: Experiments in culture of fish in pens lined with velon netting were started at Mulky where two such farms were got ready, measuring 400 and 800 sq.m. However, due to interruptions by heavy rain floods, the experiments could not be maintained and completed.

10. Breeding, seed production and culture of grey mullets (FB/CUL/1.1.3)

P.S.B.R. JAMES, G. MOHAN RAJ, A. RAJU, V.S. RENGASWAMY AND L. KRISHNAN.

At Mandapam Camp: Breeders were collected from the landings of veechuvalai (cast net) seria valai (gillnet) and Kalambatti valai (stake net) at Pamban, Manoli Island, Krusadai Islands, Theedai and Pullaimadam and from the special bag-net, viduvalai at Thonithurai. Apart from this, regular seed collections were also made from lagoons, creeks, tidal pools and coastal waters.

Monoculture experiments were carried out in pond stocked with seeds of *Liza vaigiensis* at 58 mm length and 3.3 g weight. After a 12-months period they were harvested. The monthly average growth increase was 3.5 mm and 1.02 g. The total yield was 568.5 kg/ha with survival rate of 72.9% with *Ralamugil seheli* stocked at density of 700/225 sq.m. the monthly average increase was 11.9 mm and 2.9 g, In another experiment with *V. sehili* at a reduced stocking density of 500/225 sq.m. This gave a monthly growth rate of 12.5 mm and 3.3 g. In both cases they were fed with rice bran and ground-nut oil cake in equal proportions at the rate of 5% of body weight of fish.

Experiments on the induced breeding of mullets were carried out on *L. macrolepis, M. cephalus* and *V. seheli* by infra-muscular injections of pituitary extract of cat-fish and carp, as also of follicle stimulating Hormone (FSH). The experiments, however, were not successful.

At Narakkal: Pituitary extracts were collected from the available species like *M. cephalus, L. parsia, L. macrolepis, V. cunnesius.* These as well as carp pituitary extracts and Human Chorionic Gonadotrophin (HCG) were used in the induced breeding experiments on M. *cephalus, L. parsia* and *L. macrolepis.* Of these *L. parsia* gave successful results and the larvae were reared in the lab upto stocking size and were released into larger tanks. The young were fed with groundnut oil cake, artificial food pellets, mosquito larvae and other minute organisms.

11. Culture of eels (FB/CUL/1.2)

R. SOUNDARARAJAN, K. DORAIRAJ AND D. KANDASWAMI.

Three culture experiments were conducted at Mandapam Camp. In addition to biochemical analysis of artificial feed and the cultured eels, attempts at induced breeding of eels were made.

Culture of eels in recycled waters, with a stocking density of 500 g/sq m. and initial size of 17.3 g. average weight, showed a growth increase in weight from 9 kg to 37.3 kg at the end of 8 months. The average individual weight increased from 17.3 g. to 73.3 g. The survival rate was 97.9%. The gross conversion ratio of the feed was 10.13 : 1. The net production worked out to 1.57 kg/sq.m.

Cultured in 12 ft. diameter polycraft ponds, 7.5 kg of elvers, stocked at the rate of 680 g/sq.m., gave a net weight increase of 12,54 kg at the end of 9 months (which was 167.2% of annual stocking weight), the average weight of elvers increasing from 13.2 g to 73 g. The survival rate was 84.6%. The gross conversion ratio of the feed was 20.42 : 1. The net production works out to 1.14 kg/sq. m.

In a comparative study of the growth of elvers in fresh waters (4‰) and seawater (35‰). 1.3 kg of elvers were stocked at a density of 500 g/sq.m. The average weight of elvers increased from 7.1 g to 31.4 g. in fresh water and from 6.25 to 13.16 g in sea water in 9 months. The net total weight increase in this period was 315.4% of initial stocking weight in fresh water and 15.4% in sea water. Though the total food consumed in both cases was the same, the food conversion was higher in fresh water-reared elvers (13.98 : 1) than in those reared in sea water. (260.15 : 1). The net production rate was 1.56 kg/sq.m. in fresh water and 0.08 kg/sq.m. in sea water.

Biochemical analysis showed that the fat content of the whole eel was 16.45%, the maximum accumulation was between the skin and the adjoining area.

Induced breeding experiments on cultured eels gradually transferred to sea water and subjected to treatment by 3 types of hormones and pituitary extracts of major carp are progressing. In some of the eels secondary sexual character have appeared.

CRUSTACEAN FISHERIES DIVISION

In the Crustacean Fisheries Division the main areas of work were centred around nine research projects on the resource aspects in the capture fisheries and five projects in the culture fisheries of crustaceans such as prawns, spiny lobsters, crabs and stomatopods. Only two time-bound projects were initiated this year, one on preparation of count-size conversion tables for commercially important species and the other on a survey of the prawn fishery of the Little Rann of Kutch during monsoon months. The latter was completed during the year.

In the capture fisheries the important features of the prawn resources during the year 1980-81 were: (1) the total production in prawns indicated a further decrease when compared to the previous two years; (2) the same trend of overall decrease was seen in the penaeid prawn fishery, in spite of the conspicuously higher catches noticed in Kerala state, especially from Neendakara, the decline in the catches of other areas being partly compensated by the high landings here; (3) the penaeid prawn catches of the mechanised boats at Neendakara showed considerable improvements from last year, almost reaching the pre 1979 figures and constituted by mostly *Parapenaeopsis stylifera;* (4) the non-penaeid prawn fishery also showed slight decrease as compared to previous year; (5) the spiny lobster fishery showed a drop in catches in the important landing centres of Kanyakumari district, Mandapam and Bombay while showing slight improvements at Tuticorin and Madras and (6) the project to survey the prawn fishery during the monsoon season July to September in the Little Rann of Kutch in Gujarat in an area of about 1200 sq. km. was completed, showing an estimated catch of 2,311.5 tonnes of juveniles of the species *Metapenaeus kutchensis.*

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

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In the fishery for penaeid prawns most of the observation centres showed decrease in catches compared to that of 1979, except at Sassoon Dock in Maharashtra, Neendakara in Kerala and Kakinada in Andhra Pradesh. The same trend is noticed in catch per unit effort also. The significant feature in the penaeid prawns is the revival of the monsoon fishery at Neendakara in Kerala state, the most important prawn landing centre by mechanised vessels in the country, the catches exceeding double the catch of 1979. In fact the catches at this place has considerably compensated for the decline in many other centres of observation including Cochin and Calicut, the other observation centres in the same state. As usual the dominant species contributing to the fishery at Neendakara was *Parapanaeopsis stylifera* (Karikkadi). However, the sizes of these prawns landed during the season showed a significant decrease in comparison to previous years, the modal size showing a decrease of about 10 mm from 81–85 mm to 71–75 mm, resulting in under-utilisation of the raw material due to lesser intake of the landed catches by the processing industry. Analysis of the data on the prawn fishery of this centre over the past 10 years revealed economic overfishing taking place here, requiring proper management of the fishery.

The estimated landings of penaeid prawns along with catch per unit effort, species composition, the peak season of fishery and price structure at the different observation centres are given in table 3. The dominant species in all the observation centres on the west coast, except Mangalore and Cochin is *Parapenaeopis stylifera*. At these two centres *Metapenaeus*

dobsoni dominated as usual. While *Penaeus* spp. dominated along the centres in Tamil Nadu coast *Metapenaeus* spp. dominated in the centres along Andhra Pradesh. Along the south west coast the peak season is in the first half of the year except at Neendakara where the peak is in July-September period. At all other places the peak season falls in the second half of the year, even extending upto January, February in some places. The mean lengths of the dominant species remained almost the same as in previous year at Mangalore, while showing increase at Calicut and Cochin and decrease at Neendakara.

In the prawn fishery at Kakinada, mesh size reduction of trawl nets was noticed to cause change in species composition and size of prawns along with increase in production and catch rate.

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

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The non-penaeid prawn fishery improved considerably at Veraval, while decreasing at Bombay and Kakinada when compared to 1979. The catch per unit effort also showed the same trend. While dol net was the main gear operated at Bombay and Veraval, trawl nets were operated at Kakinada in the sea and drag nets and stake nets in the backwaters. *Acetes indicus* was the dominant species at Veraval (67.2%) and Bombay (73.4%) with *Nematopalaemon tenuipes* coming next. At Kakinada *Exopalaemon styliferus* was the main species, closely followed by *Acetes* sp. In the backwater catches from there, however, *N. tenuipes* was dominant.

TABLE - 3

Penaeid prawn fishery at various centres in 1980–81

	Veraval	Bombay Sassoon Dock	Bombay Kasara Bunder	Karwar
Mechanised fishery				
(a) Catch in tonnes	1,565.5	4,071.0	6,023.5	563.6
(b) Catch/effort in kg.	35.5 (/unit)	224.3 (/unit)	302.0 (/unit)	18.2(/hour)
(c) Important species*	j, l e, k, c	J, b, c, d	j b l, c	j, a, c, b
(d) Productive months**	11, 5, 10, 12	10, 11, 12, 8, 9	11, 10, 12, 9	5, 4, 9, 1
Indigenous fishery				
(a) Catch in tonnes	—	—	—	5.8
(b) Catch/effort in kg.	—	—	—	7, 4 (hour)
(c) Important species	—	—	—	f, b, h, j, a
(d) Productive months	—	—	—	7, 8, 6

*a—*M. dobsoni* d—*M. brevicornis* g—*P. merguiensis* j—*P. stylifera*
b—*M. affinis* e—*M. kutchensis* h—*P. mondon* k—*P. hardwickii*
c—*M. monoceros* f—*P. indicus* i—*P. semisulcatus* l—*Solenocera crassicornis*

** Calendar months

Table 3 (contd.)

Price Structure			
(a) Jumbo	—	50–70	—
(b) Large	45–60	40–50	40–60
(c) Medium	12–25	10–30	10–30
(d) Small	7–15	5–10	8–20
(e) Tiny	3–5		3–8

		Mangalore	*Calicut*	*Neendakara*	*Cochin*	*Tuticorin (January--March)*
I						
(a)	...	620.7	215.1	36,021.4	2,783.5	54.5
(b)	...	26.4 (/unit)	37.4 (/unit)	45.0 (/unit)	12.5 (/hour)	12.7 (/unit)
(c)	...	a, j, f, b	j, c, a, f	j, f, a	a, j, f	i, f, a
(d)	...	4 1, 2	4, 5, 1	7, 8, 9	1–5	--
II						
(a)	...	12.6	13.6	—	38.9	—
(b)	...	—	7.6 (/hour)	—	66.6 (/unit)	—
(c)	...	a, f	a, f	—	a, f	—
(d)	...	7, 9, 8	7, 6	—	6, 7	—

Table - 3 contd.

III

(a)	...	—	—	65–75	—	—
(b)	...	32–50	45–60	45–65	45–65	50–60
(c)	...	13–30	20–35	25–40	15–45	20–35
(d)	...	4–14	5–15	8–15	5–15	10–15
(e)	...			3–7	4–5	

1 Jumbo—*P. modonon & P. semisulcatus* Large—*P. indicus, P. monodon, P. semisulcatus, P. merguiensis*
Medium—*M. affinis, M. monoceros*
Small—*P. stylifera, M. dobsoni* Tiny—*Solenocera crassicornis, M. dobsoni etc.*

		Mandapam	*Madras*	*Kakinada*	*Waltair (January-March)*	*Puri*
I						
(a)	...	305.9	229.2	2,020.3	328.9	—
(b)	...	14.6 (/unit)	13.5 (/unit)	54.2 (/unit)	36.2 (/unit)	—
(c)	...	i, b	f, a, i, c, h	a, c, f, b, j, h	c, l, f	
(d)	...	2, 1, 12, 10	1, 12, 11, 10, 2	1, 8, 10, 9, 12	—	—

Table 3 contd.

II						
(a)	...	—	—	697.1	—	50.4
(b)	...	—	—	7.6 (/unit)		1.2 (/gillnet)
(c)	...	—	—	a, f, j, d, e	—	g, f, b
(d)	...	—	—	2, 5, 4	—	11, 12
III						
(a)	...	—	—	—	—	—
(b)	...	45–60	50–65	60–70	—	40–55
(c)	...	25–35	30–40	15–30	—	14–25
(d)	...	10–15	15–20	8–12	—	—
(e)	...	—	—	—	—	—

In the case of *N. tenuipes* the major size groups represented in the fishery were 43–53 mm at Veraval, 40–60 mm at Bombay and 40–55 mm at Kakinada. Only females were represented in the catches at Veraval while females outnumbered males at Kakinada. The breeding season of the species, as indicated by the presence of larger number of matured females, is September January period, August-September and July–August at Veraval, Bombay and Kakinada respectively.

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

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Investigations on the resources and biology of penaeid prawns from estuarine environments of Mangalore, Calicut, Cochin, Kakinada and Puri revealed considerably low production of their juvenile population at most of the centres when compared to the previous year. The centre-wise landings and other details are shown in Table 4. At Mangalore, commercial fishing by cast nets and seines in Nethravathy estuary yielded 3.9 tonnes of prawns of which about 70% was contributed by *Penaeus indicus*, followed by *Metapenaeus dobsoni*, *M. monoceros* and *P. monodon* in the order of their abundance. The stake net catches of Korapuzha estuary and Cochin backwaters amounting to 46.4 tonnes and 1411 tonnes respectively were of a low magnitude this year and constituted mainly by *M. dobsoni*. *P. indicus* continued to be the dominant species in the cast net and gill net catches of Cochin backwaters. With a total production of 809.5 tonnes of penaeid prawns for the three observation centres the Kakinada backwaters witnessed a severe decline in yield over that of the previous year. As usual, *M. monoceros* formed the mainstay of the fishery. At Puri also the prawn catch (20.3 tonnes) was relatively less although some improvement was noticed towards the end of the period.

TABLE - 4

Estuarine prawn fishery at selected centres during the year 1980—'81

	Mangalore	*Calicut*	*Cochin*	*Kakinada*	*Puri*
Estimated catch of penaeid prawns in tonnes	3.9	46.4	1556.4	809.5	20.3
Catch/unit in Kg.	1.1	8.8	1.9*	15.6	3.4
Fishing gears	Cast nets seines	Stake nets	Stake nets Cast nets Gill nets	Drag nets Stake nets	Drag nets
Peak fishing seasons	November–February	November–January	December–April	September–December	May–July
Important species	*P. indicus* *M. dobsoni*	*M. dobsoni* *M. monoceros* *P. indicus*	*M. dobsoni* *P. indicus* *M. monoceros*	*M. monoceros* *M. dobsoni* *P. indicus* *P. monodon* *M. brevicornis*	*P. indicus* *M. monoceros* *P. monodon* *M. dobsoni*

*Stake nets

The dominant size groups of *P. indicus* in the estuarine fisheries belonged to 71–120 mm at most of the centres, with fresh recruitment during August and January. In Korapuzha estuary, however, it was recorded during May–June period. *P. monodon* caught by drag nets mostly belonged to the size range 86–150 mm at Puri and 60–169 mm at Kakinada with peak recruitment during January and December at the two centres respectively. The major size group of *M. dobsoni* was 40–64 mm at Cochin and Kakinada. In Korapuzha estuary the monthly mean size of the species ranged from 40.0 mm to 55.2 mm. While April was the peak period of recruitment in the stake net fihsery of Cochin backwaters, December and November, February and March were the peak periods at Calicut and Kakinada respectively. *M. monoceros* was mostly represented by the size groups 35–79 mm at Kakinada and 56–90 mm at Puri. Its mean size at Calicut ranged between 63.2 mm in January and 86.4 mm in August.

The lesser abundance of prawns in the nursery areas at most of the centres would suggest a poor fishery in the marine region for the ensuing year.

Evaluation of penaeid prawn fishery with reference to size and effort (CF/RE/1.1.4)

M.J. George, M.M. Thomas, N.S. Kurup, C. Suseelan, V. Thangaraj Subramanian and C. Nalini.

Under this project an anlysis of the data on penaeid prawn fishery of Neendakara over the past ten years with special reference to fishing effort and dynamics of the resources was made and the results published. The study reveals that there is economic, if not biological overfishing taking place in this area and management measures for maintaining the yield at optimum sustainable level have been indicated. A study of the impact of mesh size reduction of trawl nets on the prawn fishery of Kakinada in Andhra Pradesh based on the data from 1967 to 1979 was also undertaken. The analysis shows that from 1977 onwards with the effect of change in mesh sizes of the nets there is difference in prawn production, catch rate, species composition and sizes of the constituent species.

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

P.V. KAGWADE, E.V. RADHAKRISHNAN, K.M.S. AMEER HAMSA, M. KATHIRVEL, MARY K. MANISSERY, M.M. KUNJU K.K. SUKUMARAN, S. LALITHA DEVI, G. SUDHAKARA RAO, W. VENUGOPALAN, M. MANICKARAJA AND K.K. BALA SUBRAMANIAN.

Monitoring of the lobster resources was continued. A slight improvement in the landings of spiny lobsters was noticed at Tuticorin, Madras and Calicut while there was a drop in the catches at Bombay, Kanyakumari district and Mandapam. October to December appear to be the period of maximum abundance for these lobsters in most of the centres. While *Panulirus polyphagus* dominated in the fishery in the north west coast, *P. homarus* was the dominant species in all other areas except at Mandapam where *P. ornatus* was dominant. Fairly good quantities of *Thenus orientalis* were landed at Veraval, Bombay and Madras. The sizes of the major species did not show much change from observations of previous years.

The crab fishery improved at Mandapam and Kakinada when compared to previous year. Mangalore and Madras showed slight decrease. *Portunus pelagicus* and *P. sanguinolentus* were the most common species, January–December and March–April were good months for the fishery at the different places. *P. pelagicus* showed larger sizes in the fishery while *P. sanguinolentus* were comparatively smaller in sizes.

Prawn fishery atlas (CF/RE/1.4)

I. E.G. SILAS, K. RENGARAJAN, S.K. DHARMARAJA AND DAVID RAJ.

Data on prawn fisheries resources and from different areas along the coast of India were collected and analysed for preparation of maps and charts. Some more maps were drawn and added on the basis of the model copy already prepared.

Genetic resources of the commercially important prawns (CF/RE/1.6)

M.M. THOMAS, N. SURENDRANATHA KURUP, C. NALINI, S. LAKSHMI AND K. CHELLAPPAN.

In an attempt to study whether there are different races of commercially important penaeid prawns occurring in areas and environments along the coasts, in addition to morphometric studies electrophoretic studies were initiated. Relative mobilities of the muscle proteins as indicated by the stain bands in polyacrylamide gels were studied in the case of *P. indicus, M. dobsoni* and *M. monoceros*. There were distinct differences in the patterns of the bands representing the various fractions of proteins in the different species. While 5 fractions were clearly demarcated in the stained gels in *P. indicus* there were only 3 distinct fractions in the species of *Metapenaeus* the relative mobility of the fractions also showing difference between species.

Assessment of stomatopod resources (CF/RE/1.7)

M.M. KUNJU, V.S. KAKATI, K.N. RAJAN, K.K. SUKUMARAN, K.Y. TELANG, TIPPAISAMY, KOUMUDI MENON, MOHAMED IQBAL AND M. AYYAPPAN PILLAI.

The estimated total landings of stomatopods by mechanised vessels from Karwar, Mangalore, Calicut, Cochin and Madras during the year is 1679.4 tonnes against 2103.5 tonnes in previous year, constituted by a single species, viz. *Oratosquilla nepa* except at Madras where 5 species were involved in small quantities. The marked decline in catches at Karwar from 1164.2 tonnes in last year to 211 tonnes this year and at the same time substantial increase at Mangalore from 498.7 tonnes to 1756.3 tonnes are important features of the fishery. The synoptic data on the fishery is given in table 5. The peak fishing season appears to be from March to December in all the centres. In the west coast the breeding season is from March to May.

TABLE - - 5

Stomatopod fishery at various centres in 1980–81

Centre	Catch (tonnes)	Catch/ Unit (Kg)	Species composition	Fishing season	Size range (mm)	Breeding season	Gear used
Karwar	211.8	19.9	*Orato-squilla nepa*	March–December	41–115	March	Trawl & Rampan
Mangalore	1756.3	55.3	"	December	41–120	April	Trawl
Calicut	99.3	12.5	"	February –April	46–120	May	Trawl
Cochin	618.4	13.4	"	January–May	30–120	—	Trawl
Madras	12.4	0.9	5 species	December	70–189	—	Trawl

Count-size conversion of prawns and lobsters (CF/RE/1.8)

K.N. RAJAN, S. LALITHA DEVI, MARY K. MANISSERY, M.J. GEORGE, M.M. THOMAS, N.S. KURUP, M. KATHIRVEL, M.M. KUNJU, S. RAMAMURTHY, P.V. KAGWADE, G. SUDHAKARA RAO.

Measurements of total length, tail length, total weight, tail weight and meat weight of different species of prawns and lobsters of importance in the fishery of different areas have been taken. On examination of the data for preparation of conversion factors it was found that there were some gaps in these measurements of different sizes of prawns. After obtaining these measurements the data will be processed to determine the count-size conversion tables in each species.

