Major components of marine fish landing in India-1998

(Total estimated landing : 2.67 mt)

- Oil sardine: 43%
- Mackerel: 7%
- B. duck: 7%
- Perches: 7%
- Carangids: 5%
- Croackers: 6%
- P. prawns: 6%
- N. prawns: 7%
- Cephalopods: 7%
- Others: 4%
ANNUAL REPORT
1998-1999

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
Indian Council of Agricultural Research
POST BOX NO. 1603, TATAPURAM P.O.
ERNAKULAM, COCHIN - 682 014, INDIA
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This is only the report of the research work carried out by the CMFRI for one year (1998-99). The data incorporated herein need to be processed further and utilised in conjunction with similar data collected in the past and to be generated in future, for preparing scientific papers by the staff of the Institute. Hence the contents of this report could be used only with the permission of the Institute.

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PREFACE

The marine fisheries R&D is receiving increased attention at the National as well as International levels in view of the 1) declining yields of the exploited stocks, necessitating measures to sustain their yields, 2) underexploitation of deep-sea and oceanic resources, warranting the development of strategies for their effective and sustained exploitation, 3) need to combat protein-malnutrition of the rapidly increasing human population, demanding the development and upgradation of mariculture technologies and utilisation of regions and species suitable for culture, and step up the production, and 4) the lack of trained manpower for research and operatives, necessitating increased thrust to Human Resources Development in these areas. The Central Marine Fisheries Research Institute has the mandate to address these issues and has been constantly contributing to the long-term and short-term needs of the industry and the Government through its Research, Education, Extension and Consultancy programmes.

The Institute continued its efforts towards development of sound database on exploited stocks, development and upgradation of mariculture technologies and development of research infrastructure through its own programmes and those sponsored by the funding agencies. Hatchery complexes were built at Mandapam, Cochin, Calicut and Vizhinjam and they are being made operational. Two projects under the NATP were approved by the ICAR for implementation at the Institute. Along with organisations in seven other countries in the Asian region, the Institute took up a collaborative programme with the International Centre for Living Aquatic Resources Management, Philippines on the Sustainable Management of Coastal Fish Stocks in the Asian Region. Besides, collaborative programmes were also undertaken with the NRSA and the SAC in the area of Fishery Forecast.

The Institute achieved breakthrough in broodstock development, maturation, sex reversal, spawning, fertilisation and hatching of the grouper in the onshore, fully-controlled culture system at Cochin, opening up avenues for developing suitable package for culture of groupers. Another breakthrough was achieved in the hatchery development of the cuttlefish and development of F1 generation of the cuttlefish under controlled conditions at Tuticorin. Technology of breeding and seed production of clownfish was also perfected.

A total of nine consultancy projects valued at Rs 27,51,800/- were completed, five projects for Rs 19,19,650/- are under operation and four projects with a total outlay of Rs 6,74,480 are approved for implementation.

The education and training programmes continued as usual; proposals were submitted for establishing a School of Marine Fisheries at the Institute with additional courses leading to M.F.Sc and Ph.D. degrees in frontier areas of Marine Fisheries Research. Besides, the Institute also made a proposal to start a Division of Marine Biodiversity Conservation to address the issues related to the subject.

The progress of work during 1998-'99 is included in this Report briefly.

The CMFRI, thus, made significant contribution during the year achieving the targets. All these would not have been possible without the support of the ICAR and the staff of the Institute. I am thankful to Dr. R. S. Paroda, Director General, ICAR for his sustained support and encouragement. Dr. K. Gopakumar, Deputy Director General (Fy) ICAR and Dr. R. A. Selvakumar, Assistant Director General (MFy), ICAR extended all co-operation and support to the Institute in its endeavour. I congratulate all my colleagues in the Institute for their whole-hearted support and contribution in fulfilling the objectives of the Institute.

Cochin
June, 1999

V. N. PILLAI
Director
EXECUTIVE SUMMARY

During the year, the CMFRI implemented 67 ongoing in-house research projects, 12 projects sponsored by funding agencies in India, 2 by SIDA and 1 by ICLARM.

Database on exploited stocks

The total marine fish production in the country was estimated at 2.67 million tonnes which is about 2% less than that obtained during 1997. The mechanized units contributed 73% of the landings followed by motorized units 19% and the artisanal units 8%. The northwestern region comprising Gujarat and Maharashtra contributed 42% of total production in the country followed by southwest 28% (Kerala, Karnataka and Goa), southeast 24% (Andhra Pradesh, Tamilnadu and Pondicherry), northeast 5% (West Bengal, Orissa) and Lakshadweep and Andamans 1%. The landings increased by about 11,000t over the previous year along northeast coast, declined by about 60,000t along southeast coast, 71,000t along southwest coast, and increased by 60,000t along northwest coast. The penaeid prawn production increased by 3%, non-penaeid prawn 13% catfish 18% and threadfin bream 12% over the previous year. The dominant components of marine fish production in 1998 are sardines (2.04 lakh t), other sardines (1.00 lakh t), mackerel (1.77 lakh t), Bombay duck (1.23 lakh t), penaeid prawn (2.5 lakh t), non-penaeid prawn (1.74 lakh t), croakers (2 lakh t), threadfin breams (0.8 lakh t) and cephalopods (1.07 lakh t).

All relevant data on a large number of species of pelagic and demersal finfishes crustaceans and molluscs were collected and analyzed to study the fishery and resource characteristics of exploited stocks. In the case of sardines the catch declined by 8.5% over the previous year; the ring seine effort increased by 50% resulted in 68% increase in production at Mangalore whereas at Cochin the increase was only 0.9% in the effort but the catch increase was 62%. In anchovies, the IV quarter was most productive at Mangalore; spawning took place during October-May along both the coasts. The seerfish landing was higher (48,000 t) during the year. Scomberomorus commerson and S. guttatus accounted for 99% of catch. In mackerel, the increase in the mean length noticed in the landings was due to the delay in the commencement of fishery along the southwest coast. Among tunas, Euthynnus affinis was the most dominant species forming about 90% of the ribbonfish catch and the maximum quantities were taken by trawl. Trawl and purseseine took maximum catch of carangids.

Trichiurus lepturus was the most dominant species forming about 90% of the ribbonfish catch and the maximum quantities were taken by trawl. Trawl and purseseine took maximum catch of carangids.

The total demersal finfish production in the country was 0.7 million t; 68.1% of this was taken by trawl, 13.2% by other
mechanized units, 10.2% by motorized units and 8.5% by artisanal units. Maximum quantity (38.7% of the demersal finfish catch in the country) was obtained from Gujarat followed by Tamilnadu (16.8%), Kerala (13.9%), Maharashtra (11.4%), Karnataka (6%), Andhra Pradesh (5.6%), West Bengal (3.3%), Orissa (2.6%), Goa (1.5%) and Pondicherry (0.2%). The landings of demersal finfish increased by 8% over those of previous year, which is mainly brought about by 47% increase along the northwest coast, though there was considerable decline in the landings along the east coast.

*Scyllorhinus canicula* was the most common shark in the landings at Mumbai, whereas *Carcharius melanopterus* was dominant at Cochin and *C. bleekeri* at Tuticorin. In the perches, *Epinephelus diacanthus* was the dominant species at Mumbai. In threadfin breams, *Nemipterus japonicus* and *N. mesoprion* were most dominant. In Karnataka peak catch of *N. mesoprion* was obtained in September-November period. Maximum catch was taken along the west coast. Maximum catch of silverbellies was taken along the southeast coast of India; along west coast centres *Leiognathus bindus*, *L. splendens* and *Secutor insidiator* were dominant, along the northeast coast *L. bindus*, *S. insidiator* were abundant whereas along the southeast coast *L. dussumieri* and *L. jonesi* were dominant.

In sciaenids, the species composition and dominant species were different at different centres; maximum catch of this group was taken at Veraval and Mumbai. At Kakinada, an estimated 197 t of juveniles of sciaenids (40-183 mm length) were taken by trawlers with peak in January. In Lizardfish, *Saurida tumida* was dominant along the west coast except Cochin and *S. undosquamis* along east coast and Cochin. Peak landings were taken during April and December along the northwest coast. The length range of *Polynemus indicus* at Veraval was 170-770 mm in the trawl and 310-1090 mm in gillnet. *P. heptadactylus* was in the length range of 65-275 mm in the trawl at Mumbai.

The first and last quarters were productive for pomfrets at Veraval and Mumbai, high catch rates of 250 kg, 725 kg were obtained during August and October at Satpati in gillnet. *Pampus argentus* was dominant at Mumbai.

*Priacanthus hamrur* was the principal species of Bull's eye at all the centres and the length range in the catch was 90-330 mm at different centres.

The flatfish fishery was most dominant along the southwest coast. *Cynoglossus macrostomus* was dominant along north Kerala and south Karnataka whereas *C. bilineatus* and *C. macrolepidotus* were dominant along south Kerala and Gulf of Mannar.

Goatfish was abundant along east coast between Mandapam and Visakhapatnam. *U. sundaeus* and *U. sulphureus* were dominant along south Tamilnadu, *U. taeniopeterus* along north Tamilnadu, south Andhra and *U. vittatus* along north Andhra coast.
There was improvement in the landings of whitefish along southwest coast. The length range in the catch was 30 - 209 mm.

In Kerala non-edible benthic biota formed 7.8% of the total catch, 20.6% in Karnataka and about 3% in Tamilnadu. Along Karnataka 47% of the catch was taken from less than 30 m depth, 34% from the 30-50 m depth and 19% from beyond 50 m depth. In Kerala 40% was taken from less than 30 m whereas in Tamilnadu 80% of the trawl catch was from 0-30 m depth.

Penaeid prawns contributed 42.8% to the crustacean landings followed by non-penaeid prawns 36.4%, stomatopods 13.3%, crabs 6.9% and lobsters 0.6%. The west coast contributed 75% of the penaeid catch and northwest coast supported 93% of the non-penaeid catch. *Parapenaeopsis stylifera* was dominant along the west coast and *Solenocera crassicornis* along northwest coast. *Solenocera choprai* is gaining importance in the landings due to extension of fishing into deeper ground along Kerala and Karnataka coasts. *P. semisulcatus* was dominant along southeast coast and *M. dobsoni* along north Tamilnadu and Andhra coasts.

Gujarat and Maharashtra accounted for 93% of non-penaeid prawn landings in the country and the fishery improved by 24% during this year. Trawlers contributed to the bulk of non-penaeid prawn landings. Off Mumbai, exploitation rate of *N. tenipes* was above optimal level, suggesting the need for reduction in effort. The lobster landings showed decline during the year. Trap and trawl net are the major gears for this resource. *Panulirus polyphagus* and *Thenus orientalis* contributed to the fishery at Veraval and the former species at Mumbai.

Crab landings declined by over 12,000 t. Tamilnadu, Gujarat and Kerala contributed to the bulk of the landings. *Charybdis cruciata* was dominant at Veraval and Mumbai, *P. pelagicus* at Karwar and *P. sanguinolentus* at Mangalore.

In the cephalopod landings a decline was noticed all along the west coast centres but along the east coast centres there was increase in the landings. Squids were the most dominant along west coast and Madras and cuttlefish along other east coast centres. An estimated 3700 t of mussels was landed along the Kerala and Tamilnadu coasts and *Perna indica* was most dominant. In the case of clams, about 38,000 t were landed from Karwar, Mangalore, Cochin, Madras and Kakinada.

**Mariculture**

A breakthrough was achieved in broodstock development and breeding of grouper (*Epinephelus tauvina*) at Cochin. The achievements in the experiments are successful rearing from fingerlings to broodstock size, sex reversal, maturation, spawning and fertilization. At Vizhinjam clownfish (*Amphiprion chrysogaster*) spawned in confinement in fiberglass tanks and juveniles were reared. Success was achieved for the first time in the induced maturation and spawning of
farm-raised *P. merguiensis* under captive condition at Karwar. *P. monodon* was made to spawn and produce 35,93,000 nauplii through artificial insemination. For live feed culture *Brachionus rotundiformis* was reared in sea water of 29-30 ppt salinity and *Moina micrura* was reared at 14-15 ppt salinity in translucent containers. F4 generation of *P. pelagicus* was developed at Mandapam. It was observed that pen culture is suitable for growout of *S. tranquebarica*.

The work on culture, seed production and sea ranching of bivalves progressed well.

A breakthrough in rearing of cuttlefish (*Sepiella inermis*) was achieved at Tuticorin. The larvae reared in the laboratory attained maturity and spawned from the 75th day.

The revolving fund project on pearl culture at Mandapam progressed well; nucleus implantation was done in 43798 oysters. A technique for captive maturation and breeding of pearl oyster standardized at Visakhapatnam.

**Monitoring environmental characteristics**

Data on various characteristics of the fishery environment were collected using the vessel facilities as well as from the inshore waters. In the pollution-monitoring programme the THA levels were monitored in the water and sediment and it was found to be a stimulant of phytoplankton growth and prevents pollution.

Biodiversity studies were continued in collaboration with Universities and Central Drug Research Institute.

**Upgradation and transfer of technologies**

In the area of improvement of technologies investigations on pathology, nutrition, induced maturation and isolation of substances of pharmacological importance were continued. The extension programme was strengthened taking into account larger areas and more number of women and marginal farmers.

The progress in all the sponsored projects was maintained at desirable levels. A total of 9 consultancy projects were completed and 5 are being continued. Additional 4 projects are approved.

**Education and Training**

Seven candidates obtained the M.F.Sc. degree and three candidates submitted Ph.D. theses for adjudication. The KVK conducted thirtythree training programmes and the TTC, ten.
India is endowed with a long coastline of 8129 km, 0.5 million sq km of continental shelf, 2.02 million sq km of EEZ and an estimated annual Marine Fishery Resource Potential of 3.9 million tonnes. The vast areas all along the coastline offer ideal sites for seafarming and coastal mariculture. The Indian marine fisheries sector plays a very important role in supplying protein-rich food to the increasing population, employment generation and foreign exchange earning. The present marine fisheries scenario in India is characterised by declining yields from the inshore waters, increasing conflicts between different resource users, increasing demand for fish food for domestic consumption and export and, prospects for large scale seafarming and coastal mariculture. This warrants greater and more effective R&D efforts to enable implement suitable action plans for sustained marine fisheries and mariculture development.

The Central Marine Fisheries Research Institute (established in 1947) is the nodal agency in India, responsible for research support in marine fisheries development. Over the period of nearly half a century since its inception, the CMFRI grew significantly in its size and stature by building up a fairly adequate research infrastructure and recruiting suitably qualified R&D staff. The Institute's multidisciplinary approach to research in marine capture and culture fisheries has won the recognition as a premier Institute comparable to any well-established laboratory in the World.

To accomplish its mandate, the Institute conducts researches on characteristics of exploited marine fish stocks; carries out exploratory surveys and assesses the under and unexploited resources, develops seafarming techniques, undertakes research in fishery environmental characteristics and sea-dynamics and conducts postgraduate education programmes. Besides, the Institute collects Marine Fisheries Statistics and makes estimation of species-wise landings and monitors the landings on a continual basis from all along the country's coast. Studies are also conducted on economics of fishery enterprises and socio-economic conditions of fisherfolk.

The organisational set-up

To be able to effectively carry out these tasks, the Institute has established a Regional Centre at Mandapam Camp, Research Centres at Minicoy, Veraval, Mumbai, Karwar, Mangalore, Calicut, Vizhinjam, Tuticorin, Madras, Kakinada and Visakhapatnam and 28 Field Centres all...
along the coast. The entire activity is coordinated by the Headquarters at Cochin. The Institute has, over the years, built up laboratory and field facilities including Computers and Research Vessels for carrying out research programmes and has been upgrading the same to meet the changing and additional requirements. The sanctioned staff strength of the Institute is: Scientific 189, Technical 445, Ministerial 172, Supporting 296 and Auxiliary 39.

The multidisciplinary researches in capture and culture fisheries are conducted under eight Divisions: Fisheries Resources Assessment, Pelagic Fisheries, Demersal Fisheries, Crustacean Fisheries, Molluscan Fisheries, Fishery Environment Management, Physiology, Nutrition and Pathology and Socio-economic Evaluation and Technology Transfer. Interdivisional and Interinstitutional programmes with collaborating agencies are carried out for greater utilisation of expertise and facilities. Besides, the Institute also takes up short-term research projects on important and priority areas sponsored by outside agencies in the country, and offers consultancy services to the clients from Government organisations as well as private industry.
The Mandate

- Assessment and monitoring of the status of the exploited and unexploited fish stocks in the Indian EEZ, the contiguous international waters (for the mesopelagics) and the Southern Ocean (for Antarctic krill and finfish) in relation to fishery independent and fishery dependent factors; evaluation of the technoeconomic and socioeconomics of marine fishing operations.

- Development of suitable technologies for seafarming of finfish, shellfish, seaweeds and other cultivable marine organisms; evaluation of the technoeconomics and socioeconomics of mariculture operations; upgradation of technologies through R&D in frontier areas in Biotechnology, Nutrition, Pathology and Endocrinology.

- Monitoring the health of the coastal ecosystems, particularly the endangered ecosystems in relation to artisanal fishing, mechanised fishing and marine pollution.

- Transfer of viable seafarming technologies through extension education, specialised trainings and consultancy services.

- Postgraduate education in marine fisheries and mariculture leading to M.F.Sc. and Ph.D degrees; introduction of new subjects in frontier areas and establishment of another Deemed University in Fisheries.

Under the Postgraduate Programme in Mariculture, the Institute organises M.F.Sc. and Ph.D programmes under affiliation to the Central Institute of Fisheries Education - a Deemed University under the ICAR. The teaching programme is carried out by the Scientists of the Institute.

The Krishi Vigyan Kendra and the Trainers' Training Centre impart training in mariculture, agriculture, animal husbandry and other related subjects to fish farmers, agricultural farmers and farm women and the Trainers' Training Centre to officials of State Governments, Banks, Societies and autonomous bodies interested in fisheries development.

The Library and Documentation section provides reference facilities to research staff and students of the Institute as well as to visiting scientists both within and outside the country. The results of researches carried out in the Institute are published in various journals. Besides, the Institute brings out Bulletins, Special Publications and Marine Fisheries Information Service and publishes the Indian Journal of Fisheries.
HEADQUARTERS

Director
Central Marine Fisheries Research Institute
Post Box No. 1603, Tatapuram P.O.,
Ernakulam, Cochin-682 014.
(Per) 394798, (Resi): 382972, 367053
(Off): 394867, 394357, 394794, 394312, 390191,
394268, 394795, 394750, 394296, 391407, 394818.

Headquarters
Director
Central Marine Fisheries Research Institute
Post Box No. 1603, Tatapuram RO.,
Ernakulam, Cochin-682 014.
(Per): 394798, (Resi): 382972, 367053
(Off): 394867, 394357, 394794, 394312, 390191,
394268, 394795, 394750, 394296, 391407, 394818.

REGIONAL CENTRE

Officer-in-Charge
Mandapam Regional Centre of CMFRI
Marine Fisheries P.O.
Mandapam Camp-623 520
Tamil Nadu
(Per): 41443; (Off): 41456; (Resi): 41448
Fax: 04573-41502

RESEARCH CENTRES

Officer-in-Charge
Veraval Research Centre of CMFRI
Bhudiya Plot, Near B.M.G. Fisheries
Veraval-362 267, Gujarat
(Per): 41865; (Off): 21195
Fax: 02876-41865

Officer-in-Charge
Mumbai Research Centre of CMFRI
148, Army & Navy Building
2nd Floor, M.G. Road
Mumbai-400 001, Maharashtra
(Per): 2822653; (Off): 2845260;
(Resi): 4011426
Fax: 022-2822653

Officer-in-Charge
Karwar Research Centre of CMFRI
Post Box No. 5
Karwar, North Kanara,
Karnataka
(Per): 21371; (Off): 26165;
(Resi): 26264
Fax: 08382-21371

Officer-in-Charge
Mangalore Research Centre of CMFRI
Post Box No. 244, Bolar
Mangalore-575 001
Dakshina Kanara, Karnataka
(Per): 424152; (Off): 424061;
(Resi): 435807
Fax: 0824-424061

Officer-in-Charge
Calicut Research Centre of CMFRI
West Hill P.O.
Calicut-673 005, Kerala
(Per): 382011; (Off): 382033;
(Resi): 383950
Fax: 0495-382011

Officer-in-Charge
Vizhinjam Research Centre of CMFRI
Vizhinjam P.O.
Trivandrum-695 521, Kerala
(Per): 480324; (Off): 480224;
(Resi): 474469
Fax: 0471-480435
Officer-in-Charge
Tuticorin Research Centre of CMFRI
90, North Beach Road
Tuticorin-628 001
Tamil Nadu
⑦ : (Per) : 322274;
(Off) : 320274;
(Resi) : 321472
Fax : 0461-322274

Officer-in-Charge
Madras Research Centre of CMFRI
68/1, 4th Floor, Greams Road
Madras-600 006,
Tamil Nadu
⑦ : (Per) : 8294252;
(Off) : 8293299;
(Resi) : 6285311
Fax : 044-8254252

Officer-in-Charge
Kakinada Research Centre of CMFRI
Door No. 8-14-18/2
Red Cross Street,
Gandhi Nagar
Kakinada-533 004,
Andhra Pradesh
⑦ : (Per) : 378039;
(Off) : 376231;
(Resi) : 376082
Fax : 0884-378039

Officer-in-Charge
Visakhapatnam Research Centre of CMFRI
Andhra University P.O.
Visakhapatnam-530 003
Andhra Pradesh
⑦ : (Per) : 543154;
(Off) : 543793, 63779;
(Resi) : 574701
Fax : 091-543154

Officer-in-Charge
Minicoy Research Centre of CMFRI
Minicoy, U.T. of Lakshadweep
⑦ : (Off) : 22228;
(Resi) : 22263
Fax : 04892-22228

Officer-in-Charge
Krishi Vigyan Kendra of CMFRI
Prawn Culture Farm
Narakkal-682 505
Ernakulam Dist., Kerala
⑦ : (Off) : 492482, 492450

Officer-in-Charge
Field Mariculture Laboratory of CMFRI
Cochin Fisheries Harbour
Thoppumpady, Cochin-682 005, Kerala
⑦ : (Off) : 220892

FIELD CENTRES

Alleppey Field Centre of CMFRI
Geetha Building, Kalarcode
Alleppey-688 005,
Kerala

Bhatkal Field Centre of CMFRI
1st Floor, Behind Ganesh Bhavan
Building, 27,
Kidwai Road
Bhatkal (N.K.)-581 320

Chavakkad Field Centre of CMFRI
Edakkazhiyoor P.O.
Chavakkad PO. 680 515
Trichur District, Kerala

Contai Field Centre of CMFRI
Thanapukurpar, P.O.
Contai 721 401
Midnapore Dist
West Bengal
Cuddalore Field Centre of CMFRI
Jawan's Bhavan Lawrence Road
Cuddalore-607 002

Kanyakumari Field Centre of CMFRI,
Kanyakumari-629 702
Tamil Nadu

Dahanu Field Centre of CMFRI
Kirtane Bungalow,
Maangailwada
Dahanu,
Thana District, Maharashtra

Kovalam Field Laboratory of CMFRI
Kovalam - 602 112
Chengulpet Dist
Tamil Nadu

Goa Field Centre of CMFRI
Shri P.R. Phal House
1st Floor, B.B.
Borkar Road
Alt-Porvorim-403 521
Bardez, Goa

Machilipatnam Field Centre of CMFRI
Machilipatnam-521 002
Andhra Pradesh

Gopalpur Field Centre of CMFRI
Gopalpur-on-sea (P.O.)
Ganjam Dist.,
Orissa

Mahabalipuram Field Centre of CMFRI,
Mahabalipuram-603 104
Tamil Nadu

Jammuagar Field Centre of CMFRI
Milan Chambers,
Khoodiyar Colony
Aerodrome Road
Jammagar-361 006,
Gujarat

Malwan Field Centre of CMFRI
C/o Ratnam Enterprises
Darga Street
Narasapur
West Godavari Distt.,
Andhra Pradesh

Janjira Murud Field Centre of CMFRI
Ground Floor
Janjira Murud-402 401
Raigad District,
Maharashtra

Nagappatinam Field Centre of CMFRI
C/o Inspector of Fisheries
Salt Road
14/3, Bazar Peth Road
Nagapattinam-611 001
Thanjavur Dt.,
Tamilnadu

Kannur Field Centre of CMFRI
Office of the Deputy Director of Fisheries
Moppilla Bay Fisheries Complex
District Hospital Post
Kannur-670 017

Nellore Field Centre of CMFRI
Room No. 14, Municipal Building
New A.C. Bubba Reddy Statue
Weyyalakalava Street
Nellore-524 001, Andhra Pradesh
Ongole Field Centre of CMFRI
No. 49, A.P. Housing Colony
Manidipakam
Ongole-523 002
Prakasam District
Andhra Pradesh

Puri Field Centre of CMFRI
Santikunja Lane
Near Hotel Sea ‘n’ Sand
Chakratirtha Road
Puri-752 002,
Orissa

Palasa Field Centre of CMFRI
K.T. Road (Near Ravi Electricals)
Palasa,
Srikakulam District
Andhra Pradesh

Quilon Field Centre of CMFRI
Municipal Stadium Buildings
Ward No. VII, Door No. 737
Quilon, Kerala

Pattukottai Field Centre of CMFRI
Room No. 23,
Periaswamy Building
187/A, Big Bazar Street
Pattukottai-614 601
Tanjore,
Tamilnadu

Rander Field Centre of CMFRI
II Floor, ‘Devikripa’
3/213, Bandariward
Rander, Surat-395 005

Pondicherry Field Centre of CMFRI
Room No. 1,
First Floor
V.K.G. Building
143, Chinnasubraya Street
Pondicherry-605 001

Ratnagiri Field Centre of CMFRI
Building No. 3615, Devchand Nivas
Lower Lane, Ratnagiri-415 612
Maharashtra

Srikakulam Field Centre of CMFRI
Door No. 4-1-23/1
Opp. Govt. Employees
Co-operative Stores Ltd., No.A-675,
Srikakulam-532001
Andhra Pradesh
BUDGET 1998-99

(Rs. in lakhs)

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<th>Budget Heads</th>
<th>Non Revised Estimates</th>
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* Surrendered 209.00

Library and Documentation Section

During the period under report, 158 books and 1564 journals were added to the library at Headquarters. Essential books and journals were also acquired for the libraries at Regional Centre and Research Centres. Inter-library loan of publications and collaboration were continued. Reference and reprographic facilities were provided to visiting Scientists, Scholars and others from within and outside the country. The library also stocks and distributes the institute publications.

The following publications were issued during the year:

3. CMFRI Newsletter No. 80, 81
4. CMFRI Annual Report 1997-98
5. CMFRI Special Publication No. 68
6. Proceedings of the Seminar held in Hindi on "Changing Scenario of Marine Fisheries Research and New Dimensions"

Vessel Management Cell

Coralavel VI based at Cochin was utilised for collection of fish, prawns, molluscs, water samples and plankton in the inshore and backwaters of Cochin. The vessel was also
utilised for collection of fishes for various research projects at the new Mariculture Laboratory at Calicut. At Vizhinjam, the vessel was utilised for collection of ornamental fish and for launching of artificial reef. At Mandapam, the Cadalmin-II and Sagitta were utilised for collection of seaweeds and hydrographic data. Sagitta was also utilised to conduct EIS of the Sethusamudram project, a consultancy programme of CMFRI at Tuticorin. The vessel staff at Madras was fully utilised for various consultancy projects connected with environmental studies in the Bay of Bengal and Andaman sea. Cadalmin III at Madras is being decommissioned. Steps were taken to carry out repairs of Cadalmin IV at Tuticorin. Steps were taken to procure new marine engines for the vessel Seasearch at Mangalore and for the skiff at Cochin.

The 107’ steel trawler R.V. Skipjack was decommissioned and auctioned. VMC is also actively involved in the various DOD projects: Studies on Deep Scattering Layer, Investigations on the Toxic Algal Blooms of the EEZ of India and Stock Assessment, Biology, Resource Mapping of deepsea fishes, shrimps, lobsters and cephalopods in the EEZ of India.

The Official Language Implementation Programme

During the year under report, a total of 697 Hindi letters were received of which 489 were replied in Hindi and reply was not necessary for the remaining letters. 436 documents coming under section 3(3) of the Official Language Act were issued in bilingual form. During the year 16% of correspondence was made in Hindi. The progress made in Hindi implementation programme was reviewed at the meetings of the Official Language Implementation Committee. Two meetings of the Cochin Town Official Language Implementation Committee were conducted.

Hindi Week was celebrated at Headquarters and Regional/Research Centres from 14.9.1998 to 19.9.1998.

A Seminar was organised in Hindi on 3.3.1998 on ‘Changing Scenario in Marine Fisheries and New Dimensions’; 8 research papers were presented and they were
published in Hindi. Two Hindi workshops were conducted for the Ministerial staff of Headquarters in January and July; 27 staff participated.

During the year, abstracts of 8 M.F.Sc. theses were written in Hindi. Two issues of 'Rajbhasha Circular', six issues of MFIS with Hindi summary, two issues of Newsletter bilingually and Annual Report 1997-98 with Hindi summary were published. A total of 19 books were added to the Hindi Library.

Special efforts of the year

1) An All India Rajbhasha Contest based on the Hindi periodical Rajbhasha Circular was conducted for the staff at Headquarters and outstations. The top scorers of Headquarters and 12 outstations were given prizes.

2) The Hindi Week, jointly with Cochin TOLIC was celebrated at the Institute during 16th to 25th November, 1998.

3) In order to highlight the constitutional and legal provisions to promote the use of Hindi as Official Language the Institute sponsored the Official Language Poster Competition.

4) An intensive Pragya training course was conducted at CMFRI from 12.11.1998 to 1.12.1998. 26 staff from various Central Govt. Offices at Kochi including 6 staff of CMFRI attended the course.

5) A 'Functional Hindi Training Programme' was organised at the Veraval Centre.

6) A meeting in Hindi on “Research and Management in fish production sector” was organised at the Mumbai Research Centre of CMFRI for the fishermen at Versova.
Marine fish production in India during 1998

The marine fish production in India during 1998 was provisionally estimated at 2.67 million tonnes which is 2.12% less than the estimated production of 2.73 million tonnes of 1997. The pelagic group formed about 49.2% of the total landings and demersal finfish, crustaceans and molluscs together formed 50.8%. The landings by mechanized and motorized units together accounted for about 92% of the total landings and those by nonmechanized and nonmotorized units 8%. The salient features of marine fish landings in the country during 1998 in comparison to 1997 are:

- 9% decline in the oil sardine landings, the estimate for 1998 being 203,000t.
- 47.9% increase in Coilia landings with the catch estimated at 46,000t.
- 17.8% increase in the catfish landings with annual landings estimated at 53,000t.
- 17.9% increase in the Bombay-duck landings with the catch estimated at 123,000t.
- 12.0% increase in the threadfin bream landings, the estimate for 1998 being 81,000t.
- 13.2% increase in nonpenaeid prawn landings with the landings estimated at 174,000t.
- 2.9% increase in the penaeid prawn catch with the year's landings estimated at 215,000t.
### MARINE FISH PRODUCTION (TONNES) IN INDIA DURING 1997 AND 1998

<table>
<thead>
<tr>
<th>Name</th>
<th>1997</th>
<th>1998</th>
<th>Name</th>
<th>1997</th>
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<td>Stomatopods</td>
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<td><strong>EELS</strong></td>
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<td>9573</td>
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<td>Rock cods</td>
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<td>18570</td>
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<td>Snappers</td>
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<td>Threadfin breams</td>
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<td>Other mackerels</td>
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<td>Auxis spp</td>
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<td>Silver pomfret</td>
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<td>K. pelamis</td>
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<td><strong>TOTAL DEMERSAL</strong></td>
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<td><strong>FINISH</strong></td>
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<td><strong>DEMERAL FINISH</strong></td>
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<tr>
<td><strong>TOTAL DEMERSAL</strong></td>
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<td><strong>FINISH</strong></td>
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**GRAND TOTAL** 2726230 2668484
Decline of 46,000t in mackerel landings (21.0%)

REGIONWISE LANDINGS

**Northeast Region**: The landings in the Northeast region registered an increase of about 10,800t over that of the previous year. The principal components were Bombay-duck (16,000t), catfishes (9,400t), nonpenaeid prawns (8,900t), crabs (1200t), oilsardine (700t), other sardines (4,300t) and *Coilia* spp (4,900t). Compared to the previous year, *Hilsa* shad declined by about 11,600t. However, the landings of Bombay-duck registered an increase of about 10,000t, the catfishes 770t, nonpenaeid prawns 6400t, crabs 200t, oilsardine (200t) and *Coilia* spp (1400t).

**Southeast Region**: The estimated landings in 1998 from this region was 6.8 lakh t; a decline of 60,600t from that of the previous year. An estimated 24,900t of elasmobranchs was landed in 1998 which showed a decline of 9200t. Oilsardine catch decreased by about 6700t from the 111,500t of the previous year. Other sardine landing was estimated at 57,000t.

<table>
<thead>
<tr>
<th>Region</th>
<th>Estimated production (tonnes)</th>
<th>% in the all India total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Northeast (West Bengal &amp; Orissa)</td>
<td>131,421</td>
<td>4.9</td>
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<tr>
<td>2. Southeast (Andhra Pradesh, Tamil Nadu &amp; Pondicherry)</td>
<td>626,477</td>
<td>23.5</td>
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<td>3. Southwest (Kerala, Karnataka &amp; Goa)</td>
<td>757,936</td>
<td>28.4</td>
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<tr>
<td>4. Northwest (Maharashtra &amp; Gujarat)</td>
<td>1118,846</td>
<td>41.9</td>
</tr>
<tr>
<td>5. Lakshadweep &amp; Andamans</td>
<td>33,804</td>
<td>1.3</td>
</tr>
</tbody>
</table>
which was about 24,000t less than that of the previous year. However the landings of shads (other than Hilsa shads) increased marginally by about 4,000t from about 5,500t during the previous year.

An increase of about 9,000 t was observed in the landings of whitebait from about 24,000 t during the previous year. Landings of halfbeaks and fullbeaks increased marginally by about 2000t and those of carangids decreased by about 5500t over those of previous year. A significant decrease was noticed in the landings of silverbellies from about 53,000 t in 1997 to about 45,000 t during this year. Mackerel catch decreased significantly from about 39,000 t during 1997 to 31,000 t in 1998. The landings of penaeid prawns increased to about 48,000 t during 1998 from about 42,000 t during 1997. Cephalopod landings decreased by about 2700 t from the 12,000 t during the previous year.

Southwest Region: The total landings decreased by about 71,000 t from that of the previous year. Among the major groups, oilsardine, perches, mackerel, penaeid prawns, stomatopods and cephalopods recorded reduced landings. However, the landings of whitebait, perches and carangids were better. The decrease was noticed in the oil sardine fishery by about 14,000 t, the estimated landings being 98,000 t. However, landings of whitebait registered an increase of 6500t and threadfin breams of 5600 t. The landings of perches declined from about 72,500 t in 1997 to about 64,500 t in 1998. Croakers increased by about 4500 t over the previous year. The landing of ribbonfishes declined from about 28,000 t in 1997 to about 20,000 t in 1998. The landing of scads was 47,000 t which showed an increase of about 80% over that of previous year. The landings of carangids increased from 72,700 to 83,600 t over the previous year. There was a decline of about 33,000 t in the landings of Indian Mackerel (141,000 t to 108,000 t) and soles of about 8000 t (32,000t to 24,000 t).
Northwest Region

This region contributed maximum to the total landings in the country with the estimated landings of 11.2 lakh tonnes as against 10.6 lakh tonnes during 1997. The landings (102,000t) of Bombay-duck showed slight increase of about 5,000t and nonpenaeid prawns showed a significant increase of about 22,000t. The landings of ribbonfishes registered a decline of about 35,000t, the landings being 88,000t in 1998. The landings of croakers (141,000t) showed an increase of about 33,000t over that of previous year. The penaeid prawns registered a marginal increase of about 1,100t during the year, the estimate being 93,600t. The cephalopod landing was estimated at 59,000t during this year which was about 8,000t more than that in 1997. The landing of sharks in this region was to the tune of 33,000 t in 1998 which showed a significant improvement of about 9,000t. The landings of C. nilia spp also registered increase of 11,000t from 26,000t in 1997.

Landings by Mechanized, Motorized and Artisanal Units

The landings of 24.2 lakh tonnes by the mechanized units accounted for about 73.2% of the total marine fish landings of the country during 1998 followed by the motorized (18.8%) and artisanal units (8.0%). Trawl, purse seine, gillnet and domnet were the major gears used by the mechanized units, ring seine and gill net by motorized units and gillnet, shore seine, boat seine and several others by the artisanal units.

STOCK ASSESSMENT TECHNIQUES IN MARINE FISH AND SHELLFISH RESOURCES AND MANAGEMENT (FSS/FRA/1.3)

M. Srinath and R. Venugopalan

A computer algorithm was developed to estimate the parameters of the discrete version of the Schaefer model in the non-equilibrium case, employing the Nelder-Mead minimization routine.

The catch and effort data of 1961-97 period from Maharashtra were analyzed. The catch rates of some commercially important resources in the major fisheries were also analyzed. The MSY of all the resources in the state was estimated as 361,000 t with a confidence interval of 314,000 to 407,000 t.

