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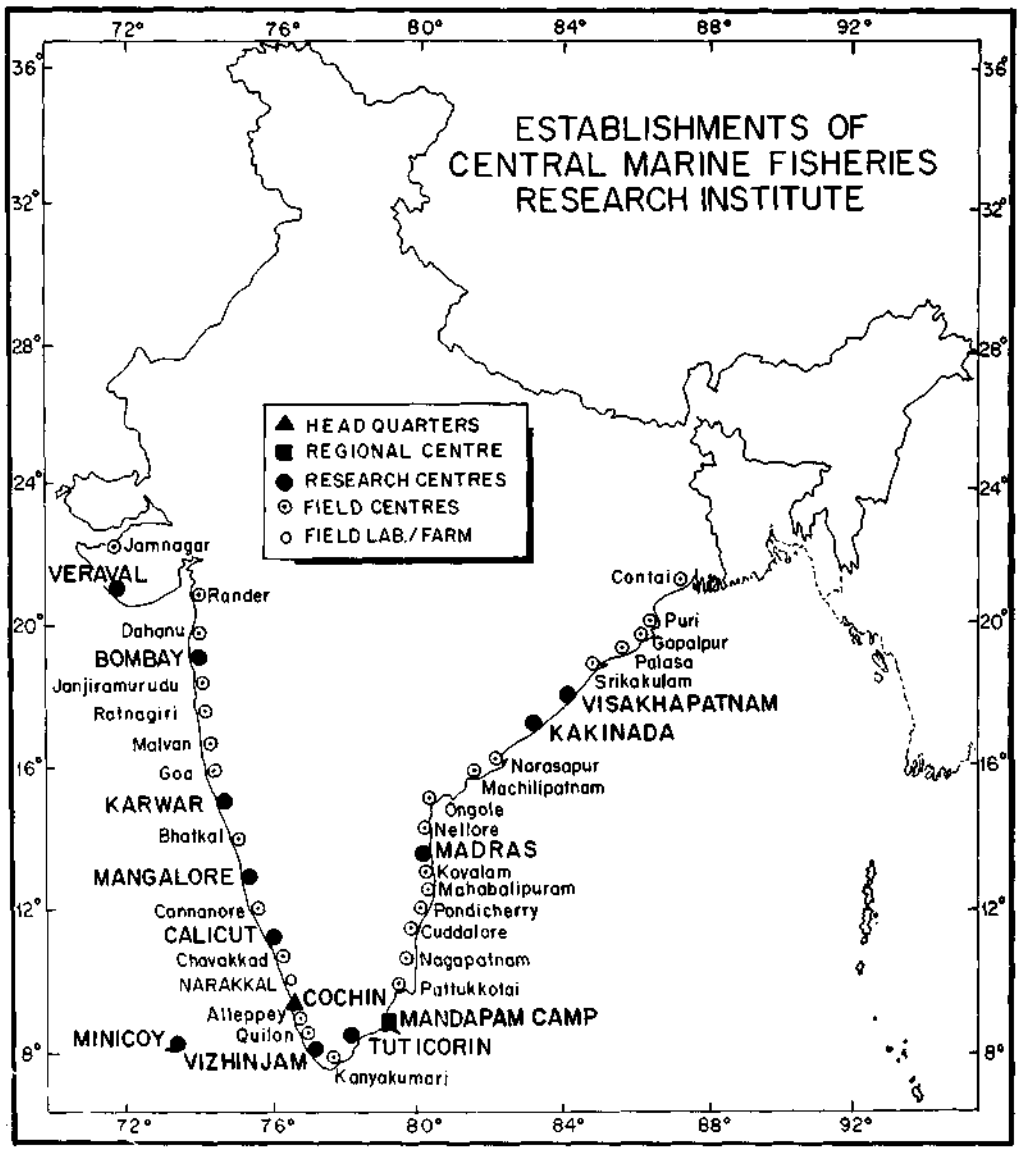
ANNUAL REPORT
1993 - 1994

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
Indian Council of Agricultural Research
Dr. Salim Ali Road, Post Box No. 1603
Tatapuram P.O., Ernakulam. Cochin - 682 014



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ANNUAL REPORT 1993-'94

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Annual Report
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CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

ABOUT THE INSTITUTE, ITS MANDATE AND ORGANISATIONAL SET UP

The **Central Marine Fisheries Research Institute**, established in 1947, is one of the eight Research Organisations in the network of Central Fisheries Research Institutes under the Indian Council of Agricultural Research devoted to research, education, training and transfer of technologies in support of development of fisheries in India. CMFRI's mandate is to conduct researches on exploited, under- and unexploited marine fishery resources and fisheries oceanography to advise on the rational exploitation and make forecast of abundance; development and upgradation of technologies for maximising production through mariculture and, conducting teaching, training and extension programmes for development of human resources in fisheries.

To accomplish the above mandate, the Institute conducts researches on characteristics of exploited marine fish stocks; develops sea-farming techniques; carries out exploratory surveys and assesses under- and unexploited resources and undertakes to integrate the fluctuations of marine fish production with environmental characteristics and sea-dynamics. 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 coastline. Studies are also conducted on economics of fishery enterprises and socio-economic conditions of fisherfolk.

To be able to effectively carry out these tasks, the Institute has set up a Regional Centre at Mandapam Camp and Research Centres at Minicoy, Veraval, Bombay, Karwar, Mangalore, Calicut, Vizhinjam, Tuticorin, Madras, Kakinada and Visakhapatnam and 28 Field Centres. The entire activity is coordinated by the Headquarters at Cochin. The Institute has, over the years, built up laboratory and field facilities including computers and research vessels for carrying out research programmes and has been upgrading the same to meet the changing and additional requirements. The sanctioned staff strength of the Institute is : Scientists 200, Technical 445, Ministerial 172, Supporting 296 and Auxillary 39.

The multi-disciplinary 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. Inter-divisional and Inter-Institutional 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 industry. Under the Post-graduate Programme in Mariculture, the

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

The Krishi Vigyan Kendra, established in 1976 and the Trainer's Training Centre impart training in mariculture, agriculture, animal husbandry and other related subjects to fish farmers, agricultural farmers and farm women and to officials of State Governments, Banks, Societies and autonomous bodies interested in fisheries development respectively.

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 scientific journals, bulletins and special publications and Marine Fisheries Information Service.

DIRECTOR'S INTRODUCTION

The Indian marine fishery resources, characterised as they are, by their diversity and complexity, continue to offer challenges to those engaged in research on fish stocks and in development and management of fisheries. The dynamics of the resources and their ecosystem, protection of the habitat, monitoring the exploitation and maintenance of stocks at optimal level of exploitation constitute the central concerns of marine fisheries research. During a short period of just four and a half decades, the coastal fishery within the 50-60 m depth zone has grown from an undeveloped state to a level of optimum exploitation. The multi-species complex of the resources, their availability often environmentally determined, multi-gear and common property nature of the fishery and the resultant over-capacity, fluctuations in demand and supply, dependence on targeted fishing on prawns and such other high value fish stocks, recurrent conflicts among the resource users, conflicting objectives of coastal fisheries management and qualification and quantification of resources in the deep-sea regions for exploitation are the important issues encountered in the sector. In the context of increasing production through mariculture and helping the coastal fisherfolk for their betterment, development of technologies and their continuous upgradation also offer major challenges for research in marine fisheries. The Central Marine Fisheries Research Institute with its mandate of R & D has been providing the information base for addressing these problems and for the sustainable development of the marine fisheries of the country.

During 1993-'94, the Institute continued its efforts to achieve improvement in the output of marine fish production through biological, ecological, technologically appropriate and environmentally viable approaches in its research programmes. In addition to consolidating and making further progress in the ongoing research programmes, thrust areas for research in marine fisheries have been identified for implementation during the Eighth Five-year Plan period. The Institute initiated research in five funded projects in focal areas strengthening the mariculture research base of the Institute.

The major research activities of the Institute are field oriented and inspite of a severe constraint of availability of TA funds, the programmes have been carried out without halt. One of the important achievements of the Institute during the year has been the completion of 30 research papers initiated earlier on population dynamics of exploited fish stocks on all-India basis and their acceptance for publication in the *Indian Journal of Fisheries* in a series of three issues. The results of these investigations have given useful insights for long-term planning for research and management of the concerned resources. Researches are continued on ways to improve the management of other commercially exploited resources.

The CMFRI has also strengthened its research activities through cooperation with the other national organisations that have a common interest. The remote sensing programme carried out at the Institute thus received further facilities and actively participated in collecting the sea-truth data aiding in forecasting of potential fishing zones.

The Institute's extension research programmes on farming systems have enabled the socio-economic reconstruction by developing qualities of empowerment of rural women and their participation in income generating avocations of prawn feed production and prawn farming.

The Institute in collaboration with Central Institute of Fisheries Technology and Department of Ocean Development, conducted the Second National Workshop on Scientific Results of FORV *Sagar Sampada*

which helped in consolidating the Institute's as well as other agencies' works utilising this national facility during the previous four years.

Fully utilising the budget allocation, the Institute augmented its research facilities by providing computers to all its research centres besides making additions at Headquarters. The infrastructure facilities of the Institute are also strengthened by replacing the old vehicles and providing further amenities to the laboratories.

The construction of the permanent laboratory building at Visakhapatnam has been completed and the same is being taken over. The construction of the residential quarters at Cochin, which has been a long felt requirement of the Institute, has been initiated.

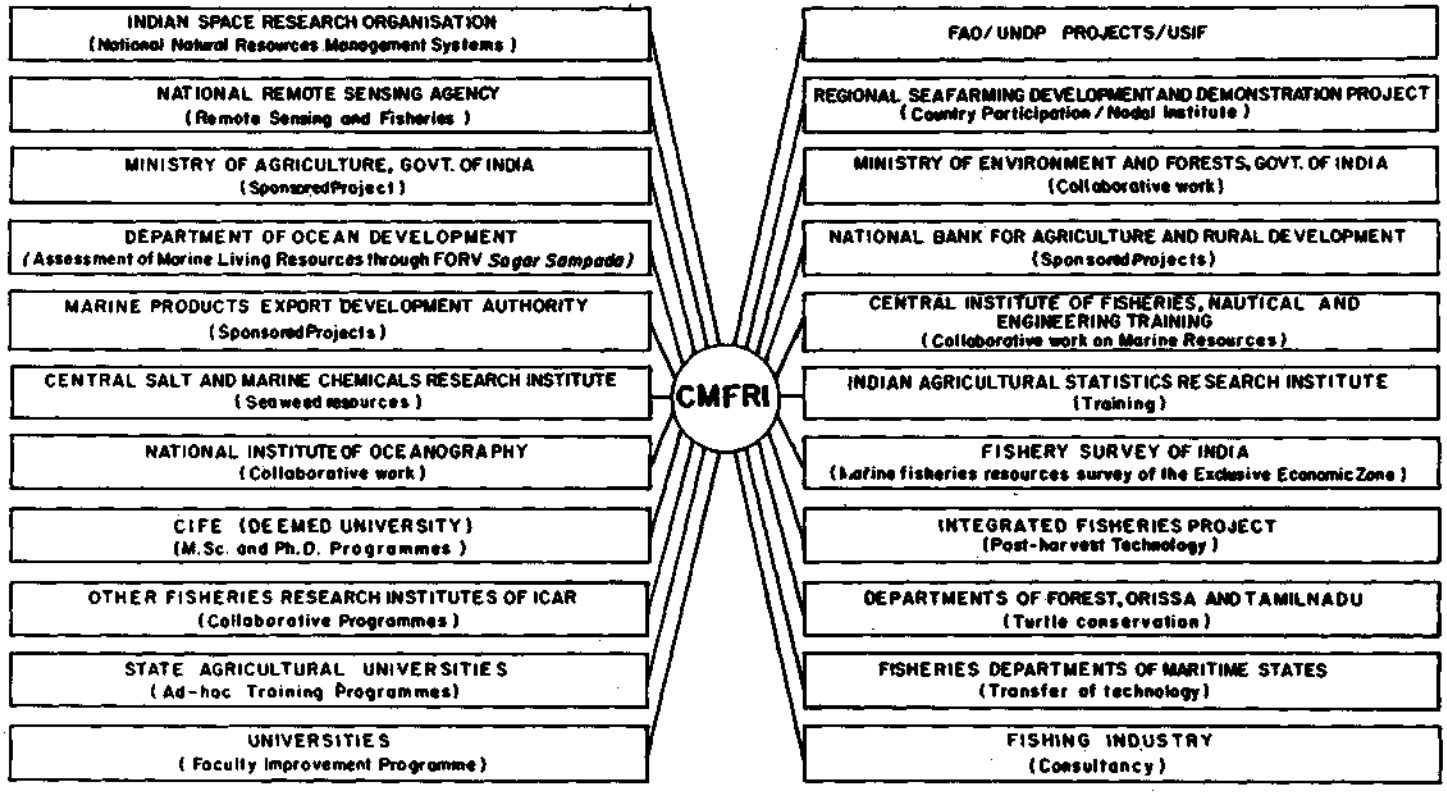
This **Annual Report** endeavours to give a glimpse of the researches carried out on the various projects during the year. My thanks are due to the Heads of Divisions, Officers-in-Charge of Research Centres, Scientists, Technical staff and other staff of the Institute who contributed to yet another year of satisfactory performance and progress of the multifarious R & D activities of the Institute and the development of the marine fisheries of the country.

Cochin - 14,
20 - 7 - 1994.

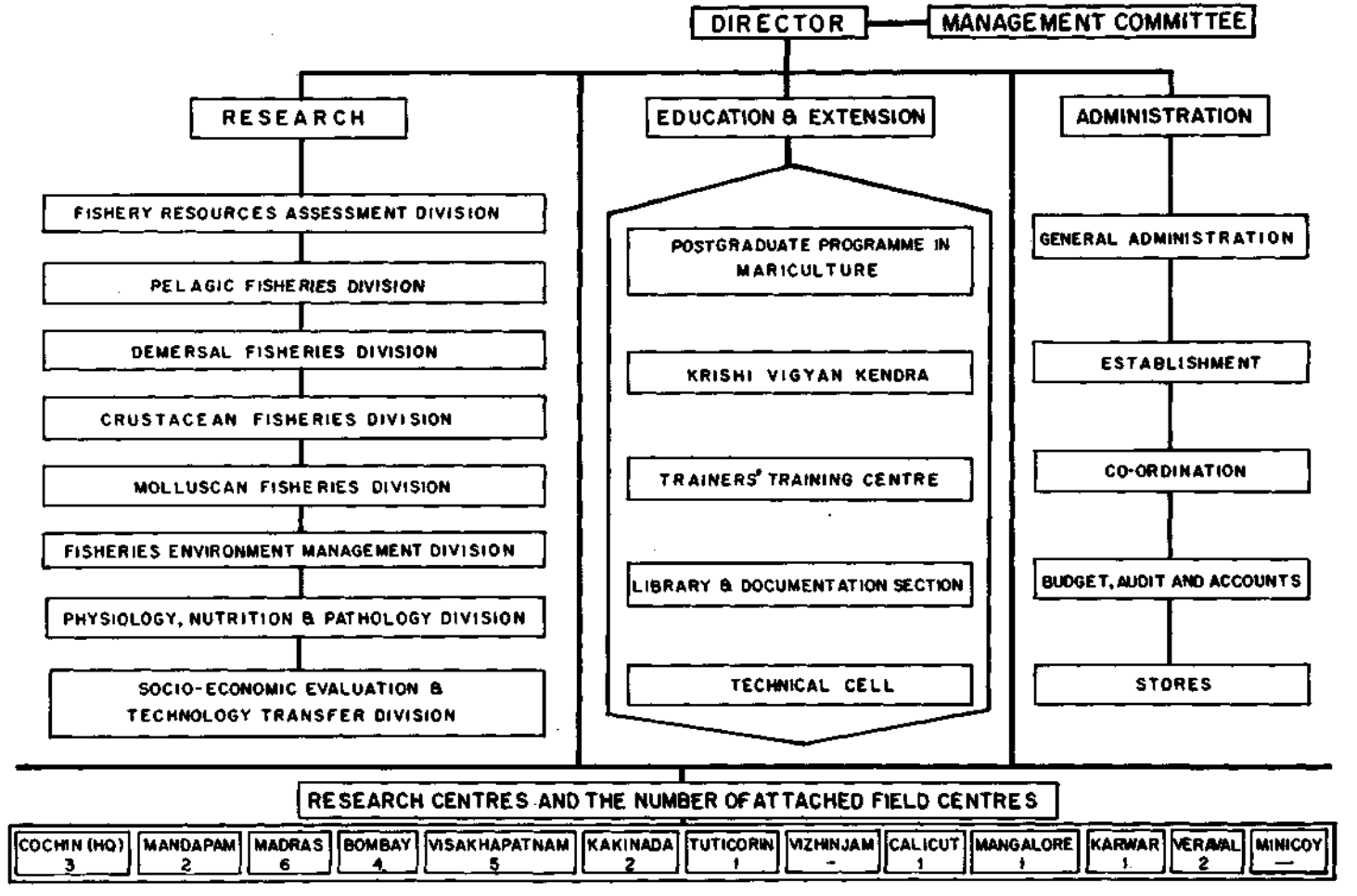
P. Vedavyasa Rao
Acting Director

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE, COCHIN
(ICAR)

LINKAGES WITH OTHER ORGANISATIONS



CENTRAL MARINE FISHERIES RESEARCH INSTITUTE: ORGANISATIONAL CHART



PROGRESS OF RESEARCH

FISHERY RESOURCES ASSESSMENT DIVISION

ASSESSMENT OF EXPLOITED MARINE FISHERY RESOURCES (FSS/FRA/1.1)

K. BALAN

The pattern of exploitation of marine fishery resources remained more or less the same during 1993 though there being targeted fishing for certain finfishes and cephalopods in addition to shrimps in certain regions of the country's coast.

MARINE FISH PRODUCTION IN INDIA DURING 1993

The total marine fish production in the country was provisionally estimated at 2.27 million tonnes against 2.30 million tonnes in 1992; there was a decline of 1% (about 25,000 tonnes) in the landings over 1992. Pelagic and demersal components were more or less in equal proportions in the total catch. The mechanised and motorised units together contributed 85.8% of the total landings. Though there was an overall decline of 1% in the landings in 1993, the Indian mackerel registered an increase of 116,000 tonnes over 1992; the landings of perches also registered an increase of 32,000 tonnes. However, the landings of oilsardine, whitebait, Bombay-duck, ribbonfish, carangids, flatfish and prawns declined during the year under report.

REGIONWISE PRODUCTION OF MARINE FISHES

Northeast region : This region contributed 1.54 lakh tonnes (6.8% of country's total) which was about 28,000 tonnes more than the landings obtained in 1992 (Table 1). Increased landings of catfishes, hilsa shad, croakers, pomfrets, and prawns and decreased landings of elasmobranchs and seerfishes were obtained during the year when compared to previous year. The landings of catfishes (28,000 t) showed an increase of 2,000 t and those of hilsa shad (28,000 t) 8,000 t. The landings of croakers (24,000 t), pomfrets (10,000 t) and prawns (5,700 t) registered increase of 9,000 t, 3,000 t and 800 t respectively. The elasmobranchs showed, however, a decline of 800 t in their landings (4,800 t) in 1993.

Southeast region : This region contributed 5.14 lakhs tonnes (22.6% of country's total) in 1993 which was 20,000 t less than that of 1992. The prominent groups which registered reduced landings were anchovies, ribbonfish, mackerel and penaeid prawns, their estimated landings in 1993 being 43,000 t, 11,000 t, 42,000 t and 36,000 t respectively which are 10,000 t, 11,000 t, 18,000 t and 5000 t less than those obtained in 1992 respectively. In the case of oilsardine, silverbellies, pomfrets and tunas, slight increase in landings was obtained, the estimated landings in 1993 (with increases in tonnes over 1992 in parentheses) being 39,000 t (800 t), 51,000 t (10,000 t), 7,000 t (2,000 t) and 10,000 t (5,000 t) respectively.

Table 1. *Regionwise marine fish production (tonnes) in India in 1993*

Region	Estimated landings	% in All India landings
Northeast (1)	154,250	6.8
Southeast (2)	514,151	22.6
Southwest (3)	839,106	36.9
Northwest (4)	734,101	32.3

Besides, island territories contributed 1.4% of the total production.

1. West Bengal and Orissa; 2. Andhra Pradesh, Tamil Nadu and Pondichery; 3. Kerala, Karnataka and Goa; 4. Maharashtra and Gujarat.

Southwest region : An estimated 8.39 lakh tonnes of total catch (36.9% of country's total) which was 13,000 t more than that of 1992, was obtained from this region in 1993. The estimated landings (in tonnes) of oilsardine, anchovies, carangids and penaeid prawns which showed decline (over 1992) during the year under report (showing the reduction in tonnes over 1992 in parentheses) were, 56,000 (10,000), 64,000 (13,000), 8,700 (59,000) and 55,000 (10,000) respectively. The landings of Indian mackerel in the region accounted for an unusual 177,000 tonnes which was 116,000 t more than the landing in 1992. About 90% increase in the landings (55,000 t) of perches was obtained during 1993 when compared to 1992 and about 30% increase in the landings (44,000 t) of cephalopods.

Northwest region : The region contributed 7.34 lakh tonnes (32.3% of country's total) in 1993 registering a decline of 46,000 t over the landings obtained in 1992. The landings in tonnes of prominent groups which showed decline in the landings during 1993 over those of 1992 (with the reduced quantities in tonnes in parentheses) were Bombay-duck, 72,000 (34,000), croakers, 97,000 (8,000), ribbonfish, 63,000 (8,000), penaeid prawns 78,000 (6,000) and non-penaeid prawns 64,000 (23,000).

The pomfrets and mackerel showed increased landings of 3,000 t and 17,000 t over the landings of 1992, the estimated landings in 1993 being 20,000 t and 29,000 t respectively.

CONTRIBUTION OF PELAGIC FISHES

Oilsardine : The landings accounted for 4.2% of the marine fish production and 8.3% of the Pelagic fish landings (Table 2). The estimated landing of oilsardine during 1993 was 95,000 t which was 18,000 t less than that in 1992. The decline was primarily due to the reduction in the landings in the southwest region.

Mackerel : This marine fish accounted for 11.0% of the total production and 21.9% of the pelagic fish catch. An estimated 250,000 t of the species was landed in 1993 registering an increase of 116,000 t over 1992. This unusual increase in mackerel production was mainly because of the substantial increase in the landings of the species along southwest region.

Whitebait : The landings of *Stolephorus* spp. accounted for 3.1% of the total marine fish production of the country and 6.3% of the pelagic fish catch. An estimated 72000 t of these fishes were landed resulting in a decline of about 9850 t when compared to their landings in 1992.

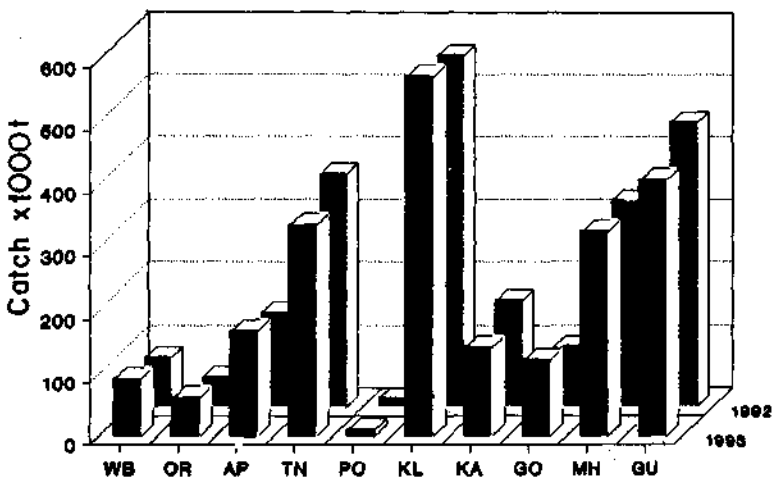
Bombay-duck : Bombay-duck landings accounted for 4.1% of the total marine fish production of the country and 8.2% of the pelagic fish landings. The estimated landing was 94,000 t registering 33,000 t less as compared to that of 1992. Northwest region contributed 72,000 t (76.5%) to the total Bombay-duck landings.

Carangids : The landings of these fishes accounted for 5.7% of the total production and 11.3% of the pelagic fish production. The estimated landing of 129,000 t in 1993 registered a decline of about 61,000 t over that of 1992. This reduction was mainly due to the decline in landing of southwest region.

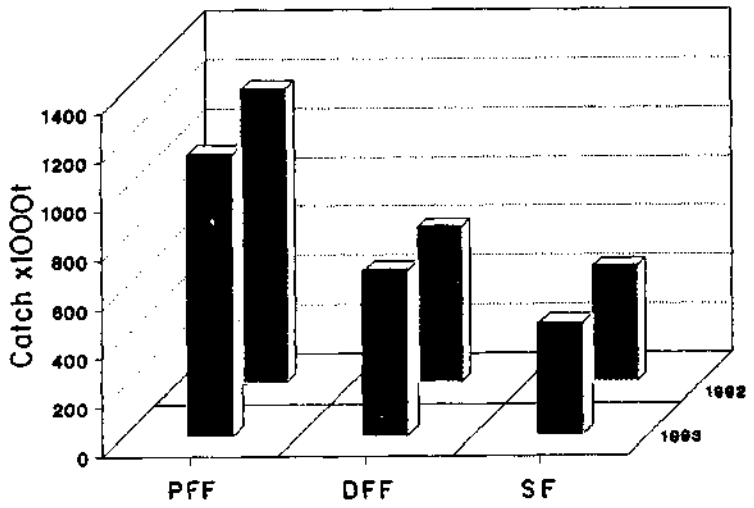
Table 2. *Estimated landings (in tonnes) of pelagic fishes in India during 1992 and 1993*

Name of fish	1992	1993*
Clupeoids		
Wolf herring	17481	17705
Oilsardine	104062	94848
Other sardines	94094	88729
Hilsa shad	22375	30203
Other shads	14195	12490
Anchovies	—	—
Coilia	31360	30412
Setipina	2748	2359

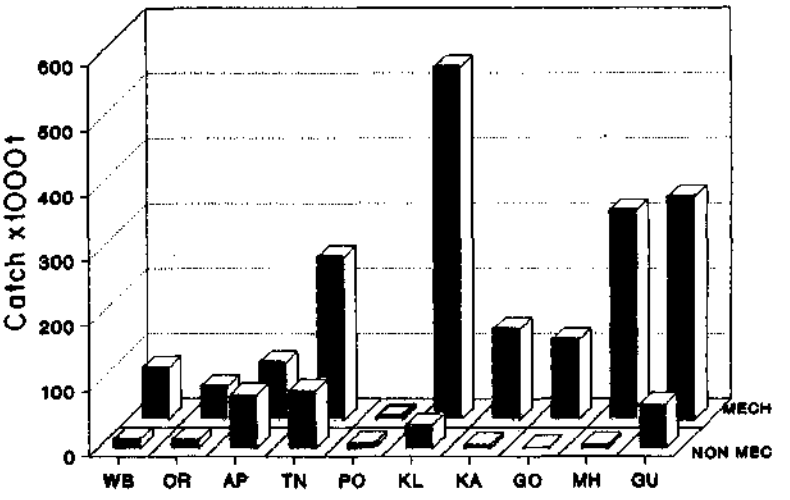
*Provisional



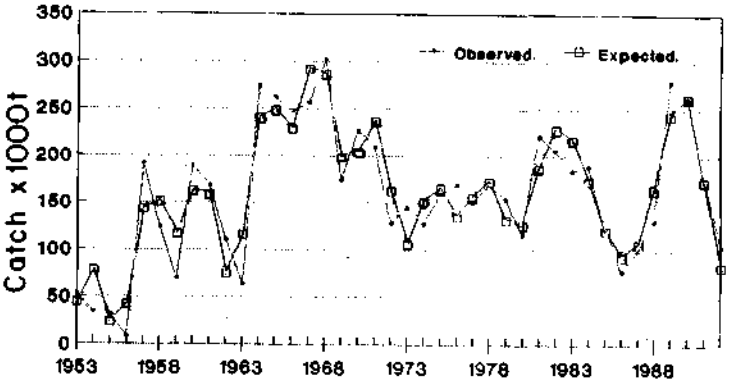
Estimated marine fish landings in different maritime States during 1992 and 1993 (WB : West Bengal; OR : Orissa; AP : Andhra Pradesh ; TN : Tamil Nadu, PO : Pondicherry; KL : Kerala; KA : Karnataka, GO : Goa; MH : Maharashtra; GU : Gujarat.