Survey of the prawn fishery of Little Rann of Kutch during monsoon months (CF/RE/1.9)*

G. SUDHAKARA RAO, B.P. TUMBER AND P.P. SOLANKI.

This was a time bound project to study the seasonal fishery of prawns in the Little Rann of Kutch during the monsoon months. The study was completed during the monsoon fishing season and completion report submitted.

The fishery is quite lucrative during July to September period in the southern part of the Little Rann of Kutch over an area of 1,200 sq. km, bordering the districts of Rajkot and Surendranagar of Gujarat state. The area gets inundated during the monsoon and establishes connection with the sea in the Gulf of Kutch. The juveniles of prawns getting migrated to the area during this time when there is access of sea water are fished out when the intensity of the monsoon subsides.

The craft employed is Malia type of plank built boat locally known as 'Odie' and the gear used in the bag net known as 'Gunja' with 4 m length and mesh size varying from 12–40 mm at different portions of the net. These nets are either collectively operated as stake nets or individually operated as drag nets. Data on the fishery were collected by enquiry from all landing centres. Almost the entire prawn catch is contributed by juveniles of *Metapenaeus kutchensis* (99%). The rest is constituted by *Macrobrachium malcolmsonii, Exopalaemon styliferus*

and *Parapenaeopsis sculptilis*. The size of *M. kutchensis* ranged from 41–115 mm total length, the major size groups being 71–95 mm. Juveniles of fishes such as gobioids, polynemids, catfish, mullets, clupeids and fresh water carps were also represented in the catches.

About 2,770 fishermen were actively engaged in the fishery during the season, with 307 boats and 1,620 nets. An estimated total catch of 2,311.5 tonnes was landed at 8 camps set up by the fishermen at Surbari, Lakhiaser, Nangavadi, Kajarda, Karadia, Vinaser, Mandraki and Tiker. The price of the prawns at the different camps varied from Rs. 3 to Rs. 6 per kg. Even at the modest rate of Rs. 3 the value realised would be about Rs. 70,00,000 in the short period of three months. But as usual, the fishermen are poor, illiterate and heavily indebted to middle men who exploit the situation to the full extent.

Intensive culture of penaeid prawns (CF/CUL/1.1.1)

K.H. MOHAMED, M. KATHIRVEL, S.K. PANDIAN, M. RAJA MANI, A. LAXMINARAYANA, N.N. PILLAI, SYED AHAMED ALI, G. NANDAKUMAR, P.E. SAMPSON MANICKAM, K.K. SURENDRAN, C.S. SASIDHARAN, S. PALANICHAMY AND S. RAJAPACKIAM.

Experiments and observation were continued to be made on methods of transportation of prawn seeds, stocking densities, supplementary feeding and effects of culturing in difficult environmental conditions. Three experiments were conducted on the growth and production of *P. indicus* in the ponds at the Narakkal Prawn Culture Laboratory. In Exp. 1 two identical ponds, 0.1 ha in area, were stocked with prawn seeds of identical size obtained from the same brood at the rate of 50,000 and 100,000 nos/ha. These natural ponds were provided with sluice gates to the outside tidal water system and the stocked prawns utilised the natural food available in the pond for their growth. However, the prawns in the densely stocked pond was given supplementary feed of laboratory prepared pellatised food at the rate of 5% of the biomass every day. The growth and yield at the end of about 100 days was better in the densely stocked pond. This clearly showed that by supplementary feeding the stocking density could be increased. But the survival was better in the less densely

stocked pond. The yield of 42.7 kg (ie. 427 kg/ha) from the densely stocked pond in 100 days was also very encouraging. Exp. 2 which was conducted to confirm the findings of Exp. 1 did not yield good results as prawns in both the ponds were affected by "softness" during the monsoon months resulting in high mortality and very poor growth of the surviving ones. Even though the prawns were retained in the ponds for double the number of days the ultimate size attained by the prawns in Exp. 2 was not different from Exp. 1. It would appear that short term culture of prawns (100 days) is better than culturing them for a longer period in the ponds. In Exp. 3 also the prawns were affected by "softness" and showed very poor growth and survival.

The results of a polyculture experiment in a 0.05 ha pond showed that the prawns were affected by softness in this experiment also resulting in very poor growth and survival. The growth was very good in *Chanos* although survival was low. On the other hand growth was very poor and survival high in the case of *E. suratensis*.

An experiment on multiple stocking and staggered harvesting of *P. indicus* was conducted in a 0.63 ha pond at the Narakkal Prawn Culture Laboratory. The details of stocking are given below:

Month	*No. of prawn seeds stocked*
December 1979	16,828
January 1980	4,387
February 1980	11,858
March 1980	29,870
TOTAL	62,943

The stocking rate was one lakh seeds per ha. and the species stocked were *P. indicus* (80%), *M. dobsoni* (15%) and *M. monoceros* (5%). The dominant size groups ranged between 16–20 mm and 26–30 mm for *P. indicus*. Partial harvesting was started from January onwards and the final harvesting was done on 24–5–'80 (169 days after first stocking). During partial har-

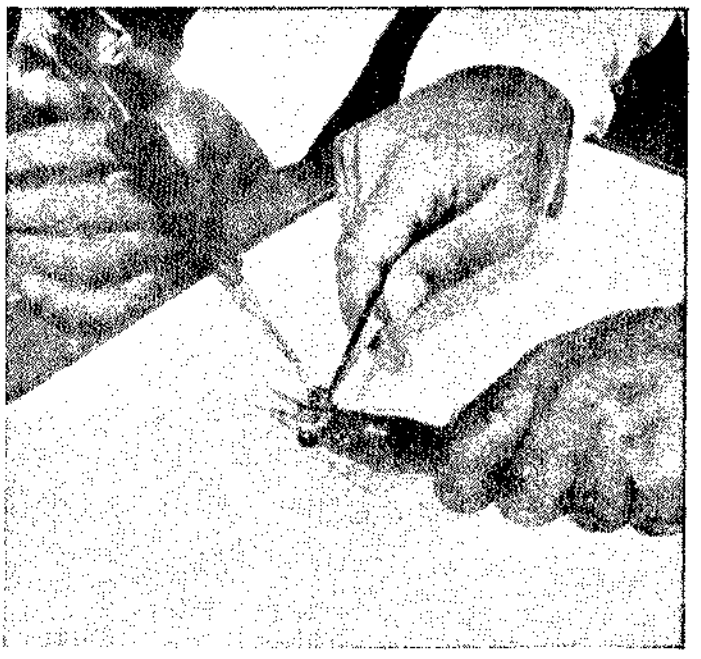
vesting only *P. indicus* larger than 100 mm were caught, the dominant size groups varying from 111–115 mm to 121-130 mm. But during the final harvest the model size of *P. indicus* was only 81–85 mm. The details of the harvest are given below:

Month	Catch in kg			
	P. indicus	*P. monodon*	*M. dobsoni*	*M. monoceros*
January	—	—	0.120	—
February	0.344	—	0.334	—
March	42.745	0.355	16.717	0.861
April	42.291	0.336	10.828	1.033
May	113.920	0.491	25.681	0.046
TOTAL	199.300	1.182	53.675	1.940

Out of the total of 257 kg harvested during the 5 months, *P.indicus* accounted for about 200 kg (i.e. 333 kg/ha in 5 months).

A semicircular trap (1m wide and 1.25m high) made of 6 mm MS rod frame covered with nylon webbing (8 mm mesh) was operated along with a bamboo-screen leader to see whether prawns could be caught by this method. When operated over a 24 hr. period, emptying the trap every 2 hrs, it was found that maximum number of prawns were caught during mid-night hours and lesser nos. during dusk & dawn and practically none during day light hours indicating that they are relatively more active during mid-night hours. It was also observed that more prawns could be caught when the trap was emptied frequently than when it was left undisturbed for longer periods. The catch in the trap was predominantly formed of *M. dobsoni* and it is possibly due to smallness of the trap. Perhaps a larger-sized trap could bring in better catches of *P. indicus.*

At Tuticorin: Some postlarvae (12 mm) and juveniles (35 mm) of *P. indicus* reared at the NPCL were transported in oxygen filled polythene bags to Tuticorin and stocked on 12-6-1980 in salt pan reservoirs where the salinity varied from 22.2 to 45.0 ppt. They were harvested on 12-1-1980 five months after stocking. The yield was poor mainly due to the high mortality of the postlarvae in pond A and the very low stocking density (14,000/ha)



Unilateral eye-stalk ablation by electric cauterisation is being performed (NPCL)

Grow out ponds at Narakkal.

Brood stock pools at Narakkal Prawn Culture Laboratory.

(Below) Live feed cultures maintained at the Laboratory.

in pond B. However these experiments show that the high saline reservoirs of salt pans could be utilised for prawn culture without interfering with normal salt production. It has also proved that the laboratory reared prawn seeds are robust enough to be transferred to distant places and utilised for culture purposes.

At Calicut: A consignment of juvenile prawns reared at the NPCL and transported to Calicut in Oxygen filled polythene bags was reared in the polythene lined ponds of the CMFRI on the Calicut beach. The prawns were fed with a wet mixture of boiled wheat, fish meal and sardine oil. As expected, the high stocking density has resulted in poor growth of prawns but since the survival rate was good and the stocking density high the production rate was high. Another interesting factor was that the prawns were growing in low salinity (1.3–6.0 ppt) throughout the experiment. It is significant that the laboratory reared juveniles of *P. indicus* at the NPCL grew equally well in the low salinity polythene lined ponds at Calicut and the high saline ponds at Tuticorin.

Transportation of prawn seeds

Observations were made on transportation of prawn seeds to distant places. One consignment of 75,000 seeds sent to Goa by truck in Oxygen packed polythene bags reached the destination in fairly good condition after 24 hours. In the entire transportation mortality of c.a. 30% was observed and this was chiefly due to leakage of the polythene bag. In connection with the Lab to Land programme of the Institute laboratory produced prawn seeds (chiefly of *P. indicus*) were transported by road in considerable quantities to Quilon and Valappu without any mortality.

Mass production of prawn seed (CF/CUL/1.1.2)*

During the period under report spectacular success has been achieved in the matter of mass production of prawn seeds chiefly through the results of the experiments conducted at the Narakkal Prawn Culture Laboratory (NPCL). Replacing the conventional Japanese method of rearing the prawn larvae by use of *Skeletonema* and *Artemia*, the NPCL has developed a new system of rearing the prawn larvae by use of the live feed

* See page 104 for personnel

organism which can be mass cultured under local conditions. This significant breakthrough in mass production of seed prawns was achieved through the development of extensive cultures of the diatom *Chaetoceros* spp. the rotifer *Brachionus plicatilis* and the cladoceran *Moina* spp.

Larval Rearing Procedures

When the hatching process are completed the active nauplii are counted and transferred into 6' dia. indoor plastic pools at a density of approximately 50,000 numbers per ton of sea water. These pools are previously cleaned and prepared with about 1 ton. of settled and filtered seawater and the pools were adquately provided with aeration from an oil-free compressor. The stocks in the pool are properly serviced everyday by siphoning out the sediment and removing nearly half the quantity of water and replenishing the same with fresh filtered seawater. This procedure is done everyday till the larvae reach the first post-larval stage when they are removed from these pools to larger outside pools. The removal of water from the rearing pools is accomplished by an electric pump; the intake pipe of which is kept in a specially designed filter box in order to avoid loss of larvae.

From the last nauplius stage onwards (which is attained within 2 days after hatching) fresh culture of *Chaetoceros* is pumped into the pool as feed. Generally about half a ton of this culture is pumped into each pool, but the quantity of the culture pumped in is determined by the concentration of cells in the culture. From the mysis stage onwards frozen rotifers are also fed to the larvae, in addition to the *Chaetoceros*. But later, as a result of experiments it was found that even mysis stages could survive, grow and metamorphose into post-larvae on a diet consisting of *Chaetoceros* alone. This was a major breakthrough resulting in simplification of larval rearing procedures. The larvae attained first post-larval stage in 8–10 days time from hatching and in this stage they are removed to outdoor 24' dia. plastic pools were also good aeration is provided.

Estimation of number of larvae in each pool is carried out everyday by drawing samples and this is essential to monitor the survival of the larvae at each stage. In the 24' dia pools

the post-larvae are regularly fed with appropriate quantities of frozen rotifers and *Moina*. Being outdoor pools the water held in it contained large amount of mixed phytoplankton growth also. Although the prawn seeds are ready for supply from PL-5 stage onwards, the practice at the NPCL was to allow them to grow further. In these pools they attained the stocking size of about 20 mm in about 2 weeks time. An average survival rate of 77% from the nauplius to post-larval stage was achieved by employing these methods although in some of the individual experiments survival as high as 98% has been recorded.

During the period under report 27 batches of larvae were reared in the Laboratory at Narakkal, out of which 20 batches successfully reached the postlarval stage. A total of 1.6 million postlarvae were produced and about 0.5 million stockable size seeds were distributed to the farmers in Vypeen Island, Quilon, Goa at Tuticorin. Major part of the seeds produced were however used for experimental purposes in the laboratory.

Culture of Live-feed organisms

One of the major happenings in the Narakkal Laboratory during the period under report was the development of facilities for culture of suitable live feed organisms. Trials with the conventional live-feed organisms such as *Skeletonema* and *Artemia* were reorganised and new cultures of locally available species were developed. There was considerable difficulty in the developing mass culture of *Skeletonema* at Narakkal. Also it was found that *Skeletonema* cultures were not giving good results for rearing larvae of *P. indicus*. It was therefore decided to experiment with the very common species of diatom in the local waters namely *Chaetoceros* spp. It has been possible to develop very good cultures of *Chaetceros* in mass quantities in specially made, 1 ton capacity, white fibreglass tanks kept in a glass roofed shed. Double filtered seawater was pumped into these 1 ton tanks and it was fertilized with nitrate, phosphate and silicate in appropriate proportion and exposed to the sun. A small quantity of *Chaetoceros* culture (obtained from the previous days culture) is also added as innoculam. Under bright sunlight the cultures developed very fast and attained a density of 1.0 to 1.5 million cells per ml. within one day. The Narakkal laboratory

facility at the moment is capable of producing six tonnes of culture per day.

The euryhaline rotifer *Brachionus plicatilis* was originally obtained in small quantity from a local brackish water pond. This was taken and developed in the form of pure culture, initially in small quantities and later in continuous mass cultures. A 24' dia pool is now developed as a continuous culture for rotifers in addition to several 6' dia pools. The brackishwater taken in this outdoor pool is fertilized with groundnut oil cake and innoculated with rotifers. The culture developed very high concentration (0.5 to 0.6 million numbers per litre) within 6 to 7 days.

After this concentration is obtained the rotifers are harvested everyday with a specially designed silk net. They are washed very well and immediately frozen into small blocks by keeping them in the freezer. Each block contains 10–15 million rotifers. These blocks are taken out and kept in sealed polythene bags in the freezer. After six to eight days of harvesting it is found that the population of rotifer in the cultures declined. In such circumstances the culture is enriched by adding groundnut oil cake in order to induce *Chlorella* blooms which form food for rotifers. In this way a continuous process of harvesting is possible. The pool being kept in the open air and exposed to the sun, considerable amount of evaporation takes place, with the result salinity of the medium rises. It has been found that the species is able to tolerate a wide range of salinity from about 5 ppt to 45 ppt. The water level is often maintained by pumping fresh brackishwater.

The Cladoceran *Moina* spp. also obtained from local fresh water ponds was also developed into continuous cultures. At the NPCL the *Moina* culture is now being carried out in 6' dia pools. Fresh water is pumped into the pools and fertilized with juice of ground-nut oil cake. This induced a bloom of *Chlorella*. After bloom of *Chlorella* is obtained *Moina* is innoculated into the culture. They developed fast and attained a concentration of 30–40 thousand numbers per litre in 6–7 days. They are also harvested and frozen into blocks just as the rotifers. The frozen block of *Moina* contain 0.5—0.75 million numbers. Periodic

enrichment of the culture is required to keep the culture continuous.

Continuous cultures of 3 strains of *Artemia* are maintained in the laboratory in 6' dia plastic pools chiefly for experimental purposes only. Feeding *Artemia* on yeast cells was discontinued and in its place the juice taken out of groundnut oil cake is given with very good results. At present *Artemia* nauplii are not being used at the NPCL for rearing prawn larvae.

During the period under report a total of 52,000 million rotifers, 2,400 million *Moina* and 1.5 million adult *Artemia* were harvested at NPCL. Another significant breakthrough was achieved by obtaining dry crysts of rotifers and *Moina*. These dry cysts were sent by post to Madras unit where they have been developed into cultures. The shelf–life of these cysts appeared to be quite good. Further experiments in developing the cysts are in progress.

Induced breeding of Penaeid prawns

The work on induced breeding of penaeid prawns at the NPCL was chiefly on the well established species of the region namely *Penaeus indicus*. Most of the experiments conducted for inducing maturation of the species have been successful although various methods have been tried. Major effort has been through maintenance of the broodstock in appropriate condition and to have the females subjected to unilateral eyestack ablation. Initially these experiments were carried out on adults collcted from the wild. Eystalk ablation performed by electrical cauterisation of single eye of the prawn has induced maturation in most of the cases within 5–20 days. The great variation in the time taken for maturation is generally dependent on initial condition of the animals. From March 1980 onwards attempts have been made to induce maturation of spawners collected from the farm of the laboratory and this has been very successful. It is a matter of great significance that the prawns collected from the grow–out ponds of the laboratory have been made to spawn in the maturation tank particularly as these spawners have never been to the sea in their life and have been always living under farm conditions. This process of domestication is being continued and large number of prawns obtained from our own grow-

out ponds are now induced to spawn viable eggs in the laboratory. 97 specimens of *P. indicus* collected from farm were induced to mature and spawn in the laboratory during the period under report yielding viable and active nauplii in 91 cases. It is now possible to take the farm-grown *P. indicus* and predictably induce them to mature and spawn within 5–8 days in the land based maturation facility at NPCL. A crop of F_2 generation is now occupying the grow-out pond of the laboratory.

Attempts have also been made to induce spawning by pH manipulation in the broodstock pools. Although some of these experiments have been successful further work is in progress to establish such procedure. Similarly in certain cases successful spawnings have occurred with the help of special feed treatment given out the spawners in the specially made broodstock pools. In this case also intensive work is in progress in order to systematise procedures. It is a matter of routine in the laboratory that the spawners are made to remature after initial spawning. Generally the spawners after having spawned can be made to remature and spawn within 5–8 days and an instance of a single spawner having spawned viable eggs repeatedly four times within a period of 35 days is on record. Achievement of this systematic procedure for making farm reared *P. indicus* spawn and produce seeds under controlled conditions is a major breakthrough towards development of extensive prawn culture in the country.

Induced maturation of *P. mondon* is also being attempted at the NPCL. In this case only spawners collected from the wild have been used during the two experiments conducted. In one of the experiments the eye-stalk ablated *P. monodon* matured in 20 days and spawned 0.75 million nauplius on January 1981. Further experiments are in progress.

Experiments in prawn breeding and rearing of larvae were continued at the Kovalam Centre near Madras. Wild spawners of *P. indicus* collected from the commercial fishing grounds off Madras spawned at this centre on 4 occassions but only in one experiment the larvae could be reared to stockable size. Some 5000 seeds have been given to the Operational Research Project for stocking in the farmers fields. Wild spawners of *P. monodon* also spawned in this centre but the larvae could not be reared

to stockable size. The major constraint at this centre is the non-availability of dependable live feed cultures. Steps are now being taken to remedy this situation.

Towards end of 1980 a small unit has been organised at the Tuticorin Research Centre to conduct experiments on breeding of commercial shrimps of the area and to rear their larvae to stockable size. Facilities have been put up and preliminary experiments have been undertaken. A wild specimen of *Penaeus semisulcatus* collected from the sea spawned and produced viable eggs. Although hatching rate was good it was not possible to rear the larvae to the postlarval stage. Further experiments are in progress.

Culture of commercially important crabs (CF/CUL/1.1.3)

R. MARICHAMY, M. KATHIRVEL AND S. RAJAPACKIAM.

Juveniles of *Scylla serrata* were collected from the mangrove areas and stocked in departmental ponds at Tuticorin to study their growth and production. The crabs grew from an initial weight of 15 g. to 555 in pond A and from 28.9 g. to 650 g. in Pond B during a culture period of 8–10 months. The crabs were fed with trash fish and fish entrails from the fish market. The production rate was 494 kg and 690 kg in g./month in pond A and 69 g/month in pond B. In another experiment which is still in progress similar growth rates were obtained. The production rate and growth rate are highly encouraging. An interesting observation made during the course of the experiment is that the average weight input was more in the case of male crabs after they attain a size of 145 mm.