The CPUE of the penaeid prawns, catfish and croakers showed an inverse relationship with the trawl effort. For these three resources, the equilibrium and non-equilibrium versions of the Schaefer model and the equilibrium version of the Fox's model were fitted. For the penaeid prawns and the catfish, a harmonic component to account for the cyclical variations in the catches was introduced in the non-equilibrium model. The
MSY, fMSY were estimated. The fitted models were validated through a failure index (F.I%). Higher the F.I, the poorer is the fit. The results are summarized in the following table.

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<th>MODEL</th>
<th>RESOURCE</th>
<th>MSY</th>
<th>fMSY</th>
<th>F.I</th>
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<td>280</td>
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<td></td>
<td>Croakers</td>
<td>24</td>
<td>265</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Catfishes</td>
<td>46</td>
<td>24</td>
<td>11</td>
</tr>
<tr>
<td>With harmonic component</td>
<td>Penaeid prawns</td>
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<td></td>
<td>Catfishes</td>
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<td>Catfishes</td>
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</tbody>
</table>

The deterministic, univariate and multivariate term series modelling approaches were evaluated on the basis of their efficiency with a view to modelling and providing operational forecasts of the quarterly commercial landings of seven species along with the total landings of Tamilnadu during 1975-'96. The analysis revealed that ARIMA models provided better fits to other sardines, croakers and silverbellies, besides the total landings. The WES model gave a better account of elasmobranchs, carangids and penaeid prawns. The HREG provided better explanation of the landings of the perches.

EVALUATION OF CHANGE IN THE PATTERN OF CATCH AND COMPOSITION OF MARINE FISHERY RESOURCES IN INDIA (FSS/FRA/1.19)

K.S.Scariah, K.N.Kurup, K.Balan, M.Srinath and K.Vijayalekshmi

Trend in the landings of the major marine fishery resources (elasmobranchs, catfish, Bombay-duck, perches, croakers, ribbonfish, carangids, pomfrets, mackerel, seerfish, penaeid prawns, nonpenaeid prawns and cephalopods) in Maharashtra was analyzed. The data on estimated landings from 1961 to 1997 were used for the study.

It was found that the major fishery resources could be grouped in 5 distinct clusters.
Cluster I: Both the resources have been showing gradual declining trend in the landings since attaining their peaks (Bombay-duck during 1981 and the nonpenaeid prawns during 1972). The landings of Bombay-duck declined from a peak of about 82,000 t during 1981 to about 10,000 t in 1996 and the nonpenaeid prawns have declined from about 84,000 t in 1972 to low of about 15,000 t in 1995. These resources which together accounted for more than 50% of the total landings during the 1970s and 1980s, accounted for only 10% currently.

Cluster II: Showing a general increasing trend upto 1987, all the three resources of this cluster, suffered declining trend; their relative contribution also exhibited a similar trend.

Cluster III: The landings of the three resources exhibited a general increasing trend from 1974 onwards. The penaeid prawns showed fluctuations in the landings from 1981, so also the seerfish.

Cluster IV: The landings of these resources have significantly increased from 1981 onwards and these four resources exhibiting similar trend from 1981 onwards. These four resources together contributed relatively more than the hitherto dominant resources such as the Bombay-duck and the nonpenaeid prawns.

Cluster V: The mackerel stood as a group distinct from the other major resources. During 1961-68, the landings were almost insignificant and shot upto about 21,000 t in 1969 again decreased to insignificant levels till 1988. In 1989, again shot the landing up to about 22,000 t and showed a general increasing trend latter with peak landings of about 38,000 t in 1996.

Thus, the analysis revealed that there was a tangible change in the composition of the total marine fish landings in Maharashtra. This may be attributed to gradual decline of the dolnet fishery and increase in the case of trawl fishery targeting economically more valuable fishery resources.

The tabulation and analysis of data of different seasons and gears in respect of Gujarat are in progress. The major groups identified are to be subjected to further analysis on the basis of gearwise and seasonwise landings. The collection of relevant details on technological changes in marine fisheries sector are also in progress. Further analysis would continue by taking all the relevant data.
The large volume of data generated through the survey programme of the Institute were fed into the computers installed at the Marine Data Centre on monthly zonewise formats. The fishery data in respect of all the geographical zones of the mainland were verified, coded and transferred to storage devices.

These stored data were analyzed and the results were promptly made available to various endusers. Software developed by the Data Centre were used for creation, updating, processing and retrieval of data/results. The supervision and co-ordination work in respect of data scrutiny, transfer and processing was attended during 1998-99 period. The information on districtwise, gearwise and specieswise marine fish landings were completed for the year 1998.

Additional data collected through survey programme on turtles was transferred to the computer and processed. Backup files were created on the magnetic tapes.

The course contents included theory and practical classes on elementary mathematics, differential calculus, elements of computers, descriptive statistics and statistical methods. An exposure on the use of computer softwares related to statistics was also offered for the benefit of trainees. The practical classes were conducted at the computer laboratory, using softwares such as *statistica, mstac, msexcel* etc.
II. PELAGIC FISHERIES DIVISION

During 1998-99 the Pelagic Fisheries Division carried out investigations under eight Research Projects. Pelagic finfish production during 1985-1998 fluctuated from 0.78 mt in 1985 to 1.42 mt in 1998 forming 51.1% of the total marine fish production. A stagnation in the catch at 1.3 mt (annual) against an annual potential yield of 2.21 mt of pelagic resources from the Indian EEZ is discernible for the last eight years. About 66.4% of the production of pelagics in 1998 was obtained from the west coast, 31.9% from the east coast and the rest (1.7%) from the Island territories. Among the maritime states, Kerala ranked first, contributing 23.4% of the total pelagics, followed by Gujarat 21.6%, Tamilnadu 16.7%, Maharashtra 12.3%, Karnataka 11.1%, Andhra Pradesh 8.9%, Lakshadweep 3.0% and the rest from other States.

FISHERY AND RESOURCE CHARACTERISTICS OF SARDINELLA SPP. (PF/RE/1.1)

N.G.K. Pillai, U. Ganga, Prathibha Rohit, T.M. Yohannan, A.A. Jayaprakash and K. Dorairaj

After the fluctuating trend noticed in the mid-nineties, the oilsardine fishery showed an upward swing during the year 1995 along the west coast of India. The process was fast at centres along the south (Cochin, Calicut and Managalore), and slow in the north at Karwar. The production during the last 14 years varied from 0.47 lakh t in 1994 to 2.79 lakh t...
in 1989. During 1998, the production was 2.03 lakh t which is less by 8.5% over last year. The lesser sardine landing during the current year was 1.01 lakh t compared to 1.17 lakh t during the previous year.

Fishery

Data on the fishery and resource characteristics of *Sardinella* spp. were collected at Karwar, Mangalore, Calicut and Cochin along the west coast, and Tuticorin, Mandapam, Madras and Visakhapatnam along the east coast. At all the centres except Mangalore, Mandapam and Visakhapatnam the sardine landings register an increase as follows: Karwar 4184 t (+260%), Calicut 769 t (+21%), Cochin 3161 t (+62%), and Tuticorin 8319 t (+98%). The purseseines contributed 100% of the total sardine catch at Karwar, 85% at Mangalore and 55% at Cochin. Ringseines shared 2.2% at Mangalore compared to 99.8% at Calicut and 42% at Cochin. The trawls accounted for 2.2% at Mangalore, 2.4% at Cochin, 1.4% at Mandapam and 4.5% at Visakhapatnam. Gillnets were the sole gear at Tuticorin, while the gear shared 20% and 24% of the sardine catch at Mandapam and Visakhapatnam respectively.

At Mangalore, though the purseseine effort was less by 16%, the catch (7539 t) increased by 0.7% over the last year, while in the trawls there was a 15% reduction in effort with a consequent decline (52%) in the catch (176 t). The ringseine effort increased by 50% bringing 66% increase in the catch (195 t). At Cochin, the purseseine effort decreased by 29%, but the landings were high by 20% (1756 t). A similar trend was noticed in the trawl landings at this centre. On the other hand, a marginal increase in effort by 0.9% in the operation of ringseines yielded 1328 t, an increase of 62% over the previous year. The *Chalavala* landings at Tuticorin (901 t) was less by 8% with a reduction in effort input by 28% over last year. At Punnakayal the same gear landed 7419 t, the effort and landings indicated 55% increase. At Pamban, the trawl landings (35 t) were less (-99%) consequent on a reduction in effort (-54%). The gillnet catch (484 t) showed 113% increase for 46% increase in effort. Inspite of an increase in effort by
129% in pairtrawling, the landings (434 t) dropped by 83%. But at Rameswaram the effort input increased by 249% and concomitantly landings by 419% (1450 t).

The highest c/e of 916 kg was realised by the purseseines at Cochin followed by 714 kg at Karwar and 495 kg at Mangalore. The ringseines also recorded a higher c/e of 478 kg at Cochin compared to 100 kg at Mangalore and 49 kg at Calicut. The trawls realised less than 5 kg along the west coast compared to 8-9 kg along the east coast. The c/e was 631 kg in pair trawling along southeast coast. The gillnets at Tuticorin showed a c/e of 81-88 kg compared to 46 kg noticed at Visakhapatnam.

At Karwar and Calicut, the fishing season started by October and continued up to February/March, with a peak during November-January. Sardines were exploited throughout the year by one gear or the other at Mangalore/Malpe, Cochin and at east coast centres. Along the west coast the peak fishing took place from September-November compared to I and II quarters at Tuticorin; May to November at Mandapam; and IV and I quarters at Visakhapatnam.

In all the gears operated along the west and southeast coasts, oilsardine was the dominant species forming 50-100% of total sardines landed. In the purseseines at Karwar, trawls and ringnets at Calicut the species formed 100% compared to 86-92% in the pair trawls at Mandapam. Lesser sardines (S.albella and S.gibbosa) dominated at Mandapam Area while S.gibbosa and S.sirm formed the major species landed at Tuticorin. S.fimbriata and S.gibbosa dominated in the sardine fishery along the west coast.

**Biology**

Oilsardine of 105-205 mm (modal length: 140) were exploited by the purseseines at Karwar, 85-205 mm (128, mm) at Mangalore

**Length range (mm) and modal length (mm) of oilsardine landed by various gears at different Centres during 1998**

<table>
<thead>
<tr>
<th>Centres</th>
<th>Gear</th>
<th>Length range Modal length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karwar</td>
<td>PS</td>
<td>105-205</td>
</tr>
<tr>
<td>Tadri</td>
<td>PS</td>
<td>165-205</td>
</tr>
<tr>
<td>Mangalore</td>
<td>PS</td>
<td>85-205</td>
</tr>
<tr>
<td>Malpe</td>
<td>TR</td>
<td>120-195</td>
</tr>
<tr>
<td></td>
<td>RB</td>
<td>105-150</td>
</tr>
<tr>
<td>Calicut</td>
<td>RS</td>
<td>90-205</td>
</tr>
<tr>
<td>Cochin</td>
<td>TR</td>
<td>115-215</td>
</tr>
<tr>
<td></td>
<td>PS</td>
<td>105-215</td>
</tr>
<tr>
<td></td>
<td>RS</td>
<td>50-210</td>
</tr>
<tr>
<td>Visakhapatnam</td>
<td>BS</td>
<td>70-200</td>
</tr>
<tr>
<td></td>
<td>GN</td>
<td>130-195</td>
</tr>
<tr>
<td></td>
<td>TN</td>
<td>155-200</td>
</tr>
</tbody>
</table>

**PS** - Purseseine  **GN** - Gillnet  **TR** - Trawl  **TN** - Trawl  **BS** - Boatsnare  **RB** - Ramhaia
and 100-210 mm (140 mm) at Malpe. The ringseine catch consisted of 105-150 mm (125 mm) at Mangalore, 110-200 mm (125 mm) at Malpe, 90-205 mm (180 mm) at Calicut and 50-210 mm (70 mm) at Cochin. Relatively larger fishes were observed in trawls as: 120-195 mm (170 mm) at Mangalore, 155-190 mm (175 mm) at Malpe, 115-215 mm (180 mm) at Cochin and 155-200 mm (170 mm) at Visakhapatnam. In the boatseines 70-200 mm (91 mm) were noted at Visakhapatnam. *S. gibbosa* of 85-165 mm were noticed in the Chalavalai at Tuticorin while 70-170 mm were obtained in purseseines at Mangalore. *S. albella* of 85-145 mm were exploited at Mandapam.

There was good concentration of spawning population of oilsardine off Mangalore/Malpe unlike that in the previous year where such concentration was observed off Cochin. Probably, the large concentration of young oilsardines off Cochin during July in 1998 is the result of the spawning success and survival of oilsardine recruited last year. But this year a shift was observed in the spawning ground towards north in the Malabar Upwelling Ecosystem. Along the east coast, at Visakhapatnam, it is the post spawners and new recruits that were exploited.

**FISHERY AND RESOURCE CHARACTERISTICS OF ANCHOVIES (PF/RE/1.2)**

R. Thiagarajan, M. Zaffar Khan, Prathibha Rohit, A.A. Jayaprakash, K. Dorairaj and H. Mohammed Kasim

During the last one and a half decade the anchovies recorded the highest production of 1.65 lakh t in 1991, but further showed a declining trend and appeared to have stabilized between 1 lakh t and 1.6 lakh t. The production of 1.38 lakh t in 1997 is only a marginal improvement by 3.8% over 1996, but it further improved to 1.63 lakh t in 1998. Statewise, the highest contribution of 21.9% was from Kerala followed by 19.7% from Gujarat and 19.5% from Tamilnadu.

**Fishery**

At Mangalore, the landings improved from 4715 t in 1997 to 6225 t (-32%) in 1998. At Cochin, 184 t were landed against 101 t of the previous year. At Vizhinjam, 789 t were landed against 398 t during 1997. Along the east coast, at Kakinada the catch was 1155 t. A production of 184 t at Cochin is an improvement over the preceding year, but is relatively low compared to the landings recorded during the early nineties.

At Mangalore/Malpe though the effort input has gone down in all the gears, the catch indicated an increase. In the purseseines the effort (15232 units) was down by 10% but the catch (4198 t) improved by 71%. The effort (58061) and catch (2026 t) in trawls decreased by 2.4% and 11% respectively. The ringseines registered 60% increase in catch against 5.6% decrease in effort. At Cochin, the effort input by purseseines and trawls
declined by 52% and 29% but the landings improved by 100% and 5% respectively. In the ringseines the decrease in effort (6%) though marginal, resulted in 138% increase in the catch. The highest c/e of 276 kg was observed in the purseseines at Mangalore followed by 49 kg by ringseines at Cochin. The trawls recorded a highest c/e of 35 kg at Mangalore/Malpe followed by 18.7 kg at Kakinada and 2.5 kg at Cochin.

In the purseseines at Mangalore the IV quarter was highly productive (46%) followed by I (41%), II (12%) and III (1%) quarters. But in trawls the first quarter (76%) was highly productive followed by IV (15%) and III (9%) quarters. At Cochin, the trawls landed (50 t) anchovies only during January, September, November and December with a highest catch of 34 t in September. The purseseine also landed a catch of 5 t in September and

<table>
<thead>
<tr>
<th>Centre</th>
<th>Gear</th>
<th>Species</th>
<th>Length range (mm)</th>
<th>Modal length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mumbai</td>
<td>TN</td>
<td>Ca/la dussumieri</td>
<td>30-209</td>
<td>140</td>
</tr>
<tr>
<td>Mangalore</td>
<td>TN</td>
<td>S. devisi</td>
<td>45-95</td>
<td>85</td>
</tr>
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<td></td>
<td>TN</td>
<td>S. bataviensis</td>
<td>55-105</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>TN</td>
<td>S. macrops</td>
<td>70-75</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>PS</td>
<td>S. devisi</td>
<td>50-95</td>
<td>85</td>
</tr>
<tr>
<td>Cochin</td>
<td>RS</td>
<td>S. buckaneeri</td>
<td>55-70</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>RS</td>
<td>S. commersonii</td>
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<td>70</td>
</tr>
<tr>
<td></td>
<td>TN</td>
<td>S. devisi</td>
<td>60-100</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>TN</td>
<td>S. commersonii</td>
<td>50-130</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>PS</td>
<td>S. commersonii</td>
<td>80-95</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>PS</td>
<td>S. buckaneeri</td>
<td>80-95</td>
<td>80</td>
</tr>
<tr>
<td>Kakinada</td>
<td>TN</td>
<td>S. devisi</td>
<td>40-95</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>TN</td>
<td>S. bataviensis</td>
<td>45-135</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>TN</td>
<td>S. commersonii</td>
<td>75-150</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>TN</td>
<td>S. indicus</td>
<td>65-155</td>
<td>90</td>
</tr>
<tr>
<td>Mandapam</td>
<td>SS</td>
<td>S. indicus</td>
<td>55-125</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>TN</td>
<td>S. commersonii</td>
<td>90-135</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td>TN</td>
<td>S. indicus</td>
<td>75-135</td>
<td>130</td>
</tr>
</tbody>
</table>

TN - Trawl net, RS - Ringseine, PS - Purseseine, SS - Shoreseine
no landing was recorded during the rest of the period. In the ringseine the season was from April to September with a peak catch of 78 t in July. At Kakinada, the trawls recorded a highest catch during II quarter (36%), followed by IV (24%), I (22%) and III (18%) quarters.

*S. devisi* was the dominant species in all the gears at Mangalore. In the purseseines, the species formed 90% followed by *S. bataviensis* (9%), *S. macrops* and *S. buccaneeri* formed the rest. In the trawls at Mangalore and Malpe *S. devisi* constituted 85% and 77% respectively. *S. bataviensis* formed 14% at the former centre and 8% at the latter centre. Other species, each contributed to less than 10%. *S. devisi* was the dominant species in the trawls at Cochin. But in the ringseines *S. commersonii* dominated which was unusual. This is because the regular fishery for *S. macrops* has been a failure. At Kakinada, *S. bataviensis* (48.5%) followed by *S. commersonii* (20%) and *S. devisi* (12.2%) constituted the fishery.

**Biology**

*S. devisi* of 50-95 mm in the purseseines, 45-95 mm in trawls, *S. bataviensis* 55-105 mm in trawls were observed at Mangalore. At Malpe, both species from 35 mm and above were represented. At Cochin, *S. devisi* of 60-100 mm were noticed in trawls. *S. commersonii* of 80-130 mm in the purseseines, 50-100 mm in trawls, and 55-100 mm in ringseines were encountered. *S. buccaneeri* occurred in the size range of 55-70 mm in ringseines and 80-95 mm in purseseines.

Along both east and west coasts, most of the anchovies indicated a spawning season extending from October to May. While some of them were with peak spawning activity during the post-monsoon period, others were more oriented to a premonsoon peak.

**FISHERY AND RESOURCE CHARACTERISTICS OF SEERFISHES (PF/RE/2.1)**

* C.Muthiah, B. Manoj Kumar, T.M. Yohannan, N.G.K. Pillai and H.Mohammed Kasim

The seerfish landings, though fluctuating gradually increased from 0.35 lakh t in 1985 to a peak of 0.55 lakh t in 1998. Investigations on the fishery and resource characteristics of seerfishes were carried out from Veraval, Mangalore, Calicut and Kochi on the west coast and Tuticorin, Madras, Kakinada and Visakhapatnam along the east coast. Work at Kakinada was initiated on April 1998.

**Fishery**

Seerfish landing by gillnet and trawl at the centres along the west coast and by gillnet, trawl and hook & line at the east coast centres showed marginal improvement (10%) as compared to that in 1997. There was an increase in production, varying from 10.6% (Calicut) to 154.6% (Kochi) in all centres except Veraval and Tuticorin where, the
landing declined by 30% and 12% respectively. The catch at different centres ranged from 131 t (Calicut) to 1236 t (Veraval). There had been better abundance of the resource in the gillnet and trawling grounds off Mangalore-Malpe, Kochi and Madras and in the gillnet fishing grounds off Visakhapatnam while it was poor in the gillnet and trawl fishing grounds off Veraval and hook & line grounds off Tuticorin.

Peak production of seerfish was recorded in the 1st quarter (35%), followed by the IVth quarter (28.4%), 111st quarter (19.2%) and I1Ind quarter (17.2%). Along the west coast at different centres maximum catches were recorded during 1st quarter (40.5%) followed by the 111st quarter (33.7%). In the east coast, 111st quarter (32.6%) registered high production followed by 1st quarter (25.8%) and I1Ind quarter (22.7%) at different centres. Peak catches were recorded in October at Veraval and Kochi, December at Visakhapatnam, February at Madras, March at Mangalore, April at Calicut, July at Kakinada and August at Tuticorin.

As in the previous year, gillnet was the major gear contributing 56.9% followed by trawl 34.3%, hook & line 8.3%, purse seine 0.4% and indigenous gears 0.07%.

Gillnet was the dominant gear at Veraval (71.3%), Kochi (93.4%), Tuticorin (51.3%) and Madras (43.4%). The total effort from all the eight centres increased marginally (1.3%) as compared to last year. The effort at different centres varied from 2,977 units (Calicut) to 31,194 units (Veraval). The C/E in large meshed gillnet ranged from 21.2 kg (Calicut) to 71.6 kg (Madras). The catch was highest at Veraval (881 t) and lowest at Visakhapatnam (42.8 t). The C/E had improved at Mangalore (25.3%), Kochi (155%), Tuticorin (48%) and Madras (49.2%), while it declined at Veraval (22.3%) and Calicut (31.6%). Seerfish constituted 23.9% in the total catch of gillnet at Veraval, 23.9% at Mangalore-Malpe, 21.9% at Kochi and 16% at Visakhapatnam.

Trawl was the chief gear for seerfish fishery at Mangalore-Malpe (589 t, 55.6%) and Calicut (68.2 t, 51.9%). In other centres the catch fluctuated from 32.2 t (Kochi) to 354.3 t (Veraval). The effort input at individual centres varied from 10,554 units at Calicut to 70,531 units at Veraval. C/E was highest at Mangalore-Malpe (23.7 kg in multiday trawlers) and lowest at Kakinada (1.3 kg). The C/E had improved at Mangalore-Malpe (135.8%), Kochi (841.2%) and Madras (74.4%) whereas it declined at Veraval (17%) and Tuticorin (28.3%). Seerfishes formed 0.6% of the total fish catch by trawls at Veraval, 1.3% at Mangalore-Malpe and 0.3% at Kochi.

Hook and line was the prime gear for seerfish production at Visakhapatnam (137 t, C/E = 5.4 kg) constituting 43% of the total catch of the gear. The catch and catch rate were high at Madras (142 t; C/E = 23.6 kg) and low at Tuticorin (76 t; C/E = 6.5 kg). The
effort was highest at Visakhapatnam (25,593 units) followed by Tuticorin (11,704 units) and Madras (6,012 units).

Purse seiners landed 17.5 t at Mangalore-Malpe and 1.2 t at Kochi which was less by 69.2% at the former and 3.5% at the latter centres. Indigenous gears landed about 2.8 t at Mangalore-Malpe and 0.2 t at Calicut as compared to 0.8 t and 20.8 t respectively in 1977.

The fishery was constituted by four species, *Scomberomorus commerson*, *S. guttatus*, *S. lineolatus* and *Acanthocybium solandri* in the proportion of 64.4%, 34.9%, 0.3% and 0.4% respectively. As compared to 1997-98, the percentage of king seer landing increased by 4.5% and this loss was gained by that of the spotted seer. The king seer dominated in all gears and all centres except at the northern centres at Veraval, Kakinada and Visakhapatnam where the spotted seer was dominant.

**Biology**

The length range of *S. commerson* was 26-132 cm in the large meshed gillnet with dominant modes at 62 cm (Veraval), 52 cm (Mangalore-Malpe), 60 cm (Calicut), 70-75 cm (Kochi) and 74 cm (Tuticorin). In the small meshed size gillnet *podivalai* at Tuticorin and bottom-set gillnet at Kakinada the size range was 12 to 66 cm and 16 to 128 cm with modal size at 40 cm and 26 cm respectively. The fishery was supported by 46-112 cm (99.2%) at Veraval, 36-96 cm (97.7%) at Mangalore-Malpe, 34-88 cm (97.9%) at Calicut, 44-144 cm (98%) at Tuticorin and 34-104 cm (96.5%) at Madras. The proportion of youngfish (< 34 cm size) component was high in *podivalai* at Tuticorin (52.5%) and in the bottom set gillnet at Kakinada (64.9%). In trawl, the size range was 10-106 cm with dominant modes at 60 cm (Veraval), 24 cm (Mangalore-Malpe), 25-30 cm (Kochi), 50 cm (Tuticorin) and 12 cm (Kakinada). The youngfish exploitation was higher at Kakinada (92.8%), Mangalore-Malpe (77%) and Tuticorin (40.9%) indicating the threat of growth overfishing. The size-range was relatively high in hook & line (40-138 cm) with dominant modes at 62 cm at Tuticorin and 68 cm at Chennai. In purse seine catch at Kochi, small sized specimens (10-50 cm) constituted the catch.

The size range of *S. guttatus* in gillnet was 12-70 cm with dominant modes at 42 cm (Veraval and Mangalore-Malpe), 52 cm (Madras) and 16 cm (Kakinada). In the trawl, the size ranged from 8 to 62 cm with dominant mode at 42 cm (Veraval), 34 cm (Mangalore-Malpe), 36 cm (Madras) and 12 cm (Kakinada). Overall, the fishery was supported by 12-68 cm in gillnet (98%) and 8-54 cm in trawl (65-99%). Youngfish (< 18 cm size) were caught more abundantly at Kakinada by both gillnet (46.4%) and trawl (48%), indicating high fishing pressure on the stock.
FISHERY AND RESOURCE CHARACTERISTICS OF TUNAS, TUNA-LIVEBAITS AND BILLFISHES (PF/RE/2.2)

P.P.Pillai, B.Manoj Kumar, M.Zaffar Khan, C. Muthiah, T.M.Yohannan, N.G.K.Pillai, G.Gopakumar, H.Mohammed Kasim, M. Sivadas and A.K.V. Nasser

The all India tuna landings after a highest ever record of 0.52 lakh t in 1990 fluctuated around 0.40 lakh t till 1998. Studies on the fishery and resource characteristics of tunas, tuna-livebaits and billfishes were carried out at Veraval, Mumbai, Mangalore, Calicut, Cochin, Vizhinjam, Tuticorin, Madras, Kakinada and Minicoy.

**Fishery**

The catch and percentage increase/decrease over to the previous year were as follows: Veraval 851.6 t (-52.1%), Mumbai 429.2 t (-41.2%), Mangalore 1121.6 t (+196.8%), Calicut 51.3 t (-34.2%), Cochin 10101 (-28.3%), Vizhinjam 4600.4 t (+67.4%), Tuticorin 952.2 t (+194.6%), Madras 319.5 t (+21%), Kakinada 17.9 t (+31%) and Minicoy 1030.8 t (+49.6%). Tunas and billfishes formed between 0.7% in hooks and line fishery at Tuticorin and 99.7% in pole and line fishery at Minicoy. The catch per unit effort in the gillnet fishery varied from 2.8 kg at Kakinada to 138.6 kg at Cochin. In the pole and line fishery at Minicoy (Lakshadweep) it was 366.9 kg in 1998. Because of the calmness of sea during this year, the pole and line fishing resumed after the monsoon in early August. At Agatti, the monsoon fishery came to an end as early as in August due to the resumption of pole and line tuna fishery. At Tuticorin, some trawlers (25 ft) were converted for drift gillnet operation throughout the year for tunas keeping the Tharuvaikulam as their landing centre.

Among tunas, *E. affinis* was the major species except at Vizhinjam and Minicoy. At Veraval this species formed 36.7%, 56.6% at Mumbai, 57.04% at Mangalore (DGN), 70.4% at Mangalore (PS), Cochin (DGN) 56.7%, Cochin (PS) 78.9%, Calicut (DGN) 71.1%, Tuticorin (DGN) 41%, Tuticorin (POD) 84.4%, Tuticorin (H&L) 98.4%, Madras (DGN) 69.3%, and Kakinada (DGN) 55.4% of the tuna catch. At Vizhinjam 45.5% of the catch was constituted by *A. rochei* followed by *E. affinis* (25.4%). At Minicoy in pole and line fishery *K. pelamis* was dominant forming 82.8% followed by *T. albacares* (16.5%), *E. affinis* (0.2%) and *Auxis* spp. (0.5%). *K. pelamis* and *T. albacares* occurred in all the months in the fishery. The total billfish landing in 1998 was 212 t which was 70% more than that in 1997. The major billfish species was *Istiophorus platypterus*. *Makaira indica* and *Xiphias gladius* also contributed to the billfish catch at different centres along the mainland of India.

**Biology**

Biological studies were carried out on *K. pelamis* at Minicoy. Of the estimated total fishes, 44% was represented by size groups upto 44 cm, whereas 73.7% was by 50 cm.
Length range (cm) and modal length (cm) of dominant species of tunas landed by various gears at different Centres during 1998

<table>
<thead>
<tr>
<th>Centre</th>
<th>Gear</th>
<th>E.A</th>
<th>A.T</th>
<th>T.T</th>
<th>T.A</th>
<th>K.P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>26-68</td>
<td>20-46</td>
<td>32-88</td>
<td>76-100</td>
<td></td>
</tr>
<tr>
<td>Veraval</td>
<td>GN</td>
<td>(56)</td>
<td>(38)</td>
<td>(66)</td>
<td>(88)</td>
<td></td>
</tr>
<tr>
<td>Dhamlej</td>
<td>GN</td>
<td>30-66</td>
<td>28-46</td>
<td>50-92</td>
<td>70-102</td>
<td></td>
</tr>
<tr>
<td>Mumbai</td>
<td>GN</td>
<td>26-68</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Mangalore</td>
<td>PS</td>
<td>32-58</td>
<td>38-48</td>
<td>56-58</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>GN</td>
<td>(44)</td>
<td>(40)</td>
<td>(56)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malpe</td>
<td>PS</td>
<td>42-62</td>
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</tr>
<tr>
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<td>30-50</td>
<td>30-50</td>
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<td></td>
</tr>
<tr>
<td>Kaup</td>
<td>GN</td>
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<td>38-50</td>
<td>30-64</td>
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<tr>
<td></td>
<td>GN</td>
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<td>(40)</td>
<td>(46)</td>
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<tr>
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<td>GN</td>
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<td>60-100</td>
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</tr>
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</tr>
<tr>
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<tr>
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</tr>
<tr>
<td></td>
<td>GN</td>
<td>(44)</td>
<td></td>
<td></td>
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</tr>
<tr>
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</tr>
<tr>
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<td>GN</td>
<td>(52)</td>
<td>(36)</td>
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<tr>
<td>Minicoy</td>
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<td>28-78</td>
<td>24-68</td>
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<td></td>
<td></td>
<td></td>
<td>(50)</td>
<td>(40,48)</td>
</tr>
</tbody>
</table>

**Legend:**
- GN - Gillnet
- PS - Purseseine
- PAR - Large meshed drift gillnet
- E.A - E. affinis
- A.T - A. thazard
- T.T - T. tonggol
- T.A - T. albacores
- K.P - K. pelamis
- P&L - Pole and line
Fishes with empty stomachs were maximum followed by 1/2 and 3/4th full conditions. Natural food items comprised of fishes, prawns and squid. Fishes observed were flying fish, *Decapterus* sp., balistids and *Stolephorus* sp. Prawns were constituted mainly by *Thalassocaris* sp. and *Leptochela* sp. The sex ratio was almost equal in most of the months. Among mature fishes, partially spent ones were dominant in all the months. The fishes below 50 cm were invariably immature.

**Baitfish fishery**

The baitfish catch in 1998 at Minicoy was 6.5 t with a C/E of 3.0 kg. Clupeids formed 65% of the catch. Caesionids and apogonids which formed 28% and 7% respectively were noticed in the first half of the season. The total catch during the postmonsoon period was only 3.2 t whereas it was 5.6 t in 1997. The temporary cessation of monsoon during August coupled with the availability of tuna had made the resumption of live-bait fishing very early this year. In November and December acute shortage of live bait was felt. It was observed that about 5 kg of *Spratelloides gracilis* was obtained after 8 hauls expending about 4 hours, whereas in normal situation this much quantity could be obtained by one or two hauls. As a result of spending too much time on bait fishing, the return of boats after tuna fishing was belated.

**FISHERY AND RESOURCE CHARACTERISTICS OF MACKEREL (PF/RE/2.3)**

T.M. Yohannan, U.Ganga, Prathibha Rohit, P.P.Pillai, P.N.Radhakrishnan Nair, G. Gopakumar and E.M. Abdussamad

The mackerel production after reaching a peak of 2.9 lakh t in 1989 started showing downward trend. However, 2.7 lakh t were landed during 1996, and subsequently declined to 2.28 lakh t in 1997 and to 1.8 lakh t in 1998. Intensification of exploitation of mackerel by more efficient fishing methods does not seem to affect
the resource adversely. The fishery showed improvement at Karwar (6258t), Mangalore (10794t (+5.3%), Vizhinjam 1545t (+91%), Madras 808t (+47%) and Kakinada 3214t. On the other hand the trend was reverse at Calicut 768t, Kochi 3697t (-68.5%), Tuticorin 275 t (-29%) and Visakhapatnam 119t.

The fishing pattern was observed to be almost similar i.e. at Karwar, Mangalore, Calicut, Cochin, Vizhinjam and Tuticorin as well as Madras, Visakhapatnam and Kakinada. Karwar and Mangalore had a comparatively shorter period of active fishery - September to November. Here the fishery was completely dominated by purse seines (92.67% of the total mackerel catch). In the Calicut-Cochin Area, landings by purseseines/ringseines indicated a peak during September-November, whereas in the trawls the major peak was during summer (May-June). 42.62% of the total mackerel catch in this area was contributed by trawls, a recent development caused by the intensification of trawling in the deeper waters during summer. This has revealed its movement to the deeper waters as the summer advances thereby reducing the availability of the shoals to surface gears. At Vizhinjam and Tuticorin, the resource has been exploited to the maximum around June. At Vizhinjam the major gear is the driftnet whereas, at Tuticorin bulk of the catches were taken by trawls.

Along the Madras-Visakhapatnam-Kakinada Area peak catches were recorded in February. The fishery is sustained throughout the year and monthly fluctuations are not sharp. In Madras and Kakinada, trawl nets landed the bulk of the catch whereas, in Visakhapatnam trawl nets and gillnets were equally important. The bottom trawl is slowly emerging as an important gear in the mackerel fishery during the demersal phase in its life history during summer. Along the west coast, the demersal phase of the fish protect the resource from over-exploitation by pelagic gears by the end of the post monsoon period. The fish is caught by trawls in the summer from areas deeper than 30 m. The recent extension of trawling grounds to deeper areas, and the large scale occurrence of mackerel in this gear indicate that the demersal phase is spent in deeper waters beyond the...
traditional trawling grounds.

One positive change in the mackerel fishery in India during 1998 was the increased mean length of the fish in the commercial catches. Low mean lengths were recorded only at Visakhapatnam and Tuticorin. At Visakhapatnam the trawl used to bring juveniles in the earlier years also. During this year, boatseines and gill nets also brought juveniles in abundance. It is surprising that the lowest mean length was recorded in trawl net and gill net catches.

The comparative increase of mean length along the west coast was not the result of any kind of conservation measures. There was a general delay in the commencement of active fishery especially at Calicut-Cochin area. The peak fishery used to take place during August-September in this area, but, in 1998, the fishery was better in October-November. The 52 cm rainfall in September 1998 is a record since 1985. Continuation of intensive rainfall to September/October is observed to cause a delay in the commencement of active mackerel fishery. As the intensive spawning of mackerel occurs around May, and recruitment by July/August, any delay in the commencement of the fishery allow the growth of the new recruits. The summer fishery for mackerel exploit mainly post spawners. However, the situation has put a control over the emerging growth overfishing in the mackerel fishery except in Visakhapatnam and Tuticorin.

Juveniles of mackerel were first caught in September in Karwar; at Mangalore an early recruitment was observed in January/February; peak recruitment was observed at Calicut in September/October. At Cochin it was observed in June-August as well as in November. At Tuticorin its recruitment was observed in May/June, at Madras in April and July-August, and at Visakhapatnam in April-May and October-November. The indications are that there are local populations along the east and west coasts of India with large scale mixing during exploitation phase.

**FISHERY AND RESOURCE CHARACTERISTICS OF BOMBAY-DUCK (PF/RE/3)**

Alexander Kurian and B. Manoj Kumar

The production trend of Bombay-duck for the past decade fluctuated from 0.47 lakh t in 1988 to 1.77 lakh t during 1995. During 1998 the production was 1.2 lakh t registering an increase of 17.3% over the last year.

The total landing during 1998 was estimated at 1,10,503 t with dolnet effort of 6,09,212 hauls (catch per haul of 181 kg). There has been a reduction of catch and catch/haul from that of 1997 (1,12,566 t; 733 kg). Similarly, a reduction in effort from 7,67,683 hauls in 1997 was also observed.
However, the cpue increased from 146 kg (1997) to 181 kg (1998).

There has been slight reduction in the proportion of Bombay-duck in the total dolnet landing (58 % in 1997 and 55 % in 1998). It is interesting to note that the catchability coefficient during 1997 was $3.8 \times 10^4$ and for 1998 the value was at around $3.77 \times 10^4$, indicating the probability of capture remaining almost constant and further indicating a need for reduction in effort.

