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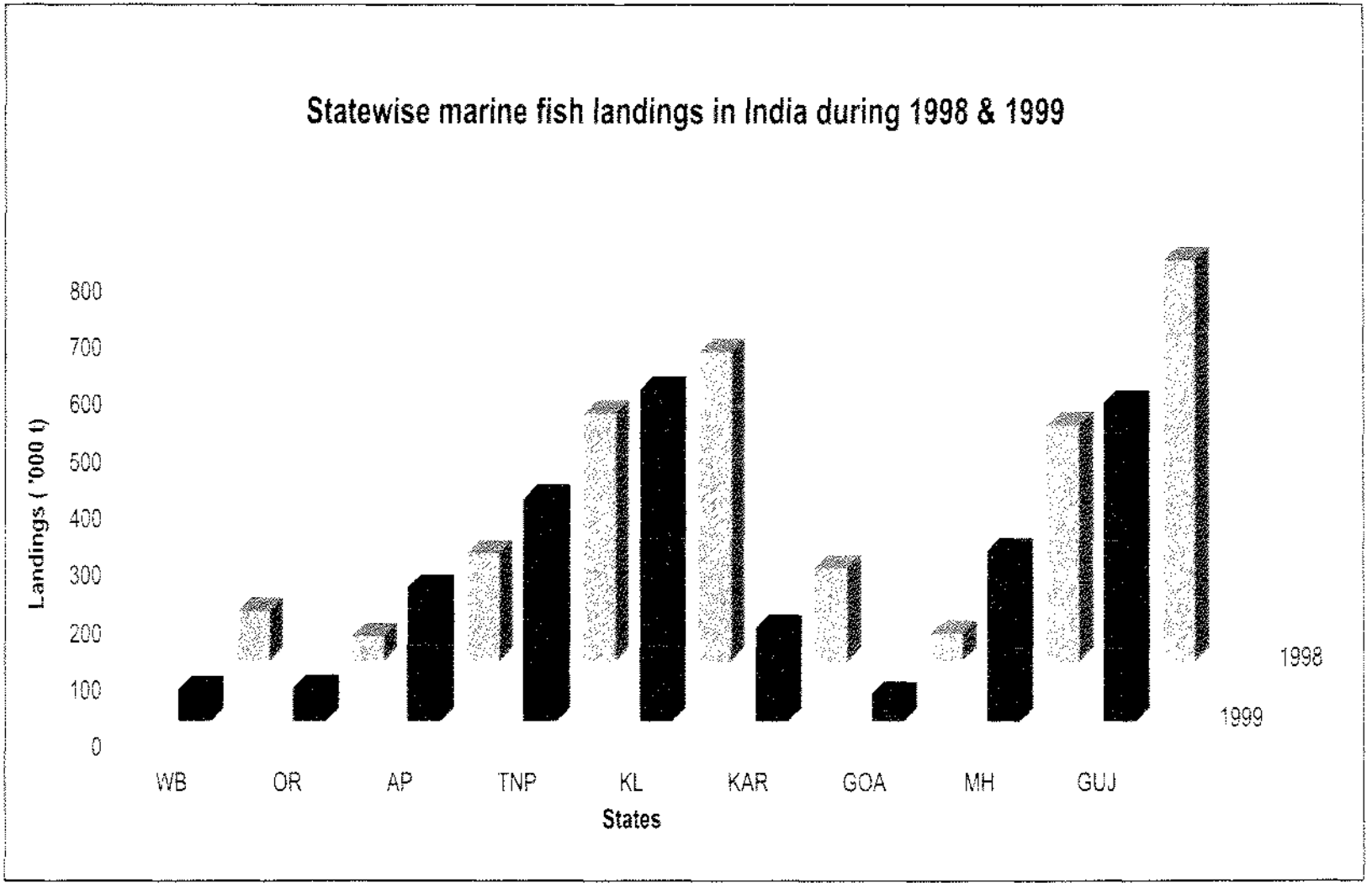
ANNUAL REPORT
1999 - 2000

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
Indian Council of Agricultural Research
Post Box No. 1603, Kochi - 682 014


Statewise marine fish landings in India during 1998 & 1999
Landings ('000 t)
800
700
600
500
400
300
200
100
0
WB
OR
AP
TNP
KL
KAR
GOA
MH
GUJ
States
1998
1999

ANNUAL REPORT
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CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
Indian Council of Agricultural Research
POST BOX NO: 1603, TATAPURAM P.O.
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Front Cover
Deep sea prawns - a resource holding potential for exploitation

Back Cover
Ring seine - a mass harvesting gear for coastal pelagics

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PREFACE

I have great pleasure in presenting the millennium's first Annual Report of Central Marine Fisheries Research Institute. Eventhough the achievements of the past have been rated high, the millennium challenge is to ensure a reasonable per capita seafood to our countrymen and to widen our seafood export trade in the coming decade. The hard option is to increase production through 1) careful treading of measures to ensure sustained yields from the present capture fisheries sector, 2) development of strategies for exploitation of deep sea and oceanic resources, 3) domestication of candidate species and utilization of potential areas for mariculture through upgradation of technologies, 4) Human Resource Development, and 5) transfer of technology programmes. The Central Marine Fisheries Research Institute has the Mandate to address these issues and has been consistently contributing to the needs of the industry and Government through its Research, Education, Extension and Consultancy programmes.

The Institute has successfully implemented the programmes under various in-house and sponsored research projects. The database on exploited fish stocks has proved helpful in formulating management measures and fishing ban impacts by maritime states and policy planners. The marine fish production of 2.42 million tonnes during 1999 was short by 10% over that of last year. However, it is gratifying to note that our earlier exploratory survey results from the outershelf/slope proved fruitful when the medium range trawlers fished substantial quantities of deep sea prawns during 1999 from the southwest coast through capacity building by innovative means.

Towards developing culture technologies the success in hatching out larvae of damselfish; brood stock development, egg laying and hatching in a highly priced ornamental fish like Pomacentrus pavo brought from Lakshadweep are worth mentioning.

The pearl oyster hatchery that has a production capacity of two million spat, established with the assistance under ICAR Revolving Fund (Rs.30,00,000) could realize a revenue of Rs.3,77,500 through sale of spat. In addition, 2.75 kg of pearls worth Rs.2,00,000 have been produced. Consequent on the successful transfer of mussel and oyster farming technology at several parts in Kerala and Karnataka, the BFFDA, DWRCA and NABARD have come forward to assist the prospective farmers.

Two Research projects under NATP were operational and ICAR sanctioned an Agricultural Technology Information Centre (ATIC) under NATP to disseminate information to the end users. Also an Agricultural Research Information System (ARIS) Cell has started functioning in the Institute. The Institute received external funding support for 9 research projects from within the country and 1 from abroad.

A total of 13 Consultancy/Contract services valued at Rs.36,81,130 have been taken up during the year on diverse areas of Institute's expertise.

I am sure that only CMFRI can answer to many of the issues of marine capture, culture and related aspects and the compliments go to all my colleagues for their great involvement in elevating the Institute to an enviable status. I am thankful to Dr. R.S.Paroda, Director General, ICAR for the support that he has been extending to achieve our targets. Dr.K.Gopakumar, Deputy Director General (Fy) and Dr. R.A.Selvakumar, Assistant Director General (M.Fy) have been of great support in sustaining the growth of the Institute.

Kochi
July, 2000

V.N.PILLAI
Director

EXECUTIVE SUMMARY

During 1999-2000 the CMFRI implemented the programmes of 67 ongoing in-house research projects, 9 projects sponsored by funding agencies in India, 2 by SIDA and one by ICLARM.

Database on exploited resources

The all India marine fish production of 2.42 million tonnes during 1999 indicated a decline by 10% over that of last year. The pelagic groups formed 52.9% and the rest was shared by demersal finfish, crustaceans and molluscs. The mechanised and motorised units together accounted for 91% of the total landings and the artisanal units 9%. The northwest region (Gujarat and Maharashtra) contributed 35.3% followed by southwest region (Kerala, Karnataka, Goa) 32.8%, southeast (Andhra Pradesh, Tamil Nadu and Pondichery) 25.8%, northeast (Orissa and West Bengal) 4.7% and Union Territories of Lakshadweep and Andamans 1.4%. The fishery along the northwest region suffered a severe set back as the production of 8.55 lakh t dipped by 2.64 lakh t over last year. The landings of 1.13 lakh t in the northeast and 6.2 lakh t in the southeast also indicated a reduction to the tune of 18,500 t (14%) and 2,900 t respectively. On the other hand along the southwest coast the landings of 7.92 lakh t was higher by 34,000 t against the previous year. At the all India level the resources which indicated increased production were: oil sardine, 2.4 lakh t (18%); lesser sardines, 1.27 lakh t (27%); mackerel 2.1 lakh t (18%); and ribbonfishes 1.25 lakh t (9%). All the other resources indicated a decrease in landings as: *Coilia* (34%), Bombayduck (25%); threadfin breams (9%), croakers (21%), penaeid prawns (20%), non-penaeids (15%), stomatopods (31%) and cephalopods (14%).

The data base established on a number of species has been put to analyses for studies on fishery and resource characteristics of exploited stocks.

The pelagic finfish production during 1985-99 fluctuated from 0.78 lakh t in 1985 to 1.33 lakh t in 1999 forming 55% of the total marine fish landings. The west coast accounted for 61.9% of the pelagics in 1999, east coast 36.3% and the rest was from island territories. The contribution from maritime states were: Kerala 28.2%; Tamil Nadu 22%; Gujarat 14.6%; Andhra Pradesh 9.8%; Maharashtra 9.5%; Karnataka 7%; Goa 2.7%; Orissa 2.1% and the rest from other states. While increase in the production was noticed in oil sardine (+18%), lesser sardines (+27%), ribbonfishes (+9%) and mackerel (+18%), resources like *Coilia* (-34%) and Bombayduck (-25%) showed a descending trend. Fishery and biological aspects of about 32 commercially important species have been analysed to study their population dynamics. The exploitation rate of oil sardine in Kerala and at Karwar was around 0.5 and 0.56 during the year. Among seerfishes *Scomberomorus commerson* is exposed to high fishing pressure by the gillnet. The empirical relationship of tuna fishery with meteorological parameters indicated that the wind force is one of the deciding factors in the success of pole and line tuna fishery at Minicoy.

The demersal finfish production was 0.65 lakh t and indicated a reduction to the tune of 12% over previous year. Nearly 65% of the

landings was from the mechanised sector. There was a decrease in production of elasmobranchs (-8,000 t), croakers (-36,000 t) along northwest coast; perches (-3,000 t), croakers (-7,000 t) along southwest coast; silverbellies (-4,000 t) along southeast coast and catfishes (-1,700 t) along northeast coast.

The reduction in the landings of rays mainly accounted for the downfall of the elasmobranch fishery. At Mumbai and Kozhikode *Scoliodon laticaudus*; and at Kochi and Chennai *Carcharhinus melanopterus* dominated the shark landings. The Atlas under preparation on elasmobranchs is in the final stage. The perch fishery was dominated by *Epinephelus tauvina* and *Lethrinus nebulosus* at Tuticorin where the trawls realised a higher c/e of 172 kg than gillnets and hooks and line. At Vizhinjam the perch landings were highest during May-June. At Kochi, the gillnets (96%) and at Kozhikode the trawls exploited the perches. Groupers and snappers constituted the fishery at the latter centre. Here large specimens of *Epinephelus diacanthus* (28-49 cm) were noticed during September. The production of silverbellies was down at all centres except at Kochi. *Leiognathus bindus* (20-120 mm) along upper east coast, *L. dussumieri* (70-150 mm) and *L. brevirostris* (65-195 mm) at Mandapam and *L. equulus* at Kozhikode dominated the fishery. Nearly 80% of croakers were landed by trawls. Among the sciaenids, at Veraval and Karwar *Otolithus cuvieri* and at Mumbai *Johnieops vogleri*, at Kozhikode *J. belengeri*, at Tuticorin *J. maculatus*, at Chennai *O. ruber*, and at Kakinada *Kathala axillaris* dominated the fishery.

The lizardfishes, dominated by *Saurida tumbil* at all centres also indicated a reduction in landings. *S. undosquamis* was observed to spawn throughout the year. The bull's eye catch showed an ascending trend at all centres. The highest c/e of 31 kg was at Mumbai. A gradual shift in higher yields (c/e) starting by November-December from Veraval to Kochi by July-September was interesting. Large fishes 205-245 mm were recorded from southern centres. Ripe gonads were observed during March-June at Kochi. Among threadfins *Polynemus indicus* dominated and were in 115-145 mm size. The pomfret fishery improved by 23 to 211% at various centres. *Pampus argenteus* and *Formio niger* were dominant species. The flatfish fishery confined to the southwest coast was mostly constituted by *Cynoglossus macrostomus* (50-179 mm). Availability and exploitation of larger species like *C. bilineatus* and *C. macrolepidotus* were mainly from southern Kerala. The species domination in goatfishes was area specific. *Upeneus taeniopterus* were in 90-259 mm length range. At Mangalore the length range of whitefish was 70-229 mm. The catch and c/e indicated a reduction over last year. Studies on the impact of bottom trawling on demersal fishes and macrobenthos showed that the target : bycatch ratio was 1:4.6 along southwest and 1:2.6 along southeast regions.

The crustaceans contributed 3.99 lakh t forming 16.5% of the total marine landings and showed a decline by 19.8% over last year. Penaeid prawns constituted 41.4%, non-penaeids 38.7%, lobsters 0.5%, crabs 6.9% and stomatopods 12.5%.

The penaeid catch from west coast was 1.09 lakh t compared to 0.55 lakh t realised from east coast. While the production from west coast was down by 32%, there was an increase by 4.8% along the east coast. The

decrease observed, except at Karnataka, was to the tune of 39% in Kerala, 43% in Goa, 30.5% in Maharashtra and 34% in Gujarat. The failure of the post monsoon fishery and diversion fishing for deep sea prawns led to the decrease in production in Kerala. *Parapenaeopsis stylifera* dominated the west coast landings, though the contribution by *Metapenaeus dobsoni* was significant at Mangalore, Kochi and Karwar. Peak spawning in *P. stylifera* was observed during May to December.

Along the east coast, Andhra Pradesh and Tamil Nadu accounted for 86% of penaeid prawn landings. *Penaeus semisulcatus* dominated, however, *M. monoceros* formed 45% of the prawn fishery at Visakhapatnam.

The deep sea fishing venture by the trawling fleet to exploit the prawn and lobster resources of southwest coast is a milestone achievement of the year. The potential and profitability in exploitation of these resources have been indicated decades back through the R&D efforts of the Institute. Nearly 11,218 t of deep sea prawns at 78 kg/hour was realised during November-December. Pandalid prawns like *Heterocarpus woodmasoni* (41.2%), *Plesionika spinipes* (31.5%), *H. gibbosus* (9.3%) and few others constituted the fishery. Non-penaeids formed 1.5 lakh t and showed a decrease by 11.2% compared to previous year. Gujarat accounted for 58.2% (-5.4%) and Maharashtra 28.6% (-34.3%). The 'dol' net in Gujarat obtained a catch/haul of 32-44 kg, compared to 15-33 kg at Mumbai. The trawls realised 21 kg/haul in Gujarat. *Acetes* spp. contributed 80-99% in both the gears except in trawls at Mumbai wherein *Nematopalaemon tenuipes* formed 99.8%.

Nearly 2,093 t of lobsters exploited during the year was less compared to 2611 t of the previous year. The west coast accounted for 85% of the lobster landings in the country. At Veraval *Panulirus polyphagus* and *Thenus orientalis*; at Kozhikode *P. homarus*; and at Tuticorin *P. ornatus* and *P. homarus* dominated the fishery.

The production of crab was 27,547 t against 34,276 t of last year. Except in Karnataka, the landings decreased at all the other centres. Major species observed were: Veraval, *Charybdis cruciata*; Karwar, *Portunus pelagicus*; Mangalore, *C. feriatus*; Mandapam, *P. pelagicus* and Chennai, *P. sanguinolentus*.

The cephalopod production was 92,292t. Compared to last year the landings showed an increase at Tadri, Mangalore, Kozhikode and Mandapam; and a decrease at Veraval, Mangrol, Mumbai, Karwar, Chennai, Kakinada and Visakhapatnam. Squids dominated the landings at Mangrol, Tadri, Mangalore, Malpe, Kozhikode and Chennai and cuttlefishes at other centres. At Kozhikode 4,781 t of green mussel *Perna viridis* and at Vizhinjam 174 t of brown mussels were landed.

Among clams *Meretrix casta* amounted to 455 t at Mangalore, 3 t of *Paphia malabarica* at Karwar and 1,152 t of *Anadara granosa* at Kakinada. The production of black clam was 37,036 t from Vembanad Lake and *Paphia malabarica* 480 t from Ashtamudi Lake. Nearly 4 million chanks were netted from southeast coast this year.

Mariculture

Progress has been achieved in the spontaneous spawning of the grouper *Epinephelus tauvina*. Larval rearing upto 13 days has been

carried out. Technology of breeding and seed production of clownfish has been perfected. Several batches of larvae of the highly priced ornamental fish, the blue damsel have hatched out. Also brood stock development, egg laying and hatching of *Pomacentrus pavo* brought from Lakshadweep have been achieved. Females of *Penaeus monodon* after unilateral eyestalk ablation were induced to mature under controlled conditions. Farming experiments using *Penaeus semisulcatus* and *P. monodon* realised a net profit of Rs 4.5 lakh at Mandapam. The larvae of seahorse obtained from natural spawning in the laboratory could be reared upto three weeks at Karwar.

The tissue culture programme in pearl oyster made good progress. The formation of nacreous layer over a bead is an achievement in this regard. Another achievement is the half pearl production from the abalone (*Haliotis varia*). For the first time mussels were farmed by direct settlement of seed on spat collectors and subsequently suspending them from the raft.

The project on commercial propagation of marine pearls under the ICAR Revolving Fund made good headway. Rs. 6.17 lakh was realised from sale of hatchery produced spat, mother oysters and pearls.

Monitoring environmental characteristics

Data on oceanographic and other environmental factors, in relation to biological productivity and fisheries, from the Indian Seas have been collected using vessel facilities. The coastal ecosystem health in relation to pollution and aquaculture activities was monitored from east and west coasts of the country. The sanitory significance of faecal coliforms in selected coastal environments growing marine shellfishes showed that the concentration of indicator organisms in these sites varied considerably in intensity and duration. The project on biodiversity also made good progress. Nearly 265 species consisting of sponges, gorgonids and Alcyonarian have been identified.

Studies on feed biotechnology proved the beneficial effects of gut probionts in shrimp feeds. It was shown that the pollution in aquaculture system can be minimised by keeping low P/N ratios of ingredients in the feed. The project on extraction and isolation of substances of pharmacological importance from marine organisms and as well the studies on population genetics of selected finfish/shellfish progressed well.

Extension programmes like 1) empowerment of coastal communities, 2) socio-economic survey of small scale fisheries in Lakshadweep and Kerala and 3) integration of small scale mariculture with small scale fisheries along the peninsular India made good progress.

All the programmes have been implemented and the sponsored projects made good headway. A total of 7 consultancy projects were completed and 6 are being continued.

Education and Training

Ten students of the 16th batch have completed their M.F.Sc programme. Two students were awarded Ph.D and another two have submitted their theses for adjudication. The KVK conducted 45 training programmes and the TTC organised 9, and a workshop.

INTRODUCTION

India is endowed with a long coastline of 8,129 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.

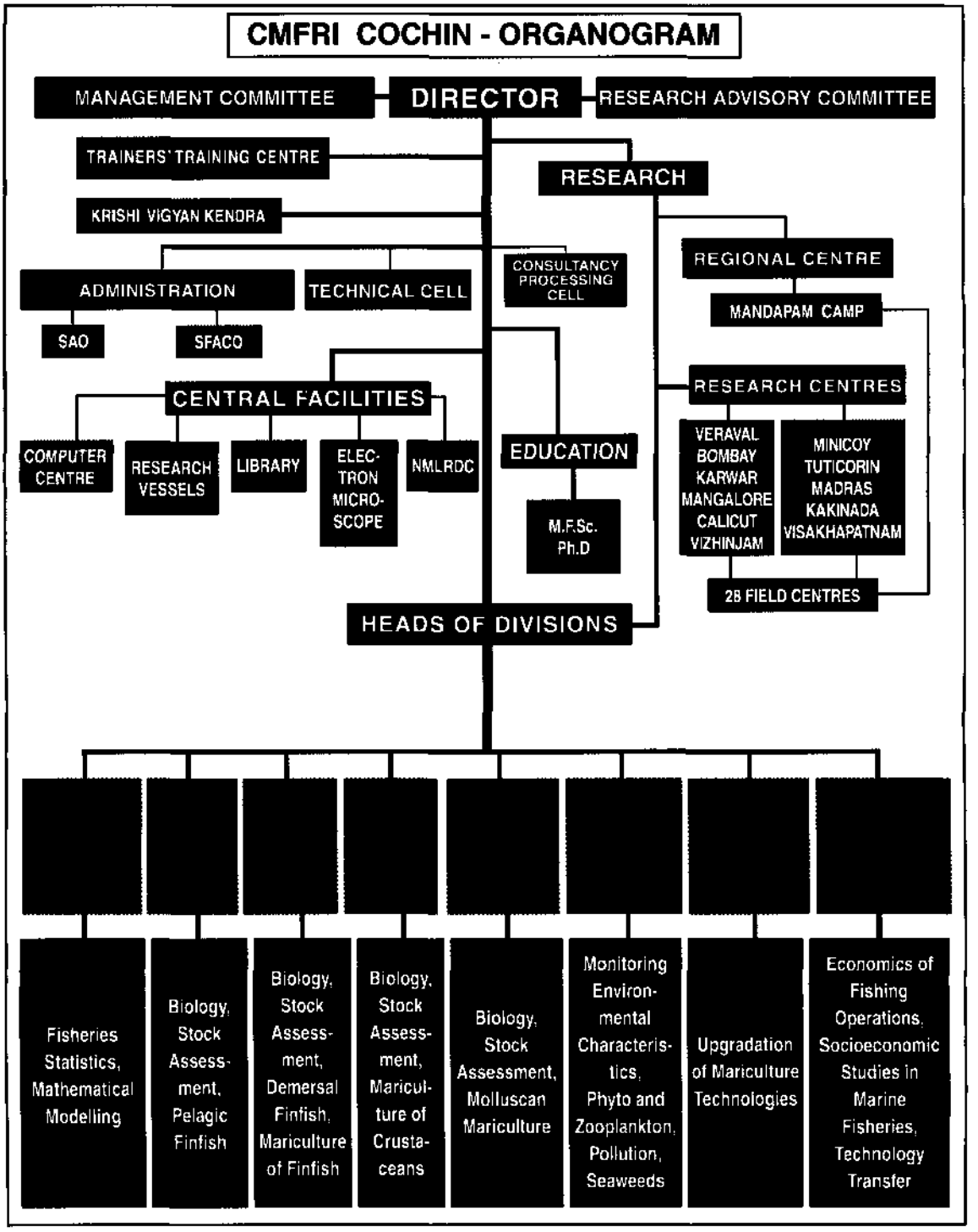
The Central Marine Fisheries Research Institute (established in 1947) is the nodal agency in India, responsible for research support in marine fisheries development. Over the period of nearly half a century since its inception, the CMFRI grew significantly in its size and stature by building up a fairly 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, Kozhikode, Vizhinjam, Tuticorin, Chennai, Kakinada and Visakhapatnam and 28 Field Centres all along the coast. The entire activity is coordinated by the Headquarters at Kochi. 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 190, Technical 416, Ministerial 176 and Supporting 329.

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.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VERAVAL BOMBAY KARWAR MANGALORE CALICUT VIZHINJAM
MINICOY TUTICORIN MADRAS KAKINADA VISAKHAPATNAM
28 FIELD CENTRES
HEADS OF DIVISIONS
Fisheries Statistics, Mathematical Modelling
Biology, Stock Assess-ment, Pelagic Finfish
Biology, Stock Assess-ment, Demersal Finfish, Mariculture of Finfish
Biology, Stock Assess-ment, Mariculture of Crusta-ceans
Biology, Stock Assessment, Molluscan Mariculture
Monitoring Environ-mental Characteris-tics, Phyto and Zooplankton, Pollution, Seaweeds
Upgradation of Mariculture Technologies
Economics of Fishing Operations, Socioeconomic Studies in Marine Fisheries, Technology Transfer

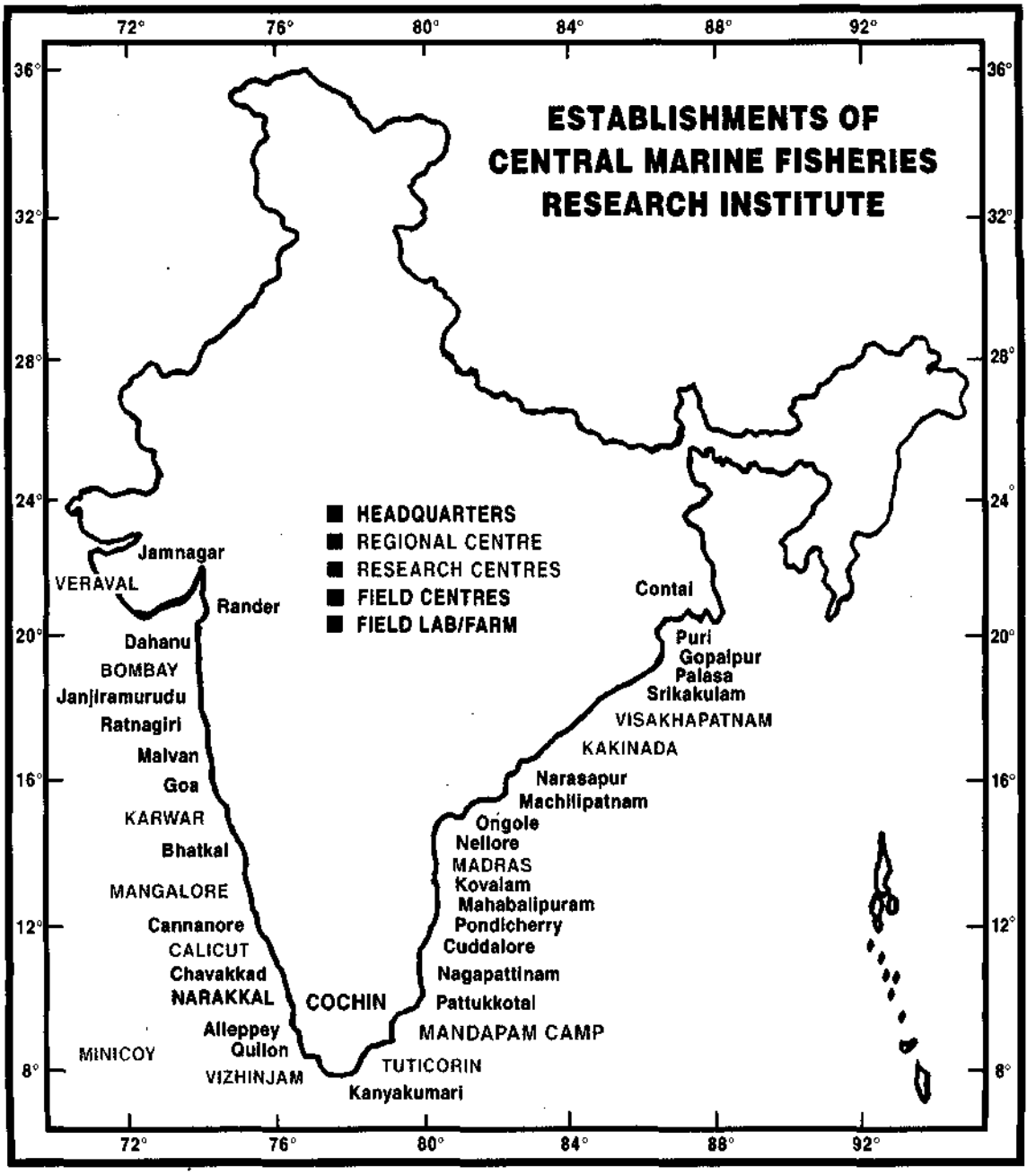
The Mandate

- 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 training 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, Mumbai, 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 and Central 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*.


ESTABLISHMENTS OF
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RESEARCH CENTRES
FIELD CENTRES
FIELD LAB/FARM
72°
76°
80°
84°
88°
92°
36°
32°
28°
24°
20°
16°
12°
8°
Jamnagar
VERAVAL
Rander
Dahanu
BOMBAY
Janjiramurudu
Ratnagiri
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Goa
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Bhatkal
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Field Mariculture Laboratory of CMFRI
Cochin Fisheries Harbour
Thoppumpady
Kochi-682 005, Kerala
✆ : (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 P.O. 680 515
Trichur District, Kerala

Contai Field Centre of CMFRI
Thanapukurpar, P.O.
Contai 721 401, Midnapore District
West Bengal

Cuddalore Field Centre of CMFRI
Jawan's Bhavan Lawrence Road
Cuddalore-607 002

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

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

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

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

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

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

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

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

Machilipatnam Field Centre of CMFRI
17/299, Sidimbi Agraharam Lane,
Machilipatnam-521 002
Andhra Pradesh

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

Malwan Field Centre of CMFRI
2799/2, Dawoolwads,
Pawar Chal
Malwan-416 606, Maharashtra

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

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

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

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

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

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

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

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

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

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 1999-2000
(Rs. in lakhs)

Budget Heads	Non Plan		Plan	
	Funds Allotted	Actual Expenditure	Funds Allotted	Actual Expenditure
Establishment charges	1220.00	1220.00	-	-
O.T.A.	1.20	1.20	-	-
T.A.	13.00	13.00	30.00	30.00
Other charges (including equipments)	88.01	91.59	245.73	245.73
Works	21.00	17.42	49.00	49.00
Other items	1.79	1.79	21.27	21.27
Total	1345.00	1345.00	346.00	346.00

Library and Documentation Section

During the period under report 85 books and 1768 journals were added to the Library at the Headquarters. Essential books and journals were also acquired for the Libraries at the Regional and the Research Centres. Inter-library loan and Inter-library collaboration of publications were continued. Reference and reprographic facilities were provided to visiting scientists, scholars and others. The Library also stocks and distributes the Institute publications.

The following publications were issued:

1. *Indian Journal of Fisheries* Vol. 45 No. 4 (1998), Vol. 46 No. 1, 2 (1999)
2. *Marine Fisheries Information Service T&E Ser.* Nos. 157, 158
3. CMFRI Newsletter Nos. 82-86
4. CMFRI Annual Report 1998-99
5. Proceedings of Scientific Seminar in Hindi : Small scale sea farming and small scale sea fishing
6. 'Kadalekum kanivukal' (Malayalam)
7. Consultancy Services in Marine Fisheries

Vessel Management Cell

The *Cadalmin-VI* based at Kochi was utilised for collection of samples, plankton, live feed and other environmental studies in the inshore and backwaters of Kochi. *R.V. Sagitta*, the vessel based at Mandapam Camp was utilised for collection of seaweeds and hydrography data. The vessel was also utilised for consultancy projects at Tuticorin. *Cadalmin-IX* at Kochi and *Cadalmin-IV* at Tuticorin are under repairs. Steps have been taken to utilise the boat skiff at Kochi, *Sea Search*, at Mangalore by fixing new inboard engines. A proposal to import a 23 m Fishery Oceanography Research Vessel with all latest equipments to carry out various vessel based research programmes of CMFRI, CIFT and CIFE and steps have already been taken to float the global tender. The crew at various Centres are actively engaged in mariculture programmes

and at Kochi they are involved in DOD Projects *viz* (a) Studies on Deep Scattering Layers (b) Investigation on the Toxic Blooms of the EEZ of India (c) Stock Assessment, Biology, Resources Mapping of various marine resources in the EEZ of India and participation in research cruises of FORV *Sagar Sampada*.

The Official Language Implementation Programme

Under bilingualisation programme, ensured the preparation of stationery items, name plates, notice boards, forms, procedural literature etc as and when required and Golden Jubilee Year logo stickers were printed and widely circulated among the Research Centres of the Institute and other R&D organisations, renewed the identity cards and reprinted the Annual Confidential Report forms. Ensured the cent percent bilingual issue of Section 3(3) documents and replied to in Hindi of cent percent letters received in Hindi as per rules. 15.4% of the General Correspondence was made in Hindi.

The progress made in Hindi implementation programme was reviewed at the quarterly meetings of the Institute Official Language Implementation Committee. Attended the meetings of the relevant TOLICs by the Director and Officers-in-charge of Centres.

Hindi week was celebrated at the Headquarters and Regional/Research Centres by conducting literary art competitions, cultural programmes, public meetings and by awarding prizes to the winners and outstanding contributors.

Hindi workshops were organised at the Research Centres of Kozhikode, Minicoy and at Headquarters.

During the year, abstracts of 8 M.F.Sc theses were submitted in Hindi.

Two issues of Newsletter and MFIS were released bilingually. Released the Proceedings of Scientific Seminar *'Small Scale Sea farming and small scale sea fishing'* and leaflet on ARIS Cell in Hindi.

Special efforts

As a tribute to the Golden Jubilee Year of Hindi, the Institute inaugurated the Golden Jubilee Year Hindi planner on 14-9-1999 with monthly programmes continuing upto 14-9-2000. In this series 3 open meets were conducted on Personality Development (Self Presentation); Hindi improvement programme (All India Institutional Hindi essay contest on India the glorious past and the future challenges) and Future outlook (Children's programme).

RESEARCH ACHIEVEMENTS

1. FISHERY RESOURCES ASSESSMENT DIVISION

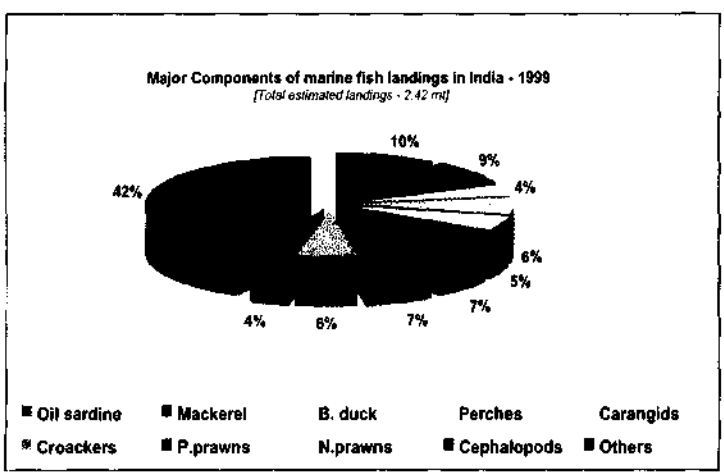
ASSESSMENT OF EXPLOITED MARINE FISHERY RESOURCES

(FSS/FRA/1.1)

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

Marine fish production in India during 1999

The marine fish production in India during 1999 has been provisionally estimated at 2.42 million tonnes (mt) which is 9.3% (2,50,000 t) less compared to 2.67 mt of 1998. The pelagic group formed 52.9% of the total landings and demersal finfish, crustaceans and molluscs together contributed 47.1%. The landings by mechanised units accounted for 65% of the production while the traditional units 35%; motorised units 26% and non-motorised units 9%.



The salient features of marine fish landings of the country during 1999, compared to 1998 are:

- Increase in the landings of oil sardine, lesser sardines, mackerel and ribbonfishes,
- Decrease in the landings of *Coilia*, catfishes, Bombayduck, threadfin breams, croakers, penaeid prawns, non-penaeid prawns, stomatopods and cephalopods,
- An increase of 18% (37,000 t) in the landings of oil sardine with an estimate of 2,41,000 t,
- An increase of 27% (27,000 t) in the landings of lesser sardines with an estimate of 1,27,000 t,
- A decrease of 16,000 t (34%) in the landings of golden anchovy with an estimate of 30,500 t.
- A decrease of 31,000 t (25%) in the landings of Bombayduck with an estimated landings of 92,000 t,
- A decrease of 7,000 t (9%) in the landings of threadfin breams, the estimate being 74,000 t,
- A decrease of 42,000 t (21%) in the landings of croakers with an estimate of 1,57,000 t,
- An increase of 18% (33,000 t) in the mackerel landings with an estimate of 2,10,000 t,

MARINE FISH PRODUCTION (TONNES) IN INDIA DURING 1998 AND 1999

Name	1998	1999
PELAGIC FINFISH		
CLUPEOIDS		
Wolf herring	19546	14147
Oilsardine	203909	240978
Other sardines	100059	127053
Hilsa shad	17215	10018
Other shads	14990	11055
Anchovies	4	1
Coilia	46293	30537
Setipinna	2805	2314
Stolephorus	72637	49543
Thrissina	5	156
Thryssa	42231	31547
Other clupeoids	52053	47857
BOMBAYDUCK	122803	91853
HALF BEAKS & FULL BEAKS	5926	5634
FLYING FISHES	3320	1798
RIBBONFISHES	113883	124548
CARANGIDS		
Horse Mackerel	25439	32693
Scads	54024	32864
Leather-jackets	6995	5671
Other carangids	61076	55069
MACKERELS		
Indian mackerel	177172	209741
Other mackerels	4	26
SEER FISHES		
S. commerson	30675	30934
S. guttatus	24064	14130
S. lineolatus	114	133
Acanthocybium spp.	23	31
TUNNIES		
E. affinis	18609	22753
Auxis spp.	9249	8276
K. pelamis	1249	1841
T. tonggol	5722	9121
Other tunnies	4855	6536
BILLFISHES	3337	2926
BARRACUDAS	21697	14315
MULLETS	7397	6860
UNICORN COD	386	314
MISCELLANEOUS	57827	36291
TOTAL PELAGIC FINFISH	1327593	1279564

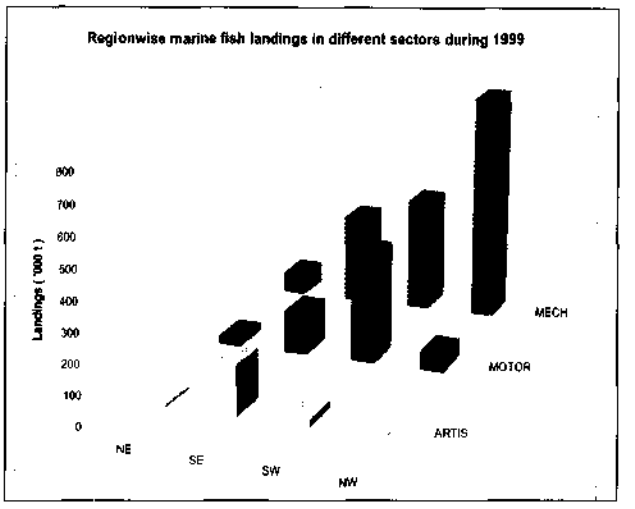
Name	1998	1999
SHELLFISH		
CRUSTACEANS		
Penaeid prawns	214948	172117
Non-penaeid prawns	173950	147906
Lobsters	2620	2093
Crabs	34293	27547
Stomatopods	72603	49908
MOLLUSCS		
Bivalves	501	109
Gastropods	1182	902
Cephalopods	107020	92363
TOTAL SHELLFISH	607117	492945
DEMERSAL FINFISH		
ELASMOBRANCHS		
Sharks	47434	41421
Skates	3342	2716
Rays	24525	21677
EELS	9594	11287
CATFISHES	52710	46093
LIZARD FISHES	24115	17707
PERCHES		
Rock cods	18580	15158
Snappers	5687	6542
Pigface breams	11701	11301
Threadfin breams	81340	73994
Other perches	36795	38013
GOATFISHES	15784	20552
THREADFINS	9346	7411
CROAKERS	199953	157462
SILVERBELLIES	56556	53498
BIG-JAWED JUMPER	9121	4945
POMFRETS		
Black pomfret	17395	10260
Silver pomfret	31391	22843
Chinese pomfret	578	906
FLATFISHES		
Halibut	2103	1137
Flounders	336	104
Soles	44379	45391
MISCELLANEOUS	32005	34867
TOTAL DEMERSAL FINFISH	734770	646005
GRAND TOTAL	2669480	2418514

- A decrease of 20% (43,000 t) in the penaeid prawns landings, the estimate being 1,72,000 t.
- A decrease of 15% (26,000 t) in the landings of non-penaeid prawns with an estimate of 1,48,000 t.
- A decrease of 31% (23,000 t) in the landings of stomatopods, the catch being 49,900 t.
- A decrease of 15,000 t (14%) in the landings of cephalopods the production being 92,000 t.
- An increase of 11,000 t (9%) in the landings of ribbonfishes, the estimate being 1,25,000 t.

REGIONWISE LANDINGS

The contribution of northeast region to the total production was 4.7%, southeast region 25.8%, southwest region 32.8% and northwest region 35.3%. The Union Territories of Andamans and Lakshadweep contributed, the rest, 1.4%.

Northeast region: The landings in the region registered a decrease of about 18,500 t (14%) from that in the previous year. The landings of catfishes, *Hilsa* shad, Bombayduck,



Regionwise marine fish production in India during 1999*

	Region	Estimated production (tonnes)	% in the all India total
1.	Northeast (West Bengal & Orissa)	1,13,885	4.7
2.	Southeast (Andhra Pradesh, Tamil Nadu & Pondicherry)	6,23,556	25.8
3.	Southwest (Kerala, Karnataka & Goa)	7,92,335	32.8
4.	Northwest (Maharashtra & Gujarat)	8,54,934	35.3
5.	Union Territories (Andamans & Lakshadweep)	33,804	1.4

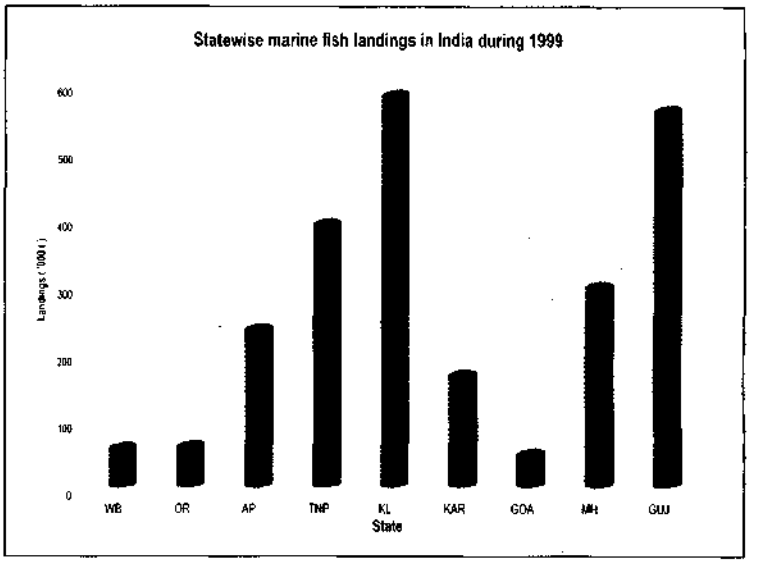
*Provisional

Coilia and non-penaeid prawns recorded a decrease. However, production of lesser sardines, ribbonfishes and penaeid prawns indicated an upward trend.

The production of catfishes was 7,800 t which showed a reduction of 1,700 t and *Hilsa* shad was short by 6,800 t, the estimate being 8,700 t. The catch of *Coilia* was 27,000 t showing a reduction of 2,200 t. A noticeable reduction of 9,600 t was observed in the landings of Bombayduck, the estimate being 6,400 t in 1999. The landings of 6,000 t non-penaeid prawn recorded a decrease of 3,000 t.

The lesser sardines estimate of 9,500 t recorded a substantial increase of 5,200 t. The ribbonfish landings was 8,000 t indicating an increase of 1,800 t over last year. Penaeid prawns landings was 7,000 t in 1999; 1,600 t less compared to that in 1998.

Southeast region: The contribution from this region was 6.2 lakh t showing a marginal reduction of 2,900 t compared to 1998. The decrease was mainly in the landings of oil sardine, *Stolephorus* spp. and silverbellies. However, lesser sardines, goatfishes, ribbonfishes, mackerel, penaeid prawns and cephalopods contributed better landings.