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

T. THOLASILINGAM, K. RENGARAJAN, E.V. RADHAKRISHNAN, M. VIJAYAKUMARAN AND SHAHUL HAMEED.

During the period under report various aspects like the reproductive biology of lobsters, breeding, seasonal occurrence of pueruli, moulting behaviour, food and feeding habits of the larvae were investigatied at the Kovalam Field Laboratory of the CMFRI.

Adult *Panulirus homarus* kept in laboratory tanks was found to acquire berry very frequently. The incubation period was observed to be 15–20 days. The juveniles reared in the laboratory reached maturity when they reached a size of 57.0 to 77.4 mm carapace length and started breeding. The newly hatched phyllosoma larvae measured 1.4 mm in total length and they readily fed on freshly hatched *Artemia* nauplii, *Ctenophores* and *Sagitta* sp. Use of a self-cleaning conical bottom tank facilitated the process of rearing the larvae and it was found that the percentage of survival was better when the larval density was 150 per four litre containers.

The study of the moulting process of *P. homarus* indicated that the actual process of moulting takes only 3–4 minutes. A series of photographs have been taken to record this process. While the discorded exoskeleton formed about 30% of the body weight the increase in body weight itself is recorded as about 20%.

Pelletised feed was found to be acceptable to the juveniles and adults of lobsters. The percentage of tapioca was increased to 30% to give a more water-stable pellet.

Addendum

Personnel associated with project, CF/CUL/1.1.2

K. H. Mohamed, M. S. Muthu, N. N. Pillai, S. K. Pandian, A. Lakshminarayana, M. Rajamani, Syed Ahamed Ali, C.P. Gopinathan, K. Devarajan, K.K. Surendran, C. S. Sasidharan, Shahul Hameed.

MOLLUSCAN FISHERIES DIVISION

Various investigations undertaken during the year enabled a clearer understanding of the resources potential of the cultivable molluscs occurring in Indian waters, particularly those along Karnataka, Kerala and Tamil Nadu coasts. Problems confronting culture of molluscs were taken up on priority basis. All research data and information obtained ever since mussel culture work was started were consolidated and discussed at a workshop on Mussel Farming to take stock of the extent of success achieved and formulation of plan of action in the coming years to establish a reliable system of culture. Very good progress was maintained in hatchery method of oyster seed production and in the culture of flagellates and diatoms. Training programme in SCUBA diving was initiated. The salient features of the Division projects are detailed below.

Resources survey of commercially important molluscs (MOL/RE/1.1)

K. NAGAPPAN NAYAR, S. MAHADEVAN, K. RAMADOSS, T. APPA RAO, K.A. NARASIMHAM, Y. APPANNA SASTRY, R. SARVESAN, V. RAMACHANDRAN, D. SIVALINGAM, S. KRISHNA PILLAI, K.K. APPUKUTTAN, G.P. KUMARA SWAMY ACHARI, M.M. MEIYAPPAN, G. RADHAKRISHNAN, P.S. KURIAKOSE, K. SATYANARAYANA RAO, G. SYDA RAO, KUBER VIDYA SAGAR AND K.S. SUNDARAM.

In Kakinada bay, about 150 tonnes of molluscs were estimated to have been fished, of which *Anadara granosa* (blood clam) accounted for 130 tonnes (86%). The maximum landing was in the month of April. Survey of Kovalam backwaters near Madras brought to light the existence of considerable population of edible oyster, distributed in several patches of 1 x 0.25 sq.m.

The beds contained predominantly live oysters of 60 mm size. In the area close to the barmouth thin population of *Meretrix* sp. was noticed.

In Pinnakayal estuary south of Tuticorin, apart from stray beds of edible oyster on the upper reaches of the estuary, there is very little edible molluscan resources.

The commercially exploited chanks by skin diving reached upto 906,202 shells, mainly from Tuticorin and Tiruchendur fishing grounds. Incidence of worming of chanks in different paars ranged from 7.5% to 14.7% Longlining landed 2000 chanks at Vizhinjam while trawl nets landed 13,000 nos. Diving brought 500 chanks. At Vizhinjam a total of 57 tonnes of mussel were landed during September–December season. In the areas south, at Colachel and Muttom, the exploitation of chanks was limited.

A bed of *Katelysia opima* was found at Dalavapuram area in the Ashtamudi lake. This species contributes to a regular fishery for extracting flesh as well as for using the shell for manufacture of lime. A detailed study was carried out at Ramanthuruthu area in the Cochin backwaters on the distribution pattern of clam *Meretrix casta* var. *ovum* by taking samples from 16 different stations in the northern and western side of the island. This water area is partially isolated by a bund constructed from the north–eastern side connecting the island with Vallarpadam area affecting the water movements.

Molluscan resources of the Venkatapur and Sharavathi estuaries in North Kanara district and Udyavara and Malpe estuaries in South Kanara District were surveyed in addition to the molluscan fishery of Netravathi estuary. In Venkatapur estuary, two clam beds and three oyster beds were located. A clam bed of 28 ha contains *Paphia malabarica* at average density of 35/sq.m. The *Meretrix casta* bed showed an average density of 27/sq.m. Two oyster beds of *Crassostrea madrasensis* with a density of 5/sq.m. overlap with the first clam bed and another bed has a density of 68 oysters/sq.m. In the Sharvathi estuary a *Meretrix casta* bed of 10.5 ha with a density of 3/m, another bed of the same species with 2.64 ha area and density of 1/sq.m and an oyster bed of 11 ha area with a density of 435/sq.m.

were located. In Udyavara estuary the clam *Villorita cyprinoides* is distributed in a large bed of 30.6 ha in moderate density of 16–48/sq.m. In Malpe estuary the clam bed of 62.4 ha area is populated by *Meretrix casta* var. *ovum*, *Paphia malabarica* and *Paphia textile*. *Meretrix* predominates with an average density of 202/sq.m. Two small oyster beds of 1.8 ha and 0.5 ha area with *C. madrasensis* at average densities of 18 and 22/sq.m. are present on the eastern side of the large clam bed. The sustenance fishery for clams in all these beds was studied. The *Villorita* fishery of Netravathi estuary accounted for landings of 79.5 tonnes during the year (January–May; November–December).

Survey of creeks at Dahanu, Dharapur, Ucchali and Satpati in Maharashtra were carried out in 1980. Of the edible molluscs in the above areas, *Crassostrea gryphoides* constituted a good percentage particularly in the Dahanu and Satpati creeks. *Meretrix meretrix* population was seen in Satpati Moorba area where there is a good fishery for this clam as well as for *M. casta*.

Genetic resources of commercially important molluscs (MOL/RE/1.5)

K. ALAGARSWAMI, P.V. SREENIVASAN AND M.M. MEIYAPPAN

Detailed investigations on the variations of the backwater clam *Meretrix casta* were taken up. Among the three '*varieties*' of (i) type, (ii) *ovum* and (iii) black shell of the species, the morphometric characters were analysed. These were also subjected to electrophoretic studies (polyacrylamide gel). The poretin bands were similar in all cases. The results suggest that there are not genetic variations in the species. Some of the differences noticed in a few shell characters and colour may be attributable to polymorphism in the species caused by environmental conditions.

Similar studies were initiated on the clams *Villorita* spp. and *Sunetta scripta* and th pearl oysters of genus *Pinctada*.

Culture of edible oysters (MOL/CUL/1.1)

K. NAGAPPAN NAYAR, S. MAHADEVAN, K. RAMADOSS AND M.E. RAJAPANDIAN

The project at Tuticorin mainly concentrated on perfecting spat collection methods for large scale spat procurement from

nature, stocking the racks with 4 lakhs of oyster spat, studying the rate of growth and reproductive behaviour of the oysters. Thirty thousand tiles in 34 racks were laid during April for spat collection. The open sea collection was successful enabling 30 spat being collected (average) from each tile. Out of the total spat 320,000 were scraped and stocked in the farm. Predation of transferred spat kept in box type cages was experienced. A total of 3500 gastropods, *Cymatium cignulatum*, were removed from cages and they accounted for a mortality of 20% of the stock.

The growth rate of oysters recording 12 mm during first three months, 7 mm in the next two and 6 mm thereafter followed the previous year's pattern thus growing to 85 mm in 9 months and 105 mm in 12 months. However the gonads showed fully developed stage in the ninth month itself when the oysters were 80 mm size and started spawning in January unlike in the previous year when it spawned in April. The flesh content of oysters after spawning was poor recording only 4.8%. A few thousand oysters kept in the creek however had not spawned.

Culture of mussels (MOL/CUL/1.2)

S. MAHADEVAN, S. REUBAN, S. SAMPSON MANICKAM, K. RENGARAJAN, N. RAMACHANDRAN, K.K. APPUKUTTAN AND P.S. KURIAKOSE.

The suspended culture or raft culture of green mussel in the open sea at Calicut for the season 1979–80 was started in November 1979. Collection of seed for the farming was made from the natural mussel beds of Elathur, Thikkodi and Mahe. Seed at transplantation ranged from 15 to 30 mm and 750g of juvenile mussels were seeded per metre length rope. Coir ropes ranging from 20-25 mm diameter were used and the seeded portion of the ropes was 6 m each. A total of 1000 ropes were seeded and suspended from 10 rafts.

Growth of the mussels in the farm is presented in Table 6 The average monthly growth rate recorded was 13 mm in length and 7.1 gm in wieght.

TABLE - - 6

Growth of green mussel *Perna viridis* in open-sea farm off Calicut

(averages of 100 specimens)

1979—1980

Month	Length mm	Total weight g	Shell weight (g)	Meat weight (g)
November 1979 (seed)	20.4	0.9	0.37	0.33
December	35.9	3.7	1.43	1.45
January 1980	50.0	9.1	3.31	3.68
February	59.9	13.5	5.33	5.21
March	73.6	24.1	7.49	9.01
April	85.0	36.4	12.88	13.21
		(1980—1981 (to be completed)		
November 1980 (seed)	24.2	1.32	0.52	0.40
December	44.3	7.37	2.72	2.83

The seed mussels transplanted from the natural beds to the farm showed gonad development within 30 days. Spawning started after 90 days. The percentages of maturity stages are presented in Table 7.

TABLE - - 7

Maturity stages of *P. viridis* in the Calicut farm

(data of 100 mussels each month) (M–Male; F–Female)

Month	Indeterminate	Developing	Spawning
November 1979	100	—	—
December	—	100(M–52; F–48)	—
January 1980	—	100(M–46; F–54)	—
February	—	39(M–18; F–21)	61(M–27; F–34)
March	—	35(M–14; F–21)	65(M–32; F–33)
April	34	40(M–21; F–19)	26(M–10; F–16)

A total yield of 13.4 tonnes of mussels was obtained from 393 ropes. The average production per metre length of rope

is 5.8 kg the yield being 7.8 times that of the seed weight. The remaining 607 ropes with harvestable sized mussels were lost in the sea due to damage to the rafts. Mussel culture experiments for the season 1980-81 was started in October 1980.

At Vizhinjam predation of brown mussel by the silver bream (*Rhabdosargus sarba*) was observed in February 1980. Almost all the 250 seeded ropes were damaged. Seeding work started from the third week of September. A total of 215 ropes were seeded and kept in the bay rafts.

During January–June, four rafts were launched off Kovalam near Madras on the east coast. Mussel seed measuring 15–20 mm collected from Ennore in January were used for seeding 50 ropes which were suspended from the raft. Most of the juvenile mussels fell off the ropes presumbaly due to the rough sea conditions in January and February. About 400 kg of adult mussels were suspended from the raft during the period March–May and 200 tiles introduced to collect the spat. Sporadic spawning took place during April and May but the spatfall was very poor this year.

Three rafts were again floated in July–August 1980 when the sea became fairly calm. Nearly, 2,80,000 mussel seeds measuring 15–20 mm is size were collected from the piers at Ennore and seeded on to 100 ropes of 6 metre length at the rate of 0.75 kg per metre.

The mussel seed measuring 20-25 collected during July 1980 from Ennore showed good attachment to the ropes and attained a length of 55 mm by the end of September 1980. The mussels seeded in August and September showed a tendency to slip down the rope and congregate into bunches. Loss of mussels from the ropes resulted in poor production this year. Preliminary work was carried out during the monsoon period by floating a long line and suspending seeded ropes.

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

K.A. Narasimham, S. Reuban, T. Appa Rao, P.E. Sampson Manickam, P.V. Srinivasan, G. Radhakrishnan, K. Satyanarayana Rao and G. Syda Rao.

The culture of blood clam *Anadara granosa* at Kakinada gave encouraging results. During April, 1980 seed clams of 20–28 mm size with a mean weight of 5.53 g were stocked at a density of 175/m^2 and harvested during October. The clams showed a growth increment of 16 mm in size and 23 g in weight. With a survival rate of 83%, production works out to 2606 kg/625 m^2 for $5\frac{1}{2}$ month period. From the samples collected from the natural beds the growth data was fitted into the von Bertalanffy model and the parameters obtained were $L\infty = 72.99$ mm, $K = 0.5936$ and $t_o = 0.41$ years. The theoretical lengths estimated at ages 1–3 are 41.3, 55.5 and 63.3 mm respectively.

The translpantation of *Meretrix casta* and *Villorita cyprinoides* var. *cochinensis* at Narakkal was not encouraging. Similarly the culture of *M. casta* at Waltair did not make much progress.

At Mangalore *Meretrix casta* var. *ovum* was cultured at Mulki. The clams were stocked in two sites at the rate of 126/m^2 and 262/m^2 during February, 1980 and harvested in June. The clams had grown by 13.6 mm at a mean rate of 3.4 mm per month. No difference in growth rate was found between the two stocking densities. The survival rate was 51.8%.

Replenishment and monitoring of *Villorita* spp. in the estuarine system (MOL/CUL/1.3·3)

G.P. KUMARASWAMI ACHARI.

Villorita spp. were collected from different estuarine systems and the following species were identified: (a) *Villorita cyprinoides* (Gray) (b) *V. cyprinoides var. Cochinensis* (Hanley) (c) *V. cyprionoides* var. *delicatula* (Preston), and (d) *V. cornucopia*. Prashad. *Villorita* forms an annual crop in the Vembanad Lake. The catch studies on the live clams of the lake do not show any tangible fluctuation annually which indicates that there is no positive indication of overfishing from the lake. There seems to be a peculiar regulatory mechanism by which the population levels in the estuarine ecosystem are maintained. It was observed that clams below the size of 10 mm are fished in large quantities in certain parts of the lake using nets of small mesh size. The clam production in the lake can be increased if size regulation

is enforced. From areas where seed clams below 10 mm occur above the limits of 2000 per sq.m. they can be transplanted to any other region of the lake where density of population is less and salinity and other hydrographical conditions are parallel through out the year compared with the normal beds. This also will help to enhance the production.

Pearl culture (MOL/CUL/1.4)

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

The activities of the pearl oyster farm at Tuticorin were concentrated at the harbour basin and the farm at Veppalodai was being phased out, but for a raft for monitoring purposes. It became increasingly evident that the growth of oysters at Veppalodai was badly affected due to changing ecological conditions brought about by intense bottom-trawling by mechanised fishing vessels. At the harbour basin, the oysters showed better growth and the annual mortality rate was 14% against 44% recorded at Veppalodai. The farm in Vizhinjam Bay was maintained for monitoring spatfall and rearing of oysters.

Compared to the total number of 35,000 oysters collected from the natural beds of pearl oysters in the Gulf of Mannar during 1979, the yield was very poor in 1980; in the total of 4612 pearl oysters collected by SCUBA Diving in 39 trips, 4078 were *Pinctada fucata* and the rest were the flat oyster group. Among the northern and Central groups of paars, Kurichan and Tholayiram paars gave relatively good results. The Tiruchendur group of paars were almost barren. The poor resource position of the natural beds is the result of the November-December 1979 floods which dealt a heavy mortality on the oyster stocks in the northern paars.

Biological studies were continued. While the growth of *P. fucata* was from the initial 10.9–38.2 mm DVM (0.26–6.0 g wt) to the final 41.8–72.5 mm DVM (13.7–66.0 g wt) during a 14-month period in the harbour farm it was negligible in Veppalodai farm. The phenomenon of sex reversal was studied. The condition index ranged from 38.1 (February) to 57.8 (Decem-

ber). Field control of boring and fouling organisms was carried out using the methods developed in the laboratory.

Environmental parameters of the harbour farm (annual) and natural beds (seasonal) were collected. At the harbour farm the range of values were: calcium (0.33–0.39 g/L), magnesium (1.22–1.50 g/L), phosphate (0.35–3.00 μg at/L), and silicate (0.005–0.890 μg at/L.

At Vizhinjam, peral oyster spatfall was monitored. During January–February, July–August and late December a total of 8250 spats were collected using frilled nylon ropes and other collector materials. *P. fucata* component in this was 20–30%. Predation by crab *Charybdis* spp. noticed during the last quarter resulted in 20–40% loss of spat in different rearing baskets.

Development of hatchery system for edible oyster seed production (MOL/CUL/1.5)

K. NAGAPPAN NAYAR, D.C.V. EASTERSON, K. RAMADOSS AND M.E. RAJAPANDIAN.

Experiments on induced breeding of *Crassostrea madrasensis* have not so far been successful. Gamates were collected from fully mature oysters by stripping, fertilised and the larvae reared in the laboratory. The fertilized egg 45–50 μ in diameter is spherical with dense granules. Within 18 hrs the larvae attained shelled stage. At this stage *Isochrysis galbana* was given as food. *Chlorella* sp. was given as food for a batch of larvae and their growth was very poor compared to those fed with *Isochrysis*. By 10-12 days the larvae reached 140μ. Attempts to grow the larvae further were not successful.

In connection with this project necessary laboratory facilities have been designed and built up. A temporary hatchery laboratory with continuous oil-free air supply, sea water filtration and purification systems has been completed. For feeding the larvae cultures of *Isochrysis galbana, Chlorella* sp., *Tetraselmis* sp., and *Synechocystis* sp. were maintained under controlled conditions.

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

K. RANGARAJAN, N. RAMACHANDRAN AND K.K. APPUKUTTAN.

The work on this project was carried out at Madras and Vizhinjam on *Perna viridis* and *P. indica* respectively. By subjecting the mussels to thermal shock and pricking the adductor mussel spawning was induced and the larvae reared upto straight-hinge stage. Attempts are being made to pick out the proper feed algae on which further growth depends.

Development of hatchery system for production of pearl oyster seed (MOL/CUL/1.7)

K. ALAGARSWAMI, A. CHELLAM, A.C.C. VICTOR, D.C.V. EASTERSON, S. DHARMARAJ AND T.S. VELAYUDHAN.

To corroborate the results on induced spawning of pearl oyster obtained in 1979, experiments were continued to spawn the oyster with NH_4OH injections which gave reliable results. Natural spawning due to stress was observed on several occasions. The process of ovulation and spawning were studied in detail. Fecundity estimates (eggs released) per spawning varied from 13 million to 52 million eggs.

A major effort was made to maintain favourable medium for larval rearing and feeding with live microalgal cultures of *Isochrysis, Synechocystis* and *Chlorella.* Improvements in these areas resulted in the larvae growing to Umbo stage of 157.5 x 174.2 (DVM and APM respectively) in 21 days against the straight-hinge stage obtained in 1979. Although several trials were conducted, the larvae did not progress beyond Umbo stage during 1980. The experiments with further improvements were continued.

Culture of cephalopods (MOL/CUL/1.8)

D. SIVALINGAM AND S. KRISHNA PILLAI.

Egg clusters of *Sepia aculeata* were collected in February and kept in aquarium tank with running sea water. A total of 118 young ones hatched out and they were fed with fresh zooplankton, mostly of copepods and other crustaceans. The young ones survived for ten days. The total length of young

ones ranged from 9.5 mm to 10 mm, standard length ranged from 6.00 to 6.5 mm and width was 5 mm. During April–May the hatchlings of other batches of clusters were kept in fibre-glass tank and glass tank and 560 young ones were transferred to a bigger cement tank to study the survival rates. Also 200 newly hatched young ones were released in a happa kept at one meter depth in Palk Bay. Egg clusters of *Sepioteuthis arctipinnis* were collected from the trawler catch in November and 125 young ones were hatched out in the Aquarium tank. Live plankton was given as a food and the young ones survived for 9 days.

Demonstration project in pearl culture (CMFRI/DP/1)

K. ALAGARSWAMI, A.C.C. VICTOR, A. CHELLAM, S. DHARMA RAJ AND T.S. VELAYUDHAN

The project could make only moderate progress in view of insufficient stock in the farm. A total of 649 oysters were used in nucleus-implantation with 982 pieces of spherical shell-beads of dia 3–5 mm in various months. A batch of 157 oysters seeded during March–April was examined for pearl production which yielded 113 good pearls.

The project was terminated during 1980.

Demonstration Project on edible oyster culture (CMFRI/DP/2)

P. MUTHIAH

In view of the fact that shallow water open sea spat collection during 1979 was better than other areas, 30 racks in the bay area and 2 racks in bridge and bed area were constructed. About 30,000 lime coated tiles and 100 rens with 20–25 oyster shells each were used for spat collection. The average settlement of spat in the bay area was 31 per tile with a maximum of 120 spat. A total of 3,20,500 spat were collected and kept for rearing. Average settlement of spat on the oyster shells was 7 per shell. The mortality of young oysters in the cages were more due to high intensity of predation by *Cumatium cingulatum*. In all 4500 numbers were removed from the cages. The size ranged from 7.5 to 75 mm in shell length.