The trend in the fishery was positive for Maharashtra during 1998 when compared to that in 1997. Despite an increase in effort, there has been slight increase in total dolnet catch (3,897 t) in 1997 and 4,283 t in 1998 against an estimated effort of 48,630 hauls in 1997 and 52,338 hauls in 1998. The cpue of the total dolnet landings and that of Bombay-duck did not register any perceptible increase.

In Gujarat, the total dolnet catch declined from 1,08,667 t in 1997 to 1,06,220 t in 1998 against an estimated effort of 7,19,053 hauls in 1997 to 5,56,874 hauls in 1998 with a cpue of 151 kg and 191 kg respectively. The Bombay-duck landing also decreased from 62,174 t in 1997 to 57,390 t in 1998. However, the cpue increased from 86 kg in 1997 to 103 kg in 1998. At Nawabunder, Rajpara and Jafarbad its landings in 1998 were 13,065t (-8%), 23,209t (-6.5%) and 21,175t (-8.6%) respectively (comparison with the trend is given in brackets). Though the effort level has gone up by 4.6% at Nawabunder the c/haul was 61 kg against 70 kg of last year. However, at Rajapara and Jafarbad the effort level which was low by 11% and 22% indicated a higher c/haul of 102 kg (+4%) and 105 kg (+17%) respectively.

Juvenile Bombay-duck ranked first as the most preferred food item followed by nonpenaeid prawns and golden anchovy. Studies on the breeding cycle indicated strong year classes entering the fishery. The continuous appearance of new recruits of 30mm and above in the catch indicates that the species breeds throughout the year. The peak breeding season is from November to March. In Maharashtra, males dominated the catch from December to May and females during the rest of the period. The proportion of the juveniles in the catch was low (35%) in Maharashtra compared to 56% in Nawabunder, 50.5% in Rajpara and 51.4% in Jafarbad in Gujarat. Further, the mean fish size was high (181.7 mm) in Maharashtra than that at Nawabunder (144 mm), Rajpara (150.8 mm) and Jafarbad (145.3 mm).

In Gujarat 30-314 mm and in Maharashtra 30-330 mm fishes were caught. The spawning ground in all probability lies north off Mumbai and off the Gulf off Cambay. The occurrence of juveniles (30 mm and above) in higher proportion (83%) at Rajpara was noticed during April. At Nawabunder, a centre lying towards west of Rajpara the juveniles formed only 60% during March and April and at Jafarbad, a centre lying east of Rajpara, the juveniles occurred in good numbers (70%) only during June. Probably, the juveniles, from the spawning ground are carried to south towards centres in Maharashtra with a peak occurrence during June.
The development of an export trade to China gave necessary fillip to exploit the ribbonfish resource which ultimately resulted in a peak production of 1.7 lakh t in 1997. But the production came down to 1.1 lakh t in 1998 as a result of less exploitation especially along the NW and NE coasts of India which are the most production zone, due to problems in the export of this commodity. During 1998 ribbonfishes constituted 8.3% of the total marine fish landings pooled for all the 9 observation centres viz., at Veraval, Mumbai, Karwar, Mangalore, Kochi, Vizhinjam, Madras, Kakinada and Visakhapatnam. The major gear used in their exploitation is the trawl net in which nearly 97% of the annual catch was landed. The composition of ribbonfishes in trawl net ranged from 0.7% at Karwar and Visakhapatnam to 15.5% at Cochin. It is also caught in gillnet, purse seine, boat seine and other indigenous gears in certain centres like Veraval, Madhvad, Mangalore, Kochi, Vizhinjam and Visakhapatnam. At Vizhinjam, ribbonfish are caught in boat seine and drift gillnet.

Compared to 1997, an increase in the effort of trawl unit was noticed in 1998 at Karwar (23%), Madras (58.3%), Kakinada (13.8%) and Visakhapatnam (51.1%). In other centres such as Veraval, Mumbai, Mangalore-Malpe, and Cochin the effort decreased by 28.8%, 12.7%, 15.3% and 5.1% respectively. In the case of gillnet the effort as well as catch decreased at Veraval, Madhvad and Cochin but at Vizhinjam the catch decreased by 39.5% while the effort increased by 39.9%.

The estimated ribbonfish landings by trawl ranged from 57 t at Karwar to 9174 t at Veraval along the west coast and from 147 t at Visakhapatnam to 4664 t at Kakinada along the east coast. At other centres the landings were 2164 t at Mumbai, 2202 t at Mangalore-Malpe, 2862 t at Kochi and 2240 t.
at Madras. The estimated landings in gillnet at Veraval, Madhwd, Ko<

chr and Vizhinjam were 30t, 29t, 6t and 32t respectively. A drastic decline in its catch was noticed in boatseine at Visakhapatnam. It landed 21t of ribbonfish compared to 210t in 1997. An improvement in the fishery could be noticed only at Madras and Kakinada where the effort, catch and catch rate increased, whereas at Cochin, though the catch increased, the effort declined. As a result the catch rate showed an increase of 164% than in 1997. Nearly 71% of the all India ribbonfish catch was obtained from the west coast and only 29% came from the east coast.

The C/E in trawl net ranged from 0.6kg at Visakhapatnam to 153kg at Cochin with 77.7kg at Mumbai, 2.2kg at Karwar, 37.9kg at Mangalore-Malpe and 41.7kg at Madras and 72.5kg at Kakinada. The catch rates in gillnet were 1kg at Veraval, 1.3kg at Madhwd, 0.8kg at Kochi and 0.4Kg at Vizhinjam. It was 9.3kg in boatseine at Visakhapatnam.

Along the west coast, the fishery existed almost throughout the year at Veraval, Mumbai, and Mangalore-Malpe. But at Cochin and Vizhinjam it was seasonal extending from May to December and July to September respectively. The peak landings were noticed in January-May (37.6%) and October-November (53.2%) at Veraval; January-April (37.6%) and September-December (59%) at Mumbai; January-February (63.9%) and April (26.9%) at Karwar; January-May (80.7%) and October-December (16.4%) at Mangalore-Malpe; August-October (99.3%) at Kochi; July (92.3%) at Vizhinjam; January-April (38.6%) and September-December (44.4%) at Madras; January-March (31%) and September-December (58.8%) at Kakinada; and June-December (95%) at Visakhapatnam. It could be noticed that the postmonsoon (September to December) and premonsoon (January-May) periods were the peak ribbonfish fishery seasons contributing 57.4% and 35.5% respectively, the rest (7.1%) was landed during the monsoon period (July-August).

*Trichiurus lepturus* was the dominant species in all the centres. From Kakinada and Visakhapatnam other species like *T. russelli*, *Lepturacanthus savala*, *L. gangeticus*, *Eupleurogrammus muticus* and *E.glossodon* were also reported and they together constituted 8.3% and 2% respectively. The minimum size of recruitment of *T.lepturus* in trawl was 10cm reported from Madras in September and from Kakinada in March. In other centres it was 20cm at Veraval (March), 30cm at Mumbai (March), 17cm at Karwar (March), 30cm at Mangalore-Malpe (January), 35cm at Kochi (October), and 18cm at Visakhapatnam (April & July). The recruitment size in gillnet was 44cm both at Veraval (June) and Madhwd (December). The smallest size caught in boatseine at Visakhapatnam was 18cm in July.

The largest size of *T.lepturus* caught in trawl was 126cm at Veraval. In gillnet and boatseine the target groups length were 106cm (Madhwd) and 110cm (Vizhinjam)
respectively. The major modes observed in trawl net were at 64cm at Veraval, 65cm at Mumbai, 46cm at Mangalore-Malpe, 82cm at Kochi, 30cm at Madras, 46cm at Kakinada and 28cm at Visakhapatnam. The annual mean length in trawl net ranged from 36.3cm (Visakhapatnam) to 74.8cm (Kochi). In gillnet it was 68.9cm at Veraval and 74.4cm at Madhwan. In boatseine the mean length was 41.1cm at Visakhapatnam and 54.9cm at Vizhinjam. Fishes measuring above one meter were more at Kakinada (1.7%) and Veraval (1.3%); minimum at Mangalore-Malpe (0.02%) and totally absent at Madras and Visakhapatnam.

In gillnet, at Veraval and Madhwan, 50-100cm sized fish dominated forming 97.8% and 91.9% and fishes larger than one meter formed 0.6% and 3.6% respectively. In boatseine at Visakhapatnam 70.3% was constituted by fish measuring less than 50cm, but at Vizhinjam 50-100cm size fish dominated forming 85%. In short, *T. lepturus* caught along the east coast are mostly under-sized, measuring less than 50cm, whereas it was between 50-100cm along the west coast.

The exploitation of fish measuring less than 50cm was maximum at Visakhapatnam (91.6%) followed by Madras (69.9%). At Kakinada this size range contributed 47.7% and it was minimum at Kochi (0.9%). 50-100cm size groups dominated at Veraval (75.2%), Mumbai (92.9%), Mangalore-Malpe (63.9%), Kochi (98.9%) and Kakinada (50.54%). At Mumbai the M:F ratio was 1:1 among the adults. Spawning season was generally from January to June and November.

The annual catch of carangids increased from 24,560 t in 1969 to 137,908 t in 1997 with a peak production of 196,832 t in 1995. In 1998 the production was 1.47 lakh t. The major contribution towards the enhancement in catch is mainly from the small trawls and purseseines.

**Fishery**

Studies on the fishery and resource characteristics of carangids was carried out at Veraval, Mangalore, Kochi and Vizhinjam along the west coast, and at Tuticorin and Kakinada along the east coast. The estimated carangid catch during the current year was 15581 t at Veraval (-37.7%), 9487 t at Mangalore (+2.5%), 1262 t at Kochi (+26.4%), 4032 t at Tuticorin (-16.6%) and 3095 t at Kakinada. The trawls landed 79.4% of carangids at Veraval, 42.5% at Mangalore, 64.9% at Kochi, 82.9% at Tuticorin and 99.1% at Kakinada. The gillnets landed 20.6% at Veraval, 0.3% at Mangalore, 13.7% at Kochi, 6.8% at Tuticorin, 0.9% at Kakinada. The purseseine landed 57% at Mangalore and 10% at Kochi and gillnet landed 11.5% at Kochi. The hooks & lines landed 10.3% at Tuticorin. Trawl, purseseine, gillnet and ringseine are the major gears along the west coast whereas trawl, gillnet and hooks & lines are the chief gears employed along the east coast.

At Mangalore, the effort of purseseine and trawl declined by 16.3 and 15.4% respectively and that of gillnet increased by 46.7%. The trawl and gillnet effort declined by 23.4 and 3.6% respectively and that of purse seine and ringseine increased by 5.4 and 6% respectively at Kochi. At Tuticorin the effort input by trawl and hooks & lines declined by 18.4 and 50.9% respectively and that of paruvalai and podivalai increased by 87.3 and 3.9% respectively.

The c/e by both trawl and gillnet declined by 19 and 7.2% respectively at Veraval. The catch rate by purseseine and gillnet increased by 132.5 and 4.3%
respectively and that of trawl declined by 26% at Mangalore. At Kochi the catch rate by purseseine increased by 35.5% followed by trawl 43.7%, gillnet 48.7% and ring seine 204%. The catch rate of paruvalai and trawl declined by 39.3 and 13% respectively and that of podivalai and hooks & lines increased by 37.5 and 24.5%.

Several species supported the carangid fishery and among them M. cordyla was the dominant species in both trawl and gillnet landings at Veraval; in trawl, purse seine and gillnet catches at Mangalore, in purseseine and gillnet at Kochi; in podivalai at Tuticorin and in trawl and gillnet at Kakinada. Decapterus russelli and D. macrosoma were the dominant species in purseseine and trawl at Mangalore and Kochi; in trawl alone at Kakinada. S. crumenophthalmus was dominant in trawl landings at Kochi and Tuticorin. Caranx kalla was the dominant species in purseseine and trawl landings at Mangalore and Kochi; in trawl alone at Kakinada. S. crumenophthalmus was dominant in trawl landings at Kochi and Tuticorin. Caranx kalla was the dominant species in purseseine and trawl landings at Mangalore. C. carangus was dominant in podivalai, S. leptolepis in trawl catches and C. sexfasciatus in gillnet catch at Tuticorin. It is concluded that M. cordyla occurred in all the centres, Decapterus spp at Mangalore, Kochi and Kakinada, Caranx spp. at Mangalore and Tuticorin.

Biology

The size of M. cordyla varied from 190 to 399 mm in trawl and 170-479 mm in gillnet with multimodes at Veraval; it varied from 130-385 mm with dominant modes at 140 & 255 mm in purseseine; 85-350 mm in trawl with modes at 105, 165 and 280 mm and in gillnet from 165-385 mm with modes at 185 and 335 mm at Mangalore; it ranged from 170-365 mm in trawl with mean length at 258 mm and from 170-335 mm in gillnet with dominant modes at 200, 210 and 225 mm at Kochi, it varied from 50-269 mm in trawl and 110-599 mm in gillnet with multimodes at Kakinada. The size range of D. russelli varied from 70-210 mm in purse seine with modes at 90 & 145 mm; 60-200 mm in trawl catch with modes at 80 & 165 mm at Mangalore. At Kochi the size varied from 125-255 mm with mean length at 178 mm and at Kakinada it varied from 60-189 mm with multimodes. The size of D. macrosoma varied from 85-130 mm with modes at 100 & 120 mm in purse seine, in trawl from 80-230 mm with modes at 105 & 185 mm at Mangalore, it varied from 135-215 mm with modes at 175 and 195 mm and it ranged from 75-214 mm with dominant modes at 90, 135 and 160 mm in trawl landings at Kakinada. At Mangalore, the size of C. kalla varied from 75-160 mm in trawl with modes at 90, 100, 115 and 130 mm and from 95-155 mm in purse seine with modes at 110 and 150 mm. The size of S. crumenophthalmus ranged from 115-260 mm in trawl catches with dominant modes at 170 and 190 mm and in gillnet landings from 155-250 mm with dominant modes at 165, 215 and 230 mm and that of Alepes djedaba varied from 210-390 mm with dominant mode at 300 mm at Kochi. The size of Caranx leptolepis varied from 60-184 mm with dominant mode at 115 mm and that of C. sexfasciatus ranged from 40-128 cm with dominant modes at 74 and 84 cm at Tuticorin.
Actively fed full stomached *M. cordyla* were dominant both in trawl and gillnet landings and female were dominant. Specimens with gonads in III and IV stages were dominant in the landings of both the gears at Veraval. At Mangalore also the females with developing gonads of this species were dominant. Similar observation has been reported at Kochi for this species and both the sexes occurred at equal proportion.

In both *D. russelli* and *D. macrosoma* the adults occurred more and males were dominant. Females with developing ovary were dominant followed by the spent specimens at Mangalore. Whereas at Kochi, the males were marginally dominant and more gravid females occurred followed by partially spent specimens among *D. russelli* and among *D. macrosoma*, the females occurred more and females with developing gonads were dominant. In both the species empty stomached specimen were dominant. Similarly at Kakinada also the males were dominant among *D. dayi* and females were dominant among *D. macrosoma*. In both the species the females with developing gonads were dominant.

At Mangalore, the adult *C. kalla* occurred more and the females were dominant with developing ovary in trawl landings and with gravid ovary in purseseine landings. At Kochi, preadults and immature *S. crumenophthalmus* occurred more and the females were dominant with developing ovary in trawl landings.
The total demersal finfish landing in India during the year, was estimated at 0.7 million t which formed 26% of the total marine fish production in the country. Of this, 68.1% was taken by trawl, 13.2% by other mechanised units, 10.2% by motorised units and 8.5% by artisanal units. Highest quantity, forming 38.7% of the demersal finfish catch in the country, was obtained from Gujarat, followed by Tamilnadu (16.8%), Kerala (13.9%), Maharashtra (11.4%), Karnataka (6%), Andhra Pradesh (5.6%), West Bengal (3.3%), Orissa (2.6%), Goa (1.5%) and Pondicherry (0.2%).

This increase is mainly brought out by about 47% increase in the landings along the northwest coast though there was considerable decline in the landings along the east coast. This, further, is due to the substantial increase, along the Gujarat coast, in the landings of sharks (48%), skates (125%), catfish (37%), lizard fish (82%), threadfin breams (37%), and croakers (40%).

The fishery and biological characteristics of major exploited demersal finfish stocks were monitored from all along the Indian
coast and collection and analysis of data on dominant species of all major groups was continued during the year.

In the area of finfish mariculture, the division achieved the breakthrough in developing the broodstock from fingerlings, sex reversal, maturation and spawning of the grouper (*Epinephelus tauvina*) in onshore, fully controlled captive conditions, at the facility developed at the fisheries harbour at Cochin.

The details of the research work carried out and achievements during the year under report are furnished below.

INVESTIGATIONS ON THE RESOURCE CHARACTERISTICS OF ELASMOBRANCHS (DF/RE/1)

S.G. Raje, P. Livingston, G. Mohanraj, K.K. Joshi and Rekha J. Nair

This project was implemented at Chennai, Tuticorin and Mandapam on the east coast, Mumbai and Cochin along the west coast. The total estimated catch of elasmobranchs from all the Centres was 7840 t. The landing at Chennai was the highest (32%) of all the centres. The highest CPUE was recorded at Mumbai in trawl (81 kg), at Chennai in gillnet (67 kg) and in hook and line at Tuticorin (17 kg). Rays constituted 64% in total elasmobranch catch from all the centres. In the trawl catch, sharks constituted 78% and Rays 100% at Mumbai and Mandapam respectively.

MUMBAI

The estimated catch of elasmobranchs in the trawl net at New Ferry Wharf during 1998 was 2250 t as against 2507 t during the previous year showing a decrease of 10.2%. The contribution of elasmobranchs to the total fish catch was 4.9% and the CPUE 81.0 kg.

The catch of elasmobranchs in gillnet at Satpati was 148 t with CPUE 25.5 kg.

The estimated catch in Dol net at Versova was 7872 kg and CPUE 2 kg.

Sharks were the dominant group in Trawl, Gill and Dol nets. *Scoliodon laticaudus* (72%).
Estimated gearwise landing (t) of Elasmobranchs at different centres in 1998

( CPUE in kg in parentheses)

<table>
<thead>
<tr>
<th>Gear</th>
<th>Mumbai</th>
<th>Cochin</th>
<th>Mandapam</th>
<th>Madras</th>
<th>Tuticorin</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trawl</td>
<td>2250</td>
<td>185</td>
<td>933</td>
<td>2224</td>
<td>1403</td>
<td>6995</td>
</tr>
<tr>
<td></td>
<td>(80.8)</td>
<td>(9.5)</td>
<td>(13.1)</td>
<td>(41.4)</td>
<td>(43.0)</td>
<td></td>
</tr>
<tr>
<td>Drift gill net</td>
<td>148</td>
<td>166</td>
<td></td>
<td>244</td>
<td></td>
<td>558</td>
</tr>
<tr>
<td></td>
<td>(25.5)</td>
<td>(35.5)</td>
<td></td>
<td>(67.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hook &amp; line</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>278</td>
<td>278</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(16.9)</td>
<td></td>
</tr>
<tr>
<td>Dol net</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>(1.6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2406</td>
<td>351</td>
<td>933</td>
<td>2468</td>
<td>1681</td>
<td>7839</td>
</tr>
</tbody>
</table>

% in the total of all centres

<table>
<thead>
<tr>
<th>Mumbai</th>
<th>Cochin</th>
<th>Mandapam</th>
<th>Madras</th>
<th>Tuticorin</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.7</td>
<td>4.5</td>
<td>11.9</td>
<td>31.5</td>
<td>21.4</td>
</tr>
</tbody>
</table>

Dasyatis zugie (49%) and Rhynobatus djiddensis (97%) were the most dominant species in their respective groups.

The length range of S. laticaudus in males was 200-560 mm and 160-620 mm in females. In D. imbricatus, the same was 130-290 mm and 140-360 mm respectively.

The male:female ratio of S. laticaudus and D. imbricatus was 1:1.38 and 1:1.59 respectively. Pregnant females of S. laticaudus were observed during February to May and July to October and in D. imbricatus during April and August to October. The length range of embryos in S. laticaudus was 3-11 cm and in D. imbricatus 1-2 cm. About 47% of guts in S. laticaudus and 60% in D. imbricatus were empty. Dominant food items observed in S. laticaudus were Coilia dussumieri, Harpodon nehereus, sciaenids and Loligo sp. D. imbricatus was found to feed on Acetes sp., N. tenuipes,
Estimated landing (t) of Sharks, Rays and Skates at different centres in 1998

<table>
<thead>
<tr>
<th>Centre</th>
<th>Sharks</th>
<th>Rays</th>
<th>Skates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mumbai</td>
<td>1867</td>
<td>416</td>
<td>123</td>
</tr>
<tr>
<td>Cochin</td>
<td>128</td>
<td>199</td>
<td>24</td>
</tr>
<tr>
<td>Mandapam</td>
<td>-</td>
<td>933</td>
<td>-</td>
</tr>
<tr>
<td>Madras</td>
<td>323</td>
<td>2100</td>
<td>45</td>
</tr>
<tr>
<td>Tuticorin</td>
<td>211</td>
<td>1396</td>
<td>73</td>
</tr>
<tr>
<td>Total</td>
<td>2529</td>
<td>5044</td>
<td>265</td>
</tr>
</tbody>
</table>

In the case of rays: *Dasyatis zugie*, *D. bleekeri*, *D. uarnak*, *T. walga* and *G. micrura*, females were dominant in *D. bleekeri*, *D. uarnak* and *G. micrura*. The male to female ratio in *R. djiddensis*, *R. granulatus* and *R. halvai* was 2:1.7; 1:0.5 and 1:3.33 respectively.

**COCHIN**

The total estimated catch of elasmobranchs at Cochin Fisheries Harbour was 351 t. Trawlers contributed 185 t with CPUE of 85 kg and gillnetters 166 t with CPUE of 35.5 kg. The contribution of this group in trawl net and gillnet was 1.0% and 8.9% respectively. The dominant species in the catches of both the gears in shark, rays and skates were *C. melanopterus*, *D. uarnak* and *R. djiddensis* respectively.

The size range of *C. melanopterus* and *R. acutus* in drift gillnet was 30-120 cm (mode at 70 cm) and 40-120 cm (mode at 80 cm) respectively.

**TUTICORIN**

The estimated total catch of elasmobranchs at this centre was 1680 t. Of this, fish trawl contributed 1403 t (85.5%) and hook and line 277 t (16.5%). The CPUE was 42.9 kg in trawl net and 16.9 kg in hook and line. The size range of *Amphotistus kuhlii* and *D. imbricatus* was 15-49 cm and 16-36 cm respectively.

In hook and line, *D. bleekeri* and *Carcharhinus bleekeri* were dominant among rays and sharks respectively. *D. bleekeri*, *C. bleekeri* and *Rhynobatus granulatus* were the dominant species in their respective groups in trawl catch.

**MADRAS**

The total estimated catch of elasmobranchs in trawl net and gillnet at Kasimedu landing centre was 2468 t. The landing at this centre was reported to have increased two-fold, compared to the previous year. About 90% of catch of elasmobranchs was landed by trawlers and 10% by gillnetters. The CPUE was 41.4 kg for trawlers and 67.2 kg for gillnets. The size range of *D. jenkinsi* was 10-109 cm; males were dominant in this species.
MANDAPAM

The total estimated catch of elasmobranchs in trawls landed at Rameswaram and Pamban was 933 t with CPUE of 13 kg. The contribution of elasmobranchs to total fish catch from Rameswaram in trawl net was 886 t (CPUE 13.1 kg) and at Pamban 46 t (CPUE 12.3 kg). Biological data were collected in D. sephen, D. uarnak, D. bleekeri, R. javanica, G. micrura, A. narinari, A. slagettus, C. indicus and C. melanopterus.

MONITORING THE RESOURCE CHARACTERISTICS OF GROUPERS, SNAPPERS AND PIGFACE BREAMS (DF/RE/2)

Grace Mathew, S.K. Chakraborty, P. Livingston, S. Krishna Pillai and P. Nammalwar

During the year under report, an estimated 6779 t of major perches were landed from the four centres: Cochin, Vizhinjam, Tuticorin and Chennai in the southern region and Mumbai on the northwest. The major gears in the exploitation of the major perches were trawl, hooks and lines and drift gillnets using mechanised or motorised units. As observed in the previous years, maximum catches of perches were recorded from Tuticorin in the Gulf of Mannar region; a total of 5055 t of perches forming 74.5% was landed at this centre. Kochi on the southwest contributed 1089 t forming 16% followed by Vizhinjam 308 t (4.5%) and Mumbai 322 t (4.7%). At Tuticorin, the peak landings were obtained during May-August while at Cochin maximum landings occurred during December, January and March; fairly good landings were recorded in August also. In Mumbai, fairly high catches were recorded in January, February and May. At Vizhinjam peak catches were recorded during December and fairly high catches were observed during January-March period.

At Tuticorin, all the groups of major perches occurred in the fishery in almost
equal quantities, the groupers being the dominant group. At Vizhinjam, the snappers were predominant, followed by groupers; at Cochin, the major group was grouper. *Epinephelus diacanthus* formed the major perch fishery at Mumbai. It was also observed that along the west coast, *Epinephelus diacanthus* and *Pristipomoides* spp were the dominant species. On the east coast, *Lutjanus nebulosus*, *Lutjanus rivulatus*, and *Epinephelus tauvina* were the most dominant species.

**DEVELOPMENT OF MANAGEMENT STRATEGIES FOR SUSTAINABLE FISHERY OF THREADFIN BREAMS AND SILVERBELLIES (DF/RE/4)**

V. Sriramachandra Murty, P.U. Zacharia, K.K. Joshi, E. Vivekanandan, Rekha J. Nair, U. Rajkumar and Sobha J. Kizhakudan

**THREADFIN BREAMS**

At Veraval about 2600 t of threadfin breams were landed by trawlers; maximum catch accounting for 55% of the total landings in the year, was obtained during February-April. When compared to the previous year, the catches declined by 35% along with 30% decline in the effort. The major reason for the decline in the landing at this centre appears to be due to over 90% decline in the landings in January 1998 when compared to January 1997, while the effort was more or less same in this month during both the years. *N. japonicus* was the most dominant species followed by *N. mesoprion*. These two species together accounted over 80% of the threadfin bream landing.

At Mangalore an estimated 12000 t of these fishes were landed forming 22% of the total trawl landing. September-November accounted for 60% of the threadfin breams landed during the year; *Nemipterus mesoprion* was the most dominant species during these three months contributing to about 40% of total nemipterid landing during the year. Only two species *N. japonicus* and *N. mesoprion* contributed to the fishery at this centre with
the former being the most dominant from January to June. When compared to the previous year, the landings at this centre registered an increase of 22%.

At Cochin, an estimated 1545 t of nemipterids were landed forming 13% of the total trawl landings. Peak landings were obtained during June and August; the landings during these months together accounted for 65% of total Nemipterus landings during the year. *N. mesoprion* was the most dominant species in all the months except November and December when *N. japonicus* was dominant.

At Madras an estimated 2400 t of threadfin breams were landed forming about 7% of total trawl landings. Peak landings were obtained during August-October period; the landing increased by 15% over the previous year. Of the 4 species that contributed to the fishery, *N. japonicus* was dominant forming about 40% of the threadfin bream landing.

At Visakhapatnam, the threadfin bream landings were estimated at 542 t of which 75% was taken by small trawlers and the rest by Sona boats. There was a marginal increase in the catch of this group over that of the previous year. Of the 5 species in the fishery, *N. japonicus* was the most dominant, contributing to 66% of *Nemipterus* catch by small trawl and 45% by Sona boat followed by *N. mesoprion* and others.

At Kakinada, an estimated 363 t of nemipterids were landed by the trawlers of different categories with Sona boats contributing 60% and the rest by small trawlers. When compared to the previous year, the landings declined by 9%. Peak landings were obtained during January and August.

The length range in the catch of *N. japonicus* at Veraval was 100-329 mm with the bulk of the catch belonging to the length range 120-250 mm; the length range was 100-290 mm at Mangalore; 80-279 mm at Madras; 110-240 mm at Visakhapatnam and 35-295 mm at Kakinada. In *N. mesoprion*, the length range was 100-250 mm at Mangalore; 40-350 mm at Cochin and 85-195 mm at Kakinada. Gravid individuals of *N. japonicus* occurred during January-March and September-November, but large numbers occurred in September-November in the Mangalore region. In the case of *N. mesoprion*, such fishes occurred almost throughout the year but in large quantities during April-September and November at Mangalore. At Madras, *N. japonicus* with ripe gonads occurred during January and November.

**SILVER BELLIES**

At Veraval about 488 t of silverbellies were landed by trawlers with maximum catch during September. The catch showed a decline of 26% over the previous year.

At Mangalore, an estimated 1132 t of these fishes were landed forming 1.8% of the trawl landings. January-April period accounted for 53% of the silver belly landing during the year. *Secutor insidiatior* was the most dominant species during the year contributing to about 66% of total silverbelly landing. *Leiognathus*
bindus and L. splendens formed 23% and 11% of silverbelly landings respectively.

At Cochin, an estimated 9.4 t of silverbellies were landed by trawlers. Peak landings were obtained during January-March, the landing during these months accounted for 68% of total silverbelly landings in the year. L. splendens was the most dominant species, it formed 50% of total silverbelly landing followed by S. insidiator (24%).

At Rameswaram, the trawlers landed an estimated 11898 t during this year. The silverbelly landing formed 41% of the total landing at this centre. When compared to the previous year, the landings registered a decrease of 18 %. L. brevirostris was the most dominant species followed by L. jonesi. These two species accounted for over 90% of the total landings.

At Pamban and Mandapam, the landings were estimated as 352 and 720 t respectively.

L. dussuriier was the most dominant species forming 54% of silverbelly landing.

At Madars, the trawlers landed an estimated 4340 t of silverbellies, which formed 11.9% of the total trawl landings. The catch showed an increase of 35% when compared to the previous year. L. bindus (31%) and S. insidiator (26%) were dominant in the landings.

An estimated 297 t of silverbellies were landed at Visakhapatnam, of which 63% was taken by small trawlers and the rest by Sona boats. There was a marginal increase in the catch of this group when compared to the previous year. Peak landings occurred during May-June. Of the 8 species in the fishery by small trawlers, L. bindus was the most dominant, contributing to 40% of the silverbelly catch followed by S. insidiator (18%) and G. minuta (14%).

At Kakinada, the trawlers landed an estimated 1141 t of silverbellies. Peak landings were obtained during December-January. The catch showed an increase of 23% when compared to the previous year. The catch consisted of 10 species of which L. bindus was dominant (27%), followed by S. insidiator (21%), L. splendens (17%) and G. minuta (11%).
The length range in the catch of _L. bindus_ at Mangalore was 75-105 mm; at Madras 40-120 mm; at Kakinada 22-127 mm. In _L. dussumieri_, the length range was 55-130 mm at Pamban. At Rameswaram the length range of _L. brevirostris_ was 40-135 mm and _L. jonesi_ was in 50-140 mm. At Cochin, _L. splendens_ was in the length range of 35-125 mm. In _S. insidiator_ the length range was 65-105 mm at Mangalore; 22-115 mm at Cochin and 65-114 mm at Visakhapatnam.

**DEVELOPMENT OF MANAGEMENT STRATEGIES FOR JUDICIOUS EXPLOITATION OF SCIAENIDS** (DF/RE/5)


The estimated total catch of sciaenids at the ten observation centres was 23273 tonnes during 1998. The contribution of trawlers was 95.3% and the rest was shared by _dol_ nets (3.3%), _gillnets_ (1.1%) and _shore_ seines (0.2%). At Mumbai, Calicut, Cochin, Tuticorin, Mandapam, Madras, Kakinada and Visakhapatnam, the catches were exclusively taken by the trawlers. At Veraval, in addition to the trawl (90.6%), _gillnets_ and _dol_ nets contributed to the catch. At Karwar, 92.7% of the catch was from the trawlers and the rest from the shore-seines.

The catch at different centres ranged between 95 and 9018 tonnes. The highest catch of sciaenids was recorded at Veraval followed by Mumbai. The lowest catch was reported from Cochin. The highest CPUE was recorded at Mumbai (227.9 kg) and the lowest at Cochin (4.1 kg).

At Kakinada, an estimated 197 tonnes of

![Estimated landings of Croakers in different maritime states of India during 1998](image-url)
**Biological data on dominant sciaenid species from different centres along the Indian coast**

<table>
<thead>
<tr>
<th>Centre</th>
<th>Species</th>
<th>Length range (mm)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veraval</td>
<td>Otolithus cuvieri</td>
<td>80-370</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Johnius glaucus</td>
<td>60-310</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Protonibea diacanthus</td>
<td>200-1270</td>
<td></td>
</tr>
<tr>
<td>Mumbai</td>
<td>Johnius vogleri</td>
<td>105-325</td>
<td></td>
</tr>
<tr>
<td></td>
<td>J. macrorhynus</td>
<td>105-305</td>
<td></td>
</tr>
<tr>
<td></td>
<td>O. cuvieri</td>
<td>115-345</td>
<td></td>
</tr>
<tr>
<td></td>
<td>J. sina</td>
<td>105-225</td>
<td></td>
</tr>
<tr>
<td>Karwar</td>
<td>O. cuvieri</td>
<td>80-279</td>
<td></td>
</tr>
<tr>
<td>Cochin</td>
<td>J. sina</td>
<td>70-190</td>
<td>Ripe fishes occurred during January-June</td>
</tr>
<tr>
<td></td>
<td>O. ruber</td>
<td>100-370</td>
<td>Ripe individuals occurred in December and February-April</td>
</tr>
<tr>
<td>Tuticorin</td>
<td>O. ruber</td>
<td>110-380</td>
<td></td>
</tr>
<tr>
<td></td>
<td>J. maculatus</td>
<td>100-290</td>
<td></td>
</tr>
<tr>
<td>Mandapam</td>
<td>P. macrophthalmus</td>
<td>70-210</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N. maculata</td>
<td>110-220</td>
<td></td>
</tr>
<tr>
<td>Madras</td>
<td>O. ruber</td>
<td>20-290</td>
<td>Dominant mode at 160 mm)</td>
</tr>
<tr>
<td></td>
<td>K. axillaris</td>
<td>110-150</td>
<td>(Dominant mode at 140 mm) gravid adults occurred during April</td>
</tr>
<tr>
<td>Kakinada</td>
<td>N. maculata</td>
<td>55-265</td>
<td>(Dominant mode at 145 mm)</td>
</tr>
<tr>
<td>Visakhapatnam</td>
<td>J. carutta</td>
<td>115-215</td>
<td></td>
</tr>
</tbody>
</table>
sciaenid juveniles with 40-183 mm size range forming 12.5% of the total sciaenid catch was taken during the year. Maximum quantity of the juveniles was recorded during January.

When compared to the previous year, slight decline in the catch at Kakinada (3.2%) and Veraval (25%) and sharp decline at Karwar (65%) and Cochin (68%) was noticed. Marginal increase at Navabander (10%), Calicut (12%) and substantial increase at Mumbai (35.1%) and Visakhapatnam (35% for small trawlers and 55% for Sona boats) was recorded.

### Centrewise production of Sciaenids during 1998

<table>
<thead>
<tr>
<th>Centre</th>
<th>Estimated Catch (t)</th>
<th>CPUE (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veraval</td>
<td>9018 (Trawl net)</td>
<td>127</td>
</tr>
<tr>
<td></td>
<td>234 (Gill net)</td>
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</tr>
<tr>
<td></td>
<td>696 (Dol net)</td>
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</tr>
<tr>
<td>Mumbai</td>
<td>6369 (Trawl net)</td>
<td>228</td>
</tr>
<tr>
<td>Karwar</td>
<td>597 (Trawl net)</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>46 (Shore seine)</td>
<td>7</td>
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<tr>
<td>Calicut</td>
<td>652 (Trawl net)</td>
<td>11</td>
</tr>
<tr>
<td>Cochin</td>
<td>95 (Trawl net)</td>
<td>4</td>
</tr>
<tr>
<td>Tuticorin</td>
<td>573 (Trawl net)</td>
<td>18</td>
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<tr>
<td>Mandapam</td>
<td>540 (Trawl net)</td>
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<tr>
<td>Madras</td>
<td>2383 (Trawl net)</td>
<td>44</td>
</tr>
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<td>Kakinada</td>
<td>1579 (Trawl net)</td>
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</tr>
<tr>
<td>Visakhapatnam</td>
<td>282 (Small trawlers)</td>
<td>24</td>
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<tr>
<td></td>
<td>209 (Sona boats)</td>
<td>66</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>23273</strong></td>
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</table>

### RESOURCE CHARACTERISTICS AND BIOLOGY OF LIZARDFISHES, THREADFINS, POMFRETS AND BULL’S EYE (DF/RE/6)

S. Sivakami, E. Vivekanandan, S.G. Raje, M. Feroz Khan, U. Rajkumar and Shobha J. Kizhakudan

**LIZARD FISHES**

The fishery increased by 294% when compared to 1997 at Puthiappa even with a decrease in effort by 10312 units. A similar trend was observed at Beypore also. The catch decreased this year by 43.4% at Mumbai (NFW), Madras (46.2%) and Visakhapatnam. At
Cochin however, there was an increase in the catch by 4.4%.

At all the centres except Madras and Visakhapatnam, the effort decreased this year. From Veraval, it is reported that the slump in economy in the Southeast and China resulted in a reduction in total effort and fish landings.

The landings were more during April and December at Veraval, May at Mangrol, January to May at Mumbai, March-April and August-September at Calicut, June, August-October and December at Cochin and January to March at Madras and Visakhapatnam. At Cochin, the catch rates were high during August to October.