Oil sardine fishery suffered a set back, the estimate being 69,000 t in 1999 with a decrease of 36,000 t compared to 1998. *Stolephorus* spp. also reduced considerably by 17,000 t with an estimate of 16,000 t. The landings of 41,000 t of silverbellies was, 4,000 t less than that in the previous year. Lesser sardine landings noticeably improved by 21,000 t with an estimate of 78,000 t. Goatfishes increased by 6,600 t with an estimate of 15,000 t. An increase of 10,000 t was observed in the landings of ribbonfishes with an estimate of 22,500 t during 1999. Mackerel landings during 1999 was 38,000 t, showing an increase of 6,500 t. The estimate of non-penaeid prawns during 1999 was 5,300 t with an increase of 1,800 t over the estimate of 1998. Cephalopod landings was 14,000 t, an increase of 5,000 t being registered during 1999.

Southwest region: The region contributed 7.92 lakh t to the total landings of the country during 1999 where an increase of 34,000 t (4.5%) was recorded over the previous year. Among the major groups, oil sardine and mackerel registered increased land-

previous year. Among the major groups, oil sardine and mackerel registered increased landings; reduced landings were observed in *Stolephorus* spp., perches, croakers, carangids, penaeid prawns and cephalopods.

Oil sardine and mackerel landings increased by 74,000 t and 23,000 t respectively, the estimates for 1998 being 171,000 t and 1,31,000 t. A marginal decrease of 6,000 t noticed in the landings of *Stolephorus* spp. during 1999, the estimate being 31,000 t. The perches contributed 62,000 t in 1999 which showed a marginal reduction of 3,000 t; the reduction was mainly accounted for by threadfin breams (2,700 t). A decrease of 7,000 t (37%) was recorded in the landings of croakers with an estimate of 1,20,000 t. However, mackerel fishery witnessed a substantial increase of 23,000 t with an estimate of 1,31,000 t in 1999. The carangids landings of 70,000 t showed a reduction of 14,000 t. The landings of penaeid prawns was in the order of 52,000 t registering a reduction of 15,000 t. Cephalopod landings of 41,000 t showed a marginal reduction of 1,800 t.

Northwest region: The fishery, with a conspicuous reduction to the tune of 2.64 lakh t (23%) suffered a severe set back in 1999, the estimate being 8.55 lakh tonnes. The major groups/species which contributed the down fall of the fishery were elasmobranchs, *Coilia*, Bombayduck, croakers, carangids, seerfishes, penaeid prawns, non-penaeid prawns and cephalopods.

The landings of 30,000 t of elasmobranchs registered a decrease of 8,000 t in 1999. Similarly, the landings of *Coilia* and Bombayduck, decreased by 14,000 t and 22,000 t respectively from 27,000 t and 84,000 t of the current year. The major fishery along the Gujarat coast, croakers, also suffered a severe set back by 36,000 t, the estimate being 1,09,000 t. The landings and trend in decrease with respect to various groups were: carangids 20,000 t (-9,000 t); penaeid prawns 64,000 t (-30,000 t), non-penaeid prawns 1,34,000 t (-27,000 t); and cephalopods 36,000 t (-18,000 t). The maritime states of Maharashtra and Gujarat witnessed lesser landings, Gujarat being the premier one.

However, a marginal increase of 2,600 t and 2,100 t were registered in the landings of mackerel and tunnies, the estimates respectively being 38,000 t and 10,000 t.

Landings by different sectors : Mechanised, Motorised and Artisanal

The mechanised sector contributed 64.5 % of the total marine fish landings of the mainland ; the motorised 26.2 % and artisanal 9.3 %. A maximum of 92 % of the total catch of the northwest region was from the mechanised category and minimum of 49.9% along the southeast.

Different regions and their contributions in each sector: The contribution of each region to the total mechanized, motorized and artisanal sectors of the mainland is given in the table below.

Among the regions, northwest region recorded a maximum of 46.2 % of the total mechanized landings . The southwest region registered a maximum of 62.9% in the motorized category and the southeast region, a maximum of 80.8% in the artisanal category

Percentage contribution of different sectors (mechanised, motorised and artisanal) to the total catch of each region and All India

Region	Mechanised	Motorised	Artisanal
Northeast	65.55	24.82	9.62
Southeast	49.89	23.02	27.09
Southwest	49.94	46.87	3.19
Northeast	92.95	6.52	0.54
All India	64.52	26.20	9.28

Percentage contribution of landings of each region to the All India Mechanised, Motorised and Artisanal sectors

Region	Mechanised	Motorised	Artisanal
Northeast	5.14	4.79	5.24
Southeast	21.40	24.32	80.81
Southwest	27.23	62.91	12.09
Northwest	46.23	7.98	1.86

EVALUATION OF CHANGES 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

Under this project, appraisal report in respect of Kerala has been completed. The reports in respect of West Bengal, Maharashtra and Gujarat are in progress.

MANAGEMENT INFORMATION SYSTEM IN MARINE FISHERIES
(FSS/FRA/ST. 1)

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

The large volume of fishery survey data generated through the survey programme of the Institute, during the year 1999-2000 were fed into the computers installed at the Marine Data Centre. The data were kept in formats designed for storing monthly zone-wise information. The fishery data collected from different geographical zones of the mainland were

verified, coded and transferred to storage devices.

The stored data were analyzed and the results were made available to various endusers. The results of the survey are stored in the Computer Server.

The LAN (Local Area Network) facility is provided to all the scientists/technical personnel at the headquarters. With this modern facility, fishery data stored on the Computer Server at the Marine Data Centre can be easily accessed by the scientists/technical officers. The gear-wise, species-wise landings of each maritime state on an annual basis for a period of the latest fifteen years is currently available on the server to the users at present. The transfer of data prior to 1985 is underway.

Software developed by the Marine 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 1999-2000 period. The analysis of data on marine fish landings by district-wise, gear-wise and species-wise have been completed for the year 1999.

Additional data collected through survey programme on turtles were transferred to the computer and processed.

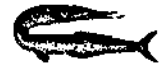
The computer backup files were updated and transferred on the magnetic tapes.

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

M.Srinath and R.Venugopalan

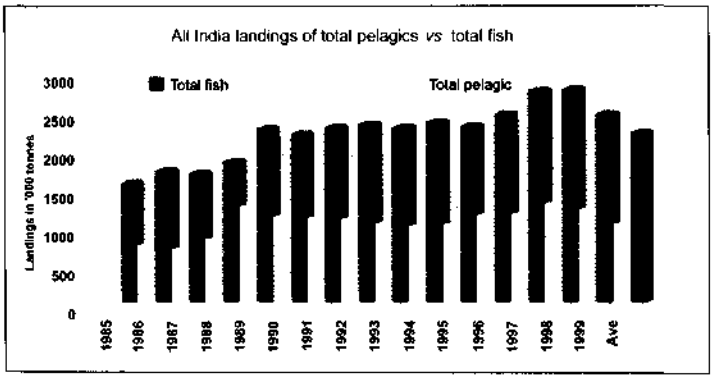
The effect of variations in the parameters of the non-equilibrium version of the Schaefer model on the trend of the fishery and biomass have been investigated. The analysis was carried out on a simulated data. It was found that the changes in *"r"*, the relative rate of natural growth for a given set of values for ***q*** (catchability co-efficient) and ***k*** (carrying capacity), induced a chaotic behaviour of the fishery beyond a certain level of ***r***. For small and faster growing stock generally the value of ***r*** will be high (say >1); which indicates rate of regeneration. For certain higher value of *"r'*, the system tends to be chaotic.

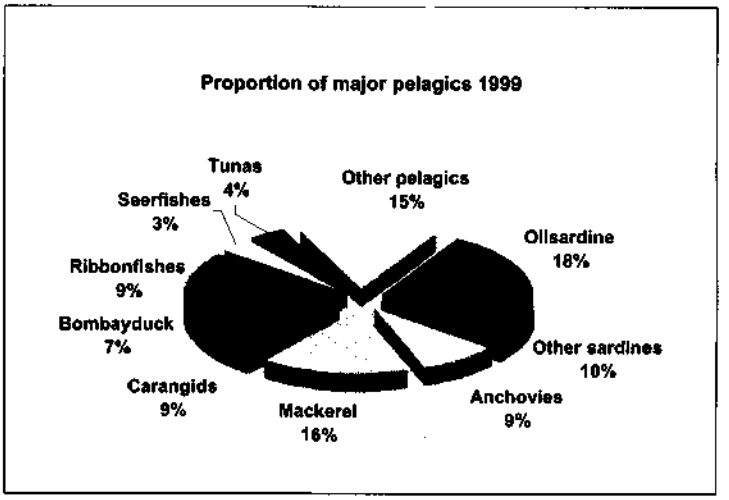
Investigations have also been made on the effect of random fluctuations in the growth and catch equations of the Schaefer's model. Depending on the error structure, and the estimation procedure, the biases in the estimates of management reference points were analyzed.



II. PELAGIC FISHERIES DIVISION

During 1999-2000, the Pelagic Fisheries Division implemented eight in-house research projects on major exploited pelagic finfish resources. Besides these projects, two *adhoc* schemes, one on Induced breeding and rearing of livebaits and another on Marine ornamental fish culture, both funded through the A.P. Cess Funds of ICAR, are in operation at Minicoy Research Centre. Relevant data on fishery and biological aspects of about 32 commercially exploited species were collected and processed during the year for understanding the dynamics of the exploited stocks and the results are presented below.





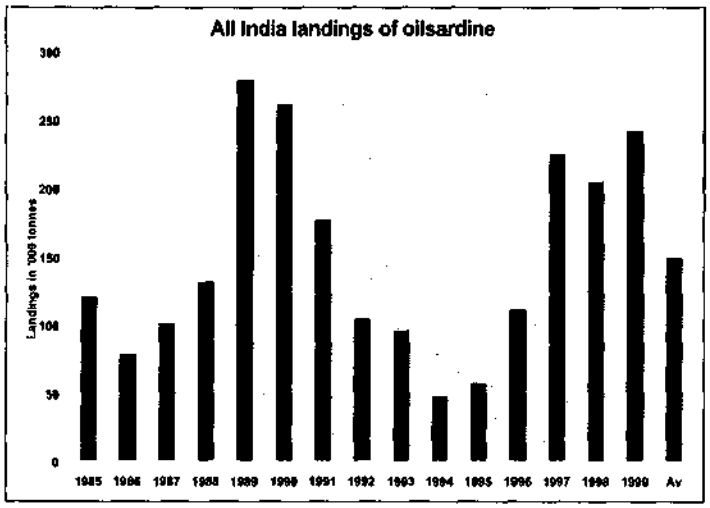
Pelagic finfish production during 1985-1999 fluctuated from 0.78 mt in 1985 to 1.33 mt in 1999 forming 55.1% of the total marine fish production. A stagnation in the pelagic catch around 1.3 mt per annum, against an annual potential yield of 2.21 mt of pelagic resources from the Indian EEZ, is discernible for the last 10 years. 61.9% of the production of pelagics in 1999 was obtained from the west coast, 36.3% from the east coast and the rest (1.8%) from the Island Territories. Among the maritime States, Kerala ranked first contributing 28.2% of the total pelagics, followed by TamilNadu 22.0%, Gujarat 14.6%, Andhra Pradesh 9.8%, Maharashtra 9.5%, Karnataka 7.0%, Goa 2.7%, Orissa 2.1% and the rest from the other States.

FISHERY AND RESOURCE CHARACTERISTICS OF *SARDINELLA SPP.*

(PF/RE/1.1)

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

The increase in trend of exploitation of oil sardine from the east coast since the late eighties took a dramatic turn when the landing crossed 1.1 lakh t in 1997 almost equaling the production of 1.11 lakh t from the west coast. By 1998 the east coast showed a clear lead producing 1.06 lakh t over 0.97 lakh t of the west coast. During 1999 the production reached an all time peak of 2.41 lakh t, the highest in the nineties. However, the production along the east coast plummeted to 0.68 lakh t whereas the west coast contributed 1.72 lakh t.



Fishery

The sardine landings during 1999 showed an upward trend at the monitoring centres along the west coast, except at Mangalore, compared to a downward trend observed along the east coast. The estimated catch was: Karwar 3,987 t (+6.1%), Mangalore 6,049 t (-17%), Kozhikode 1,748 t (+127 %), Kochi 3,358 t (+6.1%), Tuticorin 3,223 t (-61%), Mandapam 14,124 t (-4.2%) and Visakhapatnam 172 t (-120 %). At Karwar, exploitation was solely by the purseseines. At Mangalore, the purseseines, ringseines, trawls and other gears contributed 93.2%, 3.3%, 2.9% and 0.6% respectively. Sardines were exploited by ringseines (73%), trawls (25.7%) and *Chalavala* (0.6%) at Kozhikode compared to purseseines (74%), ringseines (24.7%) and trawls (1.3%) at Kochi. At Tuticorin, the *Chalavala* (93.8%) and shoreseines (6.2%); at Mandapam the pair trawls (84.6%), shrimp trawls (13.5%), the gillnets (1.9%) and shoreseines (0.04%); and at Visakhapatnam the gillnets (50.2%), boatseines (30.3%) and trawls (19.5%) exploited the resource. The highest c/e of 2.6 to 2.9 t was recorded by the pair trawls at Mandapam . The purseseines realised 1.2 t at Kochi, 0.6 t at Karwar and 0.4 t at Mangalore . The c/e in the ringseine was 0.7 t at Kozhikode compared to 0.68 t at Kochi and 0.09 t at Mangalore. The *Chalavala* at Tuticorin recorded a c/e of 19-51 kg compared to 122 kg at Kozhikode.

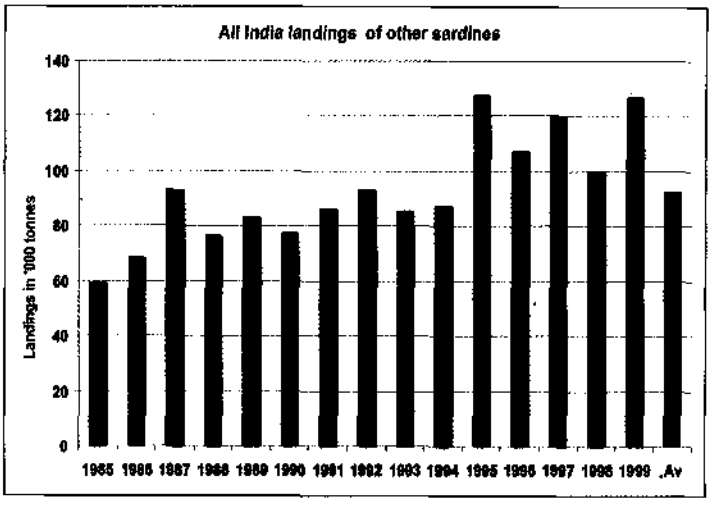
Forecast made by the Institute came true. The year witnessed good oil sardine fishery

The deployments of the various gears at these centres were such that the resource was exploited throughout the year. The peak catch was during January-February at Karwar; January, July-November at Mangalore; May-July, September- November at Kozhikode; March and July-December at Kochi; June –August at Tuticorin; February/March and June –August at Mandapam; and January-April, June-November at Visakhapatnam.

Oil sardine dominated in all the gears except the trawls at Malpe along the west coast compared to domination of lesser sardines along the east coast. At Kozhikode and Karwar no lesser sardines were encountered. *S.gibbosa*, *Sadinella fimbriata*, *S.brachysoma* and *S.sirm* occurred at Mangalore compared to *S.fimbriata* noticed at Kochi. At Tuticorin *S.gibbosa* and *S.sirm* dominated compared to *S.albella* at Mandapam. At Visakhapatnam mainly *S.fimbriata* and *S.gibbosa* constituted the lesser sardine catch.

Biology

The overall size of oil sardine ranged from 50/60-210 mm, but the recruitment size and commercial size showed slight variation at different centres. The commercial size exploited by purseseines was 120-140 mm compared to 165 mm by trawls at Mangalore; 170mm by trawls and 90 mm by ringseines at Kozhikode; 145 mm by trawls, 130 mm by ringseines and 170 mm by



purseseines at Kochi; 155-170 mm by pair trawls at Mandapam and 50-60 mm by the boat seines at Visakhapatnam. Most of the species of lesser sardines ranged in size from 100-185 mm though the length at capture showed slight variations.

The spawners formed 68% at Karwar compared to 62% at Mangalore and 38% at Kochi showing a decrease in spawning population towards the southern areas unlike what was observed in 1997. The spawning was observed during March-June and in September at Kochi compared to April at Kozhikode; March-May and September-October at Mangalore and by September at Karwar.

Stock assessment studies: At Kochi, (1989-'99) oil sardine was found to attain 168.8 mm, 197.9 mm and 210 mm at the end of I to III year of life compared to 163, 196 and 202 mm observed at Karwar. L_∞ during the period varied from 195 to 210 mm (av. 206.8mm), K from 1.3 to1.8 (av. 1.53), Z from 3.52 to 7.79 (av.5.9), M from 1.26-1.52 (av. 1.38) and F from 2- 6.95 (av. 4.5). The exploitation ratio was high and varied from 0.568 in 1999 to 0.83 in 1997 in Kerala. At Karwar and at Mangalore the species indicated a L_∞ value of 204 mm and 213 mm and K 1.6 and 1.0 respectively. The highest total stock of 2,32,552 t was observed in Kerala during 1989 and lowest of 2,010 t in 1994. The standing stock varied from 355 t in 1994 to 32,892 t in 1989. At Karwar, the values of Z, F and M for the year 1990-92 were 2.69, 1.47 and 1.43 respectively compared to 6.3, 4.9 and 1.43 observed during 1996-98. The exploitation rate was 0.51 and 0.78 during these periods and the total stock was 937t and 2,311 t respectively. The values of Z, M and F obtained at Mangalore were 3.28, 1.27 and 2.01 respectively.

Studies indicated inter annual variations in the recruitment. Only one recruitment was noticed during 1990 (peak in Aug.), 1991 (in July), 1992 (in June), 1993 (in June), 1994 and 1995 (October), 1996 (peak in July, minor peak in May/June), 1997 (June). The years 1989 and 1999 represent the two peaks of the decadal abundance with a production of 2.7 lakh t and 2.4 lakh t respectively. What is significant is that during both the years the recruitment pattern was similar, the major peak was in April and a minor one in October.

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

R. Thiagarajan, M. Zaffar Khan, Prathibha Rohit, A.A. Jayaprakash and E.M. Abdussamad

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 platteaued around 1.1 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, but decreased

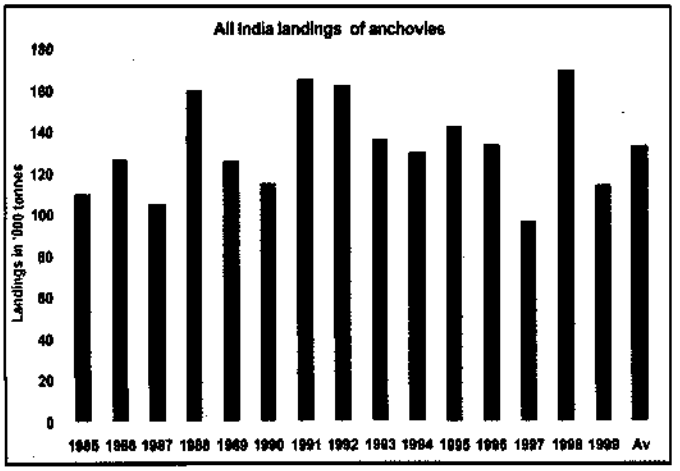
to 1.14 lakh t in 1999. Statewise, the highest contribution of 28,956 t was from Kerala followed by 22,637 t from Gujarat and 16,531 t from Andhra Pradesh during 1999.

Fishery

At Mangalore/Malpe, the production of 5,213 t declined by 16%. At Kochi, 241 t were landed against 184 t of the previous year but poor compared to the trend observed in the early nineties. At Vizhinjam, 250 t were landed by boat seine, gillnets and shore seine against 785 t during 1998. Along the east coast, at Kakinada the catch declined to 779 t compared to 2,459 t of last year.

At Mangalore and Malpe in the purseseines the effort (13,773 units) was down by 10% and the catch (2,003 t) by 52%. In the trawl though the effort (55,317 units) input decreased by 4%, the catch (3,210 t) improved by 58%. On the contrary the ringseines with 8% increase in effort recorded 15% decrease in catch. At Kochi, the ringseines shared 88% (211 t), trawls 8% (20 t) and purseseines 4% (10 t). The present catch by the purseseines was against nil catch realised last year. The trawl catch came down by 14 t, however, the ringseines showed an increase by 83 t. The effort input by trawl was 14,145 units (+25%) and purseseines (+275%). Ringseine effort decreased sharply by 52% but realised a higher c/e of 174 kg compared to 50 kg of last year. The highest c/e of 505 kg was observed in the purseseines at Mangalore followed by 697 kg by ringseines at Kochi. The trawls recorded a highest c/e of 115 kg at Mangalore and Malpe followed by 35 kg at Kakinada and 10 kg at Kochi.

In the purseseines at Mangalore/Malpe the IV quarter was highly productive (93%) followed by I (5%) and II (2%) quarters. But in trawls the first quarter (74%) was highly productive followed by II (14%) and IV (12%) quarters. At Kochi, the trawls landed a highest catch of 13 t in October. The purseseine also landed a catch of 10 t in October and no landing was recorded during the rest of the period. In the ringseine the season was from June to August with a peak catch of 101 t in July. At Kakinada, the trawls recorded a highest catch during IV quarter (35%), followed by I (33%), II (20%) and III (12%) quarters. At Mumbai, *Coilia dussumieri* landings by shrimp



trawlers at New Ferry Wharf was 2,791 t with c/e of 90 kg registering an increase of 63% and 46% respectively.

Stolephorus devisi was the dominant species in all the gears at Mangalore. In the purseseines, the species formed 69% followed by *S. bataviensis* (11%), *S. macrops* and *S. buccaneeri* formed the rest. In trawls at Mangalore and Malpe *S. devisi* constituted 84% and 86% respectively. *S. bataviensis* formed 16% at the former centre and 14% at the latter centre. Other species, each contributed to less than 10%. *S. devisi* was the dominant species in the trawls 74%, ringseine 95% and purseseine 88% at Kochi. At Kakinada, *S. bataviensis* (33%) followed *S. commersonii* (21%), *S. devisi* (19%) and *S. indicus* (7%) constituted the fishery.

Biology

Stolephorus devisi of 55-95 mm in the purseseines, 45-95 mm in trawls and *S. bataviensis* 50-105 mm in trawls were observed at Mangalore. At Malpe, both species from 35 mm and above were represented. At Kochi, *S. devisi* of 70-90 mm was noticed in trawls. *S. commersonii* of 75-120 mm in the trawls and 60-100 mm in ringseines were encountered. *S. macrops* occurred in the size range of 65-75 mm in ringseines and 70-95 mm in trawls.

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

Length range (mm) and modal length (mm) of dominant species of anchovies landed by various gears at different centres during 1999

Centre	Gear	Species	Length range	Modal length
Mumbai	TN	*Coilia dussumieri*	85-204	145
Mangalore	TN	*S. devisi*	45-95	85
	TN	*S. bataviensis*	50-105	90
	TN	*S. macrops*	60-75	70
	PS	*S. devisi*	55-95	80
	PS	*S. bataviensis*	80-110	90
Kochi	RS	*S. buccaneeri*	80-110	80
	RS	*S. commersonii*	60-100	85
	TN	*S. devisi*	70-90	80
	TN	*S. commersonii*	75-120	85
Kakinada	TN	*S. devisi*	45-100	70
	TN	*S. bataviensis*	45-140	65
	TN	*S. commersonii*	70-170	125
	TN	*S. indicus*	65-160	145
Chennai	TN	*S. devisi*	70-130	110
	TN	*S. bataviensis*	70-90	80
Mandapam	SS	*S. indicus*	55-125	70
	TN	*S. commersonii*	90-135	125
	TN	*S. indicus*	75-135	130
Vizhinjam	BS	*S. devisi*	35-95	40
	BS	*S. devisi*	70-95	85

TN – Trawl net, SS - Shoreseine RS – Ringseine, BS - Boatseine PS – Purseseine,

INVESTIGATIONS ON THE FISHERY AND RESOURCE CHARACTERISTICS OF SEERFISHES (PF/RE/2.1)

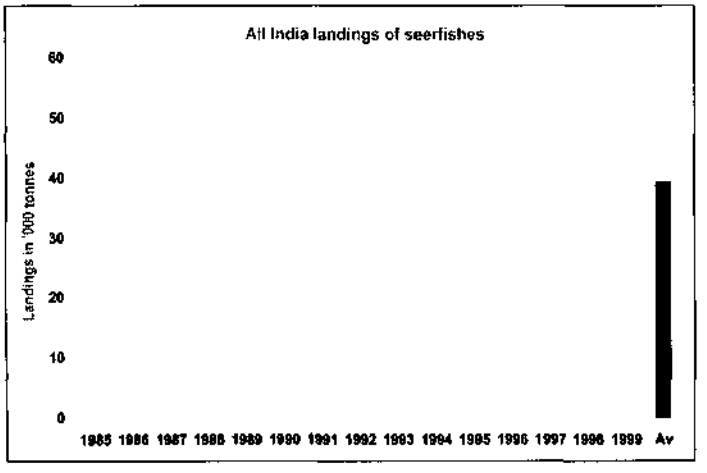
C. Muthiah, T.M. Yohannan, N.G.K. Pillai and H. Mohammed Kasim

The general increase in seerfish landings from 0.35 lakh t in 1985 to 0.55 lakh t in 1998 showed a set back (-23%) as the production slumped to 0.42 lakh t in the current year. Studies on the fishery and resource characteristics of seerfishes were continued at Veraval, Mangalore, Kozhikode and Kochi along west coast and Tuticorin, Chennai, Kakinada and Visakhapatnam along east coast.

Fishery

Gillnet, trawl, hook & line and purseseine were the major gears for seerfish exploitation contributing 58.9%, 21.6%, 11% and 8.3% respectively. Overall, the fishery during the year had improved marginally (1.3%) as compared to the previous year. On the east coast the fishery was better with 39.8% increase in landing whereas, it recorded a decline of 16.8% along the west coast. Out of the four centres on the west coast, only Mangalore-Malpe recorded slight improvement over the last year. The estimated landings were 916 t (-25.8%) at Veraval; 1,110 t (+7.6%) at Mangalore-Malpe; 68 t (-48.2%) at Kozhikode; and 327 t (-35.9%) at Kochi. In the east coast except Chennai, all the three centres registered an increase. The catches amounted to 770 t (+59%) at Tuticorin, 513 t (-9.6%) at Chennai, 391 t (+205.9%) at Kakinada and 225 t (25.3%) at Visakhapatnam.

Fourth quarter and first quarter registered peak landings with 31.9% and 30% respectively, followed by third quarter (22.9%) and second quarter (15.2%). Fourth quarter was more productive on the west coast (42.9%) whereas, first quarter landed maximum catches (36.6%) on the east coast. Along the west coast, October recorded peak catches at Veraval and Mangalore-Malpe, April-May at Kozhikode, September at Kochi, July at Tuticorin, March at Chennai and Kakinada and April at Visakhapatnam.



Gillnet was the chief gear at Veraval (749 t, 81.7%), Mangalore-Malpe (450 t, 40.5%), Kochi (321t, 98.4%), Tuticorin (388 t, 50.4%) and Kakinada (376t, 96.2%). The catch by the gear var-

A good catch of seerfish at Cochin Fisheries Harbour

ied from 18 t at Kozhikode to 749 t at Veraval. The effort ranged from 1,502 units at Kozhikode to 28,333 units at Veraval. As compared to last year the effort was less in all west coast centres except Mangalore-Malpe, while it was more in all east coast centres except Chennai. The c/e in large mesh size gillnet was highest at Chennai (101 kg) and lowest at Visakhapatnam (6.7 kg). The c/e recorded a decrease in the west coast centres unlike an increase in the east coast centres.

The trawl landing of seerfishes were reported from all centres except Visakhapatnam and showed a general decline at all centres except Tuticorin. It was the dominant gear at Kozhikode (46 t, 67.5%). In other centres its contributions ranged from 5 t (1.6%) at Kochi to 301 t (27%) at Mangalore-Malpe. The effort varied from 12,880 units at Kochi to 54,208 units at Veraval. The c/e which, varied from 0.4 kg at Kochi to 12.6 kg at Mangalore-Malpe showed a decline at all centres except Tuticorin where there was a notable increase (78.7%).

Hook and line, an important gear in the east coast, was a major contributor at Chennai (258 t, 50.3%), Visakhapatnam (134 t, 59.3%) and Tuticorin (86 t, 11%). The c/e was highest at Chennai (36.2kg) as compared to Tuticorin (9 kg) and Visakhapatnam (5 kg).

Seerfishes caught as incidental catches accounted for 357 t (32.2%, c/e 26 kg) at Mangalore-Malpe compared 0.2 t (0.05%) at Kochi. Their occurrence in small quantities in the indigenous gears were reported from Mangalore-Malpe (1.5 t) and Kozhikode (4 t).

Scomberomorus commerson was the most dominant species (70.8%) followed by *S.guttatus* (28.7%), *S.lineolatus* (0.2%) and *Acanthocybium solandri* (0.3%). *S.commerson* was found dominant at all centres except the northern most centres at higher latitude like Veraval and Visakhapatnam where the *S.guttatus* was the major species.

Biology

S.commerson: The length-range of *S.commerson* in large mesh size gillnet was 14-144 cm. The dominant modal-lengths and the fishery-support-groups were: 52 cm and 36-86 cm (96.3%) respectively at Mangalore-Malpe, 60 cm and 38-64 cm (91.5%) at Kozhikode, 74 cm and 72-76 cm at Kochi, 64

cm and 52-96 cm (89.2%) at Tuticorin, 80 cm and 48-90 cm (83%) at Chennai and 88 cm and 56-118 cm (92.1%) at Kakinada. In the small mesh size gillnet 'podivalai' at Tuticorin, the size-range was 12-62 cm with mode at 28 cm and the fishery-support-group being 22-58 cm (97.2%).

In the trawl the size ranged from 10-138 cm, with dominant modal-length and fishery- support-group at 18 cm and 16-48 cm (95.7%) respectively at Mangalore-Malpe, 36 cm and 32-82 cm (100%) at Kozhikode and 18 cm and 12-86 cm (99.4%) at Tuticorin. In hook and line the size range was 50-116 cm with dominant modes at 68 cm at Tuticorin and 70 cm at Chennai.

Exploitation of young fish by hook and line and large mesh gillnet was negligible, however, their proportion was high (61%) in 'podivalai' catch at Tuticorin, in trawl at Kakinada (100%), Mangalore-Malpe (73%) and Tuticorin (68%) and in small proportion at Kozhikode (21%). At Kochi the entire purseseine catch was composed of young ones (18-32 cm) only.

S.guttatus: The species had a size range of 16-68 cm in gill net with dominant modal-length at 42 cm at Veraval, Mangalore-Malpe and Chennai and 44 cm at Kakinada. In trawl the length varied from 10 to 54 cm with modal-length at 12 cm at Kakinada, 36 cm at Chennai and 42 cm at Mangalore-Malpe and Veraval.

Stock Assessment

The results of stock assessment studies conducted on the dominant species *S.commerson* are given below:

Centre	Gear	L_∞ (cm)	K/year	Z	M	F	E	Data period
Mangalore	Gillnet	123.2	0.88	3.80	1.12	2.68	0.71	1999
	Trawl			8.99	1.12	7.87	0.87	1999
Kochi	Gillnet	142.0	0.50	2.26	0.75	1.51	0.67	1990-98
Kakinada	Gillnet	158.8	0.80	4.86	0.97	3.89	0.80	1999

The exploitation ratio indicated that in all the three centres *S.commerson* is exposed to high fishing pressure by the dominant gear, gillnet. The fishing pressure is alarmingly high by trawl at Mangalore-Malpe area. Detailed stock assessment work accomplished at Kochi using, 9 years length frequency data (1990-98) showed differential mortality at various sizes from 44 to 48 cm and from 84 to 88 cm onwards. Spawning stock biomass when size at first maturity is taken as 75 cm, works out to be 114 t. MSY was estimated to be 283 t, indicating an extra effort of 34%.

INVESTIGATIONS ON THE FISHERY AND RESOURCE CHARACTERISTICS OF TUNAS, TUNA LIVEBAITS AND BILLFISHES

(PF/RE/2.2)

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

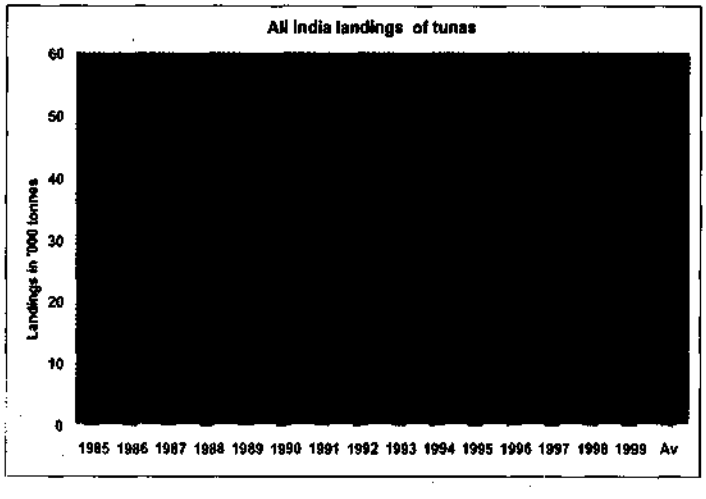
During 1999, among the large pelagics about 48,530 t of tunas and 2,926 t of billfishes were landed by the drift gillnets, hooks and lines, pole and lines and purseseines from the depth zone 0-180 m evincing an increase of 19.5% over that of 1998. Studies on the fishery and resource characteristics of tunas, tuna livebaits and billfishes were carried out at Veraval, Mumbai, Mangalore, Kozhikode, Kochi, Tuticorin, Kakinada and at Minicoy (Lakshadweep) during the period.

Fishery

Tuna landings declined at Mangalore, Kochi and Tuticorin at the rate of 2.4% to 51.8% compared to that of the previous year. Although the effort increased at most of the centres (1% to 59.2%) the c/e declined at the rate of 17% to 103% except at Mumbai where the effort, catch and c/e recorded an increase (18.3%, 97.5% and 66.9% respectively). In the pole and line fishery the c/e was 310 kg at Minicoy, and in *Paruvalai* at Tuticorin 99.5 kg.

One of the important developments at Kozhikode was the exploitation of tunas by ringseines in June, when 72% of the annual total tuna landing was recorded. At Minicoy, eventhough inclement weather deterred the pole and line tuna fishing operations during September and October, good fishery was recorded adjacent to the island in the ensuing months.

Euthynnus affinis was the dominant species and its contribution in the total tuna landing by drift gillnetters, purseseiners and ringseines at different centres varied between 32.6% and 95.3%. *Thunnus tonggol* dominated in the tuna landing at Veraval (78.9%). In pole and line fishery *Katsuwonus pelamis* constituted 89.1% of the total tuna landings followed by *Thunnus albacares* (10.9%). In the troll line fishery *T. albacares* formed 52% and the rest by *K. pelamis*. *Istiophorus platypterus* was landed in stray numbers at Veraval, Mangalore, Kochi and Tuticorin.



Purseseine catch of *Euthynnus affinis* at Mangalore Fisheries Harbour

The food and feeding studies of *K. pelamis* and *T. albacares* showed the dominance of empty condition. The food consisted of crustaceans, decapods, lesser sardines and squids. Fishes followed by crustaceans were seen in the forage item from September to November. Among the mature skipjacks, males dominated in all the months except during February and March.

The baitfish catch was about 4.8 t at Minicoy with an overall CPUE of 1.8 kg. Caesionids and clupeids were the major groups while apogonids were fished and utilised during November and December.

Biology and population structure

In the drift gillnet and purseseine landings *E. affinis* indicated a size range of 24-72 cm and 24-68 cm with fishery supporting groups at 40-54 and 30-44 cm size respectively. *Auxis thazard* occurred in the DGN and PS fisheries in the size range 24-50 cm and 30-38 cm with major modes at 36-40 cm and 34 cm respectively. The size range and fishery supporting groups of *A. rochei* in the DGN fishery was 20-40 cm (26-28 cm); *T. albacares* in the P&L and DGN fisheries ranged between 26-102 cm (46-48 cm and 84 & 92 cm); *K. pelamis* occurred in the size range 26-66 cm (54-56 cm) in the P&L fishery and 40-68 cm (54-56 cm) in the DGN fishery. In the DGN fishery the size range of *T. tonggol* was 26-94 cm (34-42 cm,56-60 cm and 70-72 cm).

At Mumbai, the total mortality coefficient (Z) estimated was 2.55 and F/Z at 0.717 indicated high fishing pressure on the resource.

Other observations

As regards the tuna pole and line fishing, there were innovative developments. One is the employment of Global Positioning System (GPS) in tuna fishing. Another positive and labour saving change was the introduction of mechanical splashers instead of manual splashing. Biting of tunas were better and catches high in these boats when compared to other units. Considering the advantage, more and more boat owners are showing interest to utilize this innovative facility.

At Vizhinjam the southwest monsoon was active and the drift gillnetters from neighbouring villages also operated from Vizhinjam Bay due to the breakwater facility available here. The hike in the fishing effort resulted in increased catch and c/e thereby indicating the abundance of tuna resource in this area during the monsoon months.

The conversion of idling mechanised shrimp trawlers for tuna longline fishing has been reported from Tuticorin. Also, the adoption of nylon monofilament in the coastal tuna fishery sector is one of the progressive developments.

A Statistical Model was formulated and submitted for publication under the title "Production-Function Model" - applied on the tuna pole and line fishery at Minicoy". Further, the empirical relationship of tuna fishery with meteorological parameters were worked out and the results indicate that the wind force is one of the deciding factors in the success of pole and line tuna fishery at Minicoy.

As a part of the study on NTADS in the fishery for tuna and allied species by the drift gillnetters, a compendium on the "bionomics, exploitation, trade and conservation of pelagic sharks in the Indian seas" has been prepared and is being submitted for publication.

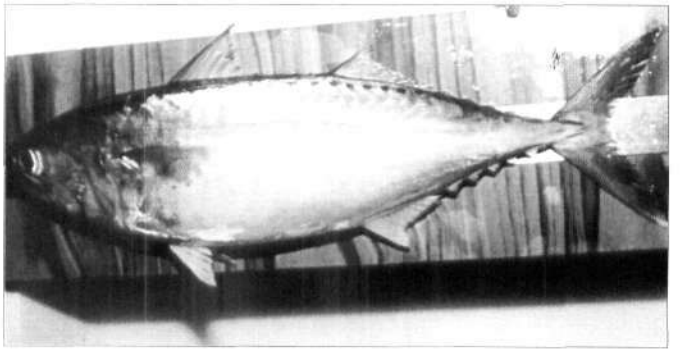
INVESTIGATIONS ON THE FISHERY AND RESOURCE CHARACTERISTICS OF MACKEREL (PF/RE/2.3)

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

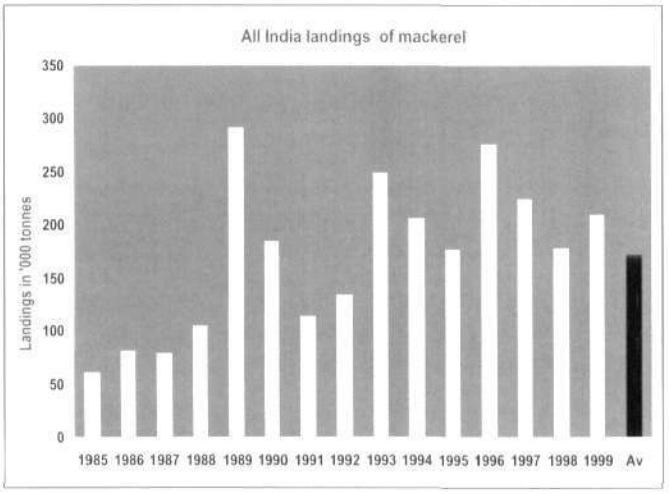
The mackerel fishery in India during 1999 showed general improvement though with centrewise variations. Major decline was observed at Mangalore. At Kochi and Kakinada also the catches declined. However, the fishery showed improvement in other centres especially at Kozhikode and Visakhapatnam.

In the area of abundance of this resource (Karwar to Kochi) the fishery was most active during August-September. The period of peak catch in different centres showed a striking pattern. It was in January at Veraval, February at Karwar, March at Mangalore, April at Kozhikode , May at Kochi and August at Tuticorin. In Visakhapatnam and Kakinada the month of peak catch was in March.

The peak fishery during August-September along the southwest coast was by the surface gears like seine nets and this can be attributed to upwelling and consequent movement of the resource in dense shoals to sur-



Record sized mackerel, *Rastrelliger kanagurta* (347mm) taken from Karwar Waters



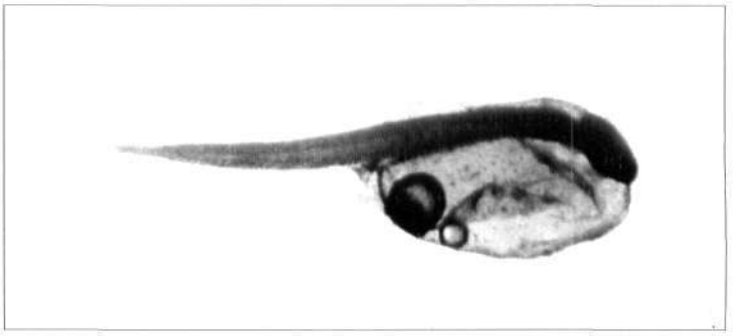
face waters. The pattern of peak catches in the first half of the year perhaps indicate a southward movement of the resource. Most of the catches during this period were made from deeper waters by trawls.

Bulk of the catches in the upwelling areas during the second half of the year was made by seine nets. Trawls and gill nets were dominant gears in the areas where the effect of upwelling is not pronounced.

The length of mackerel (*Rastrelliger kanagurta*) ranged from 5-28 cm, with peak catches from the size group 14-16 cm. Along the west coast (including Tuticorin) 3 modal sizes were seen, the prominant mode at 14.5 cm, a secondary one at 18.5 cm and a minor one at 23.5 cm. The dominant size group at 14.5 cm were caught during the monsoon season by ring seines. The second mode at 18.5 cm were the mainstay of the fishery during the post monsoon season. The mode at 23.5 cm represents the summer catches by trawls and gill nets.

Along the Andhra coast the size of mackerel ranged from 5-27 cm with a bimodal frequency distribution. The first mode was at 16.5 cm caught mainly during November-December period by gill nets and boat seines. The second mode at 22.5 cm were caught by all the gears in the first half of the year.

58.2% of the catch in numbers along the west coast comprised of mackerel below 18 cm length. Along the east coast the smaller



Larva of Indian mackerel, *Rastrelliger kanagurta* immediately after hatching in captivity at Calicut Research Centre of CMFRI

size group amounted to only 48.5%. Taking 18 cm as the optimum size at capture the mackerel fishery during monsoon along the west coast and November-December period along the Andhra coast cause growth overfishing. The effect of growth overfishing is more evident along the west coast where 49% of the catch was below the size of 16 cm against 25% along the Andhra Pradesh coast. This shows the intensity of monsoon fishery on the juveniles of mackerel.

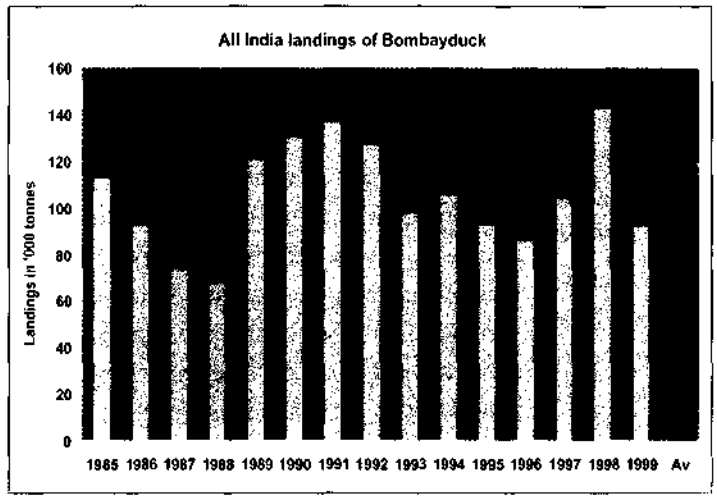
Lowest mean size was recorded at Kozhikode (14.6 cm) and highest at Pamban (23.3 cm). Kozhikode is the centre where juvenile fishery using ring seines was hectic during monsoon whereas at Pamban the exploitation was by gillnets. The mean size along the west coast was 17.3 cm and that along the Andhra Pradesh coast was 18.7 cm while the all India estimate being 17.4 cm.