Demonstration project on mussel culture (CMFRI/DP/3)

P.S. KURIAKOSE.

The demonstration of mussel culture was achieved through the Lab–to–Land programme implemented at Elathur near Calicut. The fishermen were trained at the Institute's mussel farm off Calicut, The production of mussel at the Institute's farm was 13.5 tonnes.

Training in pearl culture (CMFRI/TR/2)

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

No regular training course could be offered during the year. However, 16candidates who were participants in the Summer Institute in culture of Edible Molluscs were trained in pearl culture during 26 May–24 June 1980.

Training in edible oyster culture (CMFRI/TR/3)

K. NAGAPPAN NAYAR, S. MAHADEVAN, K. RAMADOS, M. E. RAJAPANDIAN AND P. MUTHIAH.

The course curriculum for a short–term training course in edible oyster culture was developed. The participants of the Summer Institute in Culture of Edible Molluscs were trained in edible oyster culture at Tuticorin.

Training in underwater investigation by SCUBA Diving (CMFRI/TR/4)

S. MAHADEVAN, K. NAGAPPAN NAYAR, K. RAMADOS.

Six staff members of the Institute were trained in SCUBA Diving. They have attained proficiency and can take up underwater ecological and behaviour studies. This has enabled the Institute to have a larger staff component with experience in SCUBA diving.

Survey of cephalopod resources in the economic zone (MOL/RE/1.2)

E.G. SILAS, H. MOHAMED KASIM, KUBER VIDYASAGAR, K. SATYANARAYANA RAO, M.M. MEIYAPPAN, K. PRABHAKARAN NAIR, R. SARVESAN AND Y. APPANNA SASTRY.

The estimated cephalopod landings amounted to 11336 tonnes—bulk of the catch coming from trawling operations for

shrimps. Indigenous gears such as hooks and lines and boat-seines mainly contributed to the catch in Vizhinjam and Kanya-kumari region. The fishery for cephalopods was confined to the inshore waters only. The landings of this year showed about 25% decline compared to 1979. Except Kerala (42% increase), Karnataka (81% increase) and Goa (21% increase), all other maritime states and Union Territories showed decline. The two major cephalopod landings states. Maharashtra and Gujarat showed a decline of 70% and 35% respectively. This trend of decline is reflected in the landings at biological observation centres also.

Veraval: An estimated 1156 t. of cephalopods were landed during this year constituting 5.2% of the total landings and the peak landings were in the first quarter accounting for about 33% of the annual landings. The highest catch per unit(44.6 kg) was observed in January and the lowest in November (7.6 kg). Three species—*Sepia aculeata* (30.7%), *Sepiella inermis* (16.2%), *Loligo duvaucelii* (52.4%) constituted the fishery and their size frequencies ranged from 20 to 150 mm, 25 to 85 mm and 35 to 270 mm respectively.

Bombay: Extimated landings amounted to 1180 t. which was about 37% less than that of the 1979 landings. Peak landings were in the months of January and March. The catch was composed of mainly two species *S. aculeata* and *L. duvaucelii* and their size ranged from 35 to 269 mm and 15 to 280 mm respectively.

Mangalore: The total estimated landings amounted to 46 t. About 63% of the landings were in the first quarter. The catch per unit varied from 0.60 kg to 1.95 kg. *L. duvaucelii* with a size range of 60 to 230 mm formed the bulk of the catch (68.3%) *S. aculeata* (24.2%), *S. inermis* (7%) and *S. pharaonis* (0.5%) formed the rest of the catch.

Cochin: An estimated 73 t. of cephalopods were landed during this year showing decline of about 82%. This decline was mainly due to the poor landings in the second half year when, due to the very poor prawn yields, the trawlers opted to ply as carrier boats for the purse seiners.

The rate of catch has also come down significantly from 9.0 kg to 1.5 kg per unit. The peak landings were in the months of March and January. Cuttlefish represented by *S. pharaonis* (29.1%), *S. aculeata* (16.5%), *S. elliptica* (15.7%), and *S. inermis* (15.6%) accounted for the bulk of the catch (77%). The rest of the catch was composed of *L. duvaucelii* (23.1%). The size ranges of the above species were 79 to 180 mm, 68 to 171 mm, 60 to 115 mm, 30 to 121 mm and 43 to 236 mm respectively.

Vizhinjam: The estimated catch was 130 t. showing about 47% decline. The hooks and lines accounted for 82.9% of the catch and the rest from boat seines (16.7%) and shoreseines (0.4%) The peak landings were in the months of October and February. Cuttlefishes represented mostly by *S. pharaonis* formed about 60% of the catch and the squids represented by *L. duvaucelii* and *Doryteuthis singhalensis* formed the rest of the catch. The size of the above three species ranged from 135 to 315 mm, 25 to 245 mm and 15 to 205 mm.

Madras: The estimated landings were about 138 t. showing an increase of about 170% when compared with 1979 catch. The peak landings were in the months of June and May. The catch rate was 9.4 kg per unit. Cuttlefishes represented by *S. pharaonis, S. aculeata* and *S. inermis* accounted for 67% of the catch and squids represented mostly by *L. duvaucelii* formed the rest of the catch.

Kakinada: About 130 t. of cephalopods were landed showing a slight increase. The peak landings were in the months of November and March. Three species of cuttlefishes *S. aculeata* (28.9%), *S. inermis* (27.8%) and *S. pharaonis* (20.4%) and a single species of squid *L. duvaucelii* (22.8%), constituted the fishery. The size range of *S. aculeata, S. inermis* and *L. duvaucelii* were 30 to 184 mm, 20 to 94 mm and 30 to 184 mm resepctively.

Waltair: The estimated landings amounted to 252 t. showing about 24% decrease from that of 1979 landings. Peak landings were in the months of August, October and November. The catch per unit was about 6.8 kg. Cuttlefishes represented mainly by *S. aculeata* (21.5%) *S. pharaonis* (16.7%) and *S. inermis* (9.1%) formed 56% of the landings and the squids represented mostly by *L. duvaucelii* formed the rest of the catch. The size range of *S. aculeata, S. pharaonis* and *L. duvaucelii* were 57 to 167 mm, 67 to 267 mm and 25 to 179 mm respectively.

FISHERY ENVIRONMENT MANAGEMENT DIVISION

FISHERY OCEANOGRAPHY

Fishery oceanographic investigations - Physical and Chemical aspects of the shelf and adjacent waters (MBO/ES/1.1)

A.V.S. MURTY, C.P. RAMAMIRTHAM, D.S. RAO, K.G. GIRIJAVALLABHAN, S. KRISHNA PILLAI, R. MARIACHMY, PON. SIRAIMETAN, R. PADMINI, G. G. ANNIGERI, S. MUTHUSWAMY, P. MOJUMDER AND OTHERS.

The nearshore waters are monitored from various Research Centres along the east and west coasts of India. The results of the investigations are as follows:

Bombay

Sea water samples were collected from the inshore waters off Bombay from January 1980 to March 1981 except during the months of June to September (1980) owing to rough condition of the sea.

During the summer season the surface water recorded a temperature of 33°C. The winter minimum temperature was 24°C. The post-monsoon temperature was 29°C. The salinity during winter was about 34.4‰. During April-May, the salinity recorded a maximum (36.8‰). The dissolved oxygen values are comparatively the same during the I quarter of 1980 and the I quarter of 1981. The pH values throughout the period of observations ranged between 7 and 8.5. However, the hydrogen-Ion concentration was found more (8.2) during warm weather season and its value was about 7.5 during post monsoon and winter periods. The zooplankton biomass was moderate (2-4 ml) during the summer, minimum during winter (1-2 ml) and it recorded high values (about 25 ml) during post monsoon.

Karwar

The quarterwise distribution of various hydrological parameters are given in the following table.

Quarter	Temp. °C	Salinity ‰	Dissolved oxygen ml	Phosphate /ug at/l	Nitrite /ug at/l	Silicate /ug at/l	pH
1980							
I	28.4	32.84	4.3	0.38	0.37	5.68	8.4
II	30.8	30.53	3.9	0.59	0.99	6.16	8.4
III	26.3	14.45	4.6	0.60	0.13	25.08	8.0
IV	28.7	28.65	3.9	0.48	0.46	5.82	8.3
1981							
I	27.9	34.27	4.2	0.89	0.29	5.98	8.4

Mangalore

The waters off Mangalore showed high temperature(30.5°C) during summer. Soon after summer by the end of May (1980) a dramatic change took place in the waters. The waters were cooled (25°C) followed by sudden decrease of dissolved oxygen accompanied by an appreciable increase of nutrients. This was the result of upwelling and river run-off which continued till September(1980). The hydrogen ion concentration showed a slight decrease during southwest monsoon. By October the salinity started regaining its normal value. During the first quarter of 1981, all the parameters, temperature, salinity, dissolved oxygen and nutrients showed much fluctuations. The pH value was steadily maintained during this quarter at 8.1 plus or minus 0.1.

Calicut

Water samples could not be collected off Calicut during pre-monsoon and monsoon months.

Water temperature during the first quarter of 1980 was comparable with that of the first quarter of 1981. On average it was 29.8°C. The salinity of the waters during the first quarter of 1981 was slightly less than that of the first quarter of 1980. During the first quarter of both the years the dissolved oxygen contents was above 4 ml/l. The first quarter of 1980 was rich

in nutrients except for silicate which appeared to be more in the first quarter of 1981. During the winter period of 1980–81, the average condition of water temperature, salinity, dissolved oxygen were 29.3°C, 34.0‰, and 4.4 ml/l respectively. Similarly, the phosphate, nitrate and silicate values during the same period were 0.40, 0.76 and 5.4 µg at/l respectively.

Vizhinjam

During the year 1980, the surface water temperature off Vizhinjam showed minimum (24.2 to 24.8°C) during monsoon season, maximum (28.9 to 29.2°C) during summer, and moderate (27.7 to 28.0°C) in winter. The salinity values were found maximum(35.3‰)during the post monsoon. A minimum value of 33.4‰ was attained in monsoon. In winter the salinity ranged from 30.9—35.1‰. The dissolved oxygen was never below 4.5 ml/l in any month of the year (1980) and its annual variations are very less.

During the I quarter of 1981 the sea surface temperature varied from 28.7°C to 29.5°C. For the same quarter the ranges of salinity, dissolved oxygen and inorganic phosphate are 35.10 —35.22‰, 4.9—5.1 ml/l, and 2.29—2.73 µg at/l respectively.

Tuticorin

The surface water temperature gradually rose from 26.1°C in January to 31.3°C in May. During the southwest monsoon period the temperature was lowered to 28.0°C. By December its value was 27.5 dropping towards its winter minimum in January. The salinity values over the year 1980 ranged from 32.7‰ to 34.4‰, the lower values occurring during northeast monsoon period and the higher values in summer. During southwest monsoon period the salinity values were moderate. There were no significant variations in dissolved oxygen. The hydrogen Ion concentration which remained respectively at 5.7 ± 0.7 and 7.9 ± 0.1. The values of phosphate ranged from 0.08 to 0.12 /ug at/l throughout the year of 1980. The nitrite values were lower in the post monsoon.

During the first quarter of 1981, the winter temperature of the surface waters rose to 31.0°C by March. The salinity varied from 33.0‰ to 33.45‰ and the dissolved oxygen from

5.0 ml/l to 5.9 ml/l. Among the nutrients during the first quarter of 1981, phosphate varied from 0.06 to 0.09 µg at/l and the nitrate from 0.1 to 0·7 µg at.

Mandapam Camp

The waters of the Gulf of Mannar and the Palk Bay were monitored for their hydrological properties during the period under report. During 1980, the surface water temperature in the Gulf of Mannar more or less linearly increased from 26.2°C of January to 32.0°C of May and thereafter it decreased to 29.0°C in July/August, then again rose to a secondary maximum of 30.8°C in September before reaching the winter minimum in January. In the Palk Bay the water temperature gradually rose from 26.3°C in January to 30.0°C in April. Thereafter the water temperature was maintained for a long period until September at 29.5±0.5°C. Afterwards it gradually reduced to the winter minimum in January. Thus, the water temperature in the Gulf of Mannar showed two peaks per annum whereas the water of Palk Bay showed a single but prolonged peak in the year 1981.

The salinity values of both the Gulf of Mannar and the Palk Bay are comparatively close by during the entire period of the southwest monsoon (May–September) and during this period the variations were from 33‰ to 35‰. On either side of the monsoon, especially during winter the salinity in the Palk Bay is much lower than in the Gulf of Mannar. By December/January the salinity in the Palk Bay was as low as about 27.5± 0.5‰ whereas that in the Gulf of Mannar it is about 32.5‰. Thus, the diluting effect of northeast monsoon rains is more pronounced on the Palk Bay waters than on the Gulf of Mannar waters. There was no significant seasonal variation in dissolved oxygen content both in Gulf of Mannar and the Palk Bay waters which maintained the level of oxygen at about 4 to 5 ml/l.

The silicate values in the Gulf of Mannar are considerably increased by run-off from land during the southwest monsoon period and the values reached a peak (about 12 µg at/l) by northeast monsoon rains in November. The run-off effect of the southwest monsoon rains is more prominent on the waters of Palk Bay by way of increase of its silicates to any value around 8 µg at/l. There is a tremendous impact of northeast monsoon

run–off into the Palk Bay where silicate values are as high as about 33μg at/l in November.

The inorganic phosphate values both in the Gulf of Mannar and the Palk Bay experience a gradual decrease from 3.5/ug at/l in January to as low as 0.5 μg at/l in April. The lowered values of phosphate continue for the rest of the year in Palk Bay whereas a monsoon rise is observed reaching a peak value of about 2.5 in August in the case of Gulf of Mannar. In both the waters the hydrogen Ion concentration was steadily maintained at about 8.2.

During the first quarter of the year 1981, the surface temperature of the waters of Palk Bay and Gulf of Mannar region varied from 27.0 to 28.3°C. During this quarter the salinity of the waters of Palk Bay did not exceed 29.72‰ whereas the Gulf of Mannar the salinity attained was 33.15‰. Dissolved oxygen in the Bay was 4.7 m/l while in the Gulf it was 5.2 ml/l. Phosphates and nitrates in the Gulf were more than in Palk Bay whereas the silicate values were high in the Palk Bay. The pH value in both the areas was maintained at 8.2 in this quarter.

Madras

Surface water samples were collected on board Government of India trawlers 'Red Snapper', 'Skipper II' and 'Skipper III' from fishing squares 13.80, 1C, depth 40 to 50 metres) and Madras Research Centre's Vessel 'Cadalmin III' from 12.80 6B, 6C, 13.80 1c (fishing squares) to study the seasonal variations of surface temperature, salinity and dissolved oxygen.

The monthly mean values of water temperature, dissolved oxygen and salinity are given below:

Month	Temperature°C	Dissolved oxygen ml/l	Salinity ‰
January 1980	29.2	2.04	...
February	28.2	3.56	32.35
March	29.8	3.29	35.35 to 35.99
April	No samples		
May	29.00	3.22	33.53

June	27.00	3.12	34.81
July	29.5	2.26	—
August	27.50	–	34.97
September	No samples		
October	29.2 to 29.5	5.29	2.95
November	28.1	5.74	30.67
December	25.00	4.5	28.1
January 1981	24.5	6.3	28.12
February	25.3	5.7	33.15
March	27.2	4.5	31.44

Waltair

During the period from January 1980 to March 1981, the waters of Visakha outer harbour were monitored for temperature, salinity, pH, dissolved oxygen, inorganic phosphate and silicate. The changes of various parameters of the open sea side waters of the outer harbour are described below. The surface water temperature showed a double maxima in the year (1980), the first peak (about 28°C) occurring in March, and the second maximum of the same order spreading over a period of three months July to October. The corresponding two troughs of temperature occurred in May/June and December/January and the temperatures corresponding to the depressions are 25°C and 24.5°C respectively. The air temperature showed a single maximum about 29.5°C in May and single minimum occurring in January, the temperature of which was 25.5°C in 1980 and 22°C in 1981. The annual variations of salinity did not confine to such wave-type oscillations in the year. It started from about 35.5‰ in a month ortwo. The high value of salinity persisted till May and thereafter it started declining until September (to about 31.5‰). But for a depression to the value about 25‰ in October/November, the statusquo of salinity was maintained at about 31.5‰ from December 1980 onwards till March 1981. The gradual dilution of sea waters from its May value to its September value may be the effect of the southwest monsoon rains while the October/November sudden and steep fall of salinity may be attributed to the effect of river discharge into the sea. Throughout the period of 15 months, there were no signi-

ficant changes or seasonal trends in the dissolved oxygen which varied between 3 ml/l and 5 ml/l. The inorganic phosphate values were lowest (about 0.05 μg at/l) in premonsoon or warm weather season during the year 1980. During monsoon its value steadily increased to 0.40 μg at/l by the end of August thereafter it decreased for a couple of mon hs to 0.20 μg at/l and then rose to 0.45 μg at/l in canuary 1981 and henceforth decreased to 0.18 μg at/l in March 1981. The cilicate values fluctuated much during the period. During the year 1980 the ffiuctions were between 17.2—22.4 μg al/l. Lowering the values towards monsoon season from either side of the period was the general trend of variations of silicate during the year 1980. The silicate value (21.6 μg at/l) in January 1981 are comparable with the values of the end period. But by the end of the first quarter 1981 the values of silicate decreased to 12.5 μg at/l. The hydrogen ion concentration varied between 7.6 and 8.2 during the period of 15 month observations. Relatively low values occurred in post-monsoon and winter periods.

Thus, the waters all around the coast are monitored for their physical and chemical conditions.

Apart from monitoring the waters, a simple eight-ordinate mathematical scheme was evolved for computing the wave components of periodic variations of a cascade nature. Unlike the classical method of harmonic analysis, this scheme was found best suited to split up the components of diurnal, semidiurnal, and quarter diurnal variations from the total variations of parameters like tides, barometric pressures etc. The scheme was simple and lucid and it makes the best approximation to the observed values just as in the case of statistical method of least squares. The scheme is applicable in the fields of oceanography and meteorology wherever cascade system of variations are involved.

Fishery oceanography investigations—Survey of the Ecological and Environmental characteristics of the estuarine regions of the west coast of India. (MBO/ES/1.2)

C.P. RAMAMIRTHAM AND OTHERS.

The estuarine regions from Azhikode to Vaikom, the region at Elathur (Calicut), and the one at Ullal (Mangalore) have

been taken up for study during this year. Eight stations have been fixed from Azhikode to Vaikom in the Vembanad lake viz. Azhikode, Cherai, Manjanakad, Bolgatty, Thevara, Aroorkutty, Perumbalam and Pallipuram.

The general hydrographic conditions in the estuary from Azhikode to Vaikom showed that the maximum temperature of 33.5°C was during May at the surface in the northern regions. Salinity values were also fairly high in the lake during summer. Conspicuous changes were perceptible during monsoon and the monsoon effects were maximum in the Azhikode and Thevara regions which were closest to the Arabian Sea and were subject to oceanic influences. The bottom temperatures were reduced by about 3–5°C than the premonsoon period in the areas. Drastic decrease in salinity during monsoon was another important feature. The change over from monsoon started from October onwards and maximum oceanic influence was observed during July.

Azhikode region was always richer in plankton than the other regions of observation. In general the zooplankton was represented by the following groups. Medusae, copepoda, Amphipoda, Cirripid naupilus, lucifers, zoea of crab, decapod larvae, gastropod larvae, chaetognatha, fish eggs and fish larvae. Copepods and crab larvae were dominant in the plankton. The abundance of copepods was observed at stations Manjanakad, Karuthedam, Aroorkutty and Perumbalam. Dominance of crab larvae were noted at Azhikode.

Phytoplankton and primary productivity of the shelf and adjacent waters (MBO/PP/1.1)

K. RADHAKRISHNA, P.V.R. NAIR, K.G. GIRIJAVALLABHAN, C.P. GOPINATHAN, P. KARUPPASWAMI, C.V. MATHEW AND OTHERS.

The results of investigations on primary productivity carried out from the different Research Centres of the Institute are presented below:

Waltair

While collecting baseline information for coastal aquaculture in the Bhimilipatnam area, it was observed that gross productivity in the open sea averaged to 456.24 mg.C/m^3/day during 1st quarter and in the backwaters the same was 593.4 mg./C/m /day. At Visakapatnam outer harbour two stations, one inside the harbour and the other outside the harbour were investigated. Gross productivity in the outside harbour station averaged to 564.8mg. C/m^3/day and inside harbour—591.7 mg/C/day. Maximum production was during May at both stations.

Mandapam Camp

Average gross monthly productivity at Palk Bay, Gulf of Mannar and Athankarai estuary were 308.43, 324.99 and 377.03 mg C/m /day respectively. At all three stations productivity was low during July and high during June and Decembei.