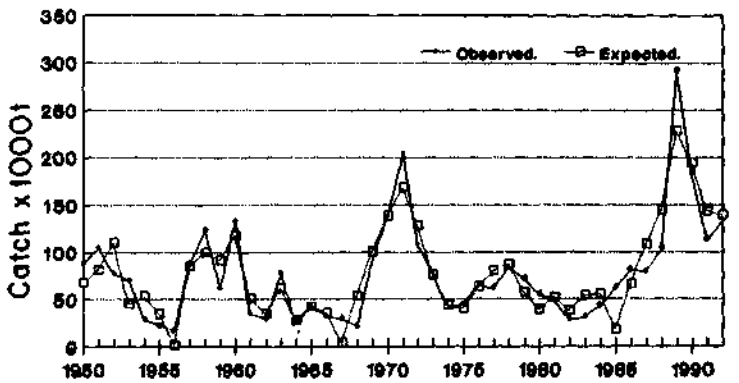
Estimated landings of Pelagic finfish, Demersal finfish, and Crustacean and Molluscan shellfish in India during 1992 and 1993. (PFF : Pelagic finfish, DFF : Demersal finfish and SF : Crustacean and Molluscan shellfish).



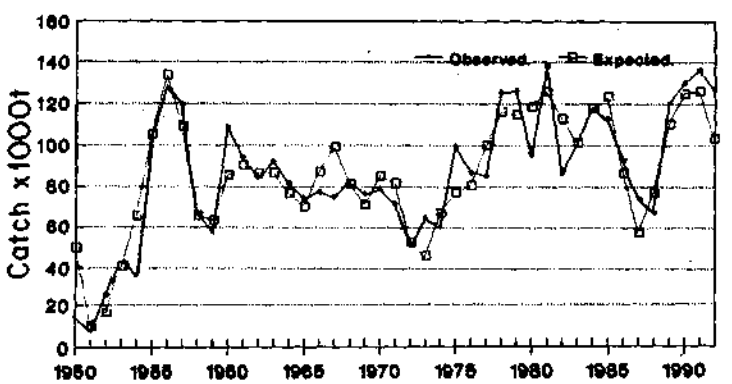
Estimated landings by mechanised and non-mechanised units in different maritime States during 1993.



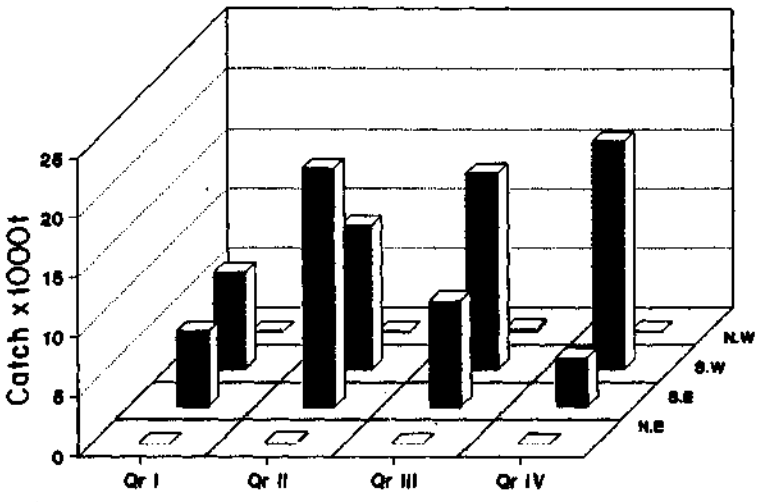
Plot of observed and expected landings (in units of 1000 t) of oilsardine in India during 1953-1992.



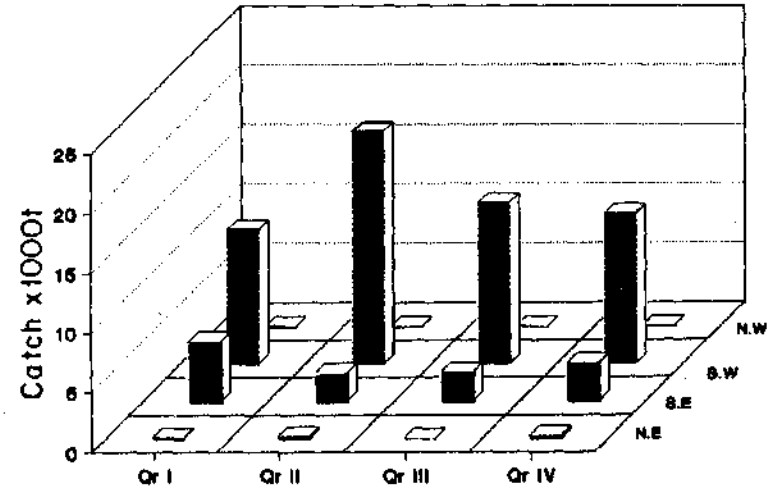
Plot of observed and expected landings (in units of 1000 t) of mackerel in India during 1950-1992



Plot of observed and expected landings (in units of 1000 t) of Bombay-duck in India during 1950-1992.



Quarterly estimated landings of oilsardine at different regions along the Indian Coast during 1993.



Quarterly estimated landings of white-bait at different regions along the Indian Coast during 1993.

Name of fish	1992	1993
Stolephorus	80774	71925
Thrissina	0	5
Thryssa	47367	34286
Other clupeoids	60474	42665
Bombay-duck	127164	93730
Half beaks and full beaks	2398	2300
Flyingfishes	4929	1654
Ribbonfishes	111271	91682
Carangids		
Horse-mackerel	19545	16028
Scads	117810	59471
Leather-jackets	5840	3995
Other carangids	47092	49570
Mackerels		
Indian mackerel	135033	250978
Other mackerels	1	5
Seerfishes		
S. commersoni	24578	21194
S. guttatus	17494	20716
S. lineolatus	1027	75
Acanthocybium sp.	10	1
Tunnies		
E. affinis	23391	16220
Auxis spp.	7895	3364
K. pelamis	833	7414
T. tonggol	2487	3657
Other tunnies	8666	13274
Billfishes	1504	1810
Barracudas	12586	11407
Mullets	5644	5174
Unicorn cod	1188	929
Miscellaneous	42698	46540
Total pelagic	1,196,014	1,146,815

Ribbonfishes : The landings formed 4.0% of the total marine fish production and 8.0% of the pelagic fish landings. When compared to 1992, there was a reduction of about 19,000 t in the landings of ribbon fishes with an estimated 91,000 t during 1993.

Tunnies : The landings of these fishes accounted for 1.5% of the total marine fish production of the country and 2.9% of the pelagic fish catch. The landing was 44,000 t during 1993 which registered a marginal decline of about 600 t.

CONTRIBUTION OF DEMERSAL FISHES

Catfishes : Catfish landings accounted for 3.0% of the total production and 6.0% of the demersal fish production. The estimated catch of 42,000 t in 1993 showed a slight increase of 6,000 t over 1992. (Table 3).

Table 3. *Estimated landings (in tonnes) of demersal finfish and shellfish in India during 1992 and 1993*

Name of fish	1992	1993*
Elasmobranchs		
Sharks	44458	47306
Skates	1957	1507
Rays	15962	18773
Eels	6546	5980
Catfishes	36247	42514
Lizardfishes	28939	25504
Perches		
Rock cods	8548	10837
Snappers	2762	3060
Pig-face breams	4433	6876
Threadfin-breams	67405	86752
Other perches	32586	40619
Goatfishes	17238	13820
Threadfins	7914	6725
Croakers	162700	161105
Silverbellies	51934	62304
Big-jawed jumber	6575	4184
Pomfrets		
Black pomfret	10840	12472
Silver pomfret	22989	28487
Chinese pomfret	245	940

*Provisional

Name of fish	1992	1993
Flatfishes		
Halibut	2012	1783
Flounders	933	182
Soles	60399	44611
Crustaceans		
Penaeid prawns	186917	175228
Non-penaeid prawns	91274	68968
Lobsters	2011	1862
Crabs	26940	26973
Stomatopods	72688	86492
Molluscs		
Cephalopods	89493	95739
Miscellaneous	40635	46278
Total Demersal	1,103,580	1,127,881

Elasmobranchs : Elasmobranchs accounted for 3.0% of the total marine fish landings of the country and 6.0% of the demersal fish landing with the estimated catch of 68,000 t in 1993.

Perches : The estimated landings of perches at 148,000 t showed an increase of 32,000 t over the landing of 1992. Perches accounted for 6.5% of the total marine fish production and 13.1% of demersal fish catch. The increased landings were contributed mainly by the southwest region.

Croakers : With an estimated landing of 161,000 t, the croakers accounted for 7.1% of the total landings and 14.3% of the demersal fish catch. When compared to the landings in 1992, the landings in 1993 did not show appreciable difference.

Pomfrets : Pomfrets accounted for 1.8% of the total marine fish production of the country and 3.7% of the total demersal landings. The landing was estimated at 42,000 t in 1993; an increase of 8,000 t was obtained over 1992.

CONTRIBUTION OF SHELLFISHES

Cephalopods : Cephalopod landings increased by 6,000 t in 1993, the estimate being 96,000 t. Cephalopod landings accounted for 4.2% of the total marine fish production and 8.5% of the demersal landings (Table 3).

Penaeid prawns : The estimated penaeid prawn landings in the marine capture fisheries of the country was 175,000 t in 1993. A decline of 12,000 t was recorded in the landings when compared to 1992. The penaeid prawn landings accounted for 7.7% of the total catch and 15.5% of demersal fish catch. The reduction in the landings was attributed to the decline along the southwest region.

Non-penaeid prawns : Non-penaeid prawns accounted for 3.0% of the total marine fish production of the country during 1993; the estimate was 69,000 t which was 22,000 t less than the landing of 1992. The reduction was primarily assigned to the reduced catches along the northwest region.

Landings by mechanised and non-mechanised units

Mechanised units accounted for 85.8% of the total marine fish production of the mainland in 1993. An upward trend (2.6%) in the landings of mechanised units was noticed in 1993. Units having mechanical power for propulsion as well as fishing (Category I) contributed 1,270,000 t (55.8%) and units having power for propulsion alone (Category II) accounted for 652,000 t (28.7%) in the total production. There was an increase of 50,000 t in the production of Category I units. However, landings by Category II units declined by 36,000 t in 1993 when compared to the landings of 1992. The reduction was noticed primarily in the landings of outboard engine units of the southwest region. Landings by the non-mechanised units (Category III) formed 353,000 t showing a reduction of 41,000 t.

In the landings from each region (Table 4), category II units landed maximum catch in the northeast coast followed by category I and category III. In the southwest and northwest regions also the maximum contribution came from category I units followed by category II

and III. The situation was similar to the one recorded in 1992 (Table 4)

Table 4. *Contribution (%) of different categories of units to the landings in each region of India during 1992 and 1993*

Region	1992 Category			1993 Category		
	I	II	III	I	II	III
Northeast	22.0	64.0	14.0	24.36	58.57	17.07
Southeast	46.7	11.6	41.7	51.52	14.02	34.46
Southwest	60.0	35.3	4.7	66.07	28.96	4.9
Northwest	56.8	32.4	10.8	56.22	33.57	10.2

In the landings by each category of units (Table 5), the category I (mechanised propulsion of fishing) produced maximum landings in 1993 along southwest coast, followed by northwest, southeast and northeast regions, there being no change over the situation observed in 1992. In the Category II (mechanised propulsion only), northwest coast was responsible for highest landings in 1993 followed by southwest, northeast and southeast coasts; during 1992, however, maximum contribution in this category came from southwest coast. In the non-mechanised units (Category III) maximum catch came from southeast coast followed by northwest, southwest and northeast coasts. Almost the same pattern existed in 1992 also (Table 5)

Table 5. *Contribution (%) of each category of units to the landings in different regions of India during 1992 and 1993*

Region	1992 Category			1993 Category		
	I	II	III	I	II	III
Northeast	2.3	11.8	4.8	2.9	13.9	8.2
Southeast	20.5	9.0	61.3	20.9	11.0	55.4
Southwest	40.8	42.4	10.7	43.7	37.3	13.0
Northwest	36.4	36.8	23.2	32.5	37.8	23.4

Table 6. *Effort (1000 units), Catch (tonnes) and CPUE (kg) of each category of units along different regions in 1992 and 1993*

Region	Category	1992			1993		
		Effort	Catch	CPUE	Effort	Catch	CPUE
Northeast	I	94	27941	297	121	37581	311
	II	260	80969	311	253	90350	356
	III	397	17498	44	494	26319	53
Southeast	I	624	249323	400	671	264904	395
	II	745	63084	83	1046	72097	69
	III	4711	222878	47	4508	177150	39
Southwest	I	833	495606	561	932	554402	595
	II	1181	291524	247	1306	242992	186
	III	1353	38755	29	1239	41712	34
Northwest	I	359	442427	1232	381	412726	1085
	II	972	253031	260	966	246465	255
	III	485	84514	174	363	74910	206

Category I - Units having mechanised power for fishing as well as propulsion, Category II - Units having mechanised power for propulsion only, Category III - Units having no mechanised power.

Regionwise, categorywise effort, catch, and CPUE are presented in Table 6. CPUE under Category I improved over 1992 in the northeast and southwest regions though there was increase in effort. In the northwest region, a reduction in CPUE in Category I appears to have resulted due to increased effort. There was an increase in CPUE of units under Category III probably because of decline in effort. In the southwest region, CPUE declined from 247 kg in 1992 to 186 kg in 1993 in category II; this has resulted mainly due to the fall in the catches of ring-seine units operated along the Kerala Coast. The effort expended under Category III (non-mechanised) in 1993 showed that there was reduction of 114,000 unit operations in the southwest region when compared to 1992. A comparable situation was seen along the southeast and southwest regions also. There was improvement in CPUE in the northwest region of the units under category III, from 174 kg in 1992 it increased to 206 kg in 1993.

Though, comparison of landings by different components within each category such as trawl and purse-seine under Category I and shoreseine and hook and line in Category III may not be meaningful, the above analysis indicates changing pattern of operation of different categories and the differences in their catch rates.

Stock Assessment Techniques in Fisheries Research and Management (FSS/FRA/1.3)

K. ALAGARAJA, K. BALAN, K. S. SCARIAH AND T. V. SATHIANANDAN

An attempt was made to use Gompertz model in the place of conventional VBG growth model for stock assessment of exploited resources. The work is in progress. Existing models of simulation of length frequency were modified and were being tested for their suitability with the computer programme developed at the Computer Centre.

Management Information System in Marine Fisheries (FSS/FRA/ST.1)

T. V. SATHIANANDAN, K. ALAGARAJA, K. BALAN, K. S. SCARIAH AND K. VIJAYALEKSHMI

A software for gearwise and specieswise estimation of daily landings with provision for merging was developed for the Research Centres.

Software with modules for data entry, data analysis and information retrieval was developed for the computerisation of biological data such as, length, weight, sex, maturity stage and stomach content of different marine fish species collected from different research centres of CMFRI for the past many years. Creation of the data base is in progress with the data collected from Mangalore, Tuticorin and Vizhinjam Research Centres.

Evaluation of Change in the Pattern of Catch and Composition of Marine Fishery Resources in India (FSS/FRA/1.19)

K. S. SCARIAH AND K. VIJAYALEKSHMI

A report on the changes in fishing pattern and resource composition of marine fisheries of Kerala was completed. Tracing the history of development of marine fishing activities of

the State, the report discussed the changing pattern of the fishery in recent years in the context of motorisation of fishing craft, introduction of ring-seines and specieswise production trend.

The study revealed that presently the inshore region of Kerala upto 50 m depth stands as one of the highest exploited region in the subcontinent. Though the fishermen belonging to the artisanal sector could successfully motorize their craft, the extension of area of operation did not increase the catch in tune with the pace and intensity of motorisation. This has led to competition and conflicts among the fishermen of motorised fishing craft and between motorised and non-motorised fishing sector leading to undesirable consequences. This situation along with the declining trend in the catch warrants close monitoring of the exploited marine fishery resources of Kerala for evolving appropriate measures for management and conservation of the resources of the State.

FORECASTING THE FISHERY OF THE OILSARDINE, MACKEREL AND BOMBAY-DUCK IN THE FISHING GROUNDS (CMFRI/IDP/I)

K. ALAGARAJA AND T. V. SATHIANANDAN

Using the annual landing data of the period 1950-92 in respect of oilsardine, mackerel and Bombay-duck, spectral analysis was attempted to bring out the inherent periodicity, if any, in these time series. The models fitted explained 88.3% of variations in oilsardine, 83.2% in mackerel and 81.7% in Bombay-duck landings. The major cyclic components identified are 21 and 11 year cycles in both oilsardine and mackerel landings, and 21, 11 and 7 year cycles in Bombay-duck landings. Using the fitted model, expected landings were computed and its plot along with observed landings for oilsardine, mackerel and Bombay-duck are shown in figures (see plates 2 and 3). Projections of landings using the estimated spectral models showed the future years of peak landings as 2010/2011 for oilsardine, 2,014 for mackerel and 1,999 for Bombay-duck.

IMPACT OF RING-SEINE OPERATIONS ON THE FISHERY OF KERALA AND KARNATAKA COASTS (CMFRI/IDP/4)

K. BALAN AND R. SATHIADAS

Along the Kerala Coast, ring-seine is primarily operated in the region from Sakthikulangara to Kasargode. In Karnataka the same (*Mattubala*) is in operation in both the coastal districts. Nine centres on these two States are identified to collect data on economics of operation of ring-seine units.

The catch and effort data were collected from the Institute's project on assessment of exploited fishery resources of these States.

A detailed report is under preparation on the economics of operation and the impact of these units on the fishery of the respective States.

PELAGIC FISHERIES DIVISION

Recent studies on the population characteristics of major pelagic fish resources have revealed a fairly good picture of the stocks in the Indian waters. Considering the dynamic nature of the resources and their changing pattern of exploitation, the Division undertook 9 Research Projects on a priority basis during the year.

FISHERY AND RESOURCE CHARACTERISTICS OF *SARDINELLA* SPP. (PF/RE/1/1)

A. A. JAYAPRAKASH, K. PREETHA, PRATHIBHA ROHIT, P. SAM BENNET AND N. S. RADHAKRISHNAN

The oilsardine *(Sardinella longiceps)* landings on the west coast started declining from 222,000 t in 1990 to 56,000 t in 1993. On the other hand, a relative increase in its catch was observed on the east coast from 14.8% in 1990 to 42.4% in 1993, though the total yearly landing was established around 38,000 t during these four years.

During 1993-'94 the total sardine catch at five centres on the west coast and at three centres on the east coast was 3,959 t and 2,099 t respectively. The catch has decreased by 82% at Karwar and Malpe, 52% at Mangalore, 75% at Cochin and 69% at Madras. The catch at Karwar (43 t) was entirely by purse seines. Out of 2,084 t landed at Mangalore, 99.5% was by purse seines and the rest by trawlers. The ring-seines (97.6%) and *Chalavala* (2.4%) contributed to 433 t at Calicut. At Cochin a total catch of 689 t was landed mainly by purse seines (90%) and ring-seines (10%). At Tuticorin, the total catch was 993 t landed exclusively in gillnet. At Madras, 88.9% of the total sardine catch (99.3 t) came from *Edavala* and 9.8% from *Kavalavalai*. Out of 134 t landed at Visakhapatnam the gear-wise contributions were : 69% by gillnets, 16.8% by boatseines and 14% by trawl net.

Among the lesser sardines *Sardinella gibbosa* was the dominant species in all the centres except at Karwar where the purse-seine catch consisted of only *S. fimbriata*. The gillnet catch at Tuticorin was composed of a number of lesser sardine species. *S. brachisoma* was noticed only at Mangalore and Malpe.

Both young ones (80-95 mm) and adult of *S. gibbosa* represented the catch in the purse seines and the trawl nets at Mangalore and in the boat seines at Visakhapatnam, while in other centres the size range was within 110-210 mm. Young ones (70 mm) of *S. gibbosa* occurred at Madras and in other centres the size ranged from 100-170 mm. With respect to *S. fimbriata* mostly pre-adults (100-125 mm) constituted the catch at Karwar and had a size range of 105-175 mm in other centres except at Mangalore, where the trawl catch was composed of 65-90 mm fish.

At Mangalore, the spawning population of oilsardine amounted to 11%. At Visakhapatnam 9% of the population was in the spawning stage and the spawning season was during December-January. *S. fimbriata* of the size 100-125 mm caught at Karwar was mostly (86%) indeterminate. At Mangalore and Malpe spawning season of *S. gibbosa* was during November-January and females dominated the catch. At Tuticorin, the gravid stage formed 10% and the spawning season appeared to be during July-September and December-March.

Recruitment size of oilsardine at Mangalore was 95 mm in the purse seine during May and September, and 80 mm in trawlnet during September. The recruitment sizes in other centres were 125 mm at Cochin

in January, 110 mm during June and September at Madras, and 60 mm in the boat seines at Visakhapatnam during April and July. At Tuticorin, new recruits of *S. gibbosa* (100 mm) occurred during July-August and of *S. fimbriata* (65 mm) in the trawlers during September.

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

N. S. RADHAKRISHNAN, M. ZAFAR KHAN, PRATHIBHA ROHIT, A. A. JAYAPRAKASH AND G. GOPAKUMAR

The total catch of anchovies was 5298 t at 5 centres on the west coast and 652 t at Madras on the east coast. *Dol* nets, trawl nets, purse-seines, ring-seines, boat-seines and shore-seines exploited the resources at different centres. Increase in the catch was noticed in *dol* net at Bombay and in trawls and purse-seines at Mangalore. The *dol* net catch at Bombay was 290 t, while at Mangalore the purse-seine landed 2,274 t and the trawlers 1,705 t. The catch at Malpe reduced to 320 t, with 290 t in trawls and 30 t in purse-seine. At Cochin a total of 601 t was landed by trawlers (481 t) and ring-seines (120 t). The ring-seine catch was down by 41%. Nearly 108 t were recorded at Vizhinjam were boat-seines (91 t), *Netholivala* (11 t) and shore-seines (6 t) were the major gears. At Madras the entire catch (652 t) came from trawl net.

Though *Coilia dussumieri* exhibited a regional dominance at Bombay, *Stolephorus devisi* generally dominated or remained in the second place along both the coasts. Other species noticed were *S. bataviensis, S. buccaneeri* and *S. commerson. S. macrops* dominated in the ring seine catch at Cochin.

C. dussumieri had a size range of 50-199 mm. Most of them were in developing stage and a few fishes were in gravid condition. At Mangalore, both in trawl and in purse-seine the size of *S. devisi* ranged from 55 to 95 mm. The adults constituted 97-99% of the catch. Gravid fishes formed 16% and the rest were in resting and in developing stages. The same trend was noticed at Malpe. *S. bataviensis* of the size range 70-105 mm were recorded in trawlers. In both the species spawning was noticed during October-December. At Cochin, the size range of these species did not show any significant variation than those noticed at Mangalore and the spawning season appeared to be around September and March. The size of *S. macrops* was 40-95 mm in ring-seine during the monsoon period. At Vizhinjam, *S. devisi* had a size range of 60-99 mm in *Netholivala* and boat seine, and 34-94 mm in shore-seines. *S. commerson* never occurred as a fishery in the west coast, but in the east coast it formed a fishery at Madras along with *S. bataviensis*. The size ranges of these species were 70- 139 mm for *S. commerson* and 60-114 mm for *S. bataviensis*.

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

C. MUTHAIAH, K. P. SAID KOYA, ALEXANDER KURIAN, N. G. K. PILLAI AND H. MOHAMAD KASIM

Along the west coast, seerfishes were exploited by gillnets and trawlers at Veraval; gillnets, trawlers and purse-seines at Mangalore/Malpe and Cochin, and by gill nets at Bombay and Calicut. Along the east coast, gill nets, hooks and lines and trawlers were the major gears.

The estimated catch was 1,710 t at Veraval, 71 t at Bombay, 853 t at

Mangalore/Malpe, 117 t at Calicut, 377 t at Cochin, 491 t at Tuticorin and 464 t at Madras. The catch increased by 42% at Tuticorin, 18% each at Veraval and Mangalore/Malpe and 26% at Cochin, but declined by 66% at Calicut. The peak fishing season was December at Veravel, January at Bombay, October at Mangalore/Malpe, April at Calicut, August at Cochin, July at Tuticorin and April at Madras.

The gillnet was the popular gear for seerfishes all along the coast and was the only gear at Bombay and Calicut. It contributed 79% at Veraval, 38% at Mangalore/Malpe, 56% at Cochin, 25% at Tuticorin and 38% at Madras. The catch varied from 71 t at Bombay to 1,348 t at Veraval. While the catch improved by 11% at Veraval, it decreased by 14% at Mangalore/Malpe, 66% at Calicut, 6% at Cochin, 17% at Tuticorin and 13% at Madras. The C/E varied from 11 kg at Bombay to 200 kg at Madras. It declined at all the west coast centres except at Veraval and increased in the east coast centres.

Scomberomorus commerson was the dominant species forming 63% followed by *S. guttatus* (36%) and the rest by *S. lineolatus* and *Acanthocybium solandri*. *S. commerson* was available in all the centres, but *S. guttatus*, which was absent at Calicut, dominated at Veraval (65%), Bombay (100%) and Madras (55%).

S. commerson in the *Podivala* at Tuticorin had a size range of 18 - 78 cm with 22-48 cm group supporting the fishery. In large meshed gillnets the catch was mostly constituted by 32 cm to 130 cm size fish. At most of the centres the fishery was supported by 40-92 cm size fish which constituted 70-95%. The trawl catch was composed of 10 cm to 100 cm size fish with 20-58 cm forming 71- 85% of the catch at various centres. In the hooks and line the size range was 44-140 cm, with 86-112 cm size groups supporting the fishery. *S. guttatus* had a size range of 28-52 cm at Madras and 8-78 cm at Veraval in gillnets.

The growth parameters and mortality rates of *S. commerson* at Tuticorin were estimated as $L\alpha$ = 1938 mm, K = 0.2006 and t_0 = 0.0835, M = 0.57, Z in different gears as 2.03 in *Paruvalai*, 5.49 in *Podivalai*, 4.34 in trawlnet and 1.69 in hooks & line and F as 1.46, 4.92, 3.77 and 1.12 respectively. The exploitation rate (U) was 0.62, 0.89, 0.85 and 0.54 respectively.

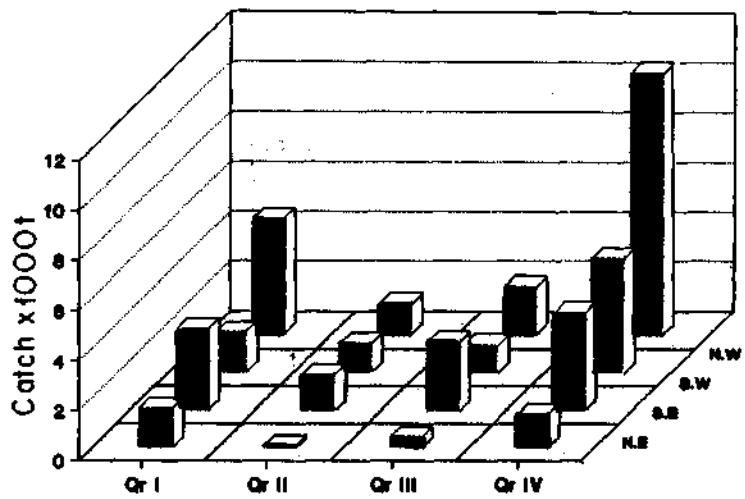
Studies on the mortality rates of *S. commerson* at Mangalore showed that the species was being exploited close to the optimum level by gillnet, whereas the fishing pressure by trawl was far above the optimum wherein a recruitment overfishing was suspected.