Along the west coast mature mackerel (above 20 cm) dominated the fishery during the first half of the year. Recruitment to the fishery started by March, reached a peak in June and continued till August. The size of the new recruiits indicated that they were the products of spawning that started in January and continued till June. The month of recruitment and spawning varied from centre to centre. This general trend along the west coast was found existing upto Tuticorin. Bulk of the catch during the second half of the year was contributed by these new recruits. In Visakhapatnam the recruitment was observed in February and November, probably from the products of spawning in October-December. In Kakinada the recruitment was observed in July-August and November-December period.

FISHERY AND RESOURCE CHARACTERISTICS OF BOMBAYDUCK (PF/RE/3)

Alexander Kurian

The Bombay duck landings though increased from 1.04 lakh t in 1997 to 1.22 lakh t in 1998, however, indicated a decrease by 25% in the current year. The fishery along the northwest coast of India continued to show declining trends. The total catch was estimated at 42,887 t against an effort input of 71,226 hauls resulting in a stock density of 60 kg per haul. The resource formed 45% of the estimated *dol* catch of 94,389 t. The total *dol* catch, when compared to 1998 to 99, declined by 20%, catch per haul by 26% but the total effort went up by 9%. The Bombay duck catch declined by 51%, catch per haul by 55% and percentage of the resource in the *dol* catch by 39%. The exploitation rate was 0.51. The size range that supported the fishery varied from 30-330 mm. A positive bathymetric cline in age-size distribution was observed for the species over period of time. This indicates the migration of actively growing individuals into the coastal zone of the northwest coast where energy resources are greater. This segment of the population usually forms the mainstay of the traditional sector. Due to high level of pollution in the coastal habitat especially in



the area known as 'golden corridor' between Maharashtra and Gujarat, the movements of the feeding populations has been seriously hampered, thus affecting the fishery. As Bombay duck is becoming less abundant in this multispecies fishery, an accurate index of stock abundance is becoming increasingly difficult to find. Therefore, the catchability coefficient q is estimated at 8.31 X 10^-7, rate of fishing 0.59 and total mortality 1.15 which are very close to values obtained from 1998-99 seasons. The exploitable stock was estimated at 84,092 t.

Recruitment to the fishery occurs over wide age range and different year classes are exploited at a time. It is possible that recruitment to the fishery is fluctuating from year to year or even within the season as indicated by the study. To monitor stock position and to keep track of recruitment, it is necessary to continue the studies because under conditions of highly variable recruitment, stocks have become unstable in the short term and potential for population collapse do exist if not already taken place in the coastal waters.

Owing to the deployment of *dol* netters into trawl net units in Maharashtra, the total *dol* catch has plummeted to 4,214 t indicating 96% reduction when compared to 1998-99 season. The effort has come down by 52% to 50,120 hauls and total Bombay duck catch by 90% to 2,839 t. The catch per haul was 57 kg indicating a reduction by 80%. The catchability coefficient was estimated at 2.45 X 10^-6, rate of fishing 0.12 and rate of exploitation 18%. The damage done to the coastal waters due to the pollution is considerable and it appears that no action has been initiated either to control or check the same.

The total landings by *dol* net units in Gujarat showed a reduction by 15% to 89,269 t in spite of 3% increase in effort resulting in catch per unit of effort of 60.5 kg which is down by 32% as compared to 1998-99. There was 30% reduction in Bombay duck catch. The resource which formed 44% of the *dol* landings also indicated 17% reduction.

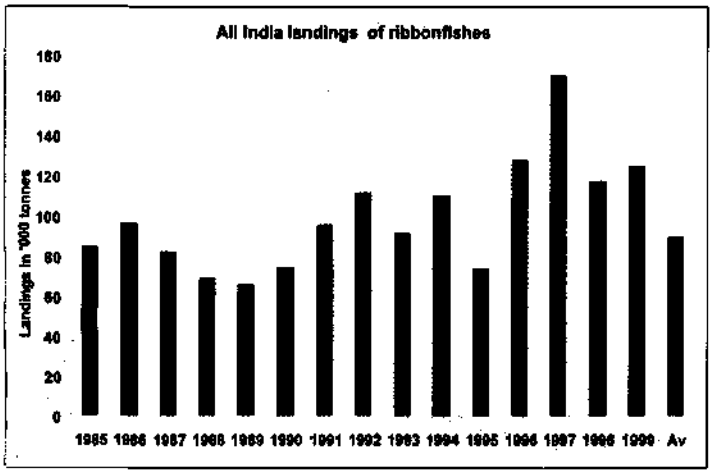
The catchability coefficient q was estimated at 1.27 X 10^-6, rate of fishing 0.84, total mortality 1.40 and rate of exploitation, 60%. Evidently, environmental damage is comparatively less felt at the Bombay duck fishing grounds off Gujarat. The catch analysis indicated that there are recurrent species mixing. The catch pattern represents multispecies mixes like ribbonfishes and golden anchovy. This presents a potential problem of calculation of stock density.

INVESTIGATIONS ON THE FISHERY AND RESOURCE CHARACTERISTICS OF RIBBONFISHES
(PF/RE/4)

P.N.Radhakrishnan Nair, M.Zaffar Khan, U.Ganga, C.Muthiah, R.Thiagarajan and E.M.Abdussamad

During 1999 the ribbonfishes constituted nearly 5.1% of the total marine fish landings in India. Approximately 75% of this was landed along the west coast and the rest along the east coast. The catch generally declined during this year at major centres. An improvement in the ribbonfish fishery could be noticed only at Mumbai (258%), whereas in all other centres the catch declined by 15.2% (Mangalore-Malpe) to 93.5% (Karwar). A comparison of ribbonfish landings in 1999 with the average annual landing for 1994-98 showed that in 1999 the landings increased at Mumbai (77.7%) and Kakinada (5.3%). In other centres it declined by 29% (Chennai) to 43.4% (Veraval).

Fishery : The major gear employed in the fishery was trawl net which accounted for nearly 99% of the annual catch. The composition of ribbonfishes in the total trawl net landing at the observation centres ranged from 3.74% at Karwar to 15.4% at Kochi. At some centres it is also being caught in gillnet, boatseine, etc. The ribbonfish landings in trawl net ranged from 74 t at Karwar-Tadri to 7,751 t at Mumbai along the west coast and from 97 t at Visakhapatnam to 3,612 t at Kakinada along the east coast. In other centres the landings were 6,402 t at Veraval, 1,866 t at Mangalore-Malpe, 1,229 t at Kochi and 1,058 t at Chennai. The landings in gillnet at Veraval and Madhwad were 64 t and 150 t respectively. The landings in boatseine at Visakhapatnam was 38 t.



An increase in effort of trawl unit was noticed only at Mumbai (11.3%) whereas at other centres it decreased by 4.3% (Visakhapatnam) to 24.3% (Kochi). With respect to indigenous gears, their number decreased in almost all centres where they were in operation.

The catch rate in trawl net ranged from

0.4kg at Karwar and Visakhapatnam to 250kg at Mumbai with 118 kg at Veraval, 33.7kg at Mangalore-Malpe, 86.9kg at Kochi, 22.7kg at Chennai and 71kg at Kakinada. In gillnet it was 2.2kg each at Veraval and Madhwad and in boatseine 26.8kg at Visakhapatnam.

The fishery existed almost throughout the year in most of the centres. Generally, the peak landings were noticed during the post monsoon period (October-December). The landings during the post-monsoon period was more at Kochi (89.3%), Kakinada (45.3%) and Visakhapatnam (53.7%). A peak in the pre-monsoon period (January-May) was noticed at Karwar (86.9%), Mangalore-Malpe (49.8%) and Chennai (49.8%). At Mumbai maximum production (56%) was observed in the monsoon period (June-September).

Species composition: *Trichiurus lepturus* was the dominant species in all the centres. Other species like *T. russelli, Lepturacanthus savala, L.gangeticus, Eupleurogrammus muticus* and *E.glossodon* were also reported from Kakinada where they together constituted 14.3%.

Biology : The minimum size of recruitment of *T.lepturus* was 10cm in trawl reported from Kakinada in September. It was 20cm at Veraval (February) and Chennai (July, November & December), 49cm at Mumbai (July-August) and 32cm at Mangalore-Malpe (February) and Kochi (March). The recruitment size in gillnet was 52cm at Veraval (December) and 42cm at Madhwad (October). The smallest size caught in boatseine at Visakhapatnam was 10cm in May.

The annual mean length in trawl net ranged from 46.4cm (Visakhapatnam) to 73.9cm (Kochi). In gillnet it was 77.7cm at Veraval and 81.7cm at Madhwad, and in boatseine 67.5cm at Visakhapatnam. This shows that along the east coast the under-sized fish was exploitated maximum. On the other hand along the west coast the exploitation was largely on bigger fish measuring above 50 cm.

The females dominated among both pre-adults and adults at all the centres except at Mumbai where the males dominated forming 55.6%. Spawning season was generally from January to June and November-December.

T.lepturus is purely a carnivore. The major food items include the Indian scad, threadfin breams, whitebaits, ribbonfishes, lizard fishes, bull's eye, sardines, silverbellies, *Acetes*, prawns, squilla, and small cephalopods.

Stock assessment :The stock assessment studies were conducted on *T. lepturus* at Mangalore, Kochi and Kakinada. The growth and mortality parameters estimated at Kochi and Kakinada gave identical values, while they slightly varied at Mangalore. The exploitation rate (E) estimated for these centres were 0.82 at Kochi, 0.76 at Kakinada and 0.83 at Mangalore which indicated that the stock was being over exploited at all these centres. The exploitation of large quantities of juveniles and pre-adults along the east coast has been noticed. The larger mean length observed at Kochi may be due to the sorting of the catch onboard and discarding overboard the under-sized fishes.

INVESTIGATIONS ON THE FISHERY AND RESOURCE CHARACTERISTICS OF CARANGIDS

(PF/RE/5)

H. Mohammed Kasim, Prathibha Rohit, P.N. Radhakrishnan Nair and R. Thiagarajan

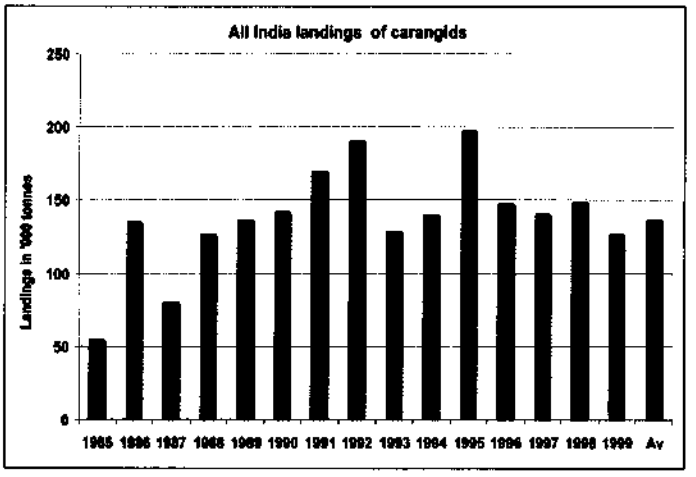
Eversince the mechanisation of the fishing crafts the landings of carangids evinced a sustained increasing trend from 24,500 t in 1969 to 137,908 t in 1997 recording a highest production of 196,832 t in 1995. The purse seines and trawls mostly contributed towards this enhancement, especially the concentration of the latter within the 50 m depth has made perceptible change in the succession of small pelagics in place of other species.

Fishery

The landings of carangids during the current year showed a mixed trend at the monitoring centres and were: Veraval 1992 t (+49%), Mangalore 7076 t (-20.3%), Kochi 1169 t (+17%), Tuticorin 3445 t (-13.5%) and Kakinada 1731 t (-30.3%). The trawls contributed 72% at Veraval, 50% at Mangalore, 69% at Kochi, 89.4% at Tuticorin and 95.8% at Kakinada. The gillnets shared 28% at Veraval, 0.6% at Mangalore, 16% at Kochi, 8.5% at Tuticorin and 4.2% at Kakinada. The contribution of purse seine was to the tune of 49% at Mangalore, 16% at Kochi and that of the ring seine was 5.6% at the latter centre. The hooks and lines shared 2.1% of the carangid catch at Tuticorin.

The trend in landings, effort input and c/e in percentage respectively for various gears in relation to the previous year were: Veraval – trawl (+15.9, +23.2, +15.6) and gillnet (+73.7, +9.2, +91.3); Mangalore – trawl (-12.1, -4.7, -7.7), purse seine (-35.7, -9.6, -28.9), indigenous gear (-35.5, -24.7, +27.6) and gillnet (+59, +24.7, +27.6); Kochi – trawl (-2, -24, +29.3), gillnet (-32.8, -8.9, -26.2); ringseine (-54.5, -53.4, -2.3); and Tuticorin – trawl (7.8, +3.5, -10.9), *Paruvalai* (-3.1, +22.3, -20.8) and *Podivalai* (+81.7, +14.9, +58.4). At Kakinada, though the trawl catch declined by 46% and that of gillnet increased by 52% the c/e was down in both the gears by 32% and 21% respectively.

Several species supported the fishery and among them *Megalaspis cordyla* was the dominant species in both the gillnet and trawl landings at Veraval; in the gillnet, purseseine and trawl catch at Mangalore; in the gillnet, purseseine and trawl catch at Kochi and in



the gillnet landings at Kakinada. *Decapterus russelli* and *D. macrosoma* were observed in purseseine and trawl at Mangalore, in the trawl and ringseine at Kochi and in the trawl landings at Veraval and Kakinada. *Selar crumenophthalmus* was noticed to occur in the trawl and gillnet landings at Kochi and in the *Podivalai* and trawl landings at Tuticorin. *Caranx kalla* used to occur in the purseseine and trawl landings at Mangalore and in *Podivalai* catch at Tuticorin. *C. carangus* was observed in *podivalai*, *C. sexfasciatus* in *paruvalai* and hooks and lines and *Selaroides leptolepis* in trawl at Tuticorin. The studies revealed that *M. cordyla* and *Decapterus* spp. occurred in almost all centres.

Biology

M. cordyla indicated a size range of 200-389 mm in trawl and 190-429 mm in the gillnet at Veraval; 190-294 mm in the purseseines, 145-384 mm in trawls and 240-449 mm in the gillnets at Mangalore; 200-389 mm in purseseines, 75-324 mm in trawls and 205-404 mm in the gillnets at Malpe; 175-369 mm in trawls and 210-374 mm in the gillnets at Kochi; and 50-319 mm in trawls and 70-609 mm in the gillnets at Kakinada. *C. kalla* occurred in the length range of 100-149 mm in the purseseines and 75-159 mm in the trawls at Mangalore; and 85-159 mm in the purseseines and 60-159 mm in the trawls at Malpe. *D. russelli* of 75-119 mm was exploited by the purseseines and 120-214 mm by trawl at Mangalore; 175-224 mm by gillnets, 140-229 mm by trawls and 95-195 mm by purseseines at Malpe; 125-239 mm at Kochi and 85-204 mm by trawls at Kakinada. In the trawl *D. macrosoma* of 130-209 mm were encountered at Mangalore compared to 105-224 mm at Malpe and Kochi; and 100-204 mm at Kakinada. The ringseines at Kochi exploited 125-165 mm size groups. *S. crumenophthalmus* was exploited only at Kochi and Kakinada and were of the size 120-264 mm in trawl and 180-264 mm in gillnets at the former centre compared to the trawl catch of 125-294 mm at the latter centre. *Alepes djedaba* exploited by the trawl and purseseine at Kochi were in 200-319 mm range against 235-304 mm obtained in gillnets. *S. leptolepis* of 80-184 mm in trawl and *C. sexfasciatus* of 50-115 mm in gillnets were noticed at Tuticorin.

At Mangalore, females dominated the *M. cordyla* and *D. russelli* population in the purseseine ground. Spawning and partially spent fishes have been found to remain in slightly offshore areas where the males dominated. This pattern was discernible in *D. macrosoma* too at this centre. Unlike the above two species, the spawning population of *C. kalla* was distributed in the entire range of purseseine, gillnet and trawling grounds. As at Mangalore, the concentration of spawning population of *D. russelli* and *D. macrosoma* were towards the offshore areas off Kochi. *S. crumenophthalmus* and *M. cordyla* population observed in the trawling ground were in the developing stage. *S. crumenophthalmus* noticed at Kakinada were in developing and gravid stages.

The food and feeding habits of *M. cordyla*, *C. kalla*, *D. russelli* and *D. macrosoma* have been studied. At Kochi, well fed *D. russelli* were found in the purseseine ground compared to poor feeding in *D. macrosoma* exploited from trawling ground. *M. cordyla* indicated good feeding in the trawling ground than those caught from gillnetting areas. *S. crumenophthalmus* caught from offshore areas evinced good feeding compared to partially fed *A. djedaba* observed in purseseine catch.

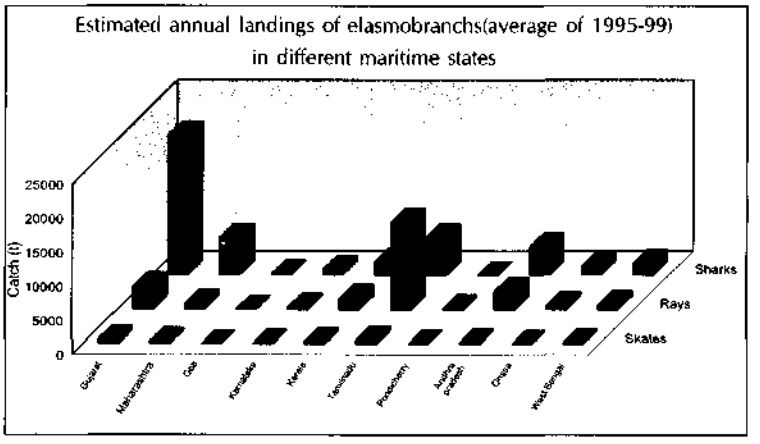
III. DEMERSAL FISHERIES DIVISION

The Demersal Fisheries Division implemented 7 research projects on monitoring the characteristics of the exploited stocks of demersal finfish, one on impact of bottom trawling on bottom fauna and one on finfish mariculture. The work initiated on the preparation of "Atlas on Elasmobranch resources" during the year progressed well and the same will be finalized for publication in the coming year. The various research projects in capture fisheries are of continuing nature and are implemented to understand the trends in fishery and biological characteristics of the exploited stocks. The analysis of data generated at the research centers revealed that almost all major species registered decline in the landings. In the study on the impact of coastal bottom trawling, the target by-catch ratio was 1:4.6 along the southwest coast and 1:2.6 along the southeast region. Large-scale exploitation of juveniles of certain demersal finfish species was reported from certain centers. In the area of mariculture, the division achieved progress particularly in spontaneous spawning of the grouper *Epinephelus tauvina*. Larval rearing could be carried out only up to 13 days. The work on broodstock development and larval rearing is continued. The technology of breeding and seed production of clown fish has been perfected and similar work on other ornamental fish species is in progress.

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

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

The work was carried out on the west coast from Mumbai, Kochi and Kozhikode and on the east coast from Chennai, Tuticorin and Mandapam. The total landing of elasmobranchs at all the centres in different gears during 1999 was 5,293 t whereas during 1998 it was 7,840 t showing a decrease of 2,547 t (-32.5%). The decline is brought about by a 53% decrease in the landings of rays, even though sharks and skates registered an increase. The highest catch of 2,909 t of elasmobranchs was recorded at Mumbai followed by



1,351 t at Chennai, 564 t at Tuticorin, 268 t at Kochi and 200 t at Kozhikode. Highest c/e was obtained in drift gillnet (39 kg), followed by trawl (32.5 kg), bottom set gill net (32 kg) hook and line (3 kg) and 'dol ' net (1 kg). Sharks constituted 49% of elasmobranch catch followed by rays (46%) and skates (5%).

An estimated catch of 2,784 t of elasmobranchs with a c/e of 81 kg was landed by trawlers at Mumbai (N.F.Wharf), 122 t a c/e of 32 kg by gill net (Satpati) and 3 t at a c/e of 1 kg by 'dol' net (Versova). Maximum catch in trawl net was during October-December and in gillnet in January, September-December. The landings of sharks, rays and skates were dominated by *S.laticaudus* (62%), *Dasyatis zugie* (55%) and *Rhynobatus djeddensis* (82%) respectively. The size range of male *S. laticaudus* was 160-560 mm and females 180-620 mm. The males of this species in the length range 280-420 mm and females in 240-360 mm formed 73% and 62% of the catch in trawl net. The males of *D.imbricatus* were in length range 160-310 mm and females in 140-320 mm. Males of 200-233 mm size formed 65% of the male catch and females of 140-320 mm size formed 73% of the specimens catch. Pregnant specimens of *S. laticaudus* were observed during April and November and that of *D. imbricatus* during August, and October-November. Maximum of nine embryos were observed in *S. laticaudus* and only one in *D.imbricatus*. Most dominant food items of these species were *Acetes* spp., *P. tenuipes* and *Squilla* spp.

At Kozhikode, a total of 200 t (9 kg/unit) were landed. *Scoliodon laticaudus* was dominant in sharks and *Gymnura micrura* in rays. The size range of male *S. laticaudus* was 262-546 mm and that of females 328-535 mm. Male to female ratio was 1:1.15.

At Kochi, elasmobranch landings were 96 t at a c/e of 6 kg by the trawl and 171 t at a c/e 39 kg by gillnets. The production showed a decline of 88 t in trawl and an increase of 5 t in gillnet as compared to the previous year. Rays formed 60% in trawl and 56 % in gillnet. More than 60% of trawl catch of sharks was contributed by *Carcharhinus melanopterus* and *Rhizoprionodon acutus* and 85% of gillnet catches by *C.melanopterus*, *R. acutus* and *R.oligolinx*. The size range of *R. acutus* in gillnet was 30-89 cm and *C. melanopterus* 20-69 cm.

At Tuticorin the exploitation was by trawl (504 t); bottom set gillnet (32 t), hook and lines (17 t) and drift or gillnet (10 t). The c/e in these gears was 15 kg, 32 kg, 3 kg and 10 kg respectively. Compared to the previous year, the landing was less by 897 t in trawl and 261 t in hook and line. Catch of rays (84%) was highest in all the gears. *Dasyatis bleekeri* was the dominant species in trawl (54%), hook and line (40%) and in bottom set gill net (38%). The size range of *D. bleekeri* was 42-101 cm, *D. kuhli* 19-49 cm, *Rhizoprionodon acutus* 69-92 cm.

At Chennai, the catch of elasmobranchs by the trawler (1,235 t) and gillnet (116 t) was 1,351 t. The catch was high during the first quarter (40%). The annual c/e in trawl was 27 kg and gillnets 77 kg. In trawl *Dasyatis* spp. formed a substantial catch (91%) in which *D.jenkinsii* was the dominant species. *C. melanopterus* (75%) was dominant in the sharks (99%), in the gillnet. The size range of *D.jenkinsii* was 10-109 cm. Prawns, crabs and cuttle fish were dominant food items in this species.

MONITORING THE RESOURCE CHARACTERISTICS OF GROUPERS, SNAPPERS AND PIG FACE BREAMS

(DF /RE/2)

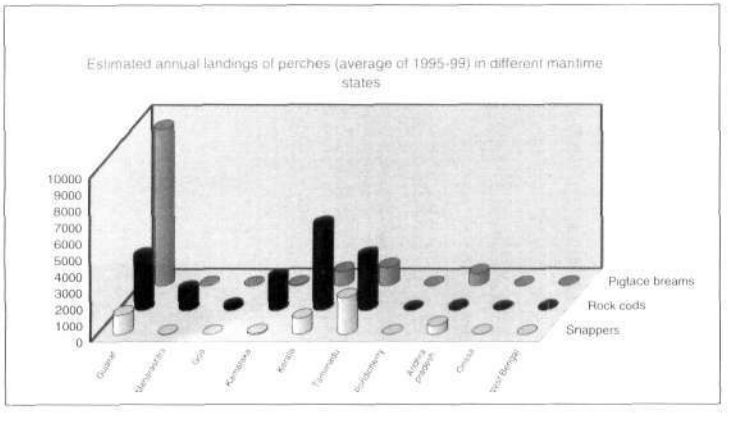
Grace Mathew, P. Livingston, S. Krishna Pillai and P.P. Manojkumar

A total of 7,123 t of major perches were landed at Kochi, Kozhikode, Vizhinjam, Tuticorin and Mumbai. The major gears employed in the exploitation of these resources were trawl nets, hooks and lines and gillnets using mechanized or motorized units. As in the previous years, maximum catches of 2,472 t was obtained off Tuticorin. Compared to the previous year, the landings from the Gulf of Mannar came down by almost half.

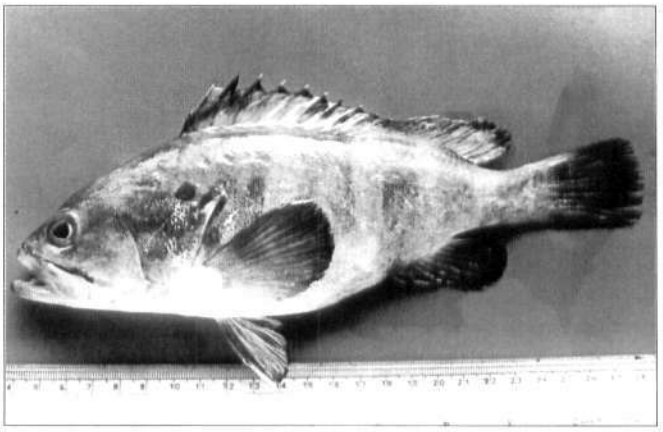
At Tuticorin, trawl nets landed 87% of the total perch catch, with a c/e of 68 kg, the hooks and lines contributed 11% with an average c/e of 44 kg. The c/e in the drift gillnet, and bottom set gillnet were 16 kg and 34 kg respectively. Highest landing was recorded during April, from trawl nets with c/e of 172 kg followed by January and December. During January and December, *Epinephelus tauvina* and *Lethrinus nebulosus* were most dominant. The dominant length range of *L.nebulosus* was 300-320 mm and *Lutjanus rivulatus* 220 - 720 mm.

At Vizhinjam, perch landings were maximum during May-June with c/e of 8 kg and 30 kg respectively. In hooks and lines peak season was February- March and May. Maximum landing of *Lethrinus spp.* was obtained during June followed by February and August.

At Kochi, trawlers and hooks and lines landed the perches. Hooks and lines were operated during November - April. Maximum catches were obtained during December and March. Trawlers landed only 4.2% of the total perches landed. *E.diacanthus* was the dominant species in the trawlers. *Pristipomoides typus, Epinephelus* spp. were the most dominant in the hooks and line catch.



At Kozhikode, these fishes were landed mainly by trawlers. April - May was the peak period. Groupers and snappers contributed to the fishery. *Epinephelus diacanthus* dominated (82.9%) followed by *E. tauvina*(10.3%) and *E.malabaricus* (6.7%).



Epinephelus diacanthus

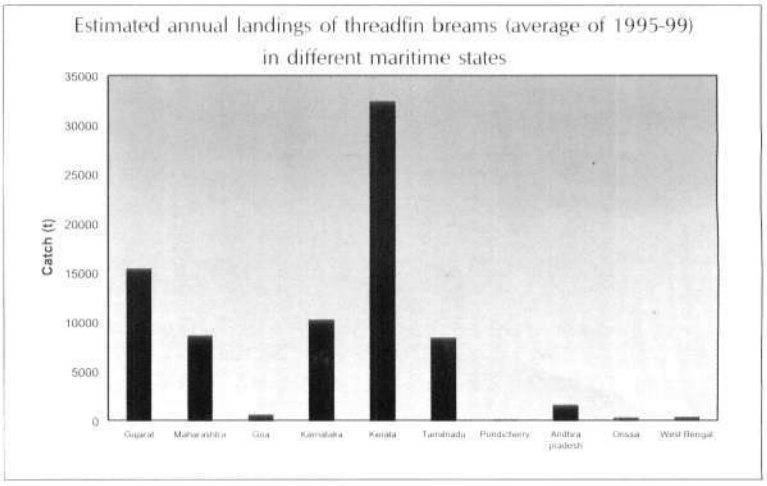
Lutjanus lutjanus was the most dominant species of snapper in the perch fishery both at Puthiappa and Beypore. Large specimens of *E.diacanthus* (280 to 490 mm) were available during the month of September, while during November-December mainly young ones were observed in the fishery.

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

V. Sriramachandra Murty, E.Vivekanandan, P.U.Zachariah, K.K.Joshi, P.P.Manojkumar, Rekha J.Nair, U.Rajkumar and Shoba J. Kizhakudan

THREADFIN BREAMS

The work was carried out at Veraval, Mumbai, Mangalore, Kozhikode and Kochi along the west coast and Visakhapatnam, Kakinada, Chennai and Mandapam along east coast. At Veraval, an estimated 1,776 t of threadfin breams were landed by trawlers, showing a decline of 30% in the catch consequent on 22% reduction in the effort. The fishes of the genera *Scolopsis* and *Parascolopsis* occurred in the fishery during October-December. *N. japonicus* and *N.mesoprion* were the major



species together accounting for 98% of the threadfin breams catch. Immature and early maturing females were dominant during January-May, while du-ring September-November and in December, most of the females were in the mature stage.

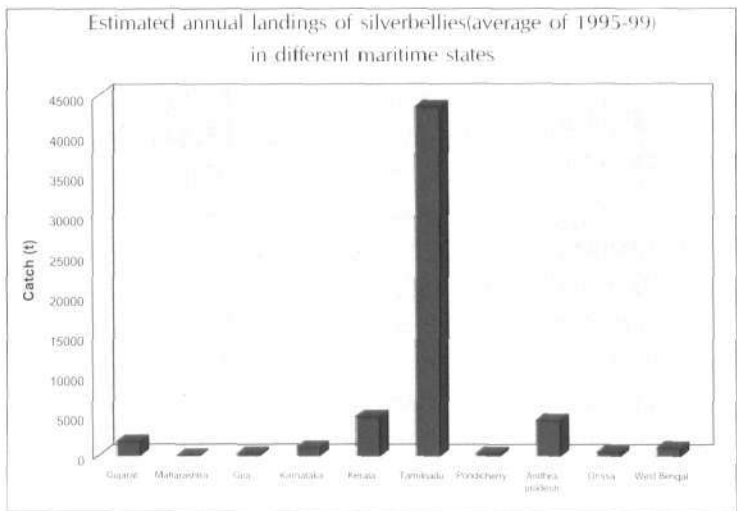
At Mumbai, an estimated 2,226 t of these fishes were landed forming 4 % of total trawl landings. February-June period accounted for 64% of the annual threadfin bream landings. *Nemipterus japonicus* was the most dominant species (43%) followed by *N.mesoprion* (40%). During February and April *N.mesoprion* was dominant whereas *N.japonicus* was dominant in other months.

At Mangalore, an estimated 12,464 t of threadfin breams were landed forming 23 % of the total trawl landing indicating a marginal increase over that of the previous year. Heavy catch of threadfin breams was obtained in September-October accounting for 46.5% of the catch during the entire year. During the post monsoon period, multiday boats operated in deeper waters for cephalopods and from November onwards resumed their operation in the regular fishing grounds. The catch of threadfin breams would have increased if these boats operated in the deeper waters during postmonsoon period. Only two species *N. japonicus* and *N. mesoprion* contributed to the fishery. The latter was the most dominant species throughout the year except November and December, forming on an average 63 % of the threadfin bream catch. The length range of *N. mesoprion* in the fishery was 70- 299 mm and in *N. japonicus* it was 80-289 mm. Ripe fishes of *N.mesoprion* were seen during September -November. Gravid fishes of *N. japonicus* were observed during September-December period.

At Kochi, an estimated 908 t of nemipterids were landed forming 12 % of the total trawl landings. Heavy catch of nemipterids was observed during May to September (except the ban period of 45 days) forming 69% of the annual catch. *N.mesoprion* was dominant forming 68.2% of threadfin bream catch. In *N.mesoprion* the length range of males was 80-270 mm and females 90-250 mm. Mature and ripe specimens were seen during the month of October. The length range of *N.japonicus* was 60-240 mm. The catch showed a decline of 41% along with a decrease of 25% in effort in comparison to the previous year.

At Chennai, the threadfin bream landings were estimated at 1,349 t, forming about 7 % of the total trawl landings. The catch showed a decline of 30% compared to the previous year. Of the 4 species that contributed to the fishery, *N. japonicus* dominated forming about 44 % of the threadfin bream landing. The length range of *N.japonicus* was 80-269 mm. Females dominated the catch throughout the year (83%) and most of the females were in early stages of gonadal maturity.

At Visakhapatnam, 66 t of threadfin breams landed was less by 87 % compared to the previous year. The reason for the decline in the landings may be the reduction in the total fishing effort by 25% as compared to the previous year. Peak landings were obtained during January-February. *N. japonicus* was the most dominant species forming 63 % followed by *N.mesoprion* (31%) and *N.delagoae* (2%) and *N.tolu* (3%). The length range for *N.japonicus* was 110-220 mm.



At Kakinada, an estimated 202 t were landed by trawlers. The contribution by *Sona* boats is about 64 %. The catch showed a decline of 44 % as compared to the previous year and the total effort also showed a decline of 20 %. Of the 5 species that contributed to the fishery *N.japonicus* was dominant forming about 53.7% of the threadfin bream landing followed by *N.tolu* (31%), *N.delagoae* (9%) and *N.mesoprion* (5%). The length range of *N.japonicus* at Kakinada was 35 - 275 mm and *N. mesoprion* 55 -195mm.

SILVERBELLIES

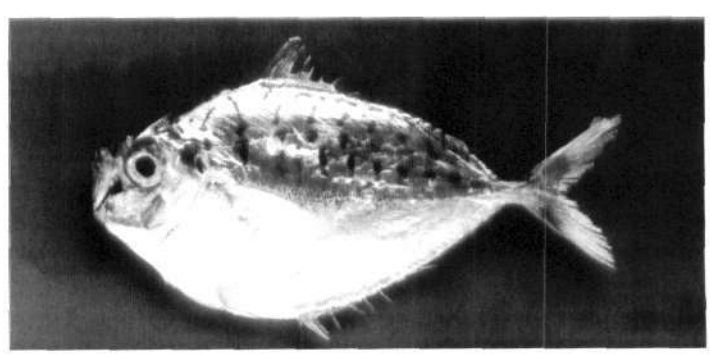
At Veraval, about 138 t of silverbellies were exploited by trawlers forming 0.3% of the trawl landing indicating a decline of 71% over the previous year.

An estimated 35 t of silverbellies were landed by trawlers at Cochin Fisheries harbour with a c/e of 2 kg. The catch showed an increase of 26 t as compared to the previous year.

At Kozhikode, 146 t of these fishes were landed. The major species contributing to the trawl fishery are *L.equulus, Secutor insidiator, L.bindus* and *L.splendens.*

At Chennai, 2,217 t of silverbellies were landed by trawlers, forming about 10.9% of trawl catch. The catch and catch rate of silver bellies decreased by 50% as compared to the previous year. *L.bindus, S.insidiator* and *L.splendens* were dominant in the landings. *L.bindus* was in the length range of 40-124 mm in the fishery.

At Rameswaram, the trawlers landed 9,049 t forming 45 % of the total landing at this centre. The catch showed a decrease of



Secutor insidiator

23% when compared to the previous year. *L.brevirostris* was the most dominant species (54%) followed by *L.jonesi* (27%) and *L.dussumieri* (7%). The length range of *L.brevirostris* was 65 -195 mm.

At Pamban and Mandapam, the silverbelly landings were 183 and 691 t respectively. Catch showed a decline of 48 % and 4% at Pamban and Mandapam. *L.dussumieri* was the most dominant species followed by *Gazza minuta*. The length range of *L.dussumieri* was 70 to 150 mm.

An estimated 165 t of silverbellies were landed at Vishakapatnam. The catch showed a decline of 44% as compared to the previous year. About 60 % of the total landing occurred during April. *L. bindus was* the most dominant species forming 66% of the total silverbelly landing followed by *L.equulus, L.leuciscus, L.dussumieri, S.insidiator, S.ruconius, Gazza minuta* and *L.splendens*.

At Kakinada, about 757 t of silverbellies landed were less by 34 % compared to the previous year. The catch consisted of 10 species of which *L.bindus* was dominant (42%) followed by *S.insidiator* (12%), *L.splendens* (10%), *S.ruconius* (10%), *L.equulus* (9%) and *Gazza minuta* (7%). The *L.bindus* was in the length range of 20 -120mm and *S.insidiator* 20-120mm.

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

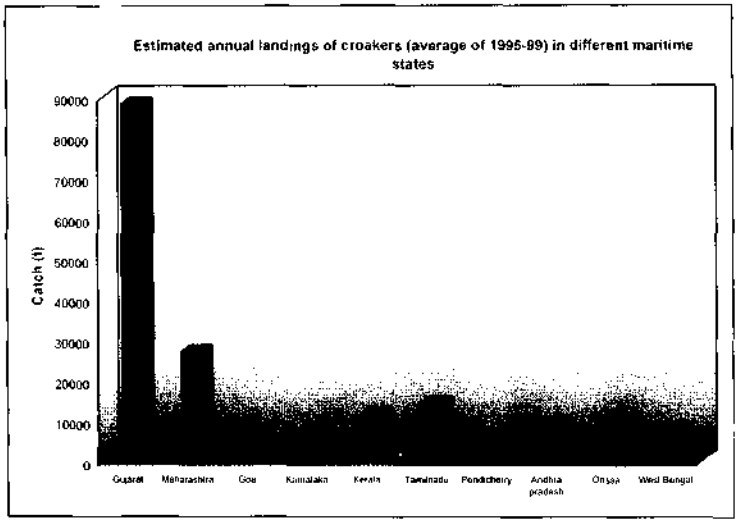
G.Mohanraj, M. Feroz Khan, S.Sivakami, P. Livingston, Rekha J. Nair, U.Rajkumar and Shoba J. Kizhakudan.

The total catch of sciaenids reported from various centres was 18,579 t during 1999. There was 20% decrease in the catch over the last year. The contribution of trawlers to the total catch was 80 % and the rest was shared by *'dol'* nets (18 %), gill nets (1.8 %) and shore seines (0.2 %).

At Mumbai, Kozhikode, Kochi, Mandapam, Chennai, Kakinada and Visakhapatnam, the catches were exclusively landed by the trawlers. At Veraval in addition to the trawl nets, gill nets and 'dol ' nets contributed to the catch. At Navabander (Gujarat) 'dol ' net was the exclusive gear. At Tuticorin, gillnets also landed sciaenids. At Karwar, in addition to the trawl nets, the shore seines landed about 16 % of sciaenid catch.

At different centres the landings of sciaenids varied between 54 t and 10,429 t. The highest catch was recorded at Veraval and the lowest from Tuticorin. The highest catch rate was reported at Mumbai (199.3 kg) while the lowest was at Tuticorin (1.6 kg).

At Kakinada, an estimated catch of 73 t of sciaenid juveniles in the length range of 40-162 mm were landed. Maximum quantity was recorded during February.



At Veraval, *Otolithes cuvieri* was the dominant species in the trawl catch (44.4 %) followed by *Johnius glaucus* (9 %). The other important species in the order of abundance were *Johnieops sina, J.vogleri, Otolithoides biauritus, Johnius carutta,* and *Protonibea diacanthus.*

Otolithes spp. (58%), *Protonibea diacanthus* (16%), *Johnius* spp., *Johnieops* spp., *Johnius* spp., and *Otolithoides biauritus* were the major sciaenid species in the gillnets at Tuticorin.

In the 'dol ' nets, *O.cuvieri* (56 %) was dominant followed by *Johnius carutta, O. biauritus, J. glaucus, P.diacanthus, Johnieops sina* and *J. vogleri.*

At Mumbai *J.vogleri* dominated the catch followed by *J.macrorhynus, O. cuvieri* and *Johnieops sina* . At Karwar *O. cuvieri* (59 %) was the dominant species followed by *J.coitor* and *O. ruber.* At Kozhikode *J. belengerii* (57 %) was the dominant species followed by *J. sina* and *O. ruber.* At Kochi *J. sina* (58 %) followed by *O.ruber* (40 %), *O. cuvieri* and *K. axillaris* were the major species recorded. At Tuticorin *J. maculatus* (39 %) formed the dominant species followed by *Pseudosciaena coiber* (34 %) and *O. ruber* (33 %). At Rameswaram, *P. macrophthalmus* (74%) was the dominant species followed by *Johnius dussumieri* (20 %). At Pamban, *O. ruber* was the dominant species (38 %) followed by *J.dussumieri* (17%).

At Chennai, *O. ruber* was the dominant species (36 t) followed by *J. carutta* (23 %), *Kathala axillaris, Johnieops sina* and *N. maculata.*

At Kakinada, *K. axillaris* (14 %) was the dominant species followed by *J. carutta* (13%), *J. macrorhynus* and *O. ruber.* At Visakhapatnam *Pennahia macrophthalmus* was the dominant species followed by *O. ruber.*

In *O. cuvieri, J.glaucus and P. diacanthus,* the length range was 90 to 359, 50 to 299 and 100 to 1519 mm respectively. The male-female ratio was 1.66: 1 in *O. cuvieri* and 1 : 1.3 in *J. glaucus.* Immature fish of *O. cuvieri* supported the fishery while mature fish of *J. glaucus* contributed to the fishery.

At Karwar, the size ranged from 90 to 219 mm in *O. cuvieri* and 95 - 269 mm in *J. coitor.* Mature fish formed a substantial component of the catch. At Kozhikode the length

Centre wise production of Sciaenids during 1999

Name of the Centre	Estimated catch (t)		CPUE (kg)
Veraval	6704	(Trawl net)	123.7
	352	(Gill net)	12.4
	3373	(*Dol* net)	111.7
Mumbai (upto Sep.)	4185	(Trawl net)	199.3
Karwar	246	(Trawl net)	12.8
	40	(Shore seine)	5.6
Kozhikode	245	(Trawl net)	6.1
Kochi	86	(Trawl net)	6.3
Tuticorin	51	(Trawl net)	1.6
	3	(Gill net)	3.8
Mandapam	585	(Trawl net)	5.1
Chennai	1170	(Trawl net)	25.1
Kakinada	1316	(Trawl net)	25.9
Visakhapatnam	151	(Small trawlers)	18.3
	72	(Sona boats)	26.4
Total	8579		

of *J. sina* ranged between 75 and 175 mm. The ratio of males to females was 3:2. Fish in I - III maturity stages supported the fishery. At Kochi, the size range was 130-280 mm in *O. ruber*. In *J. sina*, the size ranged between 90 and 175 mm. Females were dominant in the catches. Ripe stage in both species were recorded during January-April.

During January-April, the length range of 110-240 mm was recorded in the commercial catches of *J.maculatus* at Tuticorin. At Mandapam, the size ranged from 115 to 195 mm for *P. macrophthalmus*. At Chennai the size ranges of *O. ruber* and *K. axillaris* were 90-260 and 90-200 mm respectively. The dominant modal size group was 140-mm in *O. ruber* and 130 mm in *K.axillaris*. Gravid fishes of *K.axillaris* were recorded during July - October and in December, and in *O. ruber* during September-November. Fishes and prawns formed the major food item of both the species. At Kakinada the length range of *N.maculata* was from 75-245 mm with a dominant mode at 175 mm. At Visakhapatnam the size range of *J. carutta* was 95-225 mm. Immature females contributed to the fishery significantly. The food items comprised of juvenile crabs, prawns, fishes and stomatopods.