Cochin

Using 14_c technique productivity was investigated at 2 stations with depths 15 m and 30 m. The average productivity

at the surface in both stations varied from 850-1000 mg C/m^3/day. Towards the base of euphotic zone average productivity varied from 450-500 mg C/m^3/day.

Karwar

Gross productivity at the surface averaged to 369.27 mg, C/m^3/day and at 7-11m depth the same was 309.5 mg. C/m^3/day. Maximum and minimum values were respectively during July-September and November respectively.

Neustonological investigations (MBO/NU/1.1)

P. Parameswaran Pillai, P.V.R. Nair and C.P. Gopinathan.

Regular sampling of neuston and collection of data on the hydrographic parameters were conducted at 2 stations off Cochin during January-December, 1980. A rectangular twin net, each with a mouth area of 15 x 10 cm has been fabricated and used for neuston sampling.

Thermal conditions of the water off Cochin indicated that the Sigma-t values were high during pre-monsoon period and lowest during October. Surface temperature varied from 27.0-32.0°C. Surface salinity values ranged from 12.0‰ in June to 34.0‰ during summer months. Dissolved oxygen was low during the monsoon period when compared to the pre-monsoon and post-monsoon periods. Primary productivity values were relatively high during the late monsoon and early post-monsoon seasons, ranging from 464gC/m^3/day to 1250 gC/m^3/day.

Biomass in the neustonic layer showed low values during the monsoon and pre-monsoon months (0.2-2.0 ml/20 mts haul) but relatively high values (14.9 ml/20 mts haul) were recorded during post-monsoon months. Copepods formed the dominant group of plankton in the neustonic layer followed by cladocerans, chaetognaths, siphonophores and fish eggs and larvae. Larvae of *P. indicus* and *M. dobsoni* were met with in abundance during November to May and August to September. Fish larvae, mainly of clupeids were dominant in the post-monsoon months. Fish eggs formed about 24% of the neuston component in the inshore station during premonsoon months. In the offshore station,

fish eggs, mainly of *Stolephorus* sp. contributed to 58.4% of the total neuston during May. The occurrence of maximum number of fish and crustacean eggs and their larvae in the neuston during the monsoon and post-monsoon periods indicates intense breeding of these forms off Cochin during the above periods.

Secondary production of the shelf and adjacent waters (MBO/PL/1.1)

K.J. MATHEW, K. RENGARAJAN, K.G. GIRIJAVALLABHAN, S. KRISHNA PILLAI, R. MARICHAMY, PON. SIRAIMETAN, C.V. MATHEW, T.S. NAOMI, P.A. THOMAS AND TECHNICAL STAFF.

During 1980 the project was carried out from nine research centres. At majority of the centres plankton collections could be made in all months of the year. However, at Bombay, Calicut and Mangalore the south west monsoon prevented sampling in the 3rd quarter of the year. The period of zooplankton abundance was almost same on both east and west coasts being in the months of September and October. Off Bombay the maximum quantity of zooplankton that is 17 ml per 10 mts. haul was collected in October and the minimum of 1 ml was collected in December/January period. At Karwar, except in August zooplankton collections could be made throughout the year. High biomass values were obtained during the premonsoon and post monsoon periods. At Mangalore the maximum quantity of zooplankton of 34 ml per 10 mts. haul was obtained in December. In February and September also the zooplankton biomass was more. The copepods made a gradual increase from January to April. Unlike in all other centres where the maximum zooplankton abundance was noticed in September/October period, at Calicut the maximum quantity was obtained in March and the minimum was in December. The period from January to March was significantly productive. A siphonophore species *Chelophyes appendiculata* was recorded for the first time from the Lakshadweep waters. Zooplankton biomass and species composition in Mattancherry canal at Cochin during the spring tide was studied. At Vizhinjam also the maximum quantity of zooplankton was collected in the month of September and the minimum in July. Swarms of pteropod *Creseis* was noticed in Nove-

mber-December period. Fish eggs and larvae were particularly abundant in March. At Tuticorin zooplankton samples were collected in all months except in July. Maximum quantity was obtained in September. Copepods were less from January to March. At Mandapam the zooplankton biomass ranged between 3.7 ml in February and 37.8 ml in September. Blooms of *Rhizosolenia, Pleurosigma, Thalassiothrix* and *Ceratium* were obtained in May and June. In the month of March, October and November young ones of squid *Sepiteuthis arctipinnis* were noticed.

Fish eggs and larvae studies (MBO/FEL/1.1)

K.C. GEORGE, M. KUMARAN, K. RENGARAJAN, I. DAVID RAJ, K.G. GIRIJAVALLABHAN, S. KRISHNA PILLAI, PON. SIRAIMEETAN AND TECHNICAL ASSISTANTS.

Work under this project was carried out at Cochin, Vizhinjam, Tuticorin, Mandapam Camp and Madras. The general objective of this project has been to assess the seasonal abundance of fish eggs and larvae with special reference to those of commercial species and early life history studies wherever possible. Mechanised vessels have been used for collection of the plankton at all centres except Vizhinjam where the Catamaran was the craft employed. At Cochin a 'Bongo 20' net, 20 cm ring dia. twin cone net, 0.5 mm square mesh with flow meter was used for the collections, while at the other centres single cone organdie net with mouth ring of 50 cm dia without flow meter was used. While at all other centres except Cochin the method of collection was based on fixed duration (10') surface hauls, at Cochin continuous oblique haul though the entire column with the Bongo net was made at two stations 15 m and 30 m depth, at a vessel speed of 2–3 knots. At all the centres the collections have been made in the inshore waters generally within 30 m depth contour.

Results of the study at the different centres

Cochin: 35 plankton samples have been collected during the year. Each sample consists of the material collected in the two cones of the Bongo net. Mean volume considered for estimating plankton biomass is half this volume. Plankton biomass was consistently more at the offshore station at 30 m depth

(0.05–1.5 ml/m^3 of water filtered) compared to that at the nearshore station at 15 m. (0.04—0.94 ml/m^3). July to October period showed a higher standing crop than all the other months of the year. Fish eggs were found in relatively more numbers (59—95/m^2) at the nearshore station during January–February period and October–November period (52–2069/m^2). During the March to July period fish eggs were found in large numbers at the offshore station (69–701/m^2) while at the nearshore station there were only small numbers. Fish larvae were found consistently in more numbers at the offshore station. More fish larvae were caught off Cochin within the 30m depth contour during January–February and September–October periods (14–173/m^2). During May–June period moderate abundance of fish larvae (13–98/m^2) was noticed at the offshore station. Most common fish larvae in the collections were *Ambassis* spp. Gobies and Leiognathids were also quite common. *Stolephorus* larvae are collected in all months, more from the offshore station—peak period observed was February. *Sardinella* larvae were collected more at the nearshore station. They occurred in January, February and June. Mackerel larvae occurred in May–June period. Flat fish larvae occurred in all months.

Several unidentified larvae have been drawn and their salient meristic and morphological characters recorded for their eventual identification.

Environmental factors

Average surface temperature as well as salinity were lower at the nearshore station than at the offshore station. While surface waters were warm during March to May period (29.9—30.6°C) it was cool during July to September period (24.8—25.7°C). April–May period showed the maximum salinity (35‰ at the offshore station) and October was the period of minimum salinity (28.75‰ at the nearshore station).

Studies on the ichthyoplankton collected from the Mattancherry channel at Thoppumpady during 1974–76 period were completed. The collections from this station contained mainly larvae of Gobiids, Cluepieods, *Ambassis* sp. Flat fishes, milk fish, and Elops. However there was only poor representation of larvae of cultivable fin fishes.

Vizhinjam

Fish eggs and larvae work was initiated at this centre in September 1980. Weekly plankton samples were taken from one km off Vizhinjam at a depth of 6m using Catamaran. The towing distance is 1000 m which is covered in about 30 minutes.

Some of the live fertilized eggs have been reared in the laboratory for study of the early developmental stages.

Tuticorin

27 plankton samples were collected at Tuticorin from the SPIC coast (Harbour point), Punnakayal estuary and square 4 'C' in the offshore region. The depth at stations varied from 5 to 25 mts. A mechanised launch was used for the collection.

The monthly average volume of zooplankton for a 10 minutes surface haul was in the range 7.1 to 13.8 ml. The minimum and maximum volume of plankton have ranged from 5.1 to 28.7 ml. Both the maximum and minimum was recorded during March, 1980, maximum at the SPIC coast and minimum at Punnakayal estuary. The monthly average number of fish eggs encountered ranged from 57 in December to 3051 in March 1980. Fish eggs were numerous (4320) in the sample collected in February 1980 and minimum (2) was recorded during May and December 1980. The maximum number of fish larvae (608) was recorded during February 1980, while the minimum (4) was noticed in December 1980.

Mandapam Camp

During the year 45 samples were collected. Fish eggs were more in number than the fish larvae and were abundant in February, March and August to October period. Fish larvae were met with in good numbers in March and December. Young squids, *Sepioteuthis arctipinnis* were observed in the month of March, October and December. Larvae of *Chirocentrus* spp. were noticed in the month of May and June.

Madras

Plankton samples were collected for eggs and larvae study in all months except April and September. The gear used was a single cone organdie net with mouth ring of $\frac{1}{2}$ m diameter.

Maximum number of fish eggs/larvae were collected during the November to January period with the peak in January.

Seaweed resources and culture investigations (MBO/SW/1.1 & 1.2)

V.S.K. CHENNUBHOTLA, N. KALIAPERUMAL, S. KALIMUTHU J.R. RAMALINGAM AND M. SELVARAJ.

The recent technologies developed by the Institute on the cultivation of agarophytes may be summarized as follows: For the first time in India, an attempt was made on the cultivation of agar yielding seaweeds such as *Gracilaria edulis* and *Gelidiella acerosa* using HDP rope culture nets at a 4 metre deep station with a view to bring down the cost of production of cultured seaweeds and to avoid the loss of crop due to grazing by fish and due to sedimentation. Preliminary trials were carried out on the cultivation of *G. acerosa* on coral stones. An average of 6.650 kg of *G. edulis* introduced in the nets at midwater in 4m deep station yielded 16.170 kg after 90 days. A harvest of 25.7 kg was obtained after 70 days for an initial seed material of 7.0 kg in the net introduced just immediately below the surface waters at the same station. An yield of 13 kg after 55 days and 10.6 kg after 60 days of *G. acerosa was* retrieved for 6.5 kg of seed material in the nets introduced at midwater level and immediately below the surface water level respectively at 4m deep station. The fragments of *G. acerosa* fastened to coral stones with the help of nails reached harvestable size after 5 months and 1.0 kg of seed material yielded 3.1 kg during this period. The growth of these two algae were better with less sedimentation in the nets placed just immediately below the surface waters than the nets introduced at midwater level.

Marine Pollution (MBO/MP/1.1)

P.V. RAMACHANDRAN NAIR, V. KUNJUKRISHNA PILLAI, C.P. GOPINATHAN, M.S. RAJAGOPALAN, V. CHANDRIKA, K.G. GIRIJAVALLABHAN, R. MARICHAMY, P. KARUPPASWAMY, G.G. ANNIGERI, S. MUTHUSWAMI, M.V. PAI, E.K. RAVINDRAN, G.M. KULKARNI, V.K. BALACHANDRAN AND A.G. PONNAIAH.

During the year under report, water quality monitoring in the Cochin backwater area was continued. Studies were conducted on three sensitive bacterial indicators viz., Coliforms, faecal coliforms and faecal streptococci. In order to estimate the relative quantum of faecal population from human source and non human sources, faecal index estimates were also made.

A survey of bacterial population in the deposits of decaying Salvinia and overlying water was also made in the inshore waters of Cochin. The extent of decomposition of weed components by aerobic bacteria and heterotrophic bacteria, the sediment-water ratio of the Zymogenous bacteria have shown the relative distribution of organic detritus in the benthos.

A base line survey was conducted for total mercury content in the estuarine areas which showed that Mercury content in the ambient water was low. Monitoring is being carried out on fish and molluscan samples also. Mortality of fishes which occurred with the onset of monsoon in 1980 has been traced to the presence of lethal doses of Ammonia discharged from nitrogenous fertilizer industry, acting in combination with high pH of the medium.

Remote sensing in fisheries (MBO/ES/4)

G. SUBBA RAJU AND P.V. RAMACHANDRAN NAIR.

The technology of Remote Sensing provides an opportunity to view the ocean from a high altitude platform. As a result one of the most useful applications of Remote Sensing technology is being developed for the monitoring of chlorophyll pigments in the ocean in order to map areas of high productivity. Aerial photography with airborne RMK Camera can also be made use of in the identification of fish schools.

This is a collaborative programme with Indian Space Research Organisation. With the National Remote Sensing Agency, Hyderabad, mapping of the productive areas off Cochin by remote sensing was undertaken during December 1980. Chlorophyll measurements were taken by Ocean Colour Radiometer from an aircraft. Optical and biochemical data were simultaneously collected in the sea. Horizontal distribution of chlorophyll concentration in the experimental area of about 1500 sq.

km of sea was obtained. Based on this, a contour map of chlorophyll distribution has been prepared. It is proposed to utilize this technique for correlating chlorophyll distribution with the distribution of fish shoals.

In the Joint Experiments programme with Space Application Centre, Ahmedabad an aerial survey was conducted in a test area off Karwar coast in January 1981. Multi Spectral Scanner and Camera systems were operated along with collection of Sea truth data.

It would also be possible to correlate LANDSAT data and suspended sediments with fish schools. Future programme includes mapping of Exclusive Economic Zone in stages and the estimation of pelagic fish resources.

Mass culturing of plankters (MBO/MCP/1)

P.V. RAMACHANDRAN NAIR, C.P. GOPINATHAN, GEETA BHARATHAN, D.C.V. EASTERSON, V.K. BALACHANDRAN, R. PALANICHAMY.

Detailed report on mass culturing of phytoplankters at Narakkal appears in crustacean culture section. Mass culture of phytoplankters and rotifers were developed in the field laboratory at Madras/Kovalam. Blooms of *Tetraselmis* and *Chlorella* develop within 4–5 days of innocculation in plastic pools and fibre glass tanks. Following these blooms rotifer populations develop. The growth characteristics of *Chlorella* and *Phromedium* have been studied.

Investigations on coral reef resources (MBO/CR/1.1)

C.S. GOPINADHA PILLAI.

A field guide to the Scleractinian corals of south east coast has been prepared. The coral fauna includes 92 species distributed among 32 genera. A new species has also been described. An account of the coral formations of Gulf of Kutch area is being prepared. The destruction to coral colonies in Minicoy caused by the star fish, *Acanthaster planci* has been studied.

Ecological studies of mangrove areas (MBO/MS/1.1)

M.S. RAJAGOPAL, G.S. DANIEL SELVARAJ, A. BASTIAN FERNANDO AND A. KANAGAM.

Ecological studies of mangrove areas at Cochin and Tuticorin were continued. At Cochin the islets in the bar mouth area had predominant vegetation comprising of *Avicennia officianalis, Excoeccaria agallocha, Aegeceros corniculatum, Clerodendron enerme and Acanthus ilicifolius* mixed with terrestrial creepers such *as Ipomea* and *Dioscaria* and tall grass, *Panicum.*

Surface water temperature in the creeks ranged from 25.3 to 31.0°C and salinity values from 0.20 to 28‰. Dissolved oxygen content ranged from 1.7 to 7.73 ml/l.

Juveniles of *Ambassis spp. Haplocheilus, Etroplus, Therapon,* mullets and *P. indicus, M. dobsoni* and *Carridians* among crustaceans dominated the samples collected in the swamps. In the inter tidal zones, *Uca annulipes, Metapograpsis menis, Telescopium* and *Cerethedia* were quantitatively estimated.

At Puthuvyppu, the dominant vegetation is *Acanthus ilicifolius.* Physico-chemical conditions in the swamps is being studied.

Investigations on marine reptiles and mammals (MBO/MM/1.1)

E.G. SILAS, R.S. LAL MOHAN, M. RAJAGOPAL AND A. BASTIAN FERNANDO.

Cetaceans: 54 dolphins were landed at Calicut. 34 of them were *Tursiops aduncus* (1.0–2.7 m); 18 belonged to *Delphinus delphis* (1.0–2.4 m) and 2 *Tursiops sp.* Most of them landed during October to December. Females dominated in the landings. One baleen whale, *Balaenoptera borealis* was washed ashore near Quilandy.

Marine turtles: Out of the 185 turtles landed at Tuticorin 176 were *Chelonia mydas,* 7 were *Lepidochelys olivacea* and only 2 were *Eretmochelys imbricata* (January–June 1980). The size of the dominant species, *C. mydas* had a modal length, 70–75 cm. In June 1980, eight persons died after consuming the flesh of *E. imbricata* and an on the spot study has been made.

Along the Madras coast interesting observations have been made on the turtle nesting grounds and hatching rates. The species involved is *Lepidochelys olivacea*. Experiments have been carried out on the rearing of hatchlings. If the quantity of food (flesh of *Meretrix*) offered is 100% of the body weight, the animals increased their weight three folds in 2 months. Qualitatively it was observed that clam meat was better than *Halophilla* for increasing body weight.

At Tuticorin it has been possible to obtain the eggs of *E. imbricata from* Manapad–Periathalai area and a few of the eggs were hatched and the hatchlings reared.

Resources survey of Gorgonids (MBO/AR/1)

P.A. THOMAS AND RANI MARY JACOB.

About 90% of the Gorgonids exported from India are mainly fished from Rameswaram and Tuticorin area. Based on their colour the gorgonids are classified Black, Red, Monkey tail and flower types. The present investigations have revealed that several genera and species are clubbed together in each type. The black and red types have greater demand in the export market. So far 16 species have been identified and their distribution has been studied.

Calcibiocavitological investigations (FED/Misc. 1)

P.A. THOMAS, K.K. APPUKUTTAN, K. RAMADASS, V.S.K. CHENNUBHOTLA AND S.G. VINCENT.

The investigations carried out during the year may be summarised as follows:

Incidence of boring sponges is high on culture rafts both at Tuticorin and Vizhinjam (22% and 35% respectively). True pearl oyster, *Pinctada fucata* is more prone to sponge infection than flat oysters, *Pinctada sp. P. fucata* above 30 mm are usually infested and as the oyster grows older the infection is 100%. The sponges produce holes in the inner aspect of the shell which may cause physiological strain and diseases. Polychaetes such as *Polydora* also attack pearl oysters cultured at Vizhinjam. Sponge infection is common in mussels occurring in the natural beds than those from cultured rafts as they are harvested at sizes

below 60 mm. Sacred chanks collected off Quilon are heavily infested by boring sponges (50%). The chanks are also affected by boring molluses such as *Lithophaga spp.* and *Botula cinnamomoea.*

Ecological effects of Salvinia weed deposits in the inshore waters off Cochin (MBO/RE/1.1)

V. KUNJUKRISHNA PILLAI, V. CHANDRIKA, C.P. GOPINATHAN A REGUNATHAN AND P.V. RAMACHANDRAN NAIR.

The period of weed deposition starts immediately after the onset of monsoon and continuous till January. Along with the flood waters enormous quantities of *Salvinia* reach the estuarine areas. As soon as the weeds come into contact with saline waters they begin to decay. The tidal movements brings the major part of them to the inshore areas and the decayed weeds settle to the bottom in large quantities. This process continues till January-February. However the peak period is between October to January. This phenomenon decreases the dissolved oxygen content of the benthic area. The comparatively low rate of primary production in the benthic region along with high dark fixation indicate abnormal conditions prevailing. The long term effects appear to be the interference on the benthic population especially the filter feeding animals. The association of micro-organisms such as bacteria and fungi have also been investigated.

Projects completed

The research projects of the Division having Project Code Nos. MBO/ES/2.1 & 2.2; MBO/EE/1.2, MBO/MP/1.2, MBO/MS/1.2, MBO/SP/1.1 & FED/MC/P 1.1, have been completed and completion reports are being prepared.

INTER–DIVISIONAL PROJECTS

Survey of fish, Prawn and molluscan (bivalve) seed resources CMFRI/IDP/1

E.G. SILAS, K. RENGARAJAN, M. RAJAGOPALAN, S. SHANMUGAM, R. THIAGARAJAN, G.S.D. SELVARAJ, K. RENGA RAJAN, R.S. LALMOHAN, K.V. SOMASEKHARAN NAIR, N. GOPINATHA MENON, T. DHANDAPANI, BASTIAN FERNANDO, K.N. GOPALAKRISHNAN, K. NANDAKUMARAN AND P. RAMADOSS.

The survey was conducted at Calicut, Cochin, Vizhinjam, Tuticorin, Mandapam and Madras.

Calicut: The centres in this zone were surveyed eight times. In almost all the estuaries in this zone young *Penaeus indicus* were abundant during January–April period, *Metapinaeus dobsoni* from January to June, *M. monoceros* and seeds of Mullet and *Etroplus* during the December–March period.