*Saurida tumbil* was dominant at Calicut, Veraval, Mangrol and Mumbai. *S. undosquamis* formed 31% at Cochin, 100% at Madras and 64.5% and 52% in small trawlers and Sonagiri units respectively at Visakhapatnam.

At Veraval, *S. tumbil* was in the length range of 165-495 mm with the fishes in the 275-395 mm length forming 78% of the catch of the species. At Mumbai, fishes ranging from 65 mm to 185 mm formed 18.5%, while fishes in the 195-335 mm group formed 75% of the total. At Cochin, *S. tumbil* was in the length range 225-465 mm with fishes in 255-385 mm groups forming 91% of the catch of the species; the size distribution shows that the fishes above 300 mm formed about 59% and 51% of the total catch of the species during August - September.

In *S. undosquamis* off Mumbai, 125-225 mm groups formed 87.2% of the species catch and 185-265 mm group formed 73.5% at Cochin. At Madras, the size groups 125-205 mm formed 90% of the total fish landed in the length range 95-315 mm.

**THREADFINS**

The catch declined by 62.7% at Veraval in trawl and 24% in gillnet, over that of the previous year. At Mangrol, the decline was by 55.3% in trawl. At Dhamlej, in gill net, the catch declined by 45.2%. At Mumbai, in trawl, the catch declined by 49.2%. In all the centres, the effort was on the declining side this year.

At Veraval, the catch rate in trawl was higher during January/February and November/December months. In gillnet, maximum CPUE of 6.48 kg was obtained during January 98. At Mangrol, the higher CPUE was during May. At Dhamlej in gill net, also higher catch rate was during January; while at Mumbai, it was during January to April and December.

*Polynemus indicus* was the dominant species at Veraval in trawl (47.7%), in gillnet (30.2%) and at Mumbai in trawl (56%). The other species represented were *Eleutheronema tetradaactylum* (9-38.5%), *P. heptadactylus* (7.2%), and *P. sextarius* (24.6%).

The length range of *Polynemus indicus* in trawl at Veraval was 170-770 mm and 310-1090 mm in gillnet at Dhamlej. Off Mumbai, *P. heptadactylus* (65-275 mm) caught in trawl
had size groups 85-135 mm forming 91.2% of the total species catch.

**POMFRETS**

Pomfret landing also showed declining trend at Veraval (44.6%) and Mangrol in trawl (22.5%), Mumbai - NFW (18%), Versova (dol net - 64.5%), Puthiappa (89%), Beypore (76.5%), Cochin - trawl (96%), Madras (15.4%) and Visakhapatnam - Sona boat (14%). The catch showed an increasing trend at Satpathi (Mumbai) in gillnet (67%), at Cochin in gill nets (10 times) and Visakhapatnam - trawl (58.5%).

Pomfrets were caught more during the first and last quarter at Veraval, Mangrol and Mumbai. From Satpathi in gill nets, higher catch rates of 245.7 kg to 724.4 kg were obtained during August-October period. Likewise, at Visakhapatnam in Sona boat, catch rate (99 kg) was obtained during February. *Pampus argenteus* was dominant at Mumbai and *Formio niger* at Calicut.

*P. argenteus* observed off Mumbai in trawl (45-295 mm) had the size groups 65-115 mm forming 61% while those within the size groups 175-215 mm forming 22.5%. At Satpathi in gillnet (85-335 mm), size groups 135-235 mm formed 84.5% of the total catch of the species.

The food of *P. argenteus* (50 - 300 mm) off Mumbai was observed to be *Acetes* sp, medusae, and prawns.

**BULL'S EYE**

The fishery declined over the previous year at Veraval (52.5%), Mangrol (13.3%), Mumbai (Sasoon Dock) (71%), Puthiappa (88.7%), Beypore (82%) and Cochin (46.7%) and increased at Visakhapatnam by over 100% in the Sona type trawlers. *Priacanthus hamrur* was the only species at all the centres.

The length range of this species at Mumbai was 95-305 mm with 155-195 mm group forming 83%, and the length range at Cochin was 155-335 mm with 185-245 mm groups forming 77.5% of the total catch. At Cochin, *P. hamrur* had the ovaries in stage VI during January - April.
FLATFISHES

The flatfish fishery dominated along the southwest coast, especially along the north Kerala - south Karnataka coast. The landing in Mangalore - Malpe was 2333 tonnes during 1998 and formed 3.4% of the total trawl landings. Along the south Kerala coast and the Gulf of Mannar, the landings contributed 0.2 to 1.5% of the total landings.

The flatfishes have a distinct species distribution pattern. Whereas *Cynoglossus macrostomus* dominated the landings along the north Kerala-south Karnataka coast (90% of the flatfish landings), *C. bilineatus* (93.5%) and *C. macrolepidotus* (46 to 74%) dominated in the south Kerala coast and the Gulf of Mannar.

Along the southwest coast, the length range of *C. macrostomus* was 50-169 mm and the modal length was 110-119 mm.

GOATFISHES

The goatfishes were dominant along the east coast, especially between Mandapam and Visakhapatnam, where they formed 3.9 to 6.0% of the total trawl landings. During 1998, the landing was maximum (1654 t) in Madras.

*U. Sundalicus* (50.4% of the goatfish landings) and *U. Sulphureus* (42.8%) were dominant in the south Tamilnadu coast (Rameswaram and Pamban). *U. Taeniopterus* (47%) was dominant along the north Tamilnadu - south Andhra Pradesh and *U. Vittatus* (55.0 to 68.9%) along the north Andhra Pradesh coast.

The length of different species along the east coast ranged from 60 to 189 mm. Along the north Tamil Nadu and Andhra Pradesh coast, the females dominated the catch; crustaceans were the major food of the goatfishes.
WHITEFISH

There was improvement in the landings of the whitefish in all the centres along the southwest coast, especially along the south Karnataka coast, where the catch and CPUE increased by 98% and 133% respectively. The length range of *Lactarius lactarius* was 30-209 mm and females in all stages of gonadal maturity were observed in the catch. Anchovies were the major food of *L. lactarius*.

### Landings of flatfishes at different centres during January - December, 1998

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Mangalore &amp; Malpe</th>
<th>Puthiappa &amp; Beypore***</th>
<th>Cochin</th>
<th>Vizhinjam</th>
<th>Rameswaram</th>
<th>Pamban</th>
<th>Mandapam</th>
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<tr>
<td>CATCH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trawl (t)</td>
<td>2333</td>
<td>1019</td>
<td>33</td>
<td>460 **</td>
<td>195</td>
<td>12</td>
<td>71</td>
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<tr>
<td>% difference compared to</td>
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<td></td>
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</tr>
<tr>
<td>Jan.-Dec. 97</td>
<td>- 13</td>
<td>+ 65</td>
<td></td>
<td></td>
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<tr>
<td>CPUE (kg/unit)</td>
<td>0.9 *</td>
<td>1.8</td>
<td>2.9</td>
<td>3.0</td>
<td>2.0</td>
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<tr>
<td>% difference compared to</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Jan.-Dec. 97</td>
<td>- 34</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>% in total catch</td>
<td>3.4</td>
<td>0.2</td>
<td>0.7</td>
<td>0.6</td>
<td>1.5</td>
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* kg/h                  ** Catches from Konchuvalla  *** for Jan to Sep, 1998
### Landings of goatfishes at different centres during January - December, 1998

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Vizhinjam</th>
<th>Mandapam</th>
<th>Rameswaram</th>
<th>Pamban</th>
<th>Madras</th>
<th>Visakhapatnam</th>
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<tr>
<td><strong>CATCH</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Trawl (t)</td>
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<td>221</td>
<td>64</td>
<td>1654</td>
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<td>% difference compared to Jan. Dec. 98</td>
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<td></td>
<td>+31</td>
<td>+25</td>
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<tr>
<td><strong>CPUE</strong></td>
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</tr>
<tr>
<td>(kg/unit)</td>
<td>6.0</td>
<td>3.3</td>
<td>16.9</td>
<td>1.4 (kg/h)</td>
<td>1.3 (kg/h)</td>
<td>0.8</td>
</tr>
<tr>
<td>% difference compared to Jan. Dec. 98</td>
<td>-14</td>
<td>+20</td>
<td>-27</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>% in all fish catch</td>
<td>4.4</td>
<td>0.8</td>
<td>3.9</td>
<td>4.5</td>
<td>5.7</td>
<td>6.0</td>
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</table>

### Landings of whitefish from trawlers at different centres during January-December, 1998

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Vizhinjam</th>
<th>Mangalore &amp; Malpe</th>
<th>Puthiappa &amp; Beypore</th>
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<td><strong>CATCH</strong></td>
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<tr>
<td>Trawl (t)</td>
<td>10</td>
<td>1063</td>
<td>280</td>
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<tr>
<td>% difference compared to January-December, 1997</td>
<td>+16</td>
<td>+98</td>
<td>+200</td>
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<tr>
<td><strong>CPUE</strong></td>
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<td></td>
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</tr>
<tr>
<td>(kg/unit)</td>
<td>0.7 (kg/h)</td>
<td>5.5 (kg/unit)</td>
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### INVESTIGATIONS ON THE IMPACT OF COASTAL BOTTOM TRAWLING ON DEMERSAL FISHES AND MACROBENTHOS (DF/TR/1)

N.G. Menon, P. Nammalwar, P.U. Zacharia and I. Jagadish

In order to study the impact of coastal bottom trawling on the habitat and resources, the data of 1997 were analysed. In Kerala the estimated target by catch ratio was 33:67; the non-edible benthic biota formed 7.8% of the total catch. In Karnataka the above
ratio was 21:78; with the non-edible biota forming 20.6 % of the total catch. In Tamilnadu, the ratio was 17:83 wherein non-edible biota formed only less than 3 % of the total catch. In the total trawl catch of Karnataka 47 % was caught from less than 30-m depth, 34 % from the 30 -50 m depth and 19 % from above 50-m depth. Similarly, in Kerala, 43 % was caught from less than 30 m depth, 38 % from 30 – 50 m depth and 19 % from above 50 m whereas in Tamilnadu 80 % of the trawl catch was from 0-30 m, 15 % from 30 -50 m and only 5 % from above 50 m depth.

The catch particulars pertaining to 1998 are based on estimated data drawn from various centres in the project area. The centre-wise results are given below.

**KARWAR**

In the small trawlers operating in 20-40m depth, the finfish formed 54% of the total catch of Karwar, crustaceans 28%, cephalopods 0.4% and the benthic biota; the rest, whereas at Tadri, finfish accounted for 49% followed by crustaceans 14%, cephalopods 0.2% and the benthic biota 36.8%.

**MANGALORE**

The fishing was carried out in shallow grounds of less than 30 m depth by single day fishing and the multiday fishing concentrated in above 30 m depth.

During 1998, the finfish accounted for 49% of the total trawl catch, whereas the target resources constituted 14% and the remaining 37% by the benthic biota. About 12% of the finfish catch consisted of juveniles / sub adults of elasmobranchs, catfishes, lizardfishes, Epinephelus, Lactarius, silverbellies, sciaenids and flatfishes. The benthic biota consisted of 83% stomatopods, 8% gastropods 4% bivalves, 3% inedible crabs, 2% echinoderms etc.

In the multiday trawling beyond 30 m, finfishes formed 77%, crustaceans 4%, cephalopods 14% and benthic biota 5%. In the total finfish catch juveniles / sub-adults catfishes, lizard fishes, threadfin bream, Lactarius, sciaenids, flatfishes contributed about 18%. The benthic biota formed 2054 tons, which included stomatopods (84%), gastropods (3.5%), bivalves (3%), inedible crabs (3.3%), echinoderms ( 2%) etc.

**COCHIN**

The trawlers landed 18,042 t, shared by finfishes (97 %)and target resources 2. 9 % at Cochin Fisheries Harbour. The benthic biota formed only very negligible quantity mostly comprising of stomatopods, inedible crabs, gastropods and bivalves. It is reported that the catch is invariably sorted on board the vessel and the nonedible and low value components are discarded in the sea.

Experimental trawling conducted at 10 m depth off Cochin revealed the occurrence of benthic organisms such as stomatopods, gastropods, bivalves, inedible crabs and echinoderms to the tune of 30 % of the catch, silverbellies, sciaenids, flatfishes, lizard fishes ( mostly juveniles and sub-adults) were the major catch from this ground.
MANDAPAM

During 1998, the trawlers landed 1642 t from the Gulf of Mannar. Finfishes formed 67.7% of the total catch, followed by crustaceans 9.4%, cephalopods 0.5% and benthic organisms 22.4%. In the finfishes, about 21% constituted juveniles of sciaenids, silver bellies, catfishes, lizardfishes, flatfishes and goatfishes. The benthic biota (368 t) comprised mostly of stomatopods, inedible crabs, gastropods, bivalves and echinoderms. Other items were sponges, gorgonids and ascidians.

An estimated 2992 t were landed from Palk bay during 1998; which included 68.6% finfishes, 13% crustaceans, 2.8% cephalopods and 15.5% benthic biota. The finfish catches consisted of juvenile and sub adults of catfishes, sciaenids, flatfishes, goatfishes and silver bellies to the tune of 28% of the total finfish catch. The catch of benthic biota was dominated by stomatopods, inedible crabs, gastropods, bivalves, echinoderms and gastropods in the order of abundance. Gorgonids, antipatharians, sponges, ascidians and sea grass/seaweeds were also taken by trawlers in small quantities.

MADRAS

The trawlers landed 14913 t during April-Dec 1998, of which, finfish accounted for 78.6% followed by crustaceans 4.6%, cephalopods 0.6% and benthic biota 6%. Juvenile/subadults of the threadfin breams, sciaenids, silverbellies and flatfishes were recorded in appreciable quantities. The benthic biota consisted of stomatopods (44%), inedible crabs (37%), gastropods (9%), bivalves (8%) sea urchins, cephalopod juveniles and others.

KAKINADA

The trawlers landed 37647 t, consisting of 64.6% finfish, 31.6% crustaceans, 1.8% cephalopods and the rest benthic biota. An estimated catch of 582 t of juveniles of finfish were landed during the year. This portion of the catch was dominated by sciaenids (12.5%), flatfish, perchs, threadfin breams, goatfishes and lizardfishes. The benthic biota landing was to the tune of 779 tons, comprising of 61% inedible crabs, 36% stomatopods, 2.6% gastropods and bivalves, 0.1% echinoderms etc.

CULTURE OF GROUPERS, SEABASS, RABBITFISH AND ORNAMENTAL FISH (DF/CUL/3)


AT COCHIN FISHERIES HARBOUR LABORATORY

Breakthrough in the broodstock development and breeding of grouper: Thirteen specimens of Epinephelus malabaricus and five of E. tauvina in the length range of 51 - 62 cm and weight range of 2100 - 4800
Live grouper broodstock in the tank just before water change at Mandapam.

18 Hour old embryos of *E. tauvina*.

Developing embryo of *E. tauvina*.

24 Hour old larvae of *E. tauvina*. 
Freshly-laid eggs of clownfish

A fully grown clownfish larva breaking capsule to wriggle-out

Young ones of clownfish in growout tank

The clownfish in the Aquarium at Vizhinjam
g were stocked at the rate of 2 or 3 numbers at a total biomass of 1-2 kg/sq.m, in 5 tonne capacity FRP tanks in seawater of salinity 32 ppt, pH 7-8 and dissolved oxygen values 3.5-4.5 ml/L. A recirculation system was established inside the tank using insitu biofilters. From January onwards, along with the regular feed, the fishes were also given cod liver oil and vitamin B12.

A few fishes were selected for sex reversal and *Epinephelus tauvina* and *E. malabaricus* were treated separately. *E. malabaricus* was given 5 mg of the male hormone (17a methyl testosterone), in the form of pellets, through food. The fishes, both the hormone treated and the untreated were examined regularly for assessing the gonad maturation. During April 1998, the ova obtained through biopsy were in the diameter range of 260-300 m. Supplementary feeding with cod liver oil and vitamin B12 was continued; besides, during June and July, the food was further supplemented by the specially formulated maturation diet. Towards the end of September, the ova of *E. tauvina* were in the diameter range of 380-400 m. Administration of male hormone for the fish selected for sex reversal was continued.

On 29-10-1999, *E. tauvina* (male 3100 g, female 3850 g) spawned during 18.00-22.00 hrs in the same 5-tonne tank in which they were maintained throughout. Spawning took place again on the next day (30-10 1998) during almost the same time (19.00-22.00 hrs). The spawn was in the diameter range of 900-920 m with a single oil globule measuring 0.019 m. Fertilization was around 98-100%. The eggs were transferred to the incubation tanks after 22 hrs of development, the larvae hatched, which measured 1.64-1.70 mm.

Another female weighing 4700 g (and the male in the above pair) spawned on 20.12.98, producing 0.25 million eggs of 860-900 m diameter; the hatching rate was 45% and the larvae survived up to 4th day.

The achievements in the experiments are:

- successful rearing, from fingerlings, of groupers and development of broodstock in onshore, fully controlled, seawater recirculating system,
- sex reversal, maturation and spontaneous spawning under onshore captive conditions, and
- successful fertilization and larval hatching.

The results offer vast scope for developing a technology package for broodstock development, breeding, seed production and growout culture of groupers in India.

**AT NARAKKAL**

*Epinephelus tauvina* and *E. malabaricus* were reared in two silpaulin-lined ponds of 70 and 65-tonne capacity and one earthen pond of 0.3 ha, in an attempt to raise broodstock. In the silpaulin-lined ponds, water quality was maintained by effecting daily exchange (30-40%) of water.

Water temperature, salinity, dissolved
oxygen, ammonia, nitrate etc. were regularly monitored. The salinity in the silpaulin lined ponds ranged between 16.5 and 34.5 ppt and that of natural ponds between 6.0 and 18.7 ppt. During monsoon months salinity values in all the ponds showed a sharp decline due to rain water. The dissolved oxygen values ranged between 4.31 and 6.80 ml/L and from 1.58 to 6.10 ml/L in silpaulin lined and natural ponds respectively. Occurrence of nitrate and ammonia was negligible.

For induced maturation and sex inversion, two specimens of *E. tauvina* weighing about 2.5 kg were kept separately in a 70-tonne silpaulin -lined pond. 17a methyl testosterone pellets were given orally for sex inversion at weekly intervals for a period of two months. However, optimum salinity for maturation and sex inversion of the species could not be maintained in the pond during monsoon.

**AT MANDAPAM**

Live groupers (*Epinephelus tauvina*) of varying lengths, caught by traps from the wild were stocked in RCC tanks of 100-tonne capacity at the rate of 1kg biomass, per cubic meter. Besides, pond-harvested fishes transported from Tuticorin, were also maintained in the RCC tanks of the same capacity separately. 100% water exchange with water drawn directly from the sea was done after cleaning the tanks twice in a week, in addition to 50% exchange daily. Fresh sardines were given as food supplemented with codliver oil and vitamin E.

A stock of 75 specimens of 3 size groups (less than 1 kg, 1-2 kg and over 2 kg) were maintained in RCC tanks. By June, the average sizes were 381.5 mm (742 g), 472.3 mm (1515 g) and 560 mm (2600 g). On completion of another six months in December, they attained average sizes of 442.6 mm (1383 g), 550.9 mm (2480 g) and 620 mm (3670 g). The feed conversion ratio ranged from 4.6 to 7.7. Growth in weight was greater in October and November. It was observed that fishes weighing more than 1 kg grew well with less food conversion ratio.

Another stock of 120 groupers harvested from the culture ponds at Tuticorin Research Centre, were raised by stocking them in three categories (less than 0.5 kg, 0.5-1.0 kg and over 1 kg) in three tanks of size 10 x 5 x 2.3 m. After four months, in December, they progressed to an average size of 383.2 mm.
(791 g), 456.1 mm (1485 g) and 551.7 mm (2622 g) as against the initial stocking sizes of 298.8 mm (324 g), 389.7 mm (755 g) and 481.8 mm (1534 g) respectively. The monthly average increase in size was 21.1 mm (116.8 g), 16.6 mm (182.5 g) and 17.5 mm (271.5 g) with a feed conversion ratio of 3.2, 3.3 and 3.5 respectively.

Juveniles measuring average size of 69.8 mm (4.5 g) were reared in a 30-tonne capacity RCC tank feeding them with chopped sardine at the rate of 6-8% of the body weight. After nine months they attained an average size of 284.6 mm (377 g).

Experiments were conducted with six female groupers measuring 60 – 68 cm (3.4-5.4 kg) to convert them into males using hormone. They were injected with methyl testosterone at the rate of 2 mg per Kg body weight. There was no mortality due to injections for three months. The intake of food was poor latter and they became sluggish and the colour changed to dark brown ultimately leading to the death of four specimens.

AT TUTICORIN

The Grouper seed was obtained throughout the year with the peak occurrence during October-December. About 1620 seed was collected using mini shoreseine from Vellapatti area. 800 specimens of Epinephelus tauvina of an average size of 130 mm (28 g) were stocked in an earthen pond. They showed an average monthly growth rate of 12 mm (48 g). The total number harvested was 280, the survival rate being 35%. About 150 specimens were transported to Mandapam Camp for breeding experiments.

After harvest, the pond was restocked with groupers at the rate of 2700 numbers/hectare. The mean stocking size was 140 mm (34 g).

AT VIZHINJAM

The clownfish (Amphiprion chrysogaster) (8-9 cm) collected from the wild were maintained in FRP tanks. These fishes spawned frequently at intervals of 10-45 days in the tanks, the number of eggs ranging from 300 to 800 on different occasions. Hatching took place after 6-7 days during night (19.00 – 22.00 hrs). The length of the newly hatched larvae ranged from 2.5 to 3.0 mm and they were given live feed (Brachionus rotundiformis and Artemia nauplii). The larvae metamorphosed into juveniles of average length of 8 mm, after 12-15 days of hatching. The juveniles were transferred to rearing tanks for growout.
IV. CRUSTACEAN FISHERIES DIVISION

Crustacean production in 1998 was estimated at 5,06,694 t, showing an increase of 0.7% over the previous year; they formed 18.6% of the marine fish landings in 1998. Penaeid prawns with a production of 2,17,076 t contributed to 42.8% of the crustacean landings followed by nonpenaeids (184,436 t, 36.40%), stomatopods (67,601 t, 13.34%), crabs (34,814 t, 6.87%) and lobsters (2,767 t, 0.55%). When compared with the previous year, penaeid and nonpenaeid landings increased by 5.2% and 19.8% whereas those of lobsters declined by 5.2%, crabs 25.9% and stomatopods 27.3%. The west coast contributed 75.3% of the penaeids and the northwest coast supported 93% of the nonpenaeid fishery. Penaeid prawn fishery registered moderate increase in the landings in Kerala and considerable increase in Gujarat and Andhra Pradesh.

ASSESSMENT OF FISHERY AND RESOURCE CHARACTERISTICS OF PENAEID SHRIMP OF THE WEST COAST OF INDIA (CF/RE/1.11)


With a total production of 1,63,554 t in 1998, the west coast contributed to 75.3% of the penaeid prawn fishery of the country. Over the previous year, the fishery improved by 5.1%. The contribution of states to the fishery was 35.8% by Kerala, 4% by Karnataka, 1% by Goa, 27.5% by Maharashtra and 31.7% by Gujarat. Against the previous year, fishery in 1998 improved by 4.3% in Kerala and 39.3% in Gujarat. Fishery declined by 31.3% in Maharashtra, 40.8% in Goa and 9.7% in Maharashtra.

Trawl fishery

Trawlers accounted for major portion of the catch. Investigations were carried out at Veraval, New Ferry Wharf (Mumbai), Karwar, Tadri, Malpe, Mangalore, Kozhikode, Kochi and Sakhikulangara (Neendakara).

Estimated penaeid prawn catch and catch rate (in parentheses) in 1998 at trawl landing centres were 3738 t (5.0 kg/hr) at Veraval, 9259 t (6.0 kg/hr) at New Ferry Wharf, 511 t (7.0 kg/hr) at Karwar, 361 t (3.4 kg/hr) at Tadri, 744 t (1.6 kg/hr) at Malpe, 1358 t (1.3 kg/hr) at Mangalore, 1558 (47.7 kg/boat trip) at Kozhikode, 5701 t (8.6 kg/hr) at Kochi and 11066 t (7.0 kg/hr) at Sakhikulangara. When compared to the previous year, the fishery declined by 30% at Veraval, 55% at Mumbai, 63% at Karwar, 44% at Tadri, 28% at Malpe, 16% at Kozhikode and 10% at Kochi. However, at Sakhikulangara, 9% increase in the fishery was recorded.

Karikkadi fishery in the monsoon period...
amounted to 1084 t at Kochi and 4819 t at Sakthikulangara, showing improvement of 41% at Sakthikulangara and decline of 13% at Kochi over the previous year.

*P. stylifera* was the dominant constituent at most of the centres. This species contributed to 56% at Veraval, 42% at New Ferry Wharf, 43% at Karwar, 65% at Tadri, 36% at Malpe, 33% at Kozhikode, 41% at Kochi and 56% at Sakthikulangara. *Metapenaeus monoceros* (44%) was the major component at Mangalore. This species supported sizeable fishery at Malpe (25%) and Tadri (13%) too. *Metapenaeus dobsoni* was fished in large quantities at Karwar (41%), Tadri (12%), Malpe (17%), Mangalore (7%), Kozhikode (32%) and Kochi (34%).

Along the northwest coast *Solenocera crassicornis* at Veraval (27%) and New Ferry Wharf (16%), *Metapenaeus kutchensis* at Veraval (4%) and New Ferry Wharf (4%), *Metapenaeus affinis* (13%), *Metapenaeopsis stridulans* (8%) and *M. monoceros* (6%) at Mumbai were fished in fairly large quantities. In the southwestern coast, at Sakthikulangara, *Trachypenaeus curvirostris* (23%) was the second most abundant species. In recent years, with advancement of trawling into deeper grounds, *Solenocera choprai* has emerged as a potential resource at Mangalore (12%) and Sakthikulangara (4%).

Larger species like *Penaeus semisulcatus* at Veraval, *P. merguiensis* at New Ferry Wharf, Karwar and Tadri. *P. canaliculatus* at Sakthikulangara and *P. indicus* along the Kerala coast supported minor fisheries.

Size classes (combined for both sexes) dominating the *P. stylifera* fishery were 76-120 mm at Veraval, 71-115 mm at New Ferry Wharf, 71-90 mm at Karwar and Tadri, 76-110 mm at Malpe and Mangalore. Along the Kerala coast, smaller prawns within the range 61-90 mm in length were predominant.

In *M. dobsoni*, bulk of the fishery was supported by 81-100 mm sizes at Karwar, 76-85 mm at Tadri, 61-85 mm at Mangalore, 61-95 mm at Malpe and 61-85 mm at Kochi.

*M. monoceros* fishery along the Mangalore coast was dominated by 101-130 mm size at Mangalore and 111-155 mm at Malpe.

All along the west coast, peak spawning season for *P. stylifera*, *M. dobsoni* and *M. monoceros* was between December and May.

Purse seiners at Malpe and Mangalore landed 29 t of *M. dobsoni* in July. Fishery suffered a decline of 87% over the previous year.

**Artisanal prawn fishery**

In the artisanal sector, fishery was active in the monsoon period. At Calicut, ringseines, disco nets and pairtrawls together landed 144 t, registering an increase of 275% over the previous year.

At Fort Kochi, ringseines landed a paltry 3 t of prawns at a catch rate of 1 kg/unit. The entire fishery was supported by *M. dobsoni*.

Prawn fishery in the Mudbank along Trichur District was dominated by *M. dobsoni*.
81-105 mm sizes in females and 71-90 mm in males supported the fishery. Spawners formed nearly 35%.

'Konchu vala' operations at Vizhinjam and Manakudy in the southern most part of Kerala landed 68 t (3 kg/unit) of prawns showing a decline of 51% over the previous year. *P. indicus* (67%) followed by *P. canaliculatus* (11%), *P. monodon* (12%) and *P. semisulcatus* (7%) were the major component species. *P. indicus* fishery was supported mostly by 141-175 mm groups. Between July and September 50 - 54% of the females were in ripe condition.

**Prawn fishery in the nursery grounds:**

Stake nets operating in Kochi backwaters landed 281 t of juvenile prawns at a catch rate of 4.3 kg/unit. Fishery improved by 12% over the previous year. *M. dobsoni* (96%) dominated the fishery.

**ASSESSMENT OF FISHERY AND RESOURCE CHARACTERISTICS OF PENAEID SHRIMPS OF THE EAST COAST OF INDIA (CF/RE/1.12)**

G. Sudhakara Rao, M. Rajamani, V. Thangaraj Subramaniam, K.N. Saleela and G. Maheswarudu

Penaeid prawn production along east coast in 1998 was estimated at 53253 t registering an increase of 5.5% over the previous year. East coast contributed to 24.5 % of the country's penaeid prawn production. Statewise contribution to the east coast fishery, in order of abundance, was 53.2% in Tamilnadu, 35.7% in Andhra Pradesh, 5.9% in West Bengal, 3.9% in Orissa and 1.3% in Pondicherry. Against the previous year, fishery improved by 27.9% in Andhra Pradesh, 3.1% in West Bengal and 5.7% in Pondicherry. Marginal decrease of 4% in Tamilnadu and a substantial decline of 30.2% in Orissa were recorded in 1998.

**Trawl fishery**

Data were collected at Tuticorin, Mandapam, Chennai, Kakinada, Visakhapatnam and Paradeep.

Estimated penaeid prawn catch and catch rate in 1998-99 at important trawling centres were 53 t (3.4 kg/boat trip) at Tuticorin, 756 t (1.5 kg/hr) at Mandapam, 3534 t (3.1 kg/hr) at Chennai, 8711 t (8.8 kg/hr) at Kakinada, 516 t (2.5 kg/hr) at Visakhapatnam and 489 t (5.1 kg/hr) at Paradeep. In comparison to the previous year, the catches declined by 33% at Tuticorin and 32% at Paradeep while the fishery improved by 5% at Mandapam, 30% at Chennai, 24% at Kakinada and 22% at Visakhapatnam. Poor landings of *Penaeus semisulcatus* at Tuticorin and *Parapenaeopsis hardwickii*, *Metapenaeus dobsoni* and *Parapenaeopsis stylirostra* at Paradeep resulted in the decline of the fishery in these centres. Fishery improved at Chennai, Kakinada and Visakhapatnam due to increased landings of *M. dobsoni* and *P. indicus* at the former centre and *Metapenaeus monoceros* and
M. dobsoni at the latter two centres.

Along the Tamilnadu coast, P. semisulcatus (76%) at Tuticorin and P. semisulcatus (62%) and Metapenaeopsis stridulans (25%) at Mandapam and M. dobsoni (23%) and P. indicus (16%) at Chennai were the dominant species. In Andhra Pradesh M. dobsoni (35%) and Metapenaeus monoceros (33%) at Kakinada and M. monaceros (37%) and M. dobsoni (22%) at Visakhapatnam were the principal components of the fishery. At Paradeep in Orissa, the fishery was dominated by Parapenaeopsis hardwickii (30%) and M. dobsoni (20%). In addition to the above species Trachypenaeus pescadoensis (6%) at Mandapam, Parapenaeopsis maxillriped (11%), M. monoceros (9%) and P. semisulcatus (5%) at Chennai, Metapenaeus brevicornis (7%), Solenocera crassicornis (5%) at Kakinada, Metapenaeopsis spp. (6%), Solenocera spp. (17%) at Visakhapatnam and P. styliroa (12%), M. monoceros (8%) and M. lysianassa (8%) at Paradeep added substantially to the penaeid fishery of the east coast.

In P. semisulcatus the dominant length range was 106-130 mm at Mandapam; January-March was the peak spawning season of this species.

In M. dobsoni, 71-90 mm sizes at Chennai, 61-80 mm at Kakinada and 66-90 mm supported the bulk of the fishery.

111-155 mm and 106-135 mm sizes in M. monoceros mainly supported the fishery at Visakhapatnam and Paradeep respectively. A disturbing feature of M. monoceros fishery at Kakinada was the dominance of undersized prawns in the landings. Prawns less than 100 mm length contributed to 83% of the fishery. October to February was the peak spawning season of M. monoceros along the Andhra coast.

**Prawn fishery by Sona boats**

Sona boats (13.1 m OAL) operating off Visakhapatnam landed 935 t (3.4 kg/hr) of penaeid prawns during 1998 showing 41% increase over the previous year. M. dobsoni (43%), M. monaceros (20%) and Metapenaeopsis spp. (5%) were the dominant constituents of the fishery.

An analysis of the prawn fishery by Sona boats for the period 1993 to 1997 indicates the dominance of M. monaceros (24-30%) followed by M. dobsoni (12-35%), M. affinis (3-18%), P. indicus (8-15%), P. monodon (3-6%) and P. semisulcatus (1%). While there are indications of overfishing in M. affinis and P. monodon, the stocks of other species were in a healthy state of exploitation. Sona boats being highly coast-effective pose a threat to the economic viability of other fishing fleets. Hence no further increase in the number of Sona boats is recommended.

**Artisanal prawn fishery**

‘Thallumadi’ operations at Tuticorin and ‘Thalivalalai’ fishing at Mandapam landed 28t (3 kg/unit) and 11 t (0.3 kg/unit) of prawns showing improved landings of 33% and 63% over the previous year. Juveniles of P. semisulcatus dominated the fishery at both centres.
Gillnets and disco nets at Puri 49 t (0.4 kg/hr) of prawns registering a decline of 50% in the catches over the previous year. *P. indicus* (75%) and *M. affinis* (19%) were the major components of the fishery.

**Prawn fishery in the nursery grounds**

Stake nets at B.V. Palem (Kakinada) landed 305 t (2.7 kg/hr) of juvenile prawns dominated by *M. monoceros* (52%) and *M. dobsoni* (30%). Fishery improved by 83% over the previous year.

**INVESTIGATIONS ON THE NONPENAEID SHRIMP FISHERY OF NORTHWEST COAST OF INDIA (CF/RE/1.13)**

V.D. Deshmukh and A.P. Dineshbabu

Nonpenaeid prawn landings in the country in 1998 were estimated at 1,73,942 t against 1,53,959 t in the previous year, showing an improvement of 19.8% in 1998. Gujarat (53.11%) and Maharashtra (40.01%) contributed the bulk of nonpenaeid prawn production in the country. Fishery in 1998 improved by 24.12% in Maharashtra and 13.4% in Gujarat over the previous year. West Bengal (4.68%) and Andhra Pradesh (1.70%) were the other two states where this resource was exploited in moderate quantities.

**Trawl fishery**

At Veraval, an estimated 14,958 t of nonpenaeids at a catch rate of 20 kg/hr were landed during the year. Over the previous year, the fishery registered a decline of 62%. *Acetes* spp. contributed to 99% of the catch and therest being *Nematopalaemon tenuipes*.

Trawlers at in Mumbai landed 2646 t of nonpenaeids. The entire fishery was contributed by *N. tenuipes*.

While *Acetes* spp. supported almost the entire fishery in trawlers in Gujarat, their place was taken by *N. tenuipes* in Maharashtra. *Exhipholysmata ensirostris* was landed in small quantities in Maharashtra.

**Dol net fishery**

Dol netters at Nawabunder and Rajpara in Gujarat landed 5411 t (31 kg/haul) and 6375 t (29 kg/haul) of nonpenaeids respectively. The fishery improved by 32% at Nawabunder whereas a decline of 7% was recorded at Rajpara over the previous year. *Acetes* spp was the main component at both the centres, the percentage contribution being 85 at Nawabunder and 77 at Rajpara. *N. tenuipes* supported 7% and 11% of the fishery at Nawabunder and Rajpara respectively. *E. ensirostris* accounted for the rest of the fishery at these centres.

In Maharashtra, dol nets landed 1127 t at Mumbai about 80% of the landings were contributed by *Acetes* spp. *N. tenuipes* and *E. ensirostris* contributed to the rest. *N. tenuipes* fishery was dominated by 39-51 mm sizes in dol nets and 45-63 mm in trawl nets in
Maharashtra. January to April was the peak spawning season for this species. In *E. ensirostris* 73-88 mm sizes were dominant in *dol* net catches at Nawabunder.

Mortality coefficient (Z) of *N. tenuipes* at Mumbai was estimated as 11.1 and 9.35 respectively for males and females. Exploitation rate, standing stock and total biomass were 0.64, 436.5 t and 4357 t respectively during the year. Exploitation rate was above the optimum level and hence reduction in effort is recommended.

INVESTIGATIONS ON LOBSTER AND CRAB RESOURCES OF INDIAN COAST (CF/RE/1.14)


LOBSTERS

The total landing of lobsters in India during the year 1998 was 2694 t as against 2917 t during the previous year. In Gujarat (except Kutch) the fishery declined from 1405 t in 1997 to 1054 t in 1998. A decline was noticed in Maharashtra also where the catches recorded were 818 t and 442 t in 1997 and 1998, respectively. There was no landing in Goa and Karnataka whereas Kerala registered a decline from 265 t in the previous year to 64 t in the current year. However, the lobster fishery showed a slight improvement along the east coast. In Tamil Nadu the catches increased from 375 t in 1997 to 998 t in 1998, in Andhra Pradesh, from 1 t in 1997 to 12 t in 1998 and in West Bengal from 6 t in 1997 to 89 t in 1998. Maximum landing was recorded in Gujarat (39.64%) where trawl net was the major gear operated. Tamilnadu contributed to 37.5%, Maharashtra, 16.6%, West Bengal, 3.3% and Kerala 2.4%. Maximum landing (46.1%) was recorded during the first quarter of the year. 9.7% of the catch was landed during the second quarter, 17.6% during the third quarter and 26.5% during the fourth quarter. Thus the peak season was from October to March. A regionwise analysis of the data shows that better catches were obtained from the northwest coast (56.2%) followed by the southeast coast (38%).