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 Shoba J.Kizhakudan

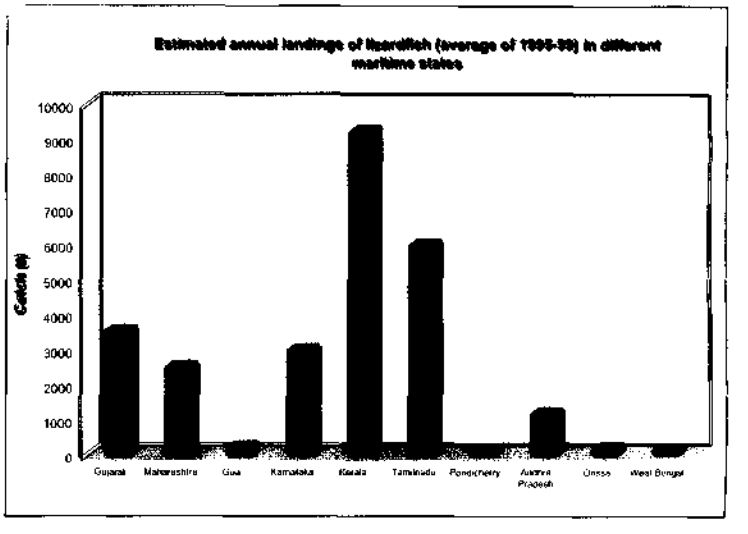
LIZARD FISH

The lizardfish fishery at various centres showed a decline when compared to the previous year. Species composition showed a dominance of *Saurida tumbil* in trawl catches at Veraval (95%), Mangrol (98 %), Mumbai (93 %), Kozhikode (100%) and in *'Sona'* boat at Visakhapatnam. *S. undosquamis* was the major species at Kochi (56 %), Chennai (100%) and trawl catch at Visakhapatnam (47 %). *Trachynocephalus myops* constituted 24% and 15% of the lizardfishes landed by small trawls and *'Sona'* boat respectively from Visakhapatnam. *Saurida micropectoralis, S.longimanus* and *Synodus englemani* were the other species recorded.

Catch rate of lizardfishes was high during September to December/January at Veraval, Mumbai and Visakhapatnam. Higher landings took place during May to September period at Kozhikode, Kochi and Chennai.

S. tumbil off Veraval was in the length range of 285-345 mm. At Mangrol, this species was dominant in smaller size groups 205-275 mm, though the length ranged from 205-425 mm. At Mumbai, the length range was 165-325 mm with 165-255 mm range dominating the fishery.

At Kozhikode, *S. tumbil* contributed to 100% of lizardfish landings, size groups 230-245 mm, 266-285 mm & 291-315 mm formed 18%, 18.7% and 34.5% respectively. At Beypore, the fishery was supported by size groups between 245-325 mm (77 %). At Kochi, where *S. tumbil* formed about 12.5% of the catch, the dominant size groups were in the range of 235-335 (84%), 355-375 mm (6%) and 405-415 mm (3 %). *S. undosquamis* at



Mumbai was in the length range of 115-305 mm and 155-325 mm at Kochi.

The study revealed that *S. undosquamis* along the west coast has a prolonged spawning period as evidenced by the presence of spent gonads almost throughout the year with a peak during September to November, and at Chennai, the species appears to have a restricted spawning during September to December.

BULL'S EYE

The Bull's eye, compared to last year, showed remarkable increase in catch and c/e respectively as: Veraval 576 t, 10 kg (+ 284 t, + 6 kg); Mumbai 829 t, 31 kg (+ 670 t, + 26 kg); Kozhikode 249 t, 12 kg (+ 156 t, + 9 kg); and Beypore 288 t, 15 kg (+ 142 t, + 9 kg) while along the southwest coast at Kochi and along the east coast at Chennai and Visakhapatnam, the Bull's eye catch declined by 15 to 95 %. *Priacanthus hamrur* was the major species at all centres. The catch rates were higher during November-December at Veraval, January-March at Mumbai and Visakhapatnam, April - June at Kozhikode and June - September at Kochi.

P. hamrur was in the length range of 135-175 mm at Mumbai (Sassoon Dock), 205-245 mm at Kozhikode and Kochi. At Mumbai, *P. hamrur* in mature condition was obtained only during October while at Kochi ripe gonads were noticed during March -June period.

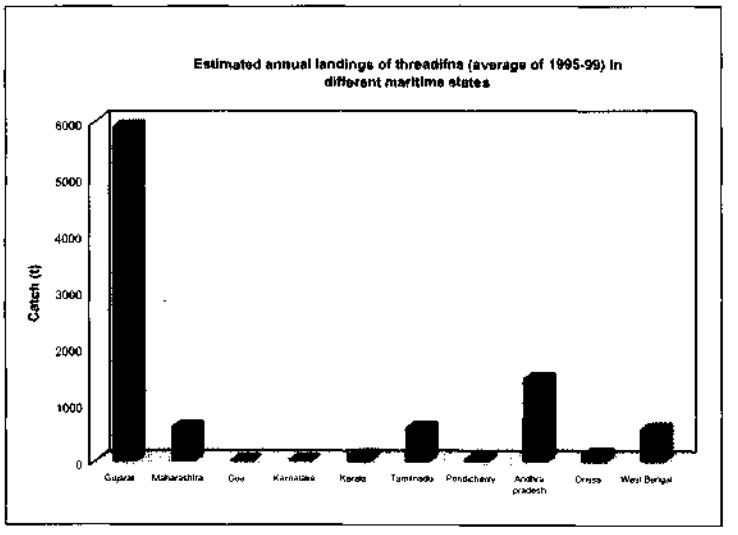
THREADFINS

The catch showed an increase by 74 % in gillnet at Veraval, and a decrease in trawl by 43% at Mangrol. Mumbai (New Ferry Wharf), brought good landings of polynemids to the tune of 622 t (20 kg/E), which showed an increase by 150 %, when compared to that of 1998 (248 t; 9 kg/E). At Dhamlej, in gill net, there was a decrease in catch by 47% this year.

Polynemus indicus formed the major species at Veraval in trawl (55 %) in gill net (74 %), at Dhamlej in gillnet (61 %) and at Mumbai in trawl (54 %). *P.heptadactylus* formed 43% at Mumbai in trawl, *P. sextarius* constituted 23 % by trawl and 16 % by gillnet at Veraval. *Eleutheronema tetradactylum* contributed to 32% of the polynemid landing at Dhamlej in drift gillnet.

At Mumbai, the fishery of *P. heptadactylus* was dominated by fishes in length groups of 115-145 mm. The gonads were in stages V & VI during March, and September to Decem-

Bull's eye, *Priacanthus hamrur*



ber. This species was found to feed on fishes (*Bregmaceros* spp., *Myctophids, Solenocera spp. and Acetes* spp.)

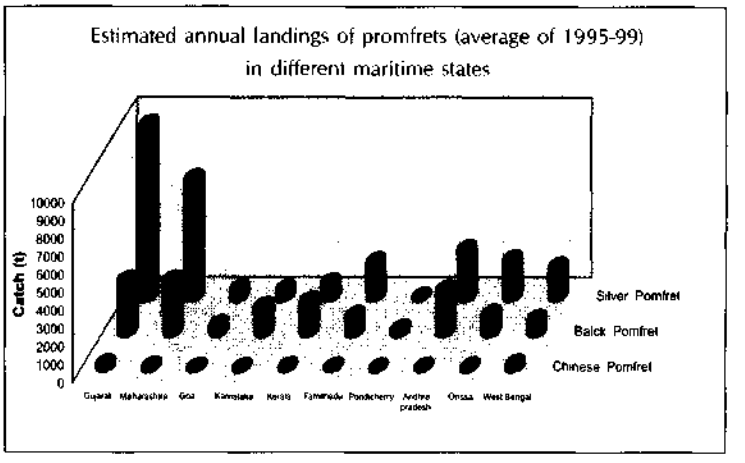
POMFRETS

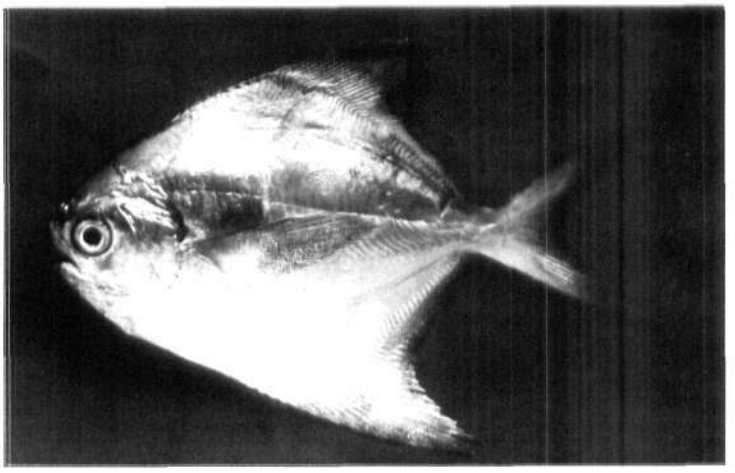
Pomfret resource was monitored in all the centres in trawl and gill net. The fishery generally showed an increasing trend to the tune of 30% at Mumbai (NFW), 62% at Versova (Mumbai), 23-70% at Kozhikode, 211 % at Kochi and 53 % at Chennai. A decline in catch was noticed at Veraval, (31 %), Mumbai (Satpati) (48%) and 44-60% at Visakhapatnam.

Pampus argenteus was the dominant species at Mumbai (60%), Kozhikode (Puthiappa) (51.5%), Kochi (44.4%), Mumbai (Satpati) (drift gillnet 96 %) and Mumbai 'dol' net (100 %). *Formio niger* formed 40% at Mumbai and 48 % at Kozhikode (Puthiappa), 79% at Beypore and 55% at Kochi. *P. chinensis* was nominally represented at Mumbai (Satpati) in gill net (1%).

The landings were maximum during March-May at Veraval, October-December at Mumbai and Satpati, June at Beypore, and February/March and July to November at Visakhapatnam.

The fishery of *P. argenteus* was supported by size groups 75-235 mm at Mumbai in trawl, 125-225 mm at Satpati in gill nets and by size groups 75-135 mm at Versova in 'dol ' net. The gonads of *P. argenteus* as studied from Mumbai, were mainly in stages I and II and they were found feeding on *Acetes* spp., medusae etc.





Silver pomfret, ***Pampus argenteus***

As a conservation measure, a ban on trawling was implemented during June-August 99 at Veraval and Mangrol, June/July along Kerala, April -May along Chennai and during May 1999 along Visakhapatnam. In the Kozhikode region the trawlers operated at depth range of 30-110 m using cod end mesh of 18-22 mm and off Chennai the depth range was 10-80 m with the cod end mesh size 10-15 mm.

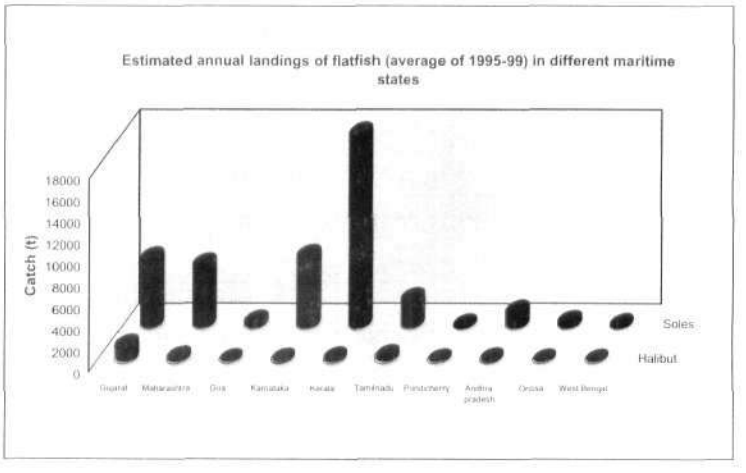
BIOLOGY AND FISHERY OF FLATFISHES, GOATFISHES AND WHITEFISH (DF/RE/7)

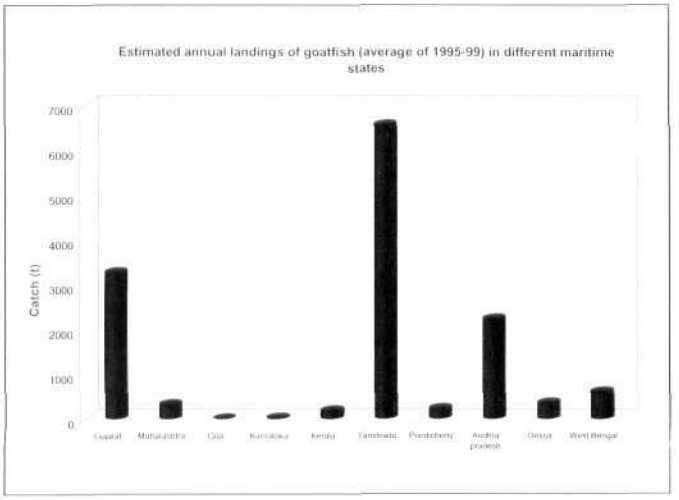
E.Vivekanandan, P.U. Zachariah, M. Feroz Khan, K.K.Joshi, U.Rajkumar and Rekha J. Nair

FLATFISHES

The exploitation of flatfish resource was mainly carried out from the southwest coast, especially the Kerala - south Karnataka coast. The landings in Mangalore and Malpe (3,257 t) and Kozhikode (1,863 t) increased by about 38% compared to a decrease by 70 and 37% at Kochi and Vizhinjam.

While *Cynoglossus macrostomus* dominated the landings along the north Kerala - south Karnataka coast, *C. bilineatus* and *C. macrolepidotus* dominated

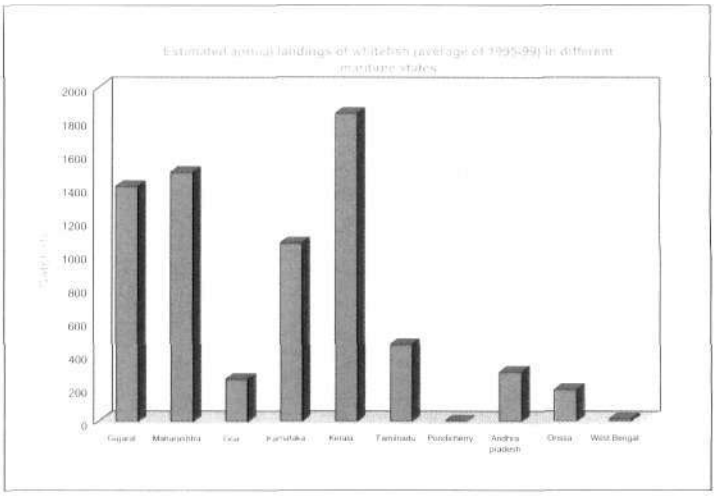




Chennai and *U. vittatus* (54.9%) and *U. sulphureus* (43.1%) at Visakhapatnam. The length range of *U. taeniopterus* at Chennai was 90-259 mm and the mean length was 129 mm. Females dominated the fishery and most of the females were in early stages of gonadal development.

the south Kerala coast and Gulf of Mannar.

The length range of *C. macrostomus* was 50-179 mm and the modal length groups were 100-109 and 110-119 mm. Females with developing gonads dominated in the catches.



GOATFISHES

The goatfishes were dominant along the east coast and constituted 1.8 to 10.3% of the total trawl landings between Mandapam and Visakhapatnam.

There was a clear area specific species domination pattern in goatfishes. *Upeneus sundaicus* (38.2%) and *U. tragula* (26.8%) at Mandapam, *U. taeniopterus* (62.2%) at

WHITEFISH

The catch (515 t) and catch rate (0.4 kg/a) of whitefish declined by 57 and 20%, respectively in the Mangalore region. The length range was 70-229 mm and the mean length was 140 mm. Anchovies and crustaceans were the major food items.

INVESTIGATIONS ON THE IMPACT OF COASTAL BOTTOM TRAWLING ON DEMERSAL FISHES AND MACROBENTHOS (DF/TR/1)

N.G.Menon, P.Nammalwar, P.U.Zachariah and I. Jagadis

The work was carried out from 6 centres (Karwar, Mangalore, Kochi, Mandapam, Mangalore and Kakinada). During 1999 the target: by catch ratios in trawlers were 1: 4.6 along the SW region and 1: 2.6 along SE region. The ratio of 1: 0.8 was recorded at Kochi (chiefly due to by catch discard at sea) and 1: 6.8 at Mangalore in depths below 30 m (due to high proportions of benthic biota in the catch).

KARWAR

At Karwar the total trawl catch was 1,870 t with a c/e of 235 kg, shared by 847 t of finfishes (45.3 %), 228 t of crustaceans (12.2 %), 8 t of cephalopods (0.4%) and 787 t of benthic biota (42.1 %). Juveniles of flatfishes, nemipterids, lizardfishes, and silverbellies were present in the catch to the tune of about 185 t (10 % of the finfish catch). The benthic biota consisted chiefly of stomatopods (95 %), gastropods, inedible crabs and echinoderms. At Tadri the total landing by trawl was 4,120 t at a catch rate of 423 kg which included 2,055 t of finfishes (49.9 %). 370 t crustaceans (8.9 %), 483 t cephalopods (11.7 %) and 1,213 t of benthic biota (29.4 %). The juvenile finfish catch of 160 t (8%) consisted of flatfish, nemipterids, *Lactarius*, *Epinephelus*, lizardfishes, silverbellies sciaenids etc. The benthic biota included stomatopods (1,167 t), gastropods, inedible crabs, bivalves, echinoderms etc.

MANGALORE

In shallow depths (below 30 m) the target: bycatch ratio was 1: 6.8, and 1:4 at depths about 30 m, obviously the latter was due to bycatch discard at sea. The single day trawling in shallow depths at Mangalore landed 5,458 t wherein finfishes formed 2,700 t (49.5 %), crustaceans 563 t (10.3 %) and cephalopods 12 t (0.2 %); whereas inedible benthic biota formed 2,182 t (60 %). Stomatopods contributed 71.4 % of the benthic biota followed by gastropods (11.4 %) bivalves (3.3%), inedible crabs (9.7 %), echinoderms (3.0%) with peak catches in June - April. Juvenile demersal fishes formed about 30 % (806 t) of the total finfish landing.

At Malpe the single day trawling landed 2991 t, of which finfish formed 984 t (33 %), crustaceans 432 t (14.4 %) cephalopods 6.8 t (0.2 %) and benthic biota 1,569 t (52.4 %). The latter group consisted of stomatopods (68.5 % of benthic biota), inedible crabs (11.5 %) and gastropods (10.8 %). In the total finfish catch, juvenile demersal fishes contributed 11.4 % (113 t).

The multiday trawlers operated beyond 30 m depth at Mangalore landed 28,869 t, consisting of finfishes 20,717 t (72 %), crustaceans 1,565 t (6 %), cephalopods 4,690 t (16 %) and benthic biota 1,867 (7 %). The benthic biota composed chiefly of stomatopods (72 %), followed gastropods (10 %), inedible crabs (8 %), echinoderms (4 %), bivalves (3 %) etc. Young demersal fish landing was 2,197 t (11 %) of the finfish catch.

At Malpe, the trawls from the same depth

(30 m) landed 16,853 t composed of finfishes, 13,351 t (79.2 %), crustaceans 307 t (2.4 %), cephalopods 2432 t (14.4 %) and benthic biota 663 t (3.9 %). The latter included stomatopods (68.5%). Young demersal fishes formed 10.2 % of the total finfish catch.

KOCHI

The small-mechanized trawlers landed 1,212 t at a c/e of 85.6 kg; of which finfishes formed 536 t (44.3 %); crustaceans 394 t (32.5%) cephalopods 281 t (23.1%) and the benthic biota to the tune of less than 1 t. This low proportion in the landing was due to discarding the bycatch in the sea. Hence the estimated target: bycatch ratio was 1: 0.8. The juvenile finfish catch of 38 t, composed mainly of sciaenids, silverbellies, nemipterids, lizardfishes, mackerel, seerfishes and ribbonfishes with particular dominance in premonsoon months.

MANDAPAM

The trawlers landed 932 t from Gulf of Mannar during the year with the maximum catch in July (237 t). Finfishes contributed 58.2 % of total catch, dominated by silverbellies (34 %). About 212 t (8.1 % of total catch) of benthic biota was dislocated during the period and the major constituents were inedible crabs (24%), seaweeds, gastropods, bivalves, echinoderms, jellyfishes, gorgonids etc. The target: bycatch ratio was 1: 4.3.

The trawlers caught 20,093 t from the Palk Bay with the peak landing in January (3,346 t). Finfishes formed 67.7 % of the total catch and composed chiefly of silverbellies (52.8 %). The benthic biota landed was to the tune of 2,586 t forming 5.7 % of the total catch. Their peak landing was in May and the components were inedible crabs (17.5%), followed by seaweeds, gastropods, bivalves and echinoderms. The target: by catch ratio was 1: 6.8.

CHENNAI

During April-December 1999 the mechanized trawlers operating from Chennai Fisheries Harbour landed a total catch of 13,104 t at a c/e of 403 kg. The major constituent groups were finfishes (67% of total catch), crustaceans (16 %), cephalopods (12 %) and benthic biota (5 %). The target: by catch ratio was 1: 2.1. About 67 % of the total trawl catch belonged to juveniles/sub adults and spawners and the major contributors were prawns, crabs, squids, goatfishes, silverbellies, nemipterids, sciaenids etc. In the inedible biota discarded (63 t) the dominant groups were stomatopods (50 % of benthic biota), inedible crabs (42 %) bivalves, gastropods and echinoderms (starfishes and sea urchins). The c/e was 19 kg.

KAKINADA

The trawlers landed 25,799 t showing a decline (31%) compared to 1998. Finfishes accounted for 60 % of the total catch, while the target groups like prawns, lobsters and cephalopods contributed 38 % and the benthic biota 2 % (487 t). The percentage composition of the latter was at its peak during April - June. The trawler catch included 296 t of juveniles of the demersal finfishes. The juveniles of goatfishes, sciaenids, perches, flatfishes, nemipterids and lizardfishes formed 31%, 21%, 13%, 10%, 2% and 0.02% respectively. An estimated 207 t of pelagic finfish juveniles forming 3 % of the total finfish catch were also caught by the trawlers. The juveniles were more frequent in the catches of March, June

and July.

The landings of benthic biota consisted of stomatopods, inedible crabs, gastropods, bivalves and echinoderms. Their occurrence was pronounced in June-September and December-March.

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

K.V. Somasekharan Nair, V.S. Rengaswamy, K.M.S. Ameer Hamsa, D.C.V. Easterson, A. Raju, V. Gandhi, D. Kandaswamy, I.Rajendran, I. Jagadish, L. Krishnan, Grace Mathew, Manpal Sridhar, Molly Varghese, Miriam Paul, P. Nammalwar and G. Gopakumar.

KOCHI

At Fisheries Harbour Laboratory the male as well as female brood stock of *Epinephelus tauvina* and *E. malabaricus* were reared in healthy condition in 5 tonne capacity FRP tanks in re-circulating sea water systems. The system was established using *in situ* biofilters. The food (dead fish - mainly sardines) was supplemented with cod liver oil and vitamin B12 capsules.

A breakthrough was achieved in natural spawning as well as larval rearing of the *E. tauvina*. Spontaneous spawning of a pair of *E. tauvina* (female weighing 5.1 kg and a sex inverted male weighing 3.9 kg) occurred on 16-5-99 between 16.00 and 20.00 hrs, which continued upto 18-5-99, releasing 100,000 viable eggs. Another spawning took place during 23-25 May 1999. The same pair spawned again on 2, 3 and 7 June and from 10-12 July 1999 releasing approximately 1 million and 1.5 million eggs respectively. Natural spawning took place for the seventh time on 22-10-99 and 23-10-99. An average of 80% of the eggs were fertilized.

The fertilized eggs were of the size 795-945 µ. Larval hatching took place within 22 hrs. The newly hatched larvae measuring 1.7 mm in total length were stocked in larval rearing tanks. The development of mouth was observed between 65 and 70 hrs. Immediately after this the larvae were fed with rotifers (*Brachionus rotundiformis*) measuring less than 100 µ. Initially the live feed was rotifers, after six days of hatching, the rotifers were enriched with HUFA. The larvae survived only upto thirteen days.

At Kochi the larval rearing experiments indicated the necessity of developing larval feed organisms less than 50 microns. To achieve this target attempts were made to collect, identify and rear suitable species of copepods to provide a continuous supply of required nauplii to the grouper larvae. Copepods were collected from the bar mouth at Kochi, the seawater storage sump at Fisheries Harbour Laboratory and the mangrove area at Mangala Vanam. Representative samples of these were grown separately in glass troughs feeding them with pure cultures of *Isochrysis* and marine *Chlorella*. The preliminary studies indicated that (a) heavy bloom of phytoplankton is detrimental to the survival of copepods, (b) the survival rate of copepods is better in dim lit containers, (c) feeding with different species of phytoplankters result in

better growth and reproduction compared to single species of phytoplankters and (d) aeration is required for cyclopoid copepods whereas it is not necessary for harpacticoid copepods even in heavy concentrations.

A prototype rearing kriesel for the larvae of grouper was designed and fabricated using a 30 l capacity circular PVC tank and an improvised *in situ* biological filter system. The flow in the system is maintained in such a way that the water is kept in motion without disturbing the larvae in it and helping in an even distribution of live feed organism. A bigger version of the system is designed in a 5000-litre capacity FRP tank at Fisheries Harbour Laboratory.

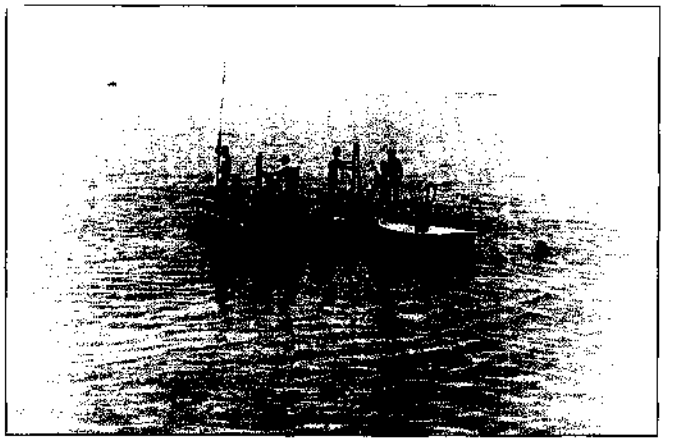
To improve the formulation of feed for groupers, studies on their digestive enzyme profile were carried out. A feed formulation utilising fish mince, soya been flour, mussel meat and other ingredients was analysed for its proximate composition and after preparation on a larger scale will be tested for its efficacy as maturation diet at Fisheries Harbour Laboratory and at Field Mariculture Laboratory.

At Narakkal, *E. tauvina* and *E. malabaricus* were reared in two silpaulin lined ponds of 65 and 70 tonne capacity to develop brood stock of groupers. Water quality was maintained by effecting daily exchange of water. *E. malabaricus* has grown from a mean size of 518.7-mm (3.36 kg) in March to 590.8 mm (4.32 kg) in December at a mean monthly growth rate of 8.01 mm (10.6 g).

With a view to induce maturation and sex inversion, two specimens of *E. tauvina* one having a length of 590 mm weighing 3.9 kg and the other with a length of 512 mm and weighing 2.8 kg were kept separately in the 70 tonne silpaulin lined pond. The male hormone 17 α methyl testosterone in a pelleted form was given orally at weekly intervals from 16-2-99 to 6-4-99. The fishes were also given cod liver oil capsules and Vitamin B12 capsules in addition to the normal diet of *Tilapia* and small pearl spots. However periodical examination of the gonads showed no indication of sex reversal.

MANDAPAM

E. tauvina harvested and transported from the culture ponds at Tuticorin were stocked in an RCC tank of 100 tonne capacity (10 x 5 x



Floating raft for grouper rearing in open sea in the Gulf of Mannar, Mandapam

2.3 m) at the rate of 1 kg per cubic meter. 100% exchange of seawater drawn directly from the sea was effected twice a week after cleaning the tanks in addition to 50% exchange daily. Fresh sardines were given as food supplemented with cod liver oil and Vitamin E capsules.

Groupers collected from the wild were reared in three different weight groups, viz., below 1 kg, between 1 and 2 kg and above 2 kg. The initial average sizes at the time of stocking in June 1998 were 378.2 mm (742 g), 472.3 mm (1515 g) and 560 mm (2600 g) respectively for the above groups, which progressed to 471.4 mm (1560 g), 550.9 mm (2480 g) and 624.6 mm (3724 g) in January 1999. On completion of another twelve months in December 1999, they attained mean sizes of 611.6 mm (3440 g), 607.8-mm (3410 g), and 666.5 mm (4540 g). The overall mean monthly growth rates were 13 mm (150 g) for groupers below 1 kg, 7.5 mm (105.3 g) for fishes between 1 and 2 kg and 5.9 mm (107.8 g) for those above 2 kg. The respective feed conversion ratio was 5:1, 7:1 and 7.3:1.

Another stock of groupers harvested from the culture ponds at Tuticorin Research centre were raised by stocking them in three different weight groups as in the previous experiments. The initial average sizes at stocking in August 1998 were 298.8-mm (324 g), 389.7-mm (755 g) and 481.8-mm (1534 g) respectively. After ten months in June 1999 they progressed to average sizes of 437.7 mm (1515 g), 521.7 mm (1985 g) and 602.7 mm (3059 g) respectively. In June, fishes belonging to above 1 kg group were transferred to FRP tanks for experiments on induced maturation and spawning. In December 1999 they attained average sizes of 573mm (3070 g) and 564 mm (2900 g) for the first two groups. The monthly average growth rate was 17.1 mm (171.6 g) and 10.9 mm (134.1 g) with a feed conversion ratio of 5.4: 1 and 8.6: 1 respectively.

Eleven tanks, each of 5 tonne capacity with recirculation system and biofilters were set up in the indoor hatchery. Eight tanks were stocked with three groupers each for hormone treatment out of which fishes in one tank were kept as control. Two fishes each in the rest of the tanks were administered with hormone injections using Follicle Stimulating Hormone (FSH), Human Chorionic Gonadotropin (HCG) and extract of major carp pituitary gland (CPG) at a dosage of 1.5 IU, 500 – 1000 IU and 3 mg/kg body weight respectively. The FSH and FSH in combination with CPG and CPG injections were given on alternate days. The HCG and its combination with CPG were administered twice and once in a week respectively. However, no response to the hormonal treatment was observed.

In another set of experiments LHRH was administered in the form of pellets to induce ovulation. The pellets were implanted below the dorsal spine above the lateral line in six specimens of average weight 4.25 kg from February to September 1999. The dosage was 86 µg/kg of body weight for two fishes and 38 µg for other fishes. However no response was observed.

Rabbitfishes collected from the wild during January 1999 were maintained and fed with squid meat at the rate of 6% of the total biomass once in a day. *Siganus canaliculatus* of mean length 182 mm (114 g) recorded an average monthly growth increment of 5.6 mm (7.5 g), their gonads were in stage II of matu-

rity. *S. javus* of an average length of 286 mm (325 g) registered a mean monthly growth increment of 9.5 mm (20.5 g).

TUTICORIN

The grouper seed occurrence was relatively poor during this year compared to the previous year. About 76 numbers were collected using mini shoreseine from Vellapatti area. 810 specimens of *Epinephelus tauvina* with a mean size of 152 mm (52 g) were stocked in an earthen pond in December 1998. They were observed to have grown to an average size of 333 mm (704 g) in December 1999 showing an average monthly growth of 13.9 mm (50.1 g). In September 1999 live grouper seed of the size range 148 to 233 mm (58 to 162 g) were transported to the Vizhinjam Research Centre of the Institute.

VIZHINJAM

A technology for the commercial level hatchery production of the clown fish *Amphiprion chrysogaster* was developed for the first time in India. The fishes collected from the wild were maintained in one tonne FRP tanks and were fed with boiled and chopped mussel meat two times daily. Natural spawning of the fishes took place during daytime between 09.00 and 12.00 hrs. with a release of 300 to 800 eggs during each spawning. The fishes exhibit parental care and hatching took place in about 6 - 7 days.

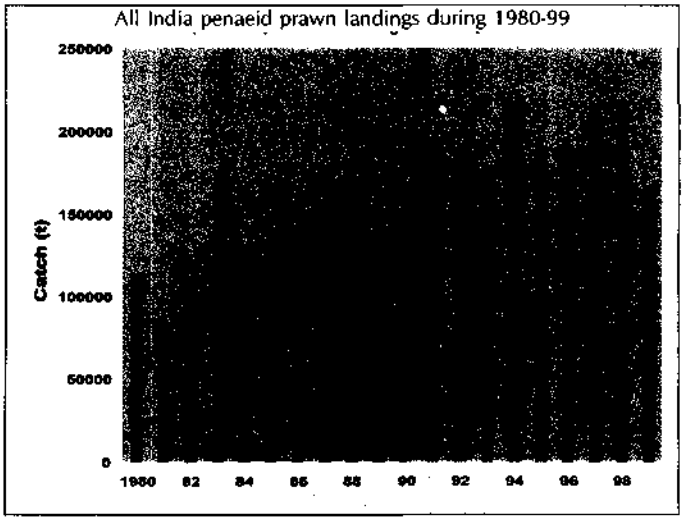
A special filtration system was designed and fabricated for larval rearing. The larvae were initially fed with the rotifer *Brachionus rotundiformis*. After ten days, the larvae were fed with *Moina* and freshly hatched *Artemia* nauplii. The larvae metamorphosed to juveniles after 15-20 days.

The brood stock of four species of damsel fishes, *viz., Pomacentrus arenareus, P. caeruleus, Neopomacentrus filamentosus and N. nemurus* were maintained in laboratory conditions. Experimental success was obtained in the larval rearing of *N. nemurus* and *N. filamentosus*.

Observations were made on thirty species of marine aquarium fishes regarding their suitability for maintenance in the aquarium. The suitability of the different species was evaluated based on size, colouration and body pattern, availability, feeding qualities, behaviour, survival in the tanks, compatibility with other species, breeding in captivity and incidence of disease. Clown fishes, damsels, wrasses, parrot fishes and blennies were evaluated as the best among the groups investigated. Butterfly fishes, and banner fishes ranked next.

IV. CRUSTACEAN FISHERIES DIVISION

The crustacean landings of 3,99,570 t in 1999 contributed 16.5% of the country's marine fish landings. The landings suffered a decline of 19.79% over the previous year. Group wise contribution of crustaceans amounted to 41.43% by penaeid prawns, 38.67% by nonpenaeids, 0.52% by lobsters, 6.89% by crabs and 12.49% by stomatopods. Over the previous year penaeid prawn fishery declined by 22.9%, non penaeids by 11.1%, lobsters by 19.8%, crabs by 19.6 % and stomatopods by 31.2%. Commercial exploitation of deep sea crustaceans by small and medium trawlers along the south west coast of India was a major event in the crustacean fishery sector. The availability of the resource has been indicated by CMFRI long time back. Total deep sea prawn landings in November and December amounted to 11,218 t with a high catch rate of 78 kg/hour of trawling. Pandalids contributed to more than 82% of the deep sea prawn resources.



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

C. Suseelan, N. Neelakanta Pillai, Mary K. Manisseri, G. Nandakumar, K. N. Rajan, K. R. Manmadhan Nair, A.P. Dinesh Babu, V. Deshmukh, M. Aravindakshan, V.S. Kakati and E.V. Radhakrishnan

The total penaeid landings from the west coast amounted to 1,09,543 t, registering a drastic decline of 32% over the previous year. The fishery declined in all states except in Karnataka. The decline amounted to 39% in Kerala, 43% in Goa, 30.5% in Maharashtra and 34% in Gujarat. However, fishery improved by 37% in Karnataka.

Trawl fishery

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

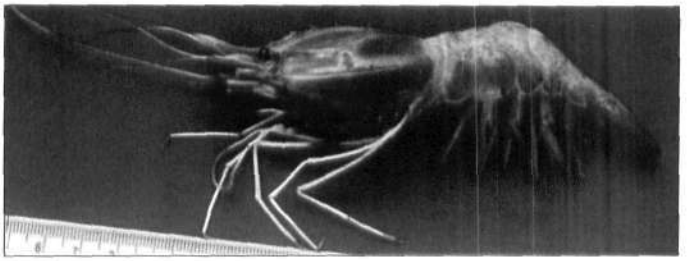
Estimated penaeid prawn catch and catch rate (in parenthesis) in 1999 at various trawl landing centres were, 2,628 t (4.1 kg/hr) at Veraval, 11,868 t (7.4 kg/hr) at New Ferry Wharf, 227 t (5.7 kg/hr) at Karwar, 2,586 t (1.7 kg/hr) at Mangalore-Malpe, 524 t (26.8 kg/unit) at Kozhikode, 4,168 t (8.2 kg/hr) at Kochi and 7,440 t (5.2 kg/hr) at Sakthikulangara-Neendakara. When compared to 1998, decline in the penaeid prawn fishery was noticed during the year in the following centres: Veraval (45.3%), Karwar (55.6%), Kozhikode (66.4%), Kochi (30 %) and Sakthikulangara-Neendakara (31 %). At New Ferry Wharf and Karwar centres the catch during the year increased by 15.9 and 14.6% respectively.

Penaeid prawn landing went down during this year at Kochi and Sakthikulangara because of failure of its fishery in the postmonsoon season as well as due to diversion of trawlers for deep sea prawn fishery. While monsoon fishery for 'Karikkadi' (*Parapenaeopsis stylifera*) declined by 48.7% at Sakthikulangara, it improved by 24% over the previous year at Kochi.

P. stylifera was the main contributor to the penaeid prawn fishery at Veraval (58%), New Ferry Wharf (40%), Karwar (54%), Kochi (47%) and Sakthikulangara (47%). *Metapenaeus monoceros* formed 32% of penaeid prawn catch at Mangalore-Malpe. *Metapenaeus dobsoni* was the dominant species in the fishery at Kozhikode (47%) and Kochi (48%) and at Karwar it formed 34% of the catch forming the second in importance. This species formed 14% of the prawn catch at Sakthikulangara and 12% at Mangalore-Malpe. *Trachypenaeus* spp. formed one of the main contributors to the fishery at Sakthikulangara and Mangalore forming 18.4% and 19.6% respectively. *Solenocera crassicornis* contributed to 29% and 21% to the prawn fishery at Veraval and New Ferry Wharf thus becoming the second dominant species and at Mangalore-Malpe *S. choprai* formed 14.5% of the prawn catch. *M. affinis* was one of the important constituents of the prawn fishery at Veraval (5%), New Ferry Wharf (13%), Karwar (10%) and Kozhikode (11%). Larger species like *Penaeus indicus* at Kozhikode, Kochi and Sakthikulangara; *P. canaliculatus* at Mangalore-Malpe and Sakthikulangara and *P. semisulcatus* at Veraval, Mumbai and Sakthikulangara supported minor fisheries.

Large sized *P. stylifera* formed the mainstay of the fishery at Veraval, Mumbai and Karwar. Dominant sizes (combined for both sexes) were 81-110 mm at Veraval and Karwar and 81-115 mm at Mumbai. Along the southwest coast comparatively smaller sizes were dominant like 66-85 mm at Malpe, 71-90 mm at Mangalore, 71-95 mm at Kochi and 71-85 mm at Sakthikulangara-Neendakara.

M. dobsoni fishery was dominated by 81-110 mm size group at Karwar, 61-85 mm at Mangalore and Malpe, 61-75 mm at Kozhikode and 71-80 mm at Kochi. *S.*



***Heterocarpus woodmasoni* - a dominant species of deep sea prawn landed at Cochin Fisheries Harbour**

crassicornis of 63-103 mm dominated the fishery in the northwest coast. The catch of *M. monoceros* was dominated by 111-135 mm group at Mangalore and 111-140 mm at Malpe.

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

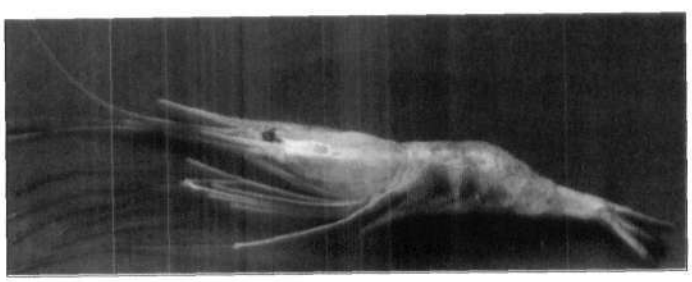
Purse seiners landed 18.9 t of *M. dobsoni* during this year at Mangalore and Malpe as against 28.6 t during 1998 showing a decline of 34%.

Catch and effort data (trawling hours) collected for the penaeid prawns landed at New Ferry Wharf during 1988-97 were analysed by Schaffer's Surplus Yield model. The MSY was found to be 18342 t and FMSY of 11,57,065 trawling hours/annum (21,427 boat trips/year).

Deep sea prawn fishery

The Institute, decades back has indicated the rich and potential grounds of deep sea shrimp resources off West coast. Except perhaps the operation of a few Mexican trawlers in the recent past the local fishing industry has shown a cold shoulder in deep sea shrimp exploitation. However, during 1999 small and medium sized trawlers of 38 to 65 ft in length ventured into deep sea fishing operations along the Kerala coast in November. Shrimp trawlers based at Sakthikulangara -Neendakara, Munambam and Kochi Fisheries Harbours carried out intensive fishing operations at 'Quilon bank' off southwest coast at depths ranging between 175 to 400 m. Some of these trawlers were fitted with GPS (Global Positioning System) and echosounders to aid the fishing operations. Between November and December the trawlers operating from the above harbours landed 11,218 t of deep sea prawns and 254 t of deep sea lobsters. The catch/hr of trawling was estimated at 78 kg for prawns and 1.8 kg for lobsters. The profit has motivated many, and more and more units are gearing up for the ensuing season.

Pandalid prawns, *Heterocarpus woodmasoni* (41.24%), *Plesionika spinipes*



***Plesionika spinipes* - the second dominant deep sea prawn species landed**

(31.53%) and *Heterocarpus gibbosus* (9.27%) were the major components. Penaeid prawns such as *Metapenaeopsis andamanensis* (16.14%), *Aristeus alcocki* (1.54%), *Solenocera hextii* (0.16%) and *Penaeopsis jerriyi* (0.12%) supported the rest of the fishery. The size ranged from 106-120 mm in *H. woodmasoni*, 116-135 mm in *H. gibbosus*, 86-105 mm in *P. spinipes* and 86-110 mm in *M. andamanensis*. Berried females formed more than 60% in pandalids indicating peak breeding season.

Artisanal prawn fishery

In the artisanal sector, the prawn fishery resource was exploited mainly during monsoon season (July-August). At Kozhikode the ring seines, pair trawl, disco net and 'choodavalai' landed 22.5 t of prawns. *M. dobsoni* formed 90% of the prawn landings.

'Konchuvala' operations yielded 184 t with cpue of 5.99 kg at Vizhinjam and 47 t with CPUE of 4.89 kg at Manakkudy. The fishery was restricted mainly during May-August. *P. indicus* was the dominant species and mature females formed a good proportion in the catch.

Prawn fishery in the nursery grounds

The estimated landings of juvenile prawns by stake nets operations in Kochi backwaters at Thevara during this year was 389 t as against 205 t in 1998. *M. dobsoni* predominated the catch (84.9%). The dominant modal groups were found between 46 and 60 mm and females out numbered males. Stake net operation at Korapuzha estuary yielded 27 t of juvenile shrimps with cpue of 8.7 kg during October-December 1999. *M. dobsoni* was the most dominant species.

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

G. Sudhakara Rao, M. Rajamani, V. Thangaraj Subramanian, K.N. Saleela, G. Maheswarudu and E. Dhanwanthari

The penaeid landings along the east coast of India accounted for 55,802 t against 53,253 t in 1998 registering an increase of 4.8%. East coast contributed to 33.7% of the penaeid landings in the country. Statewise contribution in order of abundance amounted to 24,965 t (44.7%) in Andhra Pradesh, 23,443 t (42%) in Tamil Nadu, 4,322 t (7.8%) in Orissa, 2,704 t (4.8%) in West Bengal and 368 t (0.7%) in Pondicherry. Fishery improved over the previous year by 31% in Andhra Pradesh and 109 % in Orissa whereas it declined by 13% in West Bengal, 17% in Tamil Nadu and 48% in Pondicherry.

Penaeid landings at important trawling

centres amounted to 176 t (12.5 kg/boat trip) at Tuticorin, 2263 t (2 kg/hr) at Chennai, 650 t (1.3 kg/hr) at Mandapam, 6745 t (8.5 kg/hr) at Kakinada, 446 t (2.3 kg/hr) at Visakhapatnam and 528 t (4.7 kg/hr) at Paradeep. Over the previous year fishery improved by 232% at Tuticorin and 8% at Paradeep. Fishery declined by 46% at Chennai, 11% at Mandapam and Visakhapatnam and 21% at Kakinada.