Cochin: The estuaries between Ponnani and Neendakara were surveyed regularly. While seeds of *P. indicus, M. dobson,* and *M. monoceros* were common in all the estuaries surveyed, a nursery ground of *P. semisulcatus* was found in the Ashtamudi Lake. In these areas (except the Ashtamudi and Thottappalli estuaries) the bivalves *Villorita* spp., *Meritrix* spp. and *Crassostrea* spp. constituted a major economic resource. Mullet fry were present in large numbers in the Chetwai, Puthuponnani and Ponnani estuaries and in the Ashtamudi Lake there were good *Chanos* fry resources.

Vizhinjam: In the 16 centres which were surveyed regularly, the important culturable seeds obtained were those of mullet, *Sillago* and *Etroplus* among fishes and *P. indicus, M. dobsoni*

and *M. monoceros* among prawns. Mullet fry occurred in all the centres in good numbers during December–March. Pearl oyster seeds 22–67 mm in size were available at Muttom in March, May and October.

Mandapam: From the nine centres seeds of *P. indicus* and *P. semisulcatus* were observed in large numbers during January–May period. *Chanos* fry occurreed in the tidal pools in Pamban, mullet and sillago fries in the Athankarai, Kanjirangudi and Thonithurai estuaries.

Madras: Seeds of *P. indicus* occurred at Thopputhurai, Nagapattinam, Tranquebar, Point Calimere, Thinnaveli and Killai. Young *P. monodon* occurred at Nagapattinam and Tranquebar. The Killai estuary was particularly rich in the seeds of *P. indicus, M. dobsoni, P. semisulcatus, Sillago* and mullets.

Investigations on fish and shell fish diseases CMFRI/IDP/2

S. MAHADEVAN, K. RENGARAJAN, D.C.V. EASTERSON, R. SOUNDARARAJAN, S. LAZARUS, C. THANKAPPAN PILLAI AND V.G. SURENDRANATHAN.

The investigations were conducted at Cochin, Vizhinjam, Tuticorin and Mandapam. No large scale mortality occurred in the hatcheries at these centres except in the case of larval penaeid prawns at Narakkal.

Cochin: In the prawn culture ponds at Narakkal the occurrence of *Haemorrhagic septicemia* due to the infection of *Pseudomonas fluorescens,* recognisable by the red spots which it produces on the restrume, and *Vibriosis* due to the infection by *Vibrios anquillarume* evidenced by white patches on the abdomen were recorded. Infection by *Escherichia coli* resulting in the disintegration of the appendages and telson caused mortality among the larvae of *Penacus indicus. Chondracoccus* infection (Myxobacteriosis) was met with among *P. indicus, P. monodon* and *Metapenaeus dobsoni.* 90% cure was achieved by the use of crystals of violet and the applitcaion of 10–15mg/lit of chloromycetin, investigations are in progress to find the cause of the 'soft-shell' condition met with among penaeid prawns.

Calicut: Mussels from Calicut and Vizhinjam were periodically examined to monitor the occurrence of the bacterial flora on them.

Vizhinjam: Though ectoparasites like isopods and copepods, occurred no pathogen that cause wide-spread disease was met with.

Tuticorin: Regular monitoring of the bacterial flora in the oyster farm indicated that the presence of coliforms were below the level that could cause an out-break of disease. There was no incidence of trematode cercaria being present in the viscera of oyster of 25 mm to 40 mm size group during September due to predation by the gastropod *Cymatuine cingulatum.* The predator nuisance was brought under control by the physical removal of these gastropods periodically. *Psuedomonas* infections of mullet and milk fish in the experimental ponds which occurred during October-November was brought under control by treating the fish with violet solution.

Mandapam: When whitening of the skin occurred among eels in the culture ponds, normalcy was restored by isolating such eels and releasing them in fresh tank water.

Madras: No work was possible due to lack of samples from the farm where the physical conditions of the environment caused the distruction of stock in the farm.

National programme of tagging oil sardine, mackerel and prawns CMFRI/IDP/3

P. VIJAYARAGAVAN, A. NOBLE, M.M. THOMAS, E. VIVEKANANDAN, P. SAM BENNET, S. LAZARUS, T.M. YOHANNAN, N.S. RADHAKRISHNAN AND OTHER PARTICIPANTS AT RESPECTIVE CENTRES.

Of the various proposed tagging centres, the mark release experiments could be implemented only at Cochin, Calicut and Quilon (Ashtamudi lake).

Cochin: Tagging at sea was much restricted due to the non-availability of the research vessel at the proper moments. Nine tagging trips were undertaken in the sea during which 2341 prawns belonging to the species *Penaeus indicus, Metapenaeus*

dobsoni and *Parapenaeopsis stylifera* were tagged and released off Cochin. 163 of these (+4 tags alone) were recovered from the area of their release within ten days of release, indicating that these species do not migrate far from the fishing grounds from where they were caught.

In 50 tagging operations extending over the entire year 12,859 prawns were marked and released in the Cochin backwaters off the Bolghatty island. Of these, 1680 were *P. indicus*, 9438 *M. dobsoni*, 890 *M. monoceros*, 833 *M. affinis*, 16 *P. semisulcatus* and 2 *P. monodon*. Only 38 prawns were recovered, all of them from within the backwaters and none from the sea. This confirms the findings of last years tagging programme that the prawn population of the prawn grounds off Cochin are not entirely sustained by emigrants from the Cochin backwaters.

Quilon: As a follow up of the tagging experiment which was undertaken in the Ashtamudi Lake in 1979, an intensive tagging operation lasting for 12 days was carried out during which 5379 prawns, caught from the backwaters, were marked and released in the backwaters itself. The species released were 2550 *P. semisulcatus*, 2090 *P. indicus*, 738 *M. dobsoni* and 1 *M. affinis*. Of these, 80 prawns were recovered from the backwater itself. Although a very intensive prawn fishery was in progress in the sea not far from the estuary of Ashtamudi Lake no tagged prawn was recovered from the sea.

Calicut: Owing to non availability of suitable boat at this centre tagging operations could not be intensified. Only 192 oil sardines were tagged and released in the sea off West Hill and 371 tagged prawns (*P. indicus*, *P. monodon* and *M. monocoros*) released in the Korapuzha estuary. 6 of the tagged prawns (*P. indicus*) were recovered from the estuary itself.

Artificial Enrichment of Lagoon waters of Minicoy Island CMFRI/ IDP/6

A.V.S. MURTY, G. SUBBARAJU, C. S. GOPINADHA PILLAI AND V. JOSANTO.

The data collected at Minicoy by the team during November, December 1979 were further analysed. Observations on shore stability indicated that during that period the middle region

of the lagoon shore which was composed of fine sand and coral debris has been eroded for a distance of 2 km, 20 metres in width, resulting in the uprooting of some coconut trees. Although occasional erosion and accretion is a common feature of coral atolls, no significant deposition has been noticed in Minicoy except at the southern part of the lagoon where a rich sea-grass bed serves as an efficient sediment trapper. The forceful tidal flow which enters the lagoon mainly through the sabh Magu channel and goes out, after a deviation, through the Neru Magu channel seems to affect the stability of the shore in the region. Whereas, the shores on the windward side with consolidated coral formations seem to be quite stable.

A survey of the echinoderm fauna in the Minicoy lagoon which was undertaken in view of the destruction they cause to the coral reefs revealed their paucity in this area. *Culcita, Linkia* and *Holothuria atra* occurred in small numbers on sandy bottom as well as on coral. A few sea urchins and brittle were located under stones and corals.

The multi-armed star fish *Acanthaster planci* generally considered as a major biological factor that causes large-scale mortality of reef corals in several parts of the Indo-Pacific, was specially observed. They were occasionally met with in sandy bottoms and on coral shoals, particularly in the south-western part of the lagoon near Bosh Point where there was a luxuriant growth of corals such as *Acropora corymbosa, A. intermedia, A. hebes, A. humilis* and *A. hemprichi*. At the site of their present occurrence the density of their population was 2-3 adult individuals per sq. km. The two largest specimens of this species possessing 47 arms each measured 36 and 40 cm in diameter. The feeding habit of the species which is nocturnal coincides with the growth and expansion of the coral polyps at night. The predation on polyps is visible as small white patches on the corals where the star fishes are present. However, the damage the latter cause has not been significant.

Luxuriant growth of corals chiefly *Acropora corymbosa, A. intermedia, A. hebes, A. humilis* and *A. hemprichi* forming large thickets are separated by sandy areas. The depth of water

during low tide at these coral beds ranged from 25–50 cm resulting in partial exposure of the coral.

Further analysis of the data is in progress.

Impact of Thanneermukkom Bund on the fishery of the Vembanad Lake CMFRI/IDP/7

V.K. PILLAI, S.K. DHARMARAJA, C. SUSEELAN, K.J. MATHEW G.S.D. SELVARAJ, K. K. P. PANIKKAR, V. JOSANTO, G. RADHAKRISHNAN AND M. AYYAPPAN PILLAI.

The project aimed to assess the changes in the ecosystem including the fisheries of the Vembanad Lake consequent to the construction of the salt water barrage at Thanneermukkom, was continued during 1980. The temperature, salinity and oxygen along with the distribution and abundance of zooplankton, prawns, fishes and bivalves were monitored at four stations in the Vembanad Lake, two stations each in the northern and southern zones respectively. During the year the barrage remained closed from January to May.

Hydrography and plankton

The surface water temperature in the northern zone showed bimodal fluctuation with a decreasing trend during monsoon. A minimum water temperature of 27.5°C in December and a maximum of 33°C in April were recorded. Salinity ranged from 0.% during June-July to 11.12‰ in April. In the southern zone salinity was invariably very low and the dissolved oxygen ranges from 3.65 ml/ to 6.02 ml/L.

Madusae, copepods, amphipods, decapod larvae, polycharcts, fish eggs and fish larvae were the main zooplankters. Copepods dominated the plankton. In the northern zone the distribution of zooplankters showed a bimodal fluctuation with peak during summer. They were numerically fewer in the southern zone.

Fin fish fishery

The major fishery of fin fishes was constituted of *Etroplus suratensis, Mugil cephalus, Tachysurus subrostratus, Lutianus argentimaculatus, Lates calcarifer, Scatophagus argus, Wallago attu, Brachiurus spp., Liza spp.* and *Hemirhamphids.* Local en-

quiries revealed that the fishery has dwindled after the construction of the barrage, particularly in areas south to the barrage.

Distribution, abundance and fishery of prawns

Experimental fishing using a "Try net" revealed a decline in the abundance of juvenile penaeid prawns represented by *Metapenaeus dobsoni* in all the stations compared to the previous year. The decline was pronounced in the southern zone.

Fishery using fixed nets have been abandoned between Pallipuram and Thanneermukkom barrage (northern zone) due to inadequate tidal flow. However, substantial quantities of prawns and fishes are fished by free nets in this zone. The shore seines and drag nets operating in this area catch prawns at the rate of 3.5 kg/unit, juveniles (37–102 mm in size) of *Penaeus indicus*. constituted the bulk of the catches followed by *M. dobsoni* and *Machrobrachium idella*. At the southern-most station (Muhamma), during January, and intensive shore seine fishery made an average landing of 10 kg/unit of *M. dobsoni*, 49–65 mm in size. These prawns have probably entered the area while the shutters of the barrage were open during the monsoon.

Molluscan fishery

The species contributing to the molluscan fishery, in the order of their abundance, were *Villorita cornucopia, V. cyprinaoidea* and *V. cochinensi* of these, *V. cornncopea* was dominant on both sides of the barrage and more abundant in the northern region.

Studies on Ecological Energetics of prawns (CMFRI/IDP/8)

P.V.R. Nair, M.S. Muthu, M. Rajamani, A.G. Ponnaiah, M. Vijayakumaran, D.V.C. Easterson and C.V. Mathew.

I. Studies on energy transformation

1. *Penaeus indicus*

Experiments of 15 days duration conducted in three segments of five days each, on the intake, absorption and conversion of energy, confaecal loss of energy and maintenance of energy in juvenile (average weight 1.18 g.) *P. indicus* gave the following results:-

The average intake of energy was in the order of 0.159, 0.231, 0.149, cal/individual respectively for the I, II and III five day segments. The absorption efficiency was 98.5% during the first ten days followed by loss of energy through faeces during the rest of the period which was three times greater than in the first ten days. It is presumed that this was due to the confined environment (viz. aquarium tank) in which they were reared are due to the single type of food with which they were fed.

2. *Metapenaeus dobsoni*

Juveniles of *M. dobsoni* were experimented with artificial feed containing vegetable matter only and feeds containing purely animal matter cheap material like rice, bran powder, ground nut and coconut oil cake powder, beef and prawn head were used in preparing the artificial feeds. The energy values of the feed with animal matter was 4.145 cal/g and the without animal matter was 3.836 cal/g.

It was found that in the case of feed without animal matter the energy consumed in terms of calories/individual/day was 1.15 ± 0.171 and the energy lost as faeces was 0.564 cal/7 days. In the case of feed with animal matter, the energy consumed was 1.53 ± 0.169 and that the energy lost as faeces was 0.364 cal/7 days. The day to day fluctuations in the rate of feeding was less in the latter case.

3. *Growth Experiments on Penaeus indicus and P. monodon*

Experiments were conducted on the juveniles of *P. indicus* and *P. monodon* to study the effect of three types of food namely-clam meat, a compound diet made of fish meal + ground nut cake + rice bran + tapioca powder and thirdly a feed made up of clam meat and the compound food.

In *P. monodon* maximum growth was observed when fed with clam meat and a mixed ration while minimum growth was seen when fed with the compound food. In *P. indicus* maximum growth rate was obtained with mixed ration and minimum growth on compound diet. The overall growth in *P. indicus* was low when compared with *P. monodon.*

II. Physiological studies on prawns with reference to "Soft Condition"

1. *Effect of starvation*

Experiments in which prawns were subjected starvation with controls receiving prawn meat as food indicated that the process of becoming 'soft' was gradual and directly related to the number of days of starvation. The values obtained on the gross mea content, net meat content and percentage dry matter were in agreement with those of 'soft' prawns collected from the experimental ponds during the period of adverse ecological conditions, which confirms the hypothesis that starvation is one of causative factors for the 'Soft' condition in prawns.

2. *Effect of quality of food on the 'soft' condition in P. indicus and P. monodon.*

Experiments using carbohydrate rich food (boiled rice) and protein rich food (prawn meat) clearly indicated that protein starvation is one of the causative factors for the 'soft' condition of prawns.

3. *Effect of salinity on the gross and net meat content in P. indicus.*

The experiments were conducted at 4.4, 15.8 and 20% of salinities, which showed that the gross meat content, the net meat content and the percentage of dry matter increased as salinity increased.

4. *Biochemical studies on the 'soft' condition of prawns.*

Estimates of protein nitrogen (PN) and nonprotein nitrogen (NPN) in the tissues of 'soft' as well as healthy prawns showed significantly lesser amounts of PN and NPN in the tissues of 'soft' prawns compared to the healthy prawns. This indicates the possibility of endogenous protein starvation and/or other stress factors in the environment during periods of adverse ecological conditions.

LAB–TO–LAND PROGRAMME

This is the second year of implementation of the Experimental Transfer of Technology Lab-to-Land programme at the Institute. The most successful programme was the one taken up at the AMSF Harijan Society consisting of 122 families at Valappu near Cochin. A total area of 1.54 ha (Ponds A, B, C+Canal) was used in the demonstration of prawn culture. A major change effected was the introduction of finfish culture during the monsoon season in the place of traditional pokkali paddy cultivation which proved to be more remunerative. Several harvests of prawns and fishes were taken and the production from January 1980 to March 1981 was as follows:

Prawns: *P. indicus*	—	949.38 kg
P. monodon	—	4.22 kg
Quality fishes:	—	517.82 kg
Bye-catch (small prawns & fishes)	—	980.84 kg
TOTAL	—	2452.26 kg

The AMSF Harijan Society willingly utilised part of the revenue from the Lab-to-Land Programme for further development of the farm. A field day was organised in March 1980.

A total number of 15 families had been selected for the prawn/fish culture programme in Quilon District. Although some progress was achieved in prawn culture, some of the farmers took up fish culture and a few others had to close down the farms due to various reasons. It was very difficult to obtain feed-back information from the farmers.

The mussel culture programme at Elathur near Calicut which was carried out with 30 families made satisfactory progress though not to the desired extent. Due to lack of interest of the fisherman towards the end of the programme the harvest yielded only 4.9 tonnes of mussels against a much larger expectation. A Kissan Mela was organised in March 1981.

The oyster culture programme at Tuticorin with 15 fishermen families was successful in terms of production. About 20 tonnes of oysters were produced. However, the problem of marketing remained unsolved during the year in spite of concerted efforts made by the Institute.

At Mandapam seaweed culture programme had problems of predation of the seaweed by fishes and also siltation. In spite of introducing seaweed culture in the Gulf of Mannar as well as Palk Bay no tangible results could be achieved in terms of production during the year. The fishermen also did not continue their interest.

At Madras a prawn culture pond of 800 sq.m. was developed near Muttukad for the Harijan families. The initial production of prawns was not satisfactory as the fertility of the pond was very low. This was being remedied. The three village ponds which remained silted and choked with weeds were cleared under the Food for Work Programme and were stocked with fresh water fishes. The Harijan members were assisted to form a Co-operative Society to become eligible for lease of brackish water areas. Mussel culture at Karikattukuppam failed due to lack of interest of the fishermen.

A programme of mussel culture was initiatecd in Karwar with 10 fishermen families and 4 rafts were floated with seeded ropes.

After taking stock of the progress and problems of the Lab-to-Land programme at a meeting held in January 1981; it was decided to conclude the programmes at Elathur (Calicut), Quilon, Mandapam and Karikattukuppam. At all these centres the technologies had been demonstrated to the farmers.

OPERATIONAL RESEARCH PROJECT

The second Management Committee Meeting took place in May this year which gave guidance on implementation of the project based on the earlier working of the project. Many village meetings were also organised during this year.

The mussel culture rafts with 120 ropes were positioned in the sea. No seed was available at Kovalam, Pondicherry and Cuddalore but some could be collected from Ennore. The mussels had grown well reaching 55 to 60 mm by early November i.e. in 3½ months. Due to operational difficulties effective supervision could not be maintained and the raft drifted south-wards. In December due to the weight and rough weather conditions the raft got completely submerged and could not be salvaged immediately.

A market survey conducted during the year revealed that mussels are sold in six markets in Madras where there is a regular demand for the commodity. An estimated 5 to 7 tonnes of mussels valued at Rs. 7,500/- to 10,000/- are sold in Madras in one season of 3 months from July to October.

Prawn seed was collected by the fishermen and supplied to a few parties under the project's technical guidance. In January technical help was given to a private prawn farmer at Kovalam for constructing a small farm (0 2 ha) near the backwaters. The farm was stocked with 16,000 *P. monodon* seeds. This was used as a demonstration pond for the benefit of fishermen and other farmers who came for technical guidance. The harvest was done on 6th May 1980. 95 days after stocking and 75 kg representing about 1/3 the stock was removed. The remaining stock could not be harvested as it had been poached.

EDUCATION AND TRAINING

The training programme offered at the Institute was mainly on the culture of prawns, oysters and pearls and was intended to update the knowledge of the executive/managerial/extension personnel in the Fisheries Departments of the maritime states and the teachers in the universities. A training course in underwater investigation by SCUBA diving was also offered during the year under report.

On prawn culture, the training was arranged on an *ad-hoc* basis and depended on the requirements of the end user. During the year the main beneficiaries of this programme were the officers of the Marine Products Export Development Authority and the officials of the State Fisheries Department, Orissa.

Molluscan culture in recent years has gained considerable importance in view of the high production potential in the sector. Realising this, an ICAR sponsored Summer Institute in "Culture of Edible Molluscs" was organised at the Research Centre of the Institute at Tuticorin. This Summer Institute was the third in the series to be conducted by the Institute and it was held from 26 May to 24 June, 1980. It was participated by 15 Research Officers/Scholars from Andhra Pradesh, Bihar, Gujarat, Kerala, Rajasthan and Tamil Nadu. The 30-day course comprised of 24 hours of theory and 114 hours of practical classes, on mussel, edible oyster and pearl oyster culture.

Five Scientists and two other staff were given intensive training in SCUBA diving during November–March, 1980–81. Undergoing regular sea trips and using aqua-lungs, the trainees spent 26 hours of theoretical classes and 100 hours of field trips in the course programme.

Under the Transfer of Technology programme, fifteen small-scale fishermen were trained in edible oyster spat collection and their further culture in racks at the Research Centre at Tuticorin. Besides, different training programmes on prawn culture were organised under the auspices of the Krishi Vigyan Kendra which is presented elsewhere in the report.

CONSULTANCY SERVICE

The Consultancy Service rendered by the Institute during the period under report covered a wide range of field pertaining to the marine fisheries sector and coastal aquaculture of the country. The service included dissemination of information and data available with the Institute, technical advice and suggestions needed for research and development efforts of marine fisheries by the public and private institutions, and on aquaculture of finfishes and shellfishes in the coastal zone by the farmers and enterpreneurs. A few project studies on site selection and prawn culture were also undertaken assisting the new enterpreneurs.