Studies were carried out on the fishery and biology of important edible species of lobsters at Veraval, Mumbai, Calicut, Vizhinjam and Tuticorin. Traps and trawl net are the major gears operated. Artisanal gears such as bottom-set gillnets and traps are extensively used at Calicut, Vizhinjam and Tuticorin. *Panulirus polyphagus* and *Thenus orientalis* contributed to the fishery at Veraval. 90.6 t of lobsters were landed at a catch per unit effort of 1.28 kg. The fishery showed a decline when compared to that of the previous year. *P. polyphagus* predominated the fishery.
contributing to 55.6% of the total landing. Maximum landing of *P. polyphagus* was reported in December-January and that of *T. orientalis* in November-January. In *P. polyphagus*, females were predominant in the population forming 68.8%. Of this 33.8% were in berried condition, with maximum in May. The modal length classes for males and females were at 71-80 mm and 76-85 mm, respectively. In the case of *T. orientalis* males predominated the population contributing to 54.6%. The modal length classes for males and females were at 61-65 mm and 71-75 mm, respectively. At Mumbai about 94% of lobsters were landed at a catch rate of 3.36 kg per boat trip. This formed 0.21% of the total fish landed by trawl. When compared to the catch of the previous year, the lobster landing showed an increase by 26.8%. The catch was constituted by a single species, *P. polyphagus*.

At Thikkode, Calicut, bottom set gill nets landed 1887 kg of lobsters at a CPUE of 0.05 kg in 1998. The catches decreased by 6.6% when compared with that of the previous year. *P. homarus* predominated the fishery (85.4%), followed by *P. ornatus*, *P. polyphagus* and *P. versicolor*. In *P. homarus*, the modal size in both males and females ranged from 61 to 70 mm carapace length.

The estimated total landing of lobsters at Vizhinjam during 1998 was 1.3 t and *P. homarus* was dominant. At Muttom the total landing of lobsters was 6.5 t at a CPUE of 0.87 kg. The modal sizes of *P. homarus* were at 56-60 mm CL in males and 71-75 mm CL in females. Berried specimens formed 18.4% of the female population. The estimated lobster landings at Tuticorin by trawl nets, during the year was 4.8 t at a CPUE of 0.16 kg. This showed a decline when compared to the previous year. The peak season was in the months of June-July, *P. ornatus* predominated the fishery (72.44%). Males showed dominance throughout the year and no berried females reported from the female population. At Tharuvaikulam, Tuticorin, bottom set gill nets landed 2.5 t of lobsters at a CPUE of 0.33 kg. Here also a decline was noticed when compared with the previous year's catch. The peak season fell in the month of January, *P. ornatus* predominated the fishery forming 64.74%. No berried females were noticed in *P. ornatus* whereas berried females were available in April and July, in the case of *P. homarus*.

**CRABS**

The total crab production in the country declined from 46,817 t in 1997 to 34,715 t in 1998. Tamilnadu (12,913 t), Gujarat (except Kutch) (8,300 t) and Kerala (6,985 t) recorded maximum landings, contributing to 37.5%, 24.1% and 20.3%, respectively. The landing in Andhra Pradesh was 3,326 t (9.6%). In Tamilnadu, catches decreased from 13,394 t in 1997 to 12,913 t in 1998. in Gujarat and Kerala also decline was recorded from 14,148 t to 8,300 t, and from 10,438 t to 6,985 t, respectively. Slight improvement was noticed in the fishery in Andhra Pradesh. Analysis of the data showed that catches were better during the first quarter of the year (36.3%).
Minimum landing was obtained during the third quarter (15.7%). A regionwise analysis of the data showed that maximum catches were recorded from the southeast coast (47.8%) followed by northwest (25.4%) and southwest (23.2%) coasts. Minimum landing was recorded from the northeast coast (3.4%).

At Veraval, the total landing of crabs was about 1099 t, at a CPUE of 15.6 kg. A good portion of the crabs were landed by multiday trawlers in a decomposed state and were used as fish meal or manure. *Charybdis cruciata* predominated the catches. The modal size class in males was 61-65 mm and females 56-60 mm. The total estimated catch of crabs at Mumbai was 205 t at a CPUE of 7.3 kg. This showed a 37% decline when compared to the landings of the previous year. *C. cruciata* contributing to 64% predominated the catches. The crab fishery was of a lesser magnitude at Karwar, the landing being about 27 t. The species *P. pelagicus* predominated the fishery. Crab fishery showed a trend of decline along the Mangalore-Malpe coast landing about 94 t of crabs. *P. sanguinolentus* predominate the fishery.

The total estimated catch of crabs at Calicut in the year 1998 was 282 t. *C. cruciata* predominated the catches constituting about 60% of the total landing. A good fishery for crabs was reported during January-May. The total catch of crabs at Cochin was 205 t. Of this 173 t was landed by multiday trawlers and 10 t by hand trawlers. Crabs were also landed by single day trips. *C. cruciata* and *P. sanguinolentus* predominated the landings. In *C. cruciata*, the modal class of males was at 71-75 mm and that of females at 66-70 mm size groups. In the case of *P. sanguinolentus*, the modal sizes were at 101-105 mm and 106-110 mm for males and females, respectively. Nearly 60% of females of this species were in berried condition in the month of April. At Vizhinjam, about 30 t of crabs comprising mainly *P. sanguinolentus* were landed by 'Konchuvala' units, at a CPUE of 1.7 kg.

At Tuticorin, the crab landing was estimated at 77 t; the peak was in November. *P. pelagicus* formed 93%. Berried females were present in all the months, with a maximum of 19% in September. At Mandapam, 260 t of crabs were landed. *P. pelagicus* was the only species in the trawlers. At Thoppukkadu, nearly 2 t of *Scylla tranquebarica* were landed, at Chennai an estimated 1730 t were landed at a CPH of 1.3 kg, by the trawlers. Maximum landing was recorded in January-February. *P. sanguinolentus* was dominant (47%). *P. vigil* (5%) and *C. smithi* (1%), reappeared in small numbers. Recruitment to the fishery took place during January-February and July-September. The small trawlers at Kakinada landed 689 t. Of this 52.8% was constituted by edible crabs, predominated by *P. sanguinolentus*. The price of crabs varied from Rs. 10/- to Rs. 300/- depending on the size as well as species involved.
DEVELOPMENT OF ARTIFICIAL REEFS (CF/RE/3)

M. Rajamani and K.K. Philippose

Two experimental artificial habitats were constructed in the tidal zone of the Tuticorin Bay. The first one was constructed with 24 hollow blocks in the Karapad Bay in September '98, covering an area of 3 sq. m. 46 nos of portunid crab *Thalamita crenata* were recorded from these artificial habitats in course of 6 samplings. One *Charybdis cruciata* was caught in December. 60% of *T. crenata* were berried indicating that the reef served as a good breeding ground. One of the berried crabs collected from the reefs released zoea within 2 days after collection. Juvenile fishes of commercial importance such as *Epinephelus tauvina*, *Lutjanus fulviflamma*, *Etroplus suratensis* and *Siganus javus* were also collected from the artificial reefs. The presence of juveniles indicate that the artificial habitat acts as a good nursery ground for these species. In addition to fishes and shrimps, *Trochus* sp., *Alphaeus* spp. and brittle stars *Ophiionemis marmorata* were also collected from the reefs.

The second artificial habitat was created in the Tuticorin Bay in December '98. This was constructed of 300 concrete hollow blocks of three different sizes. In course of 6 samplings 4 species of crabs and 8 species of fishes were recorded. Among crabs *T. crenata* and *Scylla oceanica* and among fishes *Siganus javus* and *Lutjanus fulviflamma* were dominant in the reef areas.

The artificial reef constructed for lobsters off Vellapatti in the previous year became a good fishing ground for *Panulirus ornatus* and *P. homarus*.

Another artificial reef of 10,000 m² was created off poovar in the Trivandrum district. This reef was designed in an oval shape using triangular concrete modules. The length of the reef perimeter was 140 m and width 72 m. Inside the oval reef mini reefs or sets were developed using triangular tubular modules, tyres mounted on concrete slabs, palm leaves and fresh twigs in bundles. A total of 111 triangular modules, 22 tubular modules 16 tyre modules, 80 bundles of palm leaves and 40 bundles of fresh twigs were used in the reef work. The reef was installed on 14.3.1999 with the participation of local fishermen and the Fisheries Department of Kerala.

The performance of the CMFRI reef off Vizhinjam was assessed during the month of April 1998 and it was reported that this reef gave a net earning of about Rs.600,000 to the local fishermen by way of fish catches. The major species that contributed to the fishery were *Sepiapharaonis*, *Selar cumenophthalmus*, *Caranx* spp. and *Epinephelus* spp. Besides this, large accumulation of ornamental fishes was also reported in this reef.
Under this project, experiments were carried out on the induced maturation, hatchery production of seed, as well as farming of commercially important species *P. semisulcatus*, *P. merguiensis* and *P. monodon*.

In the case of *P. monodon*, females of 110 - 150 g size and males of 70-75 g size were collected from trawl catches. They were brought to the laboratory at Mandapam Camp and given an initial formalin treatment (50 ppm) and stocked in the rematuration system of 5 t capacity. Salinity was maintained between 30-35%. Using heaters, the temperature was maintained at 28°C. Three females and two males were stocked in one rematuration unit. Animals were fed with oligochaetes and squid meat. After two days of acclimatisation females were induced to mature by unilateral eyestalk ablation. Sometimes eyestalk ablation promoted moulting, instead of maturation and it was observed that it has helped to shorten the moult cycle duration (Average 13 days). After moulting, artificial insemination was done in females were found to be not impregnated. This techniques was perfected during this period. Through induced maturation, one female spawned and yielded 75000 nauplii. Another female spawned 12 times in a period of 102 days and gave 35,18,000 nauplii. Thus, a total of 35,93,000 nauplii were obtained through induced maturation during this period. Nauplii per spawner ranged from 45000 to 6,25,000.

A total of 87,360 postlarvae-15 produced through artificial insemination were used to carry out growout experiments.

Succeeded for the first time in the induced maturation and spawning of farmraised *Penaeus merguiensis* under captive conditions at Karwar. The experiments
were carried out using farm-raised prawns from estuarine environment. 20-25 g size shrimps were collected and acclimatised to 27 ppt for 6 hrs. After acclimatisation unilateral eyestalk ablation was carried out on healthy females. 10 ablated females and 5 males were stocked in a velon screen netcage. The cage was kept submerged in the bay where marine conditions prevailed. Experiment was carried out for 10 days. Clam and squid meat were given as food. Salinity varied from 25-29 %o and temperature 26-30°C. No mortality was observed and within 3-6 days 70 % of the females matured and spawned releasing healthy nauplii.

From two spawners of *P. semisulcatus* 2,28,000 nauplii were obtained with a hatching rate of 78.5% and 91% respectively. 45,500 postlarvae-29 were produced under controlled conditions and they were used for growout experiments. Seven such experiments were carried out during this period. In the earlier experiments at Mandapam, the early growth in marine conditions was comparable to that of other commercially important prawns but, the growth was stagnating after reaching a length of 85 -100 mm. In the present experiments, however, this problem did not occur because of better water and feed management. Seed of *P. semisulcatus* was stocked in ponds of 2500 m² water area at stocking rates of 7/m² and 10/m². They were fed with prepared feed and after 60 days, regular water exchange was carried out once in every 15 days. Initial experiments revealed that compared to the stocking rate of 10/m² better growth and survival was observed when the stocking rate was 7/m². In one experiment 208 kg was harvested after 150 days from 2500 m² water area and Rs.41,600 was realised as revenue. Expenditure towards fertilizer, feed and diesel came to 32,400 and the profit was Rs.9200/-. 

In another experiment, *P. monodon* was stocked at the rate of 8/m² in a pond of 2500 m² water area. Water and feed management was same as followed for *P. semisulcatus*. Harvesting was carried out after 150 days. Average weight of the harvested prawn was 30 g. Survival was 85.9% and the total production amounted to 515.75 kg (i.e. @ of 2 t/ha). A sum of Rs.1.7 lakh was obtained by the sale of prawns. Expenditure towards fertilizer, feed and diesel was Rs.69,950 and the profit was Rs.1,03,239/-. 

A marine hatchery complex has been established at Calicut and an experiment was initiated to develop a broodstock of *Penaeus japonicus* from juveniles (8 to 10 cm TL) collected from Korapuzha estuary. 

Steps were taken to establish a bacteriology laboratory at Mandapam Camp. The bacterial load of the culture system was monitored; it was expressed in terms of total aerobic plate count. The results of the tests carried out indicated the absence of any
pathogenic bacteria in the culture system at Mandarin shrimp hatchery pond. There was no disease outbreak in the stock maintained during this period.

About half of the zooplankton collected from the_userdata_error report consisted of copepod nauplii. A total of 0.208 mg were collected, of which 0.156 mg were shrimp larvae mainly nauplii and mysis larvae and the rest zooplankton nauplii. Maximum shrimp larvae were observed during May followed by December and January and calm season in March and July. Feeding experiments were also carried out using nauplii of Euphausia and Paraeuphausia collected from the same hatchery. In the case of Euphausia, an average of 13 mm growth was observed during the last 3 months. In Paraeuphausia, 14 mm growth was noted in the first month which reduced to 11 mm during the second month.

Experiments on the maintenance and development of rotifers underestimates a potential species for marine aquaculture is underway at Marshall laboratory.

Experiments were conducted on the culture of mixed rotifers: Euphausia sp. and Paraeuphausia sp. A steady culture of Euphausia sp. at a concentration of 15 to 25 million cells/ml as food to Paraeuphausia, and Chlorella sp. In coordination to and as sources were also maintained. Nutrient culture was maintained in diffused sunlight at a light intensity of 600-9000 lux and in temperature of 24-28°C during the course of the experiment. No aeration was provided.

Salina mesostoma was reared in seawater at 25°C. At an initial stocking rate of 12 and 60 cells/ml, an average 29-fold increase in number was obtained in 0.5 days (0.63-901 cells/ml) to 0.64 cells/ml. No aeration was provided. Initially the food concentration in the rearing medium was maintained at 1.8 million cells/ml, which was reduced to 0.22 million cells/ml due to logarithmic within 24 hrs. After 24 hrs, the cell concentration in the medium was reduced to 1.8 million cells/ml by adding pure diatom culture. Within 48-72 hrs, the concentration of cells in the medium reached an average number of 13.6 million (range 9.3 to 17.8 cells) per ml experiments on cultures of mixed rotifers: in 14 days salinity revealed that it could be successfully reared with the same efficiency in lower salinity ranges, as well as experiments are being carried out to estimate the proportion and composition of rotifers in mesostoma.
A recirculating larval culture system was developed for culture of phyllosoma larvae at Calicut. A 500 l cylindrical-conical FRP tank was fitted with an upwelling system. Filtered sea water was recirculated through the system. *Panulirus homarus* breeder collected from the sea was brought to the laboratory and maintained under controlled conditions. Active phyllosoma larvae obtained from the breeder were reared in the recirculating larval rearing tank. Larvae metamorphosed to second stage on 7th and 8th day and stage 5 on 45th day. Broodstock development of the spiny lobster *P. homarus* was initiated. Three berried females were obtained. Studies on fecundity, egg quality and hatchability of eggs from the captive broodstock were made to compare the results with berried females from the wild.

At Veraval, breeding experiments were initiated on *P. polyphagus*. In the initial experiments success was obtained to rear the larvae up to second stage. Phyllosoma larvae reared in hapas floated in a biofiltration system were healthier and active. At Calicut one berried specimen of *P. homarus* released 94,600 phyllosoma larvae.

34 specimens of *P. homarus* measuring an average of 49.6 mm CL and 108 g weight were stocked in a 2 t FRP tank. In another tank of similar dimension 15 lobsters measuring an average of 59.5 mm CL and weight 184.7 g were stocked. The molting frequency and growth rate were regularly recorded. Lobsters were fed daily with mussels (5-7% body weight). The environmental parameters were recorded daily. After 5 months, the average weight of lobsters in the first tank was 216.5 g, registering a growth of 108.5 g. The lobsters in the second tank weighed an average of 316.5 g, registering growth of 131.9 g. Fattening experiments showed that lobsters weighing an average of 25 g can be fattened to above 100 g in less
than 30 days. Lobsters below 100 g were sold at Rs.50/- per kg and thereof 100-200 g for Rs.250-300/-. It is profitable to fatten marginal lobsters of lower grade to the next higher grade to fetch higher price. Similarly lobsters weighing an average 175 g can be fattened to above 200 g in 35 days. Lobsters weighing above 200 g fetch Rs. 400-450/- per kg. An estimated 30 t of live juvenile lobsters weighing less than 100 g are exported from India annually. This needs to be banned.

Growth studies were also carried out on captive Panulirus polyphagus. Different sizes were stocked at varying densities (3-4 gms/l and 5-6 gms/l). Juveniles exhibited gregarious co-habitation more than the sub-adults and larger ones. Initially females showed faster growth; but after reaching maturity, males showed faster growth.

MARICULTURE OF CRABS (CF/CUL/1.11)


At Mandapam, experiments on the F₁ generation of P. pelagicus were continued and F₂ generation was produced from them. Three males and two females from the F₁ generation were reared under controlled conditions. One of the females of 182 days old (145 mm/150 g) moulted and successfully mated under captive conditions releasing 3.45 lakh zoeae. From these zoeae 333 baby crabs of F₂ generation were obtained. The same female laid eggs on four subsequent occasions. From these zoeae 1203 baby crabs of F₃ generation were also produced. 333 baby crabs of F₂ generation were further maintained under controlled conditions. After 81 days, they have grown an average size of 104 mm/75 g and 108 mm/72.5 g for males and females respectively. One of the female of F₃ generation at the age of 150 days, matured, moulted and mated under laboratory conditions and released 2 lakh zoeae. Thus F₁ generation of baby crabs of P. pelagicus produced in January 1996 were successfully maintained under controlled conditions and grown upto F₄ generation and the experiments were terminated in December 1998.

Two larval rearing experiments were carried out on Scylla tranquebarica. Brachionus rotundiformis (S-type) imported from Thailand was used for larval rearing. Two lakh zoeae were stocked in 5 t capacity larval rearing tanks. Larvae were successfully reared upto 5th zoal stage with 50% survival. In the second experiment 42% survival was obtained from zoea I to zoea IV and 75.7% survival from zoea I to zoeae III. Feeding experiments on the zoeae of P. pelagicus and S. tranquebarica revealed that they need feed of less than 40 μ size.
Experiments on the broodstock development and larval rearing of Scylla tranquebarica at Tuticorin are in progress.

Initial experiments carried out at Narakkal on the reproductive biology of Scylla tranquebarica gave encouraging results. An experiment for determining the role of 5-HT was undertaken and successfully completed. Female crabs nearing first maturity were selected and reared to average size of first maturity in a cage maintained in an earthen pond at Narakkal. After they reached first maturity they were injected with 5-HT over a programmed schedule and then reared up to 30 days. Results obtained showed high activity of 17B steroid dehydrogenase in the hepatopancreas of crabs injected with 5-HT. The external morphological characters of crab also were indicative of developing ovaries in the injected crabs and clearly indicated the effect of 5-HT on promoting 17B steroid dehydrogenase activity in the hepatopancreas and enhancement of maturation.

Experiments are continued for the development of an efficient feed for enhancing growth in crabs and shrimps making use of locally available feed ingredients.

S. tranquebarica cultured in cages and pens at Narakkal showed that pen culture was better for growout culture while cages were better for fattening.

During the period under report, crab farming/fattening technologies have been imparted to the farmers at Panambukad. 20 farms (20 to 50 cents) belonging to the scheduled caste families have been selected. Ponds were stocked with 400-450 crabs of 150-200 g size. Regular water exchange was done. They were fed with trash fish @ 10% of their body weight. Growth of the stocked crabs was regularly monitored. They attained a growth of 800 to 850 g in 5-6 months and the production from 20 to 50 cent farms varied from 200 to 250 kgs. The salinity during the culture period varied from 0 to 10.5 ppt.

INTENSIVE CULTURE OF BRINE SHRIMP (CF/CUL/1.12)

M. Rajamani and S. Lakshmi Pillai

During the period under report, experiments were carried out to compare the production potential of the exotic species of brine shrimp Artemia franciscana with that of the native species A. parthenogenetica. Experiments were carried out in one ton cement tanks and the animals were fed with rice bran. A. franciscana collected from a salinity of 120‰ was maintained at a salinity of 35‰. Duration of the experiment was for three months and sampling of the stock population was carried out on five occasions.
In these samples, the percentage of nauplii ranged from 25-50%, juveniles from 33.3 to 50% and adults 12.5% to 66.6%.

A survey was carried out at five stations around Tuticorin to study the distribution of the native and exotic species and the composition of various stages in relation to the prevailing conditions. At Karapad and Veppalodai A. franciscana alone was present in the collections and the size range of females was 6.02 - 9.1 mm and 7.2 - 11.2 mm respectively. Only A. parthenogenetica was available at Alankarathattu and Tuticorin salt and Marine chemicals Ltd. and the average size of females from these centres was 10.3 mm and 9.3 mm respectively.
Trawl was the chief gear for cephalopods at all the Centres except at Vizhinjam; bulk of the catch at this centre was taken by hook & line followed by boatseines.

When compared to the production in 1997, there was decline along all west coast centres, but there was increase along east coast centres.

Squids were dominant in the cephalopod landings along west coast (47-78%) and Chennai (52%) along east coast but cuttlefish was dominant (47-68%) along other east coast centres. The estimated landing of Octopus was 31 t at Mumbai, 92 t at Mangalore, 116 t at Kozhikode, 91 t at Mandapam, 233 t at Rameswaram and 49 t at Madras.

The entire squid landing along north-west coast, north canara coast, Kozhikode and Visakhapatnam was constituted by Loligo duvauceli. Doryteuthis sibogae occurred in small quantities in the landings at Mangalore, Malpe, Vizhinjam, Chennai and Kakinada. Sepioteuthis lessoniana formed 85% of squid landing at Mandapam and 72% at Rameswaram.

Sepia pharaonis and S. aculeata were the dominant species all along the coast. Sepiella inermis was also observed all along the coast. Sepia elliptica was caught along Gujarat and Kerala coasts. S. prashadi occurred in good quantities at Mangalore (268 t), Malpe (111 t) and in stray numbers at Chennai (6 t). S. brevimana was recorded only at Chennai and Kakinada.

At Veraval, Mangalore, Malpe and Vizhinjam mature squids were dominant almost throughout the year. Juvenile were recorded at Mumbai throughout the year. Peak breeding was observed during September-October off Kochi, whereas it was

![Cephalopod landings 1998 - West coast](image-url)
during November off Kozhikode. At other centres, mature squids were observed throughout the year but they formed less than 50%.

At Veraval, mature females of Sepia aculeata were observed during January, April and December. At Visakhapatnam mature cuttlefishes were dominant whereas at Kakinada immature ones were dominant. At Madras mature males and females were observed throughout the year.

Cephalopod landings at different centres in 1998

<table>
<thead>
<tr>
<th>Centre</th>
<th>Squids</th>
<th>Cuttlefishes</th>
<th>Octopus</th>
<th>Total</th>
<th>C/E</th>
<th>% AF</th>
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<td>1365</td>
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<td>3186</td>
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<td>Mangrol</td>
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<td>8</td>
<td>9742</td>
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<tr>
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<td>232</td>
<td>113</td>
<td>-</td>
<td>345</td>
<td>-</td>
<td>-</td>
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<tr>
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<td>86</td>
<td>-</td>
<td>304</td>
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<td>-</td>
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<td>44</td>
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<td>14</td>
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<tr>
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<td>418</td>
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<td>6</td>
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<tr>
<td>Rameswararam</td>
<td>315</td>
<td>492</td>
<td>233</td>
<td>1040</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>Chennai</td>
<td>1045</td>
<td>932</td>
<td>49</td>
<td>2026</td>
<td>38</td>
<td>6</td>
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<tr>
<td>Kakinada</td>
<td>277</td>
<td>352</td>
<td>-</td>
<td>629</td>
<td>10</td>
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<tr>
<td>Visakhapatnam</td>
<td>106</td>
<td>229</td>
<td>-</td>
<td>335</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Vizhinjam</td>
<td>372</td>
<td>103</td>
<td>-</td>
<td>475</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

C/E : Catch per unit (trawler day) in kg ; % AF : % in all fish landings; NA: Not available
INVESTIGATIONS ON THE RESOURCE CHARACTERISTICS OF BIVALVES AND GASTROPODS
(MF/RE/2)

P.S. Kuriakose, Sujitha Thomas, M.K. Anil, T.S. Velayudhan, V.K. Pillai, V. Kripa, P. Laxmilatha,
N. Ramachandran, K. Ramados, Boby Ignacious, P.V. Sreenivasan, P. Sreenivasan, K.S. Rao,
Shoij Joseph and Geeta Sasikumar

The production of mussel was estimated as 3697 t, oysters 492t, clam 38118 t and
gastropods 990t.

Mussel

Along the Malabar coast, spawning started in August and spat settlement commenced in September. Good spat settlement was noticed throughout the coast during this year. A survey to assess the availability of mussel seed along the coastal region from Quilon to Chavakad was conducted.

Edible oyster

Oyster exploitation in Navabander creek (Gujarat), was monitored during the year. C. gryphoides, C. rivularis and Saccostrea cucullata were observed in this creek. About 20-22 oysters per sq. m were observed towards the freshwater side and large number of dead ones were observed in the area where the salinity was 21 ppt. Towards the bar mouth, about 140-145 oysters/sq.m were observed; the salinity was 34 ppt in this area.

The length range of C. gryphoides during September-December was 60-94 mm with the average of 75.8 mm. Average weight was about 74.2 g and average meat weight 3.36 g and dry flesh weight 0.72 g.

Pearl oyster

A record collection (15 lakhs) of pearl oyster from the 'paars' off Tuticorin was obtained during the year. This revival of the pearl oyster fishery took place nearly after three decades. The nearest paar 'karal paar' was located at 12 m depth. About 900 pearl oysters were fished from 1 sq m area by SCUBA diving.

Clam

During the year an estimated 34322 t of Villorita cyprinoides were fished from Vembanad lake. The main spawning period was during April-May. Paphia malabarica was fished from February to September in Ashtamudi lake with a total landing of 2450 tonnes. About 54% of the total landing was during the month of March. At Chettuva, 163 tonnes of M. casta was landed during January-April and August-September. The size ranged from 14 to 30 mm.

Near the bar mouth of the Navibander creek, 150-300 individuals per square meter Meretrix sp were found. The dorso ventral length range was 24-33 mm with a shell-on weight ranging from 14 to 27 g. Average raw flesh weight was 1.56 g and dry flesh weight 0.35 g. However, there was no fishery for this
resource in the creek.

**Gastropods**

222 chanks (X. pyrum) were tagged and released at Kovalam, Vizhinjam. During the year, 12 egg capsules were obtained. The laboratory reared chanks attained growth of 23.68 mm from 8.6 mm (MSD) in 6 months. 270 chanks including juveniles and adults are reared in the laboratory at Mandapam with flowthrough water system.

In Dhamlej, Sutrapada and Hirakot near Veraval, Tibia sp is landed in bulk as bycatch

<table>
<thead>
<tr>
<th>Estimated production of Bivalves &amp; Gastropods at selected centres during 1998</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Species</strong></td>
</tr>
<tr>
<td><strong>MUSSEL</strong></td>
</tr>
<tr>
<td>P. viridis</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>P. indica</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
<tr>
<td><strong>OYSTER</strong></td>
</tr>
<tr>
<td>Crassostrea madrassensis Karwar</td>
</tr>
<tr>
<td>Saccostrea cucullata Karwar</td>
</tr>
<tr>
<td>C. madrassensis Quilon (Ashtamudi lake)</td>
</tr>
<tr>
<td>C. madrassensis Madras (Ennore estuary)</td>
</tr>
<tr>
<td>C. madrassensis Kakinada</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
<tr>
<td><strong>CLAMS</strong></td>
</tr>
<tr>
<td>Paphia malabarica Karwar</td>
</tr>
<tr>
<td>M. meretrix Karwar</td>
</tr>
<tr>
<td>M. casta Mangalore</td>
</tr>
<tr>
<td>V. cyprioides Cochin (Vembanad lake)</td>
</tr>
<tr>
<td>Paphia malabarica Quilon (Ashtamudi lake)</td>
</tr>
<tr>
<td>M. casta Ennore, (Madras)</td>
</tr>
<tr>
<td>M. casta Chettuva estuary</td>
</tr>
<tr>
<td>A. granosa Kakinada</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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</table>
GASTROPODS

<table>
<thead>
<tr>
<th>Species</th>
<th>Location</th>
<th>Quantity</th>
<th>Days Fishing</th>
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<tbody>
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<td>Xancus pyrum</td>
<td>Tuticorin</td>
<td>151,8050</td>
<td>125</td>
</tr>
<tr>
<td>Ficus sp</td>
<td>Madras</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Babylonia sp</td>
<td>Madras</td>
<td>9.7</td>
<td></td>
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<tr>
<td>Hemifusus</td>
<td>Madras &amp; Kakinada</td>
<td>100.3</td>
<td></td>
</tr>
<tr>
<td>Bursa sp</td>
<td>Madras &amp; Kakinada</td>
<td>80.5</td>
<td></td>
</tr>
<tr>
<td>Cerithidea sp</td>
<td>Kakinada</td>
<td>330</td>
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</tr>
<tr>
<td>Umbonium sp</td>
<td>Kakinada</td>
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<td></td>
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<tr>
<td>Thias sp</td>
<td>Kakinada</td>
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</tr>
<tr>
<td>Telescopium sp</td>
<td>Kakinada</td>
<td>5</td>
<td></td>
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<tr>
<td>Others</td>
<td>Kakinada &amp; Madras</td>
<td>217.5</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>789.5</td>
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</tr>
</tbody>
</table>

Estimated production of bivalves 1998

- P. mepisatoria
- N. costula
- C. madrasensis
- V. cyprinoides

At Tuticorin, one tagged chank released in 1992 was recaptured in July 1998. The length and weight difference was 8.9 mm and 78 g respectively. Though licenses for chank fishing were not issued due to poor clarity, the chank exploitation was carried out off Tuticorin.

Of lobster fishery from the reefs in gillnet fishing. The length ranged from 100 to 143 mm and the shell-on weight from 34 to 137.3 g. The shells are exploited for ornamental use.
SEED PRODUCTION AND RANCHING OF BIVALVE MOLLUSCS IN COASTAL WATERS
(MF/CUL/4)

K.K. Appukuttan, A. Chellam, S. Dharmaraj, K. Ramadoss, D. Sivalingam, P. Muthiah,
G.P.K. Achary and P. Laxmilatha

In view of the stringent quality standards of the EEC for farmed shrimps, an experiment was conducted at Cherai, Cochin by transplanting clams in shrimp farm-effluent reservoirs to test the feasibility of treating the effluent water through biofiltration by bivalves before discharging into the sea.

A reservoir collecting the effluent water drained from a shrimp pond was selected. About 250 kg at 500 No/sq m of the black clam, *Villorita cyprinoides* was stocked on 18.8.98. The water, soil and bacteriological parameters were monitored every fortnight, both in the shrimp pond and reservoir. However, due to incessant rains for a week during October, there was drastic fall in the salinity and all the clams died. This experiment will be continued incorporating mussels and oysters also to be able to identify the most efficient biofilters.

**Polyculture of shrimps and green mussel:** M/s. Tata Chemicals Limited, Gujarat made an attempt to culture green mussel in shrimp ponds. 100 kg of mussel seed were transported to Gujarat with assistance from Karwar RC of CMFRI and transplanted in the shrimp ponds. The objective was to establish the dual purpose of enhancing production through two crops ie shrimps and mussels, besides testing the biofiltration capacity of the mussels to reduce the level of suspended solids. In 81 days of culture, the average growth of 49.1 mm and average shell on weight of 9.48 g and meat conversion of 44% were obtained. An yield of 100-120 kg gross weight is expected by April end. Similarly a private farmer has also successfully cultured mussels in shrimp ponds in Goa.

**Tuticorin:** During the year, a total of 16 induced spawning and rearing experiments were conducted out of this, 6 experiments were successfully reared upto setting stage. Other experiments were discarded due to various reasons. A total of 2,32,220 edible oyster spat were produced in the hatchery and sent for further culture. A total of 2.62 lakhs of pearl oyster seeds were produced in the hatchery, out of which 50,000 seed were supplied to the Regional centre of CMFRI, Mandapam, along with 12.3 million veliger larvae.
Karwar: The feasibility of pen culture of the clam, *Gelonia* sp at Harwadan was initiated in early 1998. Growth, survival and environmental parameters were monitored at regular intervals.

The long-line mussel culture programme, initiated in 1988, in Belambar area with the involvement of a Fishermen co-operative society was terminated due to heavy infestation by barnacles causing slippage of mussels, poaching of mussel ropes besides heavy cyclonic winds. Thus Belambar area was found unsuitable for mussel culture.

In order to study the possibility of mussel culture in prawn culture ponds, a batch of six farmers from Goa were involved in a training programme on mussel culture at Karwar Research Centre during December 98. A long-line of 20 m with 16 floats and 15 seeded ropes were installed in Karwar Bay for further farming.

Mangalore: The experiment on mussel culture in the Mulky estuary revealed the unsuitability of the region during monsoon months, due to drastic fall in salinity causing the mussels to drop off.

About 1.5 t of mussel, cultured in the earlier experiment in the Mulky estuary was harvested in June during a "Mussel harvest Mela".

During May 98, a successful attempt was made to transport 100 kg live mussels to Goa to assess the market response. The mortality rate was found to be 25% in 24 hrs during the transport. However, the mussels fetched only low price in Goa, whereas the response in the local market at Mangalore was good for shell-on mussels.

Visakhapatnam: A survey on the distribution of edible oyster, *Crassostrea madrasensis* indicated the patchy distribution of a few oyster beds in the estuarine areas. The spat settlement studies indicated that *C. madrasensis* showed good settlement in July and August period. The samples obtained by the end of September ranged from 10 - 15 mm in size which attained 30-40 mm at the end of December, 98. The edible oyster bed distributed in the estuarine area of Bhimili is being utilised for studying the feasibility of oyster culture.

Tuticorin: Punnakayal area was selected for testing technological feasibility of clam culture. Initially in the month of May a batch of about 1500 clam seed was transplanted at the predetermined area along with 100 numbers of shell cultches with spat of edible oyster and the growth and survival were monitored. The edible oysters survived in the area to the extent of 100% and also registered...
good growth. The clam seed could not be traced in the following months due to total mortality. Another batch, consisting of 250 numbers of pearl oysters of the size range 35-40 mm collected from the wild was transplanted at Punnakulai estuary in velon screen bags in the month of September. Data on growth and the environmental conditions were collected.

Madras: Since March 1998, clam seed of Meretrix casta were transplanted repeatedly in the culture site at Pulicat in an attempt to establish a new clam bed and this encouraging results. Growth and survival of the transplanted clam seed were monitored. Observations on the condition of gonads indicated that spent individuals were more common among both males and females. Ripe and maturing stages were found in equal numbers. Regular data on the environmental parameters were obtained to study the hydrological conditions prevailing in the culture site.

At Tuticorin 272 strings with spat set on shells were transferred from the hatchery to farm. 82.75 kg of oyster meat was sold fetching Rs.4112.50 and 5 kg of oyster meat was used for demonstrations.

Maintenance and Management of pearl oyster farm and pearl oysters: The stock in pearl oyster farm at the Mandapam Regional Centre was replenished with oysters collected from the wild. A total of 20 sea trips were made to the natural pearl oyster beds off Tuticorin and 3.53 lakhs of oysters of the size range 20-46 mm DVM were collected by SCUMA during
and transported by road to Mandapam Camp and stocked in the farm in different types of culture containers. The farm was also stocked with hatchery produced spat (5-22 mm FWML). The total stock of pearl oysters at the farm is presently 0.85 million.

**Spawning, larval rearing and spat production:** A total of 27 successful spawnings occurred in the hatchery and a total of 56 lakhs straight hinge veliger larvae were obtained, of which 52 lakhs of spat (4-6.0 mm) were raised and transported to the farm for nursery rearing.

**Nucleus implantation and pearl production:** A total of 43,798 oysters were operated and implanted with nucleus of 8 mm dia (35,606 nos), 6 mm dia (8,154 nos) and 5 mm dia (3,938 nos). These oysters are reared in the farm for pearl production. The separated oysters were harvested for pearl after a period of 9-10 months post-operative culture. Out of the 58,311 nucleated oysters, only 37,714 (65.8%) oysters were found alive at the time of harvest and on harvest, these oysters yielded 448 pearls of various quality viz. A grade-56, B grade-74 and C grade-318.