Along the south east coast *Penaeus semisulcatus* was the dominant constituent at Tuticorin and Mandapam; *Metapenaeus dobsoni* supported 21% of the landings at Madras and 35% at Kakinada. While *M. monoceros* contributed to 45% of the fishery at Visakhapatnam, *Parapenaeopsis hardwickii* accounted for 30% at Paradeep. Other important constituents of the fishery were *Penaeus indicus* (17%) and *Metapenaeopsis stridulans* at Madras, *M. stridulans* and *Trachypenaeus pescadorensis* at Mandapam, *M. monoceros* (35%) at Kakinada, *M. dobsoni* (16%) at Visakhapatnam and *Parapenaeopsis stylifera* (12%) and *Solenocera crassicornis* (7%) at Paradeep.

Penaeid landings in 'sona' boat operations

'Sona' boats based at Visakhapatnam landed 656 t (2.2 kg/hr) of penaeid prawns registering a decline of 30% over the previous year. *M. monoceros* (31%) and *M. dobsoni* (21%) were the dominant constituents of the fishery.

An unhealthy trend in the trawl fishery at Kakinada was the predominance of juveniles in *M. monoceros* fishery. More than 70% of the fishery was supported by sizes below 100 mm in length.

In the artisanal sector the *Thallumadi* landed 24 t (3 kg/unit) at Tutcorin, *Thalluvalai* 13 t at Mandapam and gill nets and disco nets 56 t at Puri. At Tuticorin and Mandapam juveniles of *P. semisulcatus* dominated the fishery. At Puri large sized *P. indicus* (78%) and *M. affinis* (15%) were the main components of the fishery.

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

V.D. Deshmukh and A.P. Dineshbabu

Nonpenaeid landings in the country amounted to 1,54,498 t showing a decline of 11.2% over the previous year. The production is inclusive of 9,200 t of pandalid prawns fished by deep sea trawlers from the southwest coast of India. Gujarat accounted for 58.2% followed by 28.6% by Maharashtra. Over the previous year the fishery declined by 5.4% in Gujarat and 34.3% in Maharashtra.

Investigations on nonpenaeid resources exploited by *dol* nets and trawls along the northwest coast were carried out at Veraval, Nawabunder and Rajpara in Gujarat and New

Ferry Wharf (Mumbai) and Versova in Maharashtra.

Dol net fishery

Dol net landings of nonpenaeids at Nawabunder and Rajpara in Gujarat were 9,370 t (+2.6%) and 8,939 t (+12.5%) with catch rates of 44 kg/haul and 32 kg/haul respectively. _Acetes_ spp. accounted for 80% of the fishery at Nawabunder and 81% at Rajpara. _Nematopalaemon tenuipes_ contributed to 15% at Nawabunder and 12% at Rajapara. The rest of the fishery was accounted by _Exhippolysmata ensirostris_.

Dol nets at Versova and New Ferry Wharf (Mumbai) in Maharashtra landed 1,271 t (+37%) and 204 t (+1.5%) at a catch rate of 33 kg/haul and 15 kg/haul respectively. _Acetes_ spp. contributed to 92% at Versova and 81% at New Ferry Wharf. _N. tenuipes_ supported 8% of the fishery at Versova and 15% at New Ferry Wharf. _E. ensirostris_ contributed to the rest of the fishery.

Trawl fishery

Trawlers operating at Veraval landed 13,527 t of nonpenaeids at a catch rate of 21 kg/hr. Fishery showed 9.3% decline over the previous year. _Acetes_ spp. contributed to 99% of the fishery.

At New Ferry Wharf (Mumbai) nonpenaeid landings amounted to 3074 t registering an increase of 38% over the previous year. Almost the entire fishery was supported by _N. tenuipes_ (99.8%). Fishery of _N. tenuipes_ in Mumbai was dominated by 45-61 mm size classes. Berried females were maximum in March (76%) and July (71%). At Veraval 47-55 mm size formed the mainstay of the fishery in _dol_ net operations. Berried females were abundant in April (43%) and November (49%).

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

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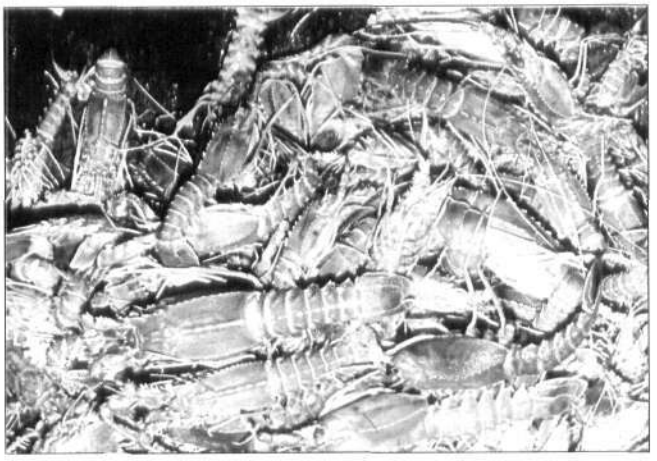
LOBSTERS

The total landing of lobsters in India during 1999 has been provisionally estimated to be 2,093 t as against 2,611 t in 1998 and 2,787 t in 1997 indicating a decreasing trend. In Gujarat the fishery declined from 1,054 t in 1998 to 975 t in 1999. A decline was noticed in Maharashtra also where the catches recorded were 442 t and 291 t in 1998 and 1999 respectively. There was no landing of lobsters in Goa and Karnataka in 1998. However, a small quantity of 2 t was landed in Karnataka during the year under report . Kerala registered an increase from 64 t in 1998 to 513 t in 1999. This was due to the unusual landing of the deep-sea lobster _Puerulus sewelli_ along with the deep sea prawns from 200 to 400 m depth, towards the end of the year.

Tamil Nadu showed a drastic decline in lobster catches, it being 998 t and 254 t in 1998 and 1999 respectively. Andhra Pradesh showed a slight increase in the landing whereas West Bengal showed a marginal decrease. There was no catch in Orissa during 1998. However, a small quantity of 9 t was landed during this year. Maximum landing was recorded in Gujarat (46.58%) followed by Kerala (24.51%), Maharashtra (13.9%) and Tamil Nadu (12.14%) in that order. A region-wise analysis showed that catch was maximum (60.5%) along the northwest coast. The southwest, southeast and northeast coasts contributed to 24.6%, 13.3% and 1.6% respectively.



Deepsea Lobster, *Puerulus sewelli*

Studies were carried out on the fishery and biology of important edible species of lobsters at Veraval, Mumbai, Kozhikode, Vizhijam and Chennai. Trawl net and artisanal gears such as traps and bottom set gill nets are used for fishing lobsters. *Panulirus polyphagus* and *Thenus orientalis* contributed to the fishery at Veraval. Total landing declined from 90.5 t in 1998 to 81.4 t in 1999. The CPUE was 1.5 kg. Of the total lobster catch, spiny lobster *P. polyphagus* contributed to 55.6% and sand lobster *T. orientalis*, 44.4%. The catch was highest in January. Modal classes for both the males and females of *P. polyphagus* was at 71-75 mm (CL) size-group. In the case of *T. orientalis* the modal classes for the males and females were at 66-75 mm and 76-80 mm size groups respectively. The male-female ratio was 1:1.55 in the former and 1.42:1 in the latter species. At Sutrapada, about

Landing of the ornate spiny lobster, *Panulirus ornatus* at Pamban

450 kg of *P. polyphagus* was landed from the reef by gill nets. The fishery showed a lesser modal class of 51-55 mm for males and 56-60 mm for females. About 38 t of lobster were landed at Mumbai during April-September. The fishery was solely constituted by *P. polyphagus*. More than 50% of the females were ovigerous during the months of August and September. Male *P. polyphagus* ranged in size from 105-215 mm and females 195-255 mm.

Bottom set gill nets were used for fishing lobsters at Kozhikode. The fishery was seasonal extending from October to March. The total landing during the year was 1.4 t with a c/e of 1.01 kg. Maximum catch was recorded during January and October-November. *P. homarus* predominated the catches contributing to 81%, followed by *P. polyphagus, P. ornatus* and *P. versicolor*. In *P. homarus* the modal classes for males ranged from 59 to 70 mm CL and those for females from 51 to 75 mm. In December, about 99% were in berried stage, indicating peak breeding during the postmonsoon months.

The production at Vizhinjam during the year was 1.7 t, forming 53% of the landings by traps. The c/e was 0.5 kg. Maximum landing was reported in January. *P. homarus* predominated the fishery with only stray numbers of other species landing occasionally. The modal class for the males was at the size group 51-60 mm and that for females at 41-45 mm CL. Females predominated the landings, berried specimens forming about 18% of the female population. At Muttom, the total landing was 5.5 t. The c/e was 0.6 kg. Maximum landing was reported in January. The modal classes for males and females were at 56-60 mm and 81-85 mm CL respectively. Berried females were more in March.

The lobster fishery off Tuticorin was of a lesser magnitude. *P. ornatus* and *P. homarus* predominated the fishery. The catches showed a decline when compared to that of the previous year. The landing of spiny lobsters at Kovalam, Chennai, by bottom set gill net was 1,199 kg at a catch rate of 1.05 kg per unit. Peak season was in July. *P. homarus* predominated the fishery followed by *P. versicolor*. Mechanised trawlers landed about 9,018 kg of *T. orientalis* at a catch rate of 0.8 kg/hr, as against 7,986 kg landed during 1998.

CRABS

The total landing of crabs in 1999 was provisionally estimated as 27,547 t, as against 34,276 t landed in 1998. The fishery showed a trend of decline in Maharashtra, Gujarat, Goa, Kerala, Pondicherry, Tamil Nadu, Andhra Pradesh and West Bengal. However, in Karnataka the catches increased from 797 t in 1998 to 1,116 t in 1999 and in Orissa, from 778 t in 1998 to 917 t in 1999. Landing about 11,836 t, Tamil Nadu contributed to 42.9% of the total catch. Kerala, Gujarat and Andhra Pradesh contributed to 17.6%, 16.9% and 10.9% of the total catch, respectively. A regionwise analysis shows that the southeast coast contributed maximum (54.4%) to the landing followed by the southwest (22.2%) and northwest (17.9%) coasts.

At Veraval, a total of 632 t of crabs were landed by trawlers, showing a decrease of 468 t

from the landings in 1998. *Charybdis cruciata* formed the major species, the modal classes for males and females being 56-70 mm and 61-65 mm respectively. The total landing of crabs by trawlers at Karwar was 45 t. *Portunus pelagicus* predominated the fishery (70%) followed by P. *sanguinolentus* (30%). The modal classes for male and female *P. pelagicus* were at the size groups 116-125 mm and 131-140 mm respectively.

At Mangalore the fishery was exceptionally good during the last quarter of the year. The fishery was constituted by *C. feriatus, P. sanguinolentus* and *P. pelagicus* in that order. The total estimated landing of crabs by trawlers at Kozhikode was 17.5 t during the period under report. This showed a decline of about 38% when compared with the landing of the previous year. The average c/e was 8.9 kg. The fishery was constituted by *C. cruciata, P. pelagicus and P. sanguinolentus* in that order. At Kochi, the crab fishery was better during the premonsoon months, the total catch being 188 t. Maximum catch was recorded in March (63 t). Trawling was banned for 45 days during the southwest monsoon period. Crab fishery was rather poor during the post monsoon months. *C. cruciata* predominated the catches in all but two months (April and May), *P. sanguinolentus* and *P. pelagicus* also contributed to the fishery. Berried females were present in all the months. About 50% of the female *P. sanguinolentus* were in berried stage in January. An estimated total of 45 t of crabs were landed by 'Konchuvala units' at Vizhinjam at a catch rate of 1.5 kg per unit. The landings showed considerable increase over the previous year, mainly due to the landing of the non-edible species *Varuna litterata* (45.6%). The edible species landed were *P. sanguinolentus, C. cruciata, C. lucifera* and *P. pelagicus.*

The catch of crabs at Mandapam was 145 t, out of which 93% was landed by trawlers at Mandapam centre and 7% by gill net at Thoppukkadu. At Mandapam the species of commercial importance was *P. pelagicus.* Berried females occurred throughout the year with a peak in February. The prices showed an increase from Rs.40/- per kg in the beginning of the year to Rs.75/- in the last quarter. At Thoppukkadu, the catches included two species: *P. pelagicus* (72%) and *Scylla tranquebarica* (28%).

At Chennai, the total landing of crabs amounted to 539 t as against 1,731 t during the previous year. *P. sanguinolentus* predominated the fishery followed by *C. natator* and *P. pelagicus.* In *P. sanguinolentus,* the sizes ranged from 48 to 158 mm in males and from 53 to 165 mm in females. Berried females were more in the first and second quarters of the year. Out of 493 t of crabs landed at Kakinada, only 54.8% was constituted by edible species. The fishery showed a decline when compared to that of the previous year. *P. sanguinolentus* (57.7%) contributed maximum to the fishery followed by *P. pelagicus, C. lucifera, C. cruciata* and *Scylla* spp. The modal class for *P. sanguinolentus* (both male and female) was at 86-90 mm size group.

DEVELOPMENT OF ARTIFICIAL REEFS
(CF/RE/3)

M. Rajamani and K.K. Philippose

Socio-economic rehabilitation of traditional fishermen by increasing the fish production in the newly created fishing habitats and protection of coastal ecosystem are the main objectives of the project.

Concrete modules for artificial reefs to be installed off Poovar, Thiruvananthapuram

Artificial reef of 10000 m^2 was installed off Poovar in Thiruvananthapuram District during the year. This reef was designed in an oval shape using triangular concrete modules. Inside the reef mini reefs or sets were developed using triangular tubular modules, tyres mounted on concrete slabs, palm leaves and fresh twigs in bundles. The project was funded by the fisheries department of Kerala Govt. This was the second reef established by CMFRI in Thiruvananthapuram District.

Kerala Govt. has also provided funds for establishing a reef off Dharmadom in Kannur District and the work is in progress.

Modules being transported for installation

At Tuticorin regular monitoring of the fishes in the artificial reef installed in December 1998 was carried out. Eight species of fishes and two species of crabs were recorded from the reefs. *Thalamita crenata* was the dominant crab species and among the fishes important constituents were *Siganus javus* (61%), *Lutianus fulviflamma* (24%) and *Etroplus suratensis* (7%). The size of the fishes ranged between 43-195 mm in *S. javus* and 37-148 mm in *L. fulviflamma*. Juveniles of *E. suratensis* were recorded in all months. Observations could not be carried out beyond August 1999 due to settlement and growth of edible oyster and consequent blocking of the cavities of artificial reef.

An attempt was made to transplant three species of sea weeds namely *Sargassum tenerrium*, *Gracilaria edulis* and *G. verucosa* in concrete hollow blocks under laboratory conditions. Of these the last 2 species grew well in the hollow blocks.

SEED PRODUCTION, EXPERIMENTAL FARMING AND TAGGING OF MARINE PRAWNS (CF/CUL/1.9)

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Experiments were carried out for brood stock maintenance, artificial insemination, hatchery technology, searanching, development of viable farming systems for commercially important marine prawns, culture of live feed etc.

P. monodon collected from trawl catches (females 110 -150 g and males 70-75 g sizes) were sanitised with 50 ppm formalin and introduced in 5 t capacity rematuration tanks. After acclimatisation the females were subjected to unilateral eye stalk ablation. After moulting, every female was observed for mating and spermatophore deposition. Artificial insemination was carried out in those females found with empty thelycum. Number of spawn per moult cycle ranged from 1-4 and 12 spawns were obtained in 5 moult cycles. One female *P. monodon* spawned 12 times in a span of 102 days yielding 35,18,000 nauplii. Another female gave 75,000 nauplii. Number of nauplii (N1) per spawn ranged from 45,000 to 6,25,000. A total of 35,93,000 nauplii were produced through induced maturation and spawning.

In three larval rearing experiments using *P. semisulcatus*, 3,79,500 nauplii were produced from which 2,78,600 PL_{1-16} were obtained. Survival from Nauplii to PL_1 ranged from 83% to 89%. 2,43,600 PL_1 produced in these experiments were searanched and 35,000 PL_{16} were utilised for experimental farming.

In another set of experiments, 6 larval rearing runs of *P. monodon* were carried out from which 10,13,000 nauplii and 3,25,810 PL_{1-26}

were produced. Survival from nauplii to PL_1 ranged from 17.2% to 85.2%, N_1 to PL_5, 63.5%, N_1 to PL_9, 50.3% and N_1 to PL_{26}, 26%. A total of 2,38,960 PL_{5-26} were used for experimental farming in the Institute's farm and 86,850 PL_1 were searanched.

To develop a commercially viable growout technology for *P. semisulcatus* and a viable technology for raising *P. monodon* broodstock in captivity, a number of experiments were undertaken in the earthen ponds of the Institute's marine fish farm.

The seed produced in the Institute's backyard hatchery was used in these farming experiments. Two ponds (0.5 ha) were stocked with 42,500 PL_{29} of *P. semisulcatus* and 5 ponds (1.1 ha) were stocked with 1,12,500 PL_{15-20} of *P. monodon*. The prawns were fed with commercial shrimp feed. After 150 days of culture 408 kg *P. semisulcatus* and 3109 kg *P. monodon* were harvested. Survival rate ranged from 58.4% to 67.7% in the former and 79% to 96.6% in the latter. Harvested size of *P. semisulcatus* was 13.7 g and 17.5 g in pond I & II respectively. The size of *P. monodon* ranged between 25.4 g to 37 g in different ponds. F C R. varied from 2.45 to 2.69 for *P. semisulcatus* and 1.80 to 2.88 for *P. monodon*. A total of Rs.9,03,426 was realised from the sale of the harvested prawn. The cost of operation was Rs.4,52,947 and the profit worked out to Rs.4,50,479.

Another set of experiment with *P. semisulcatus*, *P. monodon* and *P. indicus* to study the compatibility of the three species in polyculture system is in progress. Broodstock development of tiger prawn *P. monodon* was carried out from the seed produced in the hatchery. Among the progeny of a mother prawn 100 nos of males and 150 females that indicated faster growth than the rest, were selected for genetic improvement studies and transferred to 100 t cement tank provided with a sand bed filter recirculation system with 20% water recirculation per day. One half of the tank bottom was provided with a 20 cm thick sand bed to facilitate burrowing of the prawns. 10% water was exchanged every alternate day. Pelleted diet blended with egg, vitamin C, fish oil, cod liver oil and vitamin E was provided to the growing broodstock in addition to clam, sardine, and squid meat *adlibitum*. Perfuran, formalin and oxytetracyclin were used periodically for prophylactic treatment of the broodstock. After 80 days, male and female attained 192 mm/63 g and 208 mm/87 g respectively with a survival rate of 75% and after 200 days the survival was 32% with the male and female registering 213 mm/92.5 g and 223 mm/112 g respectively. After 155 days of rearing two females with mature ovary (stage III) and six in spent recovering stage were observed. This shows that the broodstock raised in captivity are maturing and spawning in the rearing system. Reproductive potential of the broodstock was also tested at different ages. The females tested in different experiments spawned up to six times in a span of 49 days. Fecundity ranged from 75,000 to 2,70,000 and hatching rate varied from 30 % to 63%.

Experiments were carried out on the mass culture of rotifer (*Brachionus rotundiformis*), cladocerans (*Moina micrura* and *Diaphanosoma* spp.) and small caridian prawn *Caridina longirostris*. Pure culture of *Isochrysis* spp grown in 24-30 $^{o}/_{oo}$ salinity was used (at an average cell concentration of 1.8 million cells/ml) as feed for *B. rotundiformis*. From a

stocking rate of 20 rotifer/ml, a 22.8 fold increase *ie.* 457 nos/ml was obtained in 48-50 hrs without aeration.

Freshwater *Chlorella* culture maintained in the laboratory was used as feed for caridian larvae and *Moina micrura,* whereas a mixture of freshwater *Chlorella* and *Isochrysis* grown in sea water was used for feeding *Diaphanosoma* sp. Growth of *Diaphanosoma* sp. was observed to be better in 10 – 14‰ salinity.

Crustacean larval resource of the Minicoy lagoon was monitored. A total of 28,212 decapod larvae were collected of which 83% (23,444) were crab larvae and 17% (4,756) were shrimp larvae. The shrimp larval population showed a drastic decline to 1/13th of the previous year. Penaeid postlarvae were absent in the lagoon in almost all the months. The percentage of crustacean larvae in zooplankton showed a positive relationship with total rain fall.

BROODSTOCK DEVELOPMENT, SEED PRODUCTION, FARMING AND SEARANCHING OF COMMERCIALLY IMPORTANT SPINY AND SAND LOBSTERS (CF/CUL/1.10)

E.V.Radhakrishnan, M. Rajamani, S. Lakshmi Pillai, K.K.Philippose and Joe K. Kizhakudan

Berried lobster purchased from fishermen is to be handled and transported carefully. Fishermen were advised to keep berried lobsters in seawater immediately after capture for transportation to the laboratory. Breeders from wild were disinfected in the laboratory using antibiotics. They were not fed until the eggs hatched out. Mild aeration was provided. Hatching took place in batches and that too mostly during night. Healthy larvae were collected by making use of their phototactic behaviour and transferred to another tank. Artemia nauplii was given as feed for the larvae immediately on hatching so as to facilitate faster moulting and survival.

A breeder management programme has also been developed to produce healthy breeders. Captive broodstock is maintained by feeding them with mussel meat on alternate days. Three females kept in captivity released 2.2 lakhs, 1.5 lakhs and 1.2 lakhs phyllosoma respectively in June indicating the possibility that by proper management breeding can be achieved throughout the year.

For larval rearing, 500 litre capacity conical FRP tanks, serially connected to a reservoir fitted with a biological filter, were stocked with 1500 phyllosoma larvae. The Japanese type central water circulation and drainage system was connected to each tank and operated for one hour daily. Mild aeration was provided during the rest of the day. Freshly hatched artemia nauplii were given once daily. Larvae moulted to stage 4 and 5 without much problem. Mortality was observed from stage 5 onwards. For the first time few larvae reached stage 7. Due to feeding difficulty, further rearing was not possible.

For fattening experiments, lobsters stocked at an average weight of 88.9 g attained 324.6 g in one year showing an increase of 236 g. In another experiment, an average 238 g increase was noted. Mussel meat, clam meat and trash fish were used as feed. Males showed significantly higher growth (in terms of weight) than females. When lobsters were underfed, cannibalism was noticed.

MARICULTURE OF CRABS
(CF/CUL/1.11)

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A number of experiments were carried out on the larval rearing of swimming crab *Portunus pelagicus* and mud crab *Scylla tranquebarica*. A total of 27,48,000 zoeae of *P. pelagicus* were produced. Due to shortage of tanks for rearing, zoeae in different stages were sea ranched and only 5,190 baby crabs were produced. Berried crabs with carapace width 124-157 mm and weight 125 to 255 g were used in these larval rearing experiments.

In the case of *Scylla tranquebarica* 2,78,84,140 zoea I were produced in the hatchery. Larval mortality was observed at various stages from Z1 to Z5 in different larval rearing tanks. In one tank a few larvae metamorphosed to megalopa stage and thereafter perished.

In crab culture experiments in a 0.125 ha pond 500 crabs were stocked at a rate of 8/sq.m. The size ranged from 75-117 mm for males and 75-120 mm for females. Crabs were fed chickenwaste for four days a week and trash fish twice a week at 5-10% of body weight. Sampling was done every month. After 273 days 117 crabs were harvested at a survival rate of 24%. The size at harvest ranged from 110-136 mm (cw) for males and 110-145 mm (cw) for females. Average weight increased from 133 g at stocking to 489.3 g at the time of harvest. A total of Rs.3,586/- was obtained by sale of the harvested crabs.

Culture of crabs (*S. tranquebarica*) in cages made of PVC frame and nylon netting was demonstrated in a pond at Pallipuram. Experiments for inducing maturation of this species was attempted through unilateral and bilateral eyestalk ablation. Females subjected to unilateral eyestalk ablation did not show any sign of maturation whereas bilateral eye ablated crabs showed signs of maturation after two weeks.

Scylla tranquebarica **- a megalopa stage of crab reared in the hatchery at Mandapam**

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

M. Rajamani and S. Lakshmi Pillai

A series of experiments were conducted to study several aspects of the biology and culture of two species of brine shrimp, *Artemia fransiscana* (exotic species) and *A. parthenogenetica* (native species) collected from salt pans of Tuticorin. They were cultured in 1 ton cement tanks and fed with *Isochrysis galbana* and *Chlorella*. Population density was monitored regularly. The composition of nauplii in the tank ranged from 18.8 to 45.2% in *A. parthenogenetica* and 18.2 to 47.3% in *A. fransiscana*. Cyst production of *A. parthenogenetica* was recorded in the tank in July. Cysts were collected with the help of a brush and preserved in brine collected from salt pans. In experiments, it was observed that 90% of the cysts hatchout after 22 hrs of immersion in a medium of 24.6%. The first instar measured 0.532 mm in length.

V. MOLLUSCAN FISHERIES DIVISION

INVESTIGATIONS ON THE RESOURCE CHARACTERISTICS OF CEPHALOPODS (MF/RE/1)

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The Cephalopod production for the year was 2433 t at Veraval, 661 t at Mangrol, 3,885 t at Mumbai New Ferry Wharf, 7,330 t at Mumbai Sasoon Docks, 9 t at Karwar, 422 t at Tadri, 4,702 t at Mangalore, 2,548 t at Malpe, 1,105 t at Kozhikode, 2,748 t at Kochi, 17,453 t at Quilon, 489 t at Mandapam, 1,058 t at Rameswaram, 1,385 t at Chennai, 402 t at Kakinada and 109 t at Visakhapatnam, 638 t at Vizhinjam (hooks & lines) and the estimated all India production was 92,292 t. When compared with the figures of 1998, the landings have increased at Tadri, Mangalore, Kozhikode, and Mandapam and at Rameswaram, Kochi and Vizhinjam. However the production has gone down at Veraval, Mangrol, Mumbai New Ferry Wharf, Mumbai Sasoon Docks, Karwar, Malpe, Chennai, Kakinada and Visakhapatnam.

Cephalopod contribution to the total fish production varied between 2% at Karwar and as much as 15% at Tadri. Higher shares were observed again from the west coast centres. Along the east coast the share ranged from 2% (Kakinada) to 7% (Chennai).

Higher catch rates were noted in the west coast centres from Mumbai New Ferry Wharf (133 kg), Mumbai Sasoon Docks (288 kg), Cochin Fisheries Harbour (135 kg), Neendakara Fishing Harbour (175 kg), Sakthikulangara Fishing Harbour (101 kg), Mangalore (139 kg) and Malpe (118 kg). At the east coast centres higher rates were observed from Chennai (30 kg), Mandapam and Rameswaram (14 kg each).

Squids were dominant at Mangrol, Tadri, Mangalore, Malpe, Kozhikode, Chennai and Vizhinjam. In other centres cuttlefishes dominated the catch. The *Octopus* spp. constituted less than 1% at Mumbai Sasoon Docks to 21% at Rameswaram.

The analysis of species-wise composition in major centres indicated that *Loligo duvauceli* dominated the squid landings and was the only species found along northwest coast centres, *viz.* Karwar, Tadri, Kozhikode, Visakhapatnam, Vizhinjam and Kochi. It formed major component at Mangalore, Malpe, Mandapam, Rameswaram, Chennai, and at Kakinada. *Doryteuthis sibogae* accounted for 8% at Malpe, 17% at Chennai and 6% at Kakinada. *Loligo uyii* was landed only along Chennai (4%) and Kakinada (9%) coasts. The Palk Bay squid *Sepioteuthis lessoniana* was landed at Mandapam (83%) and Rameswaram (75%). *Loliolus investigatoris* occurred in stray quantities at Chennai and Kakinada.

Among the cuttlefishes, *Sepia aculeata* was dominant at Veraval, Mangrol, Mumbai Sasoon Docks, Mangalore, Malpe, Kozhikode and Rameswaram. *Sepia pharaonis* dominated at Mumbai New Ferry Wharf, Tadri, Chennai,

Cephalopod production during1999

Centre	Squids						Cuttlefish							Octopus					
	LD	LU	DS	SL	LOI	Total	SP	SA	SE	SPR	SB	SI	Total	OM	Total ceph	Units	C/E	%AF	Total AF
Veraval	1115	0	0	0	0	1115	215	876	81	0	0	146	1318	0	2433	50022	49	5	47414
Mangrol	395	0	0	0	0	395	42	166	17	0	0	41	266	0	661	18232	36	8	8656
Mumbai NFW	1610	0	0	0	0	1610	1088	962	0	0	0	197	2247	28	3885	29164	133	7	52671
Mumbai SD	3557	0	0	0	0	3557	1527	2083	0	0	0	138	3748	25	7330	25467	288	14	53529
Karwar	9	0	0	0	0	9	0	0	0	0	0	0	0	0	9	3853	2	2	514
Tadri	267	0	0	0	0	267	155	0	0	0	0	0	155	0	422	5129	82	15	2788
Mangalore	2247	0	207	0	0	2454	390	1316	0	140	0	15	1861	387	4702	33758	139	14	33902
Malpe	1383	0	62	0	0	1445	195	650	0	49	0	0	894	209	2548	21559	118	13	19845
Cochin F H															2092	15527	135		
Vypeen F H															656	12203	54		
Sakthikulangara															6336	62456	101		
Neendakara F H															11117	63554	175		
Vizhinjam	428	0	6			434	204						638			92400	6.3*		
Kozhikode	755	0	0	0	0	755	89	246	0	0	0	0	335	15	1105	19525	57	NA	NA
Mandapam	19	0	0	95	0	114	117	124	0	0	0	34	275	100	489	35056	14	6	8844
Rameswaram	67	0	0	196	0	263	231	286	0	0	0	57	574	221	1058	77338	14	3	31590
Chennai	737	35	156	0	9	937	300	93	0	10	13	20	436	12	1385	46531	30	7	20266
Kakinada	90	10	7	0	6	113	85	53	0	0	6	145	289	0	402	50887	8	2	23456
Visakhapatnam	53	0	0	0	0	53	24	23	0	0	0	9	56	0	109	88109	1	3	4443
TOTAL						**13521**							**13092**	**997**	**46739**				**307918**

Catch in tonnes:C/E: Kg/Unit, % AF: % in all fish landings; Units in trawler days AF: All fish landings
LD: *Loligo duvauceli*; LU: *L. uyii*; DS: *Doryteuthis sibogae*; SL: *Sepioteuthis lessoniana*; LOI: *Loliolus investigatoris*
SP: *Sepia pharaonis*; SA: *S. aculeata* ; SE: *S. elliptica*; SPR: *S. prashadi*; SB: *S. brevimana*; SI: *Sepiella inermis*; CF: Cuttlefishes; OM: Octopus membranaceous
*Boatseine

Visakhapatnam, Vizhinjam and Cochin. *Sepia elliptica* was caught along Gujarat coast accounting for 6%. *Sepia inermis* was landed in all centres except at Mangalore, Malpe and Kozhikode constituting 4 to 50% at different centres. *Sepia prashadi* was landed in small quantities along Mangalore/Malpe and Chennai coasts whereas *Sepia brevimana* occurred in stray quantities at Chennai and Kakinada.

In Kochi, an important development during the current year was the extension of fishing grounds beyond the conventional. With the availability of video fish finders and GPS, many trawlers are operating beyond 500m depth and landing unconventional species. The diamond squid *Thysanoteuthis rhombus* landed from 400-500 m depth off Alleppey coast by trawl operators from Munambam. Another rare species caught was *Chiroteuthis* sp.

Octopus landings at Chennai was constituted by *Octopus dolfusi* (59%) and *Cistopus indicus* (41%). At Kochi, *O. membranaceous* formed 80% of the total landings, *O. dolfusi* 10% and *O. lobensis* and *Cistopus indicus* together formed 10% of the total.

Biological characteristics of important Cephalopod species

Centre	Species	Dorsal ML (mm)	Sex ratio (M:F)
Veraval	*Loligo duvauceli*	20-210	58:42
	Sepia aculeata	40-120	57:43
Mangrol	*L. duvauceli*	30-380	49:51
Mumbai	*L. duvauceli*	30-250	
	S. aculeata	40-140	
	S. pharaonis	120-280	
Karwar	*L. duvauceli*	100-300	
Kozhikode	*L. duvauceli*	30-180	
Chennai	*L.duvauceli*	50-190	59:41
Kakinada	*L.duvauceli*	10-130	50:50
	S. aculeata	40-190	49:51
	S. pharaonis	40-260	
Visakhapatnam	*L. duvauceli*	60-150	43:57
	S. aculeata	80-240	42:58
	S. pharaonis	80-240	

INVESTIGATIONS ON THE RESOURCE CHARACTERISTICS OF BIVALVES AND GASTROPODS

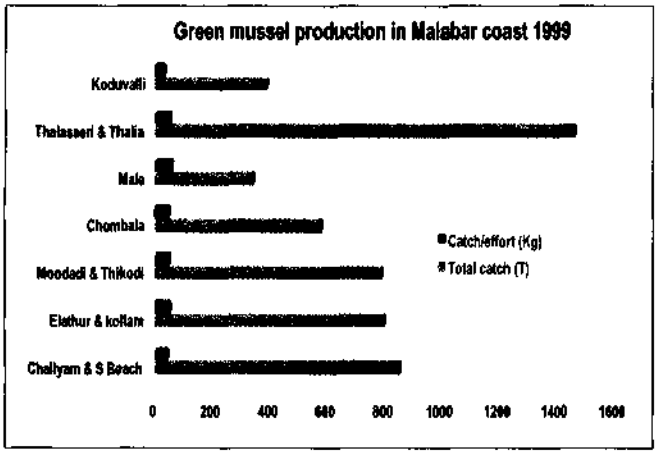
(MF/RE/2)

P.S. Kuriakose, P.K. Asokan, Sujitha Thomas, M.K. Anil, T.S. Velayudhan, V.K. Pillai, V. Kripa, P. Laxmilatha, N. Ramachandran, K. Ramadoss, Boby Ignatius, P.V. Sreenivasan, R. Sarvesan, K.S. Rao, Shoji Joseph and Geeta Sasikumar

Mussel

Kozhikode: During the year 1999, the total landing of the green mussel *Perna viridis* was 4781 t. Maximum landings took place during November (1152 t), followed by October (857 t) and September (574 t). The landings at Thalasseri/Thalai was the maximum at 1453 t followed by Chaliyam (846 t), Elathur/ Kollam (790 t) and Moodadi/Thikkodi (783 t), Chombala (592 t), Mahe (337 t) and Koduvalli (385 t). During June and July handpicking of 24 t of mussels at the inter-tidal areas was observed at Elathur.

The CPUE was maximum during November (78 kg), followed by October (76 kg) and September (65 kg). The highest CPUE was observed at Thalasseri during the month of October (92 kg). The CPUE was lowest during June and July at Elathur as it was handpicking by local fisherwomen.



Vizhinjam: A total of 174 t of brown mussel *P. indica* were landed with an effort of 12,788 mandays and catch per manday was 13.6 kg, 72 t from Vizhinjam, 52 t from Mulloor and 49.3 t from Pulinkudi. The price of mussel ranged from Rs.10 to Rs.30 for 100 numbers at the landing centres.

Culture of green mussel yielded 500-600 t at Padanna and nearby estuaries, 6 t from the CMFRI farm at Mulki, Mangalore; 1 t from Chettuva; 1.5 t from Dalavapuram, Kollam and 0.5 t from Narakkal, Kochi.

Seed survey

The mussel seed settlement pattern along Central Kerala coast was surveyed during July to September, 1999. In the Anjangadi beach to Thottapu light house stretch, the percentage of green mussel seed was higher (99%) in the total biomass than brown mussel. Dense settlement of green mussel occurred during September, the biomass was estimated at 8,603 kg.

In the Ethayi to Perinjanam stretch also green mussel seed was more abundant with dense settlement in September *in* Ethapu. In the Nayarambalam, Narakkal, Saudi to Andhakaranazi stretch, also green mussel was predominant. Heavy

settlement occurred during July in Nayarambalam. The estimated biomass was 29,880 kg.

In the Cheriya azhi, Parimanam, Neendakara to Paravoor stretch, dense settlement of brown mussel occurred, except in Neendakara, where green mussel was predominant. The estimated biomass of brown mussel at Cheriya azhi to Parimanam was 10,395 kg.

An assessment of the mussel seed resources along the coasts of Dakshina Kannada and Udipi districts of Karnataka, indicated that about 28 t of spat can be collected from these areas and the best season for seed collection is from September to December. The estimated biomass of green mussel seed in the intertidal area of 3,060 sq. m of mussel bed, was 28531 kg and in the subtidal mussel bed area of 10,490 sq. m was 1,01,938 kg.

Along the Malabar region, mussel seed settlement occurred from Kadalundi to Koduvalli stretch. The estimated extent of mussel bed was 2,00,000 sq.m covering Chaliyar/South beach, Elathur/Kollam, Moodadi/Thikodi and Chombala in Kozhikode District and Thalasseri/Thalai and Koduvalli in Kannur District and Mahe. The estimated biomass of mussel seed in this stretch was 200 t.

Clams

Mangalore: A total of 455 t of *Meretrix casta* was landed. The average catch/effort was 31 kg/manday. The size of clams ranged from 18 mm to 32 mm in Kadiku, Chitrapur, Bappananu and Mattu. *M. meretrix* accounted for 101.6 t. The mean size was 36.48 mm during October and 29.78 mm during December.

Karwar: At Kalinathi and Aghanasini estuaries, the total *Paphia malabarica* landing was 3,456 kg and catch/day was 192 kg which was less compared to last year. The mean size was 31.7 mm during April and 33.42 mm during September.

Kakinada: *Anadara granosa* 1,152 t, *Anadara rhombea* 1 t, *P. malabarica* 2 t, *Crassostrea madrasensis* 0.5 t and *Placenta placenta* 1 t were landed. The length of *A. granosa* ranged between 16-79 mm with a dominant mode at 54-55 mm and that of *P. malabarica* 48-81 mm, with dominant mode at 64-65 mm.

Kozhikode: From the five major estuaries surveyed, *Villorita cyprinoides* contributed 132 t mainly from Chaliyar estuary. 6.6 t of *P. malabarica* were landed at Dharmadom estuary. From October to December, 3 t of oyster, *C. madrasensis* was landed at Dharmadom. 6.2 t of *M. meretrix* was landed at Dharmadom, Moorad and Kadalundi estuary.

Kochi:The total annual production of *V. cyprinoides* from Vembanad Lake was 37,036 t. The size ranged from 12-44 mm, and the dominant mode was 22 mm. The total production of *P. malabarica* from Ashtamudi Lake was 480 t and were of the size 18-52 mm. The estimated annual production of *Meritrix casta* from the Ashtamudi lake was 196 t.

Mandapam: 126 t *Meretrix casta* was landed from the Athankarai estuary.

Oysters

Chennai: 583 t of edible oyster *Crassostrea madrasensis* was landed during the first half of the year. The revenue earned from sale of oyster shell and meat was Rs.1,47,000.

Veraval: In the Charwad creek area, 15-20 nos of edible oysters were found per sq. m area. The species found in this area include *C. madrasensis, C. gryphoides, C. rivularis* and *Sccostrea Cuculata*

Karwar: 144 t of *C. madrasensis* and 24 t

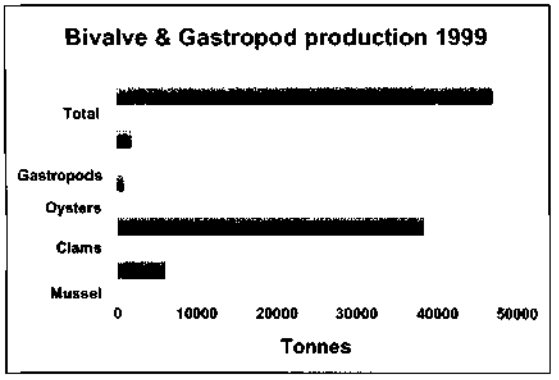
Details pertaining to the mussel seed settlement pattern along Central Kerala Coast during the period January to December 1999

Zone	Site	Month	Extent Bed (sq. m)	Average no. of seed per kilogram		Estimated mussel seed					Average Length of seed (mm)		Percentage Species in total biomass	
						Biomass (kg)		Density (nos.) X 1000		Total Biomass				
				Green	Brown	Green	Brown	Green	Brown		Green	Brown	Green	Brown
	Anjagadi	July	6000	12077	9333	198.72	4.5	150	42	203.22	6.87	10.73	97.8	2.2
	beach to	Sep	2000	3582	379	8602.56	110.8	1926	42	8713.36	12.32	27.45	98.7	1.3
	Thottapu light house	Nov	250	5299	0	1411.48	0	467.5	0	1411.48	20.13	0	100	0
I	Ethayi	Sep	1125	4767	1143	540	7.87	160.88	9	547.87	7.26	18.52	98.6	1.4
	beach	Nov	500	1818	0	352	0	40	0	352	16.74	0	100	0
		July	3000	10182	4000	264	12.8	168	51	276.75	6.94	11.82	95.4	4.6
	Perinjanam	Sep	125	3600	1500	20	0.25	4.5	0.375	20.25	8	17.63	98.8	1.2
		Nov	0		0	0	0	0	0	0	0	0	0	0
		July	3750	2325	8000	29880	86.3	4342.5	690	29966.25	10.94	9.23	99.7	0.3
	Nayarambalam	Aug	3750	2248	3549	7740	66.6	1087.5	236.25	7806.56	12.63	11.46	99.1	0.9
	to Narakal	July	9750	16769	3152	507	80.43	531.38	253.5	587.43	6.78	12.63	86.3	13.7
II	Saudi to													
	Andakaranazhi	Aug	18000	16000	419	432	10395	432	4356	10827	5.85	18.66	4	96
	Cheriya azhi to Parimanam	Nov	8000	709	1603	6323.2	1292.8	280	2072	7616	24.96	20.1	83.0	17.0
III	Neendakara	Aug	12000	0	6958	0	1716	0	11940	1716	0	10.02	0	100
	Paravoor	Nov	12000	0	534	0	5330.4	0	2844	5330.4	0	25.94	0	100

of *S. cuculata* were landed during October to December at Kali and Aghanasini estuaries.

Kochi: The annual production of *C. madrasensis* from the Ashtamudi Lake was 81 t and 0.5 t through farming in the CMFRI demonstration farm at Dalavapuram, Kollam.

Tuticorin: Approximately 10 lakh adult pearl oysters (*Pinctada fucata*) were collected from natural bed by divers engaged by CMFRI and other agencies for pearl production.



Gastropods

Tuticorin: A total of 43,33,875 chanks were netted at Tuticorin and Tiruchendur. Bottom set gill nets were operated at Tuticorin, in 14 fathoms depth and chanks above 70 mm dia were fished, while at Tiruchendur, the nets were operated in shallow areas.

Mandapam: At Mandapam, 637 numbers of *X. pyrum var acuta* of size 90-210 mm and 490 numbers of *X. pyrum var obtusa* of 90-170 mm size were landed by the trawls. At Rameswaram, 577 numbers of 90-240 mm, MSD 50 to 130 mm of *X. pyrum var acuta* and 496 numbers of *X. pyrum var obtusa* in the size range of 90 to 240 mm were landed.

At Keelakarai, 792 numbers of *X. pyrum var acuta* in the length range of 90-230 mm were landed.

Kakinada: *Cerithidea* sp. 574 t, *Telescopium* sp. 130 t, *Umbonium* sp. 13 t and *Hemifusus* sp. 0.25 t were landed.