FISHERY AND RESOURCE CHARACTERISTICS OF TUNAS AND BILLFISHES (PF/RE/2.2)

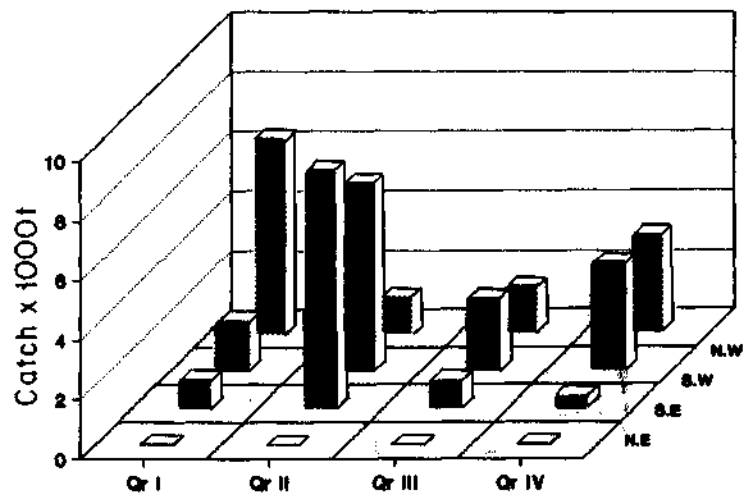
P. P. PILLAI, K. P. SAID KOYA, M. ZAFAR KHAN, T. M. YOHANNAN, N. G. K. PILLAI, G. GOPAKUMAR, H. MOHAMAD KASIM, M. SIVADAS AND A. K. V. NASSER

Tunas were mainly exploited by gillnets in all the centres and also by purse-seines at Mangalore, Malpe and Cochin, by hooks and lines at Vizhinjam and Tuticorin, and by pole and lines at Minicoy. The total catch in observation centres was 14,856 t, of which gillnets contributed to 84.5%, hooks and lines 6.9%, pole and lines 6%, purse-seines 2.6% and troll lines 0.1%.

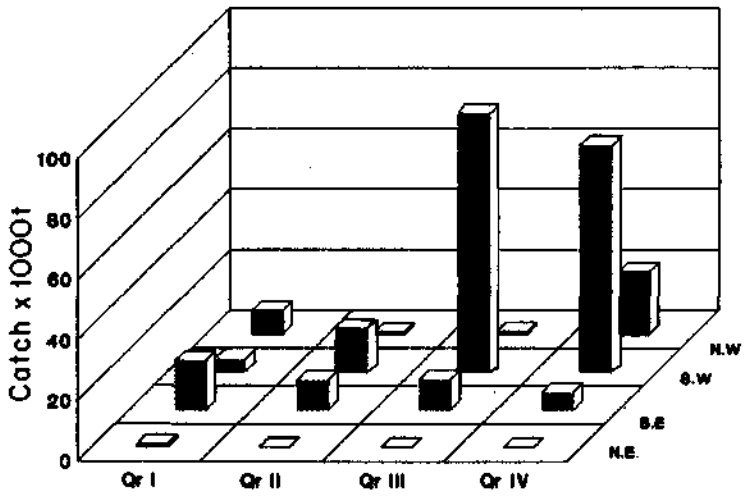
The tuna catch in gillnet varied from 104 t at Calicut to 1,299 t at Vizhinjam and the C/E varied from 16 kg at Calicut to 197 kg at Veraval. A decrease in gillnet catch by 34-62% was noticed at Mangalore, Malpe,



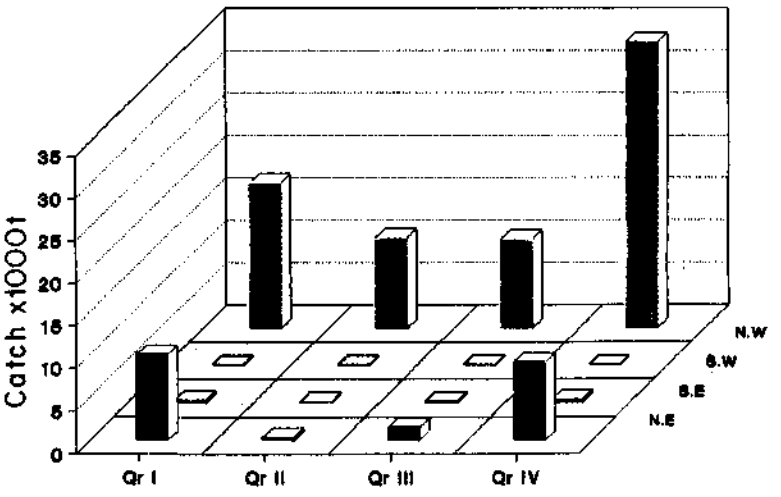
Estimated landings of seerfish at different regions along the Indian Coast during different quarters in 1993.



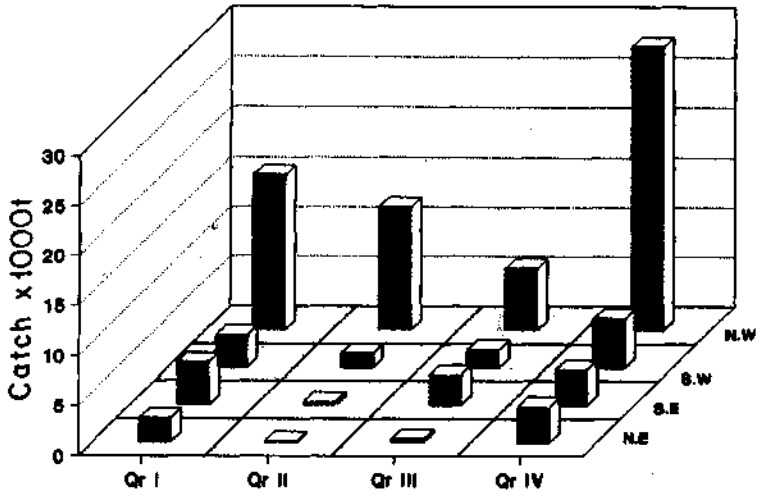
Quarterly estimated landings of tunas at different regions along the Indian Coast during 1993



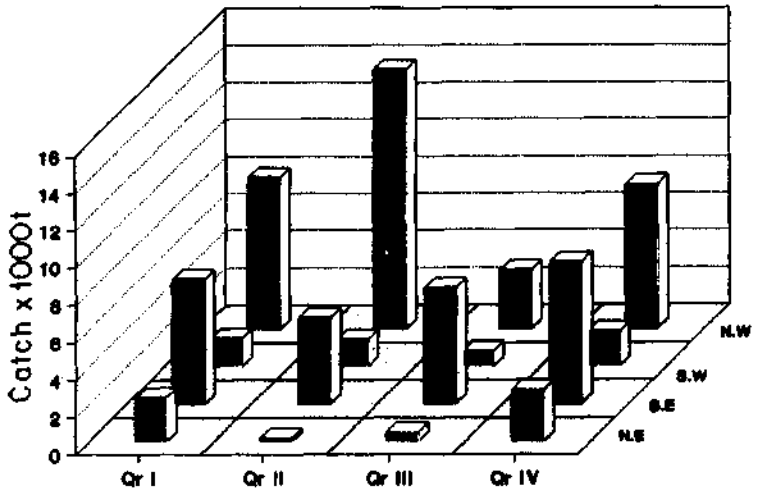
Quarterly estimated landings of Indian mackerel at different regions along the Indian Coast during 1993.



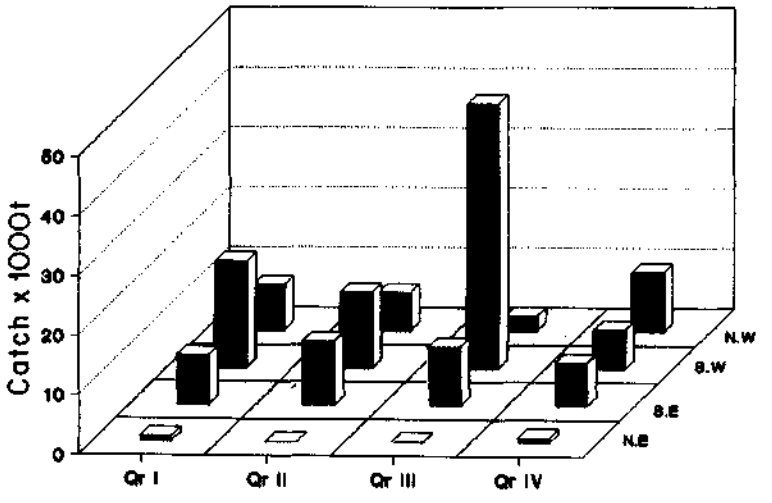
Quarterly estimated landings of Bombay-duck at different regions along the Indian Coast during 1993.



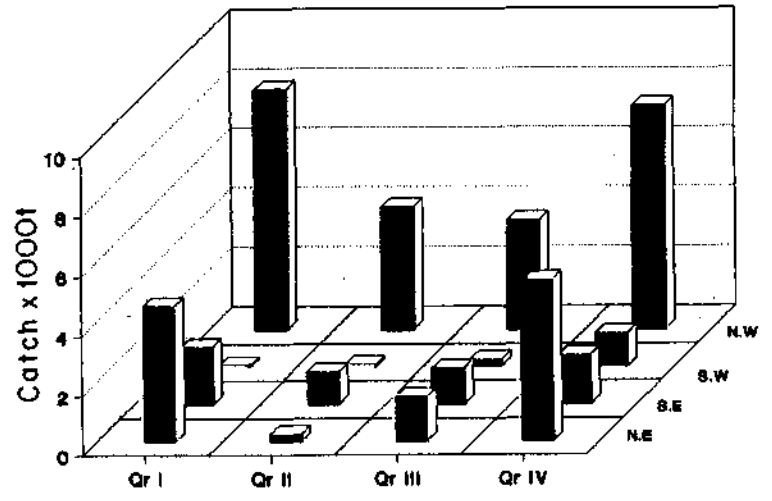
Quarterly estimated landings of ribbonfish at different regions along the Indian Coast during 1993.



Quarterly estimated landings of elasmobranchs at different regions along the Indian Coast during 1993.



Quarterly estimated landings of perches at different regions along the Indian Coast during 1993.



Quarterly estimated landings of catfish at different regions along the Indian Coast during 1993.

Calicut and Tuticorin. Increase in effort input by 34% was noted at Mangalore, but at Calicut and Tuticorin it declined by 19% and 24% respectively leading to diminished catch and C/E. At Tuticorin, inspite of 44% increased effort input by *Podivalai*, the catch declined by 79%.

The purse-seines landed 52 t at Mangalore and 83 t at Malpe with C/E of 6 kg. The catch was nearly 97% less compared to last year. At Cochin 248 t at C/E of 96 kg was landed.

The hooks and lines contributed to 2 t at Tuticorin and 1,017 t at Vizhinjam.

Total catch at Minicoy was 906 t, of which 98% was by pole and lines and the rest by troll lines. An increase by 8% in effort input, 57% in catch and 46% in C/E was noted in pole and line.

The peak fishing season was during August, November and December at Veraval; post-monsoon period at Mangalore; June-July at Cochin and Vizhinjam; and the monsoon and the post-monsoon periods at Tuticorin.

Species in the order of abundance were *Euthynnus affinis* (37.9%), *Thunnus tonggol* (21.5%), *Auxis thazard* (19.5%), *T. albacares* (9.4%), *A. rochei* (5.5%), *Sarda orientalis* (4.8%) and billfishes (1.4%). The longtail tuna (*T. tonggol*) in the gillnet catch at Veraval and its abundance decreased towards south. The yellowfin tuna which constituted a minor fishery in the late eighties, has now established as a fishery with the highest catch of 167 t at Veraval, followed by 154 t at Cochin and 124 t at Tuticorin.

In the hooks and lines *A. rochei* was the dominant species (75.4%), whereas in the purse-seines it was *E. affinis*, in the pole and lines Skipjack (82%) and in the troll lines, yellowfin tuna.

The size range of little tunny (*E. affinis*) was 18-78 cm. Smaller specimens (20 cm) of frigate tuna (*A. thazard*) were seen only at Veraval. The longtail tuna (*T. tonggol*) had a larger size range (28-98 cm) in the northern centres than in the southern centres (30-62cm). The length range of yellowfin tuna (*T. albacares*) was 48-120 cm and that of bullet tuna (*A. rochei*) was 18-32 cm.

Skipjack tuna (*Katsuwonus pelamis*) had a size range of 28-68 cm in the pole and lines and 48-64 cm in troll lines.

At Mangalore the studies revealed that the present level of exploitation of little tunny was far below the optimum level and had not reached the MSY. The estimated values of Z, M and F were 0.93, 0.71, 0.22 respectively. At Tuticorin the growth parameters L_∞ K and t_0 for males of little tunny were 798 mm, 0.8017 and -0.0109 respectively. The corresponding values for frigate tuna were 603 mm, 1.2268 and -0.0021 for males and 630 mm, 0.9664 and -0.0012 for females.

As inferred from the exploitation ratio and exploitation rates the females of little tunny and both sexes of frigate tuna are under high fishing pressure. The mortality rates of little tunny were estimated as M = 1.14, Z = 2.15 and F = 1.01 for males and 1.23, 4.15 and 2.92 respectively for females. For frigate tuna the estimates were M = 1.88, Z = 7.09 and F = 5.21 for males and M = 1.49, Z = 7.87 and F = 6.38 for females.

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

T. M. YOHANNAN, G. GOPAKUMAR, K. PREETHA, PRATHIBHA ROHIT, P. P. PILLAI, P. N. RADHAKRISHNAN NAIR, H. MOHAMAD KASIM, V. GANDHI AND G. LUTHER

On the west coast, mackerel *Rastrellinger kanagurta* was exploited by purse-seines, trawlnets, gillnets, ring-seines and artisanal gears and on the east coast mainly by gillnets and trawlnets.

Along the west coast the fishery showed considerable improvement during the year. The mackerel catch in purse-seine was 16,532 t showing a remarkable increase by 57% compared to last year and formed 15-65% of the total catch of purse-seines. The centre-wise landings ranged from 2,788 t at Cochin to 5,409 t at Mangalore. The highest C/E of 1,028 kg was at Cochin and the lowest (588 kg) at Mangalore. Significant improvement in the C/E was recorded in all these centres. The effort input increased 26% at Cochin and 1% at Mangalore while it decreased by 34% at Malpe and 9% at Karwar.

On the east coast, the fishery showed declining trend at Mandapam and Kakinada, but improved at Visakhapatnam. Out of 216 t of mackerel landed at Tuticorin 70% was by trawlers. At Mandapam, 2,833 t were landed of which 80% by gillnets and the rest by trawlers. The trawlers at Kakinada landed 526 t. At Visakhapatnam out of 156 t landed, nearly 73% was by drift gillnets and rest by trawlers.

The fishing season at Vizhinjam was during April-May and at other centres on the west coast between August and November. While no clear peak season was noticeable at Visakhapatnam, at other centres on the east coast, fishing season was mostly during July to September/October.

The size range of mackerel in the purse-seines at Cochin was 180-275 mm, at Mangalore/Malpe 70-260 mm and in the trawlers at Mangalore, Malpe and Cochin, 80-265 mm, 115-260 mm and 105-279 mm respectively.

At Mangalore, young ones of mackerel were noticed during May, September, February and March, whereas at Vizhinjam it was during August, September and March. On the east coast, at Visakhapatnam, the juveniles were recorded during March, May, October and November.

Spawners of mackerel occurred almost throughout the year at Mangalore, Vizhinjam and Visakhapatnam while at Calicut they were noticed during February-March; at Cochin during May-June and October-November; and at Mandapam during March.

The stock assessment conducted at Tuticorin indicated that mackerel is exposed to moderate to high fishing pressure by both *Podivala* and trawl and the exploitation ratio is just above the optimum level.

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

ALEXANDER KURIAN AND K. P. SAID KOYA

At Bombay, 984 t of Bombay-duck was landed by 10,373 *dol* net units at a C/E of 95 t forming 63% of the total catch of the gear. The average monthly catch was 81.9 t. The C/E varied from 12 t in June to 415 t in May. The peak fishing season was during April-June (60.6%) followed by October-December (18.5%). The size range of the species was 30-330 mm. Recruitment (30 mm) occurred during May and October-November. On an average the juveniles of 30-74 mm constituted 0.8% with a maximum abundance during May and October.

At Veraval, the catch was 25,526 t at a catch/haul of 141 t. The catch, effort and C/E came down by 60%, 24% and 47% respectively compared to previous year. Among the three *dol* net fishing centres Rajpara contributed to 11,076 t (43%) followed by Jaffrabad (33%) and Nawabunder (24%). Compared to Bombay area the size ranged from 30-389 mm and sexes were equally represented. Nearly 36% were in

advanced stage, 59% in developing and 5% in spent condition. The food mainly consisted of *Coilia* spp., *Acetes* spp., sciaenids, Bombay-duck, *Polynemus* spp., *Bregmaceros macclellandi*, prawns, *Loligo* spp., and crabs. Feeding intensity was maximum during October and December.

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

P. N. RADHAKRISHNAN NAIR, K. K. JOSHI, M. ZAFAR KHAN, K. PREETHA, S. LAZARUS, P. SAM BENNET AND A. RAJU

On the east coast at Kakinada, Madras and Tuticorin, only trawlers exploited this resource and the total landings were 2,533 t, 1,631 t and 0.6 t respectively. At Visakhapatnam both trawlers and boat seines exploited the resource and the landings were 199 t in the former and 4.1 t in the latter gears.

On west coast, ribbonfish was exploited by trawlers at Cochin, Karwar and Bombay; trawlers and gillnets at Veraval; mechanised and non-mechanised boat-seiners, gillnets and hooks and line at Vizhinjam. The C/E in trawl was the highest (152 kg) at Veraval and the lowest (7 kg) at Cochin and Karwar. The catch ranged between 74 t at Karwar and 11,326 t at Veraval. The gillnet catch was 313 t at Madhvad, 133 t at Veraval and 55 t (0.9 t) at Vizhinjam. At Vizhinjam the catch was mostly by mechanised hooks and line (37.5%), and boat-seines (31.5%).

At Veraval, gillnets were employed for exploitation of this resource throughout the year and trawl nets except during the monsoon. In trawl nets, the peak catch was observed during October-January at Veraval; April-May and September-March at Bombay; and April-May and November-March at Karwar. At Cochin, the best season was during September-October and January-March. At Madras also January-March landed the highest catch (42%) followed by October-December (40%). At Kakinada, October-December was the peak season. At all centres *Trichiurus lepturus* constituted the catch.

Both young ones (20-22 cm) and large sized specimens (102-110 cm) occurred in trawlers in the northern latitudes. At southern centres the size range was within 31-88 cm. The boat seine catch constituted of smaller (25-60 cm) specimens at Vizhinjam.

At Kakinada, females dominated in the catch. Adults formed 52% and spawners seemed to occur during January-February. At Madras, recruitment size was 15 cm observed in March and at Tuticorin, 31 cm during July. At Vizhinjam, the recruitment size was 10 cm in boat-seine, 50 cm in gillnet and 60 cm in hooks and line. Spawning occurred during September-October and January-March. At Cochin and Karwar females dominated and the recruitment sizes were 32 cm and 43 cm respectively. At Bombay and Veraval the dominance of female was insignificant and the recruitment size was 40 cm in the former centre and 20 cm at the latter.

In general 79% of the total ribbonfish catch was from the west coast and 21% from the east coast. On both these coasts the northern sectors produced the bulk of the catch.

INVESTIGATIONS ON THE FISHERY AND RESOURCE CHARACTERISTICS OF TUNA LIVE-BAITS IN LAKSHADWEEP (PF/RE/5)

M. SIVADAS AND A. K. NASSER

Investigations on the tuna live-baits at Minicoy, Agatti, Bingaram and Peremul Par revealed that their exploitation was far greater in the northern islands than at Minicoy. At

Agatti 21.7 t were used in three months against 12.8 t utilised at Minicoy. The catch of tuna per 1 kg of live-bait (CPUB) was 69 kg at Minicoy and 16 kg at Agatti. At Minicoy, sprats, apogonids and caesionids were the major groups. Among sprats *Spratelloides delicatulus* and in apogonids, *Archamia fucata* were the common species. At Agatti, the principal species exploited was *S. delicatulus* (96.7%). The lagoon at Peremul Par was the leading fishing ground during January-February. In March, a sizeable fishery was witnessed at Agatti and Bingaram. Peremul Par contributed to 60% of the total live-bait fishery.

At Minicoy the shifting of exploitation from one species/groups to another reduced the fishing pressure and also allowed the resources to resuscitate. However, at Agatti the exploitation of live-baits far exceeded the requirement and hence the low CPUB.

S. delicatulus had a size range of 15-60 mm at Minicoy and 24-60 mm at Agatti. Stages V and VI dominated at Minicoy, while all stages represented at Agatti.

FORECASTING OF OILSARDINE, MACKEREL AND BOMBAY-DUCK IN THE FISHING GROUNDS (CMFRI/IDP/1)

G. LUTHER, M. S. RAJAGOPALAN, K. ALAGARAJA, ALEXANDER KURIAN, P. N. RADHAKRISHNAN NAIR, T. V. SATHYANANDAN AND S. MUTHUSAMY

The data on the catch trends and biological features of mackerel at Cochin for the period 1978-82 were compiled for correlating with the environmental parameters in the fishing grounds so as to evolve a forecasting system. The lipid content of oil-sardine and mackerel, both sizewise and seasonwise was studied to correlate with the spawning activity.

DEMERSAL FISHERIES DIVISION

Studies undertaken during the year have shown that the demersal finfish production was mostly realized by bottom trawlers operated upto 60 m off Madras, 70 m off Bombay, 80 m off Tuticorin and 120 m off Cochin. In many cases, the operations were for "double day" fishing. Other gears such as bottom set gill nets, drift nets, long-lines and hooks and lines, were operated for elasmobranchs and perches, venturing upto 200 m depth.

STUDIES ON THE RESOURCES AND BIOLOGY OF ELASMOBRANCHS (DF/RE/1)

P. DEVADAS, G. MOHANRAJ, S. G. RAJE, GRACE MATHEW, V. GANDHI AND K. M. S. A. HAMSA

The annual production of elasmobranchs at Bombay was 3,532 t by trawlers with 121 kg CPUE which was lesser by 10% from last year. The other major centres of production were Madras 1,227 t, Tuticorin 698 t and Rameswaram 402 t, all by trawlers. At Bombay, sharks formed 68%, followed by rays 20%. *Scoliodon laticaudus* (20-62 cm) was the dominant shark and *Dasyatis zugei* was the dominant ray. At Madras, rays dominated the production (89%), followed by sharks (7%) and guitar-fishes (4%). *Dasyatis jenkinsei* varied from 20 to 110 cm in length (mean, 68 cm) *A. narinari* from 40 to 185 cm (mean 109 cm) and *Rhizopriodon javanica* from 30 to 175 cm (mean 117 cm). Deep sea trawlers operating during January-March landed 127 t of the deep sea shark *Echinorhinus brucus* from a depth of 200-300 m off Tuticorin.

STUDIES ON THE BIOLOGY AND FISHERIES OF PERCHES (DF/RE/2)

S. LAZARUS, GRACE MATHEW, K. M. S. A. HAMSA AND V. GANDHI

The perch fishery was active almost throughout the year with higher landings during December - February at Vizhinjam and during May - October around Tuticorin. Hooks and lines was the gear at Vizhinjam, but trawls, gillnets and traps were used in other centres. Lethrinids was the most dominant group in most centres, but *Pristipomoides typus* was dominant at Cochin. *Epinephelus undulosus* was the dominant serranid in almost all the centres. *Lethrinus nebulosus* ranged in length from 20 to 52 cm at Vizhinjam, while at Tuticorin the range was from 12 to 60 cm. *P. typus* had a size range of 22 to 75 cm; *L. rivulatus* 42 to 80 cm at Tuticorin, with the mode at 62 cm and *E. undulosus* from 30 to 88 cm, with the mode at 62 cm.

STUDIES ON THE BIOLOGY AND RESOURCE MANAGEMENT OF CATFISHES (DF/RE/3)

N. G. MENON, G. MOHAN RAJ, S. G. RAJE, P. LIVINGSTON, P. U. ZACHARIAH, M. FEROZKHAN, P. JAYASANKAR, E. VIVEKANANDAN AND P. APPANNA SASTRY

During the year catfish landings continued a declining trend at most of the centres. The landings were chiefly achieved by trawls and gillnets. There were no catfish

landings in the purse-seiners along the Karnataka and Kerala Coasts. Juveniles/young fishes were predominant in trawl landings. At Bombay, trawler fishery was supported mostly by *Tachysurus dussumieri* (38%), *Osteogeneiosus militaris* (26%), *T. thalassinus* (15%) and *T. caelatus* (7%). At Mangalore, *T. thalassinus* contributed to 85% in trawl nets. While *T. serratus* and *T. thalassinus* were accounted for by drift nets and at Mandapam, *T. thalassinus* was the principal species. Small mechanised trawlers at Visakhapatnam landed about 21 t of young *T. thalassinus*. All along the fishing area, *T. thalassinus*, a less migratory and benthic species, was the chief component. In many centres there was a considerable decrease in the production of migratory and shoaling species such as *T. dussumieri*, *T. tenuispinis* and *T. serratus* which were gradually replaced by *T. thalassinus*.

STOCK ASSESSMENT OF THREADFINBREAMS AND SILVERBELLIES (DF/RE/4)

E. VIVEKANANDAN, P. P. MANOJKUMAR, S. K. CHAKRABORTY, P. U. ZACHARIAH, N. G. MENON, V. GANDHI, V. S. RENGASWAMY, A. RAJU AND R. SARVESAN

Along the east and west coasts, threadfin breams formed a major fishery with maximum yield at Cochin, 9,874 t (227 kg/unit); followed by Madras 4,469 t (99 kg/unit); Bombay 3,078 t (107 kg/unit); Veraval 2,178 t (29 kg/ unit); Mangalore 1,725 t (45 kg/unit) and Tuticorin 1,253 t (39 kg/unit). On the west coast, *Nemipterus japonicus* formed more than 50% of the fishery except at Cochin, where *N. mesoprion* accounted for 89%. Both *N. japonicus* and *N. mesoprion* were the important species at Madras, Kakinada and Visakhapatnam; and *N. bleekeri* and *N. delagoae* were so at Pamban and Tuticorin respectively. The modal and mean length of *N. japonicus* and *N. mesoprion* were higher along the northwest coast than in the east coast. At Madras alone about 24 million juveniles of *N. japonicus* in the length range of 8 to 10 cm were exploited during the year, forming 57% in terms of the numbers caught and 39% by weight. If the juveniles are continued to be exploited in such an irrational manner, this would adversely affect further production. For *N. japonicus* off Bombay, the total stock estimated was 2,562 t and the yield was 1,512 t; while for *N. mesoprion* these were 4,569 t and 1,518 t respectively. The rate of exploitation at Bombay was higher than the optimum for *N. japonicus;* but lower for *N. mesoprion.* In most centres males dominated the fishery, with maturing stages III and IV forming the bulk. At Cochin, adult females of *N. mesoprion* were abundant throughout the year. The major food items consumed were : *Acetes*, non-penaeid prawns and squids on the northwest coast; anchovies, squids and prawns on the southwest and prawns and fishes on the east coast.

The production of silverbellies at Rameswaram was 8,403 t with a catch rate of 118 kg and at Madras 5,718 t with a catch rate of 127 kg. The centre-wise species dominance was *Leiognathus dussumieri* at Tuticorin and Pamban, *L. jonesi* in Rameswaram *L. bindus, Secutor insidiator* and *Gazza minuta* at Madras, Kakinada and Visakhapatnam. Juveniles of 2 - 4 cm were exploited in almost all the centres.

STOCK ASSESSMENT OF CROAKERS (DF/RE/5)

S. K. CHAKRABORTY, P. P. MANOJKUMAR, P. LIVINGSTON, C. MUTHIAH, M. FEROZKHAN, S. SIVAKAMI, V. S. RENGASWAMI, P. JAYASANKAR, P. DEVADASS, A. RAJU AND Y. APPANNA SASTRY

The sciaenid production of Veraval was 13,375 t with a catch rate of 180 kg followed by Bombay 6,392 t and Madras 4,317 t. *Otolithes cuvieri* and *Johnius glaucus* were the

most important species at Veraval, while *Johnieops macrorhynus J. vogleri* were so in Bombay, *Pennahia macropthalmus* and *O. ruber* and *J. maculata* at Tuticorin, *Pennahia macrophthalmus* at Mandapam, *O. ruber* and *J. carutta* at Madras, and *Nibea maculata* and *J. carutta* at Kakinada and Visakhapatnam. *Pseudosciaena diacanthus* ranged from 22 to 125 cm at Veraval where large quantities of juveniles were landed during January - March with modes at 28, 38, 60, 88 and 114 cm; *J. glaucus* ranged from 10 to 28 cm with modes at 16 and 23 cm, and large quantities of its juveniles also were caught during September. Biological data were continued to be collected in respect of the other more important species also. Studies undertaken at Bombay showed that for *J. macrorhynchus* the standing stock was 1,978 t and the yield 1,424 t; while for *J. vogleri* and *O. cuvieri* the corresponding figures were 3,106 t and 1,491 t and 17,053 t and 1,364 t.

BIOLOGY AND RESOURCES CHARACTERISTICS OF LIZARDFISHES, POLYNEMIDS AND FLATHEADS (DF/RE/6)

S. SIVAKAMI, P. P. MANOJKUMAR, S. G. RAJE, M. FEROZKHAN, V. S. RENGASWAMI, J. G. GNANAMUTHU (until August) AND E. VIVEKANANDAN (from September)

There was an increasing trend in the production of lizardfishes over the previous year at Veraval, Cochin and Visakhapatnam, but the catches declined at Madras, Calicut and Bombay. The increase in production at Veraval might be attributed to long voyages of the vessels, while the decline in production at Madras appeared to be due to the large scale exploitation of the juveniles a last year by the trawlers having small cod-end mesh size. At Madras during the current year also 63% of the production was composed of juveniles and it appeared as though in the next year also the production might decline further. *Saurida tumbil* dominated the production at Veraval, Calicut, Bombay and Visakhapatnam, while *S. undosquamis* was the one at Cochin and Madras.

The production of polynemids showed an increasing trend at Veraval, about 15% more than the previous year.

With regard to the flatheads, there was a 175% increase in production over the previous year at Calicut, while at Veraval and Cochin the catches declined alarmingly, at Veraval 40% and to an extent of 43% at Cochin. *Platycephalus maculipinna, P. scaber* and *P. crocodila* were the important species contributing to the fishery.

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

P. BENSAM, G. MOHAN RAJ, P. LIVINGSTON, P. U. ZACHARIAH, M. FEROZKHAN, GRACE MATHEW, S. LAZARUS, K. M. S. A. HAMSA, P. JAYASANKAR AND P. DEVADOSS

The highest production of flatfishes was for the Malabar sole amounting to 2,084 t at Mangalore. At Vizhinjam, *Cynoglossus bilineatus* was the species mostly caught by Disco nets operated from motorised craft, while at Mandapam it was *C. macrolepidotus* by trawlers. *C. macrostomus* ranged from 5 to 18 cm with modes at 8 and 12 cm and the dominant maturity stages were around III and IV. *C. bilineatus* at Vizhinjam varied from 8 to 39 cm with modes at 16 and 26 cm and maturity stages mostly around II-IV. At Mandapam *C. macrolepidotus* was in the size range of 8 - 40 cm with modes at 8, 14 and 32 cm.

Madras recorded the highest quantity in goatfish production, 2,534 t by trawlers and composed of *Upeneus sulphurus* 39% in the range of 7 - 18 cm; *U. moluccensis* 30%, 8-19 cm and *U. bensasi* 23%, 8-18 cm. At Tuticorin the production was 612 t with a marginal decrease by 9% from previous year and composed of *Parupeneus indicus* in the range of 13-14 cm. At Mandapam also there was a decline amounting to 13%, caught mostly by trawlers and composed of *P. sundaicus* in the range of 6-19 cm, *U. vittatus* in the range of 9-18 cm. At Visakhapatnam, *U. vittatus* has formed 62% in the range of 11-15 cm; both species composed mostly of immature fishes. In Cochin *U. vittatus* formed 70% in the range of 11-21 cm; *U. bensasi* in the range of 8-19 cm and *Parupeneus cinnabarius* in the range of 14-21 cm.

The white-fish *Lactarius lactarius* production has registered an increasing trend. The fish has ranged in length from 7 to 24 cm at Mangalore, 7-16 cm in Calicut, 5-21 cm at Vizhinjam and 12-29 cm at Mandapam.

Induced Breeding and Seed Production of Seabass (DF/CUL/3)

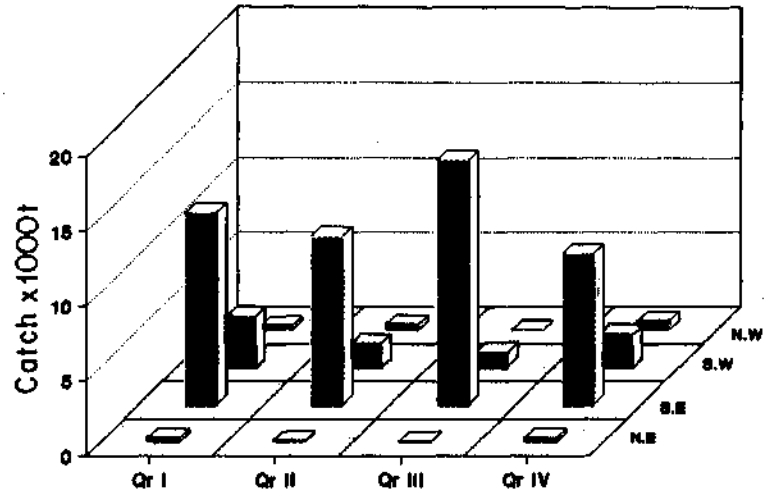
P. NAMMALWAR, R. MARICHAMY AND V. S. RENGASWAMY

A total of 16 adult seabass were collected from Pamban and the Gulf of Mannar, ranging in length from 58 to 92 cm and weighing 2 to 8.5 kg for induced breeding experiments. Five specimens in the length range 46 to 72 cm and weighing 1.5 to 5.5 kg and fed with finfishes, both live and freshly killed; and of them, two were stocked in a net cage at Krusadai Island and administered with the steroid hormone, B estradiol-17 B diol at a rate of 250/µg/kg. More than 90 fingerlings in the range of 11 to 24 cm (20-215 gm) were stocked in the fish farm at Mandapam and more than 500 fingerlings in the range of 8 to 12 cm were stocked at Veppalodai in a private farm.

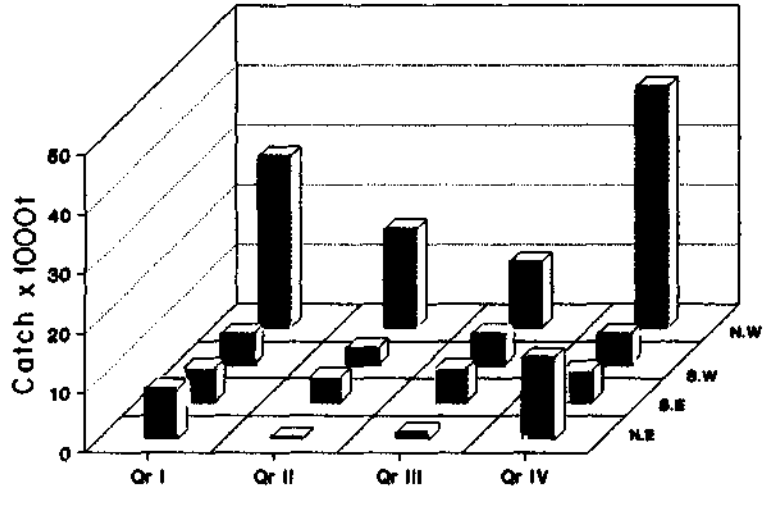
General Observations on Trawling

Effect of cod-end mesh size on exploitation : Analyses of past data at Veraval have shown that the catch rate by the trawlers trawling with 10 mm cod-end mesh size was higher than that by 15 mm and 30 mm. The mean length of exploited juveniles was smallest in the 10 mm mesh and it was estimated that about 22,185 t of juveniles of economically important demersal finfishes were exploited in each trawling season at Veraval.

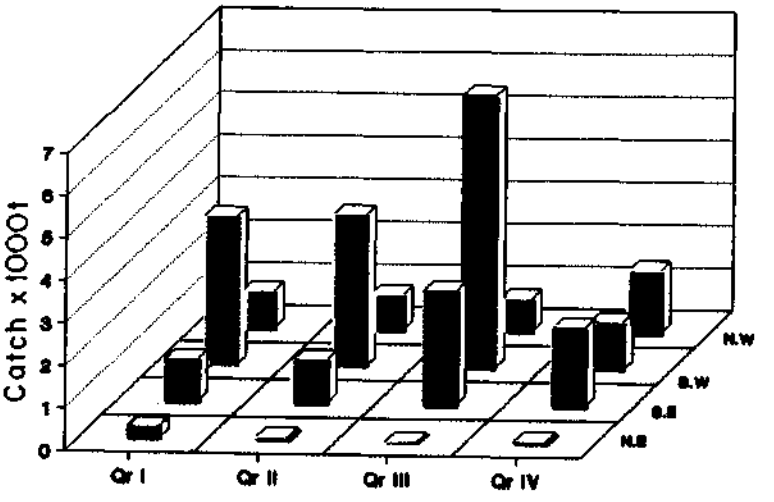
Dislocation of nonedible benthic biota due to trawling : Analyses of past data from the southeast and southwest coast centres have shown that due to bottom trawling in the presently exploited zone, a wide variety of nonedible benthic biota which are important for various demersal fish and shellfish groups have been dislocated and/or destroyed. These biota include crustaceans, bivalves, gastropods, echinoderms, polychaetes, echiuroids, ascidians, sponges and gorgonids and have varied from 1 to 15% of the total trawler production. These were especially abundant during postmonsoon and premonsoon seasons along the southeast coast and monsoon and pre-monsoon months along the southwest. Estimates have shown that on an average each trawler below 14 m OAL has trampled a bottom area of 0.3 sq km/day. The annual dislocation and/or destruction of these biota in the area observed was estimated as about 27,000 t per year. Such a process, if continued indefinitely, is likely to adversely affect the benthic diversity as well as indirectly affect the commercially important fish and shellfishes which subsist on them.



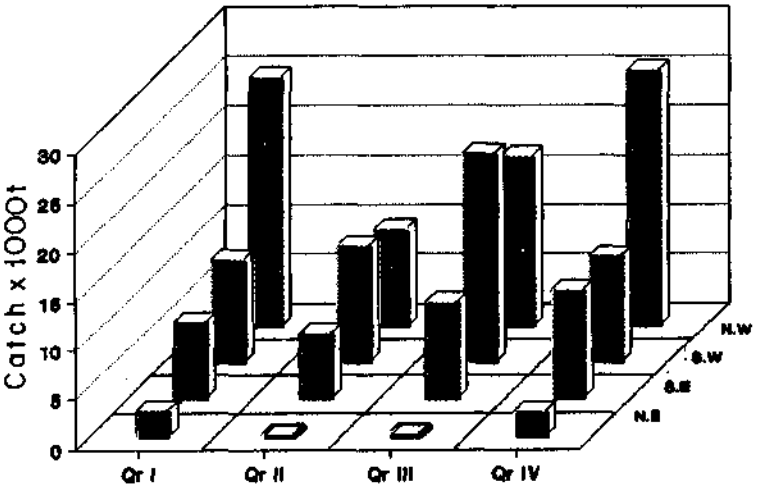
Quarterly estimated landings of silverbellies at different regions along the Indian Coast during 1993.



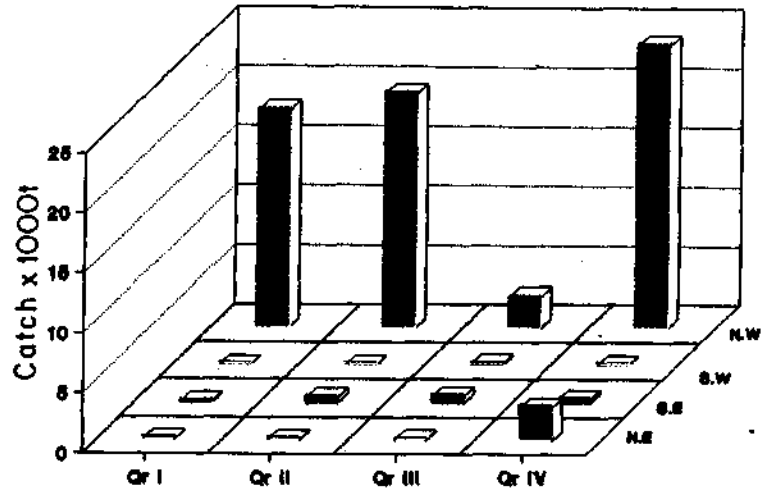
Quarterly estimated landings of croakers at different regions along the Indian Coast during 1993.



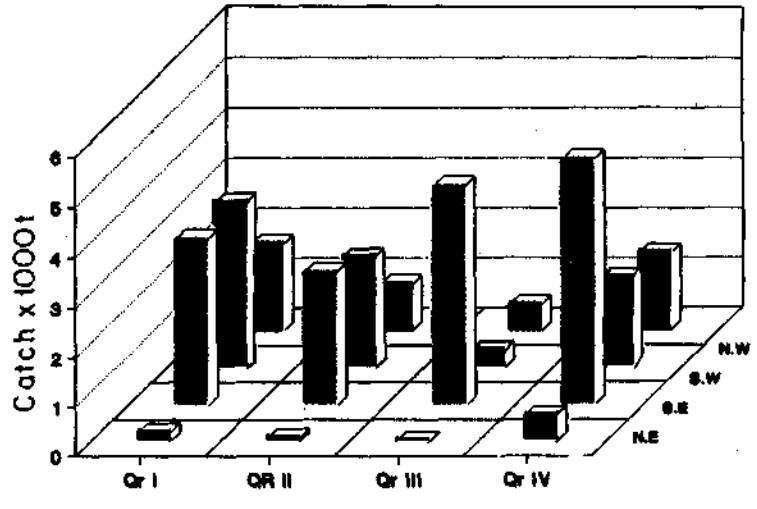
Quarterly estimated landings of lizardfish at different regions along the Indian Coast during 1993.



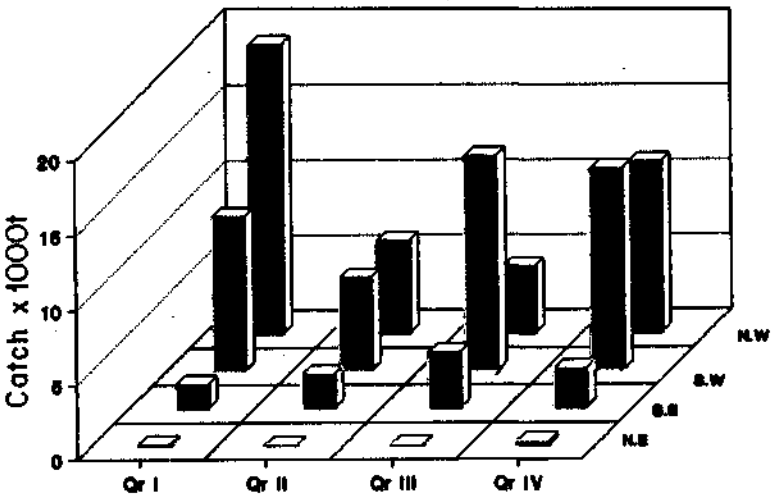
Quarterly estimated landings of penaeid prawns at different regions along the Indian Coast during 1993.



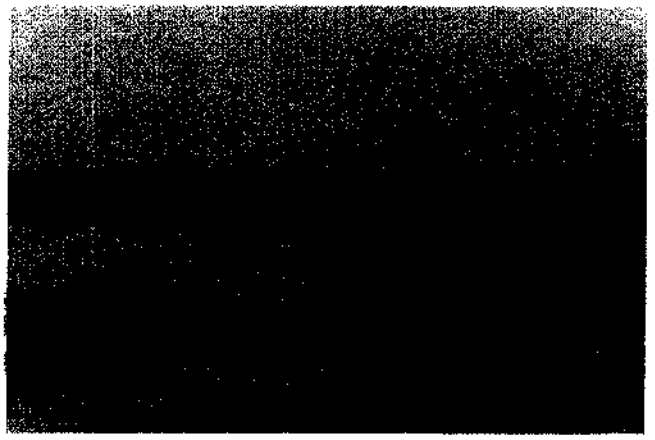
Quarterly estimated landings of non-penaeid prawns at different regions along the Indian Coast during 1993.



Quarterly estimated landings of Lobsters and crabs at different regions along the Indian Coast during 1993.



Quarterly estimated landings of cephalopods at different regions along the Indian Coast during 1993.



Clam (mostly *Paphia malabarica*) fishing in the Ashtamudi Lake. Hand-operated dredge is used from canoes.

CRUSTACEAN FISHERIES DIVISION

INVESTIGATIONS ON THE EXPLOITATION, MANAGEMENT AND CONSERVATION OF PENAEID PRAWN RESOURCES OF WEST COAST OF INDIA (CF/RE/1.11)

C. SUSEELAN, K. K. PHILIPPOSE, V. D. DESHMUKH, M. ARAVINDAKSHAN, V. S. KAKATI, K. N. RAJAN, K. R. MANMADHAN NAIR, MARY K. MANISSERY, P. E. SAMPSON MANICKAM AND G. NANDAKUMAR

The year witnessed varying degrees of improvements in the landings of penaeid prawns by small trawlers at most of the observation centres of southwest coast namely Karwar (177% increase), Mangalore (1.5%), Malpe (10.5%), Cochin (4.7%) and Sakthikulangara (10.2%) when compared with the landings of previous year. Fishery, however, declined at Veraval (6.7%) and Bombay (13.4%) of the northwest coast. Changes noticed in the pattern of fishing along the west coast during the past few years have continued this year also with further increase in the duration of voyage fishing in Maharashtra (6 to 7 days) and in the stay-over fishing, including night trawling, along the Kerala Coast. Along Saurashtra Coast in Gujarat, however, the long trip operations have considerably reduced as a result of the decline in shrimp catch and low economic returns. As far as the biological observations, a striking feature noticed was the consistant predominance of *Parapenaeopsis stylifera* at most of the west coast centres except Mangalore and Cochin where *Metapenaeus monoceros* and *Metapenaeus dobsoni* respectively dominated the fishery. As in the earlier years, the Government of Kerala imposed ban on monsoon trawling for one month from the middle of June to the middle of July. Immediately after ban, intensive shrimp trawling took place at Cochin and Sakthikulangara where the prawn production showed about 8 to 27% increase over the landings of previous monsoon season. The change in fishing pattern involving night trawling resulted in increased landings of non-conventional species such as *Trachypenaeus* spp. *Solenocera* sp., *Penaeus semisulcatus, P. canaliculatus* and *Metapenaeus monoceros* at Cochin and Sakthikulangara.

In the total penaeid prawn production of 175,236 t in 1993, nearly 76% was contributed by the west coast, Maharashtra accounted for 31.2% of the penaeid prawn landings in the country followed by 27.4% by Kerala, 13.5% by Gujarat, 2.6% by Karnataka and 1.2% by Goa. Penaeid prawn resources were exploited by trawl as well as artisanal gears.

Estimated penaeid prawn landings in trawler operations at different investigations centres during 1993-94 were 4186 t (56 kg/boat trip) at Veraval; 16130 t (12.2kg/hr) at New Ferry Wharf (Bombay); 427 t (27 kg/boat trip) at Karwar; 514 t (25 kg/boat trip) at Tadri; 1542 t (2 kg/hr) at Mangalore; 907 t (2.7kg/hr) at Malpe; 1071 t (32 kg/boat trip) at Calicut; 6579 t (63 kg/boat trip) at Cochin and 16900 t (96 kg/boat trip) at Sakthikulangara.

Major component species supporting the trawl fishery at various centres were *P. stylifera* (37%) and *S. crassicornis*(32%) at Veraval; *P. stylifera* (29%) *M. monoceros* (15%) and *S. crassicornis* (13%) at Bombay; *P. stylifera* (72%) and *M. dobsoni* (21%) at Karwar; *P. stylifera* (46%), *M. monoceros* (22%) and *M. dobsoni* (21%), at Tadri; *P. stylifera* (39%), *M. monoceros* (28%), and *M. dobsoni* (20%) at Malpe; *M. monoceros* (52%); *P. stylifera* (23%) and *M. dobsoni* (14%) at Mangalore; *P. stylifera* (53%) and *M. dobsoni* (28%) at Calicut; *M. dobsoni*

(41%) and *P. stylifera* (36%) at Cochin and *P. stylifera* (77%), *M. dobsoni* (9%) and *Trachypenaeus* sp. (7%) at Sakthikulangara.

Dominant size classes in *P. stylifera* in trawler landings were 86-120 mm at Veraval; 78-108 mm at Bombay; 81-115 mm at Karwar; 81- 120 mm at Tadri; 78-88 mm at Mangalore; and 71-90 mm at Calicut, Cochin and Sakthikulangara. In *M. dobsoni* 76-115 mm at Karwar, 81-120 mm at Tadri 68-83 mm at Mangalore; 71-90 mm at Calicut and Cochin dominated the fishery at the respective centres.

Stock assessment made at New Ferry Wharf (Bombay) indicated a total stock of about 18,200 t of prawns consisting of *P. stylifera, M. affinis, M. monoceros* and *S. crassicornis* of which about 11,000 t was exploited during the year under report at an exploitation rate of 61%. It was found that *S. crassicornis* suffered maximum exploitation rate of 78% which was rather alarming, but unavoidable in the multi-species fishery.

In the traditional sector, a successful 'Chakara' fishery was noticed in Kerala for *M. dobsoni* (99%). In the Valanjavazhi - Ambalapuzha region, 4060 t of prawns were landed at CPUE of 114 kg for ring-seine units. The catch consisted of almost exclusively of larger prawns with 40% of females in spawning condition. The same species showed up in unusually large quantities in ring-seines during December also when about 120 t at a CPUE of 669 kg was recorded. Spawners, however, were rarely represented in the fishery, although majority of animals caught were in large size groups. The monsoon period of June-July also witnessed good fishery for *Penaeus indicus* at Cochin in ring-seines.

The mini trawl operations which were confined to Alleppey in the past, extended further north along the Kerala Coast. The mesh size of the net used was found to be 12 mm at cod, resulting in the capture of large quantities of undersized prawns.

Observations on the stake net fishery of Cochin Backwater indicated catch rates of 3.1 kg/unit at Thevara and 2.99 kg/unit at Elamkunnapuzha for juvenile penaeid prawns dominated by *M. dobsoni*. A decline to the tune of 53% was recorded for juvenile prawn catches at Korapuzha Estuary this year.

INVESTIGATIONS ON THE EXPLOITATION, MANAGEMENT AND CONSERVATION OF PENAEID PRAWN RESOURCES OF EAST COAST OF INDIA (CF/RE/1.12)

G. SUDHAKARA RAO, V. THANGARAJ SUBRAMANIAN, G. MAHESWARUDU, M. RAJAMANI AND K. N. SALEELA

About 24% of the country's penaeid prawn production in 1993 was accounted by eastcoast. Percentage contributions by various states in order of abundance were 11.3% by Tamil nadu, 9.3% by Andhra Pradesh, 1.7% by Orissa, 1.6% by West Bengal and 0.1% by Pondicherry.

In the trawl fishery an increase in penaeid prawn catch varying from 30-61% over previous year was recorded at Kakinada, Madras and Tuticorin. The landings, however, declined by 17% at Visakhapatnam and 12% at Mandapam. Kakinada witnessed a remarkable increase in prawn catch, amounting to 5600 t which was the highest recorded during the last 10 years. Nearly 50% of this catch was contributed by *Metapenaeus dobsoni* and *M. monoceros*. Decline in the landings of *P. indicus* at Visakhapatnam was a set back to the industry. *P. semisulcatus* dominated the trawl fishery at Tuticorin. The overall percentage contribution of this species in the conventional fishing areas of Mandapam region showed a decline. This was mainly due to the change in species

composition brought about by changed fishing pattern. *M. dobsoni* (22%), *P. indicus* (16%) and *Parapenaeopsis maxillipedo* (11%) contributed nearly 50% of the prawn landings by trawlers on Madras Coast.

Estimated annual penaeid prawn landings by small trawler operations were 3790 t (2.9 kg/hr) at Mandapam, 3145 t (15 kg/hr) at Madras and 5593 t (7.4 kg/hr) at Kakinada.

Dominant size classes supporting the trawl fishery at different centres were 116-130 mm at Mandapam, 126-140 mm in Pamban and 106-130 mm at Rameswaram for *P. semisulcatus*, 61-90 mm in Madras and 66-85 mm in Kakinada for *M. dobsoni.*

Artisanal fishery was active at Mandapam and Tuticorin. In the Mandapam region, *Thalluvalai* landed 31 t of prawns dominated mainly by juveniles of *P. semisulcatus* while at Tuticorin *P. indicus* and other species amounting to 12 t in gill nets and 22 t in *Thallumadi* were recorded.

Juvenile prawn fishery at Kakinada backwaters : An estimated catch of 165 t of juvenile prawns were fished from B. V. Palem backwaters of Kakinada at a catch rate of 30 kg/unit. Dominant constituents were *M. monoceros* (73%), *M. dobsoni* (6%), *P.* indicus (5%) and *P. monodon* (5%). In the juvenile fishery, sizes ranged between 30-64 mm in *M. dobsoni*, 35-114 mm in *M.* monoceros, 90-204 mm in *P. monodon* and 40-139 mm in *P. indicus.*

At Tuticorin estimated quantity of 430 t of deep sea prawns were landed during the year of which *Plesionika* spp. accounted 62%, *Solenocera* spp. 22% and *Heterocarpus* spp. 15%.

INVESTIGATIONS ON THE EXPLOITATION, MANAGEMENT AND CONSERVATION OF NON-PENAEID PRAWN RESOURCES OF NORTHWEST COAST OF INDIA (CF/RE/1.13)

V. D. DESHMUKH, K. K. PHILIPPOSE AND M. ARAVINDAKSHAN

With a total catch of 68,968 t in 1993, non-penaeids formed 28.3% of the country's prawn production. Gujarat (53%) and Maharashtra (41%) accounted for almost the entire non-penaeid landings of the country. The non-penaeid resources exploited by *dol* nets on the northwest coast was studied from Nawabunder and Rajapara in Gujarat and New Ferry Wharf and Versova in Maharashtra. This fishery declined during 1993-94 by 12-34% at Nawabunder, Versova and New Ferry Wharf, while it increased by 16% at Rajapara. As observed in recent years, large quantities of non-penaeid prawns were also recorded in the trawl fishery of both maritime States. In general *Acetes* spp. formed over 75% of non-penaeid prawns of northwest coast. *Acetes* spp. formed virtually the entire portion of *non-penaeid* catch in *dol* nets in the region. At Veraval the *non-penaeid* prawn fishery by trawl nets was also dominated by *Acetes* spp. forming nearly 100%. In Bombay, however, caridean prawns *Nemetopalaeomon tenuipes* (85-90%) and *Exhippolysmata ensirostris* dominated the non-penaeid catches.

In recent years occurence of *Acetes* spp. in enormous quantities along the Saurashtra Coast in trawl fishery is a striking feature of the non-penaeid prawn fishery. Lowering of cod end mesh size to about 10 mm and operations of trawlers in the areas near to the *'dol'* net grounds are attributed to this increase.

Estimated non-penaeid landings in *dol* net operations at various centres were 2001 t (84 kg/unit) at Nawabunder; 2990 t (94 kg/ unit) at Rajpara and 4071 t (290 kg/unit) at Versova. In trawl landings, non-penaeids formed 17,717 t (238 kg/boat trip) at Veraval; 2117 t (73 kg/boat trip) at new Ferry Wharf and 557 t (31 kg/boat trip) at Versova.

Dominant size classes in *N. tenuipes* caught by *dol* nets were 30-70 mm at Nawabunder and 42-54 mm at New Ferry Wharf. The occurrence of berried females in larger percentage in trawl than in *dol* nets indicates the movement of this prawn to deeper waters for spawning and incubation of eggs.

Using Schaefer's model, data collected on the catch and effort of non-penaeids of Maharashtra for the period 80-92 was subjected for stock assessment studies and MSY of non-penaeid prawns was estimated at 50,562 t and optimum number of units at 359,516/year. Only the data of *dol* net catches were used for this study on the assumption that non-penaeids are landed by *dol* nets alone.

STUDIES ON EXPLOITATION, MANAGEMENT AND CONSERVATION OF LOBSTER AND CRAB RESOURCES OF INDIAN COAST (CF/RE/1.14)

K. K. PHILIPPOSE, V. D. DESHMUKH, V. S. KAKATI, N. NEELAKANTA PILLAI, C. SUSEELAN, MARY K. MANISSERY, M. RAJAMANI, D. B. JAMES, G. MAHESWARUDU, V. THANKARAJ SUBRAMANIAN AND K. N. SALEELA

The total estimated production of lobster production of the country stood at 1862 t in 1993 of which Gujarat contributed 62% followed by 22% by Tamilnadu, 12% by Maharashtra and 2% by Kerala.

Lobsters were exploited mainly by trawlers at Veraval and Bombay. Besides trawl nets, indigenous gears such as bottom set gill nets were also used at other centres like Tuticorin and Madras. At Vizhinjam only gill nets were used for this fishery.

Lobster fishery showed about 97% increase at Veraval and 37% at Bombay this year over the previous years. While 70% of the trawl fishery was accounted by *Thenus orientails* at Veraval, 96% was contributed by *Panulirus polyphagus* at Bombay. Other species supporting the fishery were *P. homarus* and *P. ornatus* on Tamilnadu Coast. Stock assessment of *P. polyphagus* during the year under report at Bombay revealed a stock of 161 t, out of which about 90 t was exploited, the ratio of exploitation being 57%. Third year class in males and 4th year class in females dominated in the fishery. During 1975-85 period when lobsters were fished in greater abundance, 4th year males and 5th year females were dominant in the fishery. The decline in abundance of larger year classes in recent years is attributed to over exploitation of the resource, particularly of ovigerous females during the peak breeding period of September resulting recruitment over fishing.

Estimated lobster landings in trawl nets were 286 t (3.8 kg/boat trip) at Veraval; 93 t (3.2 kg/boat trip) at New Ferry Wharf, 39 t (1.3 kg/boat trip) at Tuticorin and 61 t (0.3 kg/hr) at Madras. 53 t of lobster was fished at Tuticorin using bottom-set nets at catch rates varying between 1 to 7 kg/units.

Sizes dominating the fishery were 76-80 mm in carapace length in *P. polyphagus* at Veraval and 141-270 mm in total length at New Ferry Wharf. In *T. orientails*, 146-180 mm TL formed the bulk of the fishery at Veraval. At Tuticorin 151-490 mm sized *P. ornatus* and 140-285 mm sized *P. homarus* supported the lobster fishery. Live lobsters were sold at the rate of Rs. 700/- to Rs. 1,250/- per kg for sizes above 500 g and Rs. 250/- to Rs. 350/- per kg for sizes below 500 g weight.

A small-scale fishery was reported for deep-sea lobster *Puerulus sewelli* off Tuticorin at a depth of 400 m. It is estimated that about 60 t of this species was caught by trawlers at a catch rate of 15.4 kg/boat.

Crabs with a total production of 27123 t in 1993 constituted 7.5% of the crustacean landings of the country. This resource is exploited all along the Indian Coast, mainly by trawlers. Statewise contributions in order of abundance are 39% by Tamilnadu, 21% by Kerala, 15% by Andhra Pradesh, 9% by Gujarat and 4% by Karnataka and Maharashtra.

Crab landings in 1993-94 declined at almost all centres of investigation. They declined by 13% at Veraval, 1% at New Ferry Wharf, 18% at Karwar, 61% at Mangalore, 34% at Malpe and 26% at Madras. However landings improved at Mandapam (13%). Estimated crab landings in trawlers were 1280 t (17 kg/boat trip) at Veraval, 282 t (10 kg/boat trip) at New Ferry Wharf, 212 t (0.3 kg/hr) at Manglore, 63 t (0.5 kg/hr) at Malpe, 152 t (15 kg/boat trip) at Tuticorin, 899 t at Mandapam, 657 t (3 kg/hr) at Madras and 405 t (9 kg boat trip) at Kakinada.

As in the previous year *Charybdis lucifera* accounted for almost the entire catch of crabs along the Saurashtra Coast. *Charybdis cruciata* amounted for 38-64% at Bombay and Mangalore. *Portunus pelagicus* contributed 40-100% at Karwar, Malpe, Calicut and Mandapam. At Cochin, *Portunus pelagicus* dominated the crab fishery by trawlers in the pre-monsoon period and *Charybdis cruciata* during post-monsoon period.

FEMINIZATION OF *PENAEUS SEMISULCATUS* BY HORMONAL TREATMENT AND INDUCTION OF TRIPLOIDY BY THERMAL MANIPULATION (CF/CUL/1.8)

E. V. RADHAKRISHNAN AND G. MAHESWARUDU

Spawned eggs of *Penaeus semisulcatus* were exposed to sudden high temperature of 36°C (normal 28°C) for 10-15 minutes. Nauplii hatched out from these eggs were reared through various stages in indoor and outdoor facilities until they reached a total length of 40-45 mm. The results were not conclusive to state that thermal shock to the eggs has any specific effect on determination of sex in *Penaeus semisulcatus*.

SEED PRODUCTION, EXPERIMENTAL FARMING AND TAGGING OF MARINE PRAWNS (CF/CUL/1/9)

N. NEELAKANTA PILLAI, K. R. MANMADHAN NAIR, P. E. SAMPSON MANICKAM, N. SRIDHAR, V. S. KAKATI, M. RAJAMANI, E. V. RADHAKRISHNAN, G. MAHESWARUDU AND P. T. SARADA

Experiments were carried out on induced maturation of *Penaeus semisulcatus* and *P. indicus* without eye-stalk ablation. Maturation pools of 6' diameter fitted with biological filter and recirculation facilities were used for this purpose. The pH of the sea water was adjusted to 8-8.2 using calcium carbonate. Light intensity was reduced to 5% of ambient light. The animal were fed *ad libitum* with clam meat, squid and polychaetes. In the case of *P. semisulcatus* some specimens spawned 8-11 times within a period of 90 days. Depending on the size of the animal, the number of eggs varied from 0.5 to 3.2 lakhs and the percentage of hatching worked out to 90. The experiments also showed that repeated spawning by the same animal has not affected either the quality or quantity of eggs. In one experiment, 3 individuals by repeated spawning provided 27 lakhs nauplii from which 8 lakhs of postlarvae were produced.

In the case of *P. indicus*, females above 40 g size took 53 to 69 days for acclimatisation and initial maturation. Afterwards they matured and spawned at shorter intervals regularly. One female spawned 17 times in 190 days. During this period the prawn moulted 11 times. At an average each female produced 1.4 lakh eggs. The hatching rate varied from 69-79%. Hatchery reared and farm grown *P. semisulcatus* and *P. indicus* were released in the Palk Bay to study their growth and movements. 3382 no. of *P. semisulcatus* of 70-117 mm total length were released. Recovery of tagged prawns from commercial trawl catches started after 2 days of release. Within 20 days, 32 tagged prawns were recovered. The ovary of a few recovered prawns were in 4th stage of maturity and the data collected during this period confirmed the earlier observation on *P. semisulcatus* that hatchery reared and farm grown specimens of this species attain first maturity at the age of 6 months.

3430 *P. indicus* of 73-145 mm total length were also tagged and released in the Palk Bay. After release, within 21 days 18 tagged prawns were recovered from the trawl catches. Further recovery is being monitored.

Experiments were carried out on the cage culture of *P. semisulcatus*. Hatchery produced seeds were used for this purpose. 25.5 mm size groups registered a growth rate of 0.98 mm/day until they reached 60-65 mm and 60 mm size groups showed 0.65 mm/day growth rate until they reached a total length of 110 mm.

Experiments on the farming of *P. semisulcatus* provided encouraging results. Hatchery produced seeds PL 51 (29.8 mm) were stocked in ponds of 800 m^2 area and grown for a period of 136 days. 459 kg/ha/harvest was obtained with a survival rate of 76% (16.7 g). It was also observed that they tolerate a salinity range of 13‰ to 4‰. The possibility of introducing this species as a candidate species at Tamilnadu is very bright as CMFRI has already perfected a low cost technology for the broodstock maintenance and seed production of this species.

A consultancy to establish a 30 million *P. monodon* hatchery was taken up with Nikky Exports. A suitable site for establishing a hatchery was located at Vodarevu, Chirala. A location specific hatchery design was prepared and the construction work is in progress.

MOLLUSCAN FISHERIES DIVISION

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

M. M. MEIYAPPAN, K. K. JOSHI, KUBER VIDYASAGAR, K. S. SUNDARAM, SUNILKUMAR MOHAMED, G. P. K. ACHARY, K. PRABHAKARAN NAIR, V. KRIPA, N. RAMACHANDRAN, D. SIVALINGAM, A. P. LIPTON, G. SYDA RAO AND R. SARVESAN

With a marginal increase of about 6,000 t over last year, the cephalopod production in the country was estimated at 96,000 t in 1993 (January-December). About 90% of this came from the west coast with Kerala contributing 32%, Maharashtra 29%, Gujarat 11%, Karnataka 10% and Goa 8%. The bulk of the catch was taken in trawl nets. The estimated cephalopod landings by trawl at different centres during 1993-94 were : Veraval-Mangalore 4,792 t, Bombay 16,910 t, Mangalore-Malpe 4,970 t, Calicut 399 t, Cochin 7,238 t, Mandapam-Rameswaram 345 t, Madras 2,771 t, Kakinada 658 t and Visakhapatnam 267 t. Apart from these, 247 t were landed at Vizhinjam by indigenous gears like boat-seine and hooks and line, and 22 t at Calicut by hooks and line, purse-seine also contributed 5 t at Mangalore. Squids formed 62% of the total cephalopod landings, the Indian squid *Loligo duvauceli* alone accounting for 61%. The cuttlefish catch (38%) was shared mainly by *Sepia aculeata* (17%) and *Sepia pharaonis* (16%). Octopus catch was negligible. At Bombay, where cephalopod exploitation was high, the mortality parameters and stock position of the Indian squid *Loligo duvauceli* were estimated based on 1993-94 data : total stock 32,333 t, standing stock 12,552 t and MSY 12,239 t as against the present yield of 10,670 t.

INVESTIGATIONS ON RESOURCE CHARACTERISTICS OF BIVALVES AND GASTROPODS (MF/RE/2)

P. S. KURIAKOSE, K. K. JOSHI, K. S. SUNDARAM, P. K. ASOKAN, SUNILKUMAR MOHAMED, K. K. APPUKUTTAN, G. P. K. ACHARY, V. KRIPA, N. RAMACHANDRAN, K. RAMADOSS, A. P. LIPTON, P. V. SREENIVASAN, P. NATARAJAN, G. SYDARAO AND R. SARVESAN

Mussels : The green mussel *Perna viridis* production on the Malabar Coast from Challiyam to Ullal slightly declined from 5,100 t in 1992-93 to 4,832 t this year although there was good fishery at certain centres like Thikkodi and Challiyam. The mussel seed resource was poor, because of the failure in spatfall on account of the occurrence of *Noctiluca* bloom in coastal waters during August - October which is the normal period of spatfall.

The production of brown mussel *Perna indica* along the Vizhinjam - Colachel where the C/E also was the highest (25 kg/man-day); December was the peak month of exploitation (337 t and 30 kg/man-day).

Clams : The clam production in Mulki Estuary was only 166 t less by 27% from last year. The main reasons for the decline were the extended monsoon and the consequent delay in the re-establishment of clam beds. In earlier years there was good fishery for *Paphia malabarica* at Valapatnam, but now the stock has depleted due to indiscriminate fishing, especially with the use of hand-dredge having small mesh size. In the Krishnapatnam Harbour Basin in Kandaleru Estuary, the population size of *Meretrix casta* is estimated at about 1,360 t in 68 ha, *M. meretrix* at 160 t in 43.5 ha, *Katelysia opima* at 10 t in 34 ha and the blood clam *Anadara granosa* at 242 t in 37 ha. In Kakinada Bay, 2,074 t of clams were exploited, of which *M. casta* was 1,183 t, *M.meretrix* 106 t, *A. granosa* 715 t and *P. malabarica* 40 t. The clam fishery has improved this year.

Edible oyster : The estimated population size of the edible oyster *(Crassostrea madrasensis)* in the Dharmadam Estuary was 36 t spread over 0.33 ha with a density range of 50 - 120 nos/m^2. In Krishnapatnam Basin of Kandaleru Estuary it has about 660 t in a area of 13.5 ha. Here the maximum density was 845 no./m^2

Chanks : The chank fishery in the Gulf of Mannar started in November 1993 and a total of 1,79,086 chanks were landed at Tuticorin and 46,550 chanks at Thiruchendur. For the first time the Government of Tamil Nadu introduced licencing system for chank diving.

SEED PRODUCTION AND SEA RANCHING OF MOLLUSCS (MF/CUL/4)

K. A. NARASIMHAM, P. S. KURIAKOSE, A. C. C. VICTOR, M. E. RAJAPANDIAN, D. SIVALINGAM, A. CHELLAM, T. S. VELAYUDHAN, K. RAMADOSS, S. DHARMARAJ, G. P. K. ACHARY, K. K. APPUKUTTAN AND RANI PALANISWAMY

During this year gratifying results were obtained in the seed production of pearl oyster, edible oyster and clam in the molluscan hatcheries at Tuticorin. This was despite a setback in the hatchery operations in the third quarter when the salinity dropped to as low as 2.89 ppt resulting in the failure of the production of microalgae.

Pearl oyster hatchery : During this year four spawning and larval/spat rearing experiments were conducted in *Pinctada fucata*. A total of 28.1 million larvae were produced which yielded over 6 lakhs spat. Of these, 2,22,500 spat were supplied to Tamil Nadu Fisheries Development Corporation (TNFDC) for Rs. 8,900/-. This support by the Institute to the pearl culture project of the TNFDC was timely since the latter faced difficulty in collecting mother oysters from the pearl banks. The remaining spat were reared in the farm at Tuticorin for building the mother oyster stock. In the third quarter, which is known to be the peak spawning period, salinity dropped steeply to as low as 2.89 ppt on 24.12.'93 and the hatchery work was suspended for some time. In view of the need to raise appreciable quantity of mother oyster stock for location-testing and transfer of pearl culture technology programmes, pearl oyster seed were not ranched in the sea during this year.

Edible oyster hatchery : A total of 152 spawning experiments were conducted in *Crassostrea madrasensis* and out of 3,805 oysters subjected to thermal stimulation, 152 males and 120 females responded and released gametes. Except for April '93 and February '94 the oysters spawned in all the months. This indicates that a high degree of control has been achieved in inducing spawning in the oysters. A total of 80.28 million fertilised eggs were obtained resulting in 40 million veliger larvae. Out of 34,760 cleaned oyster shells laid as cultch, spat settled on 14,433 shells (41.5%) with an average settlement of 95 spat/shell in rearing tanks in the hatchery. Around 2,400 shell strings with attached spat were transferred to the nursery.

Clam hatchery : This part of the project is carried out with the financial support of the Marine Products Export Development Authority, Cochin, for a period of 2 years from December 1993.

A successful spawning of *Paphia malabarica* in November 1993 produced 2.5 million spat.

Low salinities in December 1993, coupled with failure of microalgal food production, resulted in poor growth and survival of spat.

Ranching of clam seed in coastal waters : Significant success was achieved in the ranching and retrieval of *P. malabarica* seed in the coastal waters of Kerala (Dalavapuram in Ashtamudi Lake and Munambam in Vembanad Lake).

Stock cultures of several species of microalgae were maintained in the laboratory. A new strain of *Dunaliella* sp. was isolated. Mass culture of *Isochrysis galbana* was continued and supplied on large scale to the molluscan hatcheries.

Most of induced spawning experiments by thermal stimulation were not successful. Due to plankton blooms, particularly *Noctiluca*, during July-November the water quality was badly affected. The inadequate hatchery facility has been found to be a constraint for developing the technology for the production of mussel seed.

SELECTION OF SUITABLE SITES FOR BIVALVE CULTURE (MF/CUL/8)

K. SATHYANARAYANA RAO, P. K. ASOKAN, SUNILKUMAR MOHAMED, P. S. KURIAKOSE, K. K. APPUKUTTAN, T. S. VELAYUDHAN, V. KRIPA, N. RAMACHANDRAN, A. CHELLAM, S. DHARMARAJ, P. V. SREENIVASAN, P. NATARAJAN, M. RAJAGOPAL AND G. SYDA RAO

Gratifying results were obtained in the programme carried out to test the suitability of selected water bodies in Kerala and Karnataka, for edible oyster culture. The studies at Ashtamudi have brought to light that good spatfall occurs in this area (upto 20 spat/shell collector) during December-March and it can be developed as an oyster spat collection centre. A seasonal crop of 6-8 months duration can be raised in the coastal waters of these two States during October-May.

In the open sea off Calicut, the pearl oyster (*Pinctada fucata*) spat of 15 mm transported from Tuticorin hatchery and suspended in cages from a raft have attained 48.9 mm length in six months. The growth was much faster when compared to the growth in the pearl farm at Tuticorin where it takes 9-10 months to reach the above length.

PILOT PROJECT ON OYSTER CULTURE (MF/CUL/9)

M. E. RAJAPANDIAN, K. RAMADOSS AND RANI PALANISWAMY

This is a three-year sponsored project, 75% of the cost is funded by NABARD. The first harvest of edible oyster *Crassostrea madrasensis* yielded 17 tonnes of shell-on oysters from the farm; this gave 1,243 kg of depurated oyster meat and the same was supplied to the Integrated Fisheries Project, Cochin. Also, 1.3 tonnes of shell-on oysters were sold locally.

The progress in this project was adversely affected due to the cyclones in the second fortnight of December 1993, resulting in very low salinities for about two weeks in the Tuticorin Bay. As a result of the rough sea conditions and continuous flow of fresh water into the oyster farm, about 2,000 strings holding oysters dropped from the racks and were smothered by the sediment, causing heavy mortality. The estimated loss of oyster stock in the farm was 12 tonnes.

During this year 2,504 shell strings, with spat attached, were transferred from hatchery to the nursery and out of them, 900 strings were taken to the farm.

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

A. C. C. VICTOR, A. CHELLAM AND S. DHARMARAJ

During this year a total of 7,812 pearl oysters *Pinctada fucata* were operated for nucleus implantation and reared in the farm at Tuticorin. Out of these, 7,142 received

single nucleus, 662 double nuclei and 8 triple nuclei.

A consignment of 2,000 pearl oyster spat, 400 mother oyster and 377 nucleated oysters were transported to Cochin and Calicut for location testing.

A total of 1,116 pearls (110 g) produced at Valinokkam were sold to the public and the amount realised was Rs. 64,067/-. The pearls produced in the farm at Tuticorin were also put on sales and a sum of Rs. 36,700/- was realised during this year.

With a view to testing the suitability of developing pearl culture in the prawn farm facility, experiments are being carried out in the Victory Aqua Farm near Tuticorin.

A short-term training programme on pearl oyster surgery and nucleus implantation was conducted for the benefit of 8 candidates at Valinokkam during October-November, 1993.

COMPOSITE SEAFARMING (CMFRI/IDP/2)

R. MARICHAMY, A. C. C. VICTOR, M. E. RAJAPANDIAN, D. B. JAMES, S. RENGASWAMI, P. NAMMALWAR, N. KALIAPERUMAL, E. V. RADHAKRISHNAN AND A. P. LIPTON

This project is in operation for the second year at Valinokkam. The interaction of the various candidate species with the environment was favourable in some cases and in others they did not fare well.

The studies on the culture of various candidate species in the Valinokkam Bay showed that this water body is highly suitable for pearl culture, a system of net cage culture for seabass *Lates calcarifer*, grouper *Epinephelus tauvina* and prawns *Penaeus semisulcatus* and *Penaeus indicus* can be developed, if the constraints of seed availability and farm management are overcome. The Bay is not suitable for the culture of edible oyster *Crassostrea madrasensis*, green mussel *Perna viridis*, clam *Paphia malabarica*, seaweed *Gracilaria edulis* and sea-cucumber *Holothuria scabra*.

GROUP DISCUSSION ON DEVELOPING EDIBLE OYSTER CULTURE IN KERALA

A group Discussion was organised on 25.1.1994 at CMFRI, Cochin.

About 100 persons, including scientists and officers from CMFRI, CIFT, IFP, MPEDA, Fisheries Colllege, Kerala State Fisheried Department, MATSYAFED, State Bank of Travancore and NABARD and fishermen representatives from Chavara, Thekkumbhagam, Ayiramthengu, Kannamali and Chellanam participated in the discussions. An exhibition on oyster culture and oyster products was organised.

During the discussion it emerged that a seasonal crop of oysters during December-May could be raised along the Kerala Coast. There is need to assess the survival, production and the economics of oyster culture along the Kerala Coast. Deputation facilities are to be developed. There is scope to develop a market for live oysters.

A part of the clam *Paphia malabarica* harvest in the Ashtamudi Lake. Hatchery raised clam seed were ranched and they reached marketable size in 5 months.

Oyster *(Crassostrea madrasensis)* shell rens used for testing the suitability of the Ashtamudi Lake for oyster culture.

Plate 14

Satellite imagery showing sea surface temperature distribution in the Indian Seas - Utilized in forecasting Potential Fishing Zones.

FISHERY ENVIRONMENT AND MANAGEMENT DIVISION

INVESTIGATION ON ENVIRONMENTAL PARAMETERS IN THE INSHORE WATERS IN RELATION TO FISHERIES (FEM/ES/1)

M. S. RAJAGOPALAN, C. P. GOPINATHAN, K. RENGARAJAN, V. CHANDRIKA, G. S. DANIEL SELVARAJ, K. G. GIRIJAVALLABHAN, S. MUTHUSAMY, T. S. NAOMI, MOLLY VARGHESE, V. V. SINGH, P. K. KRISHNAKUMAR, V. NARAYANA PILLAI, C. V. MATHEW, P. KALADHARAN, P. A. THOMAS, S. JASMIN, S. KRISHNA PILLAI, M. RAJAGOPALAN, K. VIJAYAKUMARAN, P. T. SARADA AND PON SIRAIMEETAN

Monitoring of environmental parameters in the inshore waters was continued at Cochin and other Centres.

Cochin : At the 20 m station, surface temperature was high during April (30.5°C) and progressively decreased (28°C) in August and gradually increased during subsequent months to reach 30.2°C in March '94. Bottom temperature was around 28°C during pre- and post monsoon months and was low during monsoon months (21.6°- 26.6°C).

Surface salinity was around 32.5‰ during premonsoon and postmonsoon months and was significantly low at 15.85‰ during June. Bottom salinity was around 33‰ throughout the year. Dissolved oxygen values in the surface ranged from 2.41ml/l in August to 4.62 ml/l in November. Very low oxygen values(less than 2 ml/l) were obtained in the bottom during July - September.

Average chlorophyll a values were high during June - July at both 10 and 20 m stations and moderate during other months. The average column production during pre-monsoon months was estimated as 38 mg/m^2 which increased to 48 mg/m^2 during monsoon months and declined to 29 mg/m^2 during postmonsoon months.

The average zooplankton displacement volume was in the range of 3.41 - 8.53 ml/100 m^3 during April-June and reached a peak in August (40.5 ml/100 m^3) and low levels (1.3 to 3.0 ml/100 m^3) during September - October and then increased during November - December with a secondary peak in February (15.78 ml). Majority of the groups such as chaetognaths, *Lucifer*, siphonophores, doliolids, ctenophores, fish eggs and larvae showed peak numbers during August. The number of copepods was highest in January and those of salps in February and larval decapods in March. Cladocerans were abundant during June - September. Appendicularians, molluscan larvae and pteropods were most abundant during November. Euphausids appeared in good numbers in September and January. Blooms of *Trichodesmium* appeared in April and mixed blooms and dinoflagellates occurred during October - December. The swarms of gastropod larvae and ctenophores were observed along with phytoplankton blooms. In March '94 there was also a bloom of *Noctiluca miliaris*.

Studies on bacterial population off Cochin indicated that their number ranged from 2.9 x 10^5 - 3.2 x 10^6/ml in sea water. In the sediments, the number ranged from 1.7 x 10^9/cm^3 to 4.9 x 10^9/cm^3. Postmonsoon months recorded highest number of bacterial population, but the number of genera isolated was more during monsoon months.

Karwar : Surface temperature was maximum in May (30.2°C) and minimum in December (25.9°C). Bottom temperature on the other hand was high during April - June (30.2 to 30.8°C) and reached a minimum in September (25.7°C) and gradually increased to 30.5°C in March. Surface salinity was minimum in July and in the range of 21.0-25.44‰ from May to October, and showed gradual increase from November onwards. Bottom salinity was also low during June - October (19.36 to 26.09‰).

Bottom oxygen minimum value was obtained in November. July recorded a heavy rainfall of 135 cm.

Mangalore : Surface water temperature was maximum during April (29.9°C) in July and August and in the range of 28-29°C during rest of the months. The bottom minimum temperature was 26°C at 10 m in July and 27.5°C at 20 m in October. Low surface salinity (12 to 12.66‰) was observed from June to August and also in October. Bottom salinities at 20 m were 34 to 35‰. Minimum values of bottom oxygen were obtained in May and November.

Primary production at 10 m station was maximum in July (1.5 g C/m^3) and minimum during October. Maximum rainfall was recorded in July.

Calicut: Surface temperature was 30.0-30.5°C during April - May and low during June to December (24.4, 27.8°C respectively). Salinity was in the range of 32-34‰ during most of the months except in June and it was 27.69‰. Oxygen minimum values were seen from September and net primary production was high during September - November (1.3 to 2.9 mg C/m^3) and low during December - February (less than 0.5 mg C/m^3).

Vizhinjam : Surface temperature was maximum during May (27.5°C) and minimum during September (24.0°C). Salinity did not show much variations with values ranging from 34 to 35‰. Dissolved oxygen values also did not show much fluctuation. Zooplankton displacement volume had 2 peak values, one in August and the other in October (14 ml/100 m^3) and low during August and January (3.4 ml/100 m^3). Major constituents were copepods, amphipods, mysids, decapod larvae, bivalve larvae and fish eggs. Cladocerans and appendicularians were abundant during certain months.

Minicoy : Surface temperature in the lagoon was maximum in April and also in the inshore waters. The temperature range being 26.1 to 34.4°C and the minimum is usually reached in July. The average salinity of the lagoon is around 34.96‰ in July to 38.39‰ in September. The DO content in the inshore waters showed an average range from 4.22 ml in May to 6.51 ml in March. However, in the lagoon, drastic variations have been noticed. The net primary production in the lagoon varied from 2.15 to 75.99 mgC/m^3/hour. In the inshore waters also, maximum production was obtained in November. Maximum rainfall was recorded in March '94.

Mandapam Camp : Hydrographic data collected from the Gulf of Mannar showed that surface temperature was maximum in September (32°C) and minimum in February (28°C). Bottom temperature was minimum in December (27.4°C). Salinity was high in September (36.69‰) and low in December (27.05‰). Oxygen minimum values were obtained in June. In the Palk Bay the SST was maximum in September (31.6°C) and minimum in December (26.8°C). Maximum salinity was observed in September (35.6‰) and minimum in December (26.5‰). Dissolved oxygen content was low in April and high in November. Zooplankton biomass was high in April (6.5 ml) and low in July.

Madras : Surface temperature ranged from 26.9 to 29.1°C during October - March at 10 m station and from 27.2 to 29.7°C at 20 m station. Salinity was low at 4 stations (20 to 24.9‰) in November and high in March (about 32‰). Oxygen values varied between 3.6 and 5.5 ml/l.

Kakinada : SST was maximum in September (30.75°C) and minimum in January (27.2°C). Salinity was high in September (34.8‰) and low in October (19.85‰). Dissolved oxygen varied between 3.5 and 5.8 ml. Maximum rainfall was recorded during September - October.

Visakhapatanam : Surface temperature was maximum in October (26.9°C) and minimum in December (22.3°C). Salinity was low during October - December (22 to 27‰) and varied between 28 and 34‰ during other months. Dissolved oxygen values were low during April and May at sub-surface depth.

ENVIRONMENTAL ECOLOGY OF COASTAL ZONE AND MAPPING OF POTENTIAL SITES FOR SEAFARMING (FEM/ES/5)

M. S. RAJAGOPALAN, R. N. MISRA, G. S. DANIEL SELVARAJ, MOLLY VARGHESE, M. RAJAGOPALAN, C. V. MATHEW AND B. S. RAMACHANDRUDU

Coastal water bodies at Puthuponnani, Kadalundi, Anthakaranazhi and Thanneermukkom along the southwest coast and the Killai Backwater in the east coast were monitored during the year for ecological parameters. During the summer months, mean surface temperature ranged from 31.6 to 33.1°C and salinity showed wide fluctuations. Net primary production at Puthuponnani, Kadalundi and Thanneermukkom were in the range of 0.3 to 1.3 g C/m^3/day during summer months and low during monsoon months *i.e.* less than 0.2 g /m^3 whereas at Anthakaranazhi, net primary production was high 2 gC/m^3/day during monsoon as well as non-monsoon months. At Killai Backwater the average production from 20 stations during September - October period was estimated as 1.7 g C/m^3/day. Average value of DO was 3.52 ml/l in these stations.

MONITORING MARINE POLLUTION IN RELATION TO PROTECTION OF LIVING RESOURCES (FEM/MP/1)

V. KUNJUKRISHNA PILLAI, R. N. MISRA, C. P. GOPINATHAN, P. K. KRISHANAKUMAR, M. PEER MOHAMED AND D. KANDASAMY

Biological samples representing 8 varieties of finfishes and shellfishes collected from the estuarine and inshore waters of Cochin were analysed for heavy metals. The levels found were rather low and also showed a reducing trend from bivalves to crustaceans and to finfishers. Sediment samples revealed higher level of copper, zinc and lead in the estuarine stations compared to inshore waters.

A consultancy programme has recently been taken up to monitor changes in water quality and other ecological parameters caused due to dredging activities in the Cochin Port area. At Karwar the mercury content in the tissue of oysters was relatively high ranging from 0.179 to 0.571/µg/g. At Tuticorin the quantity of fly-ash deposited from the thermal power plant has considerably increased by about 35% compared to last year.

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

V. S. K. CHENNUBHOTLA, N. KALIAPERUMAL AND REETA JAYASANKAR

The average density of the seaweed *Gracilaria edulis* in the natural beds around Minicoy showed seasonal variability. The maximum density of this species was 7200 g/m^2 in May and low at 300 g/m^2 during February.

Culture experiments on this species at Minicoy showed a biomass increase of 6.0 to 7.3 fold during July and September for a culture period of 2 months.

REMOTE SENSING AND FISHERIES (FEM/RS/1)

M. S. RAJAGOPALAN, G. SUBBARAJU, K. SATHIANANDAN, N. G. K. PILLAI, K. V. S. NAIR AND V. N. PILLAI

Information on potential fishing zones and sea surface temperature derived from satellite data was regularly received from NRSA. The information on PFZ were passed on to various end-users through media and also through mass contact programme. Feed back data on fish catches obtained from PFZ have been analyzed from Cochin, Azhikode and Alleppy. These analyses showed that the catch per unit effort from PFZ areas was generally higher by 19 - 37%. Experimental fishing in PFZ areas were also undertaken for studying the validity of satellite data. Along with remote sensing programme, sea truth data on surface meteorology and SST were regularly collected during the cruises of FORV *Sagar Sampada*.

FISHERY OCEANOGRAPHY OF THE OFFSHORE REGIONS OF THE INDIAN EEZ (FORV/SS/1)

M. S. RAJAGOPALAN, G. SUBBARAJU, V. N. PILLAI AND OTHER SCIENTISTS OF FEMD

During 1993-94 cruise No.108 covering the northwestern region was undertaken during April-May '93. Thirty six stations enclosed in 1 square grid were covered between 15° and 22° N. Data on physical, chemical and biological aspects were collected from standard depth upto 500 m.

Utilizing the CTD probe, data on physico-chemical aspects were obtained upto 1000 m from selected stations. The important features observed during the cruise were :

1. In the northwest coast region, surface temperature varied between 27.5 to 29.1°C. A low temperature pocket (28°C) was observed in the shallow regions off Veraval extending to the southward towards shelf region.
2. A pronounced thermocline was observed between 100-150 m depth and the features were more pronounced with temperature variations upto 8°C in the section along 15° N.
3. Salinity values showed a progressive increase towards the northern latitude. About 18° N surface salinity was greater than 36% in the entire EEZ. Below the 18° N in the northwest coast, salinity was between 35.37‰ and 35.98‰ in the shelf region, while in the oceanic region the values were higher (36‰) and above.
4. Surface oxygen values ranged from 4.12 ml/l off Marmagoa to 4.45 ml/l of Kandla. At 75m depth these values were ranging from 2.94 ml/l to 4.23 ml/l thus showing reduced value with increasing depth. Off Bombay, the oxygen minimum value of 1.07 ml/l was observed at 150 m depth.
5. The distribution of nutrients showed that while phosphate showed a gradual increase towards bottom, nitrate and nitrite showed higher levels in the midwater layers. A positive correlation could be found with phosphate levels and chlorophyll *a* levels.
6. Zoolplankton displacement volumes ranged from 12.6 ml/1000 m^3 to 334 ml/ 1000m^3.
7. Blooms of *Trichodesmium* sp. were observed in patches in the entire northwestern coast during the cruise.

INVESTIGATIONS ON ZOOPLANKTON AND COMPONENTS OF DSL OF EEZ OF INDIA (FORV/SS 3)

K. J. MATHEW, T. S. NAOMI, N. G. MENON, K. PRABHAKARAN NAIR, MOLLY VARGHESE, V. S. KAKATI, M. M. MEIYAPPAN AND P. V. RAO

Zooplankton samples collected during 6 cruises of FORV *Sagar sampada* were sorted out and the data documented. The data obtained were analysed for the estimation of zooplankton biomass, secondary production and also detailed studies were made for the component groups of the northeast coast, southeast coast, Andaman Nicobar waters and the southwest coast of India. The average zooplankton biomass per 1000 m^3 of water was found to be 105.5 ml for the NE coast, 83.3 ml for the SE coast ad 49.9 ml for the Andaman Nicobar waters.

The sorted samples were distributed to various experts for detailed studiess. The groups thus distributed were (1) cladocera, (2) amphipoda, (3) *Lucifer*, (4) cephalopods, (5) penaeid larvae, (6) crab larvae (to the Institute Scientists), (7) chaetognatha (to Zoological Survery of India) and (8) ostracoda, (9) medusae, (10) mysids, (11) pteropods and heteropods and (12) fish eggs and larvae (to National Institute of Oceanography).

BREEDING, SEED PRODUCTION AND SEA-RANCHING OF SEA-CUCUMBER *HOLOTHURIA SCABRA* (FEM/CUL/2)

D. B. JAMES

At Tuticorin induced spawning of *Holothuria scabra* was successful during February and March 1994 and a total of 4250 juveniles were produced. In September '93 the spawning of *H. atra* was successful on two occasions. 20,000 juveniles of *H. scabra* produced during March '93 were reared till the end of November '93, but the mortality rate was high.

CONSERVATION AND MANAGEMENT OF CORAL REEF ECOSYSTEM (FEM/EE/1)

C. S. G. PILLAI

Under this project, preparation of a monograph on corals consolidating and reviewing the work done so far on corals and coral reef ecosystem in India was initiated and the data on hermatypes were collected doing the period. The collection of corals off southwest coast during FORV *Sagar sampada* cruise was analysed.

STUDIES ON EXPLOITATION OF AUXILIARY MARINE LIVING RESOURCES (FEM/AR/1)

P. A. THOMAS AND S. JASMIN

Gorgonids collected from Andaman, Orissa and Andhra Coasts, the southwest coast of India and Karwar area were analysed qualitatively. This has considerably increased the number of species from the Indian Coasts.

Scientists from different National Institutions/Universities were provided with the identification of source material (sponges/ gorgonids) in connection with the studies on 'Marine Products Chemistry', a priority project sponsored by the DOD, New Delhi. Two SRFs working in the project on 'Antifouling compounds from sponges', an ICAR Project were given training on the identification of sponges.

Data on auxillary resources received from World Monitoring Centre, London, were analysed and relevant sections were passed on to NMLRDC, Cochin.

PHYSIOLOGY, NUTRITION AND PATHOLOGY DIVISION

ENDOCRINOLOGICAL FACTORS INFLUENCING MATURATION IN SOME PRAWNS (PNP/39)

N. SRIDHAR AND MOHAN K. ZACHARIAH

The protein fractions present in the thoracic ganglia and eye-stalk and lipid fractions from the ovary of matured prawns were processed and concentrated. The technique for concentrating the protein fractions involved an ultrafiltration cell using a membrane of molecular weight cut off in the range of 500. A 5.24 fold increase in the protein concentration of the extracts of thoracic ganglia and eyestalks could be achieved by following the procedure.

To effect a sustained release of proteins in the recipient animals, attempts were made to administer the extracts in the pelletised form. The procedure for pellet preparation was attempted using different combinations of gelatin and gum Acacia powder. The ratio of 2:1 gelatin to gum Acacia was found to be the best. The pellets thus prepared contained the extracts, cholesterol (0.5%) and ovarian extracts in different combinations [thoracic ganglia extract pellet, eye-stalk extract pellet, ovarian extract pellet, eye-stalk thoracic ganglia extract (1:5) pellet]. The pellets were sufficiently dried and weighed to determine the dosage correctly. These pellets are currently in use for bioassay studies.

TOLERANCE LIMITS OF CERTAIN ENVIRONMENTAL FACTORS AFFECTING PHYSIOLOGICAL BEHAVIOUR OF SOME CULTIVABLE ORGANISMS (PNP/44)

M. PEER MOHAMED, D. C. V. EASTERNSON
D. KANDASAMI AND N. SRIDHAR

Salinity and temperature tolerance studies were conducted on four bivalves *Crassostrea madrasensis*, the clams *Mesodesma* sp., *Donax* sp., and *Paphia malabarica*. The animals were exposed to salinities ranging from 20 to 45‰ at temperatures 25 to 27°C. The experiments on salinity tolerance indicated that *C. madrasensis* is capable of withstanding salinities ranging from 20 to 35‰ and 30‰ salinity was optimum for growth. The average increase in length and weight were 1.5 mm and 1.68 g respectively at 30‰ salinity. The salinity level of 40‰ proved to be critical for survival as all the animals died within a short time. In the case of *Mesodesma* sp. it was found that 30‰ was ideal with an average increase in length of 1.80 mm. At salinities less than 20‰ and above 30‰ these clams could not survive even for shorter durations. The *Donax* sp. showed maximum survival and optimum growth rate at 25 to 30‰ salinities. The growth was 130 mg at 25‰ salinity which was the highest. In the case of *P. malabarica* however, the optimal salinity for maximum survival and growth was found to be around 20‰ where mean weight gain per clam was 20 mg with 100% survival rate.

STUDIES ON CRYOPRESERVATION OF GAMETES AND EMBRYOS OF CERTAIN CULTIVABLE MARINE SHELLFISHES (PNP/45)

A. D. DIWAN

The morphological and ultrastructural features of the spermatozoa of two prawn species *viz. P. indicus* and *P. monodon* were carried out using SEM and TEM. The study revealed three distinct anatomical divisions of the sperm *viz.* the cell body, cap region and the spike. The cell body is composed of uncondensed nucleus followed by acrosome complex in cap region and spike at the anterior end. In penaeid prawns the sperms are non-motile. Activation of these spermatozoa could be achieved artificially using egg water and divalent ionophores.

Cryopreservation trials at 0°C, -35°C and -196°C indicated that spermatozoa of both *P. indicus* and *P. monodon* could be successfully cryopreserved for a period of 15 days. The percentages of reacted sperms after freeze -thaw varied between 70 to 80% in DMSO and glycerine combination.

EVALUATION OF FARM PERFORMANCE OF COMPOUNDED FEEDS FOR PRAWNS (PNP/35)

R. PAUL RAJ, M. VIJAYAKUMARAN, D. C. V. EASTERSON, D. KANDASAMI, MANPAL KAUR AND P. VIJAYAGOPAL

Evaluation of proximate composition of prawn feeds : Proximate analysis of fourteen compounded feeds (thirteen imported and one indigenously manufactured) were carried out under the project. The range of proximate composition estimated on dry matter basis were : moisture content 9.82 to 13.2%, crude protein 36.2 to 43.46%, ether extract 2.80 to 4.28%, crude fiber 2.62 to 3.66%, ash 14.38 to 17.43% and nitrogen free extract 22.7 to 31.28%. Water stability tests showed that all the feeds were highly water stable with a dry matter loss of 14 to 17% in 5 hours, without physical disintegration in seawater with aeration.

Digestibility studies : Digestibility studies on post-larval *P. indicus* using compounded diets were graded levels of dried mantis shrimp powder (< 250 µm) was used as replacement of shrimp meal at 0, 10, 15, 20, 25 and 30% showed highest protein (82.94%) and lipid (98.0%) digestibility at 30% inclusion. Digestibility studies in post-larval *P. indicus*, fed with different levels (10 to 60%) of soya flour showed protein digestibility (91% to 98.4%) increases with increase in levels of soya flour upto 30% followed by a sharp decline (76.8% to 60%) on further increase in dietary levels. Digestibility of lipids also showed a similar trend.

Evaluation of production performance of penaeid prawns in culture systems : The *P. indicus* yield from the 13 ponds in Nellore District under the technical advice from the project scientists ranged from 900 to 1500 kg/ha/crop in a period of 112 to 165 days with FCR ranging from 1.4 to 2.06 with stocking densities from 7 per m^2 to 11.2 per m^2. The yield from 3 ponds in a subsequent crop was 1,900 to 2,200 kg/ha/crop within a period of 150 to 170 days.

The production figures for *P. monodon* were 912 to 1,618 kg/ha with FCR ranging from 1.33 to 2.2 when stocked at 3 to 4.5 seed per m^2 during 142 to 171 days period. Production ranging between 1,500 to 3,000 kg/ha in 120 days also was recorded from farm with paddle wheel aeration.

Study on environmental characteristics of prawn culture system : The significant observation have been high salinity (38-52 ppt) in the ponds at Krishnapatnam, low dissolved oxygen at Koruttur (1.46-2.0 ml/1) during morning hours. Water pH ranged from 7.73 to 8.94 and soil pH from 7.54 to 8.76.

Swarming of hydromedusae and mysids, blooms of *Anabaena* have been observed in some ponds. Heavy protozoan (ciliate *Acineta* sp.) infestation was observed in the gills of *P. indicus* causing poor feed intake and growth. Application of Zeolite and lime improved the condition.

IDENTIFICATION OF GENETIC STOCKS IN INDIAN MACKEREL (*RASTRELLIGER KANAGURTA* (PNP/41)

M. K. GEORGE, P. C. THOMAS, N. K. VERMA AND I. D. GUPTA (upto Nov. '93)

The objective of the project is to study the biochemical genetic profile of the Indian mackerel and to find out whether there are genetically different stocks sustaining this fishery. As envisaged in the project, electrophoretic patterns of nine enzymes, namely Glucose-6 Phosphate Dehydrogenase (G6PD), Alcohol Dehydrogenase (ADH), Xanthine Dehydrogenase (XDH), Sorbitol Dehydrogenase (SDH), Peroxidase (PO), Aldehyde Oxidase (AO), Esterase (Est), Lactic Dehydrogenase (LDH) and Isocitric Dehydrogenase (IDH) were analysed to study biochemical genetic polymorphism in population samples of Indian mackerel collected from Calicut, Chellanam, Veraval and Madras regions.

Analysis of the electrophoretic data revealed a single polymorphic loci controlling XDH as against two polymorphic loci for G6PD, PO, AO and ADH. Three polymorphic loci each was observed for SDH and Esterase.

The animals from Calicut and Chellanam regions screened for LDH and IDH revealed only single band pattern. Observed genotypic frequencies deviated significantly at certain regions particularly in Madras. A comparison of allelic frequencies implied certain level of genetic heterogeneity between regional mackerel populations.

SOCIO-ECONOMIC EVALUATION AND TECHNOLOGY TRANSFER DIVISION

STUDY ON ECONOMIC PERFORMANCE OF TRAWLERS (FE & E/24.1)

D. B. S. SEHARA AND K. K. P. PANIKKAR

Economic data from sample trawlers were collected from Paradeep, Balaramgudi and Digha landing centres during 1992-93. Analysis of data of trawlers revealed that in small and medium trawlers the initial investment varied from Rs. 2.4 lakh to 3.0 lakh per unit which resulted in an annual fixed cost of Rs.85 thousand to 1.04 lakh. The annual cost of trawl operation during 1992-93 was Rs. 3.7 lakh for 220 fishing days at Paradeep, Rs. 3.29 lakh for 200 fishing days at Balaramgudi (both centres in Orissa) and Rs. 2.62 lakh for 180 fishing days at Digha (W. Bengal). Per day, gross income ranged from Rs. 1981 to Rs. 2260 of which 57-69% was contributed by prawns. Net annual income of a trawl unit was about Rs. 10 thousand in West Bengal and Rs. 17-23 thousand for Orissa. Pay back period is 4.0 - 4.7 years and rate of return to capital 22-26%. Though trawlers are operating on comparatively less number of days in north-east coast, they are running on profit. The level of profit is positively correlated with the number of fishing days.

INVESTIGATIONS ON THE IMPACT OF MOTORISATION OF COUNTRY CRAFT ON MARINE FISHERY ALONG KERALA COAST (IDP/3)

K. K. P. PANIKKAR, D. B. S. SEHARA AND K. S. SCARIAH

The data were collected from 10 centres namely Vizhinjam, Neendakara, Valanjavazhi, Munambam, Chavakkad, Thanoor, Velayil, Quilandi, Puthiangadi and Pallikkara operating OBM in Kerala. The major craft-gear combinations along Kerala Coast include gillnet and mini trawl units with 7 H.P. engines, hook & line with 15 H.P. engines ring seine with 2 engines of 25 H.P. and units operating one 40 H.P. and another 25 H.P. engine. For ring seine with 2 engines of 25 H.P., average revenue per day of operation is Rs. 5,500/- and average cost Rs. 3,500/- having a net profit of Rs. 2000/- per day. For bigger ring seine using 40 H.P. engines net profit is about Rs. 3000/-. Among all other types of units profit ability is higher for mini trawlers because of its low investment requirement.

A STUDY ON MARINE FISH MARKETING IN TAMIL NADU (FE & E/28)

R. SATHIADHAS

The preliminary analysis of data on fresh fish prices collected from selected primary, wholesale and retail markets from Kanyakumari, Tuticorin and Nagapattinam regions of Tamil Nadu indicates that the prices of marine fish are widely fluctuating at all stages of transactions in the marketing channel. The marketing margin accounted for a big chunk of the consumer price for most of the varieties. Fishermen received maximum share in consumer's rupee for quality fishes like seerfish, pomfrets and carangids and comparatively lesser share for cheaper varieties like silverbellies, other sardines and rays. Barring a few varieties, the consumer price of most of the varieties were found to

be more than double that of the landing centre price. The increase in the landing centre price to retail price ranged from Rs. 40 to 60 per seerfish; Rs. 25 to 50 pomfrets; Rs.15 to 35 carangids; Rs. 20 to 35 sharks; Rs. 18 to 35 *Lethrinus* sp.; Rs. 15 to 25 mackerel and Rs. 8 to 20 for other sardines. Further investigations on the marketing pattern of live crabs, lobsters, other exportable varieties like prawns, cuttlefishes and pharmaceutically important products like sea-horses, sea-fans and sharks are in progress .

EMPOWERING RURAL WOMEN THROUGH EXTENSION EDUCATION - AN ACTION REASEARCH IN A FISHING VILLAGE (FE & E/26.2)

KRISHNA SRINATH AND MANPAL SANJOTHIRA

The following programmes were carried out in the fishing village of South Chellanam near Cochin with the help of 'Matsya-mahilavedi', a fisher women co-operative agnecy, by the multidisciplinary team of Scientists/Technical staff from PNPD, KVK and SEETTD :

1. Awareness campaign for fisherwomen — 40 women were educated on the need for self employment, enterprise building and management, leadership, group concept, fisheries technologies and development programmes.

2. Involving women in prawn farming — A one-day seminar and one week training on prawn farming were organised specifically for women. A demonstration of the technology was carried out in a 1 acre field owned by a fisher woman under which women were trained in seed identification, feeding and other management aspects.

3. Setting up of a small-scale unit unit for prawn feed production — A group of five women were helped to start a small scale industry for prawn feed production using formulae developed by the Institute. A group loan of Rs. 25,000/- was made available through Corporation Bank under the refinance scheme of NABARD.

4. Introduction of poultry units — Ten units of poultry consisting of 20 birds each were introduced in 10 fishermen households.

5. Fishing net making — Organised 30 women for self employment generation through net making by utilizing a grant of Rs. 1.4 lakhs provided to Matsyamahilavedi by the Central Social Welfare Board.

6. Environment awareness programme — Co-operated with Matsyamahilavedi in organising an environment awareness campaign in the village in which the scientists of the Institute participated. The traditional media 'Ottamthullal' developed by the Institute was presented on the occasion.

7. Linkage development — Linkages were developed with R&D agencies in fisheries and rural development by involving them in different programmes.

8. Study of the impact of the programme — A survey was conducted among 100 programme participants from South Chellanam, the study village and 100 non-participants from Fort Kochi, the control village to assess the changes brought about by the programme and the data are being processed. A preliminary analysis indicates improvement in income and qualities of improvement such as self-perception, role perception, decision making and attitude towards group action.

STUDIES ON THE EFFICACY OF VILLAGE ADOPTION IN TRANSFER OF TECHNOLOGY (TOT) IN MARINE FISHERIES (FE & E/26.1)

A. REGUNATHAN AND M. M. THOMAS

During the year under report, finfishes stocked in 5 selected farms at Narakkal were monitored. Stocks in 2 farms were completely washed off due to flooding of the farm area in monsoon season. Other farms were partially affected. However, 800 mullets (*L. parsia*) out of 5500 and 130 *M. cephalus* out of 500 were available for harvest. Mullets registered an average growth of 214.9 mm and a weight of 195.9 gm for a period of one year. *M. cephalus* registered an average growth of 408 mm weighing 727.5 gm for the same period. The finfish culture yielded a total income of Rs. 12,370 at the end of one year period.

Under the programme of transfer of prawn culture technology, eradication using Ammonia as an input was extended to selected farms during the year. Seeds of *P. indicus* were stocked after 2 weeks interval and monitoring was continued.

The prawn culture operations in general had a setback during the year due to short supply of prawn seeds. Since the coastal population objected to collection of seeds from the coastal areas, it became necessary to explore the possibility of setting up mini-hatcheries and/or increasing the capacity of existing hatcheries to meet the demand of prawn seed by small and marginal farmers along the Kerala Coast in general and Cochin in particular.

EXTENSION OF SEAWEED CULTURE PRACTICES TO FISHERMEN (FE & E/29)

SHEELA JAMES

A training programme on seaweed recipe preparation was organised at Rameswaram for a period of 3 months for 30 women from fishermen community. This was taken up in collaboration with the Centre for Women Agriculture and Rural Development under TRYSEM. The trainees were taught in the identification of different seaweed species. Various methods of preparations of seaweed recipes were also imparted to them.

INVESTIGATIONS ON THE ENTERPRENEURIAL BEHAVIOUR OF FISHERMEN AND THE VARIABLES CONTRIBUTING TO IT (FE & E/27)

JANCY GUPTA

The data were collected on eleven dimensions of entrepreneurial behaviour. Data were also collected on personal variables like educational level, use of communication media, area under traditional, semi-scientific and scientific prawn culture production, income role played by family members in culture operations and other relevant parameters.

The study showed that there was an increasing tendency to adopt scientific prawn culture involving eradication of predators, lime treatment, manuring, supplementary feeding and removal of aquatic weeds, in recent years. However, managerial practices such as measuring of dissolved oxygen level of pondwater and its maintenance, need-based water exchange, periodic assessment of

growth were followed by only a few farmers. Further, the prawn farmers showed interest to switch over to the more valuable species *P. monodon* than *P. indicus* inspite of the difficulty in procuring seed.

The constraints analysis indicated inadequate seed supply for stocking and inability to identify the seeds of *P. indicus* caught from wild.

The study on use of information sources ascertained the first-line role played by CMFRI and the second-line transfer of technology carried out by agencies such as MPEDA as and BFFDA. The study brought out the need to widen and strengthen the training and that the prawn farmers living on the southern side of Ernakulam (Kannamaly, Kumbalangi and Chellanam) showed better entrepreneurial behaviour.

STUDY ON ADOPTION OF PRAWN FARMING TECHNOLOGY IN AND AROUND TUTICORIN (FE & E/30)

M. C. ARUNMOZHI DEVI

Initiating the project in July 1993, data on prawn farming practices in and around Tuticorin and on the farming system followed from stocking to post-harvest operation were collected.

COLLABORATIVE/SPONSORED PROJECTS

The institute during the year carried out five sponsored projects funded by external organisations. The progress made under these projects is briefly summarised below.

1. PILOT PROJECT ON EDIBLE OYSTER CULTURE

M. E. RAJAPANDIAN, K. RAMADOSS AND RANI PALANISWAMY

The National Bank for Agricultural and Rural Development (NABARD) sponsored this three-year project, effective from September 1991. The financial support by NABARD was Rs. 6.44 lakhs which formed 75% of the total cost, the balance amount being provided by CMFRI.

During this year the oyster farm at Tuticorin covered 0.75 ha and the first ever large-scale harvest of farm-grown oysters (*Crassostrea madrasensis*) was made. In July 1993, 2,200 shell strings were harvested and the shell-on yield of oysters was 17 t and meat yield 1,243 kg. The meat was sold to the Integrated Fisheries Projects, Cochin at Rs. 30/kg. Further 1.3 t of shell-on oysters were harvested and sold locally.

Although there was a loss of 2000 oyster strings due to a cyclone, the farm was strengthened by transferring 2504 strings from the hatchery.

2. HATCHERY PRODUCTION OF CLAM SEED AND RANCHING THEM IN COASTAL WATERS

K. A. NARASIMHAM, D. SIVALINGAM AND T. S. VELAYUDHAN

The Marine Products Export Development Authority (MPEDA) sponsored this two-year project with financial support of Rs. 3.625 lakhs and it came into operaion on 17.12.1992.

During the year, a total of 2.75 lakhs seed of the clam *Paphia malabarica*, were produced at the Tuticorin hatchery and of these 20,000 and 2,50,000 were ranched in the Ashtamudi in Kerala on 25.2.1994 and 29.3.1994 respectively. The stock of 8500 clam seed ranched at Munambam and 95,000 ranched in the Ashtamudi in February 1993 were harvested in this year. The retrieval and production at Munambam were 17.64% and 14.25 kg/10 m^2 / $4^1/_2$ months and in the Ashtamudi 7.05% and 62.1 kg/25 m^2/5 months respectively.

3. SURVEY AND ASSESSMENT OF ORNAMENTAL FISH RESOURCES OF LAKSHADWEEP

P. S. B. R. JAMES AND V. SRIRAMACHANDRA MURTY

This project is sponsored by the Ministry of Agriculture, Government of India. During November 1993 - April 1994, the lagoons of the islands Chetlat, Bitra, Kiltan, Kadamat, Amini, Agathi, Kavarathi and Kalpeni were surveyed using gill nets of different mesh sizes, traps and encircling nets. Among the gears employed, gill nets were found to give satisfactory results for catching ornamental fishes in the lagoons which have corals of different sizes and shapes.

A total of 2,332 specimens of ornamental fish representing 118 species were collected.

Of these 83 species (1,332 specimens) were taken by gill nets, 41 species (185 specimens) by traps and 79 species (815 specimens) by encircling nets. Among the gill net catches Holocentridae was most dominant forming 22% of total gill net catch by numbers followed by Callyodontidae (16%), Acanthuridae (15%), Labridae (12%), Mullidae (11%), Pomacentridae (10%), Serranidae (5%) and others. In the traps also Holocentridae was most dominant forming 30% of fish collected by traps, but followed by Serranidae (21%),Chaetodontidae (15%), Acanthuridae (9%), Pomacentridae (8%) and others. In the catch by encircling nets, Labridae was most dominant forming 36% of catch by this gear followed by Pomacentridae (27%), Callyodontidae (12%), Mullidae (7%), Acanthuridae (5%) and others. Studies on seasonal variations in abundance of different species in the lagoons of different islands and their biology are in progress.

INTENSIVE SEED PRODUCTION AND SEA-RANCHING OF SEA-CUCUMBERS

D. B. JAMES

Induced breeding experiments on the common species *Holothuria scabra* were continued. Rearing of baby holothurians through the various larval stages developed from the March 1993 experiment was continued till the end of November 1993 which gave indications of their enduarance capacity. Attempts were also made to rear juveniles/baby holothurians in cages at Karapad Creek in Tuticorin and at Valinokkam Bay and the rate of growth was monitored. Success was also achieved in induced spawning of another species *Holothuria atra*.

5. GENETIC STUDIES ON MARINE PENAEID PRAWNS

P. S. B. R. JAMES, M. K. GEORGE, N. N. PILLAI AND N. K. VERMA

Penaeus indicus, P. monodon and *P. semisulcatus,* were selected for genetic studies under this project. Morphometric data on 17 variable body parts of 66 *P. indicus,* 31 *P. mondon* collected and recorded. Body weight of female of *P. monodon* and particularly that of *P. semisulcatus* was found to be higher than that of their male whereas it was slightly higher in the male of *P. indicus.* Multiphore electrophoretic conditions to separate and resolve general tissue proteins in these three species were standardized.

LIBRARY AND DOCUMENTATION SECTION

During the year under report the library holding at Headquarters was expanded by adding 51 new books and 1848 issues of journals. Besides, books and periodicals were also acquired for the libraries at the Mandapam Regional Centre and all the other Research Centres. Inter-library collaboration and inter-library loan of publications were continued. Reference facilities were provided to visiting scientists, scholars and students of various universities and institutions from within and outside the country.

The library also stocks, distributes and sells the Institute's publications.

The following publications were issued :

1. CMFRI Special Publication Nos. 53 - 60.
2. CMFRI Bulletin No. 46 and 47.
3. CMFRI News Letter Nos. 56 - 60.
4. Marine Fisheries Information Service T & E Series Nos. 118 - 126.
5. Research Highlights 1992-93.
6. CMFRI Annual Report 1992-93.
7. Brochure on Minicoy Research Centre - Activities and Achievements.
8. FORV *Sagar Sampada* - IInd Workshop, Programme and Abstracts.

POST-GRADUATE PROGRAMME IN MARICULTURE

The Post-graduate M. Sc. and Ph. D degree Programmes in Mariculture of the Institute, which were affiliated with the Cochin University of Science and Technology, Cochin from its inception, was brought under the academic control of the Central Institute of Fisheries Education (CIFE), the Deemed to be University of ICAR, Bombay with effect from October 1993.

Ph. D. Programme

The following theses submitted by the Senior Research Fellows working under the programme were awarded the Ph.D. degrees by the Cochin University of Science and Technology.

1. "Heterotrophic bacterial activity in selected aquaculture system near Cochin" by Smt. S. Santhi Thirumani (Supervising Guide - Dr. Mrs. V. Chandrika) - The Thesis deals with the nature of relationship between abiotic environmental factors and heterotrophic activity of bacteria in the culture ecosystems. Using tracer studies the quantitative role of bacteria in the maintenance of pond ecology had been investigated.
2. "Growth and reproduction of the Penaeid prawn *Metapenaeus dobsoni* (Miers) in brackishwater environment" by C. Vasudevappa (Supervising Guide - Dr. C. Suseelan). The Thesis presents the growth pattern of the prawn in different brackishwater aquaculture system and in laboratory conditions. The process of spermatogenesis, spermato- phore formation and oogenesis have been studied for the first time based on prawns matured in brackishwater condition. Variations in certain biochemical parameters of muscle, haemolymph, hepatopancreas and ovary with reference to maturation have also been studied.

M. Sc. Programme

All the 10 candidates of the 12th batch have completed their course and passed in first class, 4 with distinction. The 13th batch joined the course on 1-10-1993 under the academic regulation of the Deemed University to undergo one-year Deficiency Course.

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KRISHI VIGYAN KENDRA

The Krishi Vigyan Kendra (KVK), established in 1976 at Narakkal, continued its activities imparting training in mariculture, agriculture, animal husbandry and other need-based training to fish farmers, agriculture farmers and farm women. The various courses conducted during the year were as follows.

Subject	Short term training			Total participants
	No.of courses	No. of males	No. of females	
Fisheries	20	129	133	262
Animal production	3	21	37	58
Crop production	7	14	107	121
Home science	14	33	176	209
Total	44	107	453	650

The type of trainers trained were, practicing farmers 93, youths 91, extension functionaries 13 and farm women 453.

In addition to the regular training and demonstration programmes, the Kendra prepared Project Report for AMSF, Valappu and Harijan Sangam of Mulavukad to avail grant from State Fisheries Department to develop prawn farm. A grant of Rs. 90,000 and 1.5 lakhs was sanctioned each to AMSF and Harijan Sangam respectively, based on these reports. Project Reports were also prepared and given to two farmers to avail of loan from scheduled banks for developing prawn farm.

The staff of KVK were associated with two projects of the Institute (1) Studies on the efficacy of village adoption in transfer of technology (TOT) in marine fisheries and (2) empowering rural women through extension education - An action research in a fishing village.

TRAINER'S TRAINING CENTRE

The Trainer's Training Centre (TTC) under the Institute is engaged in offering training to officials of State Government, Banks, Societies and autonomous bodies interested in fisheries development. During the year, following training courses were organised and conducted.

Training courses organised under TTC programme during 1993-94 and persons trained

Short term (below six months)					
Subject	No.	Duration (Days)	Persons trained		
			male	female	total
Prawn farming (For extension workers	1	10	14	—	14
Prawn farming (For financial institution	2	5	43	1	44
Hatchery production of marine prawn seeds	1	15	11	—	11
Seaweed culture & its utilization	2	10	30	2	32
Edible oyster culture	1	10	6	—	6
Total	7	50	104	3	107

The TTC was also involved in the demonstration of certain important components of culture systems for the benefit of farmers involved in such activities. The type and number of demonstrations carried out by the TTC were as follows :

Type of demonstration	No.	Area	Participants
Prawn seed collection	3	Surf region and canals in Vypeen Island	57
Eradication of predators	3		57
Induced maturation and spawning in prawns	1	KVK campus	11
Preparation of value added products from seaweeds	2	KVK campus	32
Seed production of edible oyster	1		6

EXTENSION PROGRAMMES

The KVK was actively involved in the extension activities to propagate widely the technologies developed at the Institute by organising field days, fairs, film shows, seminars and awareness programmes. The details of these programmes carried out during the year are given below :

Activity	No. of pro-gramme	No. of participants			No. of SC/ST participants
		male	female	total	
Field days	4	54	44	98	27
Farmers fair	1	135	119	254	67
Farm Science club/ Mahila Mandal	5	175	210	385	126
Film shows	22	542	461	1003	—
Radio talk	2	—	—	—	—
Seminar	2	175	70	245	—
Awareness programme	2	12	9	21	—

The type and number of extension activities by TTC were as follows: Film shows (3), Radio talk (1). The number of participants in the above programmes were 68.

OFFICIAL LANGUAGE IMPLEMENTATION PROGRAMME

During the year under report, several programmes were implemented on progressive use of Hindi. The letters received in Hindi were replied to in Hindi and the section 3 (3) documents were issued in bilingual form. An increase of 22.1% was made in correspondence in Hindi.

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Most of the staff of the Institute have now acquired a minimum working knowledge in Hindi. In the ongoing programme of Hindi typewriting and stenography, two Jr. clerks and one stenographer are undergoing training.

At Mandapam and Madras Research Centres of CMFRI, Centres of Hindi Teaching Scheme started functioning and 13 employees passed the Prabodh/Praveen examination at Madras and 15 at Mandapam.

The Second Sub-committee of Committee of Parliament consisting of 4 members and other officers headed by Shri Jagadish Prasad Mathur, M. P. inspected the Hindi implementation activities of Minicoy Research Centre of the Institute and recorded a satisfactory progress. At Headquarters the activities were inspected by a team consisting of Shri P. M. Naidu, Dy. Director (Imple.), Department of Official Language and at various research centres by Dr. P. S. B. R. James, Director and Smt. Sheela, P.J., Asst. Director (O.L.).

During the year, 25 Hindi books and periodicals were purchased. 23 periodicals received from the Department of Official Language, other central government offices, autonomous bodies and companies were added to the library. A total of 210 books including reference books and video cassettes of official language were maintained at the Headquarter's Hindi section.

To disseminate the results of research projects carried out in the Institute in the Official Language, Hindi, the publications of the Institute such as Marine Fisheries Information Service, CMFRI News letter, Research Highlight and Annual Report were released in bilingual form. On the occasion of the visit of Parliament Committee on Official Language, a brochure on the Minicoy Research Centre of CMFRI and a fish calendar of the region were released in Hindi.

During the year, Hindi workshops were organised, one each for ministerial, technical and scientific staff at the Headquarters and one at the Madras Research Centre. 44 officers and staff were imparted training in Hindi in these workshops.

Hindi week was celebrated at the Headquarters and Research Centres from 14 - 18th September with various competitions and cultural programmes. The winners of competitions and such of the staff who have done commendable work in Hindi during the year were given prizes in the valedictory function. The Institute also actively participated in Hindi competitions organised by the Cochin TOLIC and won the rolling trophy for outstanding performance.

CONSULTANCY

The Institute is offering a consultancy for the establishment of a hatchery of 40 million capacity for the production of *Penaeus monodon* seed at Vodaveru, Chirala in Andhra Pradesh for M/s. Sterling Shrimpex Private Limited.

Similarly another consultancy programme for Cochin Port Trust to monitor the water quality in connection with the South End Reclamation Project at a cost of Rs. 1,00,000 is progressing.

DEPUTATIONS

1. Dr. M. S. Rajagopalan, Principal Scientist was deputed to Maldives to explore the possibility of "Crab culture in Mangroves" from 28th May to 28th June 1993.
2. Dr. E. V. Radhakrishnan, Sr. Scientist was deputed to Japan for participating in the fourth International Workshop on "Lobster Biology and Management" from 21-31 July 1993.
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ENGAGEMENTS

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

The meeting of the committee on Development of Fisheries Policy, Govt. of Kerala, at Thiruvananthapuram, 17 May 1993.

The cruise planning and programme priority committee of *Sagar Sampada*, Department of Ocean Development, at New Delhi, 20 May 1993.

The harvesting of the ranched clams and observed the monsoon fish catches at Neendakara, 19 July 1993.

The Board of Management Meeting at CIFE, Bombay, 6 August, 1993.

The first National Organising Committee Meeting of "Workshop on Applications of Satellite Remote Sensing for Identifying and Forecasting Potential Fishing Zones in Developing Countries" at NRSA, Hyderabad, 13 August 1993.

Research Council meeting of the Kerala Agricultural University at Thrissur, 21 August 1993.

Meeting of the Directors of ICAR Institutes at New Delhi, 5-6 October 1993.

Meeting of the Central Board of Fisheries at New Delhi, 28-29 October 1993.

Review Committee at Vikram Sarabhai Space Centre at Trivandrum, 30 October 1993 as an external expert.

Meeting of the Joint Study Team for Development of Indigenous Ocean Remote Sensing Satellite at ISRO, Bangalore, 18-19 November 1993.

Kendriya Vidyalaya Management Committee meeting at Mandapam, 27 November and Annual Day, 28 November 1993.

Participated in the workshop on 'Application of Satellite Remote Sensing for Identifying and Forecasting Potential Fishing Zones on Developing Countries' at NRSA, Hyderabad, 10-11. December 1993.

Visited Minicoy Research Centre of CMFRI in connection with the visit of Committee of Parliament on Official Language, 11 January 1994.

XVth meeting of the ICAR Regional Committee No. VIII at I.I.H.R., Bangalore on 20th to 21st January 1994.

Group Discussion on *Beach-de-mer* at Regional Centre on 24th February, 1994 at Mandapam Camp.

Dr. M. M. Thomas, Officer-in-charge, KVK participated in the meeting of Officers-in-charge of Krishi Vigyan Kendras at Bangalore, 25 May 1993.

Dr. D. B. James, Senior Scientist attended a Seminar on sea-ranching of the sea-cucumber and presented a paper at Cochin, 28 April 1993.

Presented a paper on 'Prawn seed resoruces of Ennore Estuary' at the Seminar on "Shrimp farming" organised by the MPEDA, Tamil Nadu Fisheries Department and Indian Overseas Bank, Madras, 27 November 1993.

Presented a paper entitled 'Seed production in sea-cucumbers' at the National Seminar organised by Indian Aqua Trade Fair at Vijayawada, 20 November 1993. Chaired a Technical Session in the seminar.

Attended the Board of Director's meeting of Lakshadweep Development Corporation as Special Invitee at Cochin and explained the conservation measures for sea-cucumber at Lakshadweep, 28 January 1994.

Dr. G. Luther and Shri Y. Appanna Sastry participated in the inaugural function of Training programme on "Shrimp Culture - Management, Prospects and Problems" of Andhra University, 8 March 1994.

Dr. R. Sathiadhas, Senior Scientist attended the course on 'Computer applications in Agricultural research Management' at the National Academy of Agricultural Research and Management, Hyderabad, 15-25 June 1993.

Shri R. Marichamy, Principal Scientist, TRC of CMFRI, Tuticorin gave a lecture on shrimp farming at I.T.C. Ltd., Tuticorin, 17 September, 1993.

Participated in the Prawn Farming Seminar organised by the Waterbase Ltd., Nellore at Tuticorin, 17 August 1993.

Delivered special lectures on mud-crab culture at Madurai Kamaraj University. 1-4 November 1993.

Shri R. Marichamy, Principal Scientist and **Dr. D. B. James**, Senior Scientist, Tuticorin attended ISO 9000. Series standards organised by Marine Products Export Development Authority and Export Inspection Agency at Tuticorin, 9 August 1993.

Shri R. Marichamy, Principal Scientist and **Shri D. C. V. Easterson**, Scientist (SG) and **Dr. D. B. James**, Sr. Scientist attended a seminar on "Urban Environment of Tuticorin" organised by the Madras Institute of Development Studies and VOC College at Tuticorin, 16 August 1993. **Dr. D. B. James** gave a talk on "Urban Environment of Tuticorin with special reference to the Pollution caused by *Beche-de-mer* industry".

Dr. C. S. Gopinadha Pillai, Principal Scientist attended the third meeting of the National Committee on Wetlands, Mangroves and Coral Reefs at New Delhi, 27 September 1993.

Dr. P. Nammalwar and **Dr. E. V. Radhakrishnan,** Sr. Scientists participated in Prawn Farming Seminar organised by the Water Base Ltd., at Ramanathapuram, 3 September 1993.

Dr. V. Narayana Pillai, Principal Scientist, Calicut Research Centre of CMFRI, gave a seminar on coastal upwelling at Headquarters, 4 November 1993.

Shri K. K. Appukuttan, Scientist (SG) attended the meeting to discuss the ban on clam fishing in Ashtamudi Lake during spawning period at the Collectorate, Quilon, 21 December 1993.

Also participated in the seminar on conservation of clam wealth in the Ashtamudi Lake held at Quilon and presented a paper "Clam wealth of Ashtamudi - problems and prospects" 11 January 1994.

Dr. G. Sudhakara Rao and **Shri Y. Appanna Sastry** attended the inaugural function and **Shri K. Vijayakumaran** attended also the opening session of UNESCO curriculum workshop on Management of Mangrove Ecosystem and Coastal Protection, at Hotel Taj Residency, Visakhapatnam, 6 December 1993.

VISITORS

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Dr. V. R. K. Prasad, C.P.R. Autonomous College, Andhra Pradesh

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Justice Mr. V. Rengasamy, Judge, Highcourt, Madras

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Christian Stock, Geogapher (Tourism Studies), Germany

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Shri Hemant Kumar Sinha, IAS, Collector, V.O.C. Dist., Tuticorin

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Mr. P. Ramamohan Rao, Fishery Demonstrator, Fisheries Training Institute, Kakinada

VISAKHAPATNAM

Mr. P. Balasundara Rao, Secretary, Coastal Area Development Association, Visakhapatnam

Dr. P. V. Dehadrai, Deputy Director General (F), ICAR, New Delhi

Dr. Madhusoodana Kurup, Dr. A. Ramachandran, Department of Industrial Fisheries, Cochin University of Science and Technology, Cochin

Dr. T. N. R. Rao, Lecturer, N. S. Science College, Hyderabad

MINICOY

Parliament Committee on Official Language Implementation

KVK, NARAKKAL

The Quinquennial Review Team of KVKs under the Chairmanship of Dr. K. Krishnamoorthy, Former Vice-Chancellor, University of Agricultural Sciences, Bangalore

Dr. M. N. Sinha, Zonal Co-ordinator, TOT Projects, ICAR, Bangalore

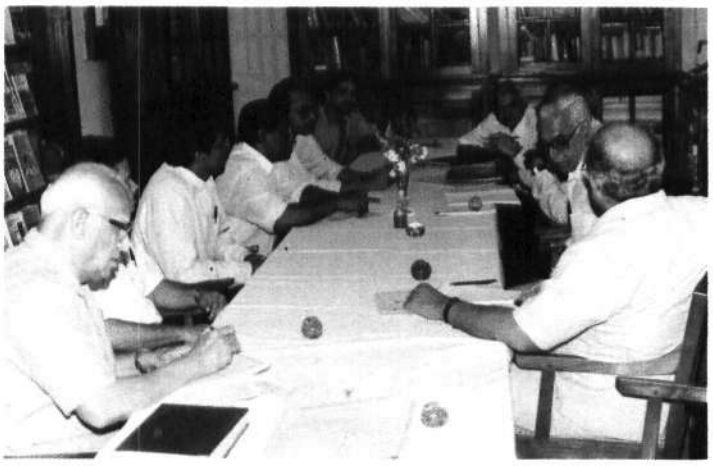
CALICUT

Prof. K. Srinivasa Rao, Chairman, QRT of CMFRI

Dr. S. V. Bapat, Member of QRT of CMFRI

The QRT Chairman and Members discuss with Director, CMFRI.

The QRT Members visit one of the laboratories at Headquarters.



The QRT Chairman and members at Calicut Research Centre of CMFRI.

Dr. S. Z. Qasim, Member (Science), Planning Commission, Govt. of India at the Electron Microscopy Laboratory at head-quarters during his visit.

INSTITUTE COMMITTEES

MANAGEMENT COMMITTEE

1.	The Director Central Marine Fisheries Research Institute Cochin	Chairman
2.	Dr. K. Radhakrishna ADG (Marine Fisheries) ICAR, Krishi Bhavan New Delhi	Member
3.	Shri P. Sam Bennet Scientist (Selection Grade) CMFRI, Tuticorin	Member (Upto 30-6-1993)
4	Finance & Accounts Officer Central Institute of Fisheries Technology, Cochin	Member (Upto 6-8-1993)
5.	Director of Fisheries Dept. of Fisheries and Ports Govt. of Kerala Thiruvananthapuram	-do-
6.	Director of Fisheries Dept. of Fisheries Govt. of Tamil Nadu, Madras	-do-
7.	The Dean College of Fisheries Cochin, Kerala	-do-
8.	Shri Subey Singh Ex-SDM 53, Vikas Nagar Sonepat Road, Rohtak (Haryana)	-do-
9.	Dr. P. Vedavyasa Rao Principal Scientist CMFRI Mangalore	Member (upto 6-8-93)
10.	Dr. K. Satyanarayana Rao Principal Scientist CMFRI, Madras	-do-
11.	Dr. P. S. Kuriakose Scientist (S-3) CMFRI, Calicut	-do-
12.	Dr. K. A. Narasimham Principal Scientist CMFRI, Cochin	Member (8-8-'93 onwards)
13.	Shri. R. Marichamy Principal Scientist CMFRI, Tuticorin	-do-
14.	Dr. M. M. Thomas Principal Scientist Krishi Vigyan Kendra of CMFRI Narakkal	-do-
15.	Dr. M. S. Rajagopalan Principal Scientist CMFRI, Cochin	-do-
16.	Administrative Officer CMFRI, Cochin	-do-

JOINT COUNCIL

OFFICE SIDE

1.	Director	Chairman
2.	Senior Administrative Officer	Member
3.	Senior Finance & Accounts Officer	Member
4.	Dr. P. P. Pillai Principal Scientist	Member
5.	Dr. (Mrs.) S. Sivakami Senior Scientist	Member
6.	Shri P. A. Naik Asst. Adm. Officer	Secretary (Official side)

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a. Technical Group

1.	Shri L. Jayasankaran	Member
2.	Shri. S. Haja Nejeemudeen Tech. Asst. (T-II-3)	Member
3.	Shri M. P. Sivadasan Tech. Asst. (T-I-3)	Member
4.	Shri D. Sunderarajan Tech. Asst. (T-I-3)	Member

b. Administrative Group

1.	Shri S. Abdulla Assistant	Member
2.	Shri K. J. Mathew Junior Clerk	Member
3.	Shri K. Sadanandan Junior Clerk	Member

c. Supporting Group

1.	Shri. A. P. Sebastian SS Gr. III (Peon)	Member
2.	Shri T. Vijayakumar SS. Gr. II (Messenger)	Member
3.	Shri B. Sainudeen SS. Gr. II (Watchman)	Member

GRIEVANCE COMMITTEE

1.	Dr. K. A. Narasimham Principal Scientist	Chaiman
2.	Dr. N. Neelakanta Pillai Senior Scientist	Member
3.	Administrative Officer	Member
4.	Sr. Finance & Accounts Officer	Member
5.	Dr. A. Regunathan Senior Scientist	Member
6.	Shri. V. K. Suresh Field Assistant (T-1)	Member
7.	Shri V. C. Subhash Junior Clerk	Member
8.	Shri. V. A. Surendran Driver	Member
9.	Shri. C. M. Rajappan SS. Gr. IV (LA)	Member
10.	Shri P.A. Naik Asst. Adm. Officer	Member Secretary

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1. Fishery Resources Assessment Division	-	Dr. K. Alagaraja Principal Scientist.
2. Pelagic Fisheries Division	-	Dr. P. P. Pillai Principal Scientist
3. Demersal Fisheries Division	-	Dr. P. Bensam Principal Scientist
4. Crustacean Fisheries Division	-	Dr. N. Neelakanta Pillai Senior Scientist
5. Mulluscan Fisheries Division	-	Dr. K. A. Narasimham Principal Scientist
6. Fishery Environment Management Division	-	Dr. M. S. Rajagopalan Principal Scientist
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8. Socio-Economic Evaluation & Technology Transfer Division	-	Shri D. B. S. Sehara Scientist SG

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Field Lab of CMFRI Cochin Fisheries Harbour Thoppumpady Cochin - 682 005, Kerala Phone - 26092	-	Mrs. Grace Mathew Scientist (Selection Grade)

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BUDGET/EXPENDITURE STATEMENT FOR THE YEAR 1993-94

Account Heads	Non Plan		Plan	
	Budget Estimates	Expenditure	Budget Estimates	Expenditure
	(Rs. in Lakhs)		(Rs. in lakhs)	
Establishment chargers	487.70	473.51	8.0	-
T.A.	8.80	8.80	5.60	5.60
Other charges - Equipments	88.50	105.03	106.40	113.69
Fellowship/Scholarships/Awards	3.00	0.66	5.00	3.09
Works	-	-	80.00	82.61
Total	588.00	588.00	205.00	204.99

PUBLICATIONS

BY SCIENTIFIC AND TECHNICAL STAFF

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Visakhapatnam. *Mar. Fish. Infor. Serv., T & E Ser.*, **122** : 24-25

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JAMES, D. B., M. E. RAJAPANDIAN, C. P. GOPINATHAN AND B. K. BASKAR 1994. Breakthrough in induced breeding and rearing of the larvae and juveniles of *Holothuria (Metriatyla) scabra* Jaeger at Tuticorin. *Bull. Cent. Mar. Fish. Res. Inst.*, **46** : 66-70.

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JAMES, D. B. AND P. THIRUMILU 1994. Shrimp seed resources of Ennore Estuary. *Fishing Chimes.*, 13 (12) : 13-18.

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ANI, S. AND A. NOBLE 1993. Laboratory studies on feeding and water exchange in the culture of *Penaeus indicus* H. Milne Edwards. *Ibid.*, **55** : 58-65.

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BY SENIOR RESEARCH FELLOWS (Ph.D)

(Not arranged alphabetically)

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Dr. P. Bensam
Dr. K. A. Narasimham
Dr. C. S. Gopinadha Pillai
Dr. P. Parameswaran Pillai

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T-8

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Shri P. R. Leopold - Skipper

PS : Principal Scientist, Sr. S : Senior Scientist, S(SG) : Scientist (Selection Grade), S(SS) : Scientist (Senior Scale) S : Scientist.

Shri P.K. Velayudhan - Mate

T-7

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Smt. D. Geetha

Junior Stenographers

Shri. C. D. Manoharan

Smt. P. K. Anitha

Junior Clerk

Shri N. K. Mohanan

CHAVAKKAD FIELD CENTRE

FIELD ASSISTANT

T-1

Shri K. G. Baby

QUILON FIELD CENTRE

TECHNICAL OFFICER

T-5

Shri Babu Philip

Shri S. B. Chandrangathan

FIELD ASSISTANT

T-I

Shri C. Unnikrishnan

ALLEPPEY FIELD CENTRE

FIELD ASSISTANT

T-1

Shri A.Y. Jacob

MANDAPAM CAMP - REGIONAL CENTRE AND ITS ATTACHED FIELD CENTRES

SCIENTISTS

Sr. S

Dr. P. Nammalwar

Dr. N. Kaliaperumal

Dr. A. P. Lipton

Dr. E. V. Radhakrishnan

S(SG)

Shri V. Gandhi

S-2

Shri S. Krishna Pillai

S(SS)

Dr. G. Maheshwaraudu

Dr. P. Jayasankar

S

Mrs. Reeta Jayasankar

Mrs. Sheela James

Technical Officers

T-5

Shri M. Badrudeen

Shri S. Kalimuthu

Shri C. Kasinathan - Curator

P. Thankappan - Foreman

T-4

Dr. K. Muniyandi

Shri S. Palanichamy

Shri A. Ganapathy

Shri V. Edwin Joseph - Lib. Assistant

Shri T. K. Sudhakaran - Bosun

Technical Assistants

T-II-3

Shri K. Muthiah

T-I-3

Shri J. R. Ramalingam

Shri M. R. Arputharaj

Shri M Najumuddin

Shri A. Ramakrishnan

Shri M. Bose

Shri R. Subramanian

Shri S. Mohan

Shri A. Muniyandi - Artist

Shri R. Marimuthu - Painter-cum-Polisher

Shri K. Alagirisamy - Motor Driver

Shri O. Muthukaruppan - Motor Driver

Shri A. Sreenivasan - Motor Driver

Shri Mohammed Jaffer - Driver (Boat)

Shri P. Muniasamy - Deckhand

Shri M. Ibrahim - Deckhand

Shri T. P. Haridasan - Carpenter

Shri S. Mohideen Meerasa - Sr. Deckhand

Shri M. Rengan - Cook (Boat)

Shri R. Sekar - Deckhand

Junior Technical Assistants

T-2

Shri M. Ramamurthy - Museum Assistant

Shri V. Sathiyanesan - Jr. Lab. Assistant

Field Assistants

T-I

Shri K. Jayabalan

Shri A. Gandhi

Shri V. Sethuraman

Shri A. Vairamani

Shri A. Shanmugavelu

Shri Sanjay Kumar Dana - Mechanic

Administration

Asst. Adm. Officer

Shri V. Chemmutty

Superintendent

Shri M. Ramakrishnan

Assistants

Shri V. M. Mariappan

Shri S. Nagarajan

Shri S. Jayachandran

Shri A. Kajendran

Shri K. Maragathavadivelu

Shri V. Chandran

Senior Clerks

Shri P. Selvaraj

Shri A. Yagappan

Shri N. Natarajan

Junior Stenographer

Mrs. N. Gomathi

Junior Clerks

Mrs. S. Parisa

Mrs. M. Rameswari

Shri U. Purandara Shetty

Supporting Staff

Laboratory Attendants

SSG-III

Shri M. Chinnasamy
Shri A. Muniasamy
Shri S. Muthuramalingam
Shri M. Ibrahimsha

Fieldmen

SSG-III

Shri A. Raman
Shri S. Pitchai - Daftry
Shri R. Nagan
Shri A. Subramanian
Shri S. Mani

Watchmen

SSG-II

Shri M. Ramu
Shri R. Sonali
Shri K. Muthiah
Shri K. Muniasamy
Shri M. Govindaraj
Shri P. Karuppiah
Shri G. Saivadurai
Shri K. Vellayan

Safaiwalas

SSG-II

Shri L. Sathan
Shri G. Ankaiah
Smt. J. Kondamma
Shri. R. Sevugan
Shri M. Muthu
Shri R. Alagan
Shri V. Santhanam
Shri K. Kuruvan
Shri A. Mari
Shri K. Gurusamy
Smt. S. Nagammal
Shri R. Sonaimuthu
Shri S. Arumugam
Shri U. Rajendran
Shri S. Murugan
Shri N. Nagamuthu
Mrs. Subhalekshmi

Lab Attendants

SSG-I

Shri N. Ramakrishnan
Shri C. Ramdoss
Shri S. Murugaboopathy
Shri E. Natarajan
Shri A. Yeshudhas
Shri K. Jeevanantham
Shri Bareen Mohammed
Shri M. Seeni
Shri K. Shanmuganathan
Shri I. Syed Sadiq
Shri V. Muniasamy
Shri V. Narasimha Bharathi
Shri K. Thangavel
Shri M. Kubaraganesan
Shri P. Villan
Shri N. Boominathan
Shri M. Sikkender Batcha
Shri T. Thananjeyan - Fieldman
Shri F. Arul Pragasam - Binder
Shri M. Sahul Hameed - Messenger
Shri M. Shanmugavelu - Messenger
Shri M. M. Athimoolam - Cook
Shri Y. Balan - Oilman
Shri J. Hameed Sultan - Pump Driver
Shri G. K. Rajan - Pump Driver
Shri K. U. Raman - Khalasi
Shri K. Govindan - Khansama

Watchmen

SSG-I

Shri P. Ramu
Shri S. Arulsamy
Shri M. Thangavelu
Shri S. Balakrishnan
Shri V. Alagan
Shri N. Rajavelu

NAGAPATTINAM FIELD CENTRE

Technical Assistants

T-I-3

Shri V. Thanapathy

Shri R. Somu

Shri V. Sivasami

PATTUKOTTAI FIELD CENTRE

Technical Assistant

T-I-3

Shri N. Vaithianathan

Junior Technical Assistants

T-2

Shri P. Palani

Shri A. Kumar

Auxiliary

T-I

Shri A. Srinivasan - Driver fro light vehicles

Field Assistants

T-I

Shri B. Thangaraj

VERAVAL RESEARCH CENTRE AND ITS FIELD CENTRES

Scientists

S

Shri K. P. Said Koya

Shri K. K. Philipose

Shri K. K. Joshi

Shri Manoj Kumar

Technical Assistants

T-I-3

Shri. Y. D. Savaria

Shri H. K. Dhokia

Shri B. P. Thumber

Junior Technical Assistants

T-2

Shri G. N. Chudasama - Motor Driver

Shri M. S. Zala

Shri J. D. Vanvi

Field Assistants

T-1

Shri A. A. Ladani

Shri A. P. Bharada

Shri J. P. Polara

Administration

Junior Clerks

Shri J. N. Jambudiya

Shri M. M. Vanvi

Supporting Staff

SSG-II

Shri Asiri Abu Bin Mehsan - Watchman

Shri L. M. Waghela - Watchman

Shri H. M. Bhint - Messenger

SSG-I

Shri H. K. Makwana - Fieldman

Shri S. P. Makwana - Watchman

JAMNAGAR FIELD CENTRE

Junior Technical Assistant

T-2

Shri B. V. Makadia

BOMBAY RESEARCH CENTRE AND ITS ATTACHED FIELD CENTRES

SCIENTISTS

Sr. S.
Dr. Kuber Vidyasagar
Dr. Alexander Kurien
Dr. S. K. Chakraborty
Dr. V. D. Deshmugh

S(SG)
Shri M. Zaffar Khan
Shri K. S. Sundaram

S(SS)
Shri S. G. Raje

S
Shri M. Aravindakshan
Dr. V. V. Singh

TECHNICAL OFFICER

T-5
Shri M. Shriram

TECHNICAL ASSISTANTS

T-II-3
Shri K. B. Waghmare

T-I-3
Shri J. L. Oza
Shri C. J. Josekutty
Shri A. D. Sawant
Shri J. D. Sarang
Shri J. R. Dias

JUNIOR TECHNICAL ASSISTANTS

T-2
Shri B. B. Chavan
Shri A. Y. Mestry
Shri P. S. Gadankush - Motor Driver

FIELD ASSISTANTS

T-I
Shri B. G. Kalbate
Shri J. S. Hotagi
Shri Thakur Das

ADMINISTRATION

SENIOR CLERKS

Ms. P. V. Shanbhag
Shri M. R. Wadadekar

JUNIOR CLERK

Ms. A. A. Sawant

JUNIOR STENOGRAPHER

Shri R. D. Medar

SUPPORTING STAFF

SSG-IV
Shri B. T. Talpade - Lab Attendant
Shri R. B. Bhangare - Fieldman

SSG-II
Shri K. G. Tawade - Watchman
Shri S. M. Tandel - Watchman

SSG-I
Shri D. D. Jangam
Shri M. P. Jadhav
Ms. Urmila S. Balmiki - Safaiwala
Shri P. S. Salvi - Messenger
Ms. Rajani Sakharam Tambe - Messenger
Shri K. K. Baiker - Fieldman

RANDER FIELD CENTRE

T-2
Shri S. D. Kamble

DAHANU FIELD CENTRE

T-2
Shri S. K. Kamble

T-1
Shri Suresh Krishna Rao

JANJIRAMURUD FIELD CENTRE

T-2
Shri D. G. Jadhav

T-1
Shri D. D. Sawant

RATNAGIRI FIELD CENTRE

T-2
Shri K. Balan K. Katkar

T-1
Shri D. D. Sawant

MALVAN FIELD CENTRE

T-1
Shri Kishore Regunatha Mainkar

Shri Bharamu S. Melimani

KARWAR RESEARCH CENTRE AND ITS FIELD CENTRE

SCIENTISTS

Sr. S.
Dr. V. S. Kakati

S(SG)
Shri P. Livingston

S(SS)
Dr. P. K. Krishnakumar

S
Miss. K. Preetha
Dr. P. K. Asokan

TECHNICAL ASSISTANTS

T-I-3
Shri C. K. Dinesh
Shri N. Chennappa Gowda
Shri Maruti S. Naik
Shri V. Varadaiah - Motor Driver

JUNIOR TECHNICAL ASSISTANTS

T-2
Shri T. B. Harikantra
Shri U. V. Argheka
Shri S. V. Pai
Shri V. M. Dhareshwar
Shri K. C. Pandurangchar

FIELD ASSISTANTS

T-I
Shri N. G. Vaidya
Shri M. E. Durgekar

ADMINISTRATION ASSISTANT

Shri G. K. Kudalkar

SENIOR CLERKS

Shri Y. H. Gamanagatti
Shri Gangadhar B. Naik

JUNIOR CLERK

Shri Ganesh R. Nadig

SUPPORTING STAFF

SSG-III
Shri. G. M. Korar - Fieldman
Shri M. P. Harikantra - Oilman

WATCHMEN

SSG-II
Shri L. K. Suvarna
Shri M. R. Kotharkar
Shri M. B. Kotharkar

SSG-I
Shri. Somayya S. Gond
Shri H. C. Naik
Shri Rajendra D. Hulswar
Smt. Somo. M. Harijan - Safaiwala
Miss. Pamila S. Palekar - Messenger

GOA FIELD CENTRE

T-2
Shri R. B. Kamble
Shri P. C. Shetty

SUPPORTING STAFF

SSG-II
Shri S. K. Naik - Messenger

MANGALORE RESEARCH CENTRE AND ITS FIELD CENTRE

SCIENTISTS

PS
Dr. P. Vedavyasa Rao
S(SG)
Shri K. K. Sukumaran
Shri C. Muthiah
S(SS)
Dr. Sunil Kumar Mohamed
S
Shri P. U. Zachariah
Mrs. Prathibha Rohit

TECHNICAL ASSISTANTS

T-I-3
Shri G. Subramanya Bhat
Smt. Alli. C. Gupta
Smt. Uma S. Bhat
Shri B. Sridhara
Shri D. Nagaraja
Shri S. Kemperaju
Shri Y. Muniappa

JUNIOR TECHNICAL ASSISTANTS

T-2
Shri H. Vasu
Shri H. S. Mahadevaswamy
Shri C. Purandhara

FIELD ASSISTANTS

T-I
Shri Lingappa
Shri Chaniappa

ADMINISTRATION

ASSISTANT

Shri Balakrishna Naik

SENIOR CLERKS

Shri K. M. Abdulla
Shri K. Rama Naik

JUNIOR CLERK

Smt. Martha R. Mascarenhas

AUXILIARY STAFF

Shri P. Narayana Naik - Driver (light vehicle)

SUPPORTING STAFF

SSG - II
Shri U.B. Sadashiva - Lascar
Shri Mohan S. Puthran - Oilman
Shri Gangadhara Gowda - Watchman
Shri A. Keshava - Watchman
Shri Ramanna Sapaliga - Watchman
SSG-I
Smt. Padmavathi - Safaiwala
Shri S. Mahalinga Naik - Watchman
Smt. Savithri - Fieldman

BHATKAL FIELD CENTRE

TECHNICAL ASSISTANT

T-I-3
Shri Maruti S. Naik

FIELD ASSISTANTS

T-1
Shri Ganesh Bhatkal
Shri C. G. Vivekar
Shri C.H. Vaman Naik
Shri R. Appaya Naik

CALICUT RESEARCH CENTRE AND ITS ATTACHED FILED CENTRE

Scientists

PS

Dr. V. Narayana Pillai

S-3

Dr. P. S. Kuriakose

S(SG)

Shri T. M. Yohannan

Shri G. P. Kumaraswamy Achary

Shri K. K. Appukuttan

S

Shri C. V. Mathew

Shri M. Feroz Khan

Technical Officers

T-5

Shri K. Nandakumaran

Shri K. K. Balasubramanian

Shri K. Soman

Mrs. K. Koumudi Menon

Mrs. S. Lakshmi

Shri T. Girija Vallabhan

Shri C. K. Krishnan

Shri N. P. Kunhikrishnan

Technical Assistants

T-I-3

Shri. K. P. Viswanathan

P. Swarnalatha

V. G. Surendranathan

V. K. Janaki

Shri M. M Bhaskaran

Administration

Assistant

Shri B. Devadasputhran

Senior Clerks

Mrs. C. Kamalakshi

Mrs. P. Subhadra

Junior Clerks

Shri R. Sreenivasan

Mrs. K. P. Shylaja

Auxiliary Staff

Shri B. K. Velukutty
- Driver for Light Motor Vehicle

Shri P. Harshakumar
- Driver for Light Motoer Vehicle

Shri V. K. Krishnankutty - Lab attendant

Supporting Staff

SSG-IV

M. Ramadasan - Lab Attendant

Fieldmen

SSG-III

Shri K. Janardhanan

Shri K. Kumaran

Watchmen

SSG-II

Shri K. E. Joseph Victor

Shri K. Chekutty

Shri A. Sivadasan

Fieldmen

SSG-I

Shri P. Dasan

Shri T. P. Renilkumar

Shri T. Haridasan

SSG-I

Shri T. Koman

Shri B. Raju

Miss. P. Renuka

Shri P.K. Suresh Babu - Watchman

Shri K.T. Mohanan - Messenger

Shri Palaniappan - Safaiwala

Shri M.K. Chandran - Safaiwala

CANNANORE FIELD CENTRE

T-I-3

Shri K. Chandran

T-2

Shri K. C. Purushothaman

VIZHINJAM RESEARCH CENTRE

Scientists

Sr. S

Dr. P. A. Thomas

Dr. S. Lazarus

S(SG)

Ms. Rani Mary George

Shri G. Gopakumar

S-2

Dr. N. Ramachandran

S(SS)

Dr. P. Kaladharan

S

Ms. S. Jasmin

Technical Officers

T-5

Shri R. Bhaskaran Achary

Shri T. G. Vijaya Warrier

Shri J. J. Joel

Shri P. S. Sadasiva Sarma

Shri S. G. Vincent

Shri K. Ramakrishnan Nair

Shri R. Vasanthakumar

Technical Assistants

T-II-3

Shri D. Sunderrajan

Shri Thomas Teles - Bosun

T-I-3

Shri A. K. Velayudhan

Smt. T. A. Omana

Shri K. T. Thomas

T-2

Shri K. Sasidharan Pillai

T-I

Shri V. M. Alwaris - Sr Deckhand

Administration

Senior Clerks

Shri M. Abdul Salam Sahib

Shri S. Erishikesan

Shri M. Reghunathan

Junior Clerk

Shri C. Johnson

Supporting Staff

SSG-IV

Shri J. Anselam

Shri K. Kunju Kunju

Shri V. Sasidharan Pillai

SSG-III

Shri A. Ayyappadas - Peon

Shri K. Chandran - Safaiwala

SSG-II

Shri S. Antony - Messenger

Watchman

SSG-II

Shri V. Viswanathan

Shri R. Madhusudhanan Nair

Shri V. Kochunarayanan Nair

SSG-I

Shri B. Prabhakaran - Messenger

TUTICORIN RESEARCH CENTRE AND ITS ATTACHED FIELD CENTRE

SCIENTISTS

PS

Shri R. Marichamy

Sr. S

Dr. A. C. C. Victor
Dr. H. Mohamad Kasim
Dr. D. B. James
Dr. M. Rajamani

S(SG)

Shri A. Chellam
Shri S. Dharmaraj
Shri M. E. Rajapandian
Shri P. Muthiah
Shri K. Ramadoss
Shri P. Sam Bennet
Shri K. M. S. Ameer Hamsa
Shri D. C. V. Easterson
Shri D. Kandasamy

S-2

Shri D. Sivalingam
Shri V. S. Rengasamy

S

Ms. Rani Palanisamy
Ms. Arun Mozhi Devi

TECHNICAL OFFICERS

T-6

Shri A. Bastian Fernando

T-5

Shri R. Gurusamy
Shri A. Agasteesapillai Mudaliar
Shri C.T. Rajan
Shri T.S. Balasubramanian
Shri P. Ferozkhan - Bosun

TECHNICAL ASSISTANTS

T-4

Shri Joseph Xavier Rodrigo
Shri A. Deivendra Gandhi

T-I-3

Shri A. Dasman Fernando - Skin Diver
Shri S. Soosai V. Rayan "
Shri M. Selvaraj "
Shri M. Manickaraja
Shri O. M. M. J. Habeeb Mohamed
Shri S. Rajapackiam
Shri G. Arumugam
Shri K. Srinivasagan
Shri M. Enose
Shri E. Sivanandam
Shri M. Xavier Mohanadoss - Motor Driver
Shri M. Chellappa
Shri D. Bosco Fernando - Deckhand
Shri N. Jesuraj - Skin Driver
Shri S. Enasteen - Deckhand
Shri R. Arockiasamy - Deckhand
Shri D. Anandan - Deckhand

T-2

Shri P. Muthukrishnan - Skin Diver
Shri R. Athipandian
Shri K. Shanmugasundaram
Shri S. Mohamed Sathakkathullah

FIELD ASSISTANTS

T-1

Shri R. Ponniah - Electrician
Shri U. Jeyaram
Shri J. Padmanabhan

ADMINISTRATION

SUPERINTENDENT

Shri J. M. Vaz

ASSISTANT

Shri D. Gnanajebamani

SENIOR CLERKS

Shri B. Bavanandam
Shri S. Antony George Retnam

JUNIOR STENOGRAPHER

Smt. S. Leelavathi

JUNIOR CLERKS

Smt. Kamalavenkataraman
Smt. S. Saradha
Smt. C. Rajeswari
Shri. M. Samuthiram

AUXILIARY STAFF

Shri S. K. Gurusamy - Motor Driver

SUPPORTING STAFF

SSG-IV

Shri A. Francis - Laboratory Attendant

SSG-III

Shri D. Motcham - Daftry
Shri M. Alfred - Watchman

WATCHMAN

SSG-II

Shri K. Thangarajan
Shri P. Muthumalai
Shri R. Utchimahali
Shri V. Samayamuthu

FIELDMEN

SSG-I

Shri W. Sathyawan Neelraj
Shri K. Muthuvel
Shri P. Kandan
Shri M. Sankaran
Shri G.S. Rayappan
Shri I. Ravindran
Shri S. Alegesan
Shri K. John James - Gardener
Shri M. Mariappan - Safaiwala
Shri M. Soundarapandian - Safaiwala
Shri M. Kalimuthu - Watchman
Shri K. Murugan - Watchman

KANYAKUMARI FIELD CENTRE

T-5

Shri N. Retnasamy
Shri T. P. Ebenezer

T-1-3

Shri A. Prosper

T-I

Shri P. Paul Sigamony

MADRAS RESEARCH CENTRE AND ITS ATTACHED FIELD CENTRES

SCIENTIST

PS

Dr. K. Satyanarayana Rao

Sr. S

Dr. P. Devadoss
Dr. P. V. Sreenivasan
Dr. E. Vivekanandan
Dr. R. Paul Raj
Dr. M. Vijayakumaran
Dr. M. Rajagopalan

S(SG)

Shri N. S. Radhakrishnan
Shri R. Thiagarajan
Shri M. M. Meiyappan
Shri J. C. Gnanamuthu

S-2

Shri V. Thangaraj Subramaniam
Shri P. Natarajan

TECHNICAL OFFICERS

T-6

Shri P. K. Mahadevan Pillai

T-5

Shri S. Kandasamy
Shri A. C. Sekar

Shri S. K. Balakumar
Shri M. Mohammed Sultan
Shri P. Ramadoss
Shri K. S. Krishnan

TECHNICAL ASSISTANTS

T-4

Dr. R. Thangavelu
Dr. V. Selvaraj
Shri U. Alagumalai, - Bosun

T-I-3

Shri L. Jayashankaran
Shri H. Kader Batcha
Shri S. Subramani
Shri S. Seetharaman
Shri Hameed Batcha
Shri C. Manimaran
Shri G. Sreenivasan
Shri P. Poovannan
Shri K. Shahul Hameed
Shri S. Chandrasekhar
Shri P. Thirumilu
Shri V. S. Gopal
Shri G. Natarajan - Motor Driver
Shri K. Pandi - Motor Driver
Shri K. Rathnakumar - Motor Driver
Shri D. Padmanabhan - Boat Driver
Shri Vali Mohamed - Boat Driver
Shri C. Manibal - Deckhand

T-2

Shri A. Ahmed Kamal Bhasha

T-1

Shri S. Rajan - Field Asst.

ADMINISTRATION

ASSISTANTS

Shri K. M. Karuppiah
Shri S. Mangalam

Senior Clerks

Shri S. K. Murali
Shri S. Balasubramanian
Mrs. M. Parvathy
Mrs. G. Abitha

STENOGRAPHER

Mrs. Rosy Joachin

JUNIOR CLERKS

Mrs. A. B. Lalitha
Mrs. P. Thankaleelal

AUXILIARY STAFF

DECKHANDS

Shri Joseph Xavier
Shri S. Selvanidhi

SUPPORTING STAFF

SSG-III

Shri M. Vellayan - Lab Attendant
Shri R. Anandha Jyothi - Watchman

SSG-II

Shri M. Ravindran - Messenger
Shri Vijayarangan - Safaiwala
Shri G. Chakrapani - Watchman

SSG-I

Shri S. Yuvarajan - Lab. Attendant
Shri P. Selvaraj - Safaiwala
Mrs. Anjali Devi - Peon
Shri Sitaramacharyalu - Helper

WATCHMEN

SSG-I

Shri T. Nagalingam
Shri S. Inbamani

FIELDMEN

SSG-I

Shri T. Manoharan
Shri R. Sundar
Shri R. Vasu

CUDDALORE FIELD CENTRE

Technical Assistants

T-I-3

Shri A. Srinivasan

Shri T. Dhandapani

Shri M. Radhakrishnan

Shri M. Manivasagam

PONDICHERRY FIELD CENTRE

Technical Assistant

T-I-3

Shri Chidambaram

MAHABALIPURAM FIELD CENTRE

Technical Officer

T-5

Shri S. Manivasagam

ONGOLE FIELD CENTRE

Technical Officer

T-5

Shri K. V. S. Seshagiri Rao

Technical Assistants

T-4

Shri A. Hanumantha Rao

Field Assistant

T-1

Shri G. Sudhakar

NELLORE FIELD CENTRE

Technical Assistant

T-5

Shri G. C. Lakshmaiah

Field Assistant

T-1

Shri S. Rajan

KOVALAM FIELD CENTRE

Technical Assistant

T-I-3

Shri S. Sankaralingam

Supporting Staff

SSG-II

Shri D. Pakkiri - Watchman

Shri A. Janagiraman - Watchman

SSG-I

Shri M. P. Chandrasekhar - Watchman

Shri M. Anbu - Messenger

KAKINADA RESEARCH CENTRE AND ITS ATTACHED FIELD CENTRES

SCIENTISTS

PS

Shri G. Subbaraju

Sr. S

Dr. G. Syda Rao

S(SG)

Shri A. Raju

S

Ms. K.N. Saleela

TECHNICAL OFFICERS

T-8

Shri B. S. Ramachandrudu

T-5

Shri P. Ramalingam

TECHNICAL ASSISTANTS

T-4

Shri K. Ramasomyajuu - Sr.Tech.Asst.

Shri K. Dhanaraju

T-I-3

Shri Ch. Ellithathayya

Shri Dharma Rao - Motor Driver

T-2

Shri T Nageswara Rao

FIELD ASSISTANTS

T-I

Shri N. Burayya

Shri P. Achayya

Shri P. Venkataramana

Shri V. Abbulu

ADMINISTRATION

SENIOR CLERK

Shri S. Suryanarayana Murthy

JUNIOR CLERK

Shri S. Appa Rao

SUPPORTING STAFF

SSG-III

Shri K. Narasimhamurthy - Lab Attendant

SSG-II

Shri R. V .S. Subramanyam - Watchman

Shri. S. Tatabai - Messenger

SSG-I

Shri K. Sathyanarayana - Watchman

Shri G. Sainyadhipathi - Watchman

Shri D. Bhaskara Rao - Safaiwala

NARSAPUR FIELD CENTRE

TECHNICAL OFFICER

T-5

Shri P. Ananda Rao

MACHILIPATNAM FIELD CENTRE

TECHNICAL ASSISTANT

T-I-3

Shri T. Chandrasekhra Rao

VISAKHAPATNAM RESEARCH CENTRE AND ITS ATTACHED FIELD CENTRES

SCIENTISTS

PS

Dr. G. Luther

Sr.S

Dr. Sudhakara Rao

S (SG)

Shri Y. Appanna Sastry
Shri R. Sarvesan
Shri G. Mohanraj

S

Shri K. Vijayakumar

TECHNICAL OFFICERS

T-5

Shri M. V. Somaraju
Shri C. V. Seshagiri Rao

TECHNICAL ASSISTANTS

T-4

Shri K. Chittibabu

T-II-3

Shri K. Diwakar
Shri T.N. Sukumaran - Bosun

T-I-3

Shri M. Chandrasekhar
Shri S. Satya Rao
Shri K. Narayana Rao
Shri J. Bhuvaneswara Varma
Shri M. Samuel Sumithrudu
Shri M. Prasada Rao
Shri P. M. Abdul Muheedu - Deckhand
Shri P. A. Reghu, Oilman-cum-Deckhand

T-2

Shri S. Chandrasekhar
Shri P. Pasupathy Rao - Motor Driver
Shri S. Ganesan - Deckhand

FIELD ASSISTANTS

T-I

Shri R. V. D. Prabhakar

AUXILIARY STAFF

Shri S. Durai Pandian - Driver for light Vehicles
Shri R.V.D. Prabhakar

ADMINISTRATION

ASSISTANT

Shri R. Appa Rao

SENIOR CLERK

Shri K. Shanthi Prasad

JUNIOR CLERKS

Smt. B. Gauri
Kum. B. Madhavi Latha

SUPPORTING STAFF

SSG-IV

Shri V. Mohana Rao - Lab Attendant
Shri R. Kanakaraju - Lab Attendant
Shri V. Demudu - Lab Attendant
Shri P. Krishna Rao - Lab Attendant

SSG-II

Shri L. Appa Rao - Messenger
Shri R. Dalayya - Safaiwala

PURI FIELD CENTRE

TECHNICAL ASSISTANTS

T-I-3

Shri P. Venkatakrishna Rao
Shri Sukdev Bar

FIELD ASSISTANT

T-I

Shri S. Hemasundara Rao