**Ashtamudi Lake (Dalavapuram, Quilon):** Experiments were carried out to upgrade the technology of edible oyster culture. The feasibility of culturing oysters by cementing individual oysters onto split bamboo poles was initiated during April. The main objective was to grow large size uniformly shaped oysters so as to market it in live condition and shell-on half-shell, which are in high demand in metro cities and highly priced in the export market.
Oysters of length 35 to 85 mm were collected from natural bed, declumped, cleaned, measured and cemented onto split bamboo pieces (1.5 m length, 5 cm width). To ensure proper fixing, iron nails were driven at intervals of 10 cm into the bamboo pole before placing the cement and fixing the oysters on it. After curing for 6 hrs, the bamboo strips with oysters were hung horizontally from the rack. Small-sized oysters of length 15 to 25 mm were stuck using "Flukwik instant" to test the efficacy of the adhesive. They were also hung from the same rack.

The growth and survival of the cemented oysters were recorded. The survival percentage after 35 days was 69%, loss due to detachment 19%, loss due to natural mortality 12%.

The growth rate of oysters grown by the ren method were also monitored. Growth of two different recruits of oysters i) oyster spat settled in March 1997 and ii) oyster spat settled in December 1997 were monitored. It was observed that large size oysters of length 128 mm total weight 175 g and meat weight 17.5 g can be obtained if the duration of the cultured period is extended to 14-15 months. However, even small oysters were noted in the ren indicating the wide variation of oyster size composition in ren.

**Oyster Harvest:** The oysters grown in the CMFRI demonstration farm at Dalavapuram, Quilon were harvested and sold for Rs.3,700. This was obtained from the sale of 74 kg of heat shucked oyster meat to the Institute staff at a subsidised rate of Rs.50/kg. Technical guidance was given to Shri Vincent Mukadan, an oyster farmer, to harvest the oyster produced in his farm. Efforts were also made to sell the oyster meat in the local markets and IFP. In this regard, Rs.25,292 realised from the sale of 404.5 kg oyster meat was handed over to Shri V. Mukadan.

**Maintenance/renovation of farm:** The demonstration oyster farm was reconstructed by replacing the old broken bamboos. However, in view of its short life, due to boring/fouling, an attempt was made to renovate the structure by replacing the bamboo poles with PVC pipes of 2" dia and 2.5 m length, filled with concrete. Oyster ren were suspended from these poles. The results are encouraging, since there is less fouling/boring and therefore more durable and permanent.

**Mussel farming:** Green mussel (the average length was 21.6 mm and weight 1.0 g) collected from Thankassery near Port Quilon, were seeded on 20 ropes of 1 m length nylon rope and 1 rope with brown mussel were seeded and suspended from the grow out structure. Mussel seed collected from Narakkal were also used, however they lost due to slipping.

**Transplantation of the Corbiculid clam:** About 50 clams (Geloina bengalensis) which were reared at Fisheries Harbour Laboratory were transplanted in, August, 1998, in Ashtamudi Lake for accelerating gonad maturation. After taking length and weight
measurements they were stocked in netlon cages. The cages were kept just above the estuarine substratum. Growth and survival of these clams were monitored regularly.

**Narakkal (Mussel culture-raft method)**

**Demonstration:** Open sea mussel culture was initiated at Narakkal as a demonstration programme with the involvement of four fishermen. The fishermen were trained in fabrication of raft and mussel seeding. The bamboo raft of 25 sq. m (5 x 5 m) was moored off Narakkal at a depth of 4 to 5 m with the help of the fishermen.

For mussel seeding also local women were given a training in October 1998 by KVK, Narakkal and after training the women actively participated in mussel seeding. Mussel seed was collected from the intertidal zone of Narakkal beach. Mussel seed (average length 27.1 mm; breadth 15.6 mm; depth 9.65 mm, total weight 2.45 g; meat wt 0.6 g) were seeded at a density of 1.5 kg/m length of nylon rope. About 58 seeded mussel ropes of 12 mm diameter of length 3 m were seeded and suspended from the raft.

In November due to the twisting of anchor ropes on the seeded ropes due to rough sea condition intense seed slipping was observed. Mussel seed was stocked in nylon bags to reduce labour and time. Initially nylon net tubes of length 1.5 to 2 m were made. In each tube, mussel seed collected from Narakkal were stocked in 5 to 6 pouches separated by knots tied at equal intervals. The stocking density was 200 g/pouch. 28 net tubes (each with 5 to 6 pouches) were prepared using 33.2 kg of seed. These nylon bags were suspended from the raft in December 1998.

**Experiments on seeding density:** An experiment to study the effect of seeding density on seed slipping and growth was initiated. Three stocking densities a) 500 g (250 nos) b) 750 g (375 nos and c) 1000 g (500 nos) per meter were tried. After 45 days it was observed that the density of seed in the three trials were 130, 215, and 290 nos/m respectively.

Another experiment to study the growth rate of mussel by direct observation was also started in October 1998. Individual mussels were measured and kept in separate velon screen pouches. Along with this, groups of 10 mussels (replicates) which were measured individually were kept together in separate pouches. The average growth rate will be observed and compared with the first experiment. In December it was noted that there was fresh settlement of mussel seed on the velon screen pouches.
SELECTIVE BREEDING OF BIVALVES AND EVALUATION OF PERFORMANCE
BY FARM TRIALS (MF/CUL/12)

T.S. Velayudhan, P.S. Kuriakose, V. Kripa, K.S. Mohamed, P.Laxmilatha and C.P. Gopinathan

Samples from Ezhikara '2' and Nettoor shown highest mean thickness of the shell at 'C' point region 2.627 mm and 1.732 respectively, followed by Ezhikkara '1' and Muhamma '1' 1.79 and 1.291 mm respectively as per samples collected from unfished sites. In the case of 'AS' anterior sinus the mean thickness at Ezhikkara '2' 2.331 and Nettoor 1.926 mm observed respectively. The selected areas of the shells thickness shown a decreasing trend 1.303 mm and 1.128 mm, 1.108 mm at Ezhikkara '1' Mohamma '2' and '1' respectively. Regarding 'PS' posterior sinus the highest mean at Ezhikkara '2' 1.845 mm and at Ezhikkara '1' 1.220 mm respectively followed by 1.011 mm at Nettoor respectively, followed by Muhamma '2' 0.959 mm and Muhamma '1' 0.925 mm.

At the outset Ezhikkara '2' shells shown highest mean thickness 2.627 mm at 'C', 2.331 mm a 'AS' and 1.845 mm at 'PS' respectively showing possible thickness for these shells for further study for the left valve of Villorita cyprinoides.

CULTURE OF CEPHALOPODS (MF/CUL/13)

D. Sivalingam, Shoji Joseph and M.K. Anil

Breakthrough in rearing of cuttlefish achieved: Laboratory rearing, breeding and larval development of Sepiella inermis, was achieved at the Tuticorin Hatchery.

Egg clusters of S. inermis collected from Manapad during September, were hatched in the laboratory. Of the 653 hatchlings released, 360 survived up to day 24 and attained a size of 11-18 mm (ML). After 75 days, 51 juveniles survived, with a size range of 57.23 mm (ML) and mean weight of 37.9 g.

These laboratory reared Sepiella inermis attained maturity and started egg deposition from the 75th day onwards, and 100% hatching was obtained. The hatching commenced 13 days after egg laying. This is the first time that the life cycle of S. inermis was completed in the laboratory. The F1 generation reached a mean size of 16.2 mm (ML) in 31 days. The hatchlings were fed with mysids and Acetes.

A total of 12,400 hatchlings of size 6.00
mm, as a result of continuous breeding of the laboratory reared S. inermis, were ranched off Hare Island at a depth of 1.3 m.

Hatchling of eggs collected from Periyathalai on 27.4.98, also occurred on 8.5.98. Of the 93 hatchlings released, successive mortality occurred up to day 69. A mean length of 53.56 mm was recorded in 70 days.

*Sepioteuthis lessoniana*: Egg clusters were collected from Periyathalai and 1240 hatchlings were obtained. Initial mortality was high. On day 68, the juveniles measured a mean size of 58.4 mm (ML), and a mean weight of 22.6 g. Total mortality occurred by August.

SEED PRODUCTION AND PEARL CULTURE IN THE ABALONE Haliotis Varia (MF/CUL/14)

A.C.C. Victor, A. Chellam, S. Dharmaraj and Boby Ignatius

Abalones were induced to spawn profusely and the development of larvae was traced. However, settlement did not take place. Different seaweeds such as Ulva, Thalamoporella Hypnea and Cymadocea were given as food, of which Cymadocea was found to be the most acceptable to the abalones.

STANDARDISATION OF TECHNIQUES IN ONSHORE PEARL CULTURE (MF/CUL/15)


After a series of experiments in 12 t cement tanks, the technique of captive maturation and breeding of the pearl oyster is standardised at Visakhapatnam. It has been inferred that pearl oysters at low density (about 12 - 15/m) with 100% daily raw sea water exchange, will induce maturation in about 10 weeks. They can be reused for spawning 2-3 times at regular intervals. Good quality pearl oyster broodstock is maintained at two private hatcheries. The first batch of spat, raised from July spawning have reached a mean DVM of 30 mm by December with least mortality. A few pearl oysters were implanted with 3-5 mm nuclei. The first trial batch of pearls are expected in March 1999. With the reconstruction of the hatchery buildings and other infrastructure facilities, both units are expected to reach commercial production by June, 1999. The feed production, species composition and their concentration in the sea water has been standardised. An average concentration of 50,000 cells/ml is being maintained, irrespective of other environmental parameters. Thus, salinity during the year ranged from 18 to 35 ppt which has not caused any problem for rearing of pearl oyster or feed (Chaetoceros calciatans, Isochrysis galbana and Nanochloropsis salina) production.
DEVELOPMENT OF LOW-COST TECHNOLOGY SYSTEM FOR SEA FARMING OF PEARLS AND MUSSELS (MF/CUL/16)

G.P. Kumaraswamy Achary, Rani Mary George, S. Jasmine, M. Sivadas and K. P. Syed Koya

Observations made at Muttom, Colachel, Kadiyapatnam revealed the availability of Pinctada fucata, indicating the suitability of these areas for shallow-bottom pearl farming.

A new raft was launched and broodstock of oysters were transferred along with spat collectors and hapa. Good growth was recorded throughout the period of observations. Two new hapas were again introduced in April, with broodstock of oysters. 35 additional spat collectors were suspended in November.

The fabrication and operation of the high-density-stocking pedestal cages were demonstrated at Tuticorin centre to trainees during 27-29 March and a cage was launched in the open sea at Arokiapuram fishing village and in April, the broodstock of pearl oysters were stocked in the cage. About 10000 Pearl oyster spat collected from the natural beds off Tuticorin were transported to Vizhinjam on 8.10.98. Good survival and growth was observed.

For maintaining and fattening lobsters as a side-crop in the multi-crop system for increased income, the lids of the high density stocking cages were slightly modified for periodic stocking of mussel as feed for the lobsters and it was observed that lobsters of around 150 mm size grew to 180 mm size (8 nos = 1 kg) within one month.
VI. FISHERY ENVIRONMENT MANAGEMENT DIVISION

During the period under report the Division was engaged in a total of 12 Institute research projects and 1 sponsored research project.

BIOLOGICAL PRODUCTIVITY OF THE INDIAN EEZ IN RELATION TO OCEANOGRAPHIC PARAMETERS (FEM/SS/1)

V.N. Pillai, V.K. Pillai and K.G. Girijavallabhan

Environmental data collected onboard FORV Sagar Sampada for validation of the Modular Optoelectronic Scanner (MOS) during April 1998 were analysed for the preparation of Algorithm in collaboration with Space Application Centre, Ahmedabad. Averages for various parameters such as seawater temperature, salinity, dissolved oxygen, nutrients, chlorophyll and zooplankton were arrived at by pooling of seatruth data collected by the erstwhile FAO/UNDP Pelagic Fisheries Project (1971-78), Cadalim series of vessels (1980-1998) and FORV Sagar Sampada (1990-1998) for the southeastern Arabian Sea region. The project undertaken in collaboration with the Space Application Centre aims at the utilisation of surface chlorophyll data obtained from satellite imageries (IRS P3 and OCEANSAT) for the preparation of PFZ advisories along with SST data in view of its proven relationship with herbivores like oilsardine, which exhibit wide fluctuations in their occurrence as well as abundance from year to year.

INVESTIGATIONS ON ENVIRONMENTAL PARAMETERS OF INSHORE WATERS IN RELATION TO FISHERIES (FEM/ES/1)

C.P. Gopinath, V. Chandrika, S. Muthusamy, T.S. Naomi, V.V. Singh, P.K. Krishnakumar, S. Krishna Pillai, M. Rajagopalan, K. Vijayakumaran and P.T. Sarada

The studies on the environmental parameters of inshore waters in relation to fisheries were continued at Cochin, Vizhinjam, Mangalore, Karwar, Mumbai, Minicoy, Kakinada, Mandapam, Tuticorin and Visakhapatnam. The salient features are given in the following table:
### Ranges of Fishery Environmental Parameters at different Centres along Indian Coast-1998

<table>
<thead>
<tr>
<th>Centre</th>
<th>SST °C</th>
<th>Diss. Oxygen (ml/l)</th>
<th>Salinity (ppt)</th>
<th>Nitrites (µg at/l)</th>
<th>Nitrates (µg at/l)</th>
<th>Phosphates (µg at/l)</th>
<th>Silicates (µg at/l)</th>
<th>Prim. Produ. (mg C/m²/day)</th>
<th>Zoopl. Biomass (ml/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cochin</td>
<td>23.5</td>
<td>32.5</td>
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<td>0.24</td>
<td>1.56</td>
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<td>3.96</td>
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<td></td>
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</table>
ECOLOGICAL INVESTIGATIONS ON THE INTERTIDAL AND SURF ZONES OF THE KERALA AND KANYAKUMARI COASTS IN RELATION TO FINFISH AND SHELLFISH SEED AND JUVENILE RESOURCES (FEM/ES/6)

G.S. Daniel Selvaraj, Molly Varghese, S.Krishna Pillai and S. Jasmine

During the year, monthly surveys were carried out at Kozhikode, Kochi, Vizhinjam and Kanyakumari along the surf regions and adjoining estuarine systems to collect data on water temperature, salinity, dissolved oxygen, nutrients and primary productivity. Information on fish and prawn juveniles was also collected from the local landing centres. The values of phosphate, nitrite and nitrate were high around Kochi and the highest values were recorded during June-July. The primary productivity was high towards Kozhikode in the surf zone and in the backwater zone. The availability of juveniles of fishes was less than the previous year. Juveniles of *M. dobsoni* were common in all the Centres throughout the year, and those of *R. indicus, M. monoceros* and nonpenaeids showed decline during 1998.

Investigations were also carried out in the mangrove area of Mangalavanam (Cochin) during the year. Dissolved oxygen values were less than 2.5 ml/l during the south-west

### Monthly hydrographic data for the surf region at Cochin during 1998

(average of Kannamaly, Manassery and Fort Cochin stations values)

<table>
<thead>
<tr>
<th>Months</th>
<th>Surface temp.(°C)</th>
<th>Salinity (ppt)</th>
<th>Diss.Oxygen (ml/l)</th>
<th>Nutrients (µg at/l)</th>
<th>Net Prim. Product. (gc/m³/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
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<td>33.2</td>
<td>4.36</td>
<td>0.70</td>
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<td>February</td>
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<td>March</td>
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<td>April</td>
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<td>34.3</td>
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<td>May</td>
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<td>30.3</td>
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<td>June</td>
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<td>19.5</td>
<td>3.97</td>
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<tr>
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<td>23.2</td>
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<td>November</td>
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<td>29.3</td>
<td>3.13</td>
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<td>December</td>
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<td>31.0</td>
<td>3.08</td>
<td>2.14</td>
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</table>

### Quarter-wise hydrographic data for the surf region of the sea at Cochin during January-December 1998

<table>
<thead>
<tr>
<th>Months</th>
<th>Surface temp.(°C)</th>
<th>Salinity (ppt)</th>
<th>Diss.Oxygen (ml/l)</th>
<th>Nutrients (µg at/l)</th>
<th>Net Prim. Product. (gc/m³/d)</th>
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<tr>
<td>I Qr.</td>
<td>30.8</td>
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<td>4.04</td>
<td>1.00</td>
<td>0.52</td>
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<td>II Qr.</td>
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<td>III Qr.</td>
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<td>IV Qr.</td>
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</tbody>
</table>
and postmonsoon months while the adjacent Cochin backwater showed average values of more than 3.5 ml/l. The rate of photosynthetic production of oxygen was found not enough to cope up the loss of oxygen by algal respiration and bacterial action in the 'Mangalavanam' waters indicating that the 'Mangalavanam' does not provide a self-replenishing environment for the healthy survival of aerobic organisms.

SEAWEED INVESTIGATION: RESOURCES ASSESSMENT OF SEAWEEDS AND THEIR CULTURE (FEM/SW/1)

V.S.K. Chennubhotla, N. Kaliaperumal, Reeta Jayasankar and Gulshad Mohammed

The agarophyte Gracilaria edulis cultured in the main laboratory at Visakhapatnam in fibre glass tanks showed a 3-fold increase in weight. The culture of Gracilaria verucosa and G. corticata also showed good growth.

Experiments were conducted at Mandapam with G. edulis by penetrating the seed material with 0.2 mg/l concentration of Inositol and further treatment of seed material with same concentration of Inositol for 12 hrs at different intervals. Control experiment was also maintained. Maximum increase in bio-mass (36%) was obtained in plants treated at intervals of 3-6 days.

G. edulis collected from Hare Island was grown in fiberglass tanks at Tuticorin. The initial weight was 2.8 kg. The average length of the plants was 16.6 cm. Due to the growth of epiphytic algae Chaetomorpha antennina, there was not much growth. The plants weighed 3.2 kg and measured 18.6 cm long after 29 days.

A 12-fold increase of weight of Acanthophora specifera was obtained in 70 days culture in Minicoy lagoon. Ropes on remnants of seed material of this species were introduced for culture and after 42 days a maximum of 36-fold increase was obtained and minimum of 30.1 fold increase in 36 days.

MONITORING THE STATE OF HEALTH OF COASTAL WATERS IN RELATION TO POLLUTION AND AQUACULTURE (FEM/MP/1)

V.K. Pillai, P. Krishnakumar, M. Rajagopalan, P. Kaladharan, D.C.V. Easterson, N.S. Asha and S. Krishna Pillai

Cochin

Regular environmental monitoring was carried out in the inshore areas of Cochin. Data on temperature, dissolved oxygen, and nutrients were collected at surface and bottom from four stations. No significant variations were noticed during the period. Analysis of sediments revealed an increasing trend in selected metals especially in the in-shore area during November and December 1998.
An instance of large scale fish kill in Chithrapuzha, Cochin estuary during July 1998 was investigated jointly by the Scientists of CMFRI and GIFT and the report was submitted to the District Collector, Ernakulam as required by the Govt. of Kerala. The investigations revealed that high levels of free ammonia (up to 102 ppm) in the water which would have originated from the industrial effluents could be the causative factor for the large scale fish mortality.

As part of the pollution monitoring programme, the total humic acid (THA) was estimated in water and sediment. THA levels in water ranged from nil to 9.55 ppm at surface and nil to 9.71 ppm at the bottom. THA is of terrestrial origin and is considered as natural chelator, stimulant of phytoplankton growth and pollution abatement agent.

Environmental monitoring in the Cochin estuarine area was carried out for Cochin Port Trust under the consultancy programme. Regular data on 12 parameters were collected from 4 stations on a fortnightly basis.

Mangalore

The Biochemical Oxygen Demand (BOD), residual chlorine, ammonia, ammoniacal nitrogen, sulphide, cyanide, grease and oil, colour and odour were determined from the sea water samples collected from 3 stations off Chithrapur near the marine outfall of a refinery. Chlorophyll a content and zooplankton biomass were estimated from the marine outfall and compared with such data from a reference site.

The results showed that the mean Ammonia content near the marine outfall was 0.011 mg/l and mean ammonical nitrogen content 0.008 mg/l. Mean BOD residual chlorine and total suspended solids (TSS) near the marine outfall were 0.92 mg/l, 0.051 mg/l and 131.4 mg/l respectively.

Mean zooplankton biomass near the marine outfall was 10.6 ml/m² and mean chlorophyll a content was 0.685 mg/m². Zooplankton biomass and chlorophyll a in seawater and the heavy metal concentration in marine biota in the marine outfall were within the normal range. There was no increase in heavy metal accumulation in marine organisms in the above site from 1996 to 1999.

Oil pollution: During the first week of June '98, weathered crude oil (tarball residues) settled on the beaches of Dakshina Kannada coast, as during the same season of the previous year. During this season, the intensity of tarball settling was less compared to 1997. The origin of the tar residues may be from offshore spillage in and around the major oil tanker routes in the Arabian Sea. During the monsoon season the surface currents in the Arabian Sea are towards the Indian coast. Therefore, with the onset of southwest monsoon, the strong westerly wind and ocean surface current must be carrying lot of tar-like oil residues towards the coast. Observations on the beaches along the west coast of India indicate that tarball deposition occurs between may and October when shoreward component of the current is strong.
Comparison of zooplankton biomass at the marine outfall of an oil refinery of Chithrapur, Mangalore with zooplankton biomass at a control site.

<table>
<thead>
<tr>
<th>Month</th>
<th>Reference site (ml/m³)</th>
<th>Marine outfall (ml/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr. 98</td>
<td>1.955</td>
<td>1.34</td>
</tr>
<tr>
<td>May</td>
<td>4.86</td>
<td>2.69</td>
</tr>
<tr>
<td>Oct.</td>
<td>9.46</td>
<td>0.42</td>
</tr>
<tr>
<td>Nov.</td>
<td>90.8</td>
<td>16.3</td>
</tr>
<tr>
<td>Dec.</td>
<td>16.6</td>
<td>13.3</td>
</tr>
<tr>
<td>Jan.99</td>
<td>15.18</td>
<td>5.59</td>
</tr>
<tr>
<td>Feb.</td>
<td>14.8</td>
<td>4.96</td>
</tr>
<tr>
<td>Mar.</td>
<td>6.4</td>
<td>20.5</td>
</tr>
<tr>
<td>Mean</td>
<td>20.0</td>
<td>8.1</td>
</tr>
</tbody>
</table>

Comparison of chlorophyll a content in seawater at the marine outfall of an oil refinery off Chithrapur, Mangalore with chlorophyll a content at a control site.

<table>
<thead>
<tr>
<th>Month</th>
<th>Reference site (ml/m³)</th>
<th>Marine outfall (ml/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr. 98</td>
<td>0.298</td>
<td>0.349</td>
</tr>
<tr>
<td>May</td>
<td>0.258</td>
<td>0.505</td>
</tr>
<tr>
<td>Oct.</td>
<td>0.273</td>
<td>2.218</td>
</tr>
<tr>
<td>Nov.</td>
<td>0.281</td>
<td>0.591</td>
</tr>
<tr>
<td>Dec.</td>
<td>0.237</td>
<td>0.348</td>
</tr>
<tr>
<td>Jan.99</td>
<td>0.247</td>
<td>0.334</td>
</tr>
<tr>
<td>Feb.</td>
<td>0.194</td>
<td>0.447</td>
</tr>
<tr>
<td>Mar.</td>
<td>0.258</td>
<td>0.331</td>
</tr>
<tr>
<td>Mean</td>
<td>0.256</td>
<td>0.640</td>
</tr>
</tbody>
</table>

Tuticorin

Regular pollution monitoring programme at Kayalpatnam and Karapad Bay were carried out. In the Karapad Bay low pH and salinity were recorded during December due to the onset of Northeast monsoon. The recorded pH and salinity values ranged between 3.26 to 7.84 and 20.62% to 37.13%o respectively. Lowest dissolved oxygen value (1.486 mg/l) was recorded in the open sea during November. At Karapad Bay, turbidity was high (range 4.5 to 78.70) during June & July '98. At Kayalpatnam the water was acidic (pH 2.44) during August '98 in the inshore area probably due to the industrial effluents discharged. However, in the open sea normal pH (8.3) was recorded.

Biodiversity Studies (FEM/AR/1)

RA. Thomas

As part of the investigations under the national project entitled 'Drugs from the Oceans', funded by DOD with CDRI and the nodal institute, the various Research Groups collected sponges and gorgonids from different parts of Indian coast and passed on to CMFRI for identification.
The Regional Research Laboratory, Bhubaneswar, made an extensive survey of marine organisms off Orissa coast at depths of 90-110 feet. About 55 species of sponges and 10 species of gorgonids were identified in these collections which is the first of its kind from greater depths off Orissa coast. This team made an extensive study on microbes/fungi which grow in association with the identified species and identified areas where both drug industry/other industries could be benefitted. They include:

1. Discovery of many new microbes useful in production of maltose sugar.
2. Microbes useful in the digestion of cellulose.
4. Enzyme to detect low level of environmental organophosphorus.
5. Enzyme useful for the removal of urethane from alcoholic beverages.
6. A new strain of bacteria useful in controlling pathogenic fungi in rice/other plant and

SANITARY SIGNIFICANCE OF FAECAL COLIFORMS IN SELECTED COASTAL ENVIRONMENTS GROWING MARINE SHELLFISHES (FEM/MB/1)

V. Chandrika

Investigations were carried out on TPC and Coliforms from Dalavapuram, Cherai and Chettuva using water and sediment samples to find out whether any correlation exists between contaminants (E.coli and TPC) and pathogenic organisms eg. (Salmonella).

Of the 28 samples analysed, 25 were positive for coliforms and 3 negative. The E.coli count of the waters ranged from 0.5 x 10^4 per 100 ml to 9.6 x 10^5 per 100 ml.

MARICULTURE OF LIVE FEED ORGANISMS (FEM/LF/1)


Eight species of microalgae were maintained at the Algology laboratory as stock culture. Utilising the inoculum of this stock culture, mass culture of required species
was carried out for providing as live feed for zooplankters (Rotifer, cladoceran) and rearing the larvae of molluscs, crustaceans and fishes.

At the FHL, the procedures were standardized for the estimation of available chlorine from bleaching powder, sodium hypochlorite solution as well as culture water and this method would be very useful for the culture of livefeed organisms under laboratory conditions. The experiments were carried out to study the effect of farm chemicals (Ammonium sulphate, urea and super phosphate) in rotifer culture system.

**Vizhinjam:** Mass culture of *Chlorella* and *Tetraselmis* was carried out in perspex tanks under laboratory conditions. Making use of inoculam of these microalgae including Isochrysis, the stock culture of rotifers was maintained under laboratory conditions.

**Mandapam:** The mass culture of zooplankton viz. Rotifer (*Brachionus plicatilis*), *Moina* and *Artemia* were maintained to feed the different stages of crustaceans and finfish larvae. The high saline (60-70%) *Chlorella* culture was also maintained to feed *Artemia salina*.

**Visakhapatnam:** Stock culture of four species of microalgae was maintained and they are being used as live feed for larvae and brood stock of fishes, crustaceans and molluscs grown in hatcheries.

**Minicoy:** Mass cultures of *Chaetoceros* sp. *Tetraselmis* sp. *Isochrysis* sp. *Nannochloropsis* sp were undertaken using potassiam nitrate, sodium orthophosphate, EDTA and Sodium silicate. Both for marine and freshwater *Chlorella* culture, commercial fertilizers were used. Both marine and freshwater *Chlorella* had grown well.

**Moina** sp and Rotifer were cultured using *Chlorella* as food.

**Cochin:** Fine powder of the seaweeds *Gracilaria edulis* and *Ulva lactuca* was given as food for bivalves and the rate of feeding was monitored. *G.edulis* was incorporated as one of the ingredients and as a binder compounded feed was prepared for shrimps and fish.

**CONSERVATION OF MARINE TURTLES (FEM/MT/1)**

M. Rajagopalan, S. Krishna Pillai and K.M.S. Ameer Hamsa

The phenomenon of “arribada” or mass nesting of the olive ridley *Lepidochelys olivacea* along the Gahirmatha beach Bhitarkanika Wildlife Sanctuary, Orissa did not occur during the 1998 season. Though the exploitation of sea turtles has been drastically reduced, a major threat which still persists along the Gahirmatha beach is the incidental catch of adult turtles in fishing gears like gill net and trawl net. During the 1998 season, around 16,000 olive ridley carcasses were washed ashore along the Gahirmatha beach.
which was due to entangling in fishing operations.

The ICAR ad-hoc research scheme 'Conservation of Green Turtle' *Chelonia mydas* was initiated in August 1998.

The Ministry of Agriculture, (Fisheries Division) approved the funded project entitled 'Study on distribution, incidental catch, mortality of sea turtles in Indian waters and efficacy of turtle excluder device at selected centres'; this project was initiated in November 1998.

**BREEDING, SEED PRODUCTION AND SEARANCHING OF SEA CUCUMBER, HOLOTHURIA SCABRA**(FEM/HOL/1)

D.B. James and P.S. Asha

During the year 1998, the seed of *Holothuria scabra* produced during earlier years was grown in concrete rings for the first time in a prawn farm. The average weight increased from 22 g to 120 g in 10 months.

The bottom of the concrete ring was covered by a velon screen to prevent the juveniles from burrowing and escaping. The top of the concrete ring was also covered by velon screen to prevent the entry of other organisms into the ring. The concrete ring was set on an even ground at the corner of a pond in a prawn farm. The concrete ring was filled with surrounding mud from the prawn farm which is organically rich. The organic carbon of the soil was estimated at the time of stocking. Every month the juveniles were examined to find out the mortality and also the increase in average weight.

Juveniles of average weight 67 g were stocked in a prawn farm in June, 1998 and this average weight increased to 284 g in six months giving an increase of 36 g per month.

It is seen that if the brood stock material is maintained for more than one year in the laboratory, they become shrunken. In order to bring them to mature condition next season some broodstock material of average weight 168 g was stocked in a separate concrete ring in October, 1998; the average weight increased to 260 g in two months time. The average weight increase per month was 46 g. The average weight of brood stock material in the control tank was 174 g and the average weight of the brood stock material subjected to light and dark method was 223 g. The brood stock material grown in the prawn farm reached maximum average weight of 260 g. It is expected that they would reach the full size by March, '99.
ULTRASTRUCTURAL STUDIES OF MARINE ORGANISMS (CMFRI/IDP/EM/1)


The EM facility was extended to the Senior Research Fellows of the Institute and to outside institutions such as School of Environmental Studies, CUSAT, Cochin, Centre for Materials for Electronics Technology, Dept. of Electronics, Govt. of India, Trichur, for sample processing and block making for TEM and SEM.

PREPARATION OF A GUIDE FOR EGGS AND LARVAE OF INDIAN MARINE FINFISHES (CMFRI/IDP/EL/2)

K.J. Mathew, P. Bensam, N.G. Menon, P.N.R. Nair, Grace Mathew and T.S. Naomi

The list of 515 species on which details of eggs and larvae were collected was further screened for making a final list of those species occurring in the Indian EEZ by referring to authentic works such as Weber and DeBeaufort, Munro, Day, Bal and Rao, Jones and Kumaran, Talwar and Jhingaran etc. As a result of this, 163 species were to be deleted and consolidation of information on the shortlisted species was started. The writeups passed on by the project associates were carefully scrutinised and final account was prepared for 31 species.
VII. PHYSIOLOGY, NUTRITION AND PATHOLOGY DIVISION

DEVELOPMENT OF FEEDS AND OPTIMIZATION OF FEEDING REGIMES FOR CULTURABLE CRUSTACEANS, MARINE FINFISHES AND PEARL OYSTERS (PNP/35)

R. Paul Raj, M. Vijayakumaran, D. Kandasami, Preetha Panicker, D.C.V. Easterson, Manpal Sridhar and P. Vijayagopal

Development of feed

At Madras, work was continued in developing feeds and feed management for spiny lobsters, mud crab and grouper. A maturation diet supplement rich in essential fatty acids, phospholipids, vitamin E, C and other vitamins and minerals was prepared and provided to feed the grouper broodstock at FHL, Cochin.

At Cochin, optimum protein: lipid ratios required in the diets of Penaeus indicus (1 g initial wt.) were studied using semipurified diets. The ingredients used to formulate the test diets were albumin, clammeal, fishmeal, shrimpmeal, groundnut oil cake, tapioca flour, oil, vitamin and mineral mixes, lecithin and cholesterol. The protein levels were 35, 40 and 45 and lipid levels were 6, 9 and 12 at each protein level. In a 28 day feeding trial, the best response in terms of growth, relative growth rate, protein efficiency ratio, food conversion ratio and productive lipid value was found to be at 45% protein and 12% lipids without any indication of an optimum level. Two way interaction between protein and lipid levels were not significant in any of the parameters tested. However, the effect of protein and the effect of lipids tested individually showed significant variations.

At Mandapam, Epinephelus tauvina (75 nos.) of mean weights 742g, 1515g and 2600g were stocked in 100 ton cement tanks. They were fed with fresh sardines on alternate days and the resultant growth rate was 147g per month with a feed conversion ratio of 5.7:1. A total of 140 groupers, segregated 3 weight groups (0.5, 0.5-1.0 and 1.0kg) were also stocked in 100 ton cement tanks. The fishes of 0.5kg group showed a monthly weight gain of 128g with an FCR of 3.9:1. The fishes of the size range 0.5-1.0kg showed a monthly growth rate of 137g with an FCR of 4.5:1 whereas monthly growth rate of the fishes of 1.0kg and above group was 170g with an FCR of 4.7:1. These were also fed with fresh sardines on alternate days. Grouper seeds of 4.5 g body weight and within the size range of 47-87mm were found to grow at the rate of 1.26g/day.

Livefeed culture

Ingestion rates of Chaetoceros spp. by pearl oyster spat were found to be 34.98±10.6 cells/hour/spat in 5-10mm size, 51.47±10.6 cells/hour/spat in 10-15mm size and 76.37±18.03 cells/hour/spat in 15-20mm size. Clown fish larvae could be reared successfully by feeding Brachionus rotundiformis (SS) supplied @ 1000 rotifers per larva per day.
**Probiotics in shrimp feeds**

Attempts were made to enumerate bacterial numbers of *Penaeus indicus* in the gut as well as in some live feeds and artificial feeds on ZoBells 2216 agar. Some of bacteria isolated from the gut shall be used as probiotics after carrying out antagonism and safety studies.

**EFFECT OF ENVIRONMENTAL STRESSORS ON THE PHYSIOLOGICAL BEHAVIOUR OF CULTIVABLE MARINE BIVALVES (PNP/44)**

M. Peer Mohamed, D. Noble and S.R. Krupesh Sharma

*Crassostrea madrasensis* was exposed to 20ppt, 30ppt and 40ppt salinities and survival rate studied for 60 days under room temperature. All remained alive for the first 30 days. The mortality was 40% in high salinity (40ppt) 20% at low salinity (20ppt). It appears that higher salinity is more detrimental and 30ppt is optimal for survival and, that edible oyster can accommodate a wide range of salinity conditions (20 ppt to 40 ppt) for about a month.

**DISEASE INVESTIGATIONS IN MARINE FINFISH AND SHELLFISH (PNP/46)**

M. Vijayakumaran, R. Paulraj, A.P. Lipton, S.R. Krupesh Sharma, Gaurav Rathore and Preetha Panikkar.

**Madras:** Prevalence of whitespot disease in commercial shrimp catches in Chennai fishing harbour was studied. Incidence ranged from 0-100% among various species. Mass mortality of early juveniles of *Penaeus monodon* in a superintensive culture farm was also investigated. The symptoms suggested bacterial or viral etiology. Studies were also conducted on spiny lobsters collected from holding centres with profuse mucus production and foul odour accompanied by spoilage of eggs at advance stage of development. 14 colonies of gram negative bacteria were isolated from water, eggs and tissue fluids. Another incidence of mass mortality was traced to sudden lowering of salinity from 30ppt to 9ppt. Mortalities were reported during the first week of stocking in lobster juveniles of about 80g weight. No pathogenic *vibrio* were recorded in culture, probably due to severe stress due to catching, holding and transporting before being stocked for fattening.

**Kakinada:** Small and medium farmers did not have problem with whitespot disease. Blackgill disease was reported in *P. monodon* in a few farms. Bulging of gills and surfacing of prawns leading eventually to red disease and mortality, was also observed in a few farms after heavy rains.

**Mandapam:** Mass mortality of pearl oyster larvae was investigated. The rearing water contained 104 to 105 cfu/ml bacteria. High
bacterial load in rearing water is suspected to be one of the factors for mass mortality of pearl oyster larvae. Mortality of clown fish larvae is suspected to be due to deficiency of highly unsaturated fatty acids (HUFA). Bacterial involvement in mass mortality of grouper broodstock is being investigated.

**FORMULATION OF NUTRITIONAL STRATEGIES FOR THE MANAGEMENT OF AQUACULTURE WASTES (NSMAW) THROUGH LOW POLLUTION DIETS FOR SHRIMP (PNP/47)**

Manpal Sridhar, M. Peer Mohamed and P. Vijayagopal

Two, high-nutrient-dense experimental feeds (HND) were prepared using fishmeal, prawnmeal, squidmeal, groundnut oil cake, soyabeanmeal, tapioca flour, wheat flour, clam meat, oil, cholesterol, vitamin mixture and mineral mixture incorporating chromic oxide at 0.5% level. The control feed had a crude protein content of 48.65% whereas the HND feeds had a crude protein content of 52.41 and 54% respectively. HND feeds were prepared by incorporating squid meal instead of prawnmeal and the P/N ratios were found to be 0.63 and 0.65 for the HND diets. These feeds are being nutritionally evaluated.

**DEVELOPMENT OF DNA FINGERPRINTS AND PROBES FOR DIAGNOSIS OF PATHOGENS OF FINFISH AND SHELLFISH (PNP/48)**

P.C. Thomas and M.K. George.