Bivalve and gastropod landings 1999

SPECIES	PLACE	LANDINGS(T)	C/E kg
MUSSEL			
Perna indica	Vizhinjam	72.00	11.4
	Mulloor	53.00	16.0
	Pulinkudi	49.30	15.5
Perna viridis	Malabar coast		
	Chaliyam & S Beach	846.35	38.4
	Elathur & Kollam	790.04	49.1
	Moodadi & Thikodi	782.75	46.0
	Chombala	571.49	46.0
	Male	336.75	55.2
	Thalasseri & Thalia	1453.42	48.2
	Koduvalli	385.40	30.3

P. viridis (Through culture)	Padanna, Cannanore	600.00	
	Mulki, Mangalore	6.00	
	Chettuva, Trichur	1.00	
	Dalavapuram, Quilon	1.50	
	Narakkal, Cochin	0.50	
Total		**5949.50**	
CLAMS			
Meretrix casta	Chettuva, Trichur	192.46	
	Mangalore (Kadika, Chitrapu, Bappananu, Mattu beds)	455.20	31.1
Meretrix meretrix	"	101.60	
	Dharmadom, Kadalundi & Moorad estuaries	6.2	
Paphia malabarica	Karwar (Kali, Aghanashini estuaries)	3.46	192.0
	Calicut (Chaliyar est.)	6.60	
	Ashtamudi estuary	480.24	
	Kakinada	2.03	42.6
Villorita cyprinoides	Kozhikode (Chaliyar estuary)	132.00	
	Vembanad Lake	37036.28	
Total		**38416.07**	
OYSTERS			
Crassostrea madrasensis	Chennai	583.00	
	Veraval (Chorwad creek)	15-20nos/Sq mt	
	Karwar (Kali & Aghanasini estuaries)	144.40	
	Kakinada	0.50	
Saccostrea cuculata	"	24.05	
C.madrasensis	Ashtamudi Lake	80.25	
Through culture	Ashtamudi lake	1.50	
Total		**833.70**	
GASTROPODS			
Xancus pyrum	Tuticorin		
	Tiruchendur	43333875 nos	
Xancus pyrum var acuta	Mandapam	637 nos	
	Rameswaram	577 nos	
	Keelakarai	792nos	
Xancus pyrum var obtusa	Mandapam	490 nos	
	Rameswaram	496 nos	
Anadara granosa	Kakinada	1150.74	
A. rhombea		0.99	
Cerithidea sp		574.09	
Telescopium sp		130.00	
Umbonium sp		13.00	
Thais sp		1.30	
Hemifusus sp		0.25	
Total		**1870.37**	

EDIBLE OYSTER CULTURE
(MF/CUL/9)

P. Muthiah and K. Ramadoss

Hatchery produced seed were used for further growth studies in the farm. Five racks with 200 rens were maintained, and 320 strings with average of 18 spat per shell were transferred from hatchery to nursery. During June, 201 strings with 8000 seed oysters were sold to Tamil Nadu Fisheries Department. Production of cultchless spat was initiated in the hatchery. In September, 3500 cultchless spat of 2-10 mm were being reared in box type cages. In April, 10,040 spat were sent to Kochi for experimental studies. During this period, 13.5 kg of oyster meat was sold locally and 2 kg of oyster meat was utilised for demonstration purpose.

UPGRADATION AND TRANSFER OF PEARL CULTURE TECHNOLOGY
(MF/CUL/10)

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

A total of 15,000 oysters were collected from the natural pearl oyster beds and stocked in the farms in Tuticorin. Two farms, one inside the Tuticorin Harbour Basin consisting of 3 rafts, and another rack of 6 x 5 m in the open bay west off Tuticorin Harbour were maintained. Mother oysters, spat and implanted oysters are being maintained in the farm.

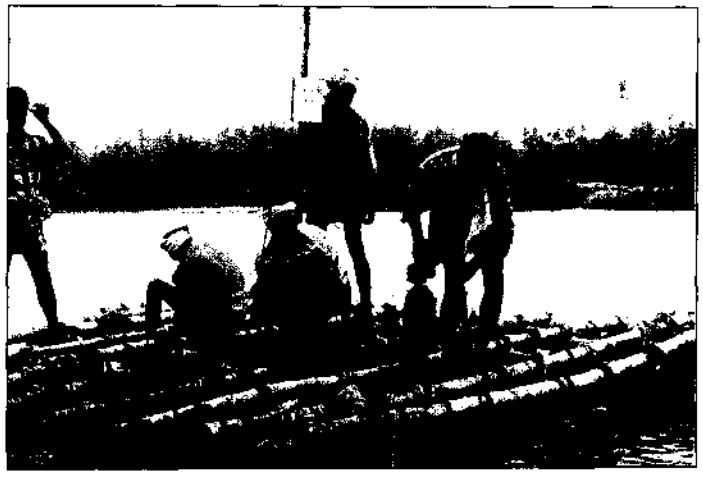
In April, 400 mother oysters were given to Vizhinjam Research Centre and Headquarters. In September 200 spat were supplied to Kochi. A total of 8,427 oysters were implanted with 3, 4 and 5 mm nucleii during June to December.

POPULARISATION AND TRANSFER OF BIVALVE CULTURE TECHNOLOGY AT SELECTED CENTRES ALONG KERALA COAST
(MF/CUL/11)

K.K. Appukuttan, T.S. Velayudhan, V. Kripa, K.S. Mohamed, P. Laxmilatha, P.S. Kuriakose, N. Ramachandran., V. Chandrika and K.P. Said Koya

Oyster

Demonstration of edible oyster culture at Dalavapuram was continued. Few more local farmers adopted CMFRI technology for edible oyster culture in this area. BFFDA has identified 15 fishermen and decided to give financial assistance for oyster



Open sea mussel culture at Elathur, off Kozhikode

farming adopting CMFRI technology.

Seed production and monitoring of growth of edible oysters were continued in the Institute's demonstration farm at Dalavapuram. About 61.6 kg of edible oyster meat harvested from the previous years stock was sold to the Integrated Fisheries Project (IFP) at the rate of Rs.52/kg of shucked meat.

Mussel

Open sea farming of the green mussel *Perna viridis*, was demonstrated at Narakkal. Growth of the mussel was monitored by suspending replicates of three size ranges in velon screen pouches and monitored over the farming period.

Experiments were conducted in Dalavapuram, to test the suitability of transplanting seed from Narakkal to Dalavapuram. The growth of seed mussel from Kollam recorded better growth than that transplanted from Narakkal. This may be due to stress in transportation over long distance.

Mussel and edible oyster farming demonstration was also initiated at Paravoor, Kollam by suspending 15 edible oyster and 30 seeded mussel ropes.

Open sea mussel culture was initiated by five enterprising mussel pickers at Kozhikode. 5 x 5 m raft was launched at Elathur, off

Harvest of mussels

Mussel and Oyster products

Kozhikode, at 5 m depth. Sixty seeded ropes, each 3.75 m seeded length with 1.75 kg/m of mussel seed (average length 30.5 mm) were suspended from the raft. The culture experiment is in progress.

Mussel harvest

Harvest *mela* was conducted on 3rd June 1999 at Dalavapuram, Ashtamudi Lake where two local farmers have adopted mussel farming technique developed by CMFRI and harvested 1 t shell-on mussel. The meat was sold to the IFP, Kochi, where it was processed into various value added products.

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

Studies on the heritability of edible oyster *Crassostrea madrasensis* collected from Paravoor and Dalavapuram, in Kollam were carried out. Two length groups were selected. The larger size group of average length 97.62 mm, width 60.68 mm and weighing 145.7 g and another group of 46.41 mm total length, width 33.46 mm were tagged with 'dymo' using 'Anabond' and 'Feviquick' for monitoring the individual growth performance. Progressive increase in growth in both size groups was monitored. Triploid oysters successfully produced at Tuticorin R.C. of CMFRI, were transported to Kochi and maintained at the Dalavapuram farm. A total of 93 spat of average size of 13.36 mm and weight 0.56 g were seggregated with two groups viz. of average length 15.95 mm and 10.76 mm and weight 0.8 and 0.31 g respectively and their growth monitored. Induced spawning experiments were carried out in the Hatchery at HQ on *Villorita cyprinoides*, *Paphia malabarica* and *C. madrasensis*.

CULTURE OF CEPHALOPODS
(MF/CUL/13)

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

The technique of spawning and larval rearing of *Sepiella inermis* in captivity was standardised in the Tuticorin Shell Fish Hatchery. Five generations were produced and maintained in the hatchery. The hatchlings were fed with mysids initially and on prawns, Acetes and fish fry subsequently. F1 generation reached adult stage in 88 days with a mean size of 59.26 mm ML weighing 486 gm. A total of 100 adults (*S. inermis*) of size 81.8-98.2 mm ML and 15841 juveniles of 3 to 31.6 mm ML size range were ranched in the sea off Hare Island.

Scientists of Karwar Research Centre have successfully reared *S. inermis* till maturity and adults have spawned in the laboratory condition.

SEED PRODUCTION AND PEARL CULTURE IN THE ABALONE *HALIOTIS VARIA*
(MF/CUL/14)

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

Seed production technique of *Haliotis* was successfully completed by continuous experiments at Mandapam Shell Fish Hatchery. *Haliotis varia* collected from the wild were induced to spawn by exposing to air for 2 hours before transferring to the tanks of 30 l capacity. The fertilised eggs were spherical and measured 18 µm in diameter. The trochophore larvae appeared within 10 hrs after fertilization. The veliger stage was reached within 12 hrs, with developed velum and long apical cilia. All the larval stages of *Haliotis* sp. are lecithotropic and hence feeding was not required. On 4th day floating veligers began to settle on substrates and had the cephalic tentacles with four branches and well developed eye spots. A mat of benthic diatoms comprising mainly of *Nitzchia* sp. and *Navicula* sp. were given as food. On 26th day when the first respiratory pore was formed the larvae attained a size of 1.3mm. At this stage, finely chopped *Ulva lactuca* was given as feed apart from the algal mat. 46th day three respiratory pores were formed at the size of 2.6 mm and on 90th day all five respiratory pores were developed. Chopped seaweeds and encrusted coralline red alga were given as food at this stage.

Half pearl production

Half pearl production was achieved successfully by implanting shell bead nucleus into the shell, of the abalone. Animals of 4 cm size were selected and nucleus of size 3 mm were fixed on the shell. This was done by drilling a hole on the shell and fixing the nucleus using synthetic adhesives. The nucleated abalones were kept in oyster cages and suspended in cement tanks of 100 t capacity. They were fed once a week with finaly chopped seaweeds, mainly *U. lactuca*. Coral pieces with encrusted red algae were provided as substratum in the cages and also as a source of feed. Pearly coating was observed after 3 months. Out of the 15 numbers implanted 4 had uniform coating over the nucleus.

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

R. Sarvesan, G. Syda Rao, P.V. Sreenivasan, M.M. Meiyappan, T.S. Velayudhan, K.S. Mohamed, K.G. Girijavallabhan, Reeta Jayasankar and K. Vijayakumaran

Pearl oyster feeding experiments are in progress at Visakhapatnam. Five species of phytoplankters *viz. Chaetoceros* spp., *Isochrysis galbana*, *Nanochloropsis salina*, *Tetraselmis* sp. and *Skeletonema* were maintained and the best combination of algae which gave better growth was determined. About 2000 pearl oyster spat are being maintained in the onshore tanks. Development of the hatchery infrastructure is nearing completion.

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. Said Koya

At Vizhinjam heavy settlement of pearl oysters occurred in the cages during October-November in the farm area. Nearly 6000 spat of *Pinctada fucata* were collected from four cages and in one cage alone 5000 spat had settled. The density in the other cages were comparatively poor because of settlement of mussel spat also on the same cages. The size range of the spat varied from 10-39 mm DV and 9-37 mm HL indicating that spawning and settlement occurred during October and November.

For the first time mussels were farmed by direct settlement of mussel seeds on spat collectors (untwisted nylon rope) and subsequently by suspending spat collectors from the raft. Huge quantities of pearl oysters also were found to settle in the upper 0-50 cm length of the ropes used as the spat collectors. Present experiments revealed that by suspending spat settlers in the upper 2 metres area both pearl oyster and mussel spat can be collected in good numbers for farming.

A variety of ornamental and edible fishes, sponges, ascidians, bryozoans, cuttlefish, lobsters were also found to aggregate around the cages and collectors.

Pearl oyster seed from a single cage (5000 nos)

VI. FISHERY ENVIRONMENT MANAGEMENT DIVISION

During the period under report, the Division was engaged in a total of 16 Research Projects of which, 11 were Institute Projects and 5 were sponsored projects funded by various agencies.

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 on board FORV *Sagar Sampada* in the exclusive cruises conducted by CMFRI between 1991 and 1995 during premonsoon, southwest monsoon and postmonsoon season were analysed to bring out the salient features of the coastal waters of the Arabian Sea during 3 different seasons in relation to biological productivity. The final report is expected to be completed by the first quarter of 2000-2001.

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

C.P. Gopinathan, 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 project is functioning at Kochi, Kozhikode, Mangalore, Karwar, Mumbai, Minicoy, Vizhinjam, Tuticorin, Mandapam and Visakhapatnam. The SST ranged from 24.5 to 31.5°C; salinity from 19.20 to 35.67‰; dissolved oxygen from 1.41 to 4.67 ml/l; phosphate ranged from 0.10 to 3.39 µg at/l; nitrites from 0.04 to 3.47 µg at/l; nitrates from 0.10 to 1.82 µg at/l and silicates from 1.33 to 56.83 µg at/l, in the inshore waters of Kochi.

During the first quarter, the chlorophyll a concentration was high in the inshore waters (1-4 mg/m^3). Bottom waters upto 30-m depth zone indicated further high concentration (2-14 mg/m^3). Moderately high values during the second quarter and comparatively low values during the 3rd and 4th quarters were noted.

Persistent blooms of *Spirogyra* and *Noctiluca* were observed in the shallow region (10m) during May-July. Swarming of *Evadne tergestina* and predominance of appendicularians were special features during June-July. *Lucifer sp.* and *Acetes sp.* were numerically more in February at 20m depth zone. Protozoeal stages of *Acetes* sp. and mysis of *Metapenaeus dobsoni* were predominant in April and June at 20m depth. While dense swarms of *Penilia avirostris* and fish eggs were observed at 10m depth zone, siphonophores were found to be abundant at 20m depth in

Centres Name	SST (°C)	D.O (ml/l)	Salinity (ppt)	pH	Phosphate (µg at/l)	Nitrite (µg at/l)	Nitrate (µg at/l)	Silicate (µg at/l)
Kochi	24.5-31.5	1.31-4.67	19.20-35.67	7.2-8.0	0.10-3.39	0.04-3.47	-	-
Kozhikode	24.8-31.0	1.80-5.39	32.0-35.75	7.8-8.1	0.18-2.36	0.01-1.68	0.36-5.76	2.00-18.37
Karwar	26.6-29.6	2.61-4.07	20.24-34.64	-	-	-	-	-
Mangalore	24.5-31.2	4.11-6.19	15.10-35.30	-	0.72-1.63	0.01-1.30	-	0.32-73.80
Mumbai	24.5-33.0	-	23.36-37.76	-	0.13-6.77	-	1.13-4.74	4.77-60.43
Minicoy	26.1-29.7	3.64-4.73	31.30-35.30	-	-	0.22-2.73	0.48-1.62	0.87-2.15
Vizhinjam	26.9-28.0	3.38-5.38	33.00-35.95	-	-	-	-	-
Chennai	26.2-30.2	2.67-6.30	25.2-32.02	-	0.25-078	0.00-1.00	-	-
Mandapam	27.5-29.8	3.20-4.89	32.90-33.34	-	0.16-0.67	0.01-0.25	0.85-7.50	3.80-16.40
Visakhapatnam	24.7-29.2	-	18.9-29.9	-	-	-	-	-

September. Fish eggs were highly abundant in the shallow environment during November. Fish larvae of *Stolephorus* spp., *Sardinella* spp., *Cynoglossus* spp. and *Ambassis* spp. were also present occasionally in the inshore area off Kochi during this year.

The oceanographic parameters as well as the primary and secondary production along the coasts adjoining major Centres of this Institute are as follows:

Centres	Chlorophyll a (mg/m³)	Gross primary Production (mgC/m³/day)	Net primary production (mgC/m³/day)	Zooplankton (ml/m³)
Kochi	1-4	-	-	1-17
Kozhikode	-	260-1540	220-2330	-
Karwar	-	308-760	-	-
Mangalore	0.41	-	-	4.47-7.80
Mumbai	0.24-3.37	-	-	-
Minicoy	-	-	-	4-15.5
Vizhinjam	-	-	-	-
Chennai	-	188-4730	85-2520	-
Mandapam	-	26-203	-	4.8-6.4
Visakhapatnam	-	-	-	-

ECOLOGICAL INVESTIGATIONS ON THE INTER-TIDAL AND SURF ZONES OF THE KERALA AND KANYAKUMARI COASTS IN RELATION TO FINFISH AND SHELLFISH SEED AND JUVENILE RESOURCES

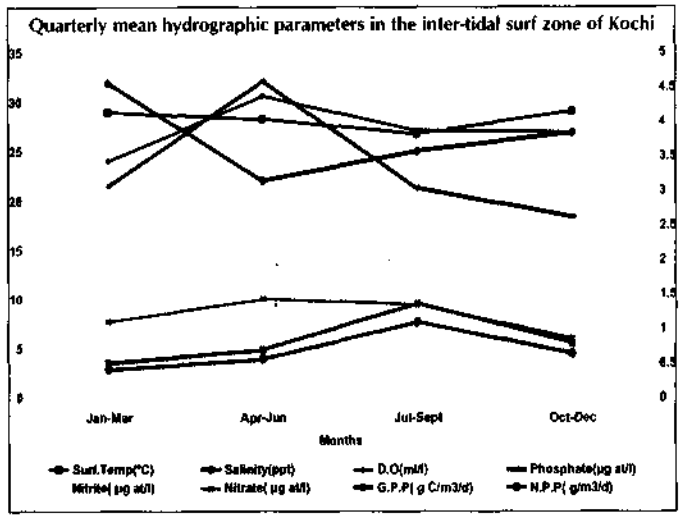
(FEM/ES/6)

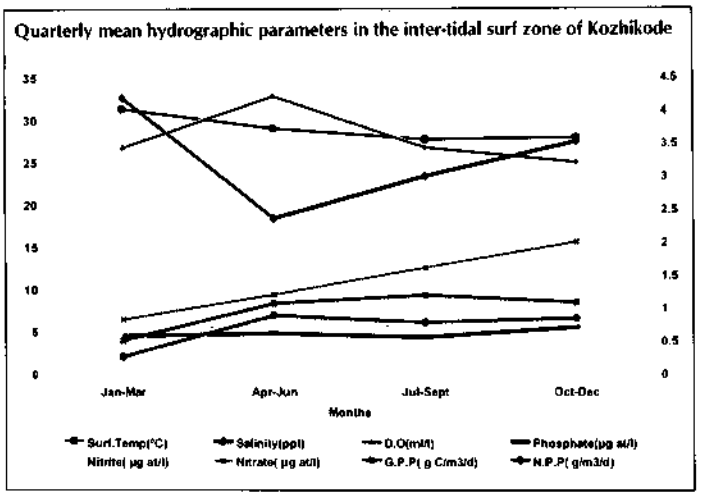
G.S.Daniel Selvaraj, Molly Varghese, S.Krishna Pillai and S. Jasmine

Data on hydrography and primary productivity were collected from the surf region of the sea and adjoining estuarine systems at Kozhikode, Kochi, Vizhinjam and Kanyakumari on monthly basis along with information on the availability of fish and prawn seed and juveniles.

Relatively low temperature and salinity and higher dissolved oxygen values were recorded during the peak southwest monsoon months. Among nutrients, phosphate and nitrite showed higher values in the Kochi sector throughout the year. The highest values of 5.73 and 2.99 mg at/l respectively were recorded during the onset of southwest monsoon, while the nitrate concentration was relatively higher in the Kozhikode sector during the third and fourth quarters. Annual average values of gross primary productivity revealed that the intertidal zone of the Kozhikode sector was more productive (0.944gC/m^3/d) than the Kochi Sector (0.846gC/m^3/d). The highest rate of production was (>2.0 g C/m^3/d) at Kozhikode and Kochi sectors during September. The surf region at Kochi revealed that the fish eggs and larvae and decapod larvae were more during the third quarter showing their monthly peaks in September (55 Nos/m^3) and July (17 Nos/m^3) respectively.

Analysis of juveniles of fish and prawn samples obtained from the adjacent estuarine systems exhibited wide species diversity among fishes. In the Cochin backwater, juveniles of *Johnius osseus* and *Caranx kalla* were more during January-March; *Gerres* spp. in April-June; *Etroplus* spp. and silverbellies during July-September; *Ambassis* spp., *Liza* sp. and *Gobius* spp. in October-December. Although





Relative abundance (%) of juvenile fishes and prawns from the intertidal estuarine zone at Kochi during 1999

Species	Jan. - Mar.	Apr. June	July – Sept.	Oct.- Dec.
No. of fish analysed:	310	323	277	195
Ambassis spp.	8.7	10.8	28.9	42.1
Etroplus spp.	2.3	5.3	18.1	10.5
Caranx spp.	5.2	1.0	0.0	1.0
Gerres spp.	2.6	11.5	0.4	1.0
Stolephorus spp.	17.4	22.0	5.4	7.4
Thrissocles spp.	6.8	16.4	16.3	9.5
Leiognathus spp.	9.7	6.2	15.2	1.0
Liza spp.	4.5	4.0	0.4	13.7
Johnius spp.	25.5	6.5	7.9	0.0
Gobius spp.	1.0	4.0	3.3	13.7
Others	16.3	12.3	4.1	0.0
No. of prawns analysed:	715	575	696	464
M.dobsoni	91.2	82.8	80.2	65.7
M.monoceros	6.15	9.4	8.5	5.8
P.indicus	2.1	3.3	-	-
P.semisulcatus	0.15	0.7	-	-
Non-penaeids	0.4	3.8	11.3	28.5

the species of *Thrissocles* contributed by *T.mystax* and *T.malabaricus* were present throughout the year, their abundance was recorded during the second and third quarters of the year. In the backwater of Manakudi, Thenkaipattinam, Parathiyoor, Panathura, Veli and Perumathura, the juveniles were dominated by mullets during September-March and *Therapon* spp. during south-west monsoon months.

Among prawns, juveniles of *Metapenaeus dobsoni* dominated throughout the year followed by *M. monoceros*. *Penaeus indicus* and *P.semisulcatus* were encountered in the samples during the first and second quarters of the year in the Cochin backwater. Among them, early juveniles (20-40 mm) of *M.dobsoni* showed their abundance during April-September (36-38%) and *M.monoceros* during July-September (40.7%). At Perumathura, early juveniles of *Metapenaeus* sp. (20-30 mm) showed their abundance during July-August.

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

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

Kochi

Regular environmental monitoring was carried out in the inshore areas off Kochi. Data on water temperature, salinity, dissolved oxygen and nutrients were collected at surface and bottom from four stations during 1999. Water temperature (°C) varied from 27.0 (July) – 31.0 (March); salinity (ppt) from 13.03 (July) - 32.48 (March); and dissolved oxygen (ml/l) from 5.45 (July) - 6.79 (May).

Very low dissolved oxygen levels were recorded at 10 m depth in August (0.53-1.19 ml/l) probably due to the movement of cold bottom water to the inshore areas. Relatively higher levels of ammonia were recorded in the estuarine areas during May-June (max. 7.84 µg at/l). Other parameters did not show any significant variations.

Sediment samples collected from four stations from the estuarine and inshore areas were analysed for heavy metals. Metal levels were comparatively high during May, June and July due to run off by river water. (Zn: 286 µg /g; pb: 34.5 µg /g; Cu: 31 µg /g and Cd: 3.9 µg /g).

Total humic acid (THA) content in water as well as in sediment was also studied. The highest level observed in water was 36.47 ppm in June '99.

Mangalore

Selected environmental parameters were monitored at identified locations to assess the health of the environment. Hydrobiological studies were carried out from the vicinity of the marine outfall of a Petroleum Refinery off Chithrapur. Subtidal benthic macrofauna near the marine outfall were also studied to assess the impact of pollution.

The BOD values varied from 0-4.31mg/l. Surface BOD values were high compared to bottom values at all stations. The seawater COD values varied from 32.4-45.8 mg/l. The BOD and COD values were within the normal range. The sulphide, phenol and cyanide values were below the detection limit in seawater collected from the marine outfall during April-May period.

Effect on marine benthos: The total benthic biomass (wet weight) at the outfall point was 12.02 g/m^2 and at 500 m away was 26.36 g/m^2 during May. The total benthic biomass at a reference station was 36.93 g/m^2. The total benthic numerical density was 5009/m^2 at the outfall point and 8780/m^2 at the 500 m point respectively. However, the same at the reference point was 1560/m^2. There were 4-6 groups of animals present at the marine outfall compared to 7 groups at the reference site. The bivalves were the most dominant group present at all the three stations. The second dominant group was polychaetes near the outfall while it was gastropods at the coastal site. Other benthic groups such as Foraminifera, Echinoderms, Decapods, Barnacles and crabs were also present in the samples. A comparative study of the results

from the present observation with the available data from Mangalore region revealed no noticeable long term changes though seasonal abundance were recorded.

Tuticorin

Environmental monitoring programmes were continued at Karapad Bay and at Kayalpatinam. At Karapad Bay, maximum water temperature (31°C) was recorded during May and minimum (25°C) during July and the pH varied from 7.78 to 8.95 respectively. Salinity was more or less same throughout the period except during August, the maximum value recorded was 46.65°/$_{oo}$. Minimum D.O concentration of 1.23 ml/l during August and a maximum of 3.69 ml/l during June were recorded in the open sea. Turbidity observed was more or less same at all the stations except during July (max: 162.5 n.t.u).

At Kayalpatinam, water temperature was minimum in April and maximum during June. pH was normal in the open sea, but in the lagoon low pH of 4.3 was noticed during July. The dissolved oxygen levels varied between 4.82 m/l during July and a minimum of 1.74 ml/l during August. Salinity showed significant variations in the lagoon (24.43°/$_{oo}$ in April and 54.95‰ in August). Mercury levels showed comparatively higher levels during August (35.38 µg /l).

Chennai

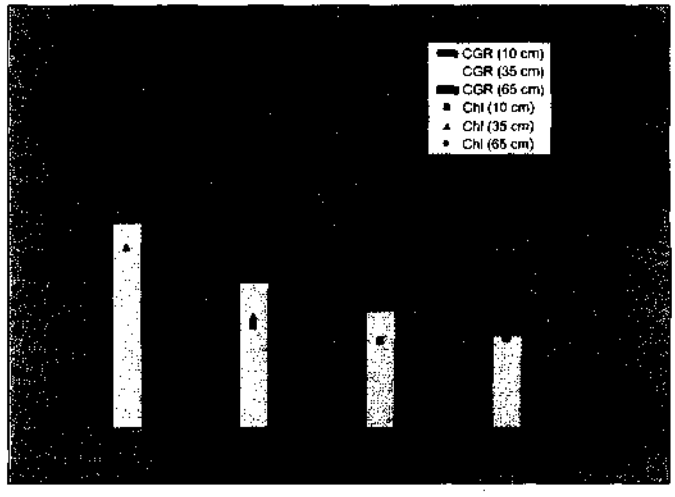
During the period under report, data for physico-chemical parameters were collected at Ennore. SST (°C) varied from 25.8 to 30.6, dissolved oxygen from trace to 5.2 ml/l, salinity (ppt) from 18.1 to 30.0, nitrites (µg/l) from 0.05 to 1.0, nitrates (µg/l) from 10 to 25 and phosphates (µg/l) from 0.15 to 0.25.

SEAWEED RESOURCES INVESTIGATIONS: RESOURCE ASSESSMENT OF SEAWEED AND THEIR CULTURE
(FEM/SW/1)

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

Investigations were carried out to assess seaweed resources along the coasts of Tamil Nadu, Andhra Pradesh and Minicoy atoll (Lakshadweep) and identified dominant vegetation having commercial relevance.

Mariculture of seaweeds *Gracilaria edulis* at Mandapam progressed well but could not



Crop growth rate and chlorophyll content of *Gracilaria edulis* under different depth

harvest the crop due to problems like sedimentation and grazing. In Minicoy atoll mariculture of *G. edulis, G. crassa* and *Laurancia papillosa* was undertaken in net pen with fixed bottom monoline methods which yielded 3.5 to 5 fold increase in wet biomass of seaweeds over their seed quantities.

Experiments on the onshore culture of seaweeds in glass/fibreglass tanks were also conducted at Visakhapatnam, Mandapam and at Kochi and the results were not encouraging. Culture of *G. edulis* under the green house at Mandapam was carried out with NPK supplements and growth hormone pre-treatment trials. Studies on spore output in red seaweeds such as *G. corticata* and *G. edulis* were carried out at Kochi. Experiments were also conducted on the effect of different wave length of light on the induction of cystocarps on the thallii of *G. edulis*. Chlorophyll, phycoe rythrin, phycocyanin and allophycocyanin content increased when *G. edulis* was grown under green light. All the pigments showed an inverse relationship with depth of culture. Pigment contents were more at a greater depth than the shallow depth. On the other hand CGR was more in shallow depth of water column.

Data were collected from 9 landing centres in TamilNadu on the quantity of seaweeds exploited from the natural beds during April - September 1999. The total quantity of seaweeds landed was 1378 t (dry wt.) which consisted of 350 t of *Sargassum spp.* and 30 t of *Turbinaria spp.* and 182 t of *Gelidiella acerossa*, 181 t of *G. edulis* and 35 t of *G. crassa*.

BIODIVERSITY STUDIES
(FEM/AR/1)

P.A. Thomas

Taxonomic studies on sponges, gorgonids and alcyonarians were continued. Attempts were made to study the taxonomy of some species of alcyonarians belonging to the genera *Sinularia, Lobophytum, Sarcophytum* etc. But this study is not progressing well as some old literature is not readily available.

Sponges/Gorgonids collected from different areas of the Indian coasts such as Ratnagiri, Vizhinjam, Cape Comorin, Tuticorin, Mandapam and Orissa were identified during the year under report. A total of 265 specimens were identified; group-wise break up being sponges-210 nos. Gorgonids-54 nos., and Alcyonarian-1 no.

Maintained collaborative linkage with Indian Institute of Chemical Technology, Hyderabad; Central Drug Research Institute, Lucknow; Regional Research Lab., Bhubaneswar; National Institute of Oceanography, Goa; and Andhra University, Visakhapatnam.

Sponges and Gorgonids collected by a team from RRL, Bhubaneswar from Orissa coast were examined and a total of 54 species of sponges were identified. A list was later published in *Curr.Sci.* (77)(2). All species of sponges were new records to the Orissa coast.

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

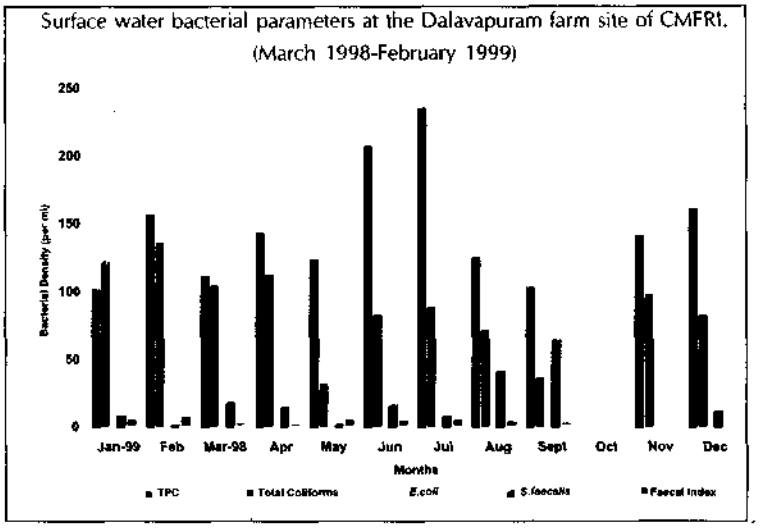
V. Chandrika

Twelve observations were made to monitor faecal pollution levels in shellfish farming sites like Dalavapuram, Cherai and Chettuva. The concentrations of indicator organisms in these sites varied considerably which were of different intensities and duration. Premonsoon and monsoon months were very rich in heterotrophic bacteria 236x10^6/ml. Faecal indicators exceeded both the WHO-Standards, EEC-guidelines ISI-standards and numbers as high as 2.6x10^6 coliforms/100 ml were obtained in clam samples and represented a potential health hazard. The recovery of pathogenic bacteria like *Pseudomonas aeruginosa*, *Salmonella*, *Serratia marinorubra* further substantiated the quantitative existence of health hazards. It is interesting to note that the distribution was similar throughout the periods among coliforms and intestinal pathogens. Approximately 45% of the isolates were *E.coli* and the rest belong to *Klebsiella* (23-31%) and Enterobacter formed (16-22%) and Citrobacter (6-10%) of the total enterobacteriaceae.

***Pseudomonas fluorescence* occurred in monsoon months in enormous numbers in oyster samples which can be killed by boiling procedures**

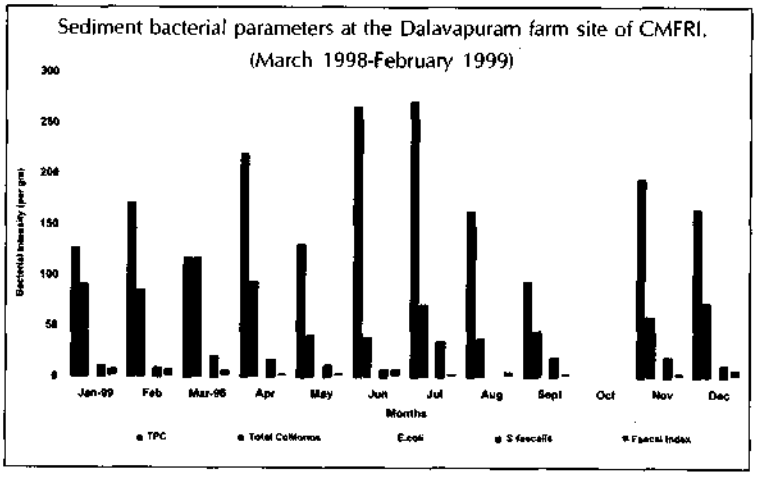
E.coli (type I) was confirmed by IMVIC tests. Greater percentage of *E.coli* were found in shellfish farming sites than the estuary or

Serratia marcescense* - Strains of *Serratia* are human pathogen produce a red cellular pigment, *Prodigiocin



faecal coliform, faecal streptococci and fungi occurred in premonsoon and monsoon months. There appeared to be little relationship between the season and the occurrence of peak bacterial indicators. As a result, no typical pattern on occurrence and seasonal distribution of indicator and heterotrophic bacteria could be established.

run off waters of farm samples. In both the estuary and the farm sites, all faecal coliforms belonged to *E.coli* (type I) based on IMVIC tests (+ + –). Maximum faecal streptococcus and fungal densities occurred during monsoon months while the highest concentration of total coliform and *P.fluorescnec* occurred after the commencement of monsoon. Coliform isolates from the observations showed the following percentage distribution pattern. *Aeromonas* sp. 50%, *Klebsiella* sp 35% and *E.coli* 25% (Type I). Maximum concentration of total coliform,



Water treatment procedures to disinfect specific portion for removing health hazards are not advisable, as there was no predictable pattern of pathogen occurrence.

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

K.G.Girijavallabhan, C.P.Gopinathan, P.Kaladharan, T.S.Naomi, Rani Mary George, S.Jasmine, Molly Varghese, Reeta Jayasankar, M.Rajagopalan, P.T.Sarada, K.Vijayakumaran, D.Sivalingam and D.Kandasamy

During the period under report, the project work was carried out at Kochi and at different Research Centres and the details are given below.

Kochi

Eleven species of microalgae were maintained at the Algology laboratory as pure and stock culture. Utilizing the inoculum of these stock cultures, mass culture of required species of microalgae were carriedout at the marine hatchery (TTC) at the HQ, FHL Thoppumpady, KVK Narakkal, Vizhinjam and Calicut and cultures were supplied to the local shrimp farms. These were fed as live feed for zooplankters such as Rotifers and Cladocerans and for rearing the larvae of molluscs, crustaceans and finfishes.

Dry *Gracilaria edulis* pulverised and sieved through a 60 µ size sieve in fine powder form was fed to adult mussels at a level of 2 g/lit. The rate of feeding was calculated by hourly measurement of turbidity in water through nephlometer. The results indicated gradual rate of filter feeding by the organisms. The preliminary study indicated the possibility of feeding bivalves with powdered seaweed samples.

At the Fisheries Harbour Laboratory (FHL), effluent from clam culture was used for mass culture of *Chlorella* sp. (instead of fertilizer application) and the results obtained were encouraging. Procedure has been standardized for estimation of available chlorine from bleaching powder, sodium hypochlorite solution as well as culture water. Also preliminary trials for the level of chlorine to tolerance of *Nannochloropsis* has been initiated.

At the FHL, mass culture of *Brachionus rotundiformis* was maintained successfully using the live feed organisms *Nannochloropsis* sp. and yeast cultured. This *Brachionus* thus cultured were used as feed for the larvae of groupers spawned at the laboratory.

At the KVK Narakkal also facilities for pure cultures of *Chlorella, Nannochloropsis, Chaetoceros and Isochrysis* were developed and repeated subculture and mass culture of these live feed organisms are being carried out.

Minicoy

Culture of *Chaetoceros, Tetraselmis, Isochrysis* and marine as well as freshwater *Chlorella* were undertaken. Water samples were collected from lagoon and offshore waters and *Losanoides* sp. and *Ceratium* sp. were isolated and maintained in culture. Culture of rotifer and *Moina* sp. was carried out using *Chlorella* as feed.

Vizhinjam

Mass culture of *Chlorella, Isochrysis,*

Nannochloropsis, Tetraselmis, Chaetoceros and Pavlova were carried out and stock cultures were maintained under laboratory conditions. Cultures of rotifer was maintained in the laboratory using *Chlorella* and *Isochrysis* as their live feed. Stock cultures of Cladocerans, Moina and Copepod were also maintained in the laboratory.

Tuticorin

Fine paste of *Sargassum* sieved through 40 μ mesh was incorporated in the artificial feed prepared for feeding larvae of sea cucumbers. For rearing larvae of cuttlefishes, cultured *Artemia* were used as live feed.

Mandapam

The mass culture of zooplankton *Brachionus plicatilis, Moina* and *Artemia* were maintained to feed the various stages of crustaceans and finfish larvae. *Artemia salina* was cultured using hyper-saline species of *Chlorella* being cultured in the laboratory as feed organisms.

Visakhapatanam

Gammarid amphipods and polychaetes culture were undertaken to use them as live-feed for larvae and broodstock of fishes, crustaceans and molluscs grown in hatcheries.

CONSERVATION OF MARINE TURTLES
(FEM/MT/1)

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

During March the mass nesting or *arribada* of Olive ridley *Lepidochelys olivacea* occurred along the Orissa Coast after a failure of mass nesting during 1997 and 1998 season. A total number of 3.4 lakhs of Olive ridley nested during 1999 season along Gahirmatha, Rushikulya and Devi River mouth area, Orissa.

With regard to incidental mortality of sea turtles, 9047 dead Olive ridley turtles were noticed during the season along the coastal districts of Balasore (3343), Cuttack (3882), Puri (1671) and Ganjam (151).

During January 2000 as requested by the Administration of the Union Territory of Lakshadweep the Principal Investigator visited several Islands in the region for site selection and establishment of "Sea turtle Park".

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

D.B. James and P.S. Asha

During the year 21 numbers of sea cucumber *Holothuria scabra* were observed to have spawned on three occasions. First was after a thermal stimulation trial on 16.5.99 and

auricularia larvae were estimated as three lakhs, second on 24.3.99 and third on 12.4.99 were spontaneous and auricularia produced were 2.4 and 2.6 lakhs respectively. The larvae maintained well in separate concrete tanks were fed with *Isochrysis galbana* (2 million cells/ml). Doliolaria larvae could be observed within 12-13 days after spawning.

Fine paste of *Sargassum* seaweed filtered through 40 μ seive was introduced into the larval rearing tank for inducing the larvae to settle. Settled Pentactulae could be observed within 17-18 days. Due to the predators attack, and also due to the absence of suitable feed, the settled pentactulae could not be maintained and the experiment was terminated. The brood stocks were maintained for their next spawning season during March-May 2000 in separate tanks by changing the water daily, sand every week and were given 5g of artificial feed prepared from rice bran (24g), soya bean powder (3g), and *Sargassum* powder (20g) on an experimental basis. Ten numbers in separate one ton tank for inducing them to mature by exposing to fixed photoperiod (5.30L:18.30D) were also continued.

For inducing the sea cucumber larvae to settle, an experiment for the culture of periphytic diatoms was started in the hatchery from November 1999 onwards. Light penetration was controlled by keeping a netlon mesh over the tank. Nutrients like Ammonium sulphate (16g), Superphosphate (3.2g), Sodium silicate (1.056 g) and micro nutrients (16ml) were added to the water. Every five days the plates were taken out and washed gently to remove larger diatoms.

Three numbers of sea cucumbers, collected from the Hare Island, and one from Vellapatti were identified as *Holothuria impatiens*, *H.moebii*, *H.cineracens* and *H.leucospilota* respectively.

ULTRASTRUCTURAL STUDIES OF MARINE ORGANISMS (CMFRI/IDP/EM/1)

K. Rengarajan, K.C. George, P.C.Thomas, N.Sridhar, N.K. Sanil and K.S. Sobhana

To understand the ultrastructure of the immune cells of *Tilapia mossambicus*, hemopoietic tissues (anterior kidney and spleen) of the fishes were processed, blocks were prepared, ultrathin sections taken and observed under Transmission electron microscope.

The anterior kidney contained various developmental stages of erythrocytes, lymphocytes and monocytes. Phagocytic monocytes were identified by injecting colloidal carbon to the fishes before sacrificing the fishes. Due to the non-availability of plate film we could not record the pictures.

VII. PHYSIOLOGY, NUTRITION AND PATHOLOGY DIVISION

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

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

Feed Biotechnology

The isolation of putative probionts from the digestive tracts of both juvenile and adult *Penaeus indicus* was carried out . Specimens collected from Narakkal were transported to the laboratory and maintained for a week on a control diet . After starving for a day the guts were excised under strictly asceptic conditions . The guts of five juvenile shrimp and three adult shrimp were pooled and homogenised and plated onto ZoBells marine agar after serial dilution and incubated at room temperature (28±2°C) . After 48 hrs the developed colonies were isolated, counted and their biochemical characteristics studied.

The different species of bacteria isolated from the gut of adult and juvenile *Penaeus indicus* (Averages of six samples data)

Groups	% of total bacterial flora
Pseudomonas	6.43 - 18.36
Moraxella	10.52 - 15:50
Micrococcus	36.45 - 40.38
Alcaligenes	8.56 - 20.34
Enterobacteriaceae	2.50 - 4.80
Acinetobacter	25.00 - 48.33
Flavobacterium	0.00 - 10.46
Vibrio	0.00 - 2.63
Unidentified	7.89 - 20.83

Acinetobacter (25 – 48.4 %) and *Micrococcus* (36.5 – 40.4%) were the predominant colonies in all the specimens examined. *Pseudomonas , Bacilli* and *Moraxella* were the next dominant groups and were observed in all shrimp specimens examined. *Vibrio* was present only in two of the examined specimens.

The biochemical characteristics of these strains were studied and they were tested for antagonism against three strains of common fish pathogens *viz. Vibrio harveyi, V. alginolyticus* and *Salmonella typhimurium*. Of the eleven strains tested for antagonism only four strains, namely MC 11- (*Micrococcus*) BS2 - (*Bacillus*), PS 10 – (*Pseudomonas*) and PS 13 - *Pseudomonas* recorded maximum antagonism to the three pathogens in the form of clear zones around the periphery. In order to test their suitability for incorporation into feeds as probionts , 0.1 ml inoculums of each containing 10^6 cells/ ml were injected as intra-peritoneal injections into *P. indicus* averaging 2.68 ± 0.234g and observed for a period of fourteen days. The animals injected with BS 2 showed necrosis at the site of injection and accompanied with heavy mortality and therefore was discarded .The other three groups were selected for the feeding experiments.