One of the fields which was quite frequently referred to the Institute for information and advice was prawn culture. About 30 enterpreneurs who approached the Institute either to start prawn culture on scientific lines or to obtain information on different aspects of the system were supplied with the relevant information/data. Following the requests from the financial institutes, farm sites located near Cochin and Quilon were surveyed and the reports on their suitability for culture or otherwise were furnished.

Besides prawn culture, technical advice of the Institute was also sought on oyster culture, pearl culture and seaweed culture by the private enterpreneurs.

The fishery resources data collected and maintained by the Institute were frequently utilised by the Fisheries Department of all the maritime states and the Marine Products Export Development Authority for formulating the development programmes. Among others, the Centre for Management in Agriculture, Indian Institute of Management, District Collector, Cannanore District and M/s Mermaid Marine Products Pvt. Ltd., Tellicherry were helped with the relevant data to study the transportation and marketing of fishes, planning of rural development programmes for the Cannanore District and the feasibility of the marine fisheries schemes for Cannanore and Calicut regions respectively.

CENTRE OF ADVANCED STUDIES IN MARICULTURE

The Centre of Advanced Studies (CAS) in Mariculture was established at this Institute in June, 1979 as one of the sub-projects of the major project entitled "Centre of Advanced Studies for post-graduate Agricultural Education and Research" operated by the Indian Council of Agricultural Research (ICAR) in collaboration with the FAO/UNDP/UNESCO. The main objectives of the sub-project are to promote research and post-graduate education in mariculture which could eventually help in enhancing fish production of the country and to meet the expertise requirements for accelerated development of the sector.

The principal activities of the Centre during 1980 included starting of Master of Science course in mariculture; Ph.D. programme in the identified priority areas; conduct of National Workshops/Seminars and arrangements for the visit of consultants to the Centre and training of counterpart Scientists in the overseas Institutions and laboratories in subject areas which call for immediate upgradation.

The first meeting of the Advisory Committee of the CAS in mariculture was held on 29 October, 1980 to discuss its various activities. On the same day the sub-project was formaly inaugurated by Dr. M.V. Pylee, Vice Chancellor, University of Cochin, in a function attended by large number of local dignitaries concerned with the development of fisheries as well as mariculture.

The M.Sc. course for the academic year 1980–82 was commenced in October, 1980 with 10 students. This is a two-year course comprising of four semesters, and imparts a comprehensive education on various systems of mariculture and corollary subjects. The course is mainly implemented and managed by

the Scientists of the Institute. The first semester of the course is in progress.

Under the Ph.D. programme, four Senior Research Scholars were admitted to the course in July, 1980 to conduct research in the following subject areas. The Ph.D. programme includes one–year course work and 2 years of research.

1. Studies on environmental stress in the prawn, *Penaeus indicus* H. Milne Edwards in culture system.
2. Kinetics of growth and extra–cellular products in some selected nannoplankters.
3. Reproductive physiology of Indian species of the genus *Perna* (Family Mytilidae).
4. Sporulation of some Agarophytes and Alginophytes with special reference to selected environmental factors and transplantation.

A National Workshop on "Mussel Farming" was held at Madras in September, 1980 for 3 days under the auspices of the CAS in Mariculture. 46 Scientists/Professors/Techno–administrators representing the National and State Fisheries Organisations, Agricultural Universities and Fisheries Development Corporations participated in the Workshop. The present status of the mussel culture technology in India and the constraints encountered for its development were discussed. The gaps existing in the basic aspects such as culture environment, biology, nutrition, physiology and genetics of mussels and on applied aspects relating to development of the system, harvesting and post–harvest technologies and marketing were identified. The need for transfer of technology and purposeful extension was stressed. Identifying the priority R & D areas for consideration and implementation by various organisations concerned in the promotion of mussel culture, an "Action Plan" was outlined by the Workshop.

Expert consultancy in areas where there is only a little competency in the country at present and training of Scientists in such areas form important component of the sub–project. Under this activity, proposals were being finalised for the assign-

ment of Dr. Akio Kanazawa, Associate Professor, Faculty of Fisheries, University of Kagoshima, Japan, a specialist in prawn nutrition, and Dr. Ching Ming Kuo, ICLARM, Philippines, an expert on reproductive physiology, to visit the Centre in 1981. Similarly individual training programmes on nutrition reproductive physiology, bio-energetics and fish pathology were proposed to be arranged in the Kagoshima University, Japan; the Oceanic Institute, Hawaii; University of California, USA; the Marine Laboratory, Department of Aquaculture and Fisheries, Scotland, U.K. respectively.

In 1981, it is proposed to intensify the activities of the centre, particularly the research efforts in post-graduate programme.

INTER INSTITUTIONAL PROJECTS

Fish/prawn feed development for intensive culture (IIP/1)

SYED AHMED ALI, M. VIJAYAKUMARAN AND M. RAJAMANI.

At Narakkal four feeds (11–14) were formulated using prawn waste, fish meal, groundnut cake and tapioca in different combinations for evolving a suitable feed for intensive culture of the prawn *P. indicus*. The feed with 30% prawn waste, 20% fish meal, 20% groundnut cake and 30% tapioca gave the best growth (0.95 mm/day), food conversion value (1.67) and highest survival rate (97%).

Fresh plant leaves of *Rhizophora mucronata* were used as food for prawns in the form of dried pellets (ML–2), wet cooked pellets (ML–1) and wet dough form (ML–3). It appeared that cooking improved the quality of the leaf material which produced better growth results.

Four feeds using squilla with prawn waste, groundnut cake and tapioca were used in feeding experiments which are continued.

Pelletised feeds with 40% prawn waste, 20% fish meal, 20% groundnut cake and 20% Tapioca powder, with a total 36% protein content, were used at the rate of 10kg/day/ha in an experimental prawn culture pond of 0.1 ha stocked at the rate of 1 lakh seed/ha. At the end of 99 days the average length and weight of prawns in these ponds were 120.8 mm and 11.1 gm as against 105.4 mm and 8.9 gm obtained from a pond stocked at the rate of 50,000 per ha.

Feeds for fish were developed using groundnut cake, fish meal, tapioca and Vitamin mixture. Feed No. F. 8 gave the best results among the feeds tested.

At Kovalam six dry pellet feeds were formulated using clam meat, fish meal, *Acetes* powder, mussel meat, lobster moult, groundnut cake, rice bran, tapioca powder and Vitamin mixture. While dry pellets were acceptable to prawns they were not to lobster. Moist pellets feeds were also prepared and used in the feeding experiments.

Food conversion efficiency of prawns was studied using clam meat, compounded feed and a combination of both. It was found that clam meat and the combination gave better results.

Product development and quality control of molluscan products (IIP/3)

CMFRI: K. ALAGARSWAMI, K.A. NARASIMHAM, K. SATYANARAYANA RAO, R. SARVESAN, A. CHELLAM, P. MUTHIAH, P.V. SREENIVASAN AND P.S. KURIAKOSE.

The project could not make the targetted progress during the year as some of the essential facilities were lacking. Materials of farm-grown green mussel (*P. indica*) were handed over to CIFT at Calicut in March and April for analysis and processing. Blood clam (*Anadara granosa*) was given to CIFT Kakinada for processing. Proximate composition of *Meretrix Casta* was studied at Cochin and Mangalore. However, all aspects could not be covered. The fat content of *M. casta* at Cochin was less (3.11–5.99%) during monsoon season compared to premonsoon (6.09–7.07%) and post monsoon (6.15–8.39%) periods. At Mangalore, the percentage edibility of the clam varied from 26.0–35.2%, total solids 22.68–32.61 (% wet wt) and lipid content 22.58–28.16 (% dry wt). The shells of pearl oyster *Pinctada fucata* were analysed and the results were as follows: Moisture—7.23%, mixed oxides—0.10%, Calcium as CaO—49.0%, Magnesium as MgO—2.00%, Silica—0.90% and loss on ignition—41.00%.

Economics of marine fisheries at Calicut area (IIP/4)

CMFRI: K. ALAGARAJA AND K.K.P. PANIKKAR.

The detailed report on the first phase of the survey is prepared, covering the socio-economic aspects such as size of the

family, occupation details, possession of fishing equipment indebtedness and income. Average annual income per family in Puthiappa-Puthiangadi (where 34% of the fishermen families own either full or partial ownership of mechanised crafts) is Rs. 2200 as against Rs. 1125 in Elathur village. Among the fishermen families 74.8% and 9.1% are in debt, the amount of debt being Rs. 1845 and Rs. 111 per fishermen family in these two regions respectively. **

FISHERY BIOLOGY DIVISION

Breeding, seed production and culture of milkfish and pearl spot (FB/CUL/1.1.2)

E.G. SILAS, A.R. THIRUNAVUKARASU, G. MOHANRAJ, V GANDHI, S. SANKARALINGAM, J.X. RODRIGO AND K.K. SURENDRAN

This project is being implemented from Narakkal and Mandapam Camp. At Narakkal, a viable brood stock of about 450 pearl spot, *Etroplus suratensis* was maintained in experimental ponds and pools for the purposes of breeding, larval rearing and culture experiments. Observations were made during the year on the breeding and parental care of this species. Rearing of pearl spot larvae has been successful. Growth rate of 0.43 to 0.46 mm/day on an average was observed in the experiments. Pearl spot fry showed greater preference to *Moina* sp. than the rotifer *Brachionus* sp.

Fry of milkfish, *Chanos chanos* collected from natural sources during the month of June were reared in experimental ponds with different types of feed. The rearing period varied from 7 to 54 days. Average growth rate was observed to range from 0.298 to 2.30 mm/day and survival varied from 77.77 to 98.76%.

In pond culture of milkfish carried out with different stocking rates, average growth rate of 0.64 mm/day (for a stocking period of 366 days) to 1.67 mm/day (for a stocking period of 166 days) was observed . Experiments on prawn and milkfish

culture as well as culture of compatibie species such as mullets, pearl spot and milkfish were also carried out.

The milkfish brood stock maintenance programme at this Centre could not progress much during the year as only one live female specimen measuring 1060 mm (80 kg) could be collected from Ariyankundu and which died during transport to the farm site inspite of all efforts to keep it alive. For biological studies, 9 specimens of milk fish could be procured during the fishing season. The sizes ranged from 659 to 1247 mm and weight 2.2 to 12.3 kg and seven specimens were females.

Resources of seerfishes. (FB/PR/3.3)

At Tuticorin, hooks & lines and drift nets were the major gears operated which yielded 301 tonnes of seerfishes in the current year as compared to 171 tonnes in 1979. The gears accounted for 43.5% and 56.5% respectively of the landings. The bulk of the catches comprised of *S. commerson* followed by *S. guttatus* and *S. lineolatus*. Stray catches of *Acanthocybium solandri* also occurred in the catches. The highest catch (57 tonnes) was recorded in November and the second half being more productive yielded 208 tonnes of fish. Size composition in the catches was as follows:

	Size range (mm)	*Range in modal size (mm)*
S. commerson	332–1342	350–990
S. guttatus	212– 945	320–610
S. lineolatus	250– 987	—

(See also report on page 62)

MANAGEMENT COMMITTEE OF CMFRI

The composition of the Management Committee of CMFRI
(as on 1 - 4 - 1981)

1.	Dr. E.G. Silas, Director, CMFRI	Chairman
2.	Dr. R. Raghu Prasad, Assistant Director General (Fisheries) ICAR, New Delhi.	Member
3.	Miss B. Lalitha Devi, Accounts Officer, IIHR, Bangalore.	"
4.	Dr. S.V. Bapat, Joint Director, CMFRI.	"
5.	Dr. A.V.S. Murty, Scientist-S 3, CMFRI	"
6.	Shri S. Mahadevan, Scientist-S 2, CMFRI.	"
7.	Shri N. Neelakanta Pillai, Scientist-S 1	"
8.	Dr. P.C. Sivaraman Nair, Director of Research, Kerala Agricultural University, Mannuthy.	"
9.	Shri P.M. Tandel, Chairman, North Kanara Dist. Co-operative Fish Marketing Union, Karwar.	"
10.	Shri A.G. Kalawar, Director of Fisheries, Maharashtra.	"
11.	Shri S.N. Rao, Director of Fisheries, Kerala.	"
12.	Shri S. Rajagopalan, Senior Administrative Officer, CMFRI.	Member-Secretary

INSTITUTE JOINT STAFF COUNCIL

(as on 1 - 4 - 1981)

1.	Dr. E.G. Silas, Director, CMFRI.	Chairman
2.	Dr. S.V. Bapat, Joint Director.	Member
3.	Shri N.S. Radhakrishnan, Scientist-S I	"
4.	Shri M.P. Chandrasekharan, Asst. Accounts Officer.	"
5.	Shri S. Rajagopalan, Senior Administrative Officer.	Member-Secretary, Office side
6.	Shri P.E. Sampson Manickam, Scientist-S	Member
7.	Shri S. Kalimuthu, Tech. Assistant (T-II-3)	"
8.	Shri B. Narayana Rao, Junior Tech. Assistant.	"
9.	Shri Varughese Jacob, Computor (T-II-3)	"
10.	Shri A. Sethubaskaran, Superintendent	"
11.	Shri K. Muthuramalingam, SS. Gr. ii	"
12.	Shri G. Soundararajulu, SS. Gr. iii	"
13.	Shri N.K. Mohanan, SS. Gr. iii	"
14.	Shri V.M. Mariappan, Senior Clerk	Secretary, Staff side

INSTITUTE'S GRIEVANCE CELL

1.	Shri P.E. Sampson Manickam	Chairman
2.	Dr. S.V. Bapat	Member
3.	Shri S. Rajagopalan	"
4.	Shri M. P. Chandrasekharan	"
5.	Shri S. Kalimuthu	"
6.	Shri V.M. Mariappan	"
7.	Shri G. Soundararajulu	"

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Staff position as on 31 - 12 - 1980

(Not a gradation list)

Director : Dr. E. G. Silas

Joint Director : Dr. S. V. Bapat
Dr. P. S. B. R. James

Scientist S-3

Shri K. H. Mohamed
Dr. A. V. S. Murty
Dr. M. S. Prabhu
Dr. P. V. Ramachandran Nair
Dr. K. Alagarswami
Shri K. Nagappan Nayar
Shri T. Tholasilingam
Dr. P. Vedavyasa Rao
Shri G. Venkataraman
Dr. S. Ramamurthy
Dr. M. J. George
Shri K. V. Narayana Rao
Shri T. Jacob
Dr. B. Krishnamoorthi
Dr. V. Balakrishnan

Scientist S-2

Dr. N. Radhakrishnan
Shri M. Mydeen Kunju
Dr. M. D. K. Kuthalingam
Dr. (Mrs.) P. V. Kagwade
Shri M. S. Muthu
Shri S. Mahadevan
Dr. K. Radhakrishna
Shri C. P. Ramamirtham
Shri D. Sadananda Rao
Shri K. Rangarajan
Shri V. S. Krishnamurthy Chennubhotla
Shri M. H. Dhulkhed
Dr. K. C. George
Shri G. Subbaraju
Dr. G. Luther
Shri P. Bensam
Shri V. M. Deshmukh
Shri M. S. Rajagopalan
Shri A. Noble
Dr. M. Vasudev Pai
Shri V. Balan
Dr. K. Satyanarayana Rao
Shri K. A. Narsimham
Shri M. Kumaran
Shri V. N. Bande
Shri P. T. Meenakshi Sundaram
Dr. K. Venkata subba Rao*
Shri R. Marichamy
Dr. P. Vijayaraghavan
Shri C. Mukundan
Shri K. N. Krishna Kartha
Shri G. G. Annigeri
Dr. C. S. Gopinadha Pillai
Shri K. Dorairaj
Dr. M. M. Thomas
Dr. P. P. Pillai
Dr. P. S. Kuriakose
Dr. K. Alagaraja
Shri S. K. Dhamaraja

Scientist S-1

Shri N. S. Radhakrishnan
Shri P. Sam Bennet
Shri J. C. Gnanamuthu
Dr. T. Appa Rao
Shri S. Reuben
Dr. R. S. Lal Mohan
Shri N. Surendranadha Kurup
Shri N. Neelakanta Pillai
Shri G. P. Kumaraswamy Achary
Shri K. Y. Telang
Shri Kuber Vidyasagar
Shri G. Sudhakara Rao
Dr. P. A. Thomas
Dr. D. B. James
Shri C. Suseelan
Shri V. Kunjukrishna Pillai
Shri C. P. Gopinathan

* On lien or deputation to other organisations.

Shri K. J. Mathew
Dr. M. Devaraj*
Dr. M. K. George
Shri K. M. S. Ameer Hamsa
Shri R. Sarvesan
Dr. P. Devadoss
Dr. V. Sriramachandra Murty
Shri G. S. Daniel Selvaraj
Shri K. K. Appukuttan
Shri Alexander Kurian
Shri D. C. V. Easterson
Shri P. V. Sreenivasan
Shri S. Lazarus
Shri M. Kathirvel
Shri K. Rengarajan
Shri K. J. Joseph*
Shri Y. Appannasastry
Miss R. Padmini
Shri A. Chellam
Shri E. V. Radhakrishnan
Miss Gracy Mathew
Dr. E. Vivekanandan
Shri M. Rajamani
Shri V. Thangaraj Subramanian
Shri C. Muthiah
Shri V. S. Kakati
Shri P. Muthiah
Shri Madan Mohan
Shri G. Mohanraj
Dr. S. Kulasekhara Pandian
Shri G. Gopakumar
Mrs. Mary K. Manisseri
Shri G. Syda Rao
Dr. A. Lakshminarayana
Dr. N. Ramachandran
Shri S. K. Chakraborty
Shri Vinay D. Deshmukh
Shri M. Vijayakumaran
Dr. L. Krishnan
Dr. (Smt.) S. Lalitha Devi
Shri A. R. Thirunavukkarasu
Dr. H. Mohamed Kasim
Shri K. G. Girijavallabhan
Shri V. Josanto
Mrs. Geetha Bharathan
Shri N. Gopalakrishna Pillai
Dr. A. G. Ponniah
Shri V. Gandhi
Shri A. Raju
Shri K. S. Sundram
Shri K. Devarajan
Shri K. V. Somasekharan Nair
Shri T. M. Yohannan
Shri A. C. C. Victor
Shri A. Reghunathan
Shri P. Livingston
Shri K. K. Sukumaran
Shri S. Shanmugham
Shri P. Nammalvar
Shri K. Prabhakaran Nair
Shri A. A. Jayaprakash
Shri G. Nandakumar
Shri K. Ramadoss
Shri R. Soundararajan
Dr. N. Gopinatha Menon
Shri Pon Siraimeetan
Shri P. N. Radhakrishnan Nair
Shri N. Kaliaperumal
Smt Rany Mary Jacob
Shri K. N. Rajan
Shri R. Thiagarajan
Shri S. Krishna Pillai
Shri M. Rajagopalan
Shri M. E. Rajapandian
Smt. V. Chandrika
Shri P. E. Sampson Manickam
Shri S. Dharmaraj
Shri K. Narayana Kurup
Shri M. Srinath
Shri K. Balan
Shri K. K. P. Panikkar
Shri R. Sathiadas
Smt. Krishna Srinath
Shri Syed Ahamedali
Shri S. Muthusamy
Shri D. Kandasami
Shri K. R. Manmadan Nair

Scientist 'S'

Shri M. Aravindakshan
Shri P. Dhandapani*
Shri D. Sivalingam
Shri M. M. Meiyappan
Shri P. Natarajan
Shri Mohammed Zafar Khan
Shri V. S. Rengaswamy
Smt. T. S. Naomi
Shri I. David Raj
Shri C. V. Mathew
Shri P. Karuppaswamy
Shri T. S. Velayudhan
Shri G. Radhakrishnan
Smt. K. Vijayalakshmi

Field Officer (T—7)

Shri S. J. Rajan
Shri C. R. Shanmughavelu
Shri P. Mojumder
Shri Syed Basheeruddin
Shri M. G. Dayanandan
Shri S. S. Dan

Field Officer (T–6)

Shri J. P. Karbhari
Shri S. Natarajan
Shri G. Balakrishnan

Sr. Technical Assistant (T-4)

Shri Varghese Philipose
Shri T. Prabhakaran Nair
Shri U. K. Sathyavan
Shri G. M. Kulkarni
Shri W. Venugopalan
Shri Srinivasarengan

Technical Assistant (T.II.3)

Shri K. Ramachandran Nair
Shri A. C. Sekhar
Shri P. S. Sadasiva Sarma
Shri P. Karunakaran Nair
Shri P. K. Mahadevan Pillai
Shri R. Reghu
Shri K. Ramakrishnan Nair
Shri R. Bhaskaran Achari
Shri N. Ratnaswami
Shri A. Agastheesa Pillai Mudaliar
Shri K. C. Yohannan
Shri T. Girijavallabhan
Shri R. Guruswami
Shri M. Babu Philip
Shri A. A. Thankappan
Shri K. Nandakumar
Shri N. P. Kunjikrishnan
Shri P. Ananda Rao
Shri M. Ayyappan Pillai
Shri M. Badruddin
Shri V. K. Balachandran
Shri M. Mohamed Sultan
Shri T. G. Vijaya Warrier
Shri Jacob Jerold Joel
Shri A. Hanumantha Rao
Shri A. Bastin Fernando
Shri C. V. Seshagiri Rao
Shri S. G. Vincent
Shri K. K. Balasubramanian
Shri P. M. Aboobacker
Shri K. V. S. Seshagiri Rao
Shri S. Kalimuthu
Shri K. N. Gopalakrishnan
Shri S. B. Chandragathan
Shri G. C. Lokshmiah
Shri M. V. Somaraju
Shri I. P. Ebenezer
Shri C. K. Krishnan
Smt. K. Koumudhi Menon
Shri K. S. Krishnan
Shri P. Ramadoss
Smt. S. Lakshmi
Shri C. T. Rajan
Shri S. Manivasagan
Shri K. K. Kunjikoya
Shri V. Suresh
Shri K. Soman
Shri M. Sriram
Shri S. K. Balakumar
Smt. C. Nalini
Shri S. Kandasamy
Smt. Geetha Antony
Shri R. Vasanthakumar

Technical Assistants (T.I.3)

Shri S. Siddalingaiah
Shri K. Thulasidas
Shri A. Ganapathi
Shri B. Narayana Rao
Shri P. Ramalingam

Jr. Technical Assistants (T-2)

Shri J. L. Oza
Shri C. Kasinathan
Shri Joseph Xavier Rodrigo
Shri K. Ramasomayajulu
Shri K. P. Viswanathan
Shri C. Thankappan Pillai
Shri Joseph Andrews
Shri N. Jayapalan
Shri V. Selvaraj
Shri K. Dhanaraju
Shri V. A. Narayanankutty
Shri V. Sivaswami
Shri K. Muniyandi
Shri N. Palaniswami
Shri K. Muthaiah
Shri K. Ramadoss Gandhi
Shri T. Chandrasekhara Rao
Shri K. Balachandran
Miss A. Kanagam
Shri D. Sundararajan
Shri D. Vincent
Shri J. R. Ramalingam
Shri M. Najmuddin
Shri K. B. Waghmare
Shri Y. D. Savaria
Shri G. Subramania Bhat
Shri C. Balasundaram
Shri L. Jayasankaran
Shri L. Chidambaran
Smt. C. M. Allikunju
Shri O. M. M. J. Habeed Mohamed
Shri M. Selvaraj
Shri R. Thangavelu
Shri A. Srinivasan
Shri T. S. Balasubramanian
Shri V. Thanapathi
Shri H. Kather Batcha
Shri S. Palnichamy
Miss K. Uma Kumari
Shri Sapan Kumar Ghosh
Shri S. Subramani
Shri K. Chitti Babu
Shri S. Russel Conrad Samuel
Shri M. Manickaraja
Shri A. Deivendra Gandhi

Shri M. R. Arputha Raj
Shri Hameed Batcha

Field Assistant (T--1)

Shri T. Krishnankutty
Mrs. K. K. Valsala
Shri K. Chellappan
Shri K. Chandran
Shri Mathew Joseph
Shri M. N. Kesavan Elayathu
Shri K. K. Surendran
Miss T. A. Omana
Shri K. Narayana Rao
Shri C. S. Sasidharan
Shri V. Achutha Rao
Shri M. Manivasagam
Shri S. Sankaralingam
Shri P. Palani
Shri M. Chandrasekhar
Shri C. Manimaran
Shri N. Vaithinathan
Shri G. Arumugham
Shri S. Rajapackiam
Smt. P. Swarnalatha
Shri G. Srinivasan
Shri R. Somu
Shri M. Radhakrishnan
Shri M. Chellappa
Shri A. Ramakrihsnan
Shri T. Dhandapani
Shri J. Krishna Babu
Shri M. Bose
Smt. V. K. Janaki
Shri V. G. Surendranathan
Shri M. P. Sivadasan
Shri J. Narayanaswami
Shri S. D. Dhuri
Shri K. T. Thomas
Shri Sailada Satya Rao
Shri A. K. Velayudhan
Shri P. Poovannan
Shri P. Venkatakrishna Rao
Shri A. Prosper
Shri C. J. Josekutty
Shri K. Srinivasagan
Shri Dalwadi Praduemen Mohanlal
Shri A. Ahamed Kamal Basha
Shri K. Shahul Hameed
Shri Shreekant Sreedhar Sugawekar
Shri H. Ramachandra
Shri S. Hanumantharaya
Shri Mascarenhas Robert
Shri C. K. Dinesh
Shri B. Sridhara
Shri G. Krishnaiah
Shri Padmasekhara
Shri D. Nagaraja
Shri N. Chennappa Gowda
Shri Y. V. Venkatachala Murthy
Shri J. Bhuvaneswara Varma
Shri Ch. Ellithathayya
Shri N. Narayana
Shri R. Dias Johnny
Shri Arun Yashawant Mestry
Shri Dhukia Harsukhlal Karsambhai
Shri Bhupendra Popatlal Thumber
Shri Solanki Pravinchandra Dahyalal
Shri S. Chandrasekhar
Shri H. S. Shivanna
Shri O. Thippeswamy
Shri D. G. Jadhav
Shri Lahu Rambhou Khambadkar
Shri V. S. Gopal
Shri M. Samuel Sumithrudu
Shri T. Mohammed Iqbal
Shri S. Kemparaju
Shri R. G. Kavitkar
Shri H. S. Mahadevaswamy
Shri N. Varatharajan
Shri M. G. Sivadasan
Shri M. Abdul Nizar
Shri A. Nandakumar
Shri R. Ankam Vijayakumar
Shri Barsingh Suresh Jayasingh
Shri A. D. Sawant
Shri P. Thirumilu
Shri R. Subramanian
Shri P. Thillairajan
Shri M. Enose

Computor (T.II.3)

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

Computor (T.I.3)

Shri A. Kanakkan

Computor (T--2)

Shri S. Haja Najmuddin
Shri C. J. Prasad
Smt. P. L. Ammini
Smt. K. Santhakumari

Punch Card Operator (T--1)

Shri K. P. George
Miss M. R. Beena
Shri M. B. Seynudeen
Shri S. Srinivasan
Miss P. T. Mani
Shri P. P. Pavithran

KRISHI VIGYAN KENDRA

Senior Training Assistant (T--6)

Shri P. Karunakaran Nair
Shri K. V. George
Shri K. Asokakumaran Unnithan
Dr. P. K. Martin Thompson

Training Assistant (T--4)

Shri K. N. Rasachandra Kartha
Shri A. N. Mohanan
Shri P. Radhakrishnan

LIBRARY

Sr. Library-cum-Documentation Asst.

Shri K. Kanagasatapathy

Sr. Library Assistant

Shri E. Johnson

Jr. Library Assistant

Smt. Girijakumari
Shri Edwin Joseph

Hindi Translator (T--4)

Miss A. Rajeswari Menon

Officers of R. V. Skipjack

Shri P. R. Leopold, Skipper
Shri K. J. Michael, Chief Engineer
Shri P. K. Velayudhan, Mate

ADMINSTRATION & ACCOUNTS

Sr. Administrative Officer

Shri S. Rajagopalan

Administrative Officer

Shri V. K. Sridhar

Asst. Accounts Officer

Shri M. P. Chandrasekharan

Superintendents

Shri S. Subramanian
Shri M. P. Lakshmanan
Shri A. Sethu Bhaskaran
Shri P. Aithappa Naik
Shri M. Subbiah
Shri R. Dorairaj

P. As. to the Director

Shri L. Krishnaswami
Shri K. M. Surendran

KRISHI VIGYAN KENDRA OF CMFRI
Narakkal

V. BALAKRISHNAN, K. V. GEORGE, P. KARUNAKARAN NAIR K. N. R. KARTHA, P. K. MARTIN THOMPSON, K. A. UNNITHAN, A. N. MOHANAN AND P. RADHAKRISHNAN.

Training

During the year under report 12 courses of 10 days duration each were conducted and 197 fish farmers, including women, took part in these courses. The complete list of trainees in the different districts and taluks is given at the end of this report. The courses involved 90% off-campus and 10% on-campus programme. The fish farmers were trained in the collection, identification, sorting and stocking of prawn seed, and intensive culture of selected species in the grow-out systems.

Survey

In addition to training programme the KVK conducted survey of socio-economic conditions of the fish farmers in the neighbouring villages and also the families of the trainees. 151 families were covered during November to March.

The survey has revealed that 13.3% of the ex-trainees are actively practising scientific Prawn culture, 17.1% engaged in Prawn seed industry, 5.7% supplementing the stock in traditional fields with selected fast-growing commercially important Prawn seeds and 1·8% employed in Prawn farms. It has also become a common practice to supplement the stock in traditional fields also with the important varieties of Prawn seeds.

Extension

The Kendra spent 140 days in extension work. The extension work involved visits to the villages of ex-trainees and other farmers and persuading them to implement the knowledge acquired by the trainees in scientific Prawn culture and also get

any feed back information from the Prawn culture operations that are available. The publications issued during the year are:

1. "Grow more Prawns" by K.N.R. Kartha and P. Karunakaran Nair (Krishi Vigyan Pathrika No. 5.)
2. "Karimeen" (The pearl spot) by P. Radhakrishnan and K.A. Unnithan (Krishi Vigyan Pathrika No. 6.)

The radio talks given during the period were:

1. Feasibility of the culture of tiger Prawns—discussion led by Shri P. Karunakaran Nair.
2. Production and collection of prawn seeds—interview by Shri K.V. George.

The Kendra has also organised 4 film shows on mari-culture in the neighbouring villages.

List of farmers trained under the Krishi Vigyan Kendra at Narakkal during 1980-81

*(Women trainees indicated with *)*

ERNAKULAM DISTRICT

Elamkunnapuzha

P. K. Babu
N. K. Babu
A. J. Antony
T. M. Mohanlal
T. K. Sasidharan
V. S. Udayakumar
N. A. Aravindakshan
K. K. Chandran
V. K. Venugopalan
K. N. Raveendran
C. P. Apto
T. A. George
M. I. Shaji
V. K. Sidharthan
A. K. Leena*
M. J. Ida*
P. V. Lincy*
K. F. Mary Grace*
T. D. Philo*

2. Narakkal

K. J. Joseph Pauly
K. P. Peethambaran
M. M. Prakasan
P. S. Ramesh
A. R. Sugathan
P. A. Varghese
K. K. Asokan
P. N. Krishnakumar
P. V. Purushan
V. V. Rajendra Babu
K. J. Joy
N. C. Rajappan
A. R. Ravi
P. K. Saseendran
K. R. Sebastian Bose
O. B. Suresh
T. K. Viswanathan
P. B. Alex
C. K. Sasidharan
T. P. Pullan
P. K. Bhasi
K. R. Jose
C. M. Kunjappan
O. R. Ramesan
V. K. Sasi
V. J. Varghese
T. K. Chinnan
C. R. Krishnan
K. V. Prakasan
K. M. Madanan
K. C. Saravanan
K. A. Nelson
A. P. Shailan
K. R. Sivadasan
K. S. Sunildath
V. V. Radhakrishnan
P. V. Babu
P. G. Raju
P. A. Elizabeth Augustine*
E. Mary Antony*
P. T. Mary*
K. X. Mary*
M. V. Pushpa*
M. K. Ammini*
T. G. Bhanumathy*
K. K. Geetha*
M. K. Girija*
P. K. Kathreena*
V. V. Kairali*
P. M. Kumari*
C. P. Lilly*
K. S. Prabha*
K. P. Rajini*
K. X. Rosy*

3. Nayarambalam

K. K. Sukumaran
K. P. Joseph
M. O. Joseph

M. S. Rajeev
M. A. Zachariah
V. T. Babu
M. K. Purushan
I. V. Sreenivasan
K. N. Vijayan
V. S. Aniyan
I. G. Joshilal
V. V. Varghese
A. B. Harshan
C. C. Joseph
R. S. Sudik Kumar
M. K. Arumughan
V. K. Babu
M. A. Kishore
V. S. Raji
P. A. Sivan
T. Udayan
A. I. Chakran
John David
P. P. Kunjachan
M. P. Paul
A. E. Sreenivasan
N. C. Suresh
K. C. Asokan
M. S. Gopinath
M. J. Joy
V. I. Padmakshan
K. K. Sasidharan
P. K. Balan
P. A. Nandakumar
T. V. Pauli
V. V. Viswanathan
K. K. Revamma*
V. J. Mary*
C. K. Prabhavathy*

4. Edavanakkad

P. A. Babu
T. R. Valsala*
R. P. Prathap
M. P. Raghu
M. K. Surendran
P. K. Sidhan
M. K. Raveendran

5. Kuzhuppilly

K. K. Sathyan
V. V. Babu
D. A. Santhoshkumar
V. K. Sidhan
V. K. Soman
A. N. Sukumaran
A. K. Mani
P. K. Sobha
P. K. Andavan
P. K. Varghese
M. G. Divakaran

6. Pallippuram

J. P. Cletus
T. K. Rajendran
K. T. Mohanan
P. Muraleedharan
A. R. Prakasan
T. K. Sudhakaran
V. K. Babu
S. Giridharan
N. N. Govindan
C. A. Aniyan
N. I. Balachandran
V. D. Sudhakaran
C. B. Babu
P. D. Murali
V. K. Beena*
N. C. Sarasu*
Lissy Abraham*

7. Ezhikkara

C. K. Jayan
N. A. Kalesan
P. K. Rajan
K. V. Shaji
V. P. Subhash
C. J. Bhasi
E. A. Kalesan
C. P. Lalan
P. K. Babu
K. B. Gopalakrishnan
P. K. Mohanan
K. K. Manikuttan
C. K. Raveendran
N. K. Raveendran
K. A. Chandran
K. B. Sobhana*
C. M. Vasanthy*

8. Varapuzha

K. P. Joshi
C. G. Murali
A. V. Varghese

9. Cochin Corporation

M. Cherian Sebastian
P. T. Joseph
B. N. Lalan
P. M. Vijayan
P. O. Saiju
A. A. Joseph
M. K. Kunjan Pillai
K. K. Jayamma*
K. D. Moly*
K. A. Babu
P. T. Clement

10. Koonammavu

P. A. Samuel Peter
K. C. Jacob
M. N. Sivadasan

11. Panambukad

T. C. George

12. Perumpadanna

T. C. Chandra Babu
P. C. Velayudhan

13. Moothakunnam

P. E. Shanmughan

14. Chendamangalam

V. Padmanabhan

15. Chittattukara

Smt: N. V. Pulomaja*

16. Tripunithura

K. D. Sudan

17. Kannamali

K. A. Antony

TRICHUR DISTRICT

18. Pulloot

N. R. Dhanajayan

KOTTAYAM DISTRICT

19. Kulasekharamangalam

A. K. Purushothaman

CANNANORE DISTRICT

20. Kasargod Taluk

K. Subramanya Bhat

ALLEPPEY DISTRICT

21. Thycattussery

P. J. Thomas
D. Shanmughom

22. Kodanthuruthu

K. S. Ambujakshan
P. A. Mohamed Ashraf
Bose Philip

(Total number of trainees 197)

Estimated marine fish landings in India during 1980 (in tonnes)

Sl. No.		Name of fish	West Bengal	Orissa	Andhra Pradesh	Tamil Nadu	Pondicherry	Kerala	Karnataka	Goa	Maharashtra	Gujarat	Andamans	Lakshadweep	Private* Trawlers	Total
1.		Elasmobranchs	114	3,772	4,842	15,442	435	6,803	2,910	894	7,752	14,558	56	284	—	57,862
2.		Eels	—	—	289	85	8	6	131	6	3,154	8,403	—	—	—	12,082
3.		Catfishes	723	2,198	2,338	4,047	78	13,936	5,354	1,151	8,653	5,235	32	—	—	43,745
4.		*Chirocentrus*	276	1,460	1,123	2,695	98	1,002	171	124	2,039	3,792	25	—	—	12,805
5.	a)	Oil sardine	—	—	—	320	—	69,667	42,727	2,367	663	—	—	—	—	1,15,744
	b)	Lesser sardines	—	1,891	13,930	29,940	2,736	11,017	4,135	1,798	1,363	—	243	—	—	67,053
	c)	*Hilsa ilisha*	644	5,091	96	37	25	14	8	8	1,017	56	—	—	—	6,996
	d)	Other *Hilsa*	20	46	1,267	3,084	53	21	25	14	607	3,965	25	—	—	9,127
	e)	*Anchoviella*	—	270	6,182	13,126	287	7,772	5,621	249	78	—	99	—	—	33,684
	f)	*Thrissocles*	194	333	7,326	5,048	387	2,241	850	779	1,271	913	—	—	—	19,342
	g)	Other clupeids	674	2,576	5,486	1,833	273	574	1,088	302	16,897	8,538	29	—	—	38,270
6.	a)	*Harpodon nehereus*	419	378	611	6	—	—	15	12	57,393	36,671	—	—	—	95,505
	b)	*Saurida & Saurus*	—	189	931	1,123	160	7,080	508	199	1,057	85	—	—	—	11,332
7.		*Hemirhamphus & Belone*	—	46	97	749	26	361	180	6	42	6	41	99	—	1,653
8.		Flying fish	—	17	43	1,106	3	—	55	2	—	—	—	29	—	1,255
9.		Perches	13	341	4,639	6,886	666	17,814	1,069	269	3,712	2,454	302	376	—	38,541
10.		Red mullets	—	296	349	1,079	150	1	38	15	461	—	—	27	—	2,416
11.		Polynemids	186	1,126	1,448	629	6	8	—	10	1,976	667	—	—	—	6,056
12.		Sciaenids	358	2,864	9,496	19,547	320	6,164	3,500	1,530	13,956	31,625	—	—	—	89,360
13.		Ribbon fish	142	928	15,646	7,862	179	12,937	1,499	1,089	11,550	10,858	—	—	—	62,690
14.	a)	*Caranx*	—	607	5,981	5,405	479	4,399	4,507	884	1,315	461	147	80	—	24,265
	b)	*Chorinemus*	130	567	710	1,111	2	145	67	71	357	1,022	—	—	—	4,182
	c)	*Trachynotus*	—	—	—	38	2	—	—	—	—	—	—	—	—	40
	d)	Other carangids	—	—	97	188	—	59	232	—	369	—	—	—	—	945
	e)	*Coryphaena*	—	—	3	141	—	138	—	—	20	—	—	—	—	302
	f)	*Elacate*	—	—	19	148	—	19	3	190	—	—	—	—	—	379
15.	a)	*Leiognathus*	34	704	3,775	38,153	681	4,147	4,671	1,727	406	—	102	—	—	54,400
	b)	*Gazza*	—	3	56	84	—	1	42	—	—	—	—	—	—	186
16.		*Lactarius*	—	65	940	938	29	861	998	614	450	2,520	—	—	—	7,415
17.		Pomfrets	921	9,072	2,201	1,306	188	907	696	257	10,081	12,587	15	—	—	38,231
18.		Mackerel	—	265	6,203	7,229	445	18,474	19,634	2,446	288	112	183	—	—	55,279
19.		Seer fish	234	1,542	2,970	7,179	85	3,763	1,941	735	3,219	4,180	117	21	—	25,986
20.		Tunnies	—	34	419	4,233	—	10,611	952	356	1,674	277	55	1,760	—	20,371
21.		*Sphyraena*	—	8	88	932	55	330	84	171	33	—	67	14	—	1,782
22.		*Mugil*	—	1	27	577	49	151	39	11	24	1,034	117	—	—	2,030
23.		*Bregmaceros*	—	—	—	—	—	—	—	—	159	757	—	—	—	916
24.		Soles	3	69	573	2,094	151	4,394	782	1,311	1,797	2,459	—	—	—	13,633
25.	a)	Penaeid prawns	152	1,074	5,660	9,082	485	52,633	3,098	1,853	23,433	14,481	54	—	32	1,12,037
	b)	Non-penaeid prawns	48	30	4,346	946	42	1,742	128	—	47,309	4,109	—	—	—	58,700
	c)	Lobsters	—	—	10	90	4	18	110	18	225	204	—	—	—	679
	d)	Other crustaceans	20	359	1,413	6,174	172	7,286	2,765	1,933	297	4,967	—	—	—	25,386
26.		Cephalopods	4	98	470	1,472	40	4,244	122	210	1,191	3,471	—	13	—	11,335
27.		Miscellaneous	788	1,055	3,913	15,230	591	7,803	4,567	879	5,475	23,027	94	206	2,212	65,840
		TOTAL	6,097	39,375	1,16,013	2,17,394	9,390	2,79,543	1,15,322	24,490	2,31,763	2,03,494	1,803	2,909	2,244	12,49,837

*Partial coverage of larger trawlers