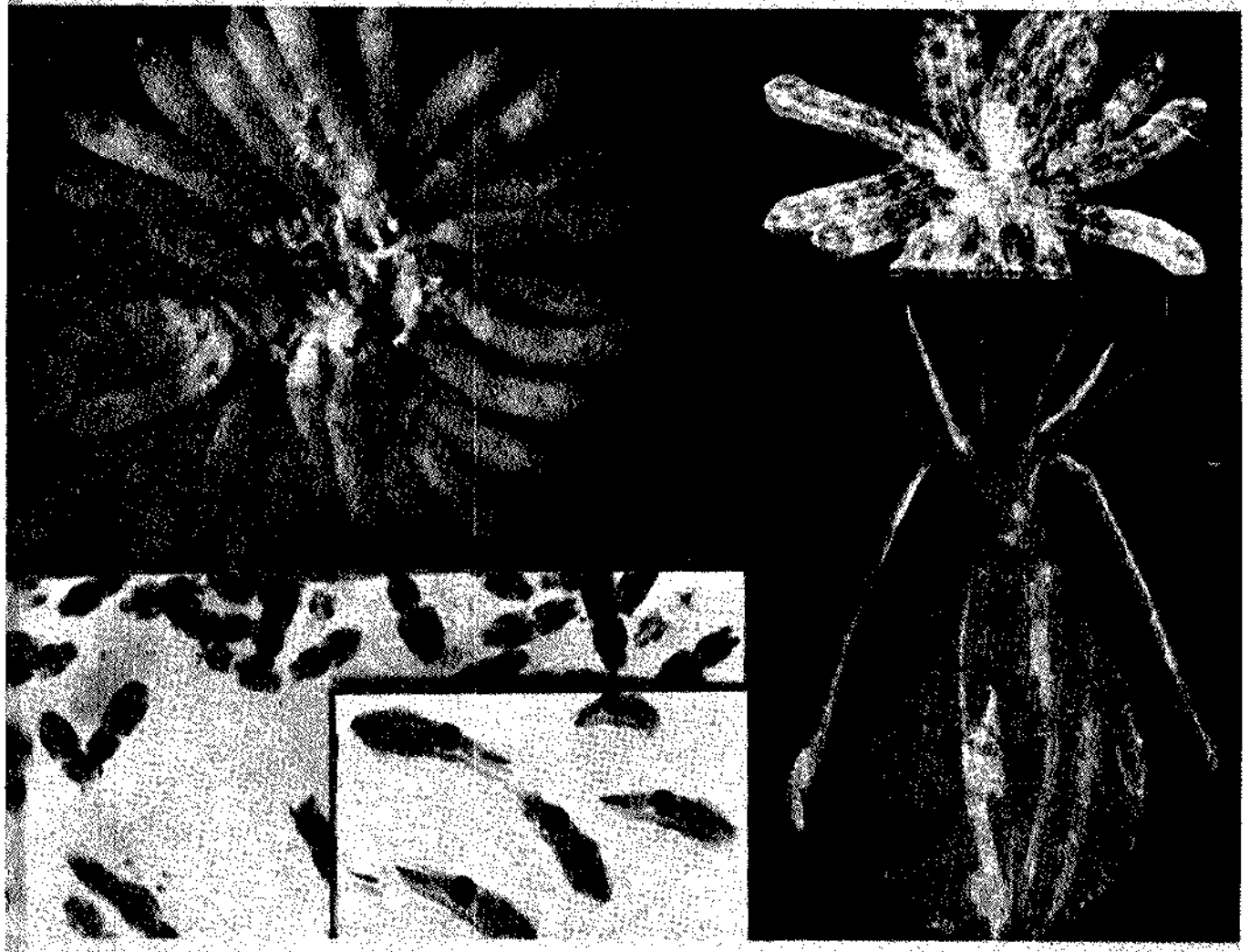
केन्द्रीय समुद्री मात्स्यिकी
अनुसंधान संस्थान, कोचीन
CENTRAL MARINE FISHERIES
RESEARCH INSTITUTE, COCHIN

Annual Report 1988



भारतीय कृषि अनुसंधान परिषद्
INDIAN COUNCIL OF AGRICULTURAL RESEARCH

CENTRAL MARINE FISHERIES
RESEARCH INSTITUTE,
COCHIN

Annual Report
1988

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Issued by

Dr. P. S. B. R. JAMES
DIRECTOR
CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
Post Box No. 2704, Cochin - 682 031

Editing and Printing

Dr. GEORGE JOHN, Scientist S - 2
Ms. PUTHRAN PRATHIBHA, Scientist S - 1

Cover Photo

CMFRI succeeded in hatching and rearing of the Palk Bay squid *Sepioteuthis lessoniana* : different stages of rearing in the laboratory, from egg to adult are depicted. Fertilized eggs are embedded in bean-shaped egg capsules attached together as a bunch. As development progresses, the capsules shrink and become more transparent. The young hatch out as miniature squids and swim freely in water, feeding on live mysids and later on small fishes.

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ANNUAL REPORT - 1988

CONTENTS

INTRODUCTION

The Central Marine Fisheries Research Institute was established in 1947 by the Ministry of Agriculture and Irrigation and subsequently brought under the Indian Council of Agricultural Research in 1967. The Institute has its headquarters located at Cochin and its regional centre at Mandapam Camp. The 11 Research Centres and 29 Field Centres are situated along the east and west coasts.

The Institute, since its inception, has been active in conducting basic and applied research activities in the marine sector and has contributed significantly to the development of marine fisheries in the country. The Institute has the mandate to conduct research for assessing and monitoring the exploited fisheries resources leading to rational exploitation, conservation and management; to assess the underexploited and unexploited marine fisheries resources of the Exclusive Economic Zone; to understand the fluctuations in abundance of marine fisheries resources in relation to changes in the environment by conducting vessel based programmes; to develop suitable mariculture technologies for finfish and shellfish in open sea to supplement marine fish production; to conduct transfer of technology; short term and long term training and post-graduate programmes.

The Institute implements its research programmes through the following nine major divisions: Fishery Resources Assessment Division; Pelagic Fisheries Division; Demersal Fisheries Division; Molluscan Fisheries Division; Crustacean Fisheries Division; Fishery Environment Management Division; Physiology, Nutrition and Pathology Division; Fishery Economics and Extension Division; Library and Documentation Division.

The post-graduate programme in mariculture affiliated to the Cochin University of Science and Technology conducts M.Sc. and Ph.D. programmes in Mariculture. The Krishi Vigyan Kendra and Trainer's Training Centre at Narakkal are involved with extension programmes and imparting training in capture and culture fisheries.

Marine Fish Production

The annual marine fish landings in India for the year 1988 has been estimated at 1.8 million t, a sharp increase of about 8% as compared to the landings of 1987. Increased landings were noticed along the west coast especially Kerala. *Stolephorus* spp., carangids, oil sardine, mackerel, catfishes, red mullets and non-penaeid prawns recorded higher catches and contributed significantly to the total landings.

Pelagic resources

The landings of tunas and billfishes increased along the mainland and the Minicoy island. Drift gill nets, purse seines, ring seines and hooks and lines contributed to the fishery in the

mainland, whereas in Minicoy, the pole and line and troll line formed the major gears. The mackerel and anchovy resources also recorded significant increase in landings.

Demersal resources

The perch fishery comprised of *Lethrinus* spp., *Lutjanus* spp., *Epinephelus* spp. and *Plectorhynchus* spp. The hooks and lines, drift gill nets and trawl nets contributed to the fishery at different centres. At Karwar, the catfish fishery comprised of only *Tachysurus seratus* and was landed exclusively by the purse seines. At Bombay, the dol nets landed juveniles of *T. dussumieri*. The landings of thread fin breams continued to show a declining trend indicating recruitment overfishing.

Molluscan resources

Cephalopods were landed by trawl nets at all centres except Vizhinjam where, hooks and lines and shore seines contributed to the fishery. The fishery comprised of both the squids and cuttlefishes at all centres. Mussel beds (602 ha) with a potential estimated stock of 16,000 t were observed along the Calicut coast.

Crustacean resources

Penaeid prawn landings improved with very good landings of *Parapenaeopsis stylifera* at Cochin. The non-penaeid resources also improved with a dominance of *Acetes* spp. Population studies at Bombay and Kakinada indicated that increase in effort would result in increase in catch; on the other hand, the decline in trawl catch at Visakhapatnam indicated fishing pressure on the exploited stock.

Environmental studies

Upwelling was intense during June at Cochin. At Visakhapatnam upwelling commenced in February and continued upto June. Deepwater fishes like *Psenes indicus, Decapterus* spp. & *Nemipterus* spp. moved shorewards. A correlation between the sea surface temperature and tuna catch was noticed.

Physiology, Nutrition, Pathology and genetics

Pituitary extracts of female mullets when subjected to electrophoresis, revealed three bands in the immature ones and five in the mature ones. The muscle protein as free amino acids in the haemolymph and ammonia excretion in *Penaeus indicus* was found to be lower at 25%o salinity. In *P. monodon* the haemolymph glucose levels increased and the muscle glycogen levels decreased during hypoxic conditions.

The quantitative protein requirement for juvenile *P. monodon* was less than 35% and for *P. latisulcatus* it was between 27.5 to 50%. The feeds developed for *Chanos chanos* and *P. indicus* showed good palatability and low deterioration rates.

Vibrio fischeri was isolated from the gill lesions and *Aeromonas hydrophila* and *Flavobacterium* sp. from ulcerative skin lesions of fishes. Furunculosis due to *Aeromonas salmonicida* and *A. hydrophila* was recorded for the first time in the laboratory reared *Lates calcarifer*.

A reliable methodology has been developed to study bivalve chromosomes. The diploid chromosome number of *Villorita cyprinoides* and *Liza parsia* were 38 and 48 respectively. The chemical malathion was found to be genetoxic. The electrophoretic conditions for locating 4 enzyme systems in *Crassostrea madrasensis* was standardised.

Fishery Economics

At Maharashtra and Gujarat the initial investment of a trawl unit was 4 - 5 lakhs with an annual income of 1 - 2 lakhs. The operation of (OBM and IBM) gill net units was profitable with an expenditure of Rs. 0.9 - 1.1 lakh for OBM and Rs. 2.3-2.6 lakhs for IBM and a net income of Rs. 1.2 - 1.4 lakhs and 2.3 - 2.7 lakhs respectively. At Cochin the purse seiners were found to be economically more efficient than the trawlers and gill netters. In Kerala, diversification of fishery activities, mechanisation and better information facilities, resulted in higher income for the fishermen.

Mariculture

Six species of prawns viz., *Trachypenaeus pescadorensis, Parapenaeopsis maxillipedo, P. uncta, Metapenaeopsis stridulans, M. hilarula* and *M. mogiensis* were bred in captivity and their larval stages were successfully reared in the laboratory for the first time.

The green mussel, *Perna viridis* was induced to spawn in the laboratory at Madras by means of mechanical, thermal and biological stimuli. The clams *Meretrix meretrix, Anadara granosa* and *Paphia malabarica* were also induced to spawn and their larvae were reared in the laboratory. Eggs of *Sepioteuthis lessoniana* and *Sepia pharaonis* collected from the wild were hatched in the laboratory and the hatchlings were fed with mysids, *Mesopodopsis* sp. and assorted fish fry.

Semi-intensive culture of *Penaeus monodon* with a stocking rate of 50,000/ha gave a production rate of 536.5 kg/ha/110 days.

An artificial reef made of old car tyres and concrete blocks was fabricated and installed in the southern end of Minicoy lagoon. The fish aggregation in relation to reef age was monitored.

Vessel based programmes

FORV *Sagar Sampada* made 16 research cruises and logged 261 days at sea. The oceanic squids *Symplectoteuthis oualaniensis* were caught in good numbers in the pelagic trawls operated during early morning and night hours between latitude 15° and 20°N at a depth range of 40 - 100 m. Rich fishing grounds for black pomfret and large perches were located at 19°53' N latitude and 86°36' E longitude.

The *Cadalmins* stationed at 6 research centres monitored the environmental parameters in the inshore waters. Studies on young fishes and benthos were also carried out.

Education, Training and Transfer of Technology

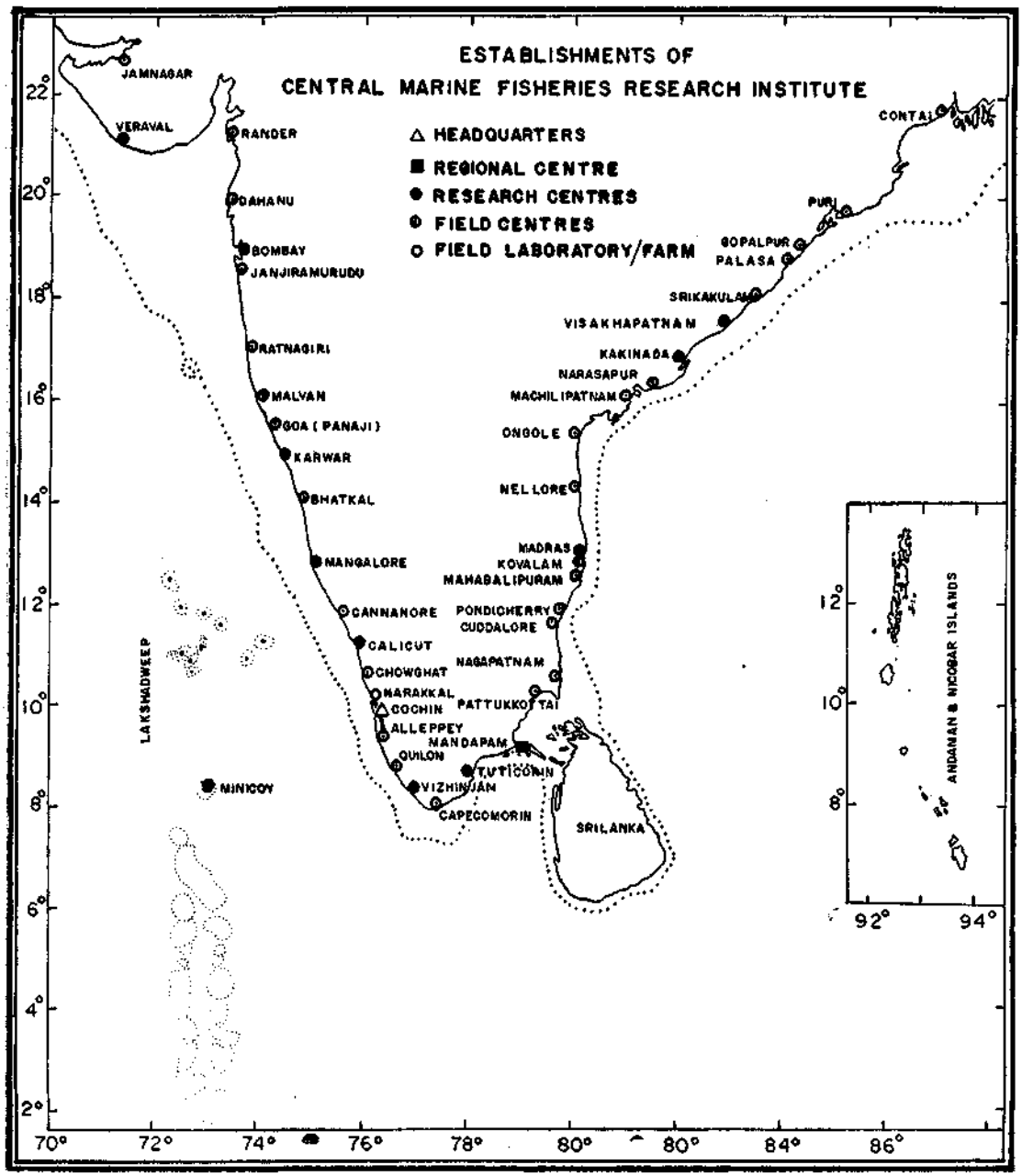
Under the post-graduate programme in Mariculture, 9 junior research fellows (Seventh batch) passed the M.Sc. examination. The syllabus for the

M.Sc. course has been revised and introduced in the ninth batch. Three senior research fellows were awarded Ph.D. degrees by the Cochin University of Science and Technology. Four senior research fellows were appointed as Assistant Development Officers (fisheries) in NABARD and four senior research fellows were selected as scientists by the ASRB. Four Scientists of CMFRI received specialised training abroad.

The KVK conducted 63 training courses and trained 638 farm women and 342 farm men. The Trainers' Training Centre organised training courses in hatchery production of marine prawns, post harvest technology and sampling technique for assessment of exploited marine fishery resources.

The progress of the Research Projects is presented under the respective Divisions.

(P. S. B. R. JAMES)
Director


ESTABLISHMENTS OF
CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
△ HEADQUARTERS
■ REGIONAL CENTRE
● RESEARCH CENTRES
◉ FIELD CENTRES
○ FIELD LABORATORY/FARM
JAMNAGAR
VERAVAL
RANDER
DAHANU
BOMBAY
JANJIRAMURUDU
RATNAGIRI
MALVAN
GOA (PANAJI)
KARWAR
BHATKAL
MANGALORE
CANNANORE
CALICUT
CHOWGHAT
MARAKKAL
COCHIN
ALLEPPEY
QUILON
VIZHINJAM
CAPECOMORIN
MINICOY
LAKSHADWEEP
CONTAI
PURI
GOPALPUR
PALASA
SRIKAKULAM
VISAKHAPATNAM
KAKINADA
NARASAPUR
MACHILIPATNAM
ONGOLE
NELLORE
MADRAS
KOVALAM
MAHABALIPURAM
PONDICHERRY
CUDDALORE
NAGAPATNAM
PATTUKKOTTAI
MANDAPAM
TUTICORIN
SRILANKA
ANDAMAN & NICOBAR ISLANDS
22°
20°
18°
16°
14°
12°
10°
8°
6°
4°
2°
70°
72°
74°
76°
78°
80°
82°
84°
86°
92°
94°

ACTUAL EXPENDITURE FOR 1987-88 UNDER NON-PLAN AND PLAN

(Rupees in Lakhs)

			Non-Plan	Plan
1.	Establishment charges	...	237.95	11.29
2.	T. A.	...	12.00	5.00
3.	Leave Salary, Pension and Provident Fund contribution	...	0.05	...
4.	Other Charges	...	75.04	15.68
5.	Seminar & Conference	...	0.51	...
6.	Fellowship/Scholarship	...	...	4.71
7.	Grant-in-aid	...	0.45	...
8.	Lands & Buildings	...	...	28.32
	TOTAL	...	326.00	65.00

GENERAL INFORMATION

Engagements :

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

Mid-term review of the VII Five Year Plan Meeting at ICAR Headquarters 20-21 January.

ICAR Co-ordination Committee Meeting to finalise annual cruise programmes for FORV *Sagar Sampada*, New Delhi, 19 February.

National Science Week celebrations and Seminar on Fisheries Development, Kandakkadavu, 28 February.

Standing Finance Committee and governing body meeting of ICAR Society, New Delhi, 8 & 9 March.

Annual General Body Meeting of the ICAR Society, New Delhi, 10 March.

Member of the delegation to Sri Lanka to assess and identify the areas of projects and schemes for rehabilitation and reconstruction work, 14 - 21 March .

Meeting of cruise planning and programme priorities committee of FORV *Sagar Sampada, Sagar Kanya* and *Gaveshini*, New Delhi, 15 April.

Meeting of the Co-ordination Committee for survey of living resources of Ocean Science and Technology Board, New Delhi, 12 May.

Workshop on Marine Fisheries Research and Development organised by Maharashtra State Fisheries Department, Bombay, 25 - 26 May.

Meeting of Central Board of Fisheries Calcutta, 30 May.

Meeting called by ICAR to consider the location of headquarters of CIBA, New Delhi, 16 June.

Meeting convened by the Secretary to Prime Minister regarding the plans and programmes of Department of Ocean Development, Delhi, 28 July.

First and Second meeting of the working group of VIII Five Year Plan of Department of Ocean Development, New Delhi, 18 August and 7th October.

First Management Committee of Kendriya Vidyalaya, CMFRI Campus, Mandapam Camp, 6 September.

Workshop on Marine Fisheries Research and Development, Madras, 13-14 September.

Second National Co-ordinators' meeting on Sea Farming, Singapore, 20-23 September.

Ninth meeting of the Steering Committee for Island Development Authority, New Delhi, 12 October.

ICAR Directors' Conference, Delhi, 31 October.

International Symposium on Aquaculture Research Needs for the year 2000, Delhi, 15-18 November.

ICAR Divisional Meeting; Delhi, 18 November.

ICAR Scientific panel for fisheries meeting, Delhi, 24 November.

International Conference on Appropriate Agricultural Technologies for Farm Women — future research strategy and linkage with development system, Delhi, 30 November - 1 December.

Working Group Meeting on Fisheries Delhi, 12 December.

National Workshop on seafarming for mainland and Islands of India, Bombay, 20 December.

Dr. M. M. Thomas, Shri S. Kalaimani, Ms. Krishna Srinath & Ms. Jancy Jacob (Scientists) and the technical staff of KVK attended the workshop on Gainful Employment for women jointly organised by Department of Science and Technology and CIFT, Cochin.

Dr. M. M. Thomas attended the Rural Programme Advisory Committee Meeting of All India Radio, Trichur.

Dr. M. M. Thomas participated in the monthly T&V workshop of the agricultural extension programme of Kerala State Agricultural Department.

Scientific and technical staff of KVK participated in the Regional Workshop-cum-Training Programme for KVK/TTC staff, Mitra Niketan, Trivandrum, 31 December to 3 January.

Dr. V. S. Kakati, Scientist S-2 attended the managing committee and technical committee meetings of the Brackishwater Fisheries Development Agency of Karnataka State Fisheries Department.

Dr. P. Bensam and **Shri M. Kathirvel**, Scientists and **Shri B. S. Ramachandradu**, Farm Engineer attended the National Workshop on Aquaculture Engineering held by Ocean Data Centre, Centre for Water Resources, College of Engineering, Anna University, Madras, 8 April.

Shri M. H. Dhulkhed, Shri G. Annigiri, Dr. V. S. Kakati, Shri P. K. Asokan and **Shri P. K. Krishnakumar**, Scientists at Karwar attended the District Entrepreneurship Development Programme for Brackishwater Prawn farming jointly organised by NABARD, MPEDA and BDFA, Karwar.

Workshop/Training :

A workshop on R & D in marine fisheries was held from 25 - 27 May at Bombay and from 13 - 14 September at Tamil Nadu to discuss the current issues in fisheries research and development at Maharashtra and Tamil Nadu respectively.

A training programme on Sampling Design of CMFRI for Survey of Exploited Marine Fishery Resources was conducted at Cochin from 12-12-'88 to 22-12-'88.

Lecture :

Dr. C. S. Gopinadha Pillai, Scientist S-3 gave a guest lecture on coral reef ecology at Salim Ali School of Ecology University of Pondicherry, 30 September.

Scientists deputed abroad for training:

Dr. V. S. K. Chennubhotla, Scientist S-3 was deputed to Philippines for a demonstration training in *Euchema*, seaweed farming 2 - 21 May.

Dr. V. Sriramachandra Murthy, Scientist S-2 was deputed to U.K. for training in Fish Stock Assessment under British Technical Corporation from 9 May - 27 July.

Dr. G. Syda Rao and **Smt. Rani Mary George,** Scientists were deputed to undergo fisheries training at Yugoslavia for 3 months from 25 August.

Visitors :

Cochin :

Dr. R. P. S. Tyagi, Member, ASRB and
Dr. V. S. Bhatt, Director (P&I), ICAR.
Shri S. W. Owk, Director (F), ICAR.

Dr. S. B. Kadrekar, Vice Chancellor, Konkan Krishi Vidyapeeth, Ratnagiri.

Hon'ble Union Minister of State for Agriculture, Shri H. Mari Krishna Sastri.

Dr. S. S. Khanna, Advisor for Aquaculture, Planning Commission, New Delhi.

Dr. N. S. Randhawa, Director General, ICAR.

Dr. P. V. Dehadrai, Deputy Director General (Fisheries).

Quinquennial Review Team consisting of Shri Chidambaram (Chairman & Managing Director of Matsya Sagar Consultancy Services Pvt. Ltd., Madras), Shri J. V. M. Dixitulu (Editor, Fishing Chimes, Visakhapatnam);

Prof. S. Dutt (Retd. Prof. of Andhra University, Bangalore); Dr. D. Sudharshan (Deputy Director General, Fishery Survey of India) and Dr. C.T. Samuel (Prof. andHead of Department of Industrial Fisheries, Cochin).

Students from 15 colleges all over the country.

Mandapam :

Shri Duleep Mathai, Member, Wildlife Board of India.

Dr. M. V. Rao, Special Director General, ICAR.

Shri K. Mohan Naidu, Director, Sugarcane Breeding Institute, Coimbatore.

Shri C. Srinivasa Sastry, Additional Secretary, Government of India.

Calicut :

Students from various colleges.

Vizhinjam :

Dr. Chandrika Prasad, Deputy Director General, ICAR.

Shri K. Viswanathan, Director, Mitraniketan and Member of CMFRI Management Committee.

Sister Vitaliae Mary, Principal, St. Mary's College, Tuticorin.

Dr. C. V. N. K. Rao, Geologist, Geological Survey of India, Hyderabad.
Shri Arokyachami, Member, UPSC.

Shri P. Kumaradhas, Member, Kerala Public Service Commission.

Dr. N. S. Randhawa, Director General, ICAR.

Veraval :

Mr. Tony Sanders, Fish Technologist, Overseas Development Administration, U.K.

Karwar :

Dr. Arjunwadkar, Dept. of Zoology, Fergusson College, Pune.

Prof. S. L. Patil, Department of Zoology, R.L.S.T., Belgaum.

Tuticorin :

Students from 29 colleges from all over India.

Kakinada :

The Quinquennial Review Team consisting of Shri J. V. N. Dixitulu, Dr. C. T. Samuel, Prof. S. Datta and Dr. D. Sudarshan.

Shri B. Biswas, Shri V. Surendran, Shri George Thomas, Shri K. Joshna, Shri Subbarao and Smt. A. Sujatha of TASPARC Hatchery Project, Visakhapatnam.

Minicoy :

Shri Roni Khosla, Prime Ministers Secretariat, Member, Island Development Authority.

Dr. Amlash Chaudry and Dr. Cecil J. Suldhana, Members, Island Development Authority.

COMMITTEES

Management Committee

1. Dr. P.S.B.R. James, Director, C.M.F.R.I., Cochin.	...	Chairman
2. Shri K. Balaram, General Secretary, INTUC, Visakhapatnam.	...	Member
3. Shri K. Viswanathan, Director, Mitra Niketan, P. O. Vellanad, Kerala.	...	Member
4. Shri P. J. Thomas, Director of Fisheries, Department of Fisheries and Ports, Government of Kerala.	...	Member
5. Shri G. Ganaleelan, IAS, Director of Fisheries, Karnataka.	...	Member
6. Dr. M. J. Sebastian, Dean, Fisheries College, Kerala Agricultural University, Panangad P. O., Cochin.	...	Member
7. Dr. M. Y. Kamal, Assistant Director-General, ICAR, New Delhi.	...	Member
8. The Assistant Accounts Officer, CIFT, Matsyapuri P. O., Cochin - 682 029.	...	Member
9. Dr. K. V. Narayana Rao, Scientist S-3, CMFRI, Mangalore.	...	Member
10. Shri C. P. Ramamirtham, Scientist S-3, CMFRI, Cochin.	...	Member
11. Dr. P. Bensam, Scientist S-2, CMFRI, Mandapam Camp.	...	Member
12. Shri P. James Abraham, Senior Administrative Officer, CMFRI, Cochin.	...	Member Secretary

Joint Council

1. Dr. P. S. B. R. James	...	Chairman
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3. Shri K. V. N. Rao	...	Member
4. Shri S. Rajagopalan	...	Member
5. Dr. P. Bensam	...	Secretary (Official side)
6. Shri P. James Abraham	...	Member
7. Shri V. A. Narayanan Kutty	...	Member
8. Shri H. Kather Batcha	...	Member
9. Shri T. S. Balasubramanian	...	Member
10. Shri Joseph Andrews	...	Member
11. Shri J. M. Vaz	...	Member
12. Shri A. P. Sebastian	...	Member
13. Shri S. Mangalam	...	Member
14. Shri K. Muthuramalingam	...	Member
15. Shri M. L. Antony	...	Member
16. Shri R. Kuppuswamy	...	Secretary (Staff side)

PROGRESS OF RESEARCH

FISHERY RESOURCES ASSESSMENT DIVISION

Annual Marine Fish Production in India during 1988

The annual marine fish landings in India during the year 1988, has been estimated at 1.80 million t as against 1.66 million t of 1987, registering a sharp increase of about 137,000 t(8%). This increase was mainly noticed in the west coast, especially Kerala coast. Among the important groups, increased landings were noticed in respect of *Stolephorus* spp, carangids, oil sardine, mackerel, catfishes and non-penaeid prawns. There was a remarkable increase of about 18,000 t in the landings of red mullets along the Kerala coast.