After accumulation of biomass the bacterial cells of these strains were coated on to compounded feed pellets as a suspension mixed with an equal volume of a lipid oraliser to achieve a dose of 5×10^2 bacterial cells / g of feed and fed *to P. indicus* juveniles averaging 0.8793 ± 0.0089 g in weight and 5.936 ± 0.0127 cm in length for a period of 45 days .The shrimp fed on the three putative probiont incorporated feeds P 1 , P 2 and P 3 recorded weight gains of 0.9969g , 0.7956g and 1.1183g respectively with corresponding specific growth rates (SGR's) of 2.21, 1.77 and 2.49. The weight gain of the control group of shrimps fed with a feed coated with oil devoid of bacterial cells was 0.2403 g and corresponded to a SGR of 0.534 . Survival in the three experimental groups was above 85 % compared to 70 % in the control group; the results of the study convincingly proved the beneficial effects of gut probionts in shrimp feeds. Colonization of the orally administered probionts in the gut was confirmed in the experimental animals by plating the asceptically homogenised guts onto Tryptone Soya Agar (TSA) plates wherein high counts of 6.8×10^6, 7.2×10^6 and 3.4×10^6 CFU / shrimp were obtained.

Macronutrient interactions in *Penaeus indicus*

Semipurified diets containing 35%, 40% and 45% protein and 6%, 9% and 12% lipids at each of the aforementioned protein levels were evaluated in three size groups of shrimps ($\leq$ 1g, > 1g but $\leq$ 5 g and > 5g but $\leq$ 10g) in a 3x3 factorial experiment. Results indicated that in shrimps of $\leq$ 1 g, a progressive increase was evident in all the nutritional parameters tested. An optimum level in this size group could not be discerned. The diet with 45% protein and 12% lipids performed the best. This result is under revalidation with higher nutrient levels.

In shrimps of > 1g but $\leq$ 5 g size, 40% protein and 9% lipids showed the best response. But in specimens of > 5g but $\leq$ 10g a further decline to the level of 35% protein and 6% lipids was observed. Decline in the requirements of these macronutrients as growth progresses could be clearly depicted.

Levels of protein and energy required in combination and protein sparing at the expense of non-protein dietary constituents; primarily carbohydrates and lipids subsequently is being examined in a more comprehensive and elaborate manner.

Lipid quality

In order to determine the quality changes occuring in the lipids during storage, the iodine number, which reflects the degree of unsaturation, has been determined. The iodine number of oils tested so far were shark liver oil 126, sunflower oil 57.6 and coconut oil 10.08. No significant difference in iodine no. was observed between crude shark liver oil stored with the addition of anti-oxidant and that of control. Experiments using safflower oil, groundnut oil, mustard oil, soyabean oil and sunflower oil are in progress.

Effect of dietary carotenoids in lobster nutrition

Experiments have been initiated to test the effect of carotenoids as supplements and as natural feeds on the colouration of spiny lobsters at Chennai.

Grouper nutrition

Growth and feed conversion ratio of groupers maintained in captivity at Mandapam is being regularly monitored

Pearl oyster nutrition

Based on the results of the earlier studies an experiment was conducted to evaluate the growth rates in pearl oyster spat of two different groups; 10-14 mm (set A) and 15-19 mm (set B) length. The oysters were fed with *Chaetoceros* spp. and the cell concentration was fixed as 6, 9, 12 and 15 lakh cells/spat/day. In set A maximum growth increment was found in the group fed with 6 lakh cells/spat/day. The weight gain in the group fed with 6 lakh cells was 0.0626g. Maximum growth increment in set B was observed in the group fed with 9 lakh cells/spat/day; the weight gain was 0.0678g.

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

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

Salinity tolerance studies were conducted with edible oyster *Crassostrea madrasensis*. Oysters of 35 – 45 mm size were exposed to different salinities ranging from 5 – 45 ppt. at 30 $\pm$ 1°C for 60 days. The highest mean survival of 80% was observed in 20 and 25 ppt salinities. The oysters exposed to 10, 30 and 35 ppt showed 60% survival. The maximum weight gain of 6 % was observed for the oyster kept in 20 and 25 ppt salinities while low weight gain of 1.7% was noticed in specimens exposed to 5 and 45 ppt salinities.

Methods for haemolymph collection for biochemical and immunological studies are being standardised for taking up further work.

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

M.Vijayakumaran, R. Paul Raj, A.P.Lipton, N.K.Sanil S.R.Krupesha Sharma and Preetha Panicker

Phagocytosis in the spiny lobsters

Phagocytosis in the lobsters *Panulirus homarus* was estimated by counting the number of haemocytes containing particles of carbon. Cells incubated at room temperature did not reveal any phagocytic changes in haemocytes whereas, 62% of the haemocytes incubated at 25°C revealed the presence of carbon particles within their cytoplasm. No ingested particles of carbon could be observed in granulocytes.

Mast cells of teleosts

The mast cells in fish play an important role in inflammatory reactions. Distribution of mast cells and their staining properties were studied in finfish by selecting tilapia as a model.

No mast cells could be detected in histological sections of gills, dermis, intestine and stomach. Impression smears of peritoneum revealed large numbers of conspicuously stained mast cells with stained metachromatic granules.

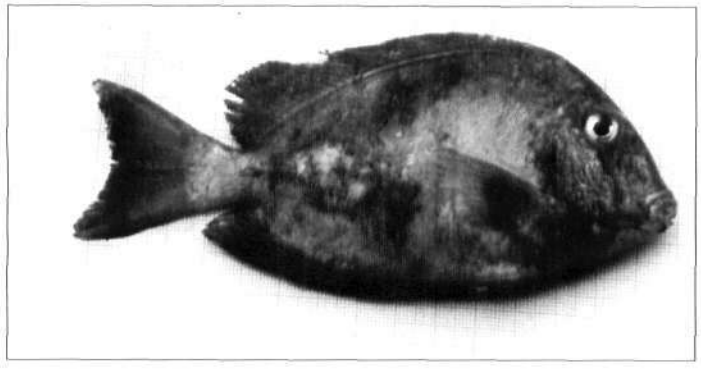
Bacterial diseases caused by *Vibrio, Pseudomonas, Alcaligens* and *Cytophaga* were recorded in ornamental fishes belonging to Acanthuridae, Pomocentridae and Chaetodontidae maintained in the marine aquarium, Vizhinjam. The symptoms observed were ulcerative haemorrhages, fin and tail rot and erythemia. Most of the bacterial isolates were sensitive to neomycin, kanamycin, pencillin and oxytetracycline. Higher bacterial load ($5.0x10^3$ and $1.6x10^4$) in the aquarium water could be correlated with the occurrence of ulcerative lesions and associated mortality. A very specific disease condition was observed in *Chaetodon collare*. This usually occurred immedieately after the fish was caught from the wild and brought to aquarium tanks. The fish appeared restless and showed upside down swimming behaviour. In two or three days lesions appeared on the abdomen and loss of scales were noticed and the fish died within 6-7 days.

Tail rot and fin rot were observed in *Amphiprion sebae* and *Abudefduf* spp. In advanced stage haemorrhages were observed on the dorsal fins and tail fin. Post-mortem examination did not reveal any significant changes in internal organs suggesting that the infection may be local and confined to external organs.

Diseases in shrimps and lobsters

Prevalence of white spot disease in commercial shrimp catches in Chennai fishing harbour was monitored. White spot occurred in 17 of the 21 species examined. The percentages of samples with white spot in some dominant species are as follows: *Metapenaeus dobsoni* 26.5% (n=1307), *M. monoceros* 69.3% (n=101), *M. moyebi* 80.4% (n=51), *Parapenaeopsis stylifera* 73.2% (n=153), *P. maxillipedo* 70.5% (n=283), *Penaeus indicus* 95.6% (n=45) and *Trachypenaeus pescadorensis* 100% (n=39). *M. ensis* was less affected by white spot.

In *Penaeus monodon* received from Kakinada soft shell and muscular opacity were observed. Low salinity, low pH and nutritional imbalance were considered as causative factors. Mortality in broodstock shrimp with



Ulcerative infection in the aquarium reared rabbit fish at Vizhinjam

red gills was observed in one of the hatcheries in Chennai.

The white spot shrimp disease was also reported from Kollam in Kerala. The average body weight of the infected/moribund/dead shrimp *P. monodon* was in the range 14-16 g. The infected shrimps had the characteristic white spots all over the carapace and body. The intestine was empty (anorexic). In some of the shrimps in addition to white spots exoskeletal erosions and bacterial infections were recorded. *Vibrio* spp. was found to be predominant among the bacterial strains isolated from moribund shrimps.

A red disease was recorded in the spiny lobster *Panulirus ornatus* in one of the lobster holding facilities in Chennai. Gram negative bacteria were observed in the smears of haemolymph and hepatopancreas of the diseased lobsters. Mortality of spiny lobsters due to copper toxicity was observed in one of the lobster holding centres in Chennai.

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

Manpal Sridhar, P.Vijayagopal and M. Peer Mohamed

The efficiency of high nutrient dense (HND) diets in promoting growth in larval *Penaeus indicus* was studied in a 45 day feeding trial. The results obtained prove the efficiency of HND diets in improving the growth performance of larval shrimps. Measurements of feed intake, waste output and quality of effluent were determined under field conditions using chemical methods as well as biological models. The results of the study (seven locations) by both methods were in close agreement and waste output could be predicted by their use. In commercial feeds where ingredients like fish meal with high P/N ratios are used, the total solid waste along with N and P are very high. The production of dissolved and solid waste can be minimised by keeping P/N ratios of ingredients of feed low.

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

P.C.Thomas

The DNA and protein fingerprint patterns of various strains of *Vibrio* spp. as well as other important pathogens like *Aeromonas salmonicida, A. hydrophila* and *Streptococci* were carried out. The antibiogram of the bacterial strains were prepared for correlating antibiotic sensitivity with plasmid and protein profile. The major findings are that

- The plasmid DNA profiles of the four *Vibrio* spp. studied were distinctly

different from each other. The antibiogram also showed variations

- The two species of *Aeromonas* also showed marked differences in their plasmid DNA profile and antibiogram
- The four *Streptococci* isolates from diseased fishes showed considerable differences in their plasmid DNA profile with respect to number and molecular size, and the antibiogram.

RAPD pattern

The RAPD pattern of two *Vibrio* spp. using the operon primer revealed species specific DNA fingerprint pattern.

Cellular protein profile

Intracellular protein profiles as resolved by SDS-PAGE in the two *Aeromonas* spp. were distinctly different and bring to light a high level of protein polymorphism that could be directly used as fingerprint.

POPULATION GENETIC STUDIES IN *RASTRELLIGER KANAGURTA, SARDINELLA LONGICEPS* AND *PENAEUS INDICUS*

(PNP/49)

P.C.Thomas and P.Jayasankar

Of the three methodologies envisaged for evaluating the Indian mackerel to ascertain whether it is a unitary stock with genetic homogeneity, the morphometric analysis of the samples from different landing sites (Ambalapuzha, Chavakkad, Kochi, Mangalore, Neendakara and Vasco – Goa) were carried out. The principal component scores calculated for body size and shape for samples from Ambalapuzha, Chavakkad and Kochi (PC I and PC II) respectively from 33 Eigen vector values were plotted on graphs to study clustering. While the variations in PC I score for body size were significant among three locations ($P < 0.001$) that of PC II for body shape was not significant.

INDUCED MATURATION OF GROUPERS

(PNP/50)

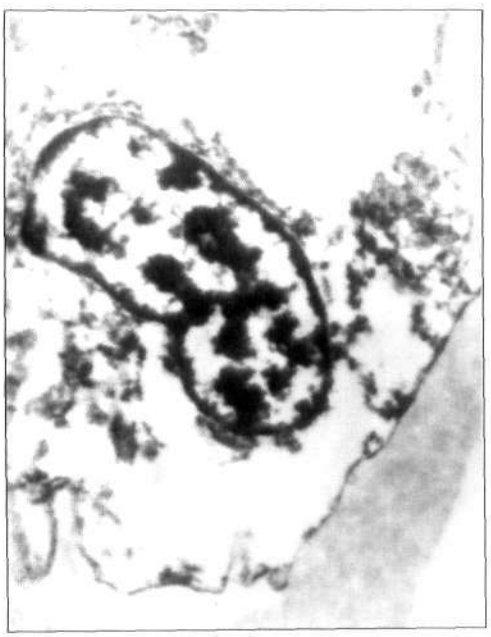
M. Peer Mohamed, N.Sridhar, Manpal Sridhar and D.Noble

Studies on the enzyme profile of groupers were carried out to formulate feeds for them. High activities of trypsin, acid proteases, chymotrypsin and aminopeptidases were recorded in all the samples analysed as compared to other proteolytic enzymes. Smaller specimens exhibited higher specific activities compared to larger specimens. The fore-gut region recorded higher proteolytic activitiy *per se* than the midgut while, very low activities were recorded in the hind-gut regions. Results indicate higher protein requirements of younger animals compared to older ones. A reverse trend was observed in the case of carbohydrases.

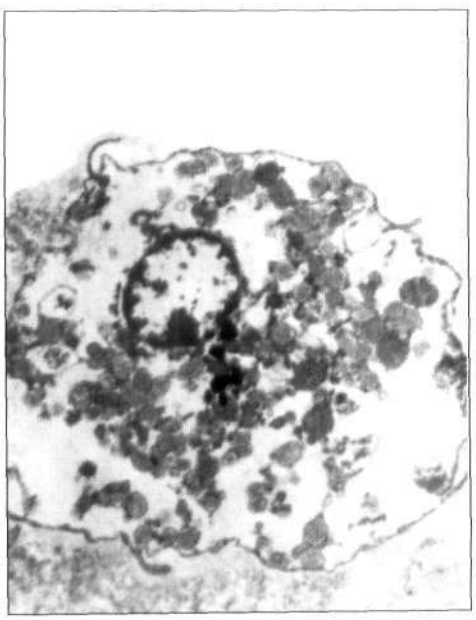
STUDIES ON THE EFFECT OF TOXINS, POLLUTANTS AND PROBIOTICS ON FISH HEALTH WITH SPECIAL REFERENCE TO IMMUNE SYSTEMS (PNP/52)

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

Various aspects of fish immune response were studied using tilapia as a model. In order to understand the dynamics of suppression of inflammatory responses in normal and immunosuppressed tilapia, two sets of experiments were conducted using Freund's complete adjuvant (FCA) and phytohaemoagglutinin (PHA). Thymus mediated cell response was induced by PHA. Histological and electron microscopic studies are in progress.



Electron micrograph of hyalinocyte type haemocyte from *Crassostrea madrasensis* (15000 x) - Granules are scanty



Electron micrograph of granulocyte type haemocyte from *Crassostrea madrasensis* (10000x) - note the large number of vesicular structures in the cytoplasm.

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

N.Sridhar, P.Kaladharan, P.A.Thomas, G.P.Kumaraswamy Achary, K.G.Girijavallabhan and A.P.Lipton

A total of 265 specimens were identified during the year, of which, 210 were sponges,

54 gorgonids and 1 alcyonarian .

Methanolic extracts of six species of sponges namely *Myrmekioderma granulata, Irinica fusca, Spirastrella inconstans* var. *digitata, S. inconstrans* var. *moendrina, Trachyopsis halichondroides* and *Psamma plysilla – purpurea* collected from Rameswaram were prepared.

The efficacy of crude GABA extracted from red seaweed collected from Vizhinjam in promoting settlement of mussel larvae (pediveliger stage) was compared with the commercial grade GABA obtained from Sigma Chemical Co., USA. The crude extract (10 and 15 ppm levels) enabled settlement of 50% of the larvae as against 100% settlement in 10 ppm and 83.3% in 15 ppm GABA from Sigma. In the control without GABA the settlement was 20.7%.

Extracts in methanol of sponges collected from Rameswaram and two species of ascidians (*Clathrina criaceae* and *Haliclona* spp.) from Vizhnjam were concentrated by flash evapouration. The extracts were sent for obtaining their IR spectrum for exploring the possibility of identifying the compounds.

Sea horses collected from Colachal, Chinnamuttom and Mulloorthurai areas along the Kanyakumari coast were shade dried and crude aqueous and the methanolic extracts prepared were subjected to screening for antibiotic and other bioactivity studies. No antibiotic activity was recorded.

VIII. SOCIO-ECONOMIC EVALUATION AND TECHNOLOGY TRANSFER DIVISION

During 1999-2000 four research projects, 3 in extension and one in economics were taken up and the achievements under each projects are presented below. In addition to research projects the Division has accomplished various tasks such as conducting exhibitions, organising regular interactions with fishermen community, engaging the visitors by taking them to various divisions and explaining the activities and highlighting the technological advancements made by the Institute with photographic and other audio/ video programmes.

A view of the CMFRI pavilion in the Millenneum Expo exhibition organised by St. Thomas College, Palai during 1 to 10 Jan. 2000

EMPOWERMENT OF COASTAL COMMUNITIES THROUGH FISHERIES EXTENSION (FE & E/31)

Sheela Immanuel and S. Ashaletha

The adopted villages Panambukad and Elankunnapuzha in Ernakulam district, Kerala were supported by transfer of prawn and finfish culture technologies with financial support from the District Administration. Thirty beneficiaries were motivated to take up scientific prawn culture at Panambukad with financial aid of Rs.10,000 each. The size of ponds varied from 10 to 20 cents and 5000 seeds of *Penaeus monodon* were supplied to each farmer. *Mahima* feed of CMFRI was supplemented along with indigenous farm-made feeds by the farmers. The cultured prawns will be harvested during April 2000 and an yield of about 70-80kg with gross revenue of Rs. 17,500 per farmer is expected.

The composite culture of finfishes and prawns was taken up in Elankunnapuzha. Twenty motivated farmers were offered

training in finfish culture. The pond size ranged from 10-20 cents. Each farmer was supplied with 400 mullets, 200 prawns and 200 pearl spot (*Etroplus suratensis*) and the culture period extended for about one year. *Mahima* feed was applied and growth was monitored. The harvest is expected during August 2000.

The participatory approach fostered with motivation, demonstration and regular field visits showed good results. Voluntary involvement of people and exposure to scientific methodologies created confidence in the farming community to adopt proven technologies in their own ponds.

Extension Education programmes have been accorded top priority for empowerment of fisherfolks in the Chittoor area. Adequate awareness has been created for initiating group farming activities in prawn culture and the District administration has allotted Rs.2 lakhs for this venture.

Self help group

It is proposed to organize three self-groups at the Panambukad village consisting of 20 women in each group and already awareness programme was organized with the help of NABARD.

Fish Processing Unit

The fish processing unit set up at Kandakadavu is progressing well and fresh fish brought from the landing centre is processed and marketed through retail shops.

***Mahima* Feed Unit at Valappu**

Building construction work for the feed unit was completed. Action has been initiated for installation of machineries and other accessories.

Fishermen-Farmers-Industry-Institution Meet

The meetings facilitated to develop good linkages between the scientists and the farmers and also provided opportunities for interaction of the researchers and farmers. These meets created tremendous awareness among the fisherfolks about the several existing technologies developed by the Institute. During the year 1999-2000, seven monthly Fishermen-Farmers-Industry-Institution Meets were organised in different villages.

Training for fisherwomen on value added products.

INTEGRATION OF SMALL SCALE MARICULTURE WITH SMALL SCALE FISHERIES ALONG THE PENINSULAR INDIA

(FE&E/32)

A.Regunathan, N. Kaliaperumal, P. Jayasankar, A.C.C. Victor, D. Sivalingam, M. Vijayakumaran, G. Syda Rao, G. Mohanraj, K. Vijayakumar, S. Krishna Pillai, Sheela Immanuel, K.K. Appukuttan, P. Kaladharan, C. Muthiah, Prathibha Rohit, Arpita Sharma, K.K. Philipose and I. Jagadis

A survey was conducted along Cuddalore and Pondicherry Coasts to assess the availability of green mussel seed. The mussel seeds from Pondicherry were transported to Thiruchendur to propagate the mussel culture technology to a group of 24 farmers drawn from Manapad, Amalipuram and Jeeva Nagar along Thiruchendur coast. The seeds which sustained the transport stress were found to fall under class intervals of 5mm width. The growth was monitored by the divisional staff. It was found that the mussels slipped off from the rope. But the seeds have attained a size range of 20-65mm indicating an average growth of 15 mm for a period of two months recording an average growth of 7.5mm/month. A meeting of the farmers was organised to appraise the feasibility of open sea green mussel culture. A convinced fishermen group is attempting to practice mussel culture in Thiruchendur.

The development of small scale fisheries is highly dependent on the effective fish marketing system. In Chennai region, varieties having high consumer preference are not only receiving comparatively high prices but also maintain less inter-seasonal variations. The primary, wholesale and retail marketing prices of all commercially important varieties of fish have been collected and the marketing margins are being worked out.

In Mumbai region, fisherwomen play a major role in fish marketing activities. The comprehensive study on the problems faced by the fisherwomen in marketing reveals that the arrival of the buyers at retail market declined due to improvement in door to door supply of fish by vendors. It is proposed to conduct a monthly meet to motivate the fisherwomen to organize fisherwomen cooperatives among themselves and thus eliminate the existing ills of fish marketing.

Mussel culture farm at Mulki estuary, Dakshina Kannada District, Karnataka

RESOURCE MANAGEMENT AND SOCIO-ECONOMIC SURVEY OF SMALL SCALE FISHERIES IN LAKSHADWEEP ISLAND AND KERALA
(FE&E/33)

R. Narayanakumar A.K.V. Nasser and M. Sivadas

The Socio-economic data from the 10 villages of the Minicoy Island have been collected through household survey. A total of 570 households were surveyed. The family size of the household ranged from 6-25 because of the joint family system. About 44% of the population surveyed were literate. Out of the literate population about 40 per cent have studied up to the middle school. The total work force accounted for 21% of the population. Out of the total work force in the island about 25-30 percent were involved in fishing activities, 27-30 percent in fishery related activities and 10 percent in government services. From each family at least one person is employed as seamen in foreign cargo ships. In fishery related activities, fish processing is the major activity where cent per cent women participation was observed. The annual household income ranged from Rs. 30,000 to Rs. 2.5 lakhs where the major contribution has been from family members working as seamen. The annual household expenditure ranged from Rs. 9,000 to Rs. 72,000 depending on their family size and income.

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

Arpita Sharma

To evaluate the physiological workload the 'Heart rate' parameter was recorded. Half hourly Heart rate from 7.00 A.M. to 11.00 A.M. were noted while the women peeler performed her work. It was found that average resting heart rate was 75 beats per minute. Average recovery heart rate was 78 beats per minute. With the increase in the time of the day the heart rate showed a linear increase. Productivity showed decline with increase in the time of the day.

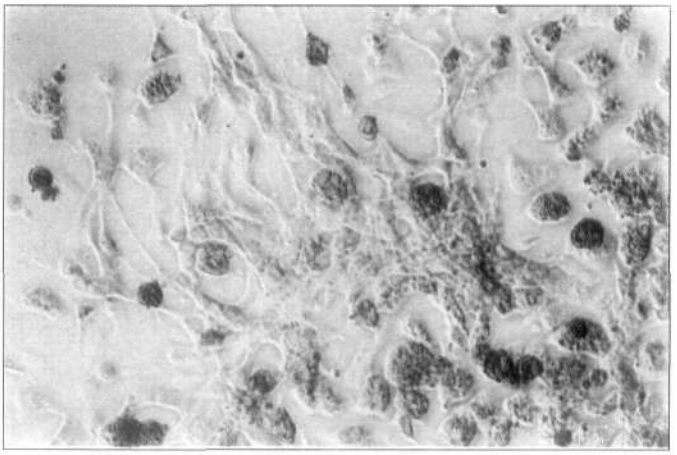
IX. SPONSORED PROJECTS

TISSUE CULTURE IN PEARL OYSTER

(Funded by : DBT)

S. Dharmaraj

Remarkable progress was achieved in organ culture of abalone mantle tissue where formation of nacreous layer over a bead was obtained. In the implant culture of pearl oyster mantle tissue, good proliferation of cells, formation of beautiful network of reticulum, filling of interspaces with organic matrix had taken place. This is an initial successful step towards the formation of pearl sac. Cell division was prolific in the *in vitro* culture. The excess cells thus obtained were further preserved for studying the cell revival, cell viability and total cells released.



Dessociating cells - produced through Tissue culture

Experiments on comparison of mantle cells in *in-vitro* and *in-vivo* cultures were conducted. The mantle cells were identified in both the cases except the presence of fibroblast cells in *in-vitro* culture.

Effect of cells from gonad tissue, hepatopancreas and cerebral ganglion in combination with mantle cells and the effect of whole body extract, gonad extract, hepatopancreas extract were also studied.

COMMERCIAL PROPAGATION OF MARINE PEARLS ADOPTING ONSHORE CULTURE TECHNOLOGY

(Funded by : ICAR)

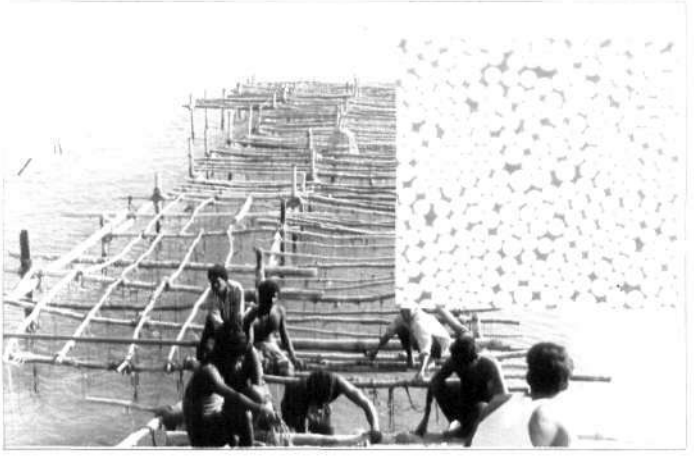
A.C.C. Victor, A. Chellam, D. Kandasamy and I. Jagadis

Maintenance and culture of mother oyster and spat under farm condition: Nearly 1,75,000 oysters of size ranging from 20-40 mm were collected from Tuticorin and transported to Mandapam by adopting the 'dry method'. The oysters were stocked in differ-

Particulars	Size (mm)	Nos.	Value (Rs)	Agency
Mother oysters	30-40	10,000	40,000	M/s.Indian Tropical Agro. Tuticorin
Spat	3-5	50,000	52,500	M/s.Orki Aqua., Mandapam
Spat/M.O.	Assorted		3,50,000	M/s.P.B. Hatchery, Visakhapatnam
Pearls	Assorted		1,75,455	Individuals
Total			6,17,955	

ent type of cages and hapas suspended from the rack system in the Gulf of Mannar. Periodical thinning and cleaning were carried out.

A stock of 5 lakh hatchery produced spat (less than 10 mm) also maintained in the farm. Regular spawnings were carried out and about 1 million spat (0.5 mm) settled in the hatchery during the year, of which 4.8 lakh (3-7 mm) were transplanted to the farm for further rearing. Spat recovery was found to be comparatively good during June-September. A total of 58,690 oysters were implanted with 3 mm (9978 nos.), 4 mm (47457 nos.) and 5 mm (1255 nos.) shell bead nucleus and transplanted to open sea for culture. The present stock of 41,192 nucleated oysters are under different stages of rearing. During the period 23,320 surviving oysters (65.7%) out of the 35,520 oysters implanted earlier were harvested. A yield of 7081 pearls of different commercial grade pearls ('A' grade: 1183 nos., 'B' grade: 1399 nos., 'C' grade: 4499 nos.) were obtained accounting for 20% of nucleated oysters. Sale of hatchery produced spat, mother oysters and pearls under this project realised Rs. 6.18 lakh and the details are given in the table.



Commercial pearl oyster farm in the open sea in the Gulf of Mannar, Mandapam - cultured pearls (inset)

Pearl Sales Mela at Kochi: The pearls (A, B & C grades) worth Rs.70,000 produced through the ICAR Revolving Fund Project were sold through a Pearl Sales Mela organised at Cochin on 11-12 May, 1999.

A stock of 7906

numbers of A, B & C grades of pearls is available for sale at the Mandapam Research Centre of CMFRI produced through the ICAR Revolving Fund Project.

PRODUCTION OF SEED AND PEARLS OF BLACK-LIP PEARL OYSTER, *PINCTADA MARGARITIFERA* IN ONSHORE TANKS

(Funded by : DBT)

A. Chellam

Two attempts were made to transport and transplant the black-lip pearl oyster, *Pinctada margaritifera* from Andaman waters. In May 81 oysters were collected, airlifted to Chennai, transported by train and transplanted to Tuticorin waters. They were reared at 4 different conditions, in the hatchery, in the farm inside the harbour, open bay and in a channel where a flow of sea water is available. Total mortality was observed in all the 4 places after 20 days. In the second attempt, 74 oysters were collected and transported during October. The initial mortality was heavy and 55 oysters survived. 25 oysters were transported to Mandapam Regional Centre and kept under running water system. 20 oysters were kept in the hatchery of Tuticorin Research Centre under controlled temperature (24-26 °C) and salinity at 30 ppt. Another 10 oysters were kept in 1 t FRP tank in the normal condition. All the oysters died within 15 days. An attempt was made to implant 10 oysters with 4 and 5 mm nuclei but without success.

TISSUE CULTURE OF SOME ECONOMICALLY IMPORTANT SEAWEEDS

(Funded by: ICAR)

V.S.K. Chennubhotla

The modified ASP-12 medium was found suitable for induction of callus in *Sargassum vulgare* and *Gracilaria corticata* and vegetative thallus initiation on *G.verrucosa*. Maximum number of callii were formed in the modified ASP-12 medium containing 0.06 mg/l of IAA and 0.03 mg/l kinetin.

In vitro "shoot" formation occurred also in the `leaf' explant culture of *S. vulgare*. From the cut end about 15 to 18 numbers of primordia appeared from the young `leaf' explants of *S. vulgare*.

Callus of *Sargassum vulgare* growing on ASP-12-as (modified medium)

Regenerated plants from the explant of *S. Vulgare*

APPLICATION OF REMOTE SENSING TECHNIQUES TO MARINE FISHERIES

(Funded by : NRSA)

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

The collaborative research project to identify PFZ in the coastal waters was continued in collaboration with Space Application Centre, Ahmedabad. CMFRI Scientists and Technicians participated in the validation experiment conducted at Space Application Centre, Ahmedabad during different sessions.

Monthly/seasonal concurrent chlorophyll and SST imageries were generated from OCM and AVHRR data. Thermal and colour features were compared to understand the colour gradient, whether the two parameters co-exist, persistance of the colour front etc. Clustering technique based on image classification was also attempted to understand the relationship between two parameters

DISTRIBUTION, INCIDENTAL CATCH AND MORTALITY OF SEA TURTLES IN INDIAN WATERS

(Funded by: Department of Agriculture, Govt. of India)

M.Rajagopalan

Carried out studies on distribution, incidental catch, mortality of sea turtles in Indian waters and the efficacy of turtle excluder device (TED) at selected centres. Barring Gahirmatha along the Indian coast 3,190 and 2,605 turtles were incidentally caught by fishing gears during 1997 and 1998 respectively. Gill nets accounted for 60% of the catch and the trawl for 13% only. To reduce the mortality, two options namely closure of fishing during mass nesting period along Orissa and attachment of turtle excluder device (TED) to the trawl nets are suggested. The findings from the funded project will be helpful for the maritime Governments while formulating regulatory measures on fishing.

CONSERVATION OF GREEN TURTLE

(Funded by: ICAR)

M.Rajagopalan

Carried out detailed studies since 1998 along Tamil Nadu and Gujarat coasts with the assistance of the Senior Research Fellows. The results of the project will facilitate effective conservation and management of endangered green turtle population in the Indian seas.

LARGE SCALE CULTIVATION OF *GRACILARIA EDULIS* BY REPRODUCTIVE METHOD

(Funded by: ICAR)

Reeta Jayasankar

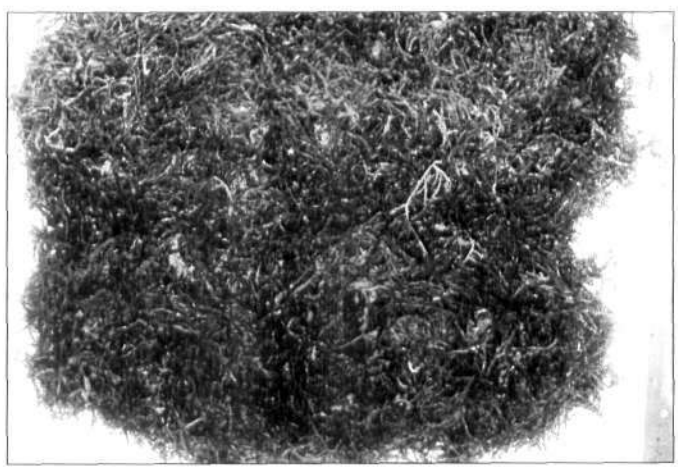
The project was sanctioned by the Indian Council of Agricultural Research for the duration of three years from 30.3.1999 to 29.3.2002.

Spore growth of different species of *Gracilaria*

Studies on spore output in *Gracilaria edulis, G.corticata* var.*cylindrica* and *G.follifera* were carried out to compare their growth. Glass beakers of 1 litre capacity were used for spore output study. The beakers were filled with dechlorinated seawater and the cystocarpic plants of these three species of *Gracilaria*, well rinsed, were held on the nylon net pieces dipped in the seawater, in individual beaker. Glass microslides were kept on the bottom of these beakers as substrata for spore output. After 24 hrs of spore liberation the slides were kept in Conway and Walne's medium for growth. Observations on the growth were made regularly under 10x X 40x magnification and the diameter of the spore were measured.

Cultivation of *G.edulis* from spores

Cystocarpic plants of *G.edulis* were brought from Vedalai, Mandapam of TamilNadu coast and set in 25 l capacity trough for spore output on polypropylene raphae wound on PVC frames. Spores were reared in the hatchery in enriched seawater medium before transplanting them to the natural environment. Sufficient aeration and light intensity were provided till the erect frond appeared on the raphae.



Fully grown plant of *Gracilaria edulis* grown from spores, harvested from the culture raft, off shore of Narakkal, Kochi

The raphae with spores attached on it were transplanted to sea in Gulf of Mannar near CMFRI jetty during November. Regular water analysis was carried out from the culture site. The raphae were transported to Kochi in a plastic bucket containing enriched seawater. One more raphae with germlings was sent to Vishakhapatnam RC of CMFRI to carry out the work there. One set of germlings was sent to Minicoy RC of CMFRI to carry out the

work in island. Another set of germlings was transplanted to Narakkal and transplanted in the raft of the mussel farm. Few reproductive plants and vegetative plants were also tied on perforated plastic bags and hung on the raft. Very good growth of naturally collected germlings was found along with the growing plants of 10-15 cm size. Approximately 1.5 kg of *G.edulis* was harvested from the site. Work is being continued there. One set of germlings was transplanted in Cochin backwater. The raphae is covered with silt deposit. Although viable germlings are still present on the raphae, they are unable to grow further. Two raphae with spores were transplanted to sea in February on a raft of 5X5m size. The raft is made up of bamboo poles tied by stone sinkers and floats. The work is being carried out with the help of local fisherfolk of Narakkal and with the cooperation of KVK.

Standarisation experiments were carried out to eliminate the ciliates in the spore output tanks using chlorine solution, ethanol, formalin, betadine and antibiotics mixture in various concentrations. However, 100% elimination could not be achieved.

TECHNOLOGY ASSESSED AND TRANSFERRED

Though oyster farming was successfully done in the farms of Institute's Research Centres, the actual momentum of technology adoption by the farmers was felt only during the past five to six years. Considering the wide variation in the different water systems, a programme on location testing and demonstration of oyster farming with farmer's involvement was started in 1993. High growth rates were obtained in most of the coastal regions and estuarine systems. The first commercial oyster farming area was developed in Ashtamudi Lake (Dalavapuram, Kollam) Kerala during 1995-96. This lake supports a wide range of bivalve fauna. The livelihood of more than 3000 villagers of this area is linked directly or indi-

Edible oyster farm at Dalavapuram, Kollam

rectly to this resource. By August 1996, more than 100 tonnes of full-grown oysters (*Crassostrea madrasensis*) were harvested. This motivated several farmers to adopt edible oyster farming leading to the establishment of a number of commercial oyster farms in this large estuarine system.

During 1999, the BFFDA gave financial assistance to 15 farmers of Kollam district to set up oyster farms. This confirms the fact that the end users and the planners have now recognized oyster culture developed by CMFRI as a viable project ideal for rural development and income generation.

Similarly, in other estuaries also the farming methods were demonstrated. In addition to creating awareness on the profitability of oyster farming, the demonstrations in the states of Karnataka, Tamil Nadu and Andhra Pradesh, gave valuable information on the spatfall, growth, and optimum period of harvest, etc. During June 1999 more than 200 oyster rens with 8000 spat were supplied to Fisheries Department, Tamil Nadu by the Shellfish Hatchery at Tuticorin. Though the level of technology adoption varied from place to place, the overall impact was acceptance of the farming method as a part time avocation for additional income to rural fishers.

EDUCATION AND TRAINING

POST-GRADUATE PROGRAMME IN MARICULTURE

Under the M.F.Sc. programme, the 16th batch comprising 10 students have successfully completed their course. At present 18 students are pursuing their M.F.Sc. studies.

Under the doctoral programme 2 students were awarded the Ph.D. degrees by Central Institute of Fisheries Education (CIFE). Results of two students who had completed all the requirements for Ph.D. degree are awaited from CIFE. Two students have submitted Ph.D. theses to the Cochin University of Science and Technology (CUSAT) for adjudication. At present 38 Ph.D. students registered under CIFE and 14 students registered under CUSAT are progressing well with their course/thesis work.

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KRISHI VIGYAN KENDRA

The Krishi Vigyan Kendra conducted 45 training programmes during 1999 and the details are given below:

Training programmes conducted during 1999

S.No.	Discipline/ Course	Duration (days)	No. of courses conducted	No. of persons trained			
				Male	Female	Total	SC
1.	Fisheries						
	a) Prawn farming	5	3	15	57	72	14
	b) Prawn farming	2	4	58	7	65	10
	c) Prawn farming	1	4	57	28	85	20
	d) Prawn seed stocking methods	1	1	14	-	14	4
	e) Mussel farming	2	1	21	-	21	3
	f) Mussel farming	1	2	14	11	25	6
	g) Seeding of mussel spat on ropes	1	2	13	15	28	18
	h) Ornamental fish culture	1	2	-	36	36	1
2.	**Agriculture/ Horticulture**						
	a) Vegetable cultivation	2	3	14	52	66	17
	b) Coconut nursery preparation and management	1	1	11	37	48	6
	c) Coconut cultivation	2	1	-	18	18	2
	d) Mushroom cultivation	1	3	60	71	131	34
	e) Mushroom cultivation	2	3	2	60	62	5
3.	**Home Science**						
	a) Fruit processing	1	1	-	6	6	1
	b) Fruit preservation	1	11	-	154	154	14
	c) Fruit preservation	2	1	-	30	30	-
	d) Tailoring and embroidery	5	1	-	11	11	8
	e) Tailoring	2	1	-	11	11	-
	TOTAL		45	279	604	883	160

Training programmes under the National Watershed development project

a) Two training programmes of 1 day duration on mushroom cultivation was conducted under the watershed development project in Narakkal and Elamkunnapuzha village. A total of 105 persons attended the training programme of which 45 were women.

b) One training programme of 1 day dura-

tion on Prawn farming was conducted and 35 persons were given training of which 15 were women.

c) Two/three days training programme for *Mitrakisans* from Ernakulam district was conducted from 5-7 and from 24-26 May 1999. 58 *Mitrakisan* from 16 watershed areas attended and the training programme was of an integrated nature covering topics in Agriculture, Animal husbandry, Fisheries and Home Science.

Frontline Demonstration

To demonstrate the feasibility of farming of mussels to the local fishermen, a raft was floated with ropes seeded with mussel spat near the KVK campus. Periodical observation and growth studies were made involving local fishermen. 40 ropes were harvested during February and 90 kg of mussel meat was obtained. The meat was sold at Rs. 70 per kg.

Extension Activities

a) KVK Narakkal has given training and technical guidance to the members of the *Matsya Vyapara Sahakarana Sangham*, Narakkal to do mussel farming (*Mytilus viridis*) in the sea off KVK campus by pole and raft method. The seeded ropes with mussel spats were tied during November, '99.

b) Training, technical guidance and project report was given to 4 fishermen in Narakkal village to get financial assistance from Narakkal Grama Panchayat to do mussel farming. A raft was floated in the sea off KVK campus and ropes seeded with mussel spat were tied during November, '99.

TRAINERS' TRAINING CENTRE

The Trainers' Training Centre (TTC) of the Institute has organised 9 short-term training courses and one workshop. The courses were conducted at Kochi, Kavaratti Island (Lakshadweep), Vallikkunnu Panchayat (Kozhikode), Mandapam Camp and Tuticorin. Rs. 51,000 was collected as course fee during the year.

Participants of the TTC training course on Seed production of Tiger prawn, conducted at Mandapam Regional centre of CMFRI

Participants of the TTC training course on Mussel farming, conducted at Vallikunnu, Kozhikode

Particulars of training programmes conducted by the TTC

Sl. No.	Title of the course	Duration (1999)	No. of courses conducted	No. of participants
1.	Application of Statistical methods in Fisheries Research	7- 27 January	1	10
2.	Seacucumber farming	16 –25 March	1	32
3.	Low-cost shrimp feed production	19-24 April	1	13
4.	Hatchery production and Aqua-culture of ornamental fishes	19-24 July	1	11
5.	Seed production of Tiger prawn, *Penaeus monodon*	16-30 August	1	6
6.	Mussel farming	14-15 &	2	18
		16-17 September		16
7.	Workshop on seaweed processing and seaweed products	16 September	1	70
8.	Seaweed culture and utilization	16-20 November	1	8
9.	Mud crab farming	13-18 December	1	15
	TOTAL		10	199

AWARDS AND RECOGNITIONS

The Institute won the *Rajbhasha rolling Trophy* (Ist position) from the Cochin TOLIC for the excellent Hindi implementation activities for the year 1999-2000.

Dr. K.C. George, Senior Scientist of the Institute received the Prof. Patri Rama Rao award for the best thesis of 1998 in Veterinary Pathology instituted by the Indian Association of Veterinary Pathologists for the thesis "Comparative pathology of afflatoxicosis in the duck and fish with special reference to the immune system".

Dr. G. Sudhakara Rao, Head of Division receiving the *Rajbhasha rolling trophy* from the Chairman, Cochin TOLIC for the best Hindi implementation programme for the year 1999.

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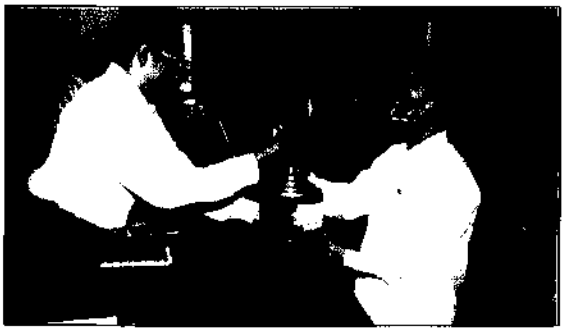

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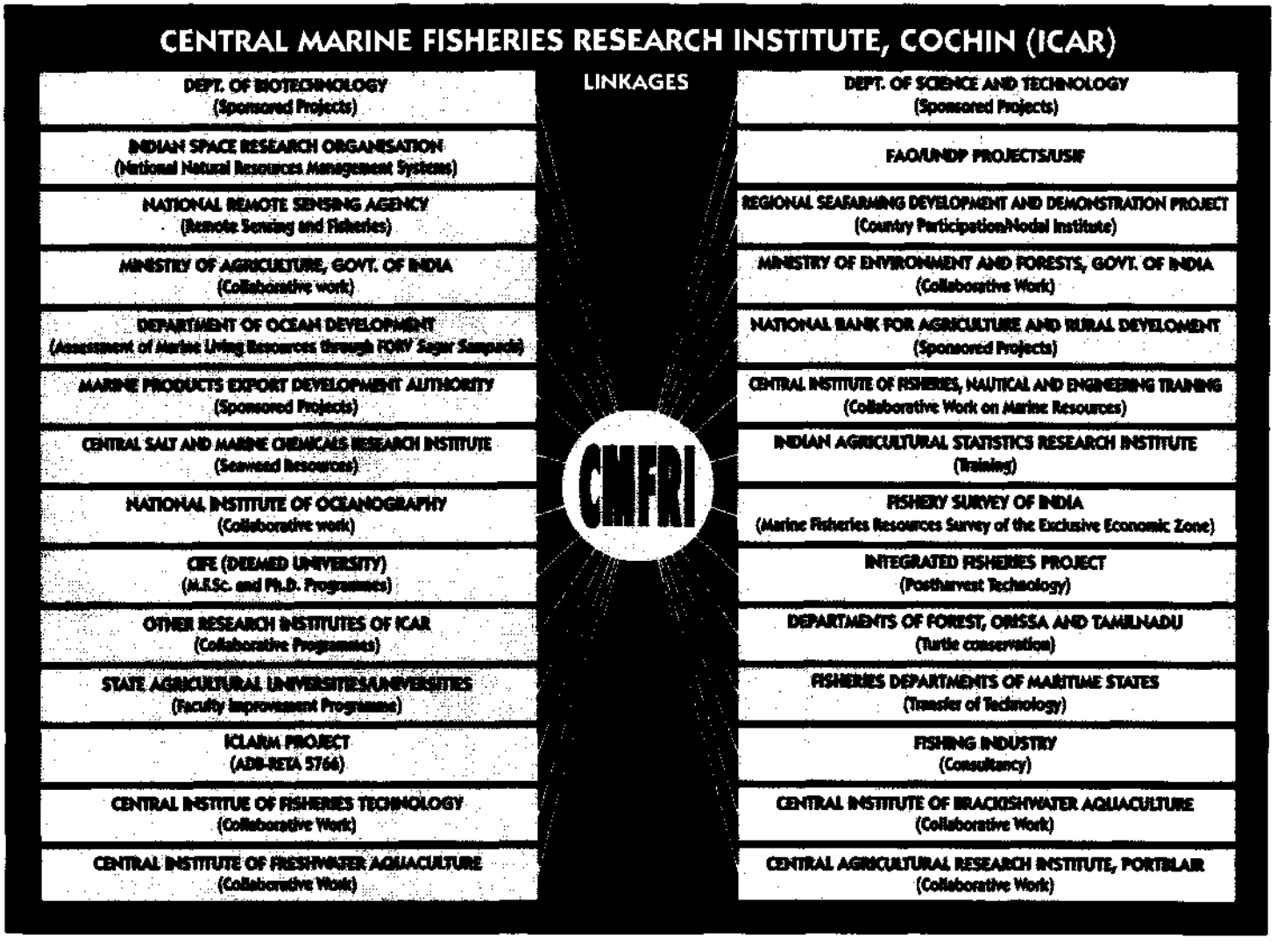
CENTRAL MARINE FISHERIES RESEARCH INSTITUTE, COCHIN (ICAR)
LINKAGES
CMFRI
DEPT. OF BIOTECHNOLOGY (Sponsored Projects)
INDIAN SPACE RESEARCH ORGANISATION (National Natural Resources Management Systems)
NATIONAL REMOTE SENSING AGENCY (Remote Sensing and Fisheries)
MINISTRY OF AGRICULTURE, GOVT. OF INDIA (Collaborative work)
DEPARTMENT OF OCEAN DEVELOPMENT (Assessment of Marine Living Resources through FORV Sagar Sampada)
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 INSTITUE 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, NAUTICAL 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)

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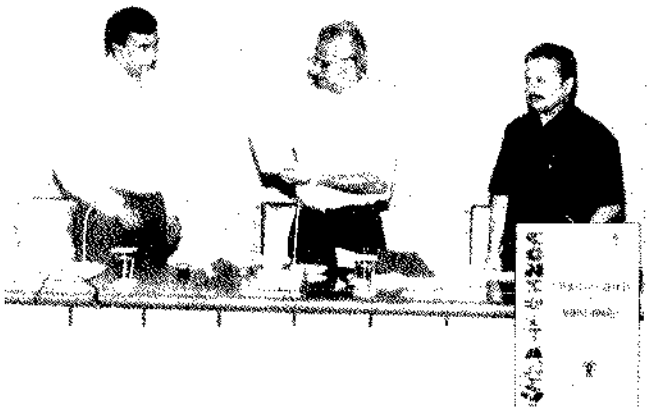
CONSULTANCY,PATENTS,COMMERCIALISATION OF TECHNONLOGY

Sl. No.	Client	Title	Amount in Rs.	Type of projects
1.	**Cochin Port Trust,** Kochi	Monitoring the impact of reclamation of south end W. Island, Kochi	4,01,370	Consultancy
2.	**Tharakan Foods Private Ltd.,** Ezhupunna	Feasibility study on Eel fattening	10,000	Contract Service
3.	**Mangalore Refinery & Petrochemicals Ltd.,** Mangalore	Environmental monitoring in the Arabian Sea off Chithrapur and effluent analysis for M\s. MRPL, Mangalore	4,00,000	Consultancy
4.	**Rajiv Gandhi Centre of Aquaculture,** Myladuthurai	Farming and fattening of spiny lobsters	5,88,280	Consultancy
5.	**Lakshadweep Shilpi Aquaculture Limited,** Kochi	Marine environment study in and around fish hatchery and cage culture sites off Port Blair	2,56,000	Consultancy
6.	**Suganthi Devadasan Marine Research Institute (SDMRI),** Tuticorin	Marine cultured pearl production – perfection of existing technology to increase the incidence of pearl and to improve their quality	15,000	Contract Research
7.	**Kudremukh Iron Ore Co. Ltd.,** Mangalore	Chemical parameters of the effluent and hydrobiological conditions in the effluent receiving water off Thannirbavi, Mangalore during Aug.'98-Jul. '99.	3,80,000	Consultancy
8.	**Indian Tropical Agro Products (P) Ltd.,** Tuticorin	Pearl oyster farming and pearl production	1,50,000	Consultancy
9.	**Master Pearls Limited,** Hyderabad	Onshore Marine pearl production	2,77,250	Consultancy

Sl. No.	Client	Title	Amount in Rs.	Type of projects
10.	**Union Bank of India,** Thane	For assessment of value of shrimp stock in the 153 hect. area shrimp farm at Safale village, Phalgar Taluka, Thane District' of M\s Shakti Aquaculture Farms Ltd. Mumbai	33,000	Consultancy
11	**Dept. of Fisheries, A & N Administration,** Port Blair	Feasibility study for pearl culture in A & N Islands	1,26,230	Consultancy
12	**Kudremukh Iron Ore Co. Ltd.,** Mangalore	Chemical parameters of the effluent and hydrobiological conditions in the effluent receiving water off Thannirbavi, Mangalore during Aug.1999-Jul. 2000.	3,80,000	Consultancy
13	**Mangalore Refinery & Petrochemicals Ltd.,** Mangalore	Environmental monitoring in the Arabian sea off Chithrapur and effluent analysis	6,64,000	Consultancy
		TOTAL	**36,81,130**	



Release of the book on *Consultancy Services in Marine Fisheries* by Shri Babu Rajeev IAS, Chairman, Cochin Port Trust

Sampling of seawater and treated effluents for environmental quality monitoring under the consultancy service with M/s. MRPL, Mangalore

The Staff Research Council meeting in progress at Headquarters

RESEARCH ADVISORY COMMITTEE, MANAGEMENT COMMITTEE AND STAFF RESEARCH COUNCIL MEETINGS

The **Research Advisory Committee meeting** was held at the Mandapam Regional Centre of CMFRI on 16.9.1999. The Committee after discussions on the progress of research projects, the following recommendations were made:

- The RAC members were deeply distressed about the present staff pattern in the Institute. This situation is directly affecting the research activities of the Institute. The members suggested that urgent remedial measures are mandatory to save the situation from deteriorating further *in lieu* of a number of Senior Scientists superannuating very shortly.
- It is disappointing to understand that the remote locality allowance fixed for places like Mandapam has not proportionately increased in comparison with high HRA, vehicle allowance etc declared to the Scientists working in cities. This disparity should be brought to the notice of the finance department and taken care of appropriately.
- The members appreciated the efforts taken by the Scientists concerned to organise one day workshop on seaweeds for the benefit of the industry. It is highly beneficial for them to hear the experts and sort out the problems faced by them in the seaweed industry.
- The members reviewed all the research activities and the Committee expressed happiness on the progress made.

The **Management Committee Meetings** were held on 21.6.1999 and 17-3-2000 and the following decisions were taken:

A proposal for purchase of one Voltametric Analyser with minimum accessories costing Rs. 8.00 lakhs for the Mangalore Research Centre of CMFRI, against the balanced amount available for purchase of FRP tanks was placed before the Committee in its meeting held on 17-3-2000. With the increasing activities under the Consultancy Project and for speedy execution of the works, it was found essential that the Centre is equipped with the Voltametric Analyser at the earliest. The Mangalore Research Centre has already generated an income of about Rs. 25.00 lakhs for the Institute under the Consultancy projects and the scope for enhancing the revenue is considerable. In view of the exigency the Committee recommended to purchase the Voltametric Analyser with accessories costing Rs. 8.00 lakhs by utilising the balance amount available against the purchase of FRP tanks approved in the IXPlan EFC of the Institute.

The **SRC meeting** of the Institute was held on 22nd and 23rd June 1999 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

Name & Designation	Particulars	Date/s
Dr. V.N. Pillai	National Team Leaders' Workshop through the project "Sustainable Management of Coastal Fish Stocks in Asia" (ADB-RETA 5766)	March 20-24, 1999
	2nd workshop on Ecosystem Modelling under ADB-RETA 5766 organised by ICLARM	June 7-11, 1999
	Research Advisory Committee Meeting constituted by the Vice-Chancellor, Madurai Kamaraj University, to monitor the research progress made under the ICAR National Professorship project at the School of Biological Sciences, Madurai Kamaraj University, Madurai	June 15, 1999
	25th Academic Council meeting at CIFE, Mumbai	July 24, 1999
	Institute's Joint Council meeting held at Vizhinjam Research Centre of CMFRI, Vizhinjam	July 29, 1999
	ICAR Director's conference at ICAR, New Delhi	September 7-8, 1999
	Research Advisory Committee meeting of the Institute at Mandapam Regional Centre of CMFRI, Mandapam Camp	September 16, 1999
	Workshop on Seaweed processing & Seaweed products at Mandapam Regional Centre of CMFRI, Mandapam camp	September 16, 1999
	Meeting of OCEANSAT organised by SAC, Ahmedabad (Joint collaborative programme) on the utilisation of SST and chlorophyll for the preparation of Potential Fishing Zone advisories.	September 21, 1999
	Workshop on "Strategy for Sustainable Development in the Coastal Area" organised by the Ministry of Environment and Forests, New Delhi	November 1-3, 1999
	10th EFC of ICAR to consider the IX Plan scheme of CMFRI at New Delhi	November 2, 1999
	Workshop on "Integrated Coastal Management with special reference to Western Coast of India"	November 29, 1999
	All India SAU's Vice-Chancellor's conference at Vigyan Bhavan, New Delhi	December 8, 1999

	International Symposium on "Agricultural Education in the Next Century: Lessons Learnt and Prospects" at Vigyan Bhavan, New Delhi	December 9-11, 1999
	Workshop on "Seaweeds" organised by the Annamalai University at Chidambaram	December 27, 1999
	Fisheries Director's meeting at Chennai	December 28, 1999
	Meeting taken by Hon'ble Minister of State for Agriculture, Govt. of India Shri Hukumdeo Narayan Yadav at Chennai	December 28, 1999
	Meeting to further enhance and strengthen the Space Technology Applications, called for by Director, VSSC, Trivandrum	January 18, 2000
	International Symposium on Tropical Root and Tuber Crops at Trivandrum, organized by CTCRI, Trivandrum	January 19, 2000
	O&M Task Force subcommittee meeting at ICAR, New Delhi	February 7, 2000
	Seminar on "Recent Trends in Small scale Fisheries of Kerala" organised by the South Indian Federation of Fishermen Societies, Department of Fisheries, Govt. of Kerala and the Centre for Development Studies, Trivandrum.	February 29, 2000
Dr. V.S.R. Murty, Head, DFD	Lecture on marine ornamental fish culture and trade to the participants of the TTC Training programme on Hatchery production and aquariculture of ornamental fishes.	July 19, 1999
	Working Group on revalidation of Potential yield of Marine Fishery Resources in the Indian EEZ, at Cochin	August 20, 1999 and October 8, 1999
	Lecture on "Marine Ornamental Fish Resources of India" at the Forum of Fisheries Professionals, Visakhapatnam	September 15, 1999
	Group discussion on "Awareness Programme on IPR" organised by the ICAR at the Directorate of Rice Research, Hyderabad	November 12-13, 1999
	First meeting of the "Group on Bioresources" organised by the DOD at New Delhi	March 1, 2000
	Fifth meeting of the Taskforce on DOD-MLR Project on Stock assessment of deepsea fishes at FSI, Mumbai	March 3, 2000
	Delivered three lectures (1. Fisheries: Marine Fisheries of India: Research Needs; 2. Problem of age and growth studies in fishes; 3. Spawning biology of fishes: the major issues at the Center of Advanced Studies in Marine Biology at Parangipettai, Annamalai University	January 31, 2000 and February 1, 2000

Dr.V.S.K. Chennubhotla Principal Scientist	National Seminar on the Conservation and Management of shrimp resources of the east coast of India organised by the Forum of Fisheries Professionals at Hotel Daspalla, Vishakapatnam	March 20, 1999
	International Conference on Environmental problems and perspectives for 21st Century conducted at the Andhra University at Vishakapatnam	June 3-5, 1999
	Working group meeting of resource persons for development of National Vocational Qualifications in Fisheries at the PSS Central Institute of Vocational Education, Bhopal	October 12-15, 1999
	National Conference-cum- Workshop on "Wetland conservation at Washim (Maharashtra)	October 23-25, 1999
	Symposium on "Man and Environment: reflections and vision for future" at Andhra University, Vishakapatnam	December 2-4, 1999
	Symposium on "Recent Trends in Algal Research In India" held at Annamalai University, Chidambaram	December 27-29, 1999
Shri.K.Vijayakumaran Scientist	National Seminar on Development and Transfer of Fisheries Technologies held at Fisheries College and Research Institute, Tuticorin	March 3-5, 1999
	National Seminar on Conservation and Management of the Shrimp Resources of the East Coast of India at Visakhapatnam	March 20, 1999
	National Symposium on Sustainable Development of Fisheries Towards 2020 AD – Opportunities and Challenges held at Cochin and presented a paper.	April 21-23, 1999
	Monthly meeting of the Forum of Fisheries Professionals, Visakhapatnam	July 16, 1999
Dr.H.M. Kasim Sr. Scientist	Fifth Indian Fisheries Forum at CIFA, Bhubaneswar	January 17-20, 2000
Smt. K.N. Saleela Scientist	National Seminar on Conservation and Management of Shrimp Resources of the east coast of India organised by Forum of Fisheries Professionals and FSI	March 20, 1999
	Workshop on the 'Development of Fisheries in Andhra Coast' at Kakinada	March 1999
	Round table Conference on tuna fishing in Indian EEZ at Visakhapatnam organised by MPEDA and Association of Indian Fishery Industries	June 14, 1999

	Seminar on "Perspectives on integrated coastal Research Basic and applied biodiversity and biopotential" at M.R.L. of B.A. Marathwada University, Ratnagiri	October 23-24, 1999
Shri .M.Z.Khan, Sr. Scientist	Consultative Group Meeting of Mumbai Base at Fishery Survey of India, Mumbai	June 29, 1999
Dr.V.D.Deshmukh, Shri M.Z.Khan and Shri S.G.Raje	Lecture on "The Food Security Vision of India" by Prof. S.R.Hashim, Member of planning Commission at C.I.F.E., Mumbai	August 25, 1999
Shri G.S.D. Selvaraj Sr. Scientist	National Seminar on Development and Transfer of Fisheries Technology and presented two papers	February 3-5, 1999
	National seminar on Coastal Pollution and Management and presented a paper	March 18-19, 1999
	National Symposium on Recent Trends in Marine Algal Research in India and presented a paper	December 27-29,1999
Dr. P. Kaladharan Scientist (SS)	Training on IRS-P4 Oceansat Chlorophyll data Validation and Image Analysis Programme at Satellite Application Centre, Ahmedabad.	April 18-26,1999
	Second National Scientific Seminar in Official Language Hindi on Small Scale Fishing and Small Scale Sea Farming held at CMFRI., Cochin	August 17,1999
	The Sixth Task Force Meeting of the D.B.T.on Animal Sciences at NewDelhi	January 24, 2000
Dr.Reeta Jayasankar Scientist (SS)	National Symposium on Recent Trends in Marine Algal Research in India , held at Annamalai University, Parangipettai	December17-20,1999
	Second National Scientific Seminar in official language Hindi on Small Scale Fishing and Small Scale Sea Farming held at CMFRI., Cochin	August 17,1999
	Fifth Indian Fisheries Forum held at CIFA, Bhubaneswar	January 17-20.1999
K. Appukuttan Head, MFD	Meeting with State Fisheries Officer at Kollam on mariculture programme of the District	February 3, 1999
	Meeting with Dist. Collector, Kollam for arrangements of ornamental fish show at Kollam	February 25, 1999
	Validictory function of Flower show at Kollam	March 2, 1999
	Meeting at Kollam Guest House for discussion on Aquarium construction by District Collector under FFDA Scheme at Kollam	April 29, 1999
	Inauguration of Aquarium Complex at Kollam by Hon'ble Minister for Fisheries, Kerala State	May 24, 1999

	Steering Committee meeting of (District level) Janakeeya Matsyakrishi at Kollam Collectorate as an expert	May 27, 1999
	Mussel harvest Mela at Dalavapuram/Kollam	June 7, 1999
	Farmers meet at Calicut	July 29, 1999
	Meeting with BFFDA officials regarding mussel culture Kollam/Dalavapuram	August 12, 1999
	Meeting with State Fisheries officials on mussel farming at Kollam	October 14, 1999
	Meeting with Dr.Iyer, CSIR Regional Lab. and Dr.Jyotilal, Fisheries Director for discussion on underwater diving and pearl culture respectively	November 3, 1999
	Meeting with State Fisheries Director at Trivandrum on Pearl culture	December 27, 1999
Dr. P. Muthiah Sr. Scientist	National Seminar on Development and transfer of fisheries technology at the Fisheries College and Research Institute, Tuticorin	January, 6-8 1999
	Pollution awareness Meet at Fisheries College & Research Centre, Tuticorin.	August 27, 1999
	A talk given on 'Edible Oyster Culture' was broadcasted by All India Radio, Tirunelveli	December 16, 1999
Shri K. Ramadoss Sr. Scientist	Coastal pollution awareness meet held at Fisheries College, Tuticorin	August 27, 1999
Shri A. Chellam Sr. Scientist	National Seminar on Development & Transfer of Fisheries Technology organised by the Fisheries College and Research Institute (TNVASU), Tuticorin	February 3-5, 1999
Shri S. Dharmaraj Sr. Scientist	National Seminar on development and transfer of fisheries technology at the Fisheries College and Research Institute, Tuticorin	January 6-8, 1999
Dr. P. Laxmilatha Scientist (SS)	Summer School on 'Recent approaches to Marine Fishery Resource assessment & Management at CMFRI, Cochin	May 24 to June 22, 1999
Dr. V. Kripa Sr. Scientist	The 2nd National Scientific seminar on Official Language Workshop held at CMFRI, Cochin	August 17, 1999
Dr.V. Kripa and Dr. K. Sunilkumar Mohammed	The 4-day training programme on Mussel farming at Vallikunnu Panchayat, Malappuram	September 14-17, 1999
Shri M. Sivadas Scientist (SS)	National Seminar on Fishery Economics, extension and management conducted by CIFE, Mumbai	January 5-6, 2000

	Training programme on Recent Advances in Marine Biotoxinology conducted by CIFE, Mumbai	January 10-30, 2000
Dr. Gulshad Mohammed Scientist	National Symposium on sustainable development of fisheries towards 2020 AD : Opportunities and challenges. Conducted by Department of Industrial Fisheries, CUSAT, Kochi	April 21-23, 1999
	National Symposium on recent trends in Marine Algal Research in India at Annamalai University, Parangipettai, Tamilnadu	December 27-29, 1999
Mrs.Sheela Immanuel and Mrs.S. Ashaletha, Scientists	National Symposium on Sustainable Development of Fisheries towards 2020 AD organised by School of Industrial Fisheries, CUSAT, Kochi	April 21-23, 1999
Dr. R. Narayanakumar Scientist	VII Annual Conference of the Agricultural Economics Research Association (India) held at University of Agricultural Sciences, Dharwar, Karnataka	October 6-7, 1999
	Seminar on fuel conservation in fishing organised by CIFT, Kochi and the Petroleum Conservation Research Association, Kochi at Munambam	October 21, 1999
	National Conference on Fisheries Economics, Extension and Management held at CIFE, Mumbai	January 5-6, 2000
Dr. R. Paul Raj Head, PNPD	Technical Consultation on Integrated Natural Resources Management in Coastal Areas organized by the Department of Atomic Energy, Nuclear Power Corporation of India and M.S. Swaminathan Research Foundation, Chennai	May 31, 1999
	Workshop on strengthening of Monitoring and Evaluation System of the Dept. of Fisheries, Govt. of Tamil Nadu, Chennai	June 25, 1999
	Workshop on Generating New Opportunities for Livelihood Security in the vicinity of the Gulf of Mannar Biosphere Reserve organised by the Ministry of Rural Areas and Employment, Govt. of India and M.S. Swaminathan Research Foundation, Chennai	July 26, 1999
	National Agricultural Technology Project-IVLP Site Committee Meeting, Central Institute of Aquaculture, Chennai	December 20, 1999
	NATP-Coastal Agro-Ecosystem Project Review Meeting, Chennai	December 20, 1999
	NATP-Coastal Agro-Ecosystem Scientifific Advisory Panel Fourth Meeting, CMFRI, Kochi	January 29-30, 2000

D.C.V. Easterson Sr. Scientist	Tamil Nadu State Fisheries Advisory Board Meeting, Govt. of Tamil Nadu	January 7, 1999
	Coastal Zone Management Committee of Tuticorin	
Dr. Manpal Sridhar Scientist (SS)	National Symposium on Sustainable Development of Fisheries towards 2020 AD opportunities and challenges organized by the School of Industrial Fisheries, CUSAT, Kochi	April 21-23, 1999
	Second National Seminar in Official Language, Hindi, CMFRI, Kochi	August 17, 1999
	Seminar on Prospects of Biotechnology in the next Millenium organized by the Department of Biotechnology, Cochin University	November 26, 1999
Dr. M. Vijayakumaran Sr. Scientist	Meeting on lobster conservation, MPEDA, Kochi	May 18, 1999
	Fifth Indian Fisheries Forum, Asian Fisheries Society, Bhubaneswar	January 17-20, 2000
Dr. P. Jayasankar Scientist (SS)	Fifth Indian Fisheries Forum, Asian Fisheries Society, Bhubaneswar	January 17-20, 2000
Dr. K.C. George Scientist (SS)	IAVP Symposium at Bangalore	November 25-27, 1999
Dr.G.Sudhakara Rao Head, CFD	Summer School on "Recent Approaches to Marine Fishery resources assessment and management" conducted at CMFRI, Kochi.	May 24 to June 22, 1999
	Workshop on "Development of sustainable management practices in shrimp farming" at Bubaneshwar organized by Central project unit of the World Bank project on shrimp and fish culture, Dept. of Animal Husbandry and Dairying, Ministry of Agriculture and Govt. of India and Directorate of Fisheries, Orissa.	June 30, 1999
	National symposium on "Sustainable development of fisheries towards 2020 AD – Opportunities and Challenges" organized by School of Industrial Fisheries, Cochin University of Science and Technology, Kochi	April 21-23, 1999
Dr. N.G.K. Pillai Head, PFD	Colloquium on Marine Benthos organised by School of Marine Sciences, CUSAT, Kochi	March 6, 1999
	Second National Scientific Seminar in Hindi on Small scale fishing and small scale seafarming organised by CMFRI, Cochin	August 17, 1999

	Task Force Meeting on Harvest Technology and catch composition of deep sea fishery resources of Indian EEZ organised by DOD/CIFT, Cochin	March 6, 2000
	Meeting of the Management Committee of CMFRI	March 17, 2000
A.A.Jayaprakash, Sr. Scientist	National Symposium on sustainable development of fisheries towards 2020 AD: Opportunities and challenges, Dept. of Industrial Fisheries CUSAT, Cochin	April 21-23, 1999
	The Second National Seminar in Official Language, Hindi, CMFRI, Kochi	August 17, 1999
	Released the Proceedings of the National Seminar on Ocean, Fish and Fisheries in the Meeting held at Christ College, Iringalakuda	March 28, 2000
K.R. Manmadhan Nair Sr. Scientist	Second National Scientific Seminar in official language Hindi at Kochi organized by CMFRI	August 17, 1999
Lakshmi Pillai Scientist	Second National Scientific Seminar in official language Hindi at Kochi organized by CMFRI	August 17, 1999
A.P. Dinesh Babu Scientist	Second National Scientific Seminar in official language Hindi at Kochi organized by CMFRI	August 17, 1999
Dr. S. Sivakami, Senior Scentist	National Symposium on "Sustainable Development of Fisheries towards 2020 A-D" Opportunities challenges" at Cochin in the School of Industrial Fisheries, Cochin University of Science & Technology	April 21– 23, 1999
Shri M. Feroz Khan, Scientist (S.S)	Attended the " Summer School on Marine Fish Stock Assessment held at CMFRI, Kochi	May 24 to June 22 1999
Dr. P. Nammalwar, Senior Scientist	Seminar/workshop on Fisheries Management" at Quaid-E-Millath Govt. College for Women, Chennai, Tamilnadu.	January 29-30, 1999
	National Symposium on " Sustainable development of fisheries towards 2020 AD – Opportunities or Challenges" at the School of Industrial Fisheries, Cochin University of Science & Technology, Kochi.	April 21 – 23, 1999
	National Scientific Seminar in Hindi on small scale fishing and small scale sea farming in India. Central Marine Fisheries Research Institute, Kochi.	August 16-17, 1999
Dr. L. Krishnan, Senior Scientist	One day seminar on " Developmental aspects of fisheries sector, as a Faculty Member and resource person in the Peoples campaign of *Janakeeya Asoothranam* – District level fisheries sector in Ernakulam	February 19, 2000.

	National Scientific Seminar in Hindi on "Small-scale fishing and small-scale seafarming in India." Central Marine Fisheries Research Institute, Kochi.	August 16-17, 1999
	Poets Meet in Hindi oirganised by CMFRI, Kochi	March 24, 2000
	Delivered a lecture on Fin fish culture to invited farmers in the fishermen – farmers – industry – institutions meet of CMFRI at Puduvaippu	July 15, 1999
	Delivered a lecture on *Etroplus* breeding and culture to invited farmers in the fishermen – farmers-industry – institutions meet of CMFRI at Kadamakkudi	January 29, 2000
	Meeting of the Departmental Research Committee	February 15, 2000
Dr. U. Rajkumar, Scientist	Training programme on 'Application of statistical methods in fishery research" at CMFRI, Kochi	June 16-31, 1999
	Hindi Seminar at CIFRI, Barackpur	September 21, 1999

	National Scientific Seminar in Hindi on "Small-scale fishing and small-scale seafarming in India." Central Marine Fisheries Research Institute, Kochi.	August 16-17, 1999
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	Hindi Seminar at CIFRI, Barackpur	September 21, 1999

WORKSHOP, SUMMER SCHOOL, SEMINARS, FARMERS' MEETS ORGANISED

1. Hindi Week day celebration at Madras Research Centre of CMFRI, Chennai during 15-19 September, 1999.
2. A 'Matsya Mela' was organized in the KVK campus at Narakkal on 10.3.1999.
3. Scientific Seminar in Hindi was organised on 17 August, 1999 at Headquarters on the subject 'Small Scale Sea farming and small scale sea fishing' in which 16 Research papers were presented.
4. A one day workshop on "Seaweed processing & Seaweed Products" was organized at the Regional Centre of CMFRI, Mandapam Camp on 16.9.1999 under the Trainers' Training Centre of CMFRI.
5. A training programme on "Seaweed Culture & Utilization" was conducted for the benefit of 8 trainees for a period of 5 days from 16- 20 November, 1999 at the Regional Centre of CMFRI, Mandapam Camp under the auspices of the Trainers' Training Centre of CMFRI.
6. Farmers' day was conducted at Vallikunnu on 11-6-1999 and Puduponnani on 9-3-2000 to create awareness on mussel culture. Farmers' day was also conducted at Dharmadom on 16-2-2000 and 20-3-2000 for creating awareness among the traditional fishermen about artificial reefs.
7. Training programme on ornamental fishes was organised at Kozhikode from 28-2-2000 to 4-3-2000 under Trainers' Training Centre of CMFRI for the unemployed youth of Kannur District sponsored by BFFDA, Kannur.

1. Training programme under TTC was conducted from 14-17 September, 1999 at Vallikunnu on mussel culture.
2. A Hindi workshop was organised at Kozhikode Research Centre of CMFRI from 14- 18 February, 2000.
3. A Summer School on 'Recent Approaches to Marine fishery Resources Assessment and Management', sponsored by the Indian Council of Agricultural Research was conducted at CMFRI, from 24 May to 22 June 1999 by the DFD, under the supervision of Dr.V.Sriramachndra Murty, Head DFD who was also the Director of the Summer School. The core faculty included Dr.G.Sudhakara Rao, Dr.V.Sriramachndra Murty, Dr.S.Sivakami, Shri.K.Balan and Dr.M.Srinath. A total of 20 Scientists of CMFRI worked as Faculty. Besides this, invited lectures were delivered by Dr.K.Ravindran, Director, CIFT, Kochi, Dr.V.S.Somavanshi, Director General, Fishery Survey of India, Mumbai, Dr.C.P.Varghese, Director, CIFNET and Dr. P. Vedavyasa Rao former Director, CMFRI, Kochi. A total of 23 participants from ICAR Institutes, Agricultural Universities, and other Universities attended the Summer School.

Inaugural function of Golden Jubilee Year of Official Language - Hindi

Inagural function of Summer School on 'Recent Approaches to Marine fishery Resources Assessment and Management'

Discussion on the ICLARM project, 'Sustainable Management of Coastal fish stocks in Asia'.

A Fishermen Meet

WORKSHOP, SUMMER SCHOOL, SEMINARS, FARMERS' MEETS ORGANISED

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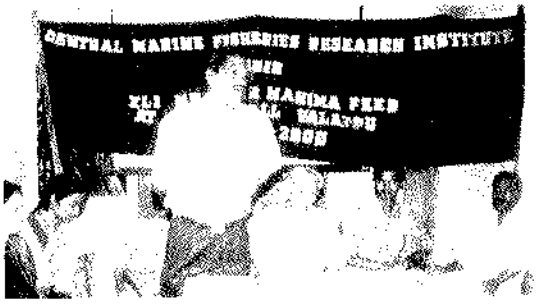

DISTINGUISHED VISITORS

Kochi

Shri Hukumdeo Narayan Yadav, Union Minister of State for Agriculture, AHD & DARE, Govt. of India, New Delhi

Shri Anil Kumar Dubey, Director (Hindi), ICAR

Shri Mohammed Yasin, IPS, Cochin City Police Commissioner

Dr.(Smt.) Shamim Aliyar, Professor , Hindi Department, Cochin University of Science & Technology.

Dr.V.K.Jaleel, Head of Hindi Department, Sree Sankaracharya Sanskrit University, Kalady.

Dr. Tom Verghese, Deptt. of Hindi, Sacred Heart College, Thevara

Shri D.K. Ghoshal, Director of Fisheries, Govt. of West Bengal

Dr. Swe Thwin, Professor, Dept. of Marine Science, University of Mawlamyine, Mawlamyine, Myanmar

Dr. Htay Aung, Dept. of Marine Science, University of Mawlamyine, Mawlamyine, Myanmar

Dr. D. Beeharry, Minister of Fisheries & Co-operatives, John Kennedy Street, Port-Lewis, Mauritius

Shri S. Amarasekara, Secretary, Ministry of Fisheries and Aquatic Resources Development, Colombo

Shri A.M. Jayasekara, Director General, National Aquaculture Development Authority, Colombo,

Veraval

Dr. G. Ragothaman, Head, Department of Aquatic Biology, South Gujarat University, Gujarat, Surat

Dr. R.L. Shiyani, Associate Professor, Gujarat Agriculture University, Junagadh

Shri Mahendra Agarwal, Collage communications, New Delhi

Shri Vijaya Sharma, Doordarsan Unit, Rajkot

Shri J.R. Mehtha, Research Officer, Gujarat Pollution Control Board

Dr. K.P.P. Nambiar, Director, INFOFISH, Kualalampur

Dr. R.L. Shiyani and Shri Ramparia, Department of Agriculture Economics, Gujarat Agricultural University, Junagadh

Mumbai

Ms. Padmaja, Freelance Consultant , CARE India

Mrs Anita Kendrik , Consultant Sociologist with Dr. Sunanda Mane of CARE India

Karwar

Prof. K. Krishna Rao, former Chairman, QRT & Retired Professor of Zoology of the Andhra University

Mangalore

Shri. P. Balakrishnan, Director, Geographical Survey of India, Marine Wing, Mannagudda, PKV Bhandarkar's Complex, Mangalore

Shri.G.M.N. Sastry, Chemist (Sr.), Geographical Survey of India, Marine Wing, Mannagudda, PKV, Bhandarkar's Complex, Mangalore

Inaugural function of the National Scientific Seminar in Hindi organised by the Institute.

Shri Hukumdeo Narayan Yadav, Hon'ble Minister of State for Agriculture, Govt. of India visiting the nucleus implantation laboratory at Mandapam Regional Centre of CMFRI

Shri E. K. Nayanar, Hon'ble Chief Minister of Kerala interstingly watching the marine ornamental fishes in CMFRI pavilion in the *Flower Show* -1999 at Thiruvananthapuram

Dr. D. Beehary, Minister of Fisheries and Cooperatives, Govt. of Mauritius with the Director

Prof. K. Srinivasa Rao, Retd. Professor, Dept. of Zoology, Andhra University, Visakhapatanam

Kozhikode

Dr. S.A.H. Abidi, Director & Vice-Chancellor, CIFE, Mumbai

Shri U. Kalanathan, President, Vallikunnu Panchayat

Prof. N. Sivarajan, Consultant, Matsyafed

Shri Thottathil Ravindran, Dy. Mayor, Kozhikode Corporation

Vizhinjam

Dr. V. Sundararaj, Dean & staff members, Fisheries College and Research Institute, Tuticorin.

Dr. Pabitra Kumar Gupta, Member, West Bengal College Service Commission, Calcutta

Dr. Bishan Singh, ICAR, New Delhi

Dr. M. Shahul Hameed, Director, School of Industrial Fisheries, Cochin University

Dr. S. Prasad, Indian Institute of Technology, Kanpur

Dr. Atma Rani, Director of Entomology, IARI, New Delhi

Shri S. Upendran Nair, Managing Director, Matsyafed, Thiruvananthapuram

Shri R.D. Iyer, Head of Division (Rtd), Crop Implement, CPCRI, Kasargod

Dr. B.K. Tonsane, CTCRI, Mysore

Dr. S. Edrisan, Director, CFCRI, Thiruvananthapuram

Shri Oliver N. Sheprmang, Minister of Law & Tourism, Meghalaya

Dr. N.R. Menon, Director, School of Marine Sciences, Cochin University of Science & Technology

Dr M. Devaraj, Retd. Director, CMFRI, Chennai

Capt. S. Sen, Retired Director (Marine), Calcutta Port Trust

Dr. Pradeep Sharma, Addl. Professor, AIIMS, New Delhi

Justice B.K. Sangalad, High Court of Karnataka, Bangalore

Dr. S.T. Sungle, Professor, Marathwada University, Aurangabad

Justice Ashok L. Dave, High Court of Gujarat, Ahmedabad

Dr. M. Mary Bai & Dr. Geetha, Ministry of Environment & Forest, Govt. of India, New Delhi

Dr. S.D. Rai, ADG (Technial Coordination), ICAR, New Delhi

Tuticorin

Shri Hukumdeo Narayan Yadav, Union Minister of State for Agriculture , AHD & DARE, Govt. of India, New Delhi

Shri N.S. Madhavan, Secretary (Fisheries), Govt. of Kerala, Thiruvananthapuram

Shri R. Prabhakaran, Director of Fisheries, Govt. of Kerala, Thiruvananthapuram

Shri K.K. Raveendran, Chief Engineer, Harbour Engineering Department, Thiruvananthapuram

Dr. K. Alagarswami, Ex. Director, CIBA, Distinguished Fellow, M.S. Swaminathan Research Foundation, Chennai

Shri Ajitkumar Solanki, Pearl Bead Expert, Allahabad

Shri K.R. Jyothilal, Director, Department of Fisheries, Govt. of Kerala, Thiruvananthapuram

Mandapam Camp

Shri Hukumdeo Narayan Yadav, Hon'ble Minister of State for Agriculture (AHD & DARE), Govt. of India, Krishi Bhavan

Professor V. Krishnamurthy, Krishnamurthy Institute of Algology, Thiyagaraja Nagar, Chennai

Dr. A.K. Kumara Guru, Professor & Head, Centre of Marine & Coastal Studies, Madurai Kamaraj University, Madurai

Dr. P.K. Ghosh, Director, CSMCRI, Bhavnagar

Dr. K. Alagarswami, Director (CIBA) (Retd), (ICAR), C/o M.S. Swaminathan Research Foundation

Shri I.D. Sharma, Deputy Secretary to the Government of India, Ministry of Parliamentary Affairs, New Delhi

Dr. Jothilal, Director of Fisheries, Kerala, Thiruvananthapuram

Dr. P.S. Reddy, Co-ordinator, Indian Fish & Fishery, Madras Christian College, Chennai

Dr. P.V. Rao, Director (Retd), CMFRI, 'Vinayas', Alleppey, Thiruvananthapuram

Dr. T.J. Pandian, ICAR National Professor, Madurai Kamaraj University, Madurai

Dr. V.S. Rao Chintala, Director, Department of Ocean Development, Government of India, New Delhi

Dr. G.R.M. Rao, Director, CIBA, Chennai

Shri K.R. Varadarajan, Deputy Conservator of Forests, Industrial Wood Research Division, Mukkombu, Trichy

Chennai (Kovalam Field Laboratory)

Dr. Sinha, Director, Inland Capture Fisheries Research Institute, Barrackpore

Dr. Vass, Director, Coldwater Fisheries Research Institute, Nainital

Dr. Singh Kholi, Joint Director, Central Institute of Fisheries Education, Mumbai

Shri Anil Agarwal, Sr. Scientist, ICAR, Krishi Bhavan, New Delhi

Kakinada

Shri R. Srinivasa Rao, Lecturer and Shri Subbaraya, Narayanan College, Narsaraopet, Guntur alongwith 7 students

Shri B.R. Rajabhushanam, Lecturer, Associate Principal, A.C. College, Guntur alongwith 2 staff and 20 students

Shri M.A. Yakub Basha, Assistant Director, SIFT Kakinada alongwith State Fisheries Department staff trainees

Visakhapatnam

Shri P.V.Srinivasa Rao, Fisheries Development Officer, Government of Andhra Pradesh

Dr. S. Sundararaj, Dean, Dr. Ramanathan and Dr. S. Felix, Associate Professors of Fisheries College, (Tamil Nadu Agriculture University), Tuticorin

Dr. K. Venkataramanujam, Director of Research and Extension (Fisheries), Tamil Nadu Veterinary and Animal Sciences University, Tuticorin.

Dr. Rama Rao Athota, Coordinator, Refresher Course, Academic Staff College, Andhra University, Visakhapatnam

PERSONNEL (MANAGERIAL POSITION ONLY)

1.	**Director**	-	**Dr. V. Narayana Pillai**
2.	**Heads of Divisions**		
	Fishery Resources Assessment Division	-	Shri K. Narayana Kurup Sr. Scientist
	Pelagic Fisheries Division	-	Dr.N.Gopalakrishna Pillai
	Demersal Fisheries Division	-	Dr.V.Sriramachandra Murty
	Crustacean Fisheries Division	-	Dr. G. Sudhakara Rao
	Molluscan Fisheries Division	-	Dr. K.K. Appukuttan
	Fishery Environment Management Division	-	Dr.V. Kunjukrishna Pillai Sr. Scientist
	Physiology, Nutrition and Pathology Division	-	Dr. R. Paul Raj
	Socio-Economic Evaluation & Technology Transfer Division	-	Smt Sheela Immanuel Scientist
3.	**Sr. Administrative Officer**	-	Shri Charles Ekka
4.	**Sr. Finance & Accounts Officer**	-	Shri Radhey Sham
5.	**Administrative Officer**	-	Shri P.S. Sudersanan
6.	**Officers-in-Charge of Research Centres**		
	Mandapam Camp	-	Dr. A.C.C. Victor Sr. Scientist
	Chennai	-	Dr. R. Sarvesan Sr. Scientist
	Tuticorin	-	Shri D.C.V. Easterson Sr. Scientist
	Kakinada	-	Dr. H. Mohammed Kasim Sr. Scientist
	Karwar	-	Dr. V.S. Kakati Sr. Scientist
	Mangalore	-	Dr. C. Muthiah Sr. Scientist

Veraval	-	Shri A.P. Dinesh Babu Scientist
Vizhinjam	-	Shri K. Prabhakaran Nair Sr. Scientist
Mumbai	-	Dr. V.D. Deshmukh Sr. Scientist
Minicoy	-	Shri M. Sivadas Scientist (SS)
Visakhapatnam	-	Dr. V.S.K. Chennubhotla Principal Scientist
Kodhikode	-	Dr. T.M. Yohannan Sr. Scientist
Krishi Vigyan Kendra	-	Shri K.P. Said Koya, Scientist (SS)
Trainers' Training Centre	-	Dr. V. Kunjukrishna Pillai Sr. Scientist
Fisheries Harbour Laboratory	-	Shri P.E. Sampson Manickam Sr. Scientist

SPECIAL INFRASTRUCTURAL DEVELOPMENT

Veraval

Nine fibre glass tanks worth Rs. 94,080 were purchased for strengthening the aquaculture activities of the Centre during May 1999.

Visakhapatnam

New mariculture laboratories (wet Lab.) of approximately 8000 sq. ft. area were completed for conducting culture experiments on finfishes, shellfishes and other marine organisms. Accessory infrastructure facilities such as seawater pumping, aeration and slow sand filter are under process of completion. The construction of 12 nos. of residential quarters have been completed and allotted to the staff.

Minicoy

A hatchery shed of 10 x 4.5 m and a sea water sump of 10 t capacity have been constructed under the funded project 'Marine Ornamental Fish Culture'. The construction of 4 Nos. of residential quarters have been completed and allotted to the staff.

Kozhikode

A marine Aquarium was constructed during the year. This aquarium is expected to be commissioned shortly.

Veraval	-	Shri A.P. Dinesh Babu Scientist
Vizhinjam	-	Shri K. Prabhakaran Nair Sr. Scientist
Mumbai	-	Dr. V.D. Deshmukh Sr. Scientist
Minicoy	-	Shri M. Sivadas Scientist (SS)
Visakhapatnam	-	Dr. V.S.K. Chennubhotla Principal Scientist
Kodhikode	-	Dr. T.M. Yohannan Sr. Scientist
Krishi Vigyan Kendra	-	Shri K.P. Said Koya, Scientist (SS)
Trainers' Training Centre	-	Dr. V. Kunjukrishna Pillai Sr. Scientist
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Kochi

Additional Computers were installed at the Regional/Research Centres and the Headquarters.

The LAN (Local Area Network) facility is provided to all the scientists/technical personnel at the headquarters. With this modern facility, fishery data stored on the Computer Server at the Marine Data Centre can be easily accessed by the Scientists/Technical Officers.

The Agricultural Research Information system (ARIS) an important componet of the NATP of the ICAR was established.

Tuticorin

A lobster hatchery has been inagurated by the Shri. Hukumdeo Narayan Yadav, Hon'ble Union Minister of State for Agriculture, Govt. of India.

Shri Hukumdeo Narayan Yadav, Minister of State for Agriculture, Govt. of India open a multipurpose hatchery at Tuticorin Research Centre of CMFRI

Dr. K. Gopakumar, Deputy Director General (Fy.), ICAR inaugurating the ARIS Cell at Headquarters

Air Vice Marshal Nirmal Thusa & Team with the Officer-in-charge, Tuticorin Research Centre of CMFRI