The standard strains and field strains of bacterial pathogens isolated from the shrimp body as well as from aquaculture ponds were cultured in the laboratory. Genomic and plasmid DNA were isolated from them using alkaline lysis method, modified and standardized for the purpose. The protocol standardized for the plasmid isolation consists of the initial lysis of bacterial cell wall using lysozyme, followed by selective denaturation of nuclear DNA, and precipitation of covalently closed circular plasmid DNA was purified from proteins by neutral phenol extraction followed by precipitation with alcohol in the presence of salt. Spectrophotometric analysis of the DNA extracts were carried out followed by submarine electrophoresis and ethidium bromide staining of the electrophoretic gel to visualize the DNA.

The field strains revealed considerable variations in their plasmid profile and antibiotic resistance pattern. Differences were observed in the number of plasmids and molecular size of plasmid DNA. While the standard strain of *Vibrio parahaemolyticus* (Vp1) had only one plasmid of 19 kb, two of the field strains (Vp2 and Vp3) had multiple plasmids. Vp2 carried two plasmids of 3.5 kb...
and 21 kb as against 5 plasmids of 3 kb, 5 kb, 5.5 kb, 23 kb and 35 kb in Vp3. Two other field strain Vp4 and Vp5 harboured only single plasmid.

The antibiotic resistance pattern of different strains was also investigated since antibiotic resistance is reported to be mediated by plasmid DNA. While the standard strain carrying single plasmid was resistant only to 7 antibiotics out of 20 tested, Vp2 and Vp3 were resistant to 11 and 12 antibiotics respectively.

Restriction trials were carried out by enzymatically cleaving the DNA. While the restriction digestion of genomic DNA was carried out with Hind III and Pst I, plasmid DNA was restricted with ECOR I and Pst I. Restriction of genomic DNA resulted in the generation of numerous fragments indicating the existence of too many recognition sites, because of which resolution of individual fragments under submarine electrophoresis became impracticable.

Restriction of the plasmid DNA of Vibrio with Pst I produced three fragments of 9.5, 6.0 and 4.5 kb sizes indicating the existence of three cleaving sites. However ECOR I had no sites.

Restriction analysis of the genomic DNA with rare cutting enzymes are envisaged to generate less numerous fragments which shall facilitate their better resolution on electrophoresis. Restriction analysis of the plasmid DNA using array of endonucleases has also been initiated.

**POPULATION GENETIC STUDIES IN RASTRELLIGER KANAGURTA, SARDINELLA LONGICEPS AND PENAUS INDICUS (PNP/49)**

M.K. George, P.C. Thomas and P. Jayasanker

The study of the morphometric characteristics of mackerel was continued to evaluate the population genetic heterogeneity in the species.

The preliminary results of the principal component analysis of the 15 body dimensions taken from the mackerel samples from Ambalapuzha, Cochin and Chavakkad indicated that the variation in PC scores is significantly different between Ambalapuzha and Chavakkad.

**INDUCED MATURATION OF GROUPERS (PNP/50)**

M. Peer Mohamed, N. Sridhar, Manpal Sridhar and D. Noble

The procedure for incorporation of 17α-methyl testosterone in the form of pellets using cholesterol, gelatin and gum acacia powder was standardized. Specimens 2.9 kg and 2.4 kg were fed hormone incorporated pellets once in two days. The female
specimens yielded oocytes which were in size range of 320 to 350mm. Biopsy in males showed oocytes in degenerative state. Experiments are being planned to induce maturation through ovaprim as well as LHRHa. Inter conversion of females to males at harbour laboratory was successful.

**IN VITRO EFFECT OF NEUROHORMONES ON OVARY DEVELOPMENT IN CRUSTACEANS (PNP/51)**

N.Sridhar and M. Peer Mohamed

The procedure for assaying lipogenic enzymes in the ovary and hepatopancreas of *P. indicus* as indicators of the onset of maturation was standardized. Studies on the effect of certain steroids on the activities of lipogenic enzymes in the ovary and hepatopancreas were conducted. These experiments indicate the involvement of steroids on the onset of maturation in *P. indicus*.

Enzyme activity in the hepatopancreas of the female green mud crab *Scylla tranquebarica* during different maturation stages was also studied. An experiment to determine the role of 5-hydroxytryptamine was successfully completed.

**STUDIES ON THE EFFECT OF TOXINS, POLLUTANTS AND PROBIOTICS ON FISH HEALTH WITH SPECIAL REFERENCE TO IMMUNE SYSTEM (PNP/52)**

K.C. George, N.K. Sanil and K.S. Sobhana

Histopathological studies of different organs of aflatoxin treated fishes were conducted. Damages to liver, spleen, kidney and lymphoid organs were recorded. Antibodies against fish serum proteins were raised in rabbits to develop methods for estimating fish immunoglobulins. Studies on the inflammatory reactions were done by injecting mineral oil into the tissues and assessing the responses histopathologically. Aflatoxin treated fishes showed poor leucocytic infiltration, indicating a reduced immune response.

**EXTRACTION AND ISOLATION OF SUBSTANCES OF PHARMACOLOGICAL IMPORTANCE FROM MARINE ORGANISMS (PNP/53)**


*Caulerpa racemosa* collected from Rameswaram coast was tested for presence of cytokinin like substances (plant growth hormones). A procedure for preparation of
cytokinin group of substances was standard­ized and the prepared substance was assayed for cell elongation activity in comparison to commercially available kinetin. Seaweeds collected from Vizhinjam and Dalavapuram were extracted for gamma amino butyric acid (GABA) with chloroform and methanol mixture and the fine crystals obtained were preserved for further analysis. The procedure for determination of GABA from red seaweed was standardised using thin layer chromatography. The sponges collected from Rameswaram and ascidian from Vizhinjam were also processed for infrared spectral analysis for possible identification of bio­active components.
The programme of crab culture was extended through the Kerala Pulayar Maha sabha for 20 farmers through the SC/ST programme funded (Rs 2 lakhs) by the District Administration. Farmers having an area of 20 to 50 cents were selected. Each farmer was provided with 400 crabs, each weighing 100 to 150 g. Crab seeds purchased from a private entrepreneur was stocked during August in the respective fields. Trash fishes were given as feed. Regular monitoring of water parameters was done. Training was given to the farmers on pond preparation, stocking, feeding and other package of practices. A harvest festival was organised in this regard which was presided over by the District Collector. The farmers obtained a yield of 150 to 200 kg on harvesting in February.

A society was organised at Ottamassery, with the involvement of local people, to propagate the technology of mussel culture. This society serves as a link between the scientists and fishermen.

Ten farmers were identified as beneficiaries under the SC/ST programme to take up prawn culture; training was imparted to them and culture work was initiated. Farmers at Chellanam were encouraged to take up finfish culture, as the second phase of the integrated finfish culture project funded by the District Administration. In the culture of milkfish and mullet the farmers obtained very good harvests. Ornamental fish were provided to five farmers and the culture is in progress.

A project at a cost of Rs 8 lakh was sanctioned by the District administration to promote crab and finfish culture at Panampukad and Elamkunnapuzha and another project was sanctioned for an amount of Rs 2 lakh to implement group farming in prawn culture.

INTEGRATION OF SMALL SCALE MARICULTURE WITH SMALL SCALE FISHERIES ALONG THE PENINSULAR INDIA (FE & E/32)


Pulicat village (Tamil Nadu) was selected for transfer of technologies and a fishermen meet was organised.

The programme of mussel culture at
Manapad was abandoned for the current year due to damage caused to the raft off Kulasekharapattinam and nonavailability of seed. This programme is to be continued at Jeeva Nagar/Chungam during 1998-99 season under a part finance scheme between the C.M.F.R.I. and the fishermen group of Manapad.

Fisherwomen at Versova (Mumbai) showed readiness on packing and marketing of dried fish. The marketing of packed dry fishes is encouraged and slowly if this succeeds, a brand name by fisherwomen group and later a fisherwomen cooperative can come into picture.

Monthly meets were organised at the Headquarters, Regional and Research Centres regularly. The topics covered includes clam farming, fish culture, crab farming and prawn farming. The programmes organised in fishing villages have inspired the fishermen to take up the culture in their farms. High level participation from the fishermen community was observed, in all the programmes.

RESOURCE MANAGEMENT AND SOCIO-ECONOMIC SURVEY OF SMALLSCALE FISHERIES IN LAKSHADWEEP ISLAND AND KERALA (FE & E/33)
M. Sivadas and A.K.V. Nasser

Data on resource assessment and household details of selected villages at Lakshadweep and Kerala are being collected with the help of the interview schedule.

EVALUATION OF SOCIO-ECONOMIC CONDITIONS AND ERGONOMICAL PROBLEMS OF WOMEN ENGAGED IN PRAWN PEELING IN MUMBAI REGION (FE & E/35)
Arpita Sharma

Sixty nine women engaged in prawn peeling at New Ferry Wharf and Versova landing centres were interviewed. 57.97% followed Islamic religion and 42.03% followed Hinduism. Most of the women (82.61%) are married and have nuclear family (85.51%). The mean monthly income of women engaged in prawn peeling is Rs 813.04 and family income is Rs 2063.77. Number of earning members per family is 3. Reason for joining this job, as reported by them is economical. 82.61% of the women sampled migrated from other states mostly because of economic reasons. Only 15.94% are able to read and write. Most of the women stay in huts and some of them stay in chawls.

The landing centre is an open place and the working time depends on the catch. Working throughout the week and more or less 7 hours per day existed here. They adopt continuous squatting posture for the whole work hours. The prawn peelers also report that because of pricking of rostrum of
In conclusion, the study revealed that the nutritional and socio-economic status of women engaged in prawn peeling is poor and they face occupational problems. The working conditions of these women also invites attention.
IX. SPONSORED PROJECTS

HATCHERY PRODUCTION OF CLAM (MERETRIX SP.) SEED (CMFRI/SPO/3)

P.V. Sreenivasan and D. Sivalingam

*M. casta* (150 numbers) of 28-51 mm length collected at Mandapam were transported and maintained as broodstock in the shellfish hatchery at Tuticorin. 5 spawnings of *M. casta* occurred, of which 2 were without stimulation and others by thermal induction. However, larvae of all the 4 spawnings were attacked by ciliates. In the fifth spawning, 14.1 million larvae were reared and 2.3 million seed produced. Settlement occurred on the 7th day; settlement was 16.2%. The seeds after attaining 5-16.5 mm size were ranched in Punnakayal estuaries and creeks near Tuticorin.

HATCHERY PRODUCTION OF THE GREEN MUSSEL (PERNA VIRIDIS) SEED (CMFRI/SPO/4)

P.S. Kuriakose

During the period under report two successful spawning experiments were conducted in the hatchery. In the first spawning on 21.2.1998, 20 males and 24 females spawned. A total of 5.65 million larvae were reared up to 7th day. Spat settlement commenced on the 18th day and a total of 0.904 million spats settled in the rearing tanks. The spats were further reared up to the seed size and a total of 0.47 million seeds were produced in the hatchery. The hatchery produced seeds were kept in the Puthiappa fisheries harbour for further growth up to 30 mm size.

The second experiment was conducted on 12.3.98, in this experiment 9 males and 13 females spawned in the hatchery. A total of 1.8 million veliger larvae were reared up to 7 days. On the 30th day 0.504 million spats settled in the larval rearing tanks. The spats were further reared up to the seed size of 10-12 mm in the nursery rearing tanks. The seeds produced were sea-ranched.

Stock cultures of 5 species of microalgae were well maintained in the temperature controlled room. Mass cultures of microalgae and phytoplankton were developed in one tonne capacity FRP tanks for feeding the larvae and juveniles in the hatchery.

TISSUE CULTURE IN PEARL OYSTER (CMFRI/SPO/6)

S. Dharmaraj

Three explant cultures of pearl oyster mantle were organised during the year. Mediums 199 and L-15 were used. Since foetal calf serum was not available,
whole-body extract was used as a substitute. A few cells were found to dissociate. Development of microbes was observed and control measures were taken.

COMMERCIAL PROPAGATION OF MARINE PEARL CULTURE TECHNOLOGY (CMFRI/SPO/7)

A.C.C. Victor, A. Chellam, D. Kandasamy and I. Jagadis

The infrastructure facilities at the Mandapam Regional Centre were developed with the assistance of Rs.25 lakhs from DOD under MRDF programme fund with the aim of commercialising the pearl culture technology for the benefit of farmers and entrepreneurs.

The seawater pumping and filtration system was strengthened by extending the intake point in the sea by 3 m, four pairs of 100 t RCC tanks were constructed for rearing of nucleated oysters and four air-blowers commissioned.

A hatchery of 2 million capacity was developed along with phytoplankton culture laboratory and mass culture facility. Open sea farm 'Racks' (1.44 sq.m) and raft (of 3 x 3m) were established at the Gulf of Mannar.

Induced spawning of pearl oysters was carried out by temperature manipulation. Seven successful spawnings were achieved during June 1997 to August 1997 and 90 lakhs larvae were produced of which 7.2 lakh spat were raised and reared. The percentage of spat recovery ranged from 4.3 to 16.0%.

Rearing of oysters juvenile was carried out in both the Gulf of Mannar and the Palk Bay. In the Gulf of Mannar, juveniles were reared in box type cage suspended from 3x3 m rafts at a stocking density of 1500/cage. The spats were periodically thinned, at the end of six month culture period the spats from an average size of 7.2 mm had reached 44.9 mm showing a monthly growth of 6.3 mm. The survival was 50%. Spats of larger size (Av. 16.6 mm) stocked at 1500 nos/cage attained an average size of 24.9 mm within 1 1/2 months of culture registering 5.5 mm/month. The survival was 80%.

Initial experiments conducted in the Gulf of Mannar yielded satisfactory result of pearl production. The quality of the pearls produced was high and comparable to that of Japanese pearls.

To develop the expert manpower in the nucleus implantation technique, a training programme was conducted for 15 women in all aspects of pearl culture.
A joint collaborative research project viz. "Identification of PFZ in the Coastal Waters" was taken up with Space Application Centre, Ahmedabad and a workplan was finalised for the project "Ocean colour applications" after undertaking detailed discussions with the concerned scientists both at Ahmedabad and Cochin. A background paper based on historic data was prepared and discussed during the seminar held at Ahmedabad during February, 1999.

Multi season, concurrent chlorophyll and SST images would be generated from SeaWiFS/OCM and AVHRR data. Thermal and colour features would be compared to understand the aspects like what additional information is available from the colour gradient, whether the two parameters co-exist and collected or not, period (season) of collocation, whether colour front is more persistent etc. Clustering technique based on image classification would also be attempted to understand relation between the two parameters. Based on the understanding gained through this study, an approach to generate the fishery forecasts using combined data set (SST and chlorophyll) would be developed.

**TECHNOLOGY ASSESSED AND TRANSFERRED**

Open sea mussel culture was initiated at Narakkal as a demonstration programme with the involvement of four fishermen. The fishermen were trained in fabrication of raft and mussel seeding. The bamboo raft of 25 sq m (5 x 5) was moored off Narakkal at a depth of 4 to 5 m with the help of the fishermen.

For mussel seeding also local women were given a training in October 1998 by KVK, Narakkal and after training, the women actively participated in mussel seeding. Mussel seed was collected from the intertidal zone of Narakkal beach. Mussel seed (average length 27.1 mm; breadth 15.6 mm; depth 9.65 mm, total weight 2.45 g; meat wt 0.6 g) were seeded at a density of 1.5 kg/m length of nylon rope. About 58 seeded mussel ropes of 12 mm diameter of length 3 m were seeded and suspended from the raft.

In November due to the twisting of anchor ropes on the seeded ropes due to rough sea condition, intense seed slipping was observed. Mussel seed was stocked in nylon bags to reduce labour and time. Initially nylon net tubes of length 1.5 to 2 m were made. In each tube, mussel seed collected from
Narakkal were stocked in 5 to 6 pouches separated by knots tied at equal intervals. The stocking density was 200 g/pouch. 28 net tubes (each with 5 to 6 pouches) were prepared using 33.2 kg of seed. These nylon bags were suspended from the raft in December 1998.

**EDUCATION AND TRAINING**

*Postgraduate Programme in Mariculture*

In the M.F.Sc. programme, 7 students of 1996-97 batch completed their course and passed the examination. Nine students of 1997-98 batch completed their third semester and moved to final semester. Ten students of 1998-2000 academic year, joined the programme in September, 1998 and completed the first semester. One student of this batch, discontinued the programme due to personal reasons.

In the Ph.D. Programme, all the 3 candidates of 12th batch (1994-97) submitted their theses. The viva-voce of two of them was also over and the results are awaited. Among the four students of the 13th batch (1995-98), one student has completed his work and the work of the remaining three was progressed well. The research work of 10 students of the 14th batch and 12 students of the 15th batch has also progressed well. The fresh batch of students (16th batch) admitted to the Ph.D. programme during the year under report has completed the first semester course work and commenced the second semester.

**Krishi Vigyan Kendra**

**Frontline Demonstration**

The feasibility of farming of mussels was demonstrated to the local fishermen, was by floating a raft in the sea near the KVK campus and tying about 20 seeded ropes to it. Periodical observations were made involving the same fishermen.

The Krishi Vigyan Kendra conducted thirtythree training programmes during 1998 and the details are given below:
APPLICATION OF REMOTE SENSING TECHNIQUE TO MARINE FISHERIES (CMFRI/SPO/11)

V.N. Pillai, C.P. Gopinathian, V.K. Pillai, M. Srinath, M. Ferozkhan, Rani Mary George and M. Sivadas

A joint collaborative research project viz. "Identification of PFZ in the Coastal Waters" was taken up with Space Application Centre, Ahmedabad and a workplan was finalised for the project "Ocean colour applications" after undertaking detailed discussions with the concerned scientists both at Ahmedabad and Cochin. A background paper based on historic data was prepared and discussed during the seminar held at Ahmedabad during February, 1999.

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## KRISHI VIGYAN KENDRA

Training Programmes conducted during 1998

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Subject</th>
<th>Duration (days)</th>
<th>No. of courses conducted</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
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<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>A.</td>
<td>FISHERIES</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Prawn farming</td>
<td>5</td>
<td>4</td>
<td>10</td>
<td>63</td>
<td>73</td>
</tr>
<tr>
<td>2.</td>
<td>Prawn farming</td>
<td>1</td>
<td>1</td>
<td>30</td>
<td>35</td>
<td>65</td>
</tr>
<tr>
<td>3.</td>
<td>Fish farming</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>19</td>
<td>24</td>
</tr>
<tr>
<td>4.</td>
<td>Mussel farming</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td>24</td>
<td>32</td>
</tr>
<tr>
<td>5.</td>
<td>Pearl oyster farming and pearl production</td>
<td>15</td>
<td>1</td>
<td>-</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>6.</td>
<td>Pearl oyster farming and pearl production</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>21</td>
<td>22</td>
</tr>
<tr>
<td>7.</td>
<td>Prospects of self employment in fisheries for rural youth</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>21</td>
<td>25</td>
</tr>
<tr>
<td>B.</td>
<td>AGRICULTURE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Coconut cultivation</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>25</td>
<td>26</td>
</tr>
<tr>
<td>2.</td>
<td>Vegetable cultivation</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>3.</td>
<td>Vegetable cultivation</td>
<td>1</td>
<td>4</td>
<td>71</td>
<td>75</td>
<td>146</td>
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<tr>
<td>4.</td>
<td>Kitchen garden</td>
<td>1</td>
<td>3</td>
<td>18</td>
<td>40</td>
<td>58</td>
</tr>
<tr>
<td>5.</td>
<td>Pest control in vegetables</td>
<td>1</td>
<td>2</td>
<td>24</td>
<td>16</td>
<td>40</td>
</tr>
<tr>
<td>6.</td>
<td>Mushroom cultivation</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>46</td>
<td>50</td>
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<td>C.</td>
<td>HOME SCIENCE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Preparation of low cost Nutritional food</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td>2.</td>
<td>Fruit processing</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>3.</td>
<td>Health and Hygiene</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>36</td>
<td>36</td>
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<tr>
<td>4.</td>
<td>Health and Nutrition</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>42</td>
<td>42</td>
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<tr>
<td>TOTAL</td>
<td></td>
<td>33</td>
<td>182</td>
<td>565</td>
<td>747</td>
<td></td>
</tr>
</tbody>
</table>
Trainers' Training Centre

During the period under report, ten short-term training courses were organised availing the expertise at CMFRI, Kerala Agricultural University, CIBA, CIFT and the Integrated Fisheries Project. The courses were conducted at Cochin, Vizhinjam, Calicut, Mandapam and Tuticorin. Rs 92,000 was collected towards course fee during the year. The training programmes conducted are given below:

Particulars of Training Programmes conducted by the TTC

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the course</th>
<th>Duration</th>
<th>No. of courses conducted</th>
<th>No. of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mud crab farming</td>
<td>19.1.98 to 24.1.98</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>2.</td>
<td>Ornamental fish culture</td>
<td>16.3.98 to 21.3.98</td>
<td>2</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>26.5.98 to 30.5.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Hatchery production of marine prawn seeds</td>
<td>16.3.98 to 28.3.98</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>Marine pearl culture</td>
<td>16.3.98 to 4.4.98</td>
<td>1</td>
<td>3</td>
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<tr>
<td>5.</td>
<td>Integrated training course on Fisheries Education</td>
<td>16.4.98 to 6.5.98</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>6.</td>
<td>Culture, processing &amp; marketing of edible oyster</td>
<td>16.9.98 to 25.9.98</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>7.</td>
<td>Seaweed culture and utilisation</td>
<td>21.9.98 to 30.9.98</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>8.</td>
<td>Live feed culture</td>
<td>24.11.98 to 28.11.98</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>9.</td>
<td>Finfish Mariculture</td>
<td>1.12.98 to 11.12.98</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td><strong>10</strong></td>
<td><strong>103</strong></td>
</tr>
</tbody>
</table>
Other Training Programmes

Mr. T.A. Rajpakse, Research Assistant, National Aquatic Resources Research and Development Agency, Sri Lanka underwent Short-term Training Programme from 5.5.1998 to 30.5.1998 at CMFRI, Cochin, in the areas of Fish Taxonomy and Fish Preservation Techniques, under Dr. V. Sriramachandra Murty, Head, Demersal Fisheries Division.

AWARDS AND RECOGNITIONS

Shri G.S.D. Selvaraj, Senior Scientist, received the Best Research Paper Award for his paper "An Approach to Differentiate net Photosynthetic and other Biochemical Production and Consumption of Oxygen in Estuarine Waterbodies and Aquaculture Systems" during the National Seminar on Development and Transfer of Fisheries Technology, in February 1999, by the Fisheries College and Research Institute, Tuticorin (TANVASU).

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Shri G. S. Daniel Selvaraj, Sr. Scientist receiving the award for Best Research Paper
In the CMFRI-sponsored Rajbhasha Poster Contest -
Dr. A. A. Jayaprakash,
Sr. Scientist, CMFRI
receiving the cash award

Shri P. Bapaiah, Senior Administrative Officer receiving the Rajbhasha Trophy from the Chairman,
Cochin TOLIC for the best Hindi implementation programme for the year 1998
### Central Marine Fisheries Research Institute, Cochin (ICAR)

#### DEPT. OF BIOTECHNOLOGY
(Sponsored Projects)

#### INDIAN SPACE RESEARCH ORGANISATION
(National Natural Resources Management Systems)

#### NATIONAL REMOTE SENSING AGENCY
(Remote Sensing and Fisheries)

#### MINISTRY OF AGRICULTURE, GOVT. OF INDIA
(Collaborative work)

#### DEPARTMENT OF OCEAN DEVELOPMENT
(Assessment of Marine Living Resources through FORV Sagor Sampa)

#### MARINE PRODUCTS EXPORT DEVELOPMENT AUTHORITY
(Sponsored Projects)

#### CENTRAL SALT AND MARINE CHEMICALS RESEARCH INSTITUTE
(Seaweed Resources)

#### NATIONAL INSTITUTE OF OCEANOGRAPHY
(Collaborative work)

#### CIFE (DEEMED UNIVERSITY)
(M.F.Sc. and Ph.D. Programmes)

#### OTHER RESEARCH INSTITUTES OF ICAR
(Collaborative Programmes)

#### STATE AGRICULTURAL UNIVERSITIES/UNIVERSITIES
(Faculty Improvement Programme)

#### ICLARM PROJECT
(ADB-RETA 5766)

#### CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY
(Collaborative Work)

#### CENTRAL INSTITUTE OF FRESHWATER AQUACULTURE
(Collaborative Work)

#### DEPT. OF SCIENCE AND TECHNOLOGY
(Sponsored Projects)

#### FAO/UNDP PROJECTS/USIF

#### REGIONAL SEAFARMING DEVELOPMENT AND DEMONSTRATION PROJECT
(Country Participation/Nodal Institute)

#### MINISTRY OF ENVIRONMENT AND FORESTS, GOVT. OF INDIA
(Collaborative Work)

#### NATIONAL BANK FOR AGRICULTURE AND RURAL DEVELOPMENT
(Sponsored Projects)

#### CENTRAL INSTITUTE OF FISHERIES, NAVAL AND ENGINEERING TRAINING
(Collaborative Work on Marine Resources)

#### INDIAN AGRICULTURAL STATISTICS RESEARCH INSTITUTE
(Training)

#### FISHERY SURVEY OF INDIA
(Marine Fisheries Resources Survey of the Exclusive Economic Zone)

#### INTEGRATED FISHERIES PROJECT
(Postharvest Technology)

#### DEPARTMENTS OF FOREST, ORISSA AND TAMILNADU
(Turtle conservation)

#### FISHERIES DEPARTMENTS OF MARITIME STATES
(Transfer of Technology)

#### FISHING INDUSTRY
(Consultancy)

#### CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE
(Collaborative Work)

#### CENTRAL AGRICULTURAL RESEARCH INSTITUTE, PORTBLAIR
(Collaborative Work)
LIST OF PUBLICATIONS


SIVAKAMI, S., E. VIVEKANANDAN, P. NAMMALWAR, M. FEROZKHAN, P.U. ZACHARIA, G. MOHANRAJ, GRACE

SUKUMARAN, K.K. AND B. NEELAKANTAN 1998. Maturation process and reproductive cycle in two marine crabs, Portunus (Portunus) sanguinolentus (Herbst) and Portunus (Portunus) pelagicus (Linnaeus) along the Karnataka coast. Indian J. Fish. 455 (3): 257-264.


University of Science and Technology, Cochin : pp. 234-242.


**CONSULTANCY, PATENTS, COMMERCIALISATION OF TECHNOLOGY**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Client</th>
<th>Amount In Rs.</th>
<th>Type of projects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Projects completed during 1998-99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Mangalore Refinery &amp; Petrochemicals Ltd., Mangalore</td>
<td>3,60,000</td>
<td>Consultancy</td>
</tr>
<tr>
<td>2.</td>
<td>Indian Tropical Agro Products (P) Ltd., Tuticorin</td>
<td>1,50,000</td>
<td>Consultancy</td>
</tr>
<tr>
<td>3.</td>
<td>Kudremukh Iron Ore Co. Ltd., Mangalore</td>
<td>3,80,000</td>
<td>Consultancy</td>
</tr>
<tr>
<td>4.</td>
<td>Care India, Mumbai</td>
<td>3,30,000</td>
<td>Consultancy</td>
</tr>
<tr>
<td>5.</td>
<td>Hardy Exploration &amp; Production India (Inc), Chennai</td>
<td>9,60,000</td>
<td>Consultancy</td>
</tr>
<tr>
<td>6.</td>
<td>National Environmental Engineering Research Institute, Nagpur</td>
<td>4,59,000</td>
<td>Contract service</td>
</tr>
<tr>
<td>7.</td>
<td>Bharat Heavy electricals Ltd., Trichirappally</td>
<td>1,00,000</td>
<td>Contract service</td>
</tr>
<tr>
<td>8.</td>
<td>Hoava Foods Pvt. Ltd., Ezhupunna</td>
<td>2,000</td>
<td>Consultancy</td>
</tr>
<tr>
<td>9.</td>
<td>Tharakan Foods Private Ltd., Ezhupunna</td>
<td>10,000</td>
<td>Consultancy</td>
</tr>
</tbody>
</table>

|        | Ongoing Projects - 1998-99                      |               |                  |
|        | 1. Mangalore Refinery & Petrochemicals Ltd., Mangalore | 4,00,000      | Consultancy      |
|        | 2. Cochin Port Trust, Cochin                    | 4,01,370      | Consultancy      |
|        | 3. Indian Tropical Agro Products (P) Ltd., Tuticorin | 1,50,000      | Consultancy      |
|        | 4. Rajiv Gandhi Centre of Aquaculture, Myladuthuria | 5,88,280     | Consultancy      |
|        | 5. Kudremukh Iron Ore Co. Ltd., Mangalore       | 3,80,000      | Consultancy      |

|        | Approved Projects                               |               |                  |
|        | 1. Lakshadweep Shilpi Aquaculture Ltd., Cochin  | 2,56,000      | Consultancy      |
|        | 2. Suganthi Devadasan Marine Research Institute (SDMRI), Tuticorin | 15,000        | Contract Service |
|        | 3. Master Pearl Ltd., Hyderabad                 | 2,77,250      | Consultancy      |
|        | 4. Dept. Of Fisheries, A&N Administration, Port Blair | 1,26,230   | Consultancy      |
RESEARCH ADVISORY COMMITTEE, MANAGEMENT COMMITTEE AND STAFF RESEARCH COUNCIL MEETINGS

The RAC meeting was held on 21.1.1999 at the Calicut Research Centre. The RAC expressed satisfaction on the achievements of the Institute in the different programmes. The following recommendations were made.

- Action should be taken to patent the new technologies developed by CMFRI
- The hatchery of the Calicut Research Centre needs to be equipped for improving the training facilities at international level.
- Consultancy literature should be made available in regional languages

The Management Committee Meetings were held on 10-7-98 and 12.10.98 and the following decisions were taken.

- A proposal for construction of Hatchery-cum-Laboratory, Aquarium, retaining wall, development of site etc. for the Vizhinjam Research Centre of CMFRI, Vizhinjam at an estimated cost of Rs 39,63,460 was placed before the Management Committee in its meeting held on 10.7.1998. After going through all the relevant records, the Management Committee approved the construction of hatchery-cum-laboratory, Aquarium retaining wall and development of site etc. for the Vizhinjam Research Centre.
- Another proposal for collection of statistical data from Andaman & Nicobar Islands, Laccadives and Gulf of Kutch areas by posting officials or by opening new Centres, was placed before the Management Committee in its 50th meeting held on 10-7-1998. The Committee suggested that the CARI, Port Blair may be involved in obtaining the required data in respect of Andaman & Nicobar Islands. For Laccadives, the data may be collected by the Minicoy Research Centre of CMFRI by deploying additional hands. In regard to Gulf of Kutch, the Veraval Research Centre of CMFRI may collect the data by taking a room on rent at Rann of Kutch and by posting a person there. The Committee suggested to reopen the Field Centre at Kandla and also to open a new Field Centre in Gujarat.

The SRC meeting of the Institute was held on 4th & 5th June 1998 and the progress of the ongoing projects was discussed.
### PARTICIPATION OF SCIENTISTS IN CONFERENCES, MEETINGS, WORKSHOPS AND SYMPOSIA IN INDIA AND ABROAD AND IN FOREIGN TRAINING

<table>
<thead>
<tr>
<th>Name &amp; Designation</th>
<th>Particulars</th>
<th>Date/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. M. Devaraj, Director</td>
<td>The 26th State Fisheries Research Council meeting under the Chairman of the Hon'ble Minister for Fisheries, Govt. of Tamil Nadu at Chennai</td>
<td>June 23, 1998</td>
</tr>
<tr>
<td></td>
<td>Management Committee of the Institute at Vizhinjam</td>
<td>July 10, 1998</td>
</tr>
<tr>
<td></td>
<td>Syndicate and Establishment Committee meeting of the Manonmaniam Sundaranar University, Tirunelveli</td>
<td>July 11, 1998</td>
</tr>
<tr>
<td></td>
<td>Meeting of the Environment Committee of Kerala Legislative Assembly, Legislative Complex, Trivandrum</td>
<td>July 14, 1998</td>
</tr>
<tr>
<td></td>
<td>DPC Meeting of CIFE, Mumbai</td>
<td>July 20, 1998</td>
</tr>
<tr>
<td></td>
<td>Meeting of the Committee of Expert Members convened by the Hon'ble Minister for Fisheries, Kerala at the Minister's chamber, Trivandrum</td>
<td>July 28, 1998</td>
</tr>
<tr>
<td></td>
<td>Discussion with Fr. Tobias on pearl culture project at Arokyapuram</td>
<td>July 27, 1998</td>
</tr>
<tr>
<td></td>
<td>Meeting with Hon'ble Minister for Fisheries, Govt. of Tamil Nadu</td>
<td>August 5 &amp; 26, 1998</td>
</tr>
<tr>
<td></td>
<td>Visited Iran as a member of the Indian team representing the Govt. of India to study the Marine Fisheries opportunities in Iran under bilateral cooperation</td>
<td></td>
</tr>
</tbody>
</table>
Senate meeting of the Manonmaniam Sundarnar University, Thirunelveli September 12, 1998

Second meeting of the Governing Body of the Fisheries Resource Management Society convened by the Hon'ble Minister for Fisheries, Govt. of Kerala at Government Guest House, Thycaud, Trivandrum September 15, 1998

Workshop organised by the Department of Aquatic Biology and Fisheries, Kerala University in connection with the Golden Jubilee Celebrations of Indian Independence as well as the Diamond Jubilee of the Kerala University and delivered the keynote address on seafarming technologies for Kerala September 23, 1998

Meeting of the Kerala Biodiversity Committee of Govt. Guest House, Thycaud, Trivandrum September 24, 1998


Meeting for considering the requirements under catch-up grant convened by DDG (Education), ICAR, at CIFE, Mumbai October 3, 1998

NATP launching ceremony at ICAR, New Delhi October 6, 1998
ICAR Director’s meeting at National Bureau of Plant Genetics Resources, Pusa, New Delhi  

Meeting of the Syndicate of Manonmaniam Sundaranar University at the University Building, Tirunelveli  

Institute’s Management Committee meeting at Mandapam Camp  

DPC meeting of ISRO as an External Expert Member, at ISRO Satellite Centre, Bangalore  

EFC discussions to finalise the IXth plan document pertaining to the four Research Institutes under the Chairmanship of Deputy Director General (Fy), at Krishi Bhavan, New Delhi  

Inaugural function of Krishi Vigyan Kendra of Indian Institute of Spices Research at Peruvannamuzhi by Padmabhushan Dr. R.S. Paroda, DG, ICAR and Secretary to DARE, Govt. of India  

Workshop on Sustainable Livelihoods and Environment Management in the Coastal Ecosystems organised by M.S. Swaminathan Research Foundation, Chennai and presented a paper  

Inaugural function of the First National Seminar on Trends in Marine Biotechnology organised by Manonmaniam Sundaranar University,
Tirunelveli and delivered the
inaugural address at the Bishop’s
House, Nagercoil

XVII meeting of ICAR Regional
Committee No. VIII at Indian Bank
Management Academy for Growth &
Excellence (IMAGE) Conference Hall,
Rajah Annamalaipuram, Chennai

January 5-6, 1999

Syndicate Meeting of Manonmaniam
Sundarnar University at Tamil Nadu
State Council for Higher Education
(TANSCHE), Kamarajar Salai, Chennai

January 7, 1999

Inaugural function of the National
Seminar on Development and Transfer
of Fisheries Technologies and gave
inaugural address at Fisheries College
& Research Institute, Tuticorin

February 3, 1999

Centre for Development & Transfer of
Mariculture Technologies (CDTMT)
meeting at the Office of the Director
of Fisheries, Trivandrum

February 8, 1999

Scientific Workers’ Conference of the
Tamil Nadu Veterinary and Animal
Sciences University at Madras
Veterinary College, Chennai

March 13, 1999

Workshop on “The Small Scale Fisheries
of India” organised by the Centre for
Development Studies, Trivandrum under
the WHAT Commission and presented a
paper at Hotel Aquaserene, South
Paravoor, Quilon

March 28, 1999
<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. V.S.R. Murty, Head, DFD: National level consultation on development of protocols for access to biodiversity and consequent benefit sharing, at the Indian Institute of Management, Ahmedabad</td>
<td>April 10-12, 1998</td>
</tr>
<tr>
<td>Meeting of the subcommittee on animals of the Ministry of Environment and Forests, Government of India, on the Identification of Repositories for maintaining voucher specimens of biological material transferred from the country, at NBAGR, Karnal</td>
<td>May 7, 1998</td>
</tr>
<tr>
<td>Workshop on “Wetland Policy for India” organised by the worldwide fund for Nature, at New Delhi</td>
<td></td>
</tr>
<tr>
<td>Meetings of the Taskforce of the and project sponsored by the DOD on Stock assessment etc. at FSI, Visakhapatnam</td>
<td>June 20, 1998</td>
</tr>
<tr>
<td>Delivered lecture on Demersal Fisheries Resources and Marine Ornamental Fish Resources at the MPEDA, Cochin</td>
<td>March 8, 1999</td>
</tr>
<tr>
<td>Workshop on Germplasm Inventory and Genebanking of freshwater fishes, organized by the NBFGR, Lucknow, at the CMFRI, Cochin headed the scientific group on biology</td>
<td>October 12-13, 1998</td>
</tr>
<tr>
<td>First meeting of the Steering Committee of the UNDP/GEF/PDF B Project on Management of coral reef ecosystems of Andaman and Nicobar islands; Ministry of Environment and Forests, Govt. of India, New Delhi</td>
<td>October 26, 1998</td>
</tr>
</tbody>
</table>
International Symposium on Large Marine Ecosystems: Exploration and Exploitation for Sustainable Development and Conservation of Fish Stocks; Fishery Survey of India, and presented a paper

Ms. Sheela Immanuel, Scientist
Workshop on Fisheries Socio-economics and Management organised by ICLARM under the project on "Sustainable Management of coastal fish stocks in Asia" at Thailand

November 25-27, 1998

Shri Jiju P. Alex, Scientist
Seminar on 50 years of communication research organised by the National Council of Development Communication at IARI, New Delhi

August 4-7, 1998

Dr. V.K. Pillai, Sr. Scientist
Hindi Scientific Seminar on 'Changing Scenario in Marine Fisheries Research and New Dimensions' at CMFRI, Cochin presented a paper in Hindi on Training facilities in mariculture

March 3, 1998

Dr. P. Kaladharan, Scientist
on "Advances and priorities in Fisheries Technology" organised by SOFT and CIF at Cochin and presented a paper

February 11-13, 1998

The First National Seminar on "Trends in Marine Biotechnology" organised by the Institute for coastal area studies, Manonmanium Sundaranar University at Nagercoil and presented a paper

December 14-15, 1998

Shri G.S. Daniel Selvaraj, Sr. Scientist
National Seminar on Development and Transfer of Fisheries Technology at Fisheries College, Tuticorin

February 3-5, 1999
Dr. A.K. Unnithan
Technical Officer

Intensive Pokkali (a variety of paddy) cultivation development programme and Farmers' Seminar organised jointly by Ezhikkara Grama Panchayat (Ernakulam District) and Krishi Bhavan of Dept. of Agriculture, Govt. of Kerala and delivered lecture on shrimp farming

Farmers' Seminar organised by Dept. of Fisheries Govt. of Kerala in Kottuvally Panchayat (Ernakulam District) and delivered talk on 'Integrated farming in brackishwater areas.'

Delivered a talk over the Trichur Station of All India Radio on 'Crab farming'

Ms. K.S. Sobhana
Scientist

Training Course on 'Hybridoma Technology for Aquaculture health management' at College of Fisheries, Mangalore

Dr. K.K. Appukuttan
Head, MFD

Special invitation for lecture on Mariculture in India - on the occasion of 60th Anniversary of University of Kerala at All Saints College, Trivandrum under Talks on popular scientific topics.

Attended M.G. University M.Sc. (Fisheries) pre-valuation Board Meeting at Kottayam.
Participated in the symposium on "Advances and Priorities in Fisheries Technology" conducted by CIFT, Cochin February 11-13, 1998

Attended meeting at Thripayar, Trichur organised by AIR presented a paper on mussel farming December 19, 1998

Felicitation on behalf of the Director, CMFRI.

Attended meeting at Coimbatore and presented the details of the project on Bivalve seed production and farming. December 21, 1998


Attended Steering Committee meeting of Kollam Dist. Janakeeya Matsyakrishi at Kollam. July 98

Attended National Seminar on Aquaculture in the Changing Environmental Perspectives organised by Dept. of Aquatic Biology & Fisheries, University of Kerala. March 98

Attended 2 days Seminar on Pearl culture at Mandapam Camp organised by CMFRI February 98
<table>
<thead>
<tr>
<th>Name</th>
<th>Role</th>
<th>Participation Details</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shri T.S. Velayudhan,</td>
<td>Senior Scientist</td>
<td>Participated in Workshop on Germplasm Inventory &amp; Gene Banking, organised by NBFGR, Lucknow at CMFRI, Cochin.</td>
<td>October 12-13, 1998</td>
</tr>
<tr>
<td>Dr. P. Muthiah,</td>
<td>Senior Scientist</td>
<td>Participated in seminar on Recent developments in Pearl culture, Grouper culture and crab farming at Mandapam Camp.</td>
<td>February 6-9, 1998</td>
</tr>
<tr>
<td>Dr. V. Kripa,</td>
<td>Scientist (Sr. Scale)</td>
<td>Attended International Symposium on Large Marine Ecosystems: Exploration and Exploitation for sustainable Development and Conservation of fish stocks organised by Fishery survey of India at Cochin.</td>
<td>November 25-27, 1998</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Participated in the seminar on 'Sustainable Fishery resources management strategies for Kerala organised by Fisheries Resource Management Society, Kerala at Cochin.</td>
<td>August 8, 1998</td>
</tr>
<tr>
<td>Dr. P. Laxmilatha,</td>
<td>Scientist</td>
<td>Participated in Workshop on Germplasm Inventory &amp; Gene Banking, organised by NBFGR, Lucknow at CMFRI, Cochin.</td>
<td>October 12-13, 1998</td>
</tr>
<tr>
<td>Shri S.R. Krupesha</td>
<td>Scientist</td>
<td>Participated and presented a paper in the National Conference on Advances in Diagnostic Veterinary Pathology conducted by the Indian</td>
<td>November 9-11, 1998</td>
</tr>
</tbody>
</table>
Association of Veterinary Pathologists at College of Veterinary & Animal Sciences, Kerala Agricultural University, Trichur.

Dr. B. Manojkumar, Shri A.P. Dineshbabu, Scientists
Experience sharing workshop on "Fisheries sector development for the State of Gujarat" organised by the Commissionerate of Fisheries at IIM, Ahmedabad

September 22-23, 1998

Shri Joe K.Kizhakudan, The Consultative Committee meeting of Scientists
Fishery Survey of India, Porbander base at Gandhinagar

November 18, 1998

Shri K.Prabhakaran Nair, Sr. Scientist
31st meeting of TOLIC at Office of Chief Postmaster General, Thiruvananthapuram
32nd meeting of TOLIC at Hindustan Latex Ltd., Peroorkada

April 24, 1998
August 28, 1998

International Conference on Natural Resource Management and Conservation, Department of Environmental Science, University of Kerala, Thiruvananthapuram

November 19-20, 1998

First National Seminar on Trends in Marine Biotechnology, Institute of Coastal Area Studies (ICAS), (M.S. University), Nagercoil

December 14, 1998

Shri G.P.K. Achary, Sr. Scientist
National Seminar on "Aquaculture in the Changing Environmental Perspectives" organised by Department of Aquatic Biology and Fisheries, Thiruvananthapuram
Workshop on "Recent developments in cage culture and sea farming" at Mandapam Regional Centre of CMFRI, Mandapam Camp

March 25-27, 1998
June 26-27, 1998
Department of Environmental Sciences, University of Kerala, Trivandrum

Seminar on "Trends in Marine Biotechnology, ICAS, M.S. University
Nagercoil December 14-15, 1998

Shri G.P.K. Achary, Joint Hindi Workshop at Sree Chitra
Sr. Scientist Tirunal Institute of Medical Sciences
Smt. S. Jasmine, and Technology, Thiruvananthapuram
Scientist November 13, 1998

Dr. Rani Mary George, Seminar on Fisherwomen Welfare Co-
Sr. Scientist operatives and Self Employment Schemes
convened in connection with All India
Aquarium Fare at Thiruvananthapuram January 9, 1998

National Seminar on “Aquaculture in the Changing Environmental Perspectives” March 25, 1998
organised by Department of Aquatic Biology and Fisheries, Thiruvananthapuram


Dr. A.P. Lipton Seminar on “Recent Trends in Ultra-
Sr. Scientist microtomy and Cryotechniques” at
Trivandrum April 9, 1998

International workshop on the "Management and Culture of Marine Species used in Traditional Medicine” July 5-9, 1998
at Cebu, Philippines
First National Seminar on "Trends in Marine Biotechnology" ICAS, M.S.
University, Nagercoil December 14-15, 1998
Shri D.C.V. Easterson, Sr. Scientist
Two day Workshop organised by M.S. Swaminathan Research Foundation on “Conservation of the Gulf of Mannar Marine Biosphere Reserve” and delivered a lecture on “Impact of Marine Pollution on the Ecological Resources of Gulf of Mannar”

National Seminar on “Coastal Zone Management” organised by Manonmaniam Sundaranar University, Tirunelveli and presented a paper on “Biodiversity, Coastal Zone and Management Strategies.”

Tamil Nadu State Fisheries Advisory Board at Tuticorin January 7, 1999

Training course on Entrepreneurship Development Course at the Fisheries College and Research Institute, Tuticorin November 9, 1998

Committee meeting of CECRI, Tuticorin for selecting Research Associates July 29, 1998

Valedictory function of Training in chromosomal Technology at Kamaraj College October 26, 1998

Shri A. Chellam Sr. Scientist
First National Seminar on Trends in Marine Biotechnology at the Institute for Coastal Zone Management (MS University), Nagercoil and presented a paper “Biotechnological aspects in production of quality marine pearls December 14-15, 1998.”
Delivered a lecture on Pearl culture to the final year Degree students of Kamaraj College, Tuticorin

Dr. D.B. James
Seminar on Human Resources Development
Sr. Scientist in Fisheries Sector in Tamil Nadu organised by Fisheries Technocrats Forum, Chennai

Workshop on Coastal Biodiversity of Gulf of Mannar organised by M.S. Swaminathan Research Foundation at Chennai

Shri S. Dharmaraj
Senior Scientist
Participated and presented a scientific paper in the National Seminar on Trends in Marine Biotechnology at Nagercoil

Dr. N.G.K. Pillai
Symposium on Advances and priorities in Fisheries Technology
February 11-13, 1998
Dr. R.P. Pillai
Principal Scientist
February 10-11, 1998
Shri M. Sivadas

Dr. N.G.K. Pillai
Head, PFD
Sustainable fishery resource management strategies for Kerala organised by the Fisheries Resource Management Society, Kerala, Cochin

Workshop on germ plasm inventory and genebanking of freshwater fishes Organised by National Bureau of Fish Genetic Resources, Lucknow at CMFRI, Cochin

Colloquium on Marine Benthos organised by the Dept. Of Ocean Development, School of Marine Sciences, CUSAT, Cochin

August 8, 1998

October 12-13, 1998

March 6, 1999
Task Force Meeting on "Harvest Technology and catch composition of deep sea fishery resources of Indian EEZ, organised by DOD/CIFT, Cochin March 8, 1999

International Symposium on Large Marine Ecosystems: Exploration and exploitation for Sustainable development and conservation of Fish stocks, FSI, cochin November 25-27, 1998

Dr. C. Muthiah
Senior Scientist
Meetings on "Brackishwater Fishfarmers Development Agency, Mangalore September, 1998
Meeting on Re-classification of mudflats under coastal zone management plan, Bangalore September, 1998
West coast zonal fisheries Meet, Mangalore September, 1998

Dr. A.K. V. Nasser
Scientist
Seminar on "Clean and healthy environment" Dept. of Science & Technology, Lakshadweep June 1998
Training Programme on "Live feed culture" TTC of CMFRI, Cochin November, 1998
Talk on "Protect our coral reefs and mangroves," AIR, Kavaratti April, 1998


Dr. A.A. Jayaprakash
Senior Scientist
International Symposium on "Large Marine Ecosystem: Exploration and exploitation for sustainable development and conservation of fish stocks" FSI, Cochin November 25-27, 1998
UGC sponsored National Seminar
On Ocean Fish and Fisheries,
Irningalakuda

March 24-25, 1999

Mrs. Prathibha Rohit
Scientist (Sr. Scale)

Talk in English on the Role of CMFRI
in marine fisheries and mariculture at
College of Fisheries, Mangalore, to
Officers of the State Fisheries Depts.
attending the Training Programme for
officers of the State Fisheries Dept.

May 14-26, 1998

Talk in Kannada on "Mussel and Clam
Culture" at Nada Dhoni Meenugarara
Singha, Upunda to fisherwomen
Participating in the Fisherwomen’s
Advanced training programme

September 22-26, 1998

Meeting attended the Mangalore District
level meeting convened by the District
Collector held to discuss the causes of
marine fish famine along Karnataka coast

October 24, 1998

Dr. P.N.R. Nair
Senior Scientist

"Sustainable fishery Resource Management
Strategies for Kerala" organised by the
Fisheries Resource Management Society,
Kerala, Kochi

August 8, 1998

International Symposium
on Large Marine Ecosystem: Exploration
and Exploitation for Sustainable Development
and Conservation of Fish Stock by FSI, Cochin

November 25-27, 1998

Shri K. P. Said Koya
Scientist

Review meeting of KVKs/TTCs at
Coimbatore

October 28-30, 1998

Participated in the District level
planning for implementation of
Janakeeyasuothrana samithy at DD
Fisheries, Ernakulam

May 4, 1998
Panchayath level project formulation meeting at Nayarambalam June 17, 1998

S/Shri K.P. Said Koya, P.P. Manojkumar, Dr. P.K. Martin, S/Shri A.N. Mohanan and P. Radhakrishnan organized and conducted the National Youth Week programmes in seven different places of Vypeen island for rural youth in association with field publicity office, Food and Nutrition board, Ernakulam and Tapovanam, an NGO at Puthuvype covering different subjects in Fisheries, Agriculture and Home Science January 5-13, 1998

Shri P. Radhakrishnan, Technical Officer organized Workshop on water management organised by Kuzhupilly Panchayath at Ayyampilly March 12, 1998

Dr. P.K. Martin Thompson, S/Shri A.N. Mohanan organized Farmers' day programme at Chellanam and delivered lecture on "Prospects of prawn farming in Kerala and prawn farm management after stocking of prawn seed" March 18, 1998, March 25, 1998


Dr. R. Paul Raj, Sr. Scientist Meeting of the Management Committee of CMFRI March 23, 1998

NATP Sensitization Workshop on Priority-setting, monitoring and evaluation in Agricultural Research organised by National Centre of Agriculture Policy, New Delhi August 26-27, 1998
ICAR Fisheries Institute Directors meeting at CMFRI and CIFT, Kochi

Meeting of the Management Committee of CMFRI, Mandapam Camp

Dr. P. Nammalwar
Sr. Scientist

National Review Committee Meeting on mangroves and coral reefs at Annamalai University, Tamilnadu, sponsored by Ministry of Environment and Forests, New Delhi

Participated as resource person in the seminar/workshop on "Fisheries Management" at Quaid-E-Millath Govt. College for Women, Chennai

Dr. E. Vivekanandan
Sr. Scientist

Presented the "Methodology on Fisheries Data Collection" in the GIS based Programme of DOD at Chennai

Meeting on "Development of ornamental fish export" organised by the MPEDA at Chennai

Ornamental fish breeders meet at Chennai

Presented a series of lectures to the officials of Fisheries Department, Govt. of Tamil Nadu on fish stock Assessment

Presented a paper on "Experience sharing workshop on Gujarat Fisheries" in the Indian Institute of Management, Ahmedabad
Regional Workshop on "Socio-economics and Management of coastal fisheries" conducted by the ICLARM at Hatyai (Thailand) September 23 to December 1, 1998

Shri M. Sivadas Symposium on "Large Marine Ecosystem: Exploration and Exploitation for Sustainable development and conservation of fish stocks organised by FSI at Cochin November 25-27, 1998

Shri Gulshad Mohamed National Symposium on seaweeds and their utilization organised by Seaweed Research and Utilization Association and Department of Microbial Technology, Madurai Kamaraj University and presented two papers on seaweeds of Minicoy, Lakshadweep at Madurai May 8-10, 1998

International Conference on Natural Resource Management and Conservation (ICNRMC'98) organised by Department of Environmental Sciences, University of Kerala at Thiruvananthapuram and presented a paper November 19-21, 1998

Dr. Kuber Vidyasagar National Seminar on 'Vision on Indian Fisheries of 21st Century' at C.I.F.E., February 7-8, 1998

Shri M.Z. Khan, Dr. V.V. Singh and Ms. Arpita Sharma

Dr. Kuber Vidyasagar 29th Consultation Group meeting at FSI, April 2, 1998

Sr. Scientist

29th Consultation Group meeting at FSI, Mumbai

Colloquium on predictive Modeling for Marine Fisheries at CIFE, Mumbai May 5-6, 1998

A function arranged by the State Govt. of Maharashtra with open session of
<table>
<thead>
<tr>
<th>Event Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Fishery workshop organised by State Government</td>
<td>October 10, 1998</td>
</tr>
<tr>
<td>Dr. Kuber Vidyasagar, Dr. V.D. Deshmukh, Shri S.G. Raje, Dr. V.V. Singh and Ms. Arpita Sharma</td>
<td>November 11, 1998</td>
</tr>
<tr>
<td>Workshop on ‘Fishery Resources along Maharashtra Coast and scope for deep sea fishing’ organised by FSI, Mumbai and Karanja Machhimar Vividh Karyakari Sahakari Society Ltd., Karanja at Karanja, Maharashtra</td>
<td>January 16, 1999</td>
</tr>
<tr>
<td>Tutorial cum Workshop on IRS-P3 MOS data handling and utilization, Space Application Centre (SAC)</td>
<td>February 11-13, 1998</td>
</tr>
<tr>
<td>Delivered a specially invited guest lecture on “Coastal Zone Management and Aquaculture” to the trainees of the training programme on essentials of Environmental impact assessment EIA studies related to Aquaculture Project</td>
<td>June 2, 1998</td>
</tr>
<tr>
<td>Delivered a special lecture to the officers and staff at Fishery Survey of India, Hqrs. Mumbai on the occasion</td>
<td>August 6, 1998</td>
</tr>
</tbody>
</table>
of "The World Ocean's Day" and on the topic "ICZM with reference to the Environment and Oceans"

Delivered a lecture in the Fisherfolk Cooperative Meet on topic "Machli Ke Utpadan Me Vriddhi" in Hindi in a state level function of the Fisherfolk Community August 16, 1998


Second meeting on 'Use of dry ice in fishing vessels' organised by the Commissioner of Fisheries, Maharashtra State at FSI, Mumbai January 18, 1999

Ms. Arpita Sharma Workshop on Methodologies in Ergonomics at Industrial Design Center, Indian Institute of Technology (IIT), Mumbai May 18-22, 1998

Shri Sujit Sundaram Training course entitled 'Essentials of Environmental Impact Assessment (EIA) studies related to agriculture project organized by CIFE, Mumbai May 25, 1998 to June 4, 1998

Shri S.G. Raje and Ms. Arpita Sharma Presentation on topic 'Fishery Co-operative Society at Versova' and 'Fishery Co-operatives' respectively to fisherfolk arranged by Cooperative assistance and Relief Everywhere an International Organization and Sagar Putra Vidya Vikas Sanstha, Dabhol, Maharashtra August 27, 1998
Dr. V.D. Deshmukh,
National Symposium on Eco Physiology
and Conservation on Aquatic Resources
at Institute of Science, Mumbai
January 8-11, 1999

Dr. V.V. Singh
National Symposium on Eco Physiology
and Conservation on Aquatic Resources
at Institute of Science, Mumbai
January 8-11, 1999

Dr. V.S.K. Chennubhotla
Principal Scientist
National Workshop on coastal marine
culture systems organised by the
Department of Ocean Development,
Govt. of India at Andhra University,
Visakhapatnam
February 16-17, 1998

UGC sponsored National Seminar on
"Conservation of lakes in urban
environment" at Vivek Vardhini
College, Hyderabad
June 12-14, 1998

Meeting convened by President,
Confederation of Seafood Exporters
Association, in connection with the
visit of His Excellency Al I Riaz
Iravash, Counsellate-General Islamic
Republic of Iran at Hotel Grand
Bay, Visakhapatnam
September 17, 1998

Dr. G. Syda Rao
Sr. Scientist
Served as member, Board of Post-
graduate studies, Dept. of Zoology,
Andhra University, Visakhapatnam

Served as member in the expert group
on "Marine Living Resources in
SAARC countries" Centre for SAARC
studies, Andhra University,
Visakhapatnam.

Shri K. Vijayakumaran
Scientist
National Seminar on Conservation of
Eastern Ghats at Visakhapatnam and
presented a paper on Propagation of
two species of Palm as a part of
integrated coastal zone management
March 24-26, 1998
<table>
<thead>
<tr>
<th>Event</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Seminar on Aquaculture Economics at CIBA, Bhubaneswar</td>
<td>October 6-8, 1998</td>
</tr>
<tr>
<td>Dr. U. Rajkumar, Scientist</td>
<td>National Workshop on Recent advances in hormonal physiology of fish and shellfish production at CIFA, Bhubaneswar</td>
</tr>
<tr>
<td>Dr. E. Dhanvanthari, Scientist</td>
<td>National Workshop on Recent advances in hormonal physiology of fish and shellfish production at CIFA, Bhubaneswar</td>
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<td>National Workshop on Development of Technical guidelines on Health certification and quarantine for the responsible movement of live aquatic animals at CIFA, Bhubaneswar</td>
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<td>The training programme on “Brackishwater finfish breeding” at CIBA, Chennai</td>
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<td></td>
<td>The training programme on application of statistical methods in Fisheries Research at CMFRI Cochin</td>
</tr>
<tr>
<td>Shri P.U. Zachariah,</td>
<td>Meeting convened by the Deputy Commissioner, Dakshina Kannada</td>
</tr>
</tbody>
</table>
District to discuss about the fish famine along Karnataka coast during post monsoon months at Zila Parishad Hall, Mangalore

October 4, 1998

Smt. Rekha J. Nair
Scientist

Symposium on "Advances & Priorities in Fisheries Technology" at CIFAT, Cochin

February 11-13, 1998

Dr. S. Sivakami,
Smt. Rekha J. Nair &
Dr. K.K. Joshi,

International Symposium on Large Marine Ecosystems - Exploration and Exploitation for sustainable development and conservation of fish stocks organised by FSI, Cochin

November 25-27, 1998
WORKSHOP, SEMINARS, FARMERS’ MEETS ORGANISED

1. Fishermen meet at Pulicat, Chennai on 6-8-1998 to extend the techniques of mussel, clam, edible oyster and pearl oyster. A total of 60 fishermen participated.

2. Training programme at Madras Research Centre for the officials of the Department of Fisheries, Govt. of Tamil Nadu on “Sampling methodology for collection of fishery statistics and fish stock assessment” from 15.9.98 to 24.9.98.


4. Seminar on “Recent Developments in Pearl culture, groupers and crab farming” was conducted at Mandapam Regional Centre of CMFRI, Mandapam Camp on 6th and 7th February 1998.

5. Course Programme of Microbiology, Biochemistry genetics and Biotechnology for the post-graduate students of Professor Dhanapalan College for Women, Kalambakkam, Chennai from 19th to 21st February 1998.

6. Training course on “Finfish Mariculture” at Mandapam Regional Centre of CMFRI from 1st to 11th December 1998.


8. Training programme on “Seaweed culture and Utilization” from 21-30 September 1998 at Mandapam Camp.

9. Fisherfolk meet at the Mumbai Research Centre at Versova, Mumbai. Topic of the meet was ‘Need of research and management in fisheries’.

10. Mumbai Research Centre organized a discussion with fisherfolk on 23.9.98 at Versova on topic ‘Problems of Fisherfolk of Versova’ in Hindi.

11. A ‘Vyakhyan Mala’ was organized at Mumbai Research Centre on 24.9.98.
Cochin
Shri T.K. Ramakrishnan, Minister for Fisheries & Rural Development, Govt. Of Kerala
Dr. R.S. Paroda, Director General, ICAR, New Delhi
Tudor Amarasena Rajapakse, National Aquatic Resources Agency, Colombo, Srilanka
Shri Ram Singh, IAS, Secretary, Department of Fisheries, Trivandrum
Gerbond Redoanz, Team Leader, Indo-German Reservoir Fisheries Development Project, Malampuzha
Shri Jyothilingam, K.R., IAS, Director of Fisheries, Trivandrum
Dr. S.L. Mehta, Deputy Director General (Education), ICAR, New Delhi
Shri Dereck Johnson, IDRC Scholar, University of Guelph, Canada
Shri D. Biswas, Senior Engineer, CPWD, Rajkot
Dr. Gian Singh, Director and Dr. R.S. Vaghani, Senior Agronomist, VMA, Oil Seed Research and Development Institute, New Delhi
Dr. A. Alam, DDG (Engg.), ICAR, New Delhi
Dr. Martin Kumar, Sr. Scientist, SARDI, Australia
Dr. K. Gopakumar, DDG (Fy), ICAR, New Delhi

Veraval
Dr. A.V.R.L. Narasimhacharya, Reader, Department of Bio Sciences, Sardar Patel University, Vallabh Vidyanagar
Shri N.A. Vhora, Commissioner of Fisheries, Gujarat State and his team of Deputy Directors from Gujarat State Fisheries

Mumbai
Shri Anil Kumar Joshi, Deputy Director (Hindi), ICAR, New Delhi
Shri Anil Kumar Dube, Director (Hindi), ICAR, New Delhi

Mangalore
Dr. P. Keshavanath, Professor & Head, Dept. of Aquaculture, College of Fisheries, Mangalore
Mr. Anupam Sharma, Senior Research Fellow, Dept. of Aquatic Biology, College of Fisheries.
Mangalore
Mr. Chandra Marakala, M.F.Sc. student, Dept. of Fishery Resources & Management, College of Fisheries, Mangalore

Dr. Ramachandra Bhat, Professor & Head, Dept. of Fisheries Economics, College of Fisheries, Mangalore

Shri B.K. Chauhan, I.A.S, Secretary, ICAR & Joint Secretary, DARE, Krishi Bhawan, New Delhi

Mr. Srikantha CNR, Project Fellow, DOD-ICMAM, Dept. of Marine Geology, Mangalagangothri,

Mr. V. Hariharan, Professor & Head, Department of Fishery Oceanography, College of Fisheries, Mangalore

Dr. M.N. Venugopal, Associate Professor, Dept. of Microbiology, College of Fisheries, Mangalore

Mr. R.N. Nagaraju, Chief Executive Officer, B.F.D.A., Brahmanvar.

Vizhinjam

Dr. R.S. Paroda, Director General, ICAR, New Delhi

Shri K.R. Jyothilal, I.A.S., Director of Fisheries, Govt. of Kerala

Dr. E.G. Silas, Former Director of CMFRI and former Vice-Chancellor, Kerala Agricultural University

Dr. Martin S. Kumar, Senior Scientist, SARDI Aquatic Sciences, South Australia.

Shri T.A. Rajapakse, National Aquatic Resources Agency, Colombo, Sri Lanka

Shri A.K. Gupta, Director (Works), ICAR, New Delhi

Shri N. Vasudevan, Managing Director, Matsyafed, Thiruvananthapuram

Dr. Arun Varma, ADG ANP, Krishi Bhavan, New Delhi

Shri P.K. Chatterjee, I.A.S., Resident Commissioner of U.P. Government in Calcutta

Justice A.M. Mir, Jammu & Kashmir High Court

Shri V.S. Iyer, Atomic Energy Regulatory Board, Mumbai

Shri R.S. Bhandari, Principal Private Secretary to Director General, ICAR, New Delhi.

Dr. G.S. Dhaliwal, Professor, Horticulture, Punjab Agriculture University, Ludhiana, Punjab

Shri G.M. Srirangam, Head, Department of Industrial Fish & Fisheries, Andhra Loyola College, Vijayawada, Andhra Pradesh
Dr. K. Gopalumar, Deputy Director General (Fisheries), ICAR, New Delhi

Shri T.M. Jacob, MLA & Former Minister for Education, Govt. of Kerala
Members of Board of Management, A.N.G.R., Agriculture University, Hyderabad, Andhra Pradesh

Chairman & Members, RAC of CMFRI

Tuticorin

Mrs. Jenifer Chandran, Honourable Minister for Fisheries, Govt. of Tamil Nadu

Dr. Hansraj Verma, Director of Fisheries, Department of Fisheries, Tamil Nadu

Shri J.R. Nebhorio, Commissioner of Customs, Tiruchi

Shri T.K. Rajendran, I.P.S., DIG, Tirunelveli Range
Dr. M.N. Kutty, Retd. Professor, Puthur, Pallakkad

Dr. Usha Desai, Atomic Energy Regulatory Body, Mumbai

Dr. O.R. Reddy, Dy. Director (PP), Plant Quarantine Station, Ministry of Agriculture, Government of India, Chennai

Dr. G. Balasingam, FAO Consultant, Lodi Estate, New Delhi

Shri K.P. Mishra, Commissioner of Customs, Patna

Shri S.X. Prince, Assistant Director (Aqua), MPEDA, Kochi

Mandapam Camp

Dr. (Mrs) Vasanthi Devi, Vice Chancellor, Manonmaniam Sundaranar University, Tirunelveli

Dr. M. Dorairaj, Assistant Conservator of Forests, Tirunelveli

Prof. K. Udayakumar, Director, College Development Council, University of Kerala, Trivandrum

Prof. R.V. Dhanapalan, Chairman, Prof. Dhanapalan College for Women, Kalambakkam, Chennai.

Dr. K. Muthunayagam, Secretary, Department of Ocean Development, New Delhi

Dr. S.P. Dasthakumar, Joint Secretary, UGC, New Delhi

Mr. R. Soundaraj, I.F.S., Chief Conservator of Forests, Madurai

Mr. Balendra Shukla, Minister of Science & Technology, Government of Madhya Pradesh

Mr. N. Govindarajulu, District Judge, Pudukottai

Tudor Amadarsana Rajapakse, National Aquatic Resources Agency, Colombo, Srilanka
S.R.C. Ajaykumar, Joint Secretary, CSIR, New Delhi

Prof. A.K. Kumaraguru, Madurai Kamaraj University, Madurai

Dr. R.S. Bhandari, Principal Private Secretary to Director General, ICAR, New Delhi

Director, CECRI, Karaikudi

Vice Admiral Vinod Pasricha, Indian Navy.

Kakinada

Dr. S. Rajagopal, Dept. Aquatic Ecology University of Nijmegen, 6525 ED NJMEGEN, The Netherlands

Dr. D.E. Babu, Reader, Dept. of Zoology, Divn. of Physiol. and Aquaculture, Andhra University, Visakhapatnam

Dr. Max Troell, Ecologist, The Beijer Institute, The International Institute of Ecological Economics, The Royal Swedish Academy of Science, Stockholm, Sweden

Smt. J. Suguna, Lecturer, H.D. Degree College, AMG India International, Chilakalapudi, Guntur

Dr. P. Sardar, Scientist, CIFE Centre, Kakinada

Shri A.K. Yadav, Technical Officer and Shri S.K. Upadhyay, Trainees of Jammu & Kashmir from CIFE, Lucknow Centre

Shri R. Srinivasa Rao, Lecturer in Industrial Fish & Fisheries, Sri Subbaraya & Narayana College, Narasaraopet, Guntur.

Visakhapatnam

Dr. Ramamurty, Former Vice-Chancellor, Sri Venkateswara University, Tirupathi

Shri V. Luther Das, Dept. Zoology, Nagarjuna University, Nagarjuna Nagar along with his students

Professors and students of Scott Christian College, Calcutta
# Personnel (Managerial Position Only)

1. **Director**
   - Dr. M. Devaraj

2. **Heads of Divisions**
   - **Fishery Resources Assessment Division**
     - **Director**
       - Shri K. Narayana Kurup
     - **Sr. Scientist**
   - **Pelagic Fisheries Division**
     - **Director**
       - Dr. N. Gopalakrishna Pillai
   - **Demersal Fisheries Division**
     - **Director**
       - Dr. V. Sriramachandra Murty
   - **Crustacean Fisheries Division**
     - **Director**
       - Dr. G. Sudhakara Rao
   - **Molluscan Fisheries Division**
     - **Director**
       - Dr. K.K. Appukuttan
   - **Fishery Environment Management Division**
     - **Director**
       - Dr. V. Narayana Pillai
   - **Physiology, Nutrition and Pathology Division**
     - **Principal Scientist**
       - Dr. M. Peer Mohamed

3. **Sr. Administrative Officer**
   - Shri Nand Kishore

4. **Sr. Finance & Accounts Officer**
   - Shri Radhey Sham

5. **Administrative Officer**
   - Shri P.S. Sudersanan

6. **Officers-in-Charge of Research Centres**
   - **Mandapam Camp**
     - **Sr. Scientist**
     - Dr. A.C.C. Victor
   - **Chennai**
     - **Principal Scientist**
     - Sr. Scientist
     - Shri K. Dorairaj
   - **Tuticorin**
     - **Sr. Scientist**
     - Dr. H. Mohamed Kasim
   - **Kakinada**

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**Note:**
- The list includes key positions and the names of individuals responsible for various divisions and research centres within the organization.
<table>
<thead>
<tr>
<th>Location</th>
<th>Name</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karwar</td>
<td>Dr. V.S. Kakati</td>
<td>Sr. Scientist</td>
</tr>
<tr>
<td>Mangalore</td>
<td>Dr. C. Muthiah</td>
<td>Sr. Scientist</td>
</tr>
<tr>
<td>Veraval</td>
<td>Dr. B. Manojkumar</td>
<td>Scientist</td>
</tr>
<tr>
<td>Vizhinjam</td>
<td>Shri K. Prabhakaran Nair</td>
<td>Sr. Scientist</td>
</tr>
<tr>
<td>Mumbai</td>
<td>Dr. Kuber Vidyasagar</td>
<td>Sr. Scientist</td>
</tr>
<tr>
<td>Minicoy</td>
<td>Shri M. Sivadas</td>
<td>Scientist (SS)</td>
</tr>
<tr>
<td>Visakhapatnam</td>
<td>Dr. V.S.K. Chennubhotla</td>
<td>Principal Scientist</td>
</tr>
<tr>
<td>Calicut</td>
<td>Dr. P.S. Kuriakose</td>
<td>Principal Scientist</td>
</tr>
</tbody>
</table>
SPECIAL INFRASTRUCTURAL DEVELOPMENT

Veraval

One generator and oil free compressor were purchased for the mariculture laboratory and the chemistry laboratory was fully equipped with chemicals and glassware to take up environment monitoring studies. Museum was further strengthened by procuring additional jars and adding up several biological specimens. New aquaria were constructed for the biological studies and display.

Calicut

A modern multipurpose hatchery complex was constructed by modifying of an existing building. The complex was inaugurated by Dr. R.S. Paroda, Director General, ICAR on 7-12-1998. The complex has facilities for conducting advanced research on breeding and hatchery production of seeds of fishes, crustaceans and molluscs. The main features are a 200-tonne capacity seawater storage sump, 6 numbers of 10-tonne capacity grow out tanks, 5 numbers of 5-tonne capacity larval rearing tanks, 6 nos of 10-tonne capacity nursery rearing tanks, 2 nos. Of 10-tonne capacity broodstock tanks, and area for mass culture of live feed organisms. The complex has air-conditioned laboratory for stock culture of microalgae, a modern biotechnology laboratory, conference hall, and a library.

Cochin

A Marine Hatchery Complex having an area of 7080 sq.ft. has been constructed at the Headquarters premises for TTC at a cost of Rs. 35 lakhs. The complex was inaugurated by Dr. R.S. Paroda, Director General, ICAR on 8-12-1998.

The residential complex at Cochin was inaugurated by Dr. R.S. Paroda, Director General, ICAR on 8-12-1998.

Madras

The renovation work of the existing mariculture experimental shed has been almost completed. A mini hatchery building for spiny lobster has also been completed. Work on the sedimentation tank, sand-filter, seawater sump and overhead tank has been completed. Work has been assigned to the CPWD to execute the seawater intake system, generator facility, street-lighting etc.

Mandapam

The construction of 100 ton RCC tanks with drainage system has been completed for the maintenance of live breeders of groupers. Erection of a small borewell in the intertidal area of Gulf of Mannar adjacent to CMFRI Jetty for drawing clean seawater for hatchery operations. Construction of a 2 cement platforms inside the pearl oyster hatchery to facilitate the gravitational flow of filtered seawater from the storage tank to the larval rearing tanks. Provision of asbestos sheet covering for the sumps and sedimentation tanks. Extension of the existing pearl oyster farm in the Gulf of Mannar sea to an area of about 0.075 ha capable of holding 1 million
Dr. R. S. Paroda, Director General, ICAR
unveiling the plaque at the Calicut
Marine Hatchery Complex
on 7th December, 1998

Participants of the training course on
live feed culture held at Cochin

Multipurpose hatchery at Headquarters

Dr. R. S. Paroda, Director General, ICAR
unveiling the plaque at the Residential
Complex at Cochin on
8th December 1998
oysters of various sizes. An air-conditioned implantation room was set up at the southern part of the pearl oyster hatchery building for the nucleation of oysters under dust free environment.

The existing 8 small ponds were merged and converted into 3 grow-out ponds of 0.3 ha, 0.28 ha and 0.08 ha for shrimp culture experiments and the bunds have been elevated upto 0.3 m height at the fish farm. Drainout sump was constructed to provide alternate water exchange. Construction of sluice gates for 3 existing earthen ponds of 0.25 ha each for effective water exchange. Construction of water sump and erection of cement pipe lines to a distance of about 35 m from the shore to draw sea water through gravitational flow to the thereby feeding experimental culture ponds through pumping. Installation of 7 paddle-wheel aerators of 1 HP capacity each in the 5 experimental shrimp culture ponds for providing aeration. 3phase electrical supply was obtained from the EB to run the 12.5 HP motor for ensuring an interrupted supply of seawater to the ponds through the recently laid 6 dia PVC pipelines.

**Visakhapatnam**

Electrification of the new mariculture laboratory has been completed. Algal culture lab has been commissioned. FRP tanks were purchased for mariculture operations.