Pelagic group

The landings of pelagic groups are given in Table 1. They formed 51% of the total estimated catch.

Oil sardine : The landings of oil sardine registered an increase of about 30,000 t during 1988 as against the estimate of 1987. The increase (30%) was from the Kerala, Karnataka and Goa coasts.

Bombayduck : An estimated 68,000 t was landed during 1988 as against 74,000 t of the previous year. A slight reduction in the landing (6,000 t) was noticed in the north west coast.

Stolephorus : A substantial increase of about 50,000 t of *Stolephorus* was observed during the year over that of the previous year. This increase was mainly accounted for by the Kerala coast.

Carangids : There was an increase of about 47,000 t over that of the previous year. It was about 80,000 t in 1987 and increased to 127,000 t in 1988, registering an increase of 59%. The increase was mainly noticed along the Kerala coast.

Mackerel : During 1988, the landings were 104,000 t as against 79,000 t of 1987, registering an increase of about 25,000 t (32%). This increase was solely due to the increased catch along the Kerala coast. The other regions did not show any significant variation in the landings.

Ribbon fishes : During the year the estimated landings was 68,000 t. In contrast, other major pelagic groups, registered a fall of about 14,000 t in 1988. The decrease was noticed all along the coasts of Andhra Pradesh, Tamil Nadu, Kerala and Karnataka.

Table — 1

Estimated pelagic fish landings in India during 1987 and 1988

(in tonnes)

Name of fish	1987	1988*
CLUPEIDS	...	...
Wolf herring	16861	13076
Oil sardine	100456	131067
Other sardines	92542	76042
Hilsa shad	4450	2339
Other shads	17919	11258
Anchovies	...	...
Coilia	20536	21176
Setipinna sp	2657	1508
Stolephorus sp	51252	100451
Thrissina sp	...	35
Thryssa sp	30142	36388
Other clupeids	37810	42573
BOMBAY DUCK	73821	67626
HALF BEAKS & FULL BEAKS	2110	3397
FLYING FISHES	1378	4147
RIBBON FISHES	82498	68496
CARANGIDS	...	...
Horse Mackerel	7303	20765
Scads	16512	39475
Leather-jackets	4704	5092
Other carangids	51474	61747
MACKERELS	...	...
Indian mackerel	78920	104226
Other mackerels	110	110
SEER FISHES	...	...
S. commersoni	18349	20808
S. guttatus	12714	15370
S. lineolatus -	70	138
Acanthocybium spp.	53	53
TUNNIES	...	...
E. affinis	14008	15299
Auxis spp.	4456	5962
K. pelamis	5550	5459
T. tonggol	444	1288
Other tunnies	5703	3192
BILL FISHES	897	809
BARRACUDAS	5540	7873
MULLETS	5477	7989
UNICORN COD	1085	871
MISCELLANEOUS	28438	27897
TOTAL	796239	924002

Contd...

* Provisional

Demersal group

The landings of demersal groups of fishes, crustaceans and molluscans are given in Table 2. Of the total landings of 1.80 million t about 49% was contributed by the following groups :

Catfishes : The landings showed an increase of about 19,000 t. From 45,000 t in 1987 it rose to 64,000 t in 1988. The increase was noticed along the coasts of Kerala, Karnataka, Goa and Maharashtra.

Penaeid prawns : The landings of penaeid prawns during the year was estimated at 153,000 t as against the 154,000 t of 1987. Not much variation was noticed in the landings except along Kerala and Maharashtra coasts. In Kerala an increase of about 14,000 t was noticed. However, the decreased landings along the Maharashtra coast resulted in a reduction of about 1000 t in the total penaeid prawn landings in India.

Non-penaeid prawns : Though there was a marginal reduction in the landings of penaeid prawns, non-penaeid prawn landings registered an increase of about 13,000 t during 1988. From an estimated 36,000 t in 1987, it increased to 49,000 t in 1988. The increase was

mainly noticed along Maharashtra coast.

Croakers : The landings showed a reduction of about 10,000 t (9%) during 1988. The estimate in 1988 was 100,000 t. This reduction was mainly accounted for by the West Bengal and Gujarat regions.

Silverbellies : During 1988, an estimated 61,000 t were landed showing a reduction of about 6,000 t as against 1987, and was mainly due to decreased landings along the Andhra Pradesh and Tamil Nadu coasts.

Perches : The landings of perches showed a slight reduction of about 2,000 t. During 1988, it recorded an estimated 92,000 t as against 90,000 t of 1987.

Elasmobranchs: The landings did not differ significantly from that of the previous year. An estimated 57,000 t were landed during 1988, an increase of about 600 t.

Pomfrets : There was an increase of about 67,000 t in the landings of pomfrets during 1988 over that of the previous year. In 1988, the estimated landings were 43,000 t.

Acquisition of data on exploited marine fishery resources for stock assessment from north east region (FSS/FRA/ 1.1.1).

The marine fish landings of the north east region during 1988 was estimated at 58,600 t as against 78,500 t of 1987, registering a reduction of about 19,900 t (25%). The reduction in the landings was noticed in respect of croakers, pomfrets, hilsa shad, catfishes and penaeid prawns.

Table — 2
Estimated demersal fish landings in India during 1987 and 1988

(in tonnes)

Name of fish	1987	1988*
ELASMOBRANCHS	...	...
Sharks	30274	36741
Skates	4331	2480
Rays	21811	17862
Eels	4756	4555
Catfishes	44784	64305
LIZARD FISHES	16867	25970
PERCHES	...	...
Rock cods	4797	5101
Snappers	3783	4176
Pig-face breams	2094	3107
Threadfin breams	47031	53241
Other perches	32340	26586
GOATFISHES	10617	28475
THREADFINS	6386	4808
CROAKERS	109894	100140
SILVERBELLIES	66751	60799
BIG JAWED JUMPER	12640	11656
POMFRETS	...	...
Black pomfret	13840	15285
Silver pomfret	22804	28094
Chinese pomfret	288	99
FLAT FISHES	...	...
Halibut	1985	1724
Flounders	228	32
Soles	27964	25114
CRUSTACEANS	...	...
Penaeid prawns	154483	152784
Non-penaeid prawns	36303	49367
Lobsters	2562	1595
Crabs	23127	17369
Stomatopods	98614	68981
Cephalopods	34301	38493
MISCELLANEOUS	30948	26428
TOTAL	866603	875367

* Provisional

There was a reduction of about 4,000t in the landings of croakers during 1988. The estimate during the year was 19,000 t. The landings of pomfrets was to the tune of 2,700 t in the region as against 5,300 t of 1987, indicating a reduction of about 2,600 t (49%) in 1988. The anchovy landings also recorded a lesser catch in this region. During 1988, an estimated 2,800 t of anchovies were landed showing reduction of 1,200 t as against the estimate of 1987. Hilsa shad, an important fishery of this region also suffered a set back. An estimated 900 t were landed during this year. In 1987, the estimate was 2,300 t. The penaeid prawn landings was reduced by about 400 t. During 1988, the penaeid prawn landings were 2,100 t.

Acquisition of data on exploited marine fishery resources for stock assessment from south east region (FSS/FRA/1.1.2)

The marine fish landings of the region comprising Andhra Pradesh, Tamil Nadu and Pondicherry were estimated at 4.30 lakh t as against 4.56 lakh t of 1987, indicating a reduction of about 26,000 t (6%). *Stolephorus* catch increased by 9,000 t and goat fishes by 6,000 t. Carangid landings also improved during the year. However, the reduction in the landings of ribbon fishes, other sardines, silverbellies, mackerel, perches and elasmobranchs mainly accounted for the reduction in total landings. The landings of ribbon fishes during the year was 8,500 t as against 17,400 t of 1987 registering a reduction of about 8,900 t. The catch of other sardines reduced by 8,600 t (from 61,000 t in 1987, to 52,400 t in 1988). Silverbellies reduced from 56,000 t in 1987 to 47,500 t in 1988. The landings of mackerel were 23,000 t in 1988, registering a fall of 6900 t as compared to 1987. The reduction in the landings of elasmobranchs was about 4,600 t. The landings of perches showed a reduction of 5,500 t during 1988.

Acquisition of data on exploited marine fishery resources for stock assessment from southwest region (FSS/FRA/1.1.3).

The southwest region comprising Kerala, Karnataka and Goa contributed 7.72 lakh t of marine fish during 1988 to the total production. There was a substantial increase of about 1.83 lakh t during the year as compared to the estimate of 1987. This increase was attributed to the Kerala and Goa coasts.

Among the commercially important groups, *Stolephorus* spp., mackerel, carangids, oil sardine and penaeid prawns recorded increased landings. This year recorded the maximum landings in the past three decades.

Stolephorus spp. landings in the region was estimated at 65,000t as against 25,000 t of 1987, registering an increase of about 40,000 t. The increased landings was contributed by the Kerala coast. The landings of mackerel also showed an increase with an estimated 79,000 t during 1988. It was 42,000 t during 1987. The increase of 37,000 t was accounted for by the Kerala and Goa coasts. Carangid landings also witnessed an increase of about 36,000 t in 1988. From 48,000 t in 1987 it shot upto 84,000 t. However, the increase in the landings of oil sardine was 26,000 t. During the year, 123,000 t of oil sardines were landed. Catfish landings were 23,000 t, an increase of about 14,000 t.

The penaeid prawn landings increased by about 12,000 t. During 1988, the estimated landings of penaeid prawns was 80,000 t in the region. An increase of about 6,600 t was also noticed in the landings of cephalopods, for 1988 (17,000 t).

Acquisition of data on exploited marine fishery recources for stock assessment from Northwest region (FSS/FRA/ 1.1.4).

The total marine fish production in this region for 1988 was estimated at 5.23 lakh t as against 5.22 lakh t of 1987. Penaeid prawn landings suffered a set back and an estimated 46,000 t landed during 1988 registering a fall of about 13,000 t compared to that of 1987. However, in the case of non-penaeid prawns, an increase of 12,000 t was noticed during 1988, the estimate in 1988 being 45,000 t.

Bombayduck, an important fishery of this region suffered a slight set back. An estimate of 66,000 t was arrived at for 1988, indicating a reduction of about 6,000 t compared to 1987. The landings of croakers also showed a slight reduction of about 3,000 t. However, the landings of pomfrets, catfishes and carangids recorded better catches. During 1988, the estimate of pomfrets was 31,000 t indicating an increase of 8,600 t. Catfish landings during 1988 was 31,000 t and an increase of about 8,000 t was noticed. The landings of carangids during 1988 was 17,000 t, an increase of about 7,000 t.

Stock assessment of commercially important fishes of the exploited zone (FSS/FRA/1.3).

A simple method of estimating the total instantaneous mortality rate (Z) using the length samples was proposed. Stock assessment of penaied prawns (*M. dobsoni* and *P. stylifera)* was carried out. Stock assessment of threadfin breams, *N. japonicus* and *N. mesoprion* was being carried out. A computer algorithm was developed to estimate the growth parameters 'L' and 'K' using length frequency data. This was tested and found to give satisfactory results.

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

Software was developed for estimation of marine fish landings in India. This was written in BASICA and also in C. This is quite user friendly and extensively used. A suitable software was also developed for detailed analysis of marine fish landings in India supported with a user friendly QUERY programme for faster recovery of required information. This facilitated faster dissemination of required information to the end users. Besides these, soft ware for stock assessment using mathematical models was also developed. The salient among them are computation of yield per recruit of fish stocks having allometric growth which involved numerical analysis of incomplete beta function and the other one being an algorithm to estimate the growth parameters in the von Bertallanffy Growth Equation (L_∞ and K) using the length frequency data. A marine fisheries data base was created for the benefit of the end users and for faster and easier retrieval of the required information.

Personnel associated with the projects of the Division

K. Alagaraja, K. Narayana Kurup, K. Balan, M. Srinath, K. S. Scariah, K. Vijayalakshmi, M. Karthikeyan, U. K. Dan, J. P. Karbhari, G. Balakrishnan, U. K. Satyavan, Varughese Philiphose, K. C. Yohannan, P. K. Mahadevan Pillai, Varughese Jacob, G. Krishnankutty Nair, P. Sivaraman, V. Rajendran, V. P. Annam, P. Karunakaran Nair, Abha Kant, Joseph Andrews, A. Kanakan, S. Haia Najimudeen, C. J. Prasad, P. L. Ammini, K. P. George, M. B. Seynudeen, P. P. Pavithran, M. Ramachandran, K. Anandan, G. Subbaraman, P.T. Mani, M. R Beena, Lata Thote, Pulin Behari Dey, Sapan Kumar Ghosh, Sukdev Bar, V. Achutha Rao, M. Radhakrishnan, S. Satya Rao, M. Chandrasekhar, C. V. Seshagiri Rao, K. Chitti Babu, K. V. S. Seshagiri Rao, P. Ananda Rao, T. Chandrasekhara Rao, A. Hanumantha Rao, G. C. Lakshmaiah, Ch. Ellithathayya, A. Agastheesa Pillai Mudaliar, M. Mohamed Sultan, H. Kather Batcha, M. Bose, S. Manivasagam, L. Chidambaram, A. Srinivasan, M. Manivasagam, T. Dhandapani, S. Seetharama, R. Somu, V. Thanapathi, M. Radhakrishnan, V. Sivaswamy, A. Ganapathi, P. Palani, K. Muthaiah, Hameed Batcha, A. Kumar, K. Muniyandi, K. S. Krishnan, S. Sankaralingam, R. Subramaniam, C. Kasinathan, S. Subramani, O. M. M. J. Habeeb Mohamed. R. Guruswamy, K. Ramakrishnan Nair, N. Retnaswamy, I. P. Ebenezer, Jacob Jerald Joel, R. Bhaskaran Achari, M. Babu Philip, T. G. Vijaya Warrier, S. B. Chandrangathan, V. S. Gopal, A. A. Thankappan, K. Thulasidas, N. Palaniswami, C. K. Krishnan, T. Girijavallabhan, K. Soman, T. Krishnankutty, K.C. Purushothaman, B. Sreedhara, H. S. Mahadevaswamy, K. Chandran. Maruthi Sankar Naik, T. B. Harikantra, Ganesh Bhatkal, K. C. Pandurangachar Bharama, S. Malinmani, U. V. Argeker, S. N. V. Pai, R. B. Kamble, Prakash C. Shetty, A. Prosper, K. Ramdoss Gandhi, D. G. Jadhav, M. Sriram, J. L. Oza, K. B. Waghmare, C. J. Josekutty, Johny R. Dias, Kishas Reghunath Mainkas, B. N. Katkar, S. D. Kamble, M. Chellappa, Y. D. Savaria, B. V. Makadia, Zala Mangal Singh, V. J. Dayabhai, Polasa Jamnadas Premji, Bharada Arzan Panchabhai, Ladani Amruthalal Arjanbhai.

PELAGIC FISHERIES DIVISION

The division worked on 16 projects, 12 of them dealing with evaluation of resource characteristics and stock assessment of important pelagic fishes. The other projects dealt with studies of young fish caught in commercial fisheries, live bait fishes of Lakshadweep, tagging of selected commercial fishes, landings and strandings of marine mammals. The results of the individual projects are presented.

Investigation on the resources of tunas and related fishes (FB/PR/3.1) :

P.S.B.R. JAMES, N.G.K. PILLAI, K.K.P. PANICKER, M. SRINATH, M. SIVADAS, G.M. KULKARNI, G. GOPAKUMAR, PON SIRAIMEETAN, M.D.K. KUTHALINGAM, P.P. PILLAI, P. SAID KOYA

There was a significant increase in the catch of tunas and bill fishes at the different observation centres on the mainland and in Minicoy during the year. The increase was very significant at Minicoy, Mangalore, Cochin and Vizhinjam. The total catch for all the centres of observation on the mainland was 7872 t, an increase of 3165 t over the previous year.

Drift gill net, purse-seine, ring net and hook and line landed tunas on the mainland, while pole and line and troll line contributed to the catches at Minicoy. Drift gill nets contributed to over 56% of tuna catches in the mainland. *Euthynnus affinis* (54.4%), *Auxis rochei* (23.3%), *A. thazard* (16.4%) and *Thunnus tonggol* (2.5%) contributed to the bulk of the mainland catches. The occurrence of the bigeye *T. obesus* in small quantities along the west coast was a noteworthy feature.

The total catch of tunas and bill fishes at Minicoy during the year was 1007.4t as against 946.9t during the corresponding period of previous year. At Minicoy, 83.8% of the catches were the skipjack and 16.2% the yellowfin. Among the bill fishes caught at Minicoy 75% was constituted by *Istiophorus platypterus* and the rest by *Makaira indica*. The size of *Euthynnus affinis* caught along the westcoast (Mangalore-Cochin) were larger than those caught at Vizhinjam and Tuticorin. At Minicoy the size range of skipjack was 32-70 cm with prominent modes at 52 & 62 cms.

Investigations on the natural stocks and cultured tuna live-bait species (FB/PR/3.2) :

P.P. PILLAI, T.M. YOHANNAN and K. P. SAID KOYA

During 1988, 7448 kg of tuna live-baits were taken by 3340 pole and line fishing units registering an increase of 11% over the same period in 1987. Maximum catch and C/E were recorded in February. Low catches observed were in August and September, and minimum C/E in September. Catch per unit of bait (CPUB) of tunas for the year 1988 (133 kg) declined from that of 1987 (157 kg). Maximum CPUB was noted in January (249 kg) and minimum in September (63 kg).

Caesionids, *Caesio caerulaureus* and *P. chrysozona* constituted the bulk of tuna live-bait catch (77.6%), follow-

ed by *Chromis caeruleus* (7.9%), apogonids (5.7%), *S. delicatulus* (5.5%), *L. tapeinosoma* (1.8%), *S. gracilis* (1.3%) and others (0.2%).

The second exploratory tuna live-bait survey in the 15 lagoon/reef ecosystems of Lakshadweep was conducted using *Sagar Sampada* during Jan-Feb. 1988. 56 kg of bait fishes were collected from 81 hauls, with an average catch/haul of 691 g. Catch per haul was maximum at Kavaratti (1064 g) and minimum at Kiltan (85 g). Caesionids constituted the dominant group (40.1%) followed by apogonids (17.5%), pomacentrids (17.3%), sprats (16.6%), emmelichthyds (1.1%) and atherinids (1.0%). Species diversity was high at Minicoy, Agatti, Suheli, Kavaratti, Cheriyapaniam and Kadamat lagoons.

Holding experiments were conducted in the lagoon (cages) and in laboratory using *C. caeruleus, Archamia fucata* and *C. caerulaureus. C. caeruleus* of 36-72 mm (modes at 48 and 56 mm) were found to survive in the cage and laboratory under captivity for prolonged periods. *C. caerulaureus* showed considerable mortality in captivity and *A. fucata* was found to survive for short durations.

As an alternate live-bait species for tuna fishery, the juveniles of *Crenimugil crenilabis* were collected from the tidal creeks, and reared in the laboratory. Information on their chumming quality was reported as positive.

An Artificial Reef Structure (ARS) was fabricated and installed in the southern end of Minicoy Lagoon, and monitoring of fish aggregation relative to reef age carried out. The ARS was made of 2 m dia 3 inch thick ROC slab base, with 12 vertical ms rod holders to bind 14 discarded tyres along with 6 x 4" wooden separators. Algal growth and aggregation of different species of reef fishes were observed after 20 days.

Resource characteristics of Pomfrets (FB/PR/5.4) :

M.H. Dhulkhed, Madan Mohan, M. Kumaran

The pomfret fishery at Karwar was poor. The estimated catch was 114 t; less by 69 t compared to 1987. Purse seiners contributed to 67.8% of the catch and the rest was landed by trawlers. Black pomfrets formed 85% of the purse seine catch. 63% of the trawler catch was silver pomfret.

The fishery at Mangalore was better, the estimated catch being 335 t, an increase of 84% on 1987. Purse seiners, trawlers and drift gill netters landed 225 t, 92 t and 18 t respectively. The highest cpue of 16 kg was recorded by purse seine. At Malpe the fishery was poor. At Calicut, the catches of 16.5 t indicated a decrease of 23 t over the 1987 catch. Medium sized silver (160-220 mm) and black pomfrets (160-320 mm) comprised the commercial catches.

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

K.V. Narayana Rao, G.G. Annigiri, Madan Mohan, M. Kumaran, K.C. George, K.N. Kurup, Prathiba Puthran, P.N. Radhakrishnan Nair, P. Sam Bennet, J.C. Gnanamuthu, G. Luther.

The fishery during the current year showed an estimated landing of 1,829 t at Karwar, 11,005 t at Mangalore, 1,087 t at Calicut, 2 t at Cochin, and 8 t at Vizhinjam on the West coast. The main gears contributing to the

fishery along the west coast were the purse seines (Karwar, Mangalore, Malpe and Cochin) and boat seines (Calicut and Vizhinjam) At Madras the oil sardine was landed by Eda valai (bag net). An estimated catch of 170.1 t was recorded during the year in April, September, November and December, compared to 102.4 t during the previous year. The decline in the landings at Visakhapatnam was of the order of about 73% and appeared to be related to the unusual delay in the breeding, resulting in late recruitment to the stock during 1988. The fishery, however, recovered by November-December, with a massive recruitment of juveniles, off the Karwar-Calicut Coast.

Although the maximum exploitation (11,005 t) was off Mangalore-Malpe Coast, the maximum catch rate (553 kg/ purse seine unit day) was observed off Karwar; thus indicating a northward shift in abundance of the stock especially during November and December. The principal gears employed in the fishery were purse seine at Karwar and Mangalore, ring seine and boat seine (Pattenkolli vala) at Calicut, Vizhinjam and Visakhapatnam. The purse seiners were confined to 20-37 m and boat seiners and gill netters to less than 20 m depth on the west coast. On the east coast, boat seiners operated mainly in the 35-55 m zone and gill netters in the 55-110 m depths.

The annual estimated value of the landings at the observation centres was Rs 47.2 million at the west coast and Rs 0.17 million at the east coast. The value of the fishery at Mangalore-Malpe centre alone amounted to Rs 35.6 million.

The fishery was sustained mainly by the 60 mm - 200 mm sizes at most centres north of Calicut and from 170 mm - 190 mm at Cochin with dominant modal sizes at 95-120 mm, 150-165 mm and 185-190 mm. At Visakhapatnam the 20 mm - 190 mm fishes with modes at 25-30 mm and 65-75 mm supported the fishery. The fishery was sustained by the 0-year and 1-year classes to the extent of 90.2% and 8.6% respectively on the west coast and by the 0-year, 1-year and 2-year classes in the order of 51.5%, 34.4% and 14.1% on the east coast. The predominance of the 0-year class was evident at the northern centres of the west coast due to late recruitment of juveniles during November-December. An estimated 80.5 million and 176.8 million of juvenile oil sardines (95 mm) were landed by purse seiners at Karwar and Mangalore respectively during November and December. At Calicut, 0.8 millions of juveniles were caught by Pattenkolli in September. The fishing prospects appeared brighter at the northern centres in the following months.

The instantaneous mortality (Z) of the species during the year was estimated to be 2.7 at Mangalore and 2.3 at Visakhapatanam. The studies indicated that at Karwar the present level of exploitation of oil sardine at the centre was lower than its MSY.

Evaluation of the fishery resources of lesser sardines (FB/PR/9.2) :

P. Sam Bennet, G. Luther, C. Muthiah, A.A. Jayaprakash, P.N. Radhakrishnan Nair, Madan Mohan, G.G. Annigiri, K. Narayana Kurup.

The lesser sardine fishery was moderate at the different centres. The maximum catch (1919.2 t) was recorded at

Tuticorin by gill nets followed by catches at Mangalore (1731.3 t) by purse seine units, and Madras (612.1 t) by gill nets. Gill nets were common for lesser sardines at most centres. Purse-seiners were exclusively used at Mangalore and Karwar. Boat seines along with gill nets contributed to the catch at Visakhapatnam. Most of the crafts employed were mechanised and gave improved catch rates.

Sardinella gibbosa was the dominant species and contributed up to 88% of the lesser sardine catches at Vizhinjam, 64% at Tuticorin, 78% at Madras, 83% at Mangalore and 97% at Malpe. *S. fimbriata* was dominant at Visakhapatnam (85%) and *S. albella* at Karwar (63%). Other species which contributed to the catches were *S. sirm* (16%) and *S. dayi* (8%) at Tuticorin.

Lesser sardines caught in purse-seine at Mangalore and Karwar showed higher average size, while those from other gears at different centres showed a wide range including young juveniles.

Evaluation of the resource characteristics of anchovies (FB/PR/9.3) :

G. Luther, N.S. Radhakrishnan, P. Sam Bennet, G. Gopakumar, Prathibha Puthran, K. Balan, G.M. Kulkarni, M. Zafar Khan.

Studies on *Coilia dussumieri* were carried on samples from Satpati (dol net) and from Versova (trawl and dol nets). 450 t of fish were caught at Satpati during January-June and 214 t in October-December. 505 t were landed by trawl net during September-October period at Versova. Dol nets (25-27 mm mesh) were operated at 18-30 m and trawl nets (25 mm mesh) at 20-25 m depth. Fish of 90-170 mm length formed the dominant size. Gravid fish were observed in May and September - January period.

The white bait fishery was poor at Cochin during the year, the landings by trawl nets being only 574.7 t compared to 1879.3 t in the same period of the previous year. C/E was only 12.6 kg to 40.6 kg of last year. *Stolephorus bataviensis* (48%), *S. devisi* (29%) and *S. buccaneeri* (17.5%) formed the major components. April and June (juveniles) and November-December (adults) were the important periods of fishing for *S. bataviensis* at Cochin.

At Vizhinjam a marginal reduction in white bait catch was noticed with a catch of 283 t compared to 311 t of the previous year. The reduction in gill net effort (*Netholi vala*) appears to be a reason. June-September period accounted for bulk of the catches. *S. buccaneeri* (39%), *S. devisi* (32%) and *S. andhraensis* (15%) and *S. bataviensis* (13%) formed the catch. There was a shift in the usual composition of the species, with *S. buccaneeri* instead of *S. devisi* forming the highest catches. Adult fishes sustained the fishery at Vizhinjam. Motorization of country crafts made no significant changes in the fishery.

At Tuticorin shrimp trawls accounted for bulk of the whitebait catches of 408 t during the year. The best catches were made during the September-October period. *S. bataviensis* (48%), *S. devisi* (36%) and *S. indicus* (16%) comprised the catch.

At Visakhapatnam the shrimp trawls landed 165 t compared to 157 t of the previous year. Indigenous gears, boat seines and shore seines caught 18 t. The October-March period was the best season. *S. bataviensis* followed by *S. devisi* were the dominant species.

At Mangalore an estimated 6611 t of *Stolephorus* spp was landed recording a four fold increase over that of the previous year. Purse seines landed 93.5% and the rest was caught by trawl nets. November-December showed the best catches. *S. bataviensis* constituted bulk of the catch in purse seines as well as trawls. Fish in advanced stages of maturity formed the bulk of the catches.

The price of whitebait at the landing point in Mangalore varied from Rs. 1300 - 3500.

Evauation of the fishery and resources of mackerel (FB/PR/9.4) :

A. NOBLE, M.H. DHULKHED, M.V. PAI, M. SIVADAS M. SRINATH, G. GOPAKUMAR, A.A. JAYAPRAKASH, N.S. RADHAKRISHNAN, C. MUTHIAH, S. REUBEN.

Mackerel landing this year increased at all centres of observations, except Cochin and Visakhapatnam. The fishes were caught in purse seine, trawl, drift net and in the traditional boat seine and gill net. At Cochin the purse seines did not land this resource unlike at Karwar and Mangalore centres. At Calicut, catches came from the artisanal gears only. The catch was dominated by 0-year and one year old fishes at all centres. Some small fishes of 45 - 90 mm sizes were present at Karwar, Calicut and Visakhapatnam. Females were more in the catches at Karwar, while males were dominant at Cochin. Developing, gravid and spent fishes were present at all centres.

Evaluation of the Fishery resources of Bombay duck (FB/PR/9.6):

V.M. DESHMUKH, M. ZAFFAR KHAN

At Bombay the fishery was poor this year with a catch of 2329 t and catch rate of 41.9 kg (per haul) as against 4447 t and a catch rate of 56.5 kg in the previous year. The size range in the fishery was 30 - 285 mm. During January, May and November young ones (75 - 90 mm) were caught in large numbers. Males out-numbered females significantly in the catch in the ratio 1 : 0.54.

The estimated landings of Bombay duck at Rajpara stood at 12587 t during the year. The overall size range observed was 30 - 300 mm with modes at 45 - 75 mm and 135 - 165 mm. Best catches were made during the October - December period.

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

S. REUBEN, ALEXANDER KURIAN, G. M. KULKARNI, S. SIVAKAMI, M. KARTHIKEYAN, P. N. RADHAKRISHNAN NAIR, A. A. JAYAPRAKASH.

The species studied at the different centres were *Decapterus dayi, Megalaspis cordyla, Selar mate, S. kalla* and *Selaroides leptolepis*. Carangid landings declined especially at Visakhapatnam (13.8%), Vizhinjam (12%) and Cochin (51%).

At Visakhapatnam the landings stood at 263.4 t, and 93% of the catch

were landed by shrimp trawlers. *D. dayi, Carangoides malabaricus, Alepes djedaba and M. cordyla* were the major species landed.

At Mandapam 131.5 t were recorded of which 124 t were landed by trawlers from Rameswaram, a small quantity was contributed by landings from Palk Bay and Gulf of Mannar. *S. leptolepis* (67.9%), *S. kalla* (17%) and *S. mate* (12%) formed the dominant species landed at Rameswaram.

At Vizhinjam hook and lines contributed 67% of the total catch (953 t) and the rest by drift gill nets and shore seines. March-May and September-December were the productive months. *D. dayi* of 80-225 mm size was the most dominant species (61%).

At Cochin trawl net contributed to 89% of the catch (618.8 t) followed by drift nets and purse seines. Best catches were obtained in October and June. *D. ruselli* (61%), *S. kalla* (20%) and *M. cordyla* (10%) were the dominant species in trawl net. *A. djedaba, D. ruselli* and *M. cordyla* in that order formed the major components of gill net.

At Mangalore carangid landings decreased (4074 t) as against 4391 t of the previous year. 75% of the catch was landed by purse seiners mainly during September and October and the rest by trawl net, with good catches in May, November and December. *D. ruselli, M. cordyla* and *S. kalla* in that order were the dominant species caught.

Young fish studies (FB/PR/11) :

K. C. George, G. G. Annigiri, R. S. Lal Mohan, N. Gopalakrishna Pillai, S. Srinivasarengan.

At Cochin 3928 kg of young fishes were landed by 45234 units of bottom trawl effort with a cpue of 0.09 kg with peak catches in September (942 kg) and June (635 kg). Species analysis showed that by weight, *Johnius sina* dominated (26.27%) followed by *Nemipterus mesoprion* (15.73%), *Decapterus* sp. (11.38%), *Saurida sp.* (9.88%), *Leiognathus lineolatus* (8.54%), *Epinephalus diacanthus* (7.1%), *Platycephalus* sp. (6.9%), *K. axilaris* (5.3%), *N. japonicus* (5.12%), *J. caruta* (1.61%) and *O. ruber* (1.06%). Size distribution of dominant species were *J. sina*, 30-65 mm with a mode at 55 mm; *N. mesoprion*, 30-65 mm with the mode at 45 mm and *E. diacanthus* 70-95 mm with the mode at 80 mm. During the first week of Feb. an estimated 6850 kg of young mackerel were landed by 88 *thangu vala* units at Fort Cochin and Beach Road landing centres. The cpue was 99.49 kg. The catches were made from a depth range of 10 to 15 m off Cochin. The size range of young mackerel caught was 87-145 mm with the modes at 95 mm, and 130 mm.

Bottom trawling operations were conducted with Cadalmin-I off Cochin, at 6-30 m depths. Stray numbers of young *Sillago sihama* (100-115 mm), *Tachysurus* sp. (80-120 mm), *Stromateus argenteus* (95-120 mm) and *J. sina* (60-130 mm) were observed during April. In March 1.8 kg of young *S. argenteus* (80-165 mm) were caught by trawling for 10 mts. *Caranx kalla* (80-110 mm) were caught in May.

At Calicut trawl nets landed 174.1 t, Pattenkolli vala 0.8 m t, Nethal vala 11 t and ring net 118 t. Landings by trawl nets were mostly in February and December, and consisted mostly of sciaenids (35%), *Stolephorus* (29%), *S. tumbil* (10%) and *Cynoglossus macrostomus* (9%). About 2 t of juvenile mackerel were landed by nethal vala in July and 200 kg in October. However, oil sardine formed 80% of the juvenile fishes caught by *Nethal vala*. The OBM fitted crafts using Ring nets (7-10 mm mesh) landed juvenile oil sardines in September and December.

At Karwar 663 t of juvenile oil sardine and 3 t of juvenile mackerel were landed by purse seines. Lesser sardines or other commercial species were not observed in the catches. The recruitment of oil sardine and mackerel were better, compared to the previous year.

Evaluation of the firshery and resources of ribbon fishes (FB/PR/13):

S. LAZARUS, M. ZAFAR KHAN, K. S. SCARIAH, R. THIAGARAJAN, Y. APPANNA SASTRY.

Among the centres observed, Bombay registered the best landings (Bombay, 1142 t, Vizhinjam 640 t; Madras, 319 t; and Visakhapatnam, 278 t). The catches were made by small trawlers at all centres except Vizhinjam where the landings came from the boat seines. The CPUE at different centres were Bombay, 77.2 kg; Madras, 7.9 kg and Visakhapatnam 11.6 kg. The catch rate for boat seine at Vizhinjam was 43.4 kg. Bulk of the landings were made at these centres during the latter half of the year; however on the east coast the fishery was spread out through the year. *Trichiurus lepturus* was the dominant species at all the centres. At Visakhapatnam however *T. russelli* and *T. gangeticus* were also observed in small quantities. Larger *T. lepturus* (50-85 cm) were caught at Bombay and at Vizhinjam smaller sizes (20-30 cm) contributed to the fishery.

Investigations on whales, dolphins and dugongs (FB/PR/14) :

P. S. B. R. JAMES, J. P. KARBARI, G. M. KULKARNI, R. S. LAL MOHAN, K. V. SOMASEKHARAN NAIR, K. P. SAID KOYA, T. M. YOHANNAN, H. MOHAMED KASIM, S. KRISHNA PILLAI, P. NAMMALWAR, G. RADHAKRISHNAN, JANCY JACOB.

During the year 71 dolphins, 11 porpoises, 9 whales and 1 dugong were stranded/landed at various centres. Among dolphins the saddle back dolphin *Delhphinus delphis* was predominant (30.9%) followed by the spinner dolphin *Stenella longirostris* (28.1%) and the bottle nose dolphin *Tursiops truncatus* (25.4%). The hump back dolphin *Sousa chinensis* formed 11.3% and the snubfin dolphin *Orcaella brevirostris* formed 2.8% of the total number of dolphins landed. Among whales *Balaenoptera borealis, B. physalus, B. edeni, Balaenoptera* sp., *Physeter macrocephalus* and *Megaptera novaenglias* were the species recorded during the period.

Dugong dugong was reported only from Mandapam. *B. borealis* and *B. edeni* occurred at Tuticorin. At Calicut one specimen of the Hump back whale *Megaptera novaenglias* was recorded while from Bombay the stranding of two specimens of *Balaenoptera* were recorded. A sei whale *B. borealis* (10 m) and a sperm whale *P. macrocephalus* were reported from Madras.

The maximum number of dolphins were landed during the month of January followed by August. The seasonal distribution of whales showed that five were recorded during pre-monsoon, one during monsoon and the rest during the post-monsoon. The Dugong was reported only during April.

Evaluation of the fishery and resource characteristics of barracuda (FB/PR/15) :

MOHAMMAD KASIM, R. THIAGARAJAN and N. GOPALAKRISHNA PILLAI.

At Madras the landings this year was poor (137 t) compared to last year (435 t). At Tuticorin, the fishery was better than last year with a catch of 728.2 t and catch rate of 19.2 kg per trawl net unit. In drift gill net the landing was 101.9 t with a catch rate of 5.44 kg per unit. At Cochin, an estimated 227.43 t were landed by trawl net units at a catch rate of 5 kg per unit.

Sphyraena obtusata was dominant in trawl net landings at all the centres. At Tuticorin, *S. jello* was dominant in drift gill net landings followed by *S. picuda*, *S. obtusata* and *S. forsteri*.

The food of barracuda was constituted mainly by anchovies, mackerel, *Decapterus* spp. and squids. The mortality rate and exploitation rate at Tuticorin indicated higher fishing pressure.

Population studies by mark release experiments of oil sardine, mackerel and catfish (FB/PR/16) :

A. NOBLE, N. GOPINATHA MENON, M. H. DHULKHED, K. V. N. RAO, P. U. ZACHARIAH, Y. APPANNA SASTHRI

During the year 30 mackerels (123-244 mm) were tagged with red loop tags and released. No recoveries were reported.

10,000 numbers of celluloid loop tags for tagging mackerel and oil sardine were sent to Visakhapatnam, Mangalore and Karwar. The catfish tags were also fabricated. Formats for bilingual publicity hand bills were sent for getting them printed at the respective centres with English on one side and the vernacular on the other side.

DEMERSAL FISHERIES DIVISION

The projects operated were concerned with the evaluation of resource characteristics, stock assessment of fish caught in commercial gears and the culture of important edible fishes.

Resource characteristics of Perches (FB/DR/1.8.2) :

K. M. S. AMEER HAMSA, P. JAYASANKAR, S. LAZARUS, K. ALAGARAJA, N.G. MENON, GRACE MATHEW, S. K. CHAKRABORTY.

Tuticorin : 247 t were recorded of which 230 t were landed by 6736 units of hooks and lines at North landing centre and 17 t by drift gill nets at Tharuvaikulam forming 66% and 17% of the total fish catch of the gears. *Lethrinus nebulosus* was dominant in both the gears. The sizes of *Psammoperca waigiensis* in drift gill nets ranged between 220-230 mm and were in the maturing and mature conditions.

Mandapam : Of the 125.5 t landed at Keelakarai, 77% were caught in perch traps, 13% by hooks and lines and 10% by Disco nets. Maximum catches were recorded in the March-April period. *Siganus canaliculatus* and *L. nebulosus* dominated in traps and (80-90%) and *Lethrinus* spp and *Plectorhynchus* spp in Disco nets.

Bombay : Trawlers landed 3043 t at New Ferry Wharf and 905 t at Sassoon Docks accounting for 6% and 2% of the total trawler catch at the respective centres. The dominant species were *Lutjanus russelli, Epinephalus diacanthus* and *E. tauvina.*

Cochin : 518 t were landed at Cochin Fisheries Harbour. The contribution of Govt. of India vessels was 18 t forming 3.5% of the total catch. The peak period was October - November. The catches comprised of *E. diacanthus, E. malabaricus, L. nebulosus, Lutjanus sp* and *Pristipomoides typus.* Hook and line caught 494 t and the highest catches were recorded in January and December months. The dominant species in the January-March perod was *P. typus* and in December, *E. diacanthus, Lutjanus* sp., *E. chlorostigma, E. areolatus, E. tauvina, E. bleekeri* etc. were recorded. Small trawlers landed 6.6% of *Priacanthus hamrur* during June-December period with a peak in August. Maturing fishes dominated the landings in May.

Assessment of Sciaenid resources (FB/DR/1.8.4) :

T. APPARAO, V. SRIRAMACHANDRA MURTY, P. DEVADOSS, P. JAYASANKAR, R. S. LAL MOHAN, K. V. SOMASEKHARAN NAIR, S. K. CHAKRABORTY, C. GOPAL.

Visakhapatnam : A total of 326 t were landed by small mechanised trawlers, accounting for 4.2% of the total catch. An increase of 15% was registered in the catch over the last year. Twelve species contributed to the fishery with *Johnius carutta* (48.5%), *Kathala axillaris* (33.7%) and *Otolithus ruber* (5.7%) forming the major groups. *J. carutta* was represented by the 0 and 1 year classes and the mortality rate was estimated at 1.0035.

Kakinada: An estimated 758 t were landed. Heavy landings were recorded in January, March and August. There was a decline of 32% in the catches, as compared to last year in spite of the increase in effort by 25%. *J. carutta, J. vogleri, Nibea maculata, O. ruber, Pennhia macropthalmus* and *J. dussumieri* were the dominant species. The 'Z' value of *J. carutta* was 3.3 and the effort was found to be more than the MSY.

Madras : Trawlers landed 835 t accounting for 5.4% of the total catch, with a CPUE of 21.4 kg. September to December was the peak period of landings. Of the twelve species in the catch, *J. carutta, K. axillaris* and *O. ruber* occurred in all months. Size distribution of *O. ruber* and *K. axillaris* was studied.

Mandapam Camp: 340 t were landed (Rameswaram) with a CPUE of 6.63 kg and 600 t (Pamban) with a CPUE of 8.59 kg. September - December was the peak period of landings. *P. macropthalmus* (90%) dominated the catches at Rameswaram and *N. maculata* at Pamban.

Calicut : 102 t was landed by trawlers and 98 t by indigenous gears during the period April - December '88. Peak landings were recorded in December. Of the 11 species, contributions by *J. aneus* was 59.6% followed by *K. axillaris* 22.3%. Peak landing of the former was in July - August, October and November and of the latter in July and December.

Cochin : The sciaenid fishery increased in terms of catch and CPUE. An estimated 1303 t with 36.63 kg CPUE was landed as against 506 t with 10.5 kg CPUE in the previous year. The fishery was good during January - May and September-December period. Main species contributing to the catch were *Johniops sina* (49%), *K. axillaris* (22%) and *O. ruber* (11%). The biology of *J. sina* was studied.

Bombay : 4287 t were recorded with a 146.88 kg cph, forming 8.3% of the total landings. There was a decrease of 4.2% in the catch compared to last year. February - April and September - December were the peak periods. *J. vogleri, J. macrorhynus, O. cuvieri, J. sina* and *T. dussumieri* contributed to the catches. The mortality rates estimated for the 3 species are *O. cuvieri* — Z : 2.83, *J. vogleri* — 2.40 and *J. macrorhynus* 3.26

Resource characteristics of Silverbellies (FB/DR/1.8.5) :

V. SRIRAMACHANDRA MURTHY, A. APPANNA SASTRY, S. SREENIVASARANGAN, P. LIVINGSTON, K.S. SCARIAH

Visakhapatnam : 391 t were landed accounting for 5.5% of total trawl catch. Landings declined by 23 t as compared to last year despite the 16% increase in effort. June, September and December were the peak periods. The dominant species were *Leiognathus bindus* (65%) *S. insidiator* (15.4%) and *G. minuta* (10.2%).

Kakinada : 559 t were landed by trawlers and it formed 5.4% of total trawl catch. Catches and catch rates were good during January-April period. A decline of 58% over the previous year was noticed although the efforts were increased by 23%. Out of the 10 species available *L. bindus* (40.5%), *G. minuta* (15.9%), *L. splendens* (12.6%)

and *S. insidiator* 9.2%) were prominent. Mortality rates were estimated as Z = 4.6 for *L. bindus* and Z = 5.7 for *S. insidiator* and the exploitation rates as 0.7 and 0.54 respectively.

Madras : An increase of 12.5% was registered at Madras and 3078 t, accounting for 20% of total trawl catch was recorded during the year. July and October were the peak months of landings. Of the 10 species contributing to the catches, prominent were *L. bindus* (32.2%), *S. insidiator* (16%), *L. splendens* (13%), *G. minuta* (10.7%), *L. dussumieri* (9.6%) and *L. lineolatus* (9.5%).

Mandapam : 12677 t were landed by trawlers in the Mandapam region (Mandapam, Pamban, Rameswaram). Fishery was at its peak in February, June and October at Mandapam; May at Pamban and January, July and October in Rameswaram. 11 species contributed to the fishery, the major ones being *L. jonesi* (33.4%), *L. brevirostris* (22.8%), *L. dussumieri* (12.8%) and *L. berbis* (11.6%).

Meso and bathy pelagic resources of EEZ (FB/DR/1.9.2) :

S. Sivakami.

During the period, FORV ***Sagar Sampada*** cruise reports 1 to 49 were analysed to study the distribution pattern of meso and bathy pelagic fishes in the EEZ of India. Out of 514 fishing operations carried out by the vessel 343 were by bottom trawl and 171 by pelagic trawls. The depth of operation ranged from 23 to 631 m. The deep water fishes encountered in the bottom trawl operations were *Priacanthus hamrur, Chauliodus* sp., *Diaphus splendidus, Psenes indicus, P. cyaena, Nemipterus, Pentaprion sp., Cubiceps natalensis,* gnathostomatids and myctophids. Productive fishing grounds have been located in the south west and south east coasts.

Assessment of the catfish resources (DF/RE/11) :

V.N. Bande, C. Gopal, S.G. Raje, K.Y. Telang, P. U. Zachariah, M. Feroz Khan, N. G. Menon, K. Alagaraja, V. Rengaswami, P. Jayasankar, Y. Appanna Sastry.

Veraval : The estimated landings were 1536.5 t, a three-fold increase over last year. The peak landings were in July, June and March. The trawlers contributed 85.5% and the dominant species were *Tachysurus tenuispinis* (41%), *T. dussumieri* (26%) and *T. thalassinus* (19%).

Bombay : 3052 t were landed and it formed 5.8% of the total fish production. Peak landing was in September. In trawlers *T. dussumieri* (36%), *T. thalassinus* (17%), *T. tenuispinis* (10%) and *O. militaris* (14%) were the dominant species. Juveniles (46.3 t) of *T. dussumieri* were caught by trawl and Dol net in May and June.

Karwar : The fishery comprised of a single species, *T. serratus* and only 34.2 t were recorded as compared to 79 t of the previous year. The entire catch was landed by purse seines during October - December. The previous year *T. tenuispinis* (12 t) was caught by trawlers and *T. serratus* (66 t) by purse seines and rampans.

Mangalore : The catfish catch was 1100 t, a four-fold increase over last year. This increase was mainly by

purse seines (68%) and trawlers during October-December. *T. tenuispinis* was the dominant species in purse seine. At Malpe the catfish catch was 1592 t, about 50% of which was caught during October-December.

Calicut : The landing was 404.4 t with 89.7% contributed by hooks and line. The maximum catch was in October (66%). In both the hooks and line and the drift net, *T. tenuispinis* was dominant. In June the catch comprised exclusively of *T. serratus.*

Cochin : Catfish landing showed a two-fold increase over last year with a catch of 1455 t. Trawlers contributed 82% of the catch and *T. thalassinus* was the dominant species (56%). The peak landings were in June, September and October.

Tuticorin : 9.8 t were landed during April-December. Hooks and line contributed 60% of the catch and the rest were by bottom set gill net and drift gill net. *T. thalassinus* was the common species in all the gears.

Mandapam : Work on the project was initiated in July. At Rameswaram 13.9 t of catfishes were landed during July-December period. *T. thalassinus* accounted for 50% of the catches. Other species were *T. caelatus, T. serratus* and *T. dussumieri.* A good catch of *Osteogeneiosis militaris* was observed in July. A record specimen of *T. caelatus* measuring 975 mm and weighing 8.5 kg was landed on 9th August. At Pamban 95 t of catfish were recorded. *T. thalassinus* was the major species except in November, when *T. dussumieri* was dominant. There were no operations during October - December period due to turbulent sea.

Visakhapatnam : Small trawlers caught 135.8 t as against 141.6 t in 1987. *T. thalassinus* formed 85% of the catch and *T. tenuispinis* 13%. FSI vessels (5 months operation) landed 5 t with a catch rate of 15 kg/hour. *T. thalassinus* (97%) formed the bulk of the catch.

Stock assessment of threadfin breams (DF/RE/12) :

V. SRIRAMACHANDRA MURTY, T. APPARAO, P. NAMMALWAR, K. M. S. AMEER HAMSA, S. LAZARUS, K. V. SOMASEKHARAN NAIR, M. SRINATH, P. U. ZACHARIAH, S. K. CHAKRABORTY, C. GOPAL.

Visakhapatnam: An estimated 489t were landed forming 6% of the total trawl landings. The catches showed a decline of over 56%, when compared to last year, inspite of a 13% increase in effort. Of the five species occurring in the catches, *Nemipterus mesoprion* (72%) and *N. japonicus* (23%) were dominant.

Kakinada : Inspite of 23% increase in effort *Nemipterus* fishery registered a decline of 36%. Trawlers landed 248t of the catch, which was 2.4% of the total trawl catch. *N. japonicus* was the most dominant species (60%) followed by *N. mesoprion* (20.2%), *N. tolu* (11.6%), *N. delagoae* (4.6%) and *L. luteus* (2.9%). Catches were good in January-March and October months.

Madras : Trawlers landed 2332 t of threadfin breams, which formed 16% of total trawl catch. Catch and catch rates were good during May - October period. Of the four species contributing to the fishery *N. japonicus* (42%)

was dominant followed by *N. mesoprion* (34%), *N. tolu* (15%) and *N. delagoae* (10%).

Tuticorin : Of the 234 t landed 97% was landed by trawlers and the rest by hooks and lines. The fishery comprised exclusively of *N. delagoae.* Peak landings by trawls were in March and August-October. In hook and line they occurred only during January-March period.

Vizhinjam : 112 t were landed by hooks and lines and it formed 2% of total catch. About 75% was brought by mechanised units and rest by non-mechanised ones. Peak landings were in June-July and October. The dominant species were *N. metopias* (55%), *N. japonicus* (23%) and *N. tolu* (22%).

Cochin : A catch of 3283 t was recorded at Cochin Fisheries Harbour during the year. A decrease of 110 t (3.22%) was noticed in the landings when compared to 1987 inspite of a 10.2% increase in effort. Highest catch and catch rates were recorded in August (841 t and 3191 kg/unit) and lowest in November. *N. mesoprion* (80.70%) and *N. japonicus* (19.20%) dominated. *N. delagoae* occurred in negligible quantities.

Mangalore : Trawlers landed 3768 t and accounted for 11% of the total trawl catch. The fishing operations were suspended during the June-August period. The resource was absent in September and October. Peak landings were in March. *N. japonicus* (79%) followed by *N. mesoprion* were the dominant species.

Bombay : 2683 t were landed at New Ferry Wharf. It formed 5.2% of the total trawl catch. A decline of 9.6% over that of the previous year was registered despite an increase in efforts by 1.2%. *N. japonicus* dominated the catch together with *N. mesoprion; N. delagoae* catches were good during the October-December period.

Veraval: 2309 t landed by trawlers, accounted for 5% of the total trawl catch. There was an increase of 140% in landings as compared to 1987. Trawl operations were suspended during the June-August period. Highest catches were recorded in March and October months. *N. japonicus* (80%) and *N. mesoprion* were the important species.

Biological studies of *N. japonicus, N. mesoprion* and *N. delagoae* were carried out. At Kakinada mortality rates were estimated as Z = 2.4. The present catch rate was found to be close to the MSY of *N. japonicus.* At Bombay the total mortality coefficient was estimated as 2.9. Mortality rates for *N. mesoprion* was worked out to be Z = 2.5 and MSY at 4.6 with the current age at first capture.

Assessment of elasmobranch resources (DF/RE/13) :

M. D. K. KUTHALINGAM, P. DEVADOSS, J. C. GNANAMUTHU, P. LIVINGSTON, GRACE MATHEW, M. FEROZ KHAN, S. G. RAJE, E. VIVEKANANDAN.

Cochin : An estimated 809 t of elasmobranchs were landed at Fisheries Harbour by drift gill nets, trawls and shark long lines. There was a threefold increase in the landings as compared to last year, mainly because of the large sized sharks landed in good

numbers by shark long lines. The fishery was at its peak from April to September. Contribution by different gears was trawls 38.78%, drift gill nets 33.9% and long lines 28.13%. In trawls *Scoliodon laticaudus* and *R. acutus* were the major sharks and *Himantura* spp. the ray. *R. acutus, C. melanopterus, Sphyrna lewini, C. dussumieri* and *C. limbatus* were the major species. Shark longlines landed mostly carcharinid sharks *C. limbatus, C. melanopterus, C. amboinensis* and *S. lewini.*

Calicut: Elasmobranch fishery was mainly supported by drift nets (98.58%). The other gears which contributed to the fishery were hooks and lines, *ayilachalavala* and trawlers and a total of 64.5 t were landed by them. *Carcharhinus* spp. dominated the catches of drift net and hooks and lines. Trawl catches consisted of *Chiloscylium indicum* and ayilachalavala consisted of *Scoliodon laticaudus.* At Elathur, 306 t of sharks were caught in long lines. The black tip shark *C. limbatus* (61.53%) and *S. lewini* (25.67%) dominated the catches.

Bombay : 3936 t were landed by trawlers with a 135.87 kg CPUE. This accounted for 7.5% of the total trawl landings. Sharks formed the major component (51.33%) followed by rays (26.6%) and skates (22.07%). The percentage composition of important shark species was *S. laticaudus* (38.51%), *C. melanopterus* (23.66%) and *S. palasorrah* (4.21%). For rays it was, *H. bleekeri* (18.69%), *H. zugei* (28.92%), *H. uarnak* (14.42%) and *H. imbricatus* (4.75%). *R. djiddensis* (92.94%), *R. ancylostoma* (3.64%) were the important skates.

Veraval : The fishery by trawlers showed a slight decline when compared to last year. An estimated 1584 t were landed of which 796 t were landed by private trawlers. Unlike trawlers, gill nets registered increased catches and CPUE during the year. The gear landed 679 t as against 417 t in the previous year. The peak months were January and February. *Dasyatis* sp. (46%) and *S. laticaudus* (37%) dominated the trawl catches and the latter alone (69%) in gill nets. Biological studies were carried out on *S. laticaudus.*

Assessment of the resources of lizard fishes (DE/RE/14) :

C. MUKUNDAN, E. VIVEKANANDAN, S. G. RAJE, P.U. ZACHARIAH, K.V. SOMASEKHARAN NAIR, S. LAZARUS, J. C. GNANAMUTHU, G. MOHANRAJ.

Veraval: Lizard fish landings registered a six-fold increase as compared to the previous year. 512 t of lizard fish were landed with 71.5 kg CPUE forming 1.2% of the total trawler landings during the calendar year. The fishery was dominated by *Saurida tumbil.* Ripe gonads were observed in females in the September-December period.

Bombay : 1678 t were landed by commercial trawlers at the New Ferry Wharf, Bombay with 57.51 kg/unit. It constituted 3.22% of the trawl catch. Maximum catch, 417 t was recorded in November. Like Veraval, the fishery was dominated by a single species *S. tumbil* (99.09%). With noticeable males in the last quarter, 72% gonads were in 'resting' stage.

Mangalore : 620 t of fish were recorded at Mangalore, with 15.88 kg CPUE and 3.66% share in the total

trawl catch. The first quarter brought in better catches (56%) while none were there in the September-October period. There were no operations during June-August. *S. tumbil* made up 80% of the catches followed by *S. undosquamis*. Partially spent fishes were encountered in November-March.

Malpe : The landings at Malpe were 760 t. It formed 4.3% of the total catch with 20.77 kg CPUE. *S. tumbil* was dominant throughout the year contributing 87% and *S. undosquamis* making up the rest.

Cochin : Estimated landings at Cochin were 2024 t with 41.37 kg CPUE. The fishery registered a three-fold increase compared to 1987. Unlike northern centres the fishery was sustained by *S. undosquamis* with negligible quantities of *S. tumbil*. The former was represented mainly by indeterminates and immature fish. Spent individuals were recorded in the September-November period.

Vizhinjam : With no trawling and hardly any demersal fishing, the lizard fish landing at Vizhinjam was negligible. The catch of 35.5 t mostly landed by hooks and line represented 0.6% of the total fish catch at the centre. Good landings were recorded at Sakthikulangara, where the fish catch was estimated at 9374 t which was 26% of the total catch at the centre. *S. undosquamis* formed 99.4% of the catch, the other species being *Trachinocephalus myops*.

Madras : An estimated 1031 t of lizard fish were recorded by trawlers at Kasimedu, at a catch rate of 26.5 kg. It formed 0.6% of the total trawl catch. The catch and catch rates were much lower during the year and there was a shortfall of 59% as compared to last year. *S. undosquamis* (76.4%), *S. tumbil* (10.1%) and *T. myops* (1.1%) constituted the fishery. Females in stage I were substantial upto October and thereafter mature fishes dominated the catches.

Assessment of the resources of flat heads and flat fish (DF/RE/15) :

P. Devadoss, Grace Mathew, M. Feroz Khan, E. Vivekanandan.

Madras : The landings were sporadic without wide fluctuations throughout the year. Total catch was estimated at 19.8 t with flat fish constituting 90%. Length frequency studies on *Psettodes erumei* revealed the possibility of recruitment in April, July and December months.

Cochin : Flat heads contributed 322 t out of the total catch of 837 t at Cochin Fisheries Harbour. This was the only centre where high percentage of flat heads were recorded. *Cynoglosus macrostomus* was the dominant flat fish species. Peak landing were reported in May and juveniles were recorded in December. Mature females were observed in May and September.

Calicut : Of the total catch of 116 t the trawl gear landed 114 t and the rest by indigenous gears. 99.9% of the catch was contributed by *C. macrostomus*. The major fishery was located at Puthiyappa, near Calicut. Flat fish constituted 89% of the catch.

Veraval : The estimated landing of flat fishes were 855 t, accounting for 1.9% of the total fish landings. No flat

heads were recorded in the catches. *C. arel* was dominant (36%) followed by *C. macrostomus* (30%). Mature females were noticed in the September-October months.

Culture of marine finfishes (DF/CUL/1.7) :

P. Bensam, P. Nammalwar, G. Mohanraj, V. Gandhi, A. Raju, A. R. Mishra, K. M. S. Ameer Hamsa, H. M. Kasim, V. S. Rangaswami.

Madras: Ponds at Muttukadu farm were stocked with the seeds of *Chanos chanos, Mugil cephalus, Liza parsia* and *L. tade.* In the first experiment initiated in May '88, a growth of 195 mm and weight increase of 146 g was observed in milk fish after six months with an estimated production of 575 kg/ha. In the second experiment initiated in June '88 the growth increase was 127 mm and weight increase 43 g with 180 kg/ha production in 6 months. Pond grown *M. cephalus* were raised upto stage II of gonadal maturity.

Mandapam : Two separate experiments were conducted and *C. chanos* were fed with gingelly oilcake and groundnut oilcake respectively. A monthly average growth increase of 26.8 mm (18.5 g) to 36.6 mm (46.5 g) in the former and 22.8 mm (16.0 g) in the latter were recorded. The respective rates of production were 481 - 656 kg/ha with 44.80% survival and 570 kg/ha with 86% survival.

Seepage in culture ponds was studied. The rate of seepage was found to be directly proportional to the depth of water in the pond and its wetted surface area. Rate of silt deposition was 377 kg of sediment per square metre in tide fed ponds.

Tuticorin : Polyculture and monoculture experiments were conducted with *C. chanos* and *L. macrolepis.* The production was low due to poor survival rate. To minimise feeding cost only algal feed such as Lab lab and *Gracilaria edulis* were used. *Lates calcarifer* recorded a growth rate of 29.3 mm/45.9 g per month after 126 days in net cage culture.

Control of Tilapia in mariculture systems (DF/CUL/1.8) :

P. Bensam.

Constructed ponds (No. 6 and 7), earthen pond (No. 20) and Pillaimadom lagoon were found to be totally free from *Tilapia* during the year. Studies revealed that the formation of sand bar prevented entry of *Tilapia* into the lagoon from the Sundaramadayam fresh water source.

MOLLUSCAN FISHERIES DIVISION

Survey of natural stocks, stock assessment, population studies, culture and hatchery production of commercially important molluscs were the major projects undertaken in this division.

Survey and stock assessment of cephalopod resources of the EEZ (MOL/RE/1.2.3) :

R. SARVESAN, KUBER VIDYASAGAR, K. S. SUNDARAM, P. K. ASOKAN, SUNIL K. MOHAMMAD, P. S. KURIAKOSE, M. SRINATH, M. M. MEIYAPPAN, V. KRIPA, K. PRABHAKARAN NAIR, K. A. NARASIMHAM, A. P. LIPTON, G. SYDA RAO, G. RADHAKRISHNAN.

In the New Ferry Wharf Centre at Bombay an estimated 5300 t were landed by 29308 units of private trawlers with a CPUE of 181 kg. Production of cephalopods declined by 22.5% for a reduction of 3.8% in fishing effort compared to 1987. The squids formed 16.4% and the cuttlefishes 83.6%. The catches consisted of *Loligo duvaucelii* (15.3%), *Sepia pharaonis* (48.8%), *S. aculeata* (35.8%) and a small quantity of *Sepiella inermis*. At Sassoon Dock, 6975 t were landed by 23,626 trawlers. The squids formed 21% and the cuttlefishes 79%. The CPUE ranged between 40 - 1615 kg. *S. pharaonis* formed 29% and *S. aculeata* 71%.

An estimated 961.6 t were landed by the trawlers at Mangalore Bunder and 332.6 t at Malpe. At Mangalore Bunder the catch showed a decline of 17% and consisted of *L. duvaucelii* (80%) and *S. aculeata* (20%) and together contributed to 6% of the total fish landings.

At Calicut, 222.5 t were landed by 18,218 trawlers with a CPUE of 12.9 kg. The squids formed 64.9% while the cuttlefishes 35.1%. The landings were good in January, February, November and December.

The estimated production at Cochin Fisheries Harbour was 2394 t with a CPUE of 36 kg. The cephalopod production showed 213% increase over the production in 1987. The squid formed 60.5% and the cuttlefishes 39.5% of the catches.

At Vizhinjam 98 t were landed of which squids amounted to 89 t (91%) and cuttlefishes 9 t (9%). They were mostly caught by hooks and lines (75%) and by shore seines (25%). There was a slight improvement in the catches over the previous year.

An estimated 113 t were landed by 30899 trawlers at Tuticorin with a CPUE of 3.6 kg during April-December 1988. July-September period was the most productive period. Squids formed 52% consisting of *L. duvaucelii* (39%), *Sepioteuthis lessoniana* (3%) and *Doryteuthis sibogae* (9%) and the cuttlefishes formed 48% consisting of *S. inermis* (28%), *S. brevimana* (16%), *S. pharaonis* (2%) and *S. aculeata* (2%).

A total catch of 662.1 t consisting of 49.5% of squids and 50.5% of cuttlefishes were landed by 39581 units of trawlers with a CPUE of 16.7 kg at Madras. The total cehalopod production formed 6% of the total fish landings. The overall production showed a decline of 130 t (16.5%) as against the previous year.

Commercial trawlers landed 226 t of cephalopods at Kakinada with a CPUE of 5 kg. It formed 2.2% of the annual total fish catches indicating a 37% decline compared to the previous year.

At Visakhapatnam 106.5 t consisting of 44.2% squids and 55.8% cuttlefishes with a CPUE of 7.8 kg were landed by smaller trawlers. The total cephalopod production recorded a decline of 67% over the previous year.

Population studies on clam resources (MOL/RE/1.8) :

G. Syda Rao, N. Ramachandran, V. Kripa, Sunilkumar Mohammad, P. K. Asokan.

At the Cochin centre, the Vembanad lake supported good clam fishery. In the northern Vembanad lake, *Meretrix casta* (141.6 t), *Paphia malabarica* (4.19 t) and *Villorita cyprinoides* (31.74 t) were landed at Munambam, Maliankara and Chittoor respectively. In Southern Vembanad Lake 1649 t of *V. cyprinoides* were landed at Pallipurathussery, Kutavechoor and Aryad south. Environmental and biological parameters were monitored.

An estimated 1040 t of clams were landed at Kakinada. The other molluscs formed about 907 t. *Anadara granosa* formed 77%. *M. meretrix* 10.8%, and *P. malabarica* 5% of the total landings.

At Mangalore the clam fishery in Mulky estuary was poor and 24.9 t were fished. The fishery comprised *Katelysia opima* (42%), *M. casta* (39%), *M. meretrix* (6%) and *P. malabarica* (13%).

Studies on the population characteristics of *M. meretrix* were carried out at Karwar. The size of the samples collected from the Karwar area of Kalinadi estuary varied from 11 to 17 mm. About 83,156 kg of the catch (70%) was landed during the first five months of the year.

Studies on biology, population and migration of the sacred chank Turbinella pyrum (MOL/RE/1.10) :

S. Mahadevan, K. Ramadoss, T. S. Velayudhan, A. P. Lipton, K. K. Appukuttan, K. Prabhakaran Nair.

At Tuticorin 279 chanks were tagged and released in the Harbour basin. 8 chanks were recovered on different dates ranging 30-157 days. The average increase in length, breadth and weight were 0.33 mm, 0.37 mm and 2.16 g respectively. Baby chanks (261 nos) obtained from four egg capsules attained a growth of 23.1 mm in length, 10.2 mm in breadth and 3.85 g in weight by the end of the year.

Data on chank landing were collected from Vizhinjam, Veli, Varkala and Sakthikulangara on the Kerala coast and from Kadiyapatnam, Colachel and Enayam in the Kanyakumari district of Tamil Nadu. A total of 77805 chanks were landed at the centres.

Wormed chanks ranged from 2-5% of the total landings. Experimental fishing with longline and trawlers were attempted. Diving experiments indicated good chank bed with 70-80% undersized chanks.

Resource and ecological monitoring of pearl oyster beds and their repopulation (MOL/RE/1.11) :

A. C. C. Victor, S. Dharmaraj.

Tuticorin : 3259 oysters were collected from the Tiruchendur group of paars during the year. The study on age, growth and biology of these oysters was made. The oysters belonged to '0' year group with a few to the 1 year group. Most of these oysters were in indeterminate stage of maturity.

30,000 pearl oyster spat ranging from 1.5 to 5.8 mm DVM were sea ranched in Vanthivu Arupagam paar during June and December. The ranched oysters could not be recovered.

Assessment of mussel resources: (MOL/RE/1.12).

P. S. Kuriakose, P. K. Asokan, Sunil K. Mohammad, N. Ramachandran, V. Kripa, K. K. Appukuttan, R. Sarvesan, P. Natarajan.

In Calicut the estimated exploitation was 579.9 t (May-September), at Challiyam-South beach, 148.3 t at Elathur and 373.2 t (March-September) at Koduvally. The total extent of mussel beds along the Malabar coast was estimated at 602 ha with a potential stock of 16,000 m.t. The average density of spat in the coast in September was estimated at 12500/m^2 weighing 1.44 kg.

The intertidal area from Fort Cochin to Pallithodu and at Alleppey was devoid of mussel beds. Few numbers of *Perna viridis* were found scattered on the rocky substratum and their exploitation was not noticed. Mussel beds were seen in most of the centres between Cochin bar mouth and Chavakkad. The area between Karimpuram and Thalikulam was not surveyed. In Kara area the population density was 25-30/m^2 and towards north it was between 60-150/m^2.

In the Dakshin Kannada coast (140 km long) *P. viridis* was seen in Someshwara, Suratkal, Mulky, Uchila, Kaupu, Malpe, Hangarghatta, Gangolli, Trasi and Baindur. The magnitude of fishery varied between the centres.

In Karwar the estimated mussel fishery was 65 t at Belekeri from April to June. At Darwada the mussel seed was available in about 59,000 m^2.

Culture of edible oysters : (MOL/CUL/1.1).

P. Muthaiah, M. E. Rajapandian, Rani Palaniswamy, C.P. Gopinathan, K. Satyanarayana Rao, P. V. Sreenivasan, G. Syda Rao, K. S. Sundaram and P. K. Asokan.

At Tuticorin, 2000 spat collected from spat collectors were broadcast in the creek area and 26,500 oyster seeds were supplied to Gujarat Fisheries Department. Hydrological parameters of the farm and the Korampallam creek were monitored. The condition factor varied from 125 to 140.8 in the oysters from harbour area and 128 to 130 in the bay area during January, March and July 1988. The oyster spat showed good growth in the salinities between 15 and 25 ppt.

At Madras 4350 and 71,000 oyster spat collected from Muttukadu backwaters and lagoon were reared and

their growth and other biological parameters were monitored. 22,256 oyster spat collected from the tiles during 1987 were also monitored for their growth.

Good spat settlement ranging from 250-1000/m^2 were observed on spat collectors during February-May and August-September at Kakinada.

Survey conducted along the South Kerala and Tamil Nadu coasts indicated oyster resources in the Chunnambar, Cuddalore Port, Coleroon, Gadilam and Vellar Coleroon estuaries.

Culture of green mussel in saltwater lagoons (MOL/CUL/1.2.1) :

K. SATHYANARAYANA RAO, P. V. SREENIVASAN, P. NATARAJAN and A. P. LIPTON.

At Madras *Perna viridis* was successfully cultured in the lagoon system by bag and pole methods. The growth rate was higher in the latter method but the yield was greater in the former. Despite the wide fluctuations in salinity and temperature in Muttukadu lagoon there is a good scope for mussel culture in the area.

Development of shell bead nuclei for pearl culture (MOL/CUL/1.4.3.) :

A. CHELLAM.

Production of shell bead nuclei were not possible at Tuticorin due to non-availability of local machinery. Shells of *Tridacna* sp. were collected from Andamans for the trial production of shell beads.

Pearl culture (MOL/CUL/1.4.) :

A. CHELLAM, A. C. C. VICTOR, S. DHARMARAJ and T. S. VELAYUDHAN.

Four rafts with hatchery seeds, natural bed oysters and seeded oysters were maintained in the Tuticorin Harbour farm. Environmental and hydrological parameters were monitored. 72.4% pearl production in spent oysters and 33.3% in oysters with developing gonads were recorded. The silt load at 1 m and 5 m depths was 7.3 and 97.9 ml/100 cm^2. At the corresponding depths the pearl production was 46.3% and 4.3%. Pearl production in the size groups 45-50, 50-55 and 55-60 mm was 31.7%, 54.5% and 25.3% respectively. The nacre secretion in position 'B' was more in the 45-50 mm group, equal in 50-55 mm and less in the 55-60 mm group. Wound healing in the operated oysters was faster in farm condition than in the laboratory. The October-December season was found to be good for pearl production (44.7%) than the July-September season (12%). Azumin treated graft tissue gave 42% pearl production whereas eosin treatment gave only 35%. The black banded oysters produced 13% quality pearls and non-banded ones 60%. Trematode infection was 20% in December and 4% in October.

Mass production of edible oyster seed in hatchery (MOL/CUL/1.5.1) :

M. E. RAJAPANDIAN, RANI PALANISWAMY, P. MUTHIAH.

At Tuticorin, ripe *Crassostrea madrasensis* were held under controlled condition without spawning for about six months. This technique provided spawners throughout the year for hatchery work. A total of 3.2 lakhs of oyster spat were produced during the year in ten experiments. Of these 2.5 lakhs

were cultchless spat. The rate of spat settlement was found to be 0.5% - 9.7%. *C. cristagalli* was bred in the hatchery and 5490 spat were produced. 11,520 cultchless spat and 72,000 seed on oyster shells were reared in the farm. 15,500 oyster seeds during March and 11,000 seeds during September were sent to Gujarat.

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

P. V. Sreenivasan, K. Sathyanarayana Rao, K. K. Appukuttan, K. Prabhakaran Nair, D. Sivalingam.

P. viridis was induced to spawn 11 times by means of mechanical, thermal and biological stimuli at Madras. Five batches of larvae were reared and a total of 74,470 mussel seed were produced. The percentage of survival was found to be poor i.e. between 0.52% and 5.85%. Spat showed good growth when fed with mixed algae. The larval density of 8/ml was found to be optimum. 100% survival was achieved in the salinity range 25 to 40 ppt. Hatchery produced green mussel seed withstood 18 hours exposure to air with only 10% mortality and 17.2% weight loss. Total mortality occurred beyond this hour.

At Vizhinjam brown mussels were induced to spawn on four occasions but the larvae could not be reared due to severe ciliate infection in the rearing tanks.

Spawners of brown mussel from Vizhinjam were brought to Tuticorin and were induced to spawn. Though the larvae were reared under different conditions, there was progressive mortality and no spat settlement.

Experimental pearl oyster hatchery for mass production of spat (MOL/CUL/ 1.7.1) :

S. Dharmaraj, A. Chellam and T.S. Velayudhan.

The effect of antibiotics on larval growth and spatfall was studied at Tuticorin. Crys-4 and Kanamycin at 50-100 ppm gave comparable growth. Streptomycin at 50 ppm resulted in high spatfall (42%). Total mortality occurred with Chloramphenicol. Larval growth was equally good when fed with *Chromulina* or *Isochrysis* + *Chromulina* or *Isochrysis* + *Pavlova* + *Chromulina*. Experiments on the effect of density on spat growth indicated that the higher the density the lesser the growth. The cost of spat depended on percentage of spatfall. 15,000 hatchery seed were sea-ranched and 32,500 seed airlifted to Gujarat. Mother oysters of *P. margaritifera* brought from Andamans were bred in the hatchery.

Culture of cephalopods (MOL/CUL/1.8):

D. Sivalingam, K. Ramadoss.

Four batches of *S. lessoniana* eggs collected along Tuticorin coast, were hatched. Two batches of *S. pharaonis* eggs were also hatched in the laboratory. The hatchlings were fed with mysids, *Mesopodopsis* sp. and later with assorted fish fry. The hatchlings of the two species were reared upto adult stage in the laboratory and their growth monitored. The maintenance of adults in the laboratory tanks faced problems due to nonavailability of sufficient fish fry.

Development of hatchery system for clam seed production (MOL/CUL/1.9):
K. A. NARASIMHAM, P. MUTHIAH.

At Karapad hatchery 33,130 seed of *M. meretrix* and 8090 seeds of *A. granosa* were produced. The juveniles of these two species were reared in the field and their growth was monitored. *P. malabarica* brought from Ashtamudi, Kerala in August 1988 was conditioned by intensive feeding for spawning. Spawning occurred on 13.9.88 and on 26.11.88 and 76,900 seed produced with a survival rate of 39.1% for a period of 3 months. Experiments on the salinity tolerance of the above three species indicated the optimum level of 19-26 ppt for *A. grannosa*, 14-21 ppt for *M. meretrix* and 28-33 ppt for *P. malabarica*.

Breeding and sea ranching of commercially important gastropods (MOL/CUL/1.10) :
K. RAMADOSS, S. MAHADEVAN.

The gastropod *Trochus radiatus* was bred in the Tuticorin hatchery and the larvae reared upto adult stage. *T. niloticus* (10 nos.) were brought from Andamans for breeding in the laboratory.

CRUSTACEAN FISHERIES DIVISION

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

S. RAMAMURTHY, K. ALAGARAJA, S. SHANMUGHAM, V. D. DESHMUKH, M. ARAVINDAKSHAN, V. S. KAKATI, K. Y. TELANG, K. K. SUKUMARAN, P. T. SARADA, C. SUSEELAN, K. N. RAJAN, G. NANDAKUMAR, N. S. KURUP, K. K. PHILIPOSE, K. RAJAMANI, G. MAHESWARUDU, V. THANGARAJ SUBRAMANIAM, S. LALITHA DEVI and G. SUDHAKARA RAO.

Trawl fishery :

Penaeid prawn fishery in 1988 improved over that of the previous year at Veraval (59%), Tadri (14%), Malpe (60%), Munambam (34%), Cochin Fisheries Harbour (119%) and Waltair (15%). At Cochin the catch was an all time record. The catch declined at New Ferry Wharf (9%), Karwar (59%), Mangalore (21%), Saktikulangara (30%) and Kakinada (29%). The fishing effort in 1988 increased over that of the previous year at Munambam (5%), Cochin Fisheries Harbour (23%), Saktikulangara (14%), Kakinada (17%) and Waltair (7%) and declined at Veraval (19%), New Ferry Wharf (4%), Tadri (6%), Karwar (55%), Mangalore (14%) and Malpe (16%). Table 1 shows the centre-wise landings.

The Govt. of Kerala banned monsoon trawling along the entire coast except the region between Paravoor South Pozhi to Cheriyazickal in Quilon district. Neendakara and Saktikulangara based trawlers carried out fishing operations throughout monsoon. The ban was limited to 22 Km from the shore line. Mechanised boats based at Cochin Fisheries Harbour conducted trawling beyond the 22 Km area during the monsoon period.

There was unprecedented heavy landings of 'Karikkadi' (*P. stylifera*) at Cochin in September '88. In September alone the estimated landing of Karikkadi amounted to 4,524 t (432 kg/boat trip). Nearly 40% of the catch comprised of juveniles. With this year's fishery, Cochin emerged as the leading 'Karikkadi' fishing centre of Kerala.

On the west coast, *P. stylifera* dominated at all centres except Mangalore and Ambalapuzha where, *M. monoceros* and *M. dobsoni* respectively were the major component species. The second in abundance were *S. crassicornis* at Veraval; *M. affinis* at New Ferry Wharf and Sassoon Dock. *M. monoceros* at Tadri and Malpe; *M. dobsoni* at Karwar, Mangalore, Calicut, Cochin and Munambam; *P. stylifera* at Ambalapuzha and *P. indicus* at Saktikulangara. At Cochin and Saktikulangara *P. stylifera* contributed more than 80% of the catch.

On the east coast, *P. semisulcatus* formed the major component at Tuticorin and Mandapam while at Kakinada and Waltair it was *M. monoceros*. The second in abundance were *M. dobsoni* at Tuticorin, *Metapenaeopsis* spp. at Mandapam and Waltair and *M. affinis* at Kakinada.

Table : 1 Penaeid prawn landings at different centres during 1988

Particulars	Veraval	Sassoon Dock	New Ferry Wharf	Tadri	Karwar	Malpe	Mangalore	Calicut
MARINE								
A. *Gear*: Trawl Net								
1. Catch in tonnes	3491	12664	8342	374	267	1430	1574	490
2. Catch/boat trip (kg)	78.6	536.0	285.8	28.0	32.3	39	40.3	25.8
3. Catch/hour (kg)	5.7	...	8.8	...	6.5	5.9	3.6	3.4
4. Important species*	f;j;a;k;e	f;a;b;e	f;a;j;b;e;k	f;d;b;a	f;d;b;a	f;b;d	b;d;f	f;d;a
5. Productive months*	10;1;11;2 3;12	8;7;9;11	9;11;10;1 4;12	12;1;11;8;2	1;8;7;3;2	11;12;3;2;1	2;1;11;12	11;1;3;12;2
B. *Gear*: Purse Seine								
1. Catch in tonnes	...	...	...	...	267	...	31	...
2. Catch/unit (kg)	...	...	...	...	...	...	...	...
3. Important species	...	...	...	...	d	...	d	...
4. Productive months	...	...	...	...	...	...	...	...
C. Indigenous gears								
1. Centre	...	...	...	...	...	Panambur Harbour	Ullal	Vellayil
2. Catch in tonnes	...	...	...	...	...	15	12	18
3. Catch/Unit (kg)	...	...	...	...	...	12.8	2.9	9.7
4. Important species	...	...	...	...	...	d	d	d;f
5. Productive months	...	...	...	...	...	6;7;8	6;7;8	7;6;8
2. ESTUARINE								
1. Name of centre	...	...	...	...	Kali estuary	...	...	Korapuzha
2. Catch in tonnes	...	...	...	...	4·5	...	...	160
3. Catch/Unit (kg)	...	...	...	...	4.0	...	...	19.2
4. Important species	...	...	...	...	d;b	...	...	d;b
5. Productive months	...	...	...	...	3;1;2	...	...	5;6;12

Particulars	Cochin Fisheries harbour	Munam-bam	Ambalapuzha[1]		Sakthi-kulangara	Vizhinjam	Tuticorin	Mandapam[3]	Kakinada	Waltair
MARINE										
A. *Gear*: Trawl Net										
1. Catch in tonnes	9114	1783	514		9033	...	340	797	2558	510
2. Catch/boat trip (kg)	133.6	58.3	26.6		57.1	...	15.0	...	60.4	21.7
3. Catch/hour (kg)	28.1	11.7	...		12.9	...	3.0	1.6	7.4	1.6
4. Important species*	f;d;b	f;d;b	d;f		f;b;d;a	...	m;d;f;h;l	m;k;o;h	b;a;l;d;e	b;l;k;o
5. Productive months*	9;10;8;6	10;5;12;1	2;3		8;7;6;12	...	6;7;8;9	5;3;7;6;10;12	1;2;10;3;4	...
B. *Gear*: Purse Seine										
1. Catch in tonnes	...	...	...		...	...	...	...	...	...
2. Catch/unit (kg)	...	...	...		...	...	...	...	...	...
3. Important species	...	...	...		...	...	...	...	...	...
4. Productive months	...	...	...		...	...	...	...	...	...
C. Indigenous gears										
1. Centre	...	...	Ambalapuzha (ring seine)	(minitrawl)	...	Vizhinjam[2] (Trawlnet)	Periathalai (Gillnet)	...	...	...
2. Catch in tonnes	...	...	826	12	...	75	233	...	...	...
3. Catch/Unit (kg)	...	...	30.2	4.6	...	2.4	5.9	...	...	...
4. Important species	...	...	d;f	f;d	...	l;m	l	...	...	...
5. Productive months	...	...	8;9	12;11	...	6;7;11;12	6;7	...	...	...
2. ESTUARINE										
1. Name of centre	...	...	...		...	...	...	...	B.V. Palam	...
2. Catch in tonnes	...	...	...		...	...	...	...	469	...
3. Catch/Unit (kg)	...	...	...		...	...	...	...	21.4	...
4. Important species	...	...	...		...	...	...	...	b;d;l;m	...
5. Productive months	...	...	...		...	...	...	...	...	...

IMPORTANT SPECIES : a - *M. affinis;* b - *M. monoceros;* c - *M. kutchensis;* d - *M. dobsoni;* e - *M. brevicornis;* f - *P. stylifera;* g - *P. hardwickii;* h - *P. maxillipedo;* i - *P. uncta;* j - *S. crassicornis;* k - *Metapenaeopsis* spp.; l - *P. indicus;* m - *P. semisulcatus;* n - *P. merguiensis;* o - *Trachypenaeus* spp.

PRODUCTIVE MONTHS : Calendar months.

1) At Ambalapuzha trawling was done only for 4 months from January to April.
2) Vizhinjam landings include the catches from Valiathura, Vizhinjam, Colachel and Manakudy.
3) Mandapam landings include the catch from Mandapam and Pamban.

Table 2 : Percentage composition of penaeid prawns in the trawl fishery at various centres during 1988 (Estuarine fishery in parenthesis)

Species	Veraval	Sasoon dock	Bombay New ferry wharf	Tadri	Karwar	Malpe	Mangalore	Calicut
M. affinis	9.6	19.6	14.6	7.4	6.6	...	0.3	6.4
M. monoceros	...	16.3	10.7	22.8	15.2 (21.3)	23.2	57.0	3.9 (20.0)
M. kutchensis	6.7	...	4.1	...	...	...	...	...
M. dobsoni	...	...	...	18.2	17.8 (76.7)	12.5	22.7	40.1 (72.4)
M. brevicornis	...	9.2	6.7	...	...	...	...	...
P. stylifera	37.7	35.1	38.8	50.2	59.0	63.4	17.5	46.8
P. hardwickii	6.1	...	3.3	...	...	...	...	...
P. maxillipedo	...	...	...	...	...	...	...	...
S. crassicornis	24.4	8.5	11.3	...	...	...	...	...
Metapenaeopsis spp.	7.0	5.4	5.7	...	...	...	...	...
P. indicus	...	...	...	...	(1.7)	0.7	1.6	2.4 (7.1)
P. monodon	...	...	...	0.2	0.1 (0.3)	0.1	0.9	...
P. merguiensis	...	...	...	1.1	1.3	...	...	...
P. semisulcatus	5.6	...	...	...	...	...	...	...
Trachypenaeus spp.	...	...	...	...	...	...	...	...
Others	2.9	5.9	4.8	0.1	...	0.1	...	0.4

Species	Cochin fisheries harbour	Munambam	Ambala-puzha	Sakthi-kulangara	Vizhinjam[1]	Tuticorin	Mandapam	Kakinada	Waltair
M. affinis	0.5	1.0	...	3.3	...	...	...	12.6 (3.1)	...
M. monoceros	5.1	3.8	...	1.1	...	...	...	23.0 (55.0)	30.5
M. kutchensis	...	...	...	...	...	...	...	...	...
M. dobsoni	12.2	36.0	50.4	5.5	...	16.8	...	9.9 (10.3)	3.7
M. brevicornis	...	...	...	...	...	...	...	6.7 (3.4)	...
P. stylifera	80.9	57.0	48.4	79.9	...	11.2	...	...	...
P. hardwickii	...	...	...	...	...	...	...	...	...
P. maxillipedo	...	...	...	...	...	7.7	3.9	...	...
S. crassicornis	...	...	...	...	...	...	...	...	6.9
Metapenaeopsis spp.	...	...	...	...	...	...	19.4	...	15.5
P. indicus	0.9	1.8	1.2	6.7	90.1	5.6	...	10.2 (9.0)	17.7
P. monodon	0.2	...	...	0.1	...	...	...	6.9 (8.6)	2.7
P. merguiensis	...	...	...	...	...	...	...	...	...
P. semisulcatus	...	...	...	1.5	9.9	49.0	66.4	5.2 (6.1)	2.9
Trachypenaeus spp.	...	...	...	1.7	...	...	4.0	...	7.3
Others	0.2	0.4	...	0.2	...	9.7	6.3	25.5 (4.5)	12.8

1 Vizhinjam landings by trammel net

Table 3 : Size range in mm with modal class in parenthesis of important penaeid prawn species

M — male; F — Female; A — Both sexes; Trawl Net

Species	Veraval	New Ferry Wharf	Tadri	Karwar	Mangalore	Malpe	Calicut	Cochin Fisheries harbour
M. affinis	..	F 71-180	A 76-140	...	...	...	...	...
	...	(131-135)	F (96-125)	...	...	...	...	...
	...	M 71-150	M (116-120)	...	...	...	...	...
	...	(116-120)	...	...	...	...	...	...
M. monoceros	...	F 71-200	A 71-170	F 96-180	...	...	...	...
	...	(141-145)	F (96-120)	(131-135)	...	...	...	...
	...	M 71-170	M (76-115)	M 81-150	...	...	...	...
	...	(116-120)	...	(116-120)	...	...	...	...
M. kutchensis	F 71-175	...	...	...	...	...	...	...
	(131-135)	...	...	...	...	...	...	...
	M 81-145	...	...	...	...	...	...	...
	(116-120)	...	...	...	...	...	...	...
M. dobsoni	...	...	A 61-125	F 56-120	F 41-105	F 51-105	F 51-115	A 41-105
	...	...	F (91-105)	(81-85)	(71-75)	(81-85)	(86-90)	F (61-75)
	...	...	M (71- 80)	M 56-100	M 41-85	M 46-90	M 51-95	M (61-65)
	...	...	...	(71-75)	(61-65)	(66-70)	(71-75)	...
P. stylifera	F 56-145	F 51-130	A 56-120	F 56-125	F 56-115	F 61-125	F 61-130	A 51-120
	(91- 95)	(96-100)	F (91-95)	(81-85)	(91-95)	(81-85)	(91-95)	F (81-85)
	M 66-105	M 51-100	M (81-90)	M 56-105	M 51-100	M 56-100	M 56-105	M (71-75)
	(81- 85)	(81-85)	...	(76-80)	(76-80)	(76-80)	(76-80)	...
S. crassicornis	...	F 51-120	...	...	...	...	...	...
	...	(91-95)	...	...	...	...	...	...
	...	M 46-90	...	...	...	...	...	...
	...	(61-65)	...	...	...	...	...	...
P. indicus	...	...	...	...	...	...	...	...
P. semisulcatus	...	...	...	...	...	...	...	...

Species	Munambam	Ambalapuzha	Sakthikulangara	Vizhinjam	Tuticorin	Mandapam	Kakinada	Waltair
M. affinis	...	...	...	...	...	...	...	...
M. monoceros	...	...	...	...	...	...	...	F 81-200
	...	...	...	...	...	...	...	(136-140)
	...	...	...	...	...	...	...	M 81-165
	...	...	...	...	...	...	...	(121-125)
M. kutchensis	...	...	...	...	...	...	...	...
M. dobsoni	F 51-110	F 51-105	A 41-115)	...	...	...	F 46-110	...
	(76- 80)	(81-85)	(66-80)	...	...	...	(76-80)	...
	M 51- 95	M 51-85	...	...	...	...	M 46-110	...
	(66- 70)	(76-80)	...	...	...	...	(66-70)	...
P. stylifera	F 46-120	F 51-105	A 41-120	...	...	...	...	...
	(76- 80)	(76-80)	F (86-90)	...	...	...	...	...
	M 51-105	M 51-100	M (81-85)	...	...	...	...	...
	(71- 75)	(71-75)	...	...	...	...	...	...
S. crassicornis	...	...	...	...	...	...	...	...
P. indicus	...	...	...	F 125-194	F 121-205	...	...	F 96-205
	...	...	...	(150-154)	(151-155)	...	...	(151-155)
	...	...	...	M 120-179	M 111-200	...	...	M 96-190
	...	...	...	(145-149)	(141-145)	...	...	(136-140)
P. semisulcatus	...	...	...	...	F 106-235	F 61-230	...	...
	...	...	...	...	(151-155)	(131-135)	...	...
	...	...	...	...	M 91-210	M 71-200	...	...
	...	...	...	...	(131-135)	(106-110)	...	...

Over the years the percentage contribution of *P. indicus* to the trawl fishery at Tuticorin has reduced. During the 1981-'83 period this species contributed to 40-56% of the trawl catch whereas in 1988 this declined to a meagre 5.6%. Table 2 shows the species-wise percentage contribution at different centres.

The size structure of important species is given in Table 3. The size of Karikkadi ranged between 71-95 mm at different centres. In Kerala, dominant size classes were smaller when compared to the north-west region. There was a large scale concentration of juveniles in the fishery in September '88 at Cochin when bumper landings occurred. In *M. dobsoni*, 61-105 mm sizes contributed to the bulk at different centres. Most of the species showed peak spawning during December-March period along the west coast and July-September on the east coast.

Indigenous fishery :

Indigenous gears landed penaeid prawns in sizeable quantities at Mangalore, Calicut, Ambalapuzha, Vizhinjam and Tuticorin (Table 1). *M. dobsoni* was the principal component at Mangalore, Calicut and Ambalapuzha and *P. indicus* at Vizhinjam and Tuticorin. The landings at these centres mainly took place in the monsoon months.

Introduction of mini trawls on Kerala coast resulted in large scale destruction of Karikkadi juveniles. Mini trawl is operated in the near shore waters (3 - 8 m). Juveniles formed the major portion of the catch. Restriction should be imposed on this gear as a conservation measure.

Estuarine fishery :

The fishery improved at Calicut and declined at Karwar and Kakinada. The gears operated were sluice nets at Karwar and stake nets at Calicut and Kakinada. *M. dobsoni* supported more than 70% of the fishery at Karwar and Calicut and *M. monoceros* formed 55% at Kakinada. *M. monoceros* formed nearly 20% of the catch at Karwar and Calicut whereas *M. dobsoni* (10%) was the second in abundance at Kakinada. Table 1 shows the details from the estuarine areas.

Hatchery production of marine prawn seed (CF/CUL/1.1.2) :

M.S. Muthu, P. Vedavyasa Rao, N.N. Pillai, K. Devarajan, M. Kathirvel, E. V. Radhakrishnan, P. E. Sampson Manickam and G. Maheshwarudu.

After transfer of the Narakkal Prawn Culture Laboratory to the Central Institute of Brackishwater Aquaculture, the project was undertaken at Kovalam (Madras) and Mandapam camp with accent on breeding purely marine prawns in captivity. Six species of marine prawns viz. *Trachypenaeus pescadorensis, Parapanaeopsis maxillipedo, P. uncta, Matapenaeopsis stridulans, M. hilarula and M. mogiensis* were made to spawn in the hatchery. Their eggs were reared successfully through all the larval and post-larval stages using the well proven technique developed by the project earlier. This is the first time that the complete larval history of these six species of prawns is obtained from captive breeding.

The prawn hatcheries being built by Kerala and Karnataka states at Mopla Bay and Kumta Bay respectively with the technical assistance from this project are nearing completion. Two visits were made to Mopla Bay to render technical advice during construction of the hatchery. The operation of a small scale prawn hatchery that can be kept in the backyards of fishermen hutments on the seashore was demonstrated at a village near Shertalai.

The third generation brood stock of *Penaeus latisulcatus* maintained at Kovalam (Madras) matured and spawned without eyestalk ablation. The larvae were reared successfully to produce the 4th successive generation in captivity.

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

S. Lalitha Devi, V. D. Deshmukh, M. Aravindakshan and S. Shanmugham.

Non-penaeid landings showed an increase at Veraval (three fold) and at New Ferry Wharf (Bombay) (36%). At Kakinada the fishery declined by 45%. *Acetes* spp. formed the chief component. The annual mean length of *E. ensirostris* varied from 54-76 mm and that of *N. tenuipes* from 45-58 mm at the various centres.

Population studies on *N. tenuipes* off Bombay revealed an estimated potential yield of 2,694 t, the exploitation rate being 0.5 which showed that the fishing effort can be increased for better yield. At Kakinada also, the population studies on non-penaeid prawns showed that the yield can be more than doubled by increasing the effort.

In the dol net catches of Versova, the feather shrimp *Pontocaris pennate* contributed to the fishery. The glass shrimp *Leptochela pugnax* formed food of thread fin breams. The deep-sea pandalid prawn *Parapandalus longicauda* occurred in considerable quantities at Kakinada.

Artificial insemination of penaeid prawns (CF/CUL/1.1.5) :

M. S. Muthu, N. N. Pillai, K. Devarajan, M. Kathirvel and K. Rengarajan.

The project was greatly handicapped by lack of essential facilities. The reproductive structures of *P. indicus* were processed for ultramicroscopic work. This will be completed when the electron microscope becomes fully operational.

Studies on coastal shrimp fishery resources by experimental fishing (CF/RE/1.1.8) :

C. Suseelan, G. Nandakumar, K. N. Rajan and K. R. Manmadhan Nair.

Regular experimental shrimp trawling was conducted off Cochin to study the distribution pattern and resource characteristics of commercially important prawns. 70 trawling operations were made at the different bathymetric stations, 25 operations using R/V *Skipjack* upto 70 m depth from January to March '88 and 45 operations using *Cadalmin* upto 30m depth from April-December '88. During the non-monsoon pereiod, *Parapenaeopsis stylifera* and *Metapenaeus dobsoni* were restricted to 20 m depths while *P. monodon* and *M. monoceros* occured in greater abundance between 21 and 60 m depths. *M. affinis* showed a uniform distribution upto 25 m depth. During

the monsoon period (June - August), shrimp trawling inside the 10 m depth yielded unusually good numbers of sub-adults (101-125 mm) of *P. indicus*. This is attributed to an active emigration of prawns from Cochin backwaters caused by the influx of monsoon flood. Stray numbers of *P. stylifera* were also recorded from this depth zone. *M. affinis* mainly occupied the depth range 16-20 m during June.

Investigations on the juvenile prawn fishery of Cochin backwaters (CF/RE/1.1.9) :

G. NANDAKUMAR, MARY K. MANISSERI, N. S. KURUP and K. R. MANMADHAN NAIR.

The stake net fishery at Malianankara, Thoppumpady, Thevara, Arookutty and Vaikom yielded prawns amounting to 635 t during 1988. The maximum catch (427 t) and CPUE (3.6 kg) were recorded at Maliankara. *M. dobsoni* was predominant (63.5%) followed by *M. monoceros* (21.6%) and *P. indicus* (14.5%). The prawn landings by dip nets was 35.5 t. Cherai fishery accounted for 83.4% of the catches with a CPUE of 5.2 kg while the remaining 16.6% catches were landed at Arookutty with a CPUE of 1.0 kg.

P. indicus (56-110 mm) showed predominant modes at 73, 83 and 88 mm. *M. dobsoni* varied in length from 21 to 80 mm and 41-55 mm size prawns dominated in the fishery. *M. monoceros* measured 31-105 mm in total length with modal groups within the size range of 56-90 mm. Females were dominant in all the three species. Juveniles alone contributed to the prawn landings of stake nets and dip nets in the Cochin backwaters.

Assessment of lobster and crab resources (CF/RE/1.3.1) :

P. V. KAGWADE, S. SHANMUGHAM, K. S. SCARIAH, K.K. PHILIPOSE, M. RAJAMANI and E. V. RADHAKRISHNAN.

Bombay recorded the highest landings (262 t) among all the centres and Madras the lowest (4 t). The other centres were Veraval (87 t), Vizhinjam (16 t) & Tuticorin (8 t). *Panulirus polyphagus* was dominant in the north-west coast and *P. homarus* at other centres. The percentage of berried females of *P. polyphagus* was high at Bombay (22%) and that of *P. homarus* (40%) and *Thenus orientalis* (20%) at Madras. The sex ratio of *P. polyphagus* and *T. orientalis* was almost equal. In the case of *P. homarus* males dominated at Tuticorin.

Assessment of crab resources (CF/RE/1.3.2) :

K. K. SUKUMARAN, S. SHANMUGHAM, V. D. DESHMUKH. P. T. SARADA, MARY K. MANISSERI, M. KARTHIKEYAN, K. R. MANMADHAN NAIR, G. MAHESHWARUDU, V. THANGARAJ SUBRAMANIAM and S. LALITHA DEVI.

The crab fishery was good at Veraval, Cochin, Mandapam and Kakinada. The crab landings by shrimp trawlers at Veraval, Bombay, Mangalore, Malpe, Calicut, Cochin, Mandapam and Kakinada were 2,471 t (4kg/hr), 40.6 t (1 kg/boat trip), 116.6 t (0.3 kg/hr), 30.6 t (0.1 kg/hr), 21.8 t (0.2 kg/hr), 660 t, 174 t and 273.3 t (6.4 kg/unit) respectively. The estuarine fishery at Korapuzha (Calicut) landed 11.3 t (1.4 kg/hr).

The crab fishery was mainly supported by P. *sanguinolentus, P. pelagicus* and *C. cruciata* at most of the centres. The overall sex ratio indicated that males dominated in *P. sanguinolentus* at Mangalore, Malpe and Calicut, whereas females were more at Cochin and Kakinada in this species. Maturity studies in *P. sanguinolentus* indicated breeding during January at Mangalore, during May at Calicut and Cochin and during January-March at Kakinada. In *P. pelagicus,* males outnumbered the females at Mangalore and Cochin and in the gill net catch at Mandapam. In the trawl catch the females were more at Calicut and Mandapam. *P. pelagicus* breeding was observed in January at Mangalore, in February at Malpe, in December at Calicut and July-August at Mandapam. At Cochin, mature females were more in June (7.7%) and berried ones in February (36.8%).

Crustacean resources of EEZ — Investigations on the decapod crustacean resources of outer EEZ (CF/RE/1.8) :

N. Neelakanta Pillai, M. S. Muthu, C. Suseelan, K. R. Manmadhan Nair, K. N. Rajan, M. Kathirvel and V. S. Kakati.

Bongo net collections of the first ten cruises of FORV *Sagar Sampada* were analysed for phyllosoma/*Puerulus* larvae and brachyuran zoea. Among the phyllosoma larvae, 14 belonged to palinurid lobsters and 172 to scyllarid group. The brachyurid belonged to several major families. Zoea of raninidae family were more concentrated off Gujarat coast and off Cape Comorin.

During cruise No. 40 of FORV *Sagar Sampada* in the Quilon Bank area (south-west coast) the deep-sea lobster *P. sewelli* (total length range of 71-200 mm) was caught in the HSDT at a depth range of 290-300 m. The dominant group for males and females were 131-140 mm and 141-150 mm respectively. Smaller sized lobsters (below 130 mm) were caught from the depth range of 300-400 m and none at 150-300 m depth. Appreciable quantities of deep-sea prawns (130-201 kg/hr of trawling) were also recorded between 290-350 m depth. *Penaeopsis jerryi* (61-100 mm), *Heterocarpus woodmasoni, H. gibbosus* (101-120 mm), *Parapandalus spinipes* (91-105 mm) and *Aristeus alcocki* formed the major components of the prawn catch.

Evaluation of prawn resources of north-east coast of India exploited by big trawlers (CF/RE/1.9) :

G. Sudhakara Rao.

About 15 big trawlers from Visakhapatnam fished for deep sea lobster *P. sewelli* in the Quilon-Wadge Bank area during February-May '88 and landed 165 t. A closed season was observed by the trawlers during April - May from Visakhapatnam base. During April '87 - March '88, 1,783 t of prawns (headless) were landed (c/hr: 10.1 kg). The fishery was the poorest ever recorded. The continuous decline in the catch rate from 1984-'85 onwards might be due to fishing pressure.

During 1987-'88 'Browns' (*M. monoceros, M. ensis* and *M. affinis)* constituted 66.6%, 'Whites' *(P. indicus, P. merguiensis* and *P. penicillatus)* 24.7%, 'Tigers' *(P. monodon* and *P. semisulcatus)* 8.4% and others 0.3% of the

prawn catch. Depth distribution indicated that the total prawn catch was more in the 71-80 m depth compared to 91-100 m. 'Tigers' were abundant in the 51-60 m depth zone, 'Browns' in the 81-90 m zone and the 'Whites' within 20 m depth zone.

Field culture of marine prawns (CF/CUL/1.1.1) :

M. KATHIRVEL, K. DEVARAJAN, R. PAUL RAJ, P. E. SAMPSON MANICKAM and D. B. JAMES.

Madras : A trial semi-intensive culture of *P. monodon* was carried out in a 0.4 ha. pond at Muttukadu farm for a period of 110 days with three feedings/day and partial water management. The stocking rate was 50,000/ha. and the rearing was done in a saline medium (30-39 ppt.). The initial average size (total length) at stocking was 44.4 mm (1.1 g in total weight), which increased to 146.4 mm (26.8 g) at the time of harvest. The harvest was 215 kg with a survival rate of 40.8%. The production rate was 536.5 kg/ha./110 days.

Mandapam : The culture of hatchery-raised *P. semisulcatus* post-larvae was undertaken in a 0.04 ha. saline pond (30-44 ppt.) by stocking @ 49,225/ha. The stocked postlarvae were 11 to 30 mm with an average size of 25 mm (TL). The stocked prawns were fed with artificial feed and boiled and minced squid meat. The size recorded on the 120th day (at harvest) was 98 mm with a survival rate of 39.8% and the growth/day was 0.52 mm.

Tuticorin : Prawn rearing was monitored in a farm complex at Veppalodai near Tuticorin. Altogether 4 experiments on *P. monodon* and 7 on *P. indicus* were monitored. In *P. monodon*, the stocking rate varied from 16,000-38,000/ha. The reared prawns were fed with artificial feeds and the rearing was from 140-180 days. The production rate varied from 282-337 kg/ha. In the case of *P. indicus*, the stocking rate varied from 43,000-91,000/ha. and the culture period extended from 138-272 days. The production realised was 306-1,208 kg/ha./162 days of rearing, while 428 to 818 kg/ha./138-272 days were also recorded.

Sea ranching of marine prawns (CF/CUL/1.1.7) :

P. VEDAVYASA RAO, N. N. PILLAI, P. E. SAMPSON MANICKAM and G. MAHESWARUDU.

Fifteen spawnings and the larval rearing in the hatchery, produced 1.25 million postlarvae of *P. semisulcatus*. Of them, 0.48 million seed were released in the Gulf of Mannar and 0.45 million seed in the salt water lagoon at Mandapam. Experimental fishing conducted in the lagoon at the bar mouth during low tide after 24 hrs. of seed release caught a few of them in the process of their migration to the sea. Along with these, P.L. specimens measuring 81-105 mm were also caught. These belonged to the batch of seed released two months earlier. The results indicated that while a portion of the released population migrated to the sea, a part remained in the lagoon itself to grow to an average size of 75 mm in 2 months. This also proves that sea ranching when carried out on a large scale could help supplement the natural recruitment in the sea to augment production.

To study the effect of ranching, regular monitoring of the exploited population of *P. semisulcatus* at Mandapam and Pamban indicated better fishing season for the species during March - May '88. Intensive spawning was observed during June-August and recruitment of specimens less than 10 cm during April-July.

Culture of spiny lobsters (*Panulirus*) spp.) (CF/CUL/5.1.5) :

E. V. RADHAKRISHNAN and M. VIJAYAKUMARAN.

Unilateral eye-stalk ablation did not significantly affect the growth and normal development of secondary sexual characteristics of *P. homarus*. It was confirmed that the growth rate of lobsters in the intensive culture system was maximum at a stocking density of 7 lobsters/m^2.

Development of artificial reefs (CF/CUL/1.7) :

M. RAJAMANI.

The project was started during the 2nd quarter of 1988. Although a few places were identified as suitable for construction of reefs along the Tuticorin coast, only one place off Tuticorin was selected to carry out the work. A reef consisting of 30 old lorry tyres tied in modules of 3 each, laid in the sea at a depth of 5 m during July - August was lost. Further constructions are planned in the sheltered harbour areas to ensure safety.

FISHERY ENVIRONMENT MANAGEMENT DIVISION

The projects included studies on the important hydrographic aspects of the shelf waters, primary and secondary production, benthos and their relation to demersal fisheries, marine pollution, coral reef resources, conservation of turtle resources, culture of microalgae, seaweeds and holothurians, remote sensing and bioactive agents from marine organisms.

Physical and chemical aspects of shelf waters (FEM/ES/1) :

A. V. S. MURTY, C. P. RAMAMIRTHAM, S. MUTHUSAMY, P. K. KRISHNAKUMAR, K. G. GIRIJAVALLABHAN, S. KRISHNA PILLAI, V. V. SINGH, C. P. GOPINATHAN, S. JASMIN, C. V. MATHEW, M. P. MOLLY.

The important hydrographic parameters were monitored at different centres. Regular sampling at some centres were hampered by inclement sea conditions during the southwest monsoon and the non-availability of boat. At some centres sampling was restricted to surface water only due to lack of Nansen reversing bottles.

At Cochin, the sea surface temperature (SST) increased from January to April and remained low during the southwest monsoon (May - August). It increased again in September - October and gradually decreased during November - January due to winter cooling. The southwest monsoon commenced early in May and remained very active upto August. Upwelling was intense in June. Surface salinity decreased drastically during July on account of monsoon rains and fresh water run off.

At Calicut, surface and bottom water samples were analysed regularly except during monsoon. Temperature was low (25°C) in October and higher in April (34.5°C). Salinity ranged from 27.6‰ in September to 35.83‰ in November. Dissolved oxygen did not vary widely. Nutrient concentration was high in the post-monsoon months (October - December).

At Vizhinjam, SST was low in June - July (25°C) and high in March - April (30°C). Salinity variations were insignificant, 34.11‰ in July and 35‰ in September. Dissolved oxygen did not vary. Nutrient concentrations were low in November.

In the surface waters of Tuticorin, temperature fluctuated between 25°C & 29°C; salinity from 30.8‰ - 34.99‰ and dissolved oxygen from 4.27 - 5.36 ml/l.

At Mandapam, the surface water temperature ranged from 25.3°C (January) to 29.8°C (May); salinity increased from 29.25‰ (January) to 35.25‰ (August) and gradually decreased from 35.25‰ (September) to 28.14‰ (December); dissolved oxygen varied from 3.88 ml/l in October to 4.97 ml/l in September. Phosphate concentration was low (0.03 μ g at/l) in June and high (0.14 μg at/l) in September.

At Madras, the SST varied from 25.55°C to 29.1°C; salinity from 30 ‰ to 33.4‰; dissolved oxygen from 3.1 to 4.5 ml/l.

At Visakhapatnam, the SST was minimum in January (25.75°C) and maximum in May (30.5°C). Salinity ranged from 29.02‰ in January to 33.99‰ in July and dissolved oxygen from 6.15 mg/l (May) to 7.9 mg/l (January). At the 50m depth, temperature was lowest (24.4°C) in April and highest (26.7°C) in December; salinity lowest in December (31.52‰) & highest in July (34.61‰); oxygen lowest in July (2.4 mg/l) and highest in December (6.8 mg/l). This distribution clearly indicated upwelling in March - July and sinking in December.

At Minicoy, the SST varied from 28.45°C (September) to 31.5°C (May) and bottom temperature from 28.5°C (September) to 31.2°C (May). Salinity ranged from 34.57‰-34.96‰. Dissolved oxygen fluctuated from 3.67 ml/l to 4.37 ml/l.

Phytoplankton and primary productivity (FEM/PP/1) :

K. Radhakrishna, K. Vijayakumaran, G. S. Daniel Selvaraj, M. P. Molly.

At Visakhapatnam, productivity (by C^{14} method) and phytoplankton data from inshore waters were collected from January to July and in December. Surface primary productivity at the 35 m station ranged from 0.97mgC/m^3/day in December to 40.58 mgC/m^3/day in March; further offshore at the 55 m station, December and July recorded the low and high values of 3.35 and 23.71 mgC/m^3/day respectively. At both the stations chlorophyll *a* was high in July, chlorophyll *b* in March, chlorophyll *c* in July. On a few occasions the concentrations of chlorophylls *b* and *c* were higher, *c* being the highest. In general, both primary productivity and chlorophylls were high during upwelling (March - July). Low productivity and chlorophylls in May were attributed to the low intensity of upwelling.

At Cochin, productivity estimates employing the oxygen method gave high rates in the inshore waters. Two peaks of 1,126 mgC/m^3/day in July and 781 mgC/m^3/day in March were observed and primary productivity was low in December-February but high during the southwest monsoon. Chlorophyll *a* was also high (2.397 mg/m^3/day) during monsoon but low in December and February.

At Calicut, primary productivity studies were undertaken at one shallow inshore station (10m) for 7 months and further offshore during March, April and October. Net productivity at the surface varied from 120.12 in January to 755.04 mgC/m^3/day in November; column productivity from 669.2 (March) to 5,212.35 mgC/m^3/day (December). The post-monsoon period was more productive. Phosphates and nitrites were high in October while nitrates were high in November. Nutrient concentration was directly related to primary productivity.

Secondary production (FEM/PL/1) :

K. J. Mathew, T. S. Naomi, C. V. Mathew, P. A. Thomas, Rani Mary George, Pon Siraimeetan, S. Krishna Pillai, K. G. Girijavallabhan, V. V. Singh.

Zooplankton studies were undertaken at 7 centres viz. Bombay, Mangalore, Cochin, Vizhinjam, Tuticorin, Madras and Minicoy.

At Bombay, zooplankton samples were collected regularly from 10m, 20m and 30m off Versova. Phytoplankton blooms were observed in November at the 30m station.

At Mangalore, zooplankton was collected from 3 stations from January to May and from October to December. Plankton peak was in the post-monsoon months (October - December). Large chaetognaths, medusae and lucifers were common. *Coscinodiscus* sp. occurred throughout. *Noctiluca* was seen in December. Fish eggs were common in April and decapod larvae during January - March.

At Cochin, zooplankton was collected from 15 and 30 m depths. The peak was observed in August. Biomass (displacement volume) was high in January and numerical abundance in April. Swarms of *Sagitta euflata* in January, *Salpa democratica* in December and blooms of *Noctiluca miliaris* in November were encountered. Fish eggs (especially of *Stolephorus)* were abundant in May. Eggs of *Sardinella* spp. were recorded in January.

At Vizhinjam, zooplankton was collected from 30m depth station. The biomass varied widely through the year from 1.98 ml/100 m^3 in December to 56.6 ml/100m^3 in October. Copepod and decapod larvae were the dominant forms. Swarms of cladocerans in October and bloom of *Thalassiosira* in July were observed. Fish eggs and larvae were maximum during October-December.

At Tuticorin, zooplankton was low in December (4.8 ml) and high in September. Copepods dominated the plankton with a low in April and a high in August. Decapod larvae ranked second, followed by lucifer, bivalves, gastropods and chaetognaths. Fish eggs and larvae were few.

At Madras, zooplankton sampling was restricted to January-February and July-October. Swarms of copepods, tunicates, fish eggs (carangids and anchovies) were noticed in January. *Noctiluca* formed blooms during July-September.

At Minicoy, plankton sampling was undertaken during January - June and October - December. The biomass varied from 0.5 ml in January to 1.95 ml in December for 10 minute surface haul. Copepoda was the major group.

Studies on zooplankton collections of FORV *Sagar Sampada* (FEM/PL/2) :

K. J. Mathew, T. S. Naomi, K. Rengarajan, M.M. Meiyappan, R. Sarvesan, P. P. Pillai, P. Bensam, G. P. K. Achari.

305 samples from cruises 23 to 35 were sorted. Station maps were prepared. Groupwise analysis is under progress.

Investigations on benthos in relation to demersal fisheries (FEM/BEN/1) :

K. Radhakrishna, K. Vijayakumaran, K. G. Girijavallabhan V. V. Singh, S. Sivakami, Pon Siraimeetan.

At Visakhapatnam, 45 benthic samples from 30 m and 50 m depths along different transects were collected. The analysis showed that the sediment temperature was higher than the SST in January - February due to winter cooling, whereas it was lower during March-August. Polychaetes dominated in 37 samples and amphipods in 5 samples.

Tunicates, cumaceans and *Amphioxus* dominated in one sample each. The population density varied from 135 organisms/m^2 to 6,419 organisms/m^2. The density was low in grounds where the trawling operations were extensive. The species composition of the demersal catches varied monthwise. The abundance of *Nemipterus mesoprion* and *Priacanthus hamrur* during April was due to upwelling. The gut contents of demersal fishes showed the dominance of prawns followed by amphipods, stomatopods, crabs and polychaetes.

At Tuticorin, 11 samples of benthos, 8 from 10 m depth and 3 from 20 m depth were analysed. At the 10 m station, sand dominated whereas at the 20 m station, mud dominated. At the 10 m station, the density varied from 11 in January to 357 in December. Polychaetes were dominant. At the 20 m station, the density varied from 147 (June) to 422 (April). Polychaetes again dominated, followed by bivalves, amphipods and pteropods. *Leiognathus* dominated in the trawl landings.

At Cochin, studies on benthos were undertaken at 6m (non-trawling ground) and 10m (trawling ground) for 8 months. Sediment temperature was less than SST. Salinity was lower at the 6 m station. Polychaetes and molluscs were dominant followed by crustaceans and sipunculids. The monsoon months of June, July & August were marked by the richness of bottom fauna, especially polychaetes and molluscs. Among polychaetes, *Lumbriconereis* was abundant throughout the year and among molluscs, *Nucula* was dominant. Polychaetes were dominant in the trawling grounds and molluscs in the non-trawling grounds.

Effects of environmental factors on the growth of cultured seaweeds (FEM/SW/2) :

N. KALIAPERUMAL, REETA MAHAPATRA.

Growth rate of *Gracilaria edulis* cultured in the Gulf of Mannar was 2-fold during January, February and March and nil during October, Novem- and December due to turbidity, heavy infestation by epiphytes and grazing by fishes. In Palk Bay, the growth rate was nil during April - September due to high turbidity, epiphytic growth of sponges, ascidians, other algae and also severe grazing.

Reproductive propagation of commercially important seaweed (FEM/SW/4):

N. KALIAPERUMAL, REETA MAHAPATRA.

Propagation of commercially important agar yielding seaweeds viz. *Gelidiella acerosa, Gracilaria edulis & G. corticata* by spore settlement method was investigated. The growth was faster in plastic bags than cement blocks, the rate being 3 cm in 30 days. In the laboratory cultures, shedding of carpospores was found to be more than tetraspores. The oospores of *Sargassum wightii* developed rhizoids immediately after liberation and attached firmly to the substratum with the help of rhizoids. In the laboratory, the spores were attacked by flagellates and non-photosynthetic protozoa. Experiments to control these pests with potassium tellurite, UV light and high temperature (40°C) were underway.

Investigations on coral reef resources (FEM/CR/1) :

C. S. G. Pillai, P. A. Thomas, K. K. Appukuttan, S. Jasmin.

A comprehensive survey of Lakshadweep indicated that 105 species of scleractinian corals belonging to 37 genera occurred there. *Pocillopora* corals predominated along the Kerala and Tamil Nadu coasts.

Marine pollution in relation to protection of living resources (FEM/MP/1) :

V. Kunjukrishna Pillai, S. V. Alavandi, V. Chandrika, P. Kaladharan, I. David Raj, R.V. Singh, R. N. Misra, C. P. Gopinathan, P. K. Krishna Kumar, M. Rajagopalan.

Marine pollution monitoring was done at Cochin, Karwar, Tuticorin and Madras.

At Cochin, water sediment and biological material were analysed from 4 sections upto 25 m depth. Salinity ranged from 12.4‰ to 35.15‰. Phosphates were low in August. Chlorophyll *a* was high in September.

Heavy metal (Cu, Zn, Cd, Pb, Mn & Hg) levels were monitored. Mercury level was above the minimum risk concentration (8.2 ppb) along section III as compared to the other 3 sections (2.1 to 2.69 ppb). *Sepiella inermis, Loligo* sp., *Neptunus*, prawns and finfishes were assayed. The first three exhibited high levels of Zn, Cd and Mn. Trace metals showed wide ranges in sediment samples. Bioassay of mercury on *Isochrysis galbana* revealed that the LC-50 was 25 ppb.

Microbiological investigations revealed 58 heterotrophs belonging to *Pseudomonas, Aeromonas, Alcaligenes, Vibrio, Flavobacterium, Bacillus* and *Micrococci* in the inshore waters. Resistance of isolates of *E. coli* against different antibiotics was studied.

At Karwar, soft tissues of mussels and oysters and muscle portion of certain fin fishes, prawns, crabs and squids were assayed for Hg, Cd, Pb, Cu, Zn and Mn. Mercury levels in fishes, prawns, crabs and squids were below the permissible limit but in bivalves and seaweeds they were 5-20 times higher than in fishes and prawns. Hg levels in the vicinity of the effluent discharge point of the caustic soda factory were high. Seaweeds and mussels were better accumulators of Pb & Mn, whereas oysters accumulated Zn and Cu. *Perna viridis* and *Crassostrea cucullata* were identified as good sentinel organisms.

At Tuticorin, mercury levels were found to be high (3,500-4,800 ng/l, July) in June - August period and low (300 ng/l, November) in September - December period.

As a part of the pollution studies, environmental parameters in the culture ponds at Muthukadu (Madras) were monitored. The water temperature ranged from 26.6°C in December to 33.5°C in May; pH from 7.9 (February) to 8.8 (July); dissolved oxygen varied widely from 2.5 ml/l (September) to 5.3 ml/l (March).

Mass culture of microalgae (FEM/CUL/1) :

C. P. Gopinathan, P. Muthiah, A. Chellam.

Seven species of haptophycean flagellates were cultured to provide food for the juveniles of *Meretrix meretrix,*

Anadara granosa, Trochus sp. and *Holuthuria scabra.* Besides the well established flagellate *Isochrysis galbana,* species of *Pavlova, Dicrateria* and *Chromulina* proved to be successful as food for juvenile clams.

Culture of holothurians (FEM/CUL/2 and 3) :

D. B. JAMES, M. E. RAJAPANDIAN.

Holothuria scabra was made to spawn in the laboratory by raising the temperature from 27°C to 32°C. The hatching into dipleurula larvae and their subsequent development through auricularia and doliolaria stages to pentactula stage, with the detailed embryology were recorded. The dipleurula and auricularia were fed with *Isochrysis galbana* and pentactula with algal powder of *Ulva, Sargassum,* etc.

Seaweed resource investigations (FEM/SW/1.1. and IIP/7) :

V. S. K. CHENNUBHOTLA, N. KALIAPERUMAL, S. KRISHNA PILLAI.

Fortyfour species of seaweeds, 6 belonging to chlorophyta, 9 to phaeophyta and 29 to rhodophyta and 3 species of seagrasses were recorded in a survey from Valinokkam to Kattappadu and Thiruchendur. The standing crop was estimated at 42,150 t for an area of 442.5 km^2.

Conservation of marine turtle resources (FEM/MT/1) :

P. S. B. R. JAMES, M. RAJAGOPAL.

In Gahirmatha, nesting activity was extremely low (100) in February '88 as compared to January (2 lakhs) and March (4 lakhs). Unlike in 1987, nesting was observed one week after the new moon. The mortality rate of adults has been gradually decreasing with the all time low of 422 in 1988.

Nesting sites in a stretch of 12 km from Habalikati to Ekkula in Orissa were preferred by *Lepidochelys olivacea.*

At Muthukadu (Madras), tagging studies showed that an adult turtle grew 19 mm (length) and added 1.9 kg (weight) in 5 months.

Studies on bacterial growth rates and productivity in different aquatic environments (FEM/MB/1) :

V. CHANDRIKA.

At Cochin, the number of bacteria dividing/hour ranged from 46 - 712 in the surface water and 88 - 1,216 at the bottom. The higher number of bacterial division in sediment samples indicated the enrichment of sediments with carbon compounds.

Upwelling and fisheries (FEM/UF/1) :

G. SUBBARAJU, K. C. GEORGE, V. N. BANDE, P. KALADHARAN, K. RADHAKRISHNA.

Studies were made on upwelling and related fish distribution along the southwest coast of India covering Quilon - Mangalore region in a closer grid basis.

In the Visakhapatnam coast, upwelling commenced during the latter half of February and extended upto mid - July with varying intensities. Studies revealed that cold, high saline waters with low dissolved oxygen from depths of 30 - 40 m upwelled and moved shoreward to depths of 5 - 10 m. During March, intensity of upwelling was low in the first week, moderate in

mid-March and low again in the last week. The process was moderate in April except for a few days in the third week when its intensity declined. In May, upward and shoreward movement of water was again observed at stations I and II. In June, waters of 20 - 30 m (station I) rose to the surface as they moved shoreward. This continued till the middle of July. Thereafter the process receded. During upwelling, deep water fishes like *Psenes indicus, Decapterus dayi, Nemipterus mesoprion,* etc. moved shorewards with the upwelled waters and entered both the mechanised and traditional fisheries.

Remote sensing and fisheries (FEM/SR/1) :

G. Subbaraju, Varughese Philippose.

The relationship between georeferenced fish catch data collected by fishing vessels and the SST derived from the digital data of NOAA-AVHRR as well as 100 km MC SST (Multi-channel SST) charts were studied. (The temperature variations across different zones during the year showed an increase between January - June with the maximum during May - June. With the onset of south-west monsoon, there was a drop in temperature which rose again in October and slightly decreased under the influence of north-east monsoon). The temperature gradient across the zones on the east as well as the west coasts showed an increase from the northern Arabian sea to its southern limits during January-May with almost no change during May. During July, the temperature fell and stabilized during August-September. There was a rise in temperature during October-December.

The highest fish catch was found to be associated with a distinct temperature gradient seen on the SST map i.e. off Bombay and relatively lower fish catch associated with more or less uniform temperature seen off Goa and lowest catch values associated with uniform temperatures off Cochin. A correlation ($r^2 = 0.49$) was observed between tuna and SST.

Bioactive agents from marine organisms (FEM/BA/1) :

D. Sadananda Rao, P. A. Thomas, K. G. Girijavallabhan.

Ethanolic extracts of 118 marine organisms were screened for haemolytic activity. The following showed haemolytic activity: *Aulospongus tubulatus, Axinella donnani, Spirastrella inconstans, S. inconstans var. digitata, S. cuspidifera, Callyspongia fibrosa, C. diffusa, Spongia officinalis var, ceylonensis, Sigmadocia fibrilata, Adocia pigmentifera, Mygale grandis* (all sponges), *Pocillopora eudoxi, Porites lutea, Acropora corymbosa, A. humilis* (all corals), *Montipora divaricata, M. foliosa, A. nobilis, Goniastrea retiformis, Alcyoniarian* No. 3 (not identified), *Nerita, Drupa tuberculata, Eurythoe complanata, Isognomon isognomon, Neritis polita, Onchyduim verraculatum* and *Trochus stellatus* (all molluscs).

Two species of gorgonids viz. *Heterogorgia flabellum* and *Echinomuricea indica* were collected (600 g each), dried and powdered. The former extracted with ethyl acetate yielded on evaporation 3 g orange coloured residue.

Studies on mangrove litterfall in selected habitats (FEM/ML/1) :

M. S. RAJAGOPALAN.

The estimated litterfall during the pre-monsoon period by *Avicennia, Acanthus, Rhizophora* and *Excoccaria* in the Cochin estuarine system was 150 - 400 g, 250 - 600 g, 300 - 600 g and 100 - 300 g/m^2 respectively. 60 - 70% of this litterfall degraded before the onset of monsoon and was transferred to the estuarine system. Litterfall during the monsoon was poor and the 30 - 60% of the litterfall get accumulated during the post-monsoon months. The mangrove areas in Elamkulam, Vytilla, Panangad, Kumbalam, Fort Cochin and Vypeen were surveyed for ecological studies including the phenology of different species. Studies on litterfall in the habitat dominated by *Bruguiera* spp. was initiated.

Ecological studies of coastal water bodies (FEM/ES/5) :

M. S. RAJAGOPALAN, D. S. RAO, R. N. MISRA G. S. DANIEL SELVARAJ, I. DAVID RAJ, M. P. MOLLY, B. S. RAMACHANDRADU, R. V. SINGH.

Ecological studies based on seasonal and diurnal observations were made at Mahe, Dharmadam, Valapatnam and Killai in addition to the survey of the coastal water bodies in Trivandrum, Quilon, Alleppey and Ernakulam. During the monsoon months, the salinity was less than 1‰ in the Karichal, Poovan, Poonthura, Veli and Anjengo estuaries; the primary production less than 250mg/m^3/day and oxygen content 2.2 - 3.6 ml/l. During the pre-monsoon period the salinity in Vembanad lake ranged from 15.8 - 27.1 ‰ and the salinity and oxygen content at Kayamkulam, Thottappally and Anthakaranazhi were found to be suitable for mariculture of finfishes and prawns.

The impact of salt water barrage at Thanneermukkom was studied and vertical and lateral gradient in salinity and dissolved oxygen were observed. Seeds of *Metapenaeus dobsoni, M. monoceros* and *Penaeus indicus* were abundant along the north eastern part of the bund.

At Mahe, Dharmadam and Valapatnam the primary production during the monsoon months were 432, 674 and 628 mgC/m^3/day respectively. In the post-monsoon months these values were 916, 535 and 576 mgC/m^3/day respectively. High production, 2,587 mgC/m^3/day and high salinity, 33.01‰ were observed in June at Killai.

PHYSIOLOGY, NUTRITION AND PATHOLOGY DIVISION

The research projects included studies on reproductive physiology, endocrinology, metabolic activity, biochemical estimations, development of microparticulate diet, food additives and studies on shelf-life of compounded feeds. Diagnosis of diseases in finfish and shellfish, physio-pathological effects of chemical pollutants on fishes, genetic variation in edible oyster and genetic damage induced by environmental mutagens and toxins on bivalves were the other aspects studied.

PHYSIOLOGY

A comparison of the capabilities of juvenile and adult *Penaeus indicus* to regulate osmolality concentration in the haemolymph (PNP/23) :

A. D. DIWAN, A. K. PANDEY.

Studies on the effect of osmotic stress showed that the muscle protein as free amino acid content in the haemolymph and ammonia excretion were low in 25‰ saline medium and higher in 10‰.

Distribution of phenol-oxidase enzyme and its role in hardening of the cuticle in penaeid prawns (PNP/24) :

A. D. DIWAN, N. SRIDHAR.

Phenol-oxidase enzyme activity was determined in haemolymph and different parts of the exoskeleton of the moulted prawns. There was no enzyme activity in the rostrum and telson in the premoult stages but there was low activity in carapace, abdominal segments and haemolymph in comparison to just moult and post-moult stages.

Ecophysiology of oysters and chank (PNP/25) :

D. C. V. EASTERSON, A. C. C. VICTOR, K. RAMADOSS.

Among the various chromogenic substances used, cobaltous chloride, ferric chloride, ferric citrate and melanin obtained from ink of sepia were found suitable for improving colour of nacre of the shell of pearl oyster, *Pinctada fucata*. Highest growth was obtained with diet supplemented with ferric citrate. The nacre of the melanin fed oyster had a slight spray of black dots and those fed with cobaltous chloride and ferric chloride had a pearly white colour with pinkish tinge.

Hypothalamic control of gonadotropic functions during maturation in female mullet (*Liza parsia*) (PNP/26) :

MOHAN K. ZACHARIA, N. SRIDHAR.

Electrophoretic procedures for separation of pituitary protein fractions from immature and mature female *L. parsia* were standardized. Five protein fractions were observed in mature ones whereas only three bands were observed in the immature ones. The procedure for separating these bands in the mature females is being standardized.

Histochemically, the cyanophil cells in the pituitary of maturing females revealed strong AF and PAS positive reaction in comparison to the immature females.

Seasonal changes in certain biochemical components and their allocation to gonad and soma in *Metapenaeus dobsoni* (PNP/27) :

N. Sridhar, Mohan K. Zacharia.

The water, protein and lipid content of gonad and soma in different maturation phases were determined. The water content in gonad and soma decreased from immature to mature phase. Protein content increased in soma and decreased in gonad from immature to mature phase, whereas the lipid content increased in gonads and decreased in soma with maturity.

Histological examination showed pre-vitellogenic oocytes in the immature and early stages of maturing ovary. Mature oocytes were laid with dense granular cytoplasm. Yolk deposition was observed during these stages.

Metabolic adaptations of the cultivable species of prawns in relation to different environmental factors (PNP/33) :

M. Peer Mohammed, M. K. Zacharia.

The normal metabolic rate for *P. monodon* at 25‰ salinity was determined as 552.7 mg/kg/hour and 583.4 mg/kg/hour at 30° and 35°C respectively. Thus the metabolic rate is directly proportional to temperature. No difference in metabolic rates was noticed in 15, 20 and 30‰ salinity when tested at 30 and 35°C.

Ammonia quotient was estimated as 0.039 and 0.041 in *P. monodon* and *M. dobsoni* respectively.

M. dobsoni had a higher survival rate compared to *P. monodon* at low salinity (10-15‰) and high temperature (30-35°C). At hypoxic condition, glucose level in the haemolymph increased whereas muscle glycogen reduced.

Induced maturation and spawning of *Anguilla bicolor bicolor* under controlled condition (PNP/36) :

J. Divakar Ambrose.

Experiments were conducted to induce body growth and maturation. Administration of HCG (CHORULON) and pituitary extract resulted in increased body weight of both males and females but the gonads were not mature enough to release eggs. An oral veterinary preparation 'Aloes compound' showed rapid gonadial development in the female eels. A combination of the first and second methods gave better results. Change in environmental conditions had no effect on maturation.

NUTRITION

Nutritional requirements of penaeid prawn larvae and juveniles (PNP/9) :

M. Vijayakumaran.

The quantitative protein requirements of juveniles of *P. latisulcatus* were estimated between 27.5 to 50% in the diet whereas the requirement was below 35% for the juveniles of *P. monodon.*

Growth rate of juvenile *P. indicus* under low salinity and normal sea wa-

ter was good while high salinity resulted in low survival rate.

Development and evaluation of artificial diet for bivalve larvae and spats (PNP/11) :

D. C. V. Easterson, A. C. C. Victor, P. Muthiah, Rani Palaniswamy.

A shrimp meal based on particulate diet was prepared. The spats reared with algal diet showed twice the growth over those fed with the present particulate diet. Data indicated enhancement of the growth due to addition of algal component in the feed.

Studies on the shelf-life of compounded feed developed for nursery rearing of finfishes (PNP/35) :

R. Paulraj, Manpal K. Sanhotra, Shankar V. Alavandi, Rakesh Pancholi.

A feed was prepared using fishmeal, groundnut oil cake, gingelly oil cake, coconut oil cake, wheat flour, vitamins and mineral mixture having 36% protein, 8% lipid, 40% carbohydrate, 11% ash and 5% moisture. The feed was palatable and showed non-deterioration even after storage upto 60 days under room temperature. No signs of deficiency were noticed in *Chanos chanos* fry.

A prawn feed (41% crude protein) was prepared using fishmeal, prawn powder, groundnut oil cake, soyabean meal powder, gelatin, cod-liver oil, vitamin mixture, mineral mixture and wheat starch. The feed was palatable and the juveniles of *P. indicus* did not show signs of cannibalism.

Studies on the effect of incorporation of Butylated Hydroxy Toluene (BHT) on the shelf-life of fish feeds are in progress.

PATHOLOGY

Studies on the pathobiology of captured and cultured finfishes (PNP/28) :

S. C. Mukherjee, K. C. George, Rakesh Pancholi, A. P. Lipton.

Epinephelus diacanthus and *T. lepturus* which showed rupture of lamellar cells and extensive lamellar degeneration. *Vibrio fischeri* was isolated from the gill lesions. *Aeromonas hydrophila* and *Flavobacterium* sp. were isolated from ulcerative skin lesions of *E. diacanthus*. Histopathologically, lesions were characterized by moderate to marked necrosis of the dermis infiltrated predominantly by mononuclear cells.

Eimeria and *Hennigiya* sp. of protozoan infection causing enteritis was diagnosed in *L. parsia* and *Lates calcarifer* respectively.

Furunculosis due to *Aeromonas salmonicida* and *A. hydrophila* was recorded in laboratory reared *L. calcarifer* for the first time in the country.

Physio-pathological studies of chemical pollutants on selected species of finfishes (PNP/34) :

K. C. George, S. C. Mukherjee, A. K. Pandey, M. P. Mohammed.

Fingerlings of *L. parsia* treated with commercial D.D.T. showed clinical symptoms characterized by marked excitement and rapid swimming behaviour at 0.05 ppm concentration and

heavy mortality within 24 hours at 0.1 ppm. Blood glucose level dropped from 20 to 11 mg/dl. within three days and marked neutropenia and lymphocytosis were recorded 2 weeks after the exposure. Metabolic rate increased with exposure time and mortalities occurred due to high metabolic cost.

Histopathological lesions in the fish exposed to 0.5 ppm of mercuric chloride showed subcutaneous haemorrhages and spongiosis of epidermis, cytolysis and vacuolation of atrial wall and coagulative necrosis of the hepatic cells. Brain tissue showed neuronal degeneration, satellitosis and glial cell reaction Kidney changes were characterised by vascular changes in glomeruli, tubular casts and hyaline droplet formation. Gills revealed excessive goblet cell activity and squamous metaplasia.

GENETICS

Genetic damage induced by environmental mutagens using cytogenetic models (PNP/30) :

George John, A. G. Ponniah, I. D. Gupta, N. K. Verma.

The diploid chromosome number in *Villoritta cyprinoides* was found to be 38 and is reported for the first time. The method evolved for study of bivalve chromosome is reliable and has excellent field adaptability. Chromosome preparations of *L. parsia* revealed the diploid number to be 48. All chromosomes were acrocentrics except in rare instances when metacentric pairs occurred suggesting the possibility of intra-individual cytogenetic variation.

Malathion at doses of 0.02 and 0.04 ppm proved to be genotoxic. Genetic damage was manifested as chromosomal breaks and gaps.

The demonstration of differential staining in sister chromatids of *Therapon* sp., *O. mossambicus* and *L. parsia* showed the utility of the models in detecting mutagenicity.

Studies on genetic variation in edible oyster *Crassostrea madrasensis* (PNP/32) :

I. D. Gupta, N. K. Verma, George John, A. G. Ponniah.

Electrophoretic conditions for four enzyme systems were standardized using various buffers. The buffer Tris-boric with EDTA (TBE) was best for α – GPDH and esterases and gill tissue was the best for expressing one and four loci respectively. In case of G6-PD two loci were expressed with consistency in adductor muscle using Tris Versene Borate (TVB) buffer. 1-2 years old wild oyster stock had low mortality rate as compared to hatchery stock, as reported from Tuticorin. Better growth rate was found in wild stock of 0-1 year of age. The technique for preparation of somatic chromosomes of *C. madrasensis* was standardized.

FISHERY ECONOMICS AND EXTENSION DIVISION

In fishery economics, studies were mainly focussed on socio-economics of traditional fishery, economics of mechanised fishing units and economics of trawling by utilizing wind energy. The extension activities included studies on the adoption of innovations in capture and culture fisheries, content analysis of fisheries programmes and news in mass media and investigations on the factors affecting fish production in the marine sector. In addition, several exhibitions, documentary film shows, lectures and seminars were organised. Publicity material on the Institute's activities were brought out and a good liaison maintained with the Press Information Bureau. A roster based on the different activities of the institute was prepared for AIR and Doordarshan.

Study on the economic efficiency of trawling in northwest coast (FE & E/16):

D. B. S. SEHARA, K. K. P. PANIKKAR, J. P. KARBHARI.

The initial investment of a trawl unit in northwest coast (Maharashtra and Gujarat) ranged from Rs. 4-5 lakhs including investment on hull, net, engine and accessories. Labour and diesel were important components of the recurring expenditure. The number of days in a fishing trip varied from 1-6 at different centres in different seasons. The trawl net operated from September to May and in some centres limited fishing was observed during monsoon. Prawns, dhomas, cephalopods, ribbonfishes and catfishes were the main components of the catch at these centres. The commercially important catch was sold to the suppliers of the processing units who advanced the money to the fishermen for operational expenses. Net operational income of a trawl unit ranged from Rs. 1-2 lakhs per annum. Moderate to good infrastructural facilities were found at trawl landing centres in the northwest coast.

Economics of gillnet fishing by OBM and IBM units in northwest coast (FE & E/4.3):

D. B. S. SEHARA, J. P. KARBHARI.

The annual catch of a gillnet OBM unit at Maharashtra and Gujarat ranged from 16-18 t with a value of Rs. 1.2-1.4 lakhs. The operating expenditure of the unit was Rs. 0.9-1.1 lakhs. Of the variable costs, labour accounted for 57-63%, fuel 15-16% and marketing 10-15%. The income of a labourer working on the OBM gillnet unit worked out at about Rs. 13,500 per annum and the returns to labour and management of the boat owner Rs. 15,500.

The initial capital investment of a mechanised gillnet unit was Rs. 2.3 - 2.6 lakhs resulting in an annual fixed cost of Rs. 47,000 - 54,000. The annual fishing days ranged from 214 to 222, fetching a gross revenue of Rs. 2.3-2.7 lakhs/year. The gross cost ratio worked out to about 80% and the rate of returns

to capital about 14%. The initial investment could be recovered in 4 - 5 years. The profit per day of operation ranged from Rs. 16 - 34. The returns to labour per operating day was Rs. 33 whereas, returns to family labour and management of the owner was Rs. 82 - 99.

The operation of both the types of gillnet units (OBM and IBM) was found to be profitable. Since the investment was less and operation economical, OBM units were increasing in numbers in the northwest coast.

Socio economics of traditional fishery in southern states (FE & E/1.1) :

K. K. P. PANIKKAR, R. SATHIADHAS.

In the Trivandrum region the average annual income of a fisherman family was about Rs. 11,000/-. Average outstanding debt per indebted family was about Rs. 9,000/-. 65% of loan amount was advanced by local money lenders. About 60% of the loan was utilised for investment. Catamaran was the major fishing unit. A unit operating hook and line earned about Rs. 144/day and that operating gillnet Rs. 213/day. Most of the plank built boats were found to be fitted with outboard motors and the average gross earnings/day works out to Rs. 215. The breakeven annual production on the basis of catch composition and selling price worked out to 6.3 t for catamarans with hooks and line, 12.4 for catamaran with gillnet and 14.9 t for OBM unit.

The survey conducted at two villages along Madras coast viz. Pudumanikuppam and Thiruvottiyoorkuppam indicated that the annual average household income of a fisherman family in the former village (mechanised fishing centre) was Rs. 7,600/- and that of the latter, (predominantly a traditional fishing centre) Rs. 4,500/-. Diversified fishery activities resulted from mechanisation. Better infrastructure facilities were the major factors for better income at Pudumanikuppam as compared to Thiruvottiyoorkuppam.

Economics of mechanised fishing units in southern states (FE & E/4.1) :

K. K. P. PANIKKAR, R. SATHIADHAS.

The study on the comparative efficiency of different types of mechanised fishing units operated at Cochin Fisheries Harbour showed that the purse-seiners were economically more efficient than trawlers (30 - 36') and gillnetters (28 - 30'). Based on the cost and earnings data for 5 years (1982-86) the rate of returns, labour efficiency, fuel efficiency, net returns/day of operation, etc. were higher for purse-seiners than trawlers and gillnetters. Gillnetters were economically more efficient than trawlers. However, during 1985 and 1986 the trawlers performed better than gillnetters, mainly due to better catches and higher prices.

A study on economic efficiency of different sizes of trawlers (viz. 30', 32' and 34' to 36') at Tuticorin fisheries harbour indicated that the average annual net profit of a 30' unit was Rs. 60,000, Rs. 66,000 for 32' and Rs. 76,000 for 34' to 36'. Average wages/day of operation were Rs. 68, Rs. 75 and Rs. 103 respectively. The study indicated reduction in the over dependance of trawlers on prawn fishery. It was seen

that 56% of the annual gross revenue of 30', 67% of 32' and 66% of 34' to 36' vessels were earned from fishes only. In terms of gross income, net profit, returns to capital and labour and labour productivity, 34' to 36' vessels were more efficient.

The present marketing system and price structure in Kerala did not provide any inducement to fishermen to increase production. In the consumer's one rupee, fishermen's share was about 50 paise for low priced fishes. The fishermen's share showed marginal increase for most of the varieties from 1981-'86.

Fish marketing at Madras region was under the clutches of middlemen and the fishermen did not get their legitimate share. The percentage of marketing margin in consumer's price for 20 major varieties was more than 40%. To protect the interests of both producers and consumers, the establishment of a public agency for processing, storage and distribution can help.

A study on the adoption potentials of integrated fish/prawn farming among the small farmers at selected fishing villages around Cochin, Kerala (FE & E/12.4) :

A. REGUNATHAN.

Under this project, 85 farmers from 7 fishing villages around Cochin were selected and data on occupation, income, extension contact, media exposure, source utilization behaviour, achievement motivation, economic motivation, risk preference, integrated farming attitude and system integration preference were collected.

Of the sample population, 67% were in the age group of 17-49 and 33% in the 50 - 90 group. About 29% had only primary education and 26% high school. Regarding land holding, 66% of the farmers had less than 50 cents while 28% had 50 - 100 cents. The monthly income of the majority (68%) was between Rs. 101 - 300. About 96% of the sample population had high economic motivation and high modernization score. More than 96% were willing to take high risks in their farming practices and 52% had a favourable attitude towards integrated farming. In the preference for system integration, poultry was preferred (47%) followed by dairy (27%), duckery (18%), vegetable (2%) and piggery (1%) in their first choice. In the second choice, duckery (47%) was followed by poultry (27%), piggery (6%), vegetable (6%) and dairy (4%). Majority of the small farmers in the project area preferred to lease out their holdings to large farmers. The same trend was observed among the target population though they were the practising farmers.

A diagnostic study of the content and coverage of fisheries news in national and regional dailies (FE & E/15) :

A. REGUNATHAN.

Newspapers in English, Tamil and Malayalam were seen for coverage given to various production systems in general and fisheries in particular. The news was categorised into educative, informative and opinionary. The study showed that 89% of the agricultural news belonged to the informative category, 10% to the educative category and 1% to opinionary category. News

items formed 87% and popular articles and editorials constituted 7% and 6% respectively.

Crops enjoyed a wider coverage (87%) while dairy and veterinary (7%) and fishery (6%) had a poor coverage in the news. Studies on the microlevel content areas showed that agricultural policy (15%) and agro-socio-politics (12%) had a substantial coverage. Crops were a better treated production system in terms of headline length (24.9 cm), headline width (12 mm) and the total column length (33.4 - 131.6 cm). The regional dailies gave a better coverage for fisheries and crops while the national dailies had a wider coverage for crops and dairy and veterinary. The differences among various production systems may be due to value-based perception and the role of these in the rural economy.

Investigations on the factors affecting fish production by the artisanal fishermen along the southwest coast of India (FE & E/21) :

A. REGUNATHAN.

Centres of higher concentrations of indigenous crafts in the coastal districts of Ernakulam (Fort Cochin), Alleppey (South Punnapra), Quilon (Neendakara) and Trivandrum (Poonthura) were identified. Identification of innovations appropriate to the indigenous sector and development of schedules covering various dimensions of socio-psychological and economic characteristics were completed. Data collection was initiated.

Study on the training needs of fishery officials of the state governments and other development agencies (FE & E/ 12.2) :

KRISHNA SRINATH.

Data collected from the fishery officials of the state fisheries departments of Kerala and Tamil Nadu and rural development blocks at Kerala were analysed. Priority areas identified by the officials (in terms of number of officials and extent of training) were :

State Fisheries Department, Tamil Nadu : Technology for prawn culture, technologies in capture fisheries, technology for edible oyster culture, technology for open sea mussel culture, technology for pearl production and technology for seaweed culture.

State Fisheries Department, Kerala: Technology for prawn culture, technologies in capture fisheries, technology for edible oyster culture, technology for pearl production, technology for seaweed culture and technology for open sea mussel culture.

Rural Development Blocks, Kerala: Technology for prawn culture, technology for pearl production, technologies in capture fisheries, technology for edible oyster culture, technology for open sea mussel culture and technology for seaweed culture.

Credit repayment behaviour of marine fishermen (FE & E/18) :

KRISHNA SRINATH.

Studies showed that 27% of the respondents were regular repayers. Insufficient income from fisheries and lack of other sources of income hinder-

ed repayment. Among the sources of credit, preference was for nationalised banks and 50% favoured the group loans schemes. Middlemen also played an important role in lending money. The characteristics of payer and defaulters (mean scores out of maximum score of 5 given in brackets) as indicated by information source utilization (1.42 and 1.37), fisheries development awareness (1.55 and 1.53), credit orientation (2.48 and 2.37), economic motivation (3.60 and 3.58), risk orientation (3.40 and 3.25), knowledge about bank (3.46 and 3.36) and attitude towards bank (3.46 and 3.36) did not show significant differences. Fishermen in the age group of 35 - 45 showed better repayment behaviour. Educational level of fishermen, family size and number of earning members in the family did not show significant relationship with repayment. Lack of adequate awareness of financing schemes were observed.

Organising outreach programmes in fishing villages — an experimental study (FE & E/20) :

KRISHNA SRINATH.

Narakkal - Nayarambalam at Cochin, Blangad-Puthenkadappuram at Chavakkad and Chemencherikuppam at Madras were selected and a sample of 120 fishermen from each centre considered. The data were collected and analysed. One extension seminar involving systems approach was organised at Blangad-Puthenkadappuram centre. Four components of marine fisheries development namely 1) fisheries policies and regulations 2) innovations in capture fisheries 3) employment programmes and occupational finance available for marine fishermen and 4) welfare schemes intended for fishermen were presented to the respondents and the awareness rated. The average awareness score was high for welfare schemes, medium for innovations and policies and low for training and employment schemes.

The seminar conducted at Chavakkad was found to be very useful from the reactions of the fishermen as well as improvement in the average awareness score.

Measurement of level of aspiration of fishermen using projective and non-projective methods (FE & E/12.3) :

JANCY JACOB.

On the basis of arithmatic mean and standard deviation, the respondents were divided into three levels of aspiration in respect of sub areas. The mean score for sub areas of aspiration in rank order were education of children, followed by aspiration for craft and gear and mass media equipments. Regarding aspirations related to fisheries the highest aspiration was found for gillnet followed by ring and boat seines. The highest aspiration in the case of craft was found for plank built boats fitted with OBE.

The data when subjected to zero order correlation and path analysis revealed that variables like family size, educational status, craft ownership, ownership of outboard engine, adoption of innovations, extension participation and value orientation were significantly correlated with the dependant variable (aspiration). The multiple R value was found to explain 46 per cent of the variation in the levels of aspiration.

Utilization of information sources by fishermen in the adoption of recommended practices (FE & E/17) :

JANCY JACOB.

The data collected from 110 fishermen were analysed to find the preference of information sources, extent of use and its utilization in adoption of innovations. Newspapers were the source of maximum information, followed by radio, friends, fishery officials, film shows, exhibition and research institutions. 54% of the respondents spent 40 minutes or more in reading daily newspapers, 27% gained fishery related knowledge and only 4% could utilize the knowledge. About 64% of the fishermen possessed radios and 51% listened to news related to fisheries. 23% listened to the weather forecast but only 4% felt that it was of practical utility. The rank order of maximum knowledge gain and knowledge utilization was from friends and neighbours followed by fishery officials, newspapers, radio and films.

Planned change in a coastal village-model for a first-line extension programme (FE & E/19) :

JANCY JACOB, KRISHNA SRINATH.

A bench mark survey in Kannamali area was carried out. A seminar and an exhibition were organised and a local Fishermen's Forum was formed for better participation of the people and for identification of community actualizers. Training programmes on fish processing, prawn culture and seed collection from surf and backwater area were conducted with the collaboration of KVK, Narakkal. Women actively participated and were taken on field tour to KVK, Narakkal.

LIBRARY & DOCUMENTATION DIVISION

During the year 60 books, 2,639 issues of periodicals and 24 non-book materials were procured for the library at Headquarters in addition to those at the regional and research centres.

Reference facilities were provided for visitors both within and outside the country. The publication of Current Awareness Service and 'Selective Dissemination of Information' were continued.

The following publications were issued:

1.	Indian Journal of Fisheries	:	Vol. 34 (Nos. 3 & 4)
2.	Special Publication	:	Nos. 41 & 42 (Part I & II)
3.	Bulletin	:	No. 41 & 42 (Part I & II)
4.	Marine Fisheries Information Service	:	Nos. 76 - 90
5.	Newsletter	:	Nos. 36 - 39
6.	R & D Series	:	Nos. 17 and 18
7.	Research Highlights	:	1987 - '88
8.	CMFRI Annual Report	:	1986 - '87 and 1987 - '88.

POST-GRADUATE EDUCATION AND RESEARCH PROGRAMME IN MARICULTURE

Ph.D. Programme :

One Senior research fellow each from the 2nd, 3rd & 4th batches were awarded Ph.D. degrees by the Cochin University of Science and Technology for their work on :

1. Studies on certain nitrogen cycle bacteria in the prawn culture fields of Kerala
   ... **Arun S. Ninawe**

2. Larval biology of the spiny lobsters of the genus *Panulirus*
   ... **T. N. Sarasu**

3. Biochemical genetics of selected commercial important penaeid prawns
   ... **Philip Samuel**

One research fellow has submitted his thesis and another his synopsis to the Cochin University of Science and Technology. One research fellow from the 5th batch and another from the 6th batch passed the qualifying examination held by the Cochin University of Science and Technology. Four fellows of the 6th batch, seven fellows of the 7th batch and 9 fellows of the 8th batch are actively pursuing their research work.

Shri Kiron Vishwanath, from the 4th batch, Ms. Mary Mathews, Ms. Annie Mathew and Shri Suresh Kumar from the 6th batch were appointed as Assistant Development Officers (Fisheries) in NABARD.

Shri K. K. Vijayan (3rd batch), Shri A. Gopalakrishnan (5th batch) and Shri A. K. V. Nasser (7th batch) were selected as Scientist S-1 grade by the A.S.R.B.

M. Sc. Programme :

The 7th batch M.Sc. students completed their course in November 1988. Nine students of the 8th batch continued their course work. The 9th batch with 10 students joined in December 1988. The entire syllabus for the M.Sc. was revised and introduced in the 9th batch.

KRISHI VIGYAN KENDRA

Courses conducted under KVK, Narakkal

	Subject	No. of Courses	No. of Trainees Male	Female	Total
1.	Prawn/fish culture	21	152	172	324
2.	Prawn/fish seed collection	5	42	36	78
3.	Integrated farming	2	10	17	27
4.	Fish processing/handling	9	...	138	138
5.	Livestock management	1	20	...	20
6.	Duck farming	1	17	...	17
7.	Poultry farming	1	19	...	19
8.	Vegetable cultivation	2	15	21	36
9.	Paddy cultivation	3	26	...	26
10.	Social forestry	4	17	57	74
11.	Nutrition education	6	...	93	93
12.	Fruit preservation	5	...	82	82
13.	Environmental sanitation	3	24	22	46
	TOTAL	63	342	638	980

In addition to the regular courses, special demonstrations were also conducted.

Training courses organised under the Trainers' Training Centre

Sl. No.	Subject	Duration of days	No. of participants
1.	Hatchery production of marine prawn seeds	15	3
2.	Post harvest technology in fisheries	15	7
3.	Sampling techniques for assessment of exploited marine fishery resources	10	8

Several film shows were organised and conducted for the benefit of trainees and villagers. Dr. M. M. Thomas gave two talks on collection of prawn seed and prawn seed production and distribution which were broadcast over AIR, Trichur. A survey was also conducted to assess the post training activities of the trainees trained during 1986 - '87.

हिन्दी सारांश

मात्स्यिकी संपदा निर्धारण प्रभाग

देश में 1987 वर्ष के दौरान हुये 1.66 दशलक्ष टन मछली स्थलन के मद्दे 1988 वर्ष में 1.80 दश लक्ष टन मछली का स्थलन हुआ। इस में वेलापवर्ती मात्स्यिकी का योगदान 51% और तलमज्जी समूह का 49% था। वर्ष के दौरान कुल स्थलन में हुई वृद्धि का कारण स्टोलेफोरस एस पी पी, तारली, बांगडे, शिंगटी और नान-पेनिअइड झींगों में हुई बढती स्थलन था। कुल पकड के क्षेत्रगत विभाजन की दृष्टि से उत्तर पूर्वी, दक्षिण पूर्वी, दक्षिण पश्चिमी और उत्तर पश्चिमी तटों से यथाक्रम 58,000 टन, 43,000 टन, 772,000 टन और 523,000 टन पकड मिली।

पिछले वर्ष की तुलना में उत्तर पूर्वी क्षेत्र की पकड में 25% घटती अभिलेखित की। क्रोकर्स, पॉम्फ्रेट, हिल्सा शाड और पेनिअइड झींगों के स्थलन में यथाक्रम हुई 4,000 टन 2600 टन, 1400 टन और 400 टन की घटती इसका कारण था।

1987 वर्ष की तुलना में दक्षिण पूर्वी क्षेत्र के स्थलन में भी 6% घटती दिखायी पडी। स्टोलोफोरस एस पी और गोट फिश के स्थलन में भी यथाक्रम 900 टन और 6,000 टन की बढती दिखाई पडी। लेकिन फीतामीन (8,900 टन) अन्य तारलियां (8,600 टन) सिल्वर बेल्लियां (8,500 टन) बांगडे (6,900 टन) पर्च (5,500 टन) और उपास्थिमीन (4600 टन) आदि महत्त्वपूर्ण संपदाओं के स्थलन में हुई कमी ने इस क्षेत्र के कुल स्थलन की कमी का कारण बन गया।

वर्ष 1987 की तुलना में दक्षिण पश्चिमी क्षेत्र के स्थलन में 23.7% बढती हुई। स्थलन में 1.83 लाख टन का मजबूत बढती देखी गयी। पिछले तीन दशकों में यहां इतना अधिक स्थलन नहीं हुआ है। इसका अधिकांश स्थलन केरल और गोवा के तटों में हुआ था। स्टोलेफोरस एस पी पी. के स्थलन में 40,000 टन की बढती हुई। बांगडे के स्थलन मे 37,000 टन, करंजिडों के स्थल में 36,000 टन, तारली के स्थलन में 26,000 टन और शिंगटियों के स्थलन में 14,000 टन की बढती हुई। पेनिअइड झींगे और सेफालोपोड के स्थलन में भी यथाक्रम 2000 टन व 6,600 टन की बढती हुई।

उत्तर पश्चिमी क्षेत्र के स्थलन में उपांतिक वृद्धि हुई। वर्ष के दौरान नॉन-पेनिअइड झींगे, पॉम्फ्रेट, शिंगटी और करंजिडों के स्थलन में यथाक्रम 12,000 टन, 8,600 टन, 8,000 टन और 7,000 टन की वृद्धि हुई। इसके विपरीत पेनिअइड झींगे, बम्बिल और क्रोकर्स के स्थलन में यथाक्रम 13,000 टन, 6,000 टन और 3,000 टन की घटती हुई।

पेनिअइड झींगे (मेटापेनिअस डोबसोनि पारापेनिअपसिस स्टाइलिफेरा) और अन्य मछलियों का स्टॉक निर्धारण किया गया। ग्रोथ पैरामीटर्स L & K अनुमान केलिए लेंग्थ फिक्वन्सी डेटा की सहायता से एक कम्प्यूटर विधि का विकास किया गया।

भारत में समुद्री मछली स्थलन के अनुमान लगाने केलिए नेशनल मरैन लिविंग रिसोर्स डाटा केन्द्र ने सॉफ्टवेयर का विकास किया। कार्यक्रम BASICA और C में लिखा गया है। गणीतीय मॉडलों के जरिये स्टॉक निर्धारण करने का सॉफ्टवेयर का विकास भी किया गया है। इसके अतिरिक्त आवश्यक सूचना के शीघ्र और आसान निपटान केलिये आवश्यक पुनः प्रतिष्ठापन तकनीकियों का निर्माण किया गया है।

वेलापवर्ती मात्स्यिक प्रभाग

संपदाओं की विशिष्टताओं का मूल्यांकन और स्टॉक निर्धारण इस प्रभाग की मुख्य परियोजनायें थी। इसके अतिरिक्त वाणिज्यक गिअरों द्वारा प्राप्त बाल-मछली लक्षद्वीप की लैंव बेट मछली, समुद्री स्तनियों के टैगिंग/लैडिंग/स्ट्राडिंग आदि पर भी अध्ययन चलाया गया। वर्ष के दौरान भारत और मिनिकोय द्वीपसमूहों में ट्यूना और बिल फिशों का संपाश बढ गया। भारत में कोष संपाश, वलय सारांश और बडिश रज्जु के जरिये 51.4% यूथिन्नस अफिनिस, 23.3% अक्सिस रोचे, 16.4% ए. थनार्ड और 2.5% थुन्नस टोनगेल प्राप्त हुये। इसके अलावा पोल आन्ड लाइन और ट्रॉल लाइन के जरिये 83.8% स्किपजैक और 16.2% येलोफिन प्राप्त हुये। मिनिकोय में मिले बिल फिशों के 75% इसिटयोफोरस प्लाटिप्टीरस था। लेसर सारडीन और फीतामीन का मंद स्थलन हुआ था। मॉल्लूर में स्टोलेफोरस के स्थलन में चार गुनी बढती हुई जबकि कोचीन और विषिजम में इसकी घटती हुई। मॉल्लूर में पॉम्फ्रेटों का भी अच्छा स्थलन हुआ। बांगडे की बात ले जायें तो कोचीन और विशाखपट्टनम को छोडकर सारे केन्द्रों में स्थलन में बढती हुई। तारली, बम्बिल, करंजिड आदि के स्थलन में घटती ही दिखाई पडी।

कोचीन में ट्राल जाल के जरिये पकडी गयी बाल-मछलियों में जोनियस सीता, एपिनेफलास डैकान्थस, प्लाटुसेफालस एस पी., जे. करुटा और एन. जपोनिकस मुख्य थे। इसके उच्चतम स्थलन जून और सितंबर में हुये। तंगवला से फरवरी में तरुण बांगडों के स्थलन हुये। कालीकट में ट्राल-जालों के जरिये सीनेइड्स, स्टोलोंफोरस एस पी पी, साऊरिदा तम्बिल और सैनोग्लोसस माक्रोस्टोमस के स्थलन हुये। नेताल जाल के जरिये तरुण तारली और बांगडों का स्थलन हुआ। कारवार में कोष संपाशों द्वारा तरुण तारली का स्थलन हुआ।

लक्षद्वीप में एफ ओ आर वी सागर संपदा के जरिये चलाये गये दूसरा समन्वेषी लैंव बेट सर्वेक्षण ने व्यक्त किया कि मिनिकोय, अगत्ती, सुहेली, कवरत्ती, चेरियपानियम और कडमट लैगूनों में विविध जाति की मछलियों की एक धनी संपदा है। इस में मुख्य थे कासिनोइड्स के समूह। इसका प्रतिशत था 40.1। इसके बाद क्रमानुसार अपोगोनिडस (17.5%), पोमासोन्ट्रिड्स (17.3%), स्पाट्स (16.6%), इमलिथिड्स (1.1%) और अन्ग्रेनिडस (1.0%) देखे गये। मिनिकोय लैगून के दक्षिण भाग में एक कृत्रिम रीफ तैयार करके समुद्र में छोड दिया है। इसके जरिये रीफ की आयु के अनुसार मछलियों के उतार-चढाव पर अध्ययन चलाया गया।

विविध केन्द्रों में टैगिंग करने के कदम उठाये गये। इसकेलिये काटफिश टैगों का निर्माण किया गया। तारली और बांगडों को पकडने का सेल्लुलोइड लूप विविध केन्द्रों को भेजा गया। वर्ष के दौरान विविध निरीक्षण केन्द्रों में कुल 71 डोल्फिन, 11 शिशुमार 9 तिमिंगल और 1 ड्यूगोंग प्राप्त हुये।

तलमज्जी मात्स्यिकी प्रभाग

वाणिज्यक लंगारों में पकडी गयी तलमज्जी मात्स्यिकी संपदा की विशेषताओं का मूल्यांकन और स्टाक निर्धारण एवं मुख्य खाद्य मछलियों के संसाधन आदि परियोजनायें इस प्रभाग में वर्ष के दौरान कार्यान्वित की गयी।

पेर्चेस, सीनेइडस, मुल्लन, शिगटी, ब्रेंडफिन ब्रीम, फ्लाट हेड, चपटी मछली और उपास्थिमीन आदि का मॉनिटरन पूर्वी और पश्चिमी तटों के कई केन्द्रों में किया गया। पेर्च मात्स्यिकी में लेट्रिनस

नेबुलोसस, लुटजानस एस पी पी एपिनेहीलस एस पी पी, प्लेक्टोरैनिअस एस पी पी पिरिस्टिपोमायड्स टैपस और सामोपेरका वेगिनसिस आदि थे जिन्हें वडिश रज्जु और ड्रिफ्ट गिल नेटों द्वारा पकडे गये। सीनेइड मात्स्यिकी के मुख्य स्पीशीज जनियस एस पी, ओटोलिथस रूबर, कातला अबिसलारिस, पेम्फिया माक्रोफालनस और निबिया माकुलाटा थे। इस संपदा का स्थलन मुख्यत: ट्रालरों के जरिए हुआ और विशाखपट्टनम और कोचिन में स्थलन काफी अधिक था। ट्रालरों के जरिए मुल्लन के स्थलन में मद्रास में वृद्धि हुई विशाखपट्टनम और काकिनाडा में घटती। इस मात्स्यिकी के मुख्य देन लियोग्नाथस जोनेसी, लियोग्नाथस बिन्डस, सेबयूटर इनसिडियेटर, गजा मिनुटा, एल. स्प्लेन्डेन्स, एल. डेसुमेरी आदि स्पीशिज कारवार और विशाखपट्टनम को छोडकर अन्य अधिकांश स्थलन केन्द्रों में शिगटी का स्थलन में वृद्धि दिखायी पडी। वेरावल में ट्रालरों के जरिए, ताबिकसुरस टेनुस्पिनिस टी. डसुमेरी और टी. तालासिनस का स्थलन हुआ। बंबई में ट्रालरों के अतिरिक्त डोल जालों का भी प्रयोग किया गया जिससे टी. डसुमेरी के बालों का स्थलन हुआ। कारवार में कोष संपाशों के जरिए शिगटी मात्स्यिकी के टी. सेराटस का स्थलन हुआ। मॉगलूर की पकड में मुख्य टी. टेनुस्पिनस था। इसका स्थलन ट्रालरों और कोष संपाशों से हुआ। कालिकट में वडिशरज्जु और ड्रिफ्ट गिल जाल के जरिए टी. टेनुस्पिनस को पकडा गया कोचिन, विशाखपट्टनम, और टूटिकॉरिन में टी तालासिनस मुख्य था। कोचीन, और विशाखपट्टनम में इसकेलिए ट्राल जाल का प्रयोग किया गया जबकि टूटिकोरिन में वडिश रज्जु और गिल जाल का प्रयोग किया गया। वेरावल को छोडकर बाकी सभी केन्द्रों में नेमिप्ट्रेस मीसोप्रिओन, एन. जापोनिकस एन. डेलागोए और एन टोलु आदि ग्रेडफिन ब्रीम मात्स्यिकी की घटती दीख पडी। इस संपदा का स्थलन ट्राल जालों से हुआ था। विषिजम में वडिश रज्जु का प्रचालन करनेवाले कुछ एककों से भी इस संपदा प्राप्त हुआ। कोचिन और कालिकट में चपटी मछली की भारी पकड मिली। मद्रास से पकडी गयी चपटी मछली कुल चपटी मछली स्थलन का 90% था। वेरावल में सी. आरेल और सी. माक्रोम्टोमस मुख्य थे। सभी केन्द्रों में उपास्थिमीन संपदा का स्थलन ड्रिफ्ट गिल जाल, ट्राल जाल और वडिश रज्जु के जरिए हुआ था। सुरा में मुख्य स्कोलिओडन, लाटिकाडस, कारचारिनस एस पी पी सी. मेलानोप्टेरस और एम. पालासोरा थे। शंकुशों में मुख्य हिमानटुरा एस पी पी था।

संसाधन परीक्षण में खाद्य मछलियों के एक संख्यक व बहु संख्यक संवर्धन रीतियों पर परीक्षण भी किये थे। मद्रास के तालाबों में चानोस चानोस, मुगिल सेफालस, लिजा पारिसा और एल टेड के संग्रहण किये और इन्हें आहार के रूप में मैक्रो आलगे दिये गये। चानोस चानोस छः महीनों में लंबाई में 195 मि. मी. और भार में 146 ग्रा. की वृद्धि दिखायी। मण्डपम में संपूरक आहार देने से चानोस चानोस प्रति हैक्टर में 481-656 कि. ग्रा. वृद्धि दर एवं 44.8% अतिजीविता दिखायी। टूटिकोरिन में निम्न उत्पादन दर में अतिजीविता कम दिखायी। पिल्लेमडम् लैगून में तिलापिया के प्रवेश को रोक लिया गया।

मलस्क मात्स्यिकी प्रभाग

इस प्रभाग की, मलस्कों का प्रकृतिदत्त स्टॉक निर्धारण, आबादी अध्ययन, संवर्धन और वाणिज्यक दृष्टि से महत्वपूर्ण मलस्कों का स्पुटनशाला में उत्पादन आदि, मुख्य परियोजनायें थीं।

वर्ष के दौरान कालिकट, कोचीन और विषिजम को छोडकर सारे केन्द्रों में शीर्षपाद संपदा में घटती हुई। वर्ष के दौरान स्किड संपदा में बढती हुई, पकड

गये मुख्य स्पीशीज् थे लोलिगो ड्युवासेल्लि, सेपियोड्युथिस लेसोनियाना और डोरिटेनथिस सिबोगे। कटलफिश मात्स्यिकी में सेपिया फारोइनिस, एस. अकुलेटा, एस. बेग्भिाना और सेपियल्ला इनेरमिस आदि पकडे गये मुख्य स्पीशीज थे। सारे केन्द्रों में इन्हें पकडने केलिये ट्राल नेट का उपयोग किया गया जबकि विषिजम में मूलत: बडिश रज्जु का उपयोग किया गया। सीपी मात्स्यिकी संपदा के अधीन पकडे गये मुख्य स्पीशीज मेरिट्रिक्स कास्टा, बिल्लोरिटा सेंप्रिनोइडस, अनडारा ग्रानोसा, मेरेट्रिक्स मेरेट्रिक्स और पाफिया मलबारिका थे। करनाटक में सीपी मात्स्यिकी की हालत बहुत बुरी थी। कालीकट तट में करीब 602 हेक्टयर में मसल संस्तर की अनुमानित उत्पादन शक्यता स्टॉक 16,000 टन है। कालीकट के अलावा कोचीन और चावक्काड के बीच के तटों में और दक्षिण कन्नड के तटों में भी मसल के संस्तरें देख गये। तिरुचेन्दूर ग्रूप ओफ पार्स के मुक्ता शुक्तियों का संग्रहण करके उनकी वृद्धि और जैविकी पर अध्ययन चलाया गया। वम्बिवा अरुपयागम पार के पुनरधिवास केलिये करीब 30,000 मुक्ता शुक्ति स्पाटों का समुद्र रैंचन, जून के दोरान किया गया। टूटिकोरिन में प्रशंखों की वृद्धि का अध्ययन टैगिंग के जरिये किया गया। टूटिकोरिन हार्बर के संस्तर में टैगिंग के बाद मुक्त किये प्रशंखों में एक को 30-157 दिनों के बाद पुन: पकड लिया। इस प्रशंख की लंबाई में औसत 0.33 मि. मी, चौडाई में औसत 0.37 मि. मी. और भार में औसत 2016 ग्राम की बढती देखी इसकी अंडा संपुटिका से प्राप्त बाल प्रशंखों ने एक वर्ष के अन्दर 23.1 मि. मी की लंबाई 10.2 मि. मी की चौडाई और 3.85 ग्रा. का भार प्राप्त किया। विषिजम में 7805 प्रशंखों का स्थलन हुआ। प्राप्त लेकिन यहाँ के प्रशंखें आकार में छोटे देखे गये।

टूटिकोरिन, मद्रास और काकिनाडा में खाद्ययोग्य शुक्तियों के संवर्धन केलिये कदम उठाये गये। सारे केन्द्रों में अच्छा स्पाट सेटटूलमेन्ट हुआ। टूटिकोरिन में राफ्ट रीति के ज़रिये मुक्ता शुक्तियों का भारी संवर्धन किया गया। यहाँ से वर्ष के दौरान गुजरात में शुक्तियों के करीब 26,000 बीजें भेजे गये।

हरित मसल का प्रेरित प्रजनन मद्रास में प्रयोगशाला में किया गया। प्रयोगशाला में पालित डिम्भकों का अतिजीविता दर अच्छा देखा गया। भुरे मसल का प्रेरित प्रजनन विषिजम और टूटिकोरिन में किया गया। इनके डिम्भकों को आइसोक्राइसिस क्रोमुलिना और पावलोवा से खिलाने पर वृद्धि दर में बढती हुई। मुक्ता शुक्तियों के 32500 हैचरी बीज गुजरात में भेजे गये। मेरेट्रिक्स मेरेट्रिक्स, अनडारा ग्रानोसा और पाफ़िया मलबारिका आदि सीपियों का और जठरपाद ट्रोकस रेडियाटस का भी प्रेरित प्रजनन प्रयोगशाला में सफलतापूर्वक किये गये।

समुद्र से लेसियोनियाना और सेपिया फारोनिस के बीजों का संकलन करके उनका अंडजनन प्रयोगशाला में किये गये और डिम्भकों को मिसिडस, मीसोपोडोप्सिस से खिलाये गये।

क्रस्टेशियाई मात्स्यिकी प्रभाग

वर्ष के दौरान ग्रहण मात्स्यिकी प्रभाग ने अनन्य आर्थिक मेखला के मुख्य क्रस्टेशियाई संपदाओं का निर्धारण, कोचीन पश्चजलों की झींगे मात्स्यिकी और उत्तर-पूर्वी तट में बडे आनायकों से पकडे गये झींगों का मूल्यांकन आदि परियोजनाओं का कार्यान्वयन किया गया। मात्स्यिकी संवर्धन के अधीन शूली महाचिगटों और झींगों का संवर्धन व समुद्र रैंचन और कृत्रिम रीफों का विकास आदि परियोजनायें कार्यान्वित की।

पेनीअइड झींगे मात्स्यिकी में वेरावल, ताद्री माल्पे, मुनम्बम, कोचीन मात्स्यिकी बन्दरगाह और

वाल्टयर में पिछले वर्ष से ज्यादा प्रगति हुई। कोचिन में "करिक्काडी" का उच्च स्थलन हुई और पश्चिम तट में मॉरलूर और अम्बलपुषा को छोडकर सभी केन्द्रों की पकड में यह स्पीशीज आगे था। पूर्वी तट पर टूटिकोरिन और मण्डपम में पेनीअस सेमिसुलकाटिस मुख्य था। काकिनाडा और वाल्टयर में मेटापेनिअस मोनोसिरोस की प्रमुखता थी। वेरावल और न्यू फेरी वार्फ में नॉनपेनिअइड झींगों के स्थलन में भारी वृद्धि दिखायी पडी। बंबई और काकिनडा में चलाये गये पोपुलेशन अध्ययन में यह व्यक्त हुआ कि प्रयत्न बढाने पर पकड भी बढा सकती है। वेरावल, कोचीन, मण्डपम और काकिनाडा में कर्कट मात्स्यिकी अच्छी थी। इनके मुख्य स्पीशीज पोरटनस सांगिनोलेनटस, पी. पेलाजिक्स और कैरिन्डिस आदि थे। महाचिगटों के बारे में कहे तो उत्तर-पश्चिमी तट पानुलिसस पोलिफागस और अन्य केन्द्रों में पी. हमारस मुख्य थे।

कोचिन उपतट में नॉन-मानसून काल में परीक्षणात्मक चिगट आनायन चलाया गया। इस में पी. स्टाइलिफेरा और एम. डोबसोनी उथला जल में 29 दीख पडी। लेकिन पी. मोनडोन और एम. मोनोसिरोस 21 और 60 मी. गहराईके बीच दीख पडी। 25 मी. गहराई तक एन. अफिनिस का एकसमान वितरण देखा गया। मानसून महीनो के दौरान 10 मी. गहराई में पी. इन्डिकस की और 16-20 मी. गहराई में एम. अफिनिस की अच्छी पकड मिली। विशाखपट्टणम बेस में परिचालित वाणिज्यक अनयको से मिली पकड बहुत कम थी।

क्वयलोन उपतट में एच एस डी टी के परिचालन से 290-300 मी. की गहराई से प्यूरुलस सीवेल्ली की भारी पकड मिली। इसके अलावा 290–350 मी. गहराई में पेनिओप्सिस जेरयी, हेटिरोकारपस वुडमासोनी, एच. गिब्बोसस पारापान्डलस स्पिनिपेस और अरिस्टियस अलक्लोक्कि आदि गंभीर सागर झींगों की पकड भी इसके जरिए हुई।

मॉरलूर, कालिकट और अम्बलपुषा में इन्डीजिनस गिअरों का प्रचालन से एम. डोबसोनी, का भारी स्थलन हुआ। विषिजम और टूटिकोरिन में पी. इन्डिकस की पकड मिली। कारवार के पश्चजलों में स्लूइस जाल के परिचालन से एम. डोबसोनी का स्थलन हुआ। कालिकट, कोचिन और काकिनाडा में स्टेक नेट के प्रचालन से एम. डोबसोनी और एम. मोनोसिरोस प्राप्त हुये।

मात्स्यिकी संवर्धन परीक्षण में समुद्री झींगों के छः स्पीशीज यानी ट्रैकिपेनिअस पेसकाडेंनसिस पैरापिनोप्सिस माक्सिलिपीडों, पी. अंकटा मेटापेनिअप्सिस स्ट्रिडुलान्स, एम. हिलारुला और एम. यूजीनसेस का पहली बार प्रयोगशाला में अंडजनन किया गया और इनके डिम्भक एवं पश्चडिम्भक अवस्था में पालन-पोषण हैचरी में किया गया। केवल हैचरी में संरक्षित पी. लैटिसुलाकाटस की तीसरी पीढी भ्रूण स्टाक नेत्र वृन्त अपक्षरण के बिना प्रौढ हुआ और अंडजनन भी किया। इसके डिम्भकों का पालन-पोषण भी सफल हो गया।

मण्डपम में समुद्र रैंचन कार्यक्रम के अधीन हैचरी में उत्पादित 0.48 दश लक्ष और 0.45 दश लक्ष पी. सेमिसुलकाटस डिम्भकों को मान्नार की खाडी और लवण जल लैगून में छोड दिया

मद्रास में 0.4 हैक्टर के एक ताल में पी. मोन्डोन (स्टाकिंग दर 59,000/हैक्टर) का अर्ध-गहन संवर्धन से 110 दिनों में प्रति हैक्टर से 536.5 कि. ग्रा./उत्पादन मिला। मण्डपम में प्रति हैक्टर पर 49,225 के दर से पी. सेमिसुलकाटस बीजों को स्टाक किया और उन्हें कृत्रिम आहार से खिलाया। इसका वृद्धि दर प्रति दिन 0.5 मि. मी. दिखायी पडी

टूटिकोरिन में पी. मोन्डोन और पी. इन्डिकस का मानिटरन एक कृषक के फार्म में किया गया। पी. मोन्डन का उत्पादन दर पी. इन्डिकस की अपेक्षा कम था लेकिन उच्च दाम पी. मोन्डोन को ही मिला था

गहन संवर्धन प्रणाली में महाचिंगटों की वृद्धि दर अधिक था एकपार्श्विक नेत्रवृन्त अपक्षरण ने गौण लैंगिक लक्षणों की वृद्धि एवं विकास को विशेष रूप से प्रभावित नहीं किया था।

टूटिकोरिन में 30 टयरो से निर्माण किये कृत्रिम रीफ बुरा मौसम के कारण नष्ट हुये। अब बन्दरगाह के परिरक्षित क्षेत्र में और एक रीफ बनाने केलिए कदम उठा रहे हैं।

मत्स्यिकी पर्यावरण और प्रबन्ध प्रभाग

इस अनुभाग में उपतट जल (Shelf water) की मुख्य जलराशिक स्थिति, प्राइमरी और सेकन्डरी उत्पादन, बेन्थोस और तलमज्जी मात्स्यिकी के बीच का संबन्ध, समुद्री प्रदूषण, प्रवाल भित्ति संपदायें, कछुआ संपदाओं का आरक्षण, माइक्रोआलगे संवर्धन, समुद्री शैवाल और होलोथूरियन्स, रिमोट सेनासिंग और समुद्री जीवों से बयोएक्टीव ऐजेन्टस आदि परियेजनाओं पर अध्ययन चलाया गया।

अनेक केन्द्रों में समुद्र के प्रधान भैतिक गुण धर्मों का मॉनिटरन किया गया। पश्चिम तट में जनवरी से अप्रैल तक ताप में वृद्धि महसूस हुई और दक्षिण पश्चिम मानसून के दौरान ताप में घटती दिखाई पडी। सितंबर में यह फिर से बढ गया और नवंबर–दिसंबर में आकर वर्षा के कारण कम हो गया। पृष्ठीय ताप SST 25°C से 34.5°C और लवणता 27.6‰ से 35‰ हो गया। कोच्चीन में जून के दौरान तीव्र उत्प्रवाह देखा गया। पूर्वी तट पर ताप 25°C से 30.5°C और लवणता 29.25‰ से ६5.25‰ तक बन गयी। विशाखपट्टनम में फरवरी के दौरान उत्प्रवाह दिखाई पडी और यह परिवर्तित तीव्रताओं में जून तक जारी रही। सीनस इन्डीकस, डेकाप्टेरेस एसपी, नेमिप्टेरेस मीसाप्रिओन आदि गहरे जल की मछली तट की ओर आयी गयी। इन्हें यंत्रीकृत और परंपरागत मत्स्यन तरीकों से पकडी गयीं।

तीन केन्द्रों में प्राथमिक उत्पादकता का मापन किया गया। विशाखपट्टनम में उत्प्रवाह के समय प्राथमिक उत्पादकता और क्लोरोफिल्स आधिक थे। यहाँ 35 मी. की. गहराई में प्रतिदिन दिसंबर में 0.97mg. c/m^3 और मार्च में 40.58 mg. c/m^3 के बीच प्राथमिक उत्पादकता देखा गया। कोच्चीन में मार्च महीने में प्राथमिक उत्पादकता प्रतिदिन 781mg. c/m^3 से जुलाई में 1,126 mg. c/m^3 तक बढ गया। कालिकट में यह जनवरी में प्रतिदिन 120.12 mg. c/m^3 से नवंबर में 755.044 mg. cm^3 बन गया। मॉगलूर में कीटोग्नाथस, मेडुसे, लूसिफर और कोसिनोडिसकस एसपीपी आदि प्राणीप्लवक के सांपिलें दिखाये पडे। अप्रैल में मछली अंडे और जनवरी–मार्च में डेकापोड पश्चडिम्भक साधारण थे। दिसंबर में नोक्टिलूका दिखायी पडी कोच्चीन में दिसंबर महीना प्रणीप्लवकों का शृंग काल था। सगिट्टा एस.पी., साल्पा एस. पी. के झुंड अधिक थे। नवंबर में नोक्टिलूका एस. पी ब्लूमस दिखायी पडी। विषिजम में अरित्रपाद और दशपाद के डिम्भक मुख्य थे। अक्तूबर और जुलाई में यथाक्रम क्लाडोसिरा झुंड और थलासिसिरा के ब्लूम दिखाये पडे। अक्तूबर–दिसंबर में मत्स्य अंडे और पश्चडिम्भकें काफी अधिक थे। टूटिकोरिन में आरित्रपाद, दशपाद, पश्चडिम्भक, लूसिफेर, द्विकपाटी, जठरपाद और कीटोग्नाथस आदि देखे गये मुख्य प्राणीप्लवक थे। मद्रास में जनवरी में आरित्रपाद झुंड, कंचुकी और मत्स्य अंडे आदि दिखाये पडे। जुलाई–सितंबर में नोक्टिलूका एस. पी. ब्लूम्स दिखायी पडी। एफ.ओ.आर.वी. सागर संपदा में इकट्ठे किये गये 305 प्राणीप्लवीन नमूनों का वर्गीकरण भी किया गया।

विशाखपट्टनम में जलजीवजातों की जनसंख्या, के बारे में अध्ययन चलाया गया। अध्ययन में जनसंख्यक सान्द्रता 135 से 6419 / Organism m^2 में परिवर्तित दिखयी पडी। टूटीकोरिन में 10 मी. गहराई में सैन्ड अधिक दिखाया पडा तो 20 मी. गहराई में पंक अधिक था। कोच्चीन में मानसून काल में जून–अगस्त में सान्द्रता अधिक था। इन तीनों केन्द्रों में बहुशुक पॉलीकीट, उभयपद ऑम्फिपोड, द्विकपाटी और टीरोपोड उपस्थित थे।

तरुण मेरेट्रिक्स मेरेट्रिक्स, अनडोरा ग्रानोसा ट्रोकस एस.पी. और होलोथूरिया स्काब्रा को खिलाने केलिये हॉप्टाफिसियन फ्लाजल्लेटों के स्पीशीजों का मासकलचर किया गया। पोवोलोवा एसपी, डिक्रेटेरिया एसपी और कोमुलिना एसपी भी इन पश्चडिम्भकों केलिए अनुयोज्य आहार निकला। होलोथूरिया स्काब्रा को तापीय प्रेरणा में स्पॉन किया गया।

डिप्लूरुला और ओरिकुलेरिया पश्चडिम्भकों को भोज के रूप में आइसोक्राइसिस गोलबाना और पेन्टाक्टुला पश्चडिम्भक को समुद्री शैवालों से प्राप्त अलगल चूर्ण दिया गया। जेलेडियल्ला असिरोसा, ग्रेसिलेरिया एडुलिस और जी.कोरटिकाटा को प्रयोगशाला में स्पाट सेटिलमेन्ट प्रणाली से प्रवर्धन किये गये। फ्लजल्लेट संक्रमण नियंत्रित करने केलिए आवशयक प्रयत्न किया गया। मान्नार की खाडी में उच्च आविलता, स्पंजों के अधिपादपीय वृद्धि, ऐसिडियन्स, अन्य शैवाल और गंभीर चारण ने जी. एडुलिस की वृद्धि में बाधा डाली। संपदा सर्वेक्षण से वलिनोक्कुम से तिरुचेन्दूर तट में 4 समुद्री शैवाल एसपीपी और 3 समुद्री घास एसपीपी की उपस्थिति महसूस हुई। 4425 km^2 क्षेत्र में खडीफसल 42150 mt प्राक्कलित किया गया। लक्षद्वीप के चारों ओर प्रवाल भित्ति संपदाओं पर किये गये सर्वेक्षण से स्कलीराक्टिनियन प्रवालों के 37 कुटुंबों के 105 वंशों की उपस्थिति की सूचना मिली। केरल और तमिलनाडुके तटों में पोसिल्लोपोरा प्रवाल मुख्य थे।

कोच्चीन में किये गये प्रदूषण अध्ययनों में मेरकुरी का अंश न्यूनतम जोखिम सान्दण स्तर से अत 8.2 ppb अधिक देख लिया। सीपिएला इनरमिस लोलिगो एसपी. और नेप्टियोनल एसपी. का आमापन करने पर Zn, Cd और Mn के उच्च लेवल देख लिया। आइसोक्राइसेस गालबाना पर मेरकुरी का जैव आमापन बायोऐसे दिखाया कि LC 50, 25 ppb है। सूक्ष्म जैविकी निरिक्षण ने 58 हेट्रोट्रोफस जो सेन्डामोनास, ऐरोमोनास, ऐल्केलिजनीज, विब्रिओ, फैलेवोबैक्टीरियम, बेसिलस और माइकोकोस्सी आदि के हैं, अपस्थिति सूचित की। कारवार में द्विकपाटियों और समुद्री शैवालों में मेरकुरी का लेवल अन्य मछलियों और झींगों से 5–20 बार ऊँचा था। पेरना विरिडिस और क्रासोस्ट्रिया ककुलाटा को अच्छे सेंटिनल ऑरगानिसम के रूप में अभिनिर्धारण किया गया।

रिमोट सेनसिंग और मात्स्यिकी कार्यक्रम के अधीन मत्स्यन पोतों द्वारा संकलित च्योरेफरन्सड मत्स्य पकड डाटा (georeferenced fish-catch data) और NOAA - AVHR के डिजिटल डाटा से विकसित SST और बहु चैनल समुद्रोपरितल ताप चार्ट के बीच का संबन्ध देखने का प्रयास किया गया। SST और ट्यूना पकड के बीच एक परस्पर संबध भी दीख पडा।

रुधिरलयी प्रक्रिया पर अध्ययन करने केलिए 118 समुद्र जीवों के एथनॉलिक एक्सट्रकट स्क्रीन किया गया। इन में स्पंजों के 10 जातियों प्रवालों के 8 जातियों और डोलिसयोनेरिया के 3 जातियों और मलस्क के 7 जातियों ने सकारात्मक प्रक्रिया दिखायी। गॉगोनिडस के 2 जातियों पर इस विषयक अध्ययन चल रहा है।

देहीकी, पोषण और व्याधिकी प्रभाग

वर्ष के दौरान इस प्रभाग में मछलियों की जननीय देहिकी, अंतस्रवविज्ञान उपापचयी सक्रियता,

जैव रसायनिक प्राक्कलन, आनुवंशिकी आदि विषयों पर अध्ययन चलाया गया ।

स्त्री जाति बोईयों के परिपक्वन की अवस्था में गोनड के प्रकार्य के हैपोथालमिक नियन्त्रण के बारे में अध्ययन किया गया । परिपक्व और अपरिपक्व स्त्रीजाति बोइयों के पिट्यूटरी एक्स्ट्राक्ट लेकर विविध प्रोटिन फ्राक्शनों को अलग करने केलिए इलक्ट्रोफोरेसिस किया गया। अपरिपक्व बोइयों में 3 बैन्ड और परिपक्व बोइयों में 5 बैन्ड देख लिये । ईल ऑसिला बैकलर को औषध देकर प्रेरित अंडजनन करा दिया। स्त्री जाति में औषध के प्रेयोग से शरीर के भार में काफी वृद्धि और गोनड का शीघ्र विकास अभिलेखित की गयी । गोनड के विकास में पर्यावरण परिस्थिति व्यतियानों का असर नहीं के बराबर था । मेटापेनिअस डोब्सोनी में गोनड के परिपक्वन के साथ सोमा और गोनड के जलांश में वृद्धि हुई जबकि सोमा की प्रोटीन मात्रा में और गोनड की लिपिड मात्रा मे घटती हुई

पी. इन्डिकस और पी. मोनडोन में ओस्मोटिक स्ट्रेस के प्रभाव के बारे में अध्ययन किया गया । पी. मोनोडोन में मेटाबोलिक रेट के बारे में अध्ययन चलाया गया ।

पेनीअइड झीगों में फीनॉल अक्सिडेस ने पृष्ठवर्म, उदरीय खंड और हीमोलिम्फ में निम्न स्तर की सक्रियता दिखायी । प्रीमोल्ट स्टेज में रोस्ट्रम और टेलसन में यह सक्रिय नहीं देखा गया । पोषाहार की आवश्यकताओं के बारे में चलाये गये अध्ययनों ने व्यक्त किया कि पी. मोनडोन के किशोरों के मात्रात्मक प्रोटिन आवश्यकता 35% से कम है और पी. लाटिसुलकटस केलिए यह 27.5 से 50% के बीच में है । चानोस चानोस और पी. इन्डिकस केलिए तैयार किये मिश्रित आहार फलप्रद देख लिया ।

मछलियों के विविध गौण जैविकी स्थितियों का भी पहचान किया गया । एपिनेफालस डैकान्थस के विक्षत बलोम से विब्रियो फिशरि और व्रणीय त्वचा से एरोमानोस हाइड्रोफिला और फ्लेवोबक्टिरियम एसपी. का पृथकरण किया गया । एल. पारसिया में ईमेरिया और लेटस कालकारिफेर में हेन्निगुया एस. पी. का निदान किया गया । प्रयोगशाला में पालन किये एल. कालकारिफेर में अरोमोनास सालमोनिसिडा और ए. हाइड्रोफिला से व्रण रोग होते हुए देखा गया । 0.5 पी.पी.एम. मेरकुरिक क्लोरैड में डाली गयी मछलियों में भी ऊतक-व्याधिकी विक्षत देखा गया । 0.05 पी. पी. एम. डीडीटी में डाले गये एल. पारिसिया के अंगुलिमीनों ने मृत्युवक्र दिखाकर मर गया । 0.1 पी.पी.एम. की उच्चतम सान्द्रता में भी 24 घण्टे के अन्तर मछलियों की मृत्यु हुई ।

कुछ मछलियों और मलस्कों पर अनुवंशिकी अध्ययन चलाया गया । बैवालव क्रोमसोमों पर अध्ययन चलाने केलिये उचित एक क्रिया पद्धति का विकास किया गया । वी. सैप्रिनोइडस में डिप्लोइड क्रोमसोम की संख्या 38 देखा गया जबकि एल. पारसिया में इसकी संख्या 48 थी । परीक्षणों से व्यक्त हुआ कि तेरापन एस. पी., ओ. मोसांबिकस और एल. पारसिया के सिस्टरक्रोमाटिड् के स्टेइनिंग में देखी गयी विविधता प्रदूषकों के मूटाजेनेसिटी के पहचान केलिये उपयोग किया जा सकता है । सी. माड्रासेनसिस में 4 एन्ज़ाइम पद्धतियों के स्थान निर्धारण करनेवाला इलक्ट्रोफोरेटिक अवस्था का मानकीकरण किया गया ।

मात्स्यिकी अर्थशास्त्र व विस्तार प्रभाग

मात्स्यिकी अर्थशास्त्र के अधीन, परंपरागत मात्स्यिकी का सामाजिक और अर्थिशास्त्रीय सम्बन्ध, यंत्रीकृत मत्स्यन यूनिटों का अर्थिक स्थिति और वायु शक्ति से अनायन में होनेवाल लाभ आदि का विस्त सबन्धी अध्ययन मुख्य रूप से किया गया । विकासात्मक कार्यकलापों के अधीन, पकडी गयी और संवर्धित मात्स्यिकी में नवप्रवर्तनों की स्वीकार्यता मात्स्यिकी कार्यक्रमों का अन्तरवस्तु विश्लेषण और प्रचार माध्यमों में मात्स्यिकी

समाचार, समुद्री उत्पादन पर बाधा डालनेवाले तथ्यों का अन्वेषण आदि विषयों पर अध्ययन चलाया गया। संस्थान के कार्यकलापों से संबन्धित एक रोस्टर आकाशवाणी और दूरदर्शन केलिए तैयार किया गया।

महाराष्ट्र और गुजरात के तटों में मछुओं की कमाइ पर चलाये गये सर्वेक्षणों ने व्यक्त किया कि एक ट्राल-नेट यूनिट का प्रारंभ निवेशन 4-5 लाख रुपये के बीच और इस से प्राप्त आय 1-2 लाख रुपये के बीच है। ओ. बी. एम गिल नेट युनिटों का परिचालन व्यय 0.9-1.1 लाख रुपयों के बीच है और इसका वार्षिक राजस्व 1.2-1.4 लाख रुपयों के बीच। यंत्रीकृत गिल नेट यूनिटों का प्रारंभ निवेशन 2.3.-2.6 लाख रुपयों के बीच है और कुल वार्षिक राजस्व 2.3-2.7 लाख रुपये। इस प्रकार उपर्युक्त दोनों यूनिटों का परिचालन लाभदायक दीख पडा।

समाज अर्थशास्त्र सम्बन्धी अध्ययनों ने व्यक्त किया कि एक मछुए कुटुम्ब का औसत वार्षिक आय त्रिवेन्द्रम में 9,000 रु. पुदुमनैकुप्पम में 7,600 रु, और तिरुवेट्टियूरकुप्पम में 4,500 रु के निकट है। आज कल मत्स्यन कार्यकलापों की वैविध्यीकरण, यंत्रीकरण और अच्छा मूल संघटकों के उपयोग से अधिक आय मिल रहा है। कोचीन मात्स्यिकी बन्दरगाह में ट्रालरों और गिलनेटों की तुलना में कोश-संपाशों का प्रयोग अधिक फायदेमन्द देख लिया। टूटिकोरिन में लंबे ओपरेशनल रेंज के बडे बोटों के प्रयोग से झींगों के मत्स्यन पर होनेवाले दबाव कम करने की और अयंत्रीकृत और यंत्रीकृत वर्गों के बीच होनेवाले संघर्ष को दूर करने की साध्यतायें कम कर सकी है। अध्ययन से महसूस हुआ कि मत्स्यों के विपणन केलिये उचित संसाधन, भंडारण और वितरण सुविधायें लभ्य करने को एक सार्वजनिक अभिकरण की स्थापना आवश्यक है, क्यों कि दोनों उत्पादन और उपभोक्ता केलिये यह हितकारी होगा।

मात्स्यिकी का नवनीकरण करने की बात में कोचीन के लघु मत्स्यक अनुकूल है। मत्स्यन गिअरों के पसन्द के बारे में चलाये गये अध्ययनों ने व्यक्त किया कि पसन्द की दृष्टि से जालों में पहला आता है गिल जाल। इसके बाद यथाक्रम रिंग सीन और बोट सीन आते हैं। यानों में बाहरी इंजनों से सज्जित फलक निर्मित बोट उनको अधिक पसन्द है। मात्स्यिकी से सम्बन्धित ज्यादा समाचार, समाचार पत्रों में आया है। मात्स्यिकी सम्बन्धी समाचार के प्रचार केलिये रेडियो' मात्स्यिकी अफ़सरों का भाषण' फिल्म प्रदर्शन, प्रदर्शनियों आदि ने भी महत्वपूर्ण भूमिका निभायी है। समाचार पत्रों में मात्स्यिकी सम्बन्धी समाचार सिर्फ 6% था जबकि फसल सम्बन्धी पत्रिकाओं में यह 87% था। चावक्काड में मछुओं केलिये चलाये गय सेमिनार बहुत उपयोगी निकला। बीज संकलन और मत्स्य संसाधन पर भी कोर्सों चलाये गये।

वित्त सम्बन्धी अध्ययनों ने स्पष्ट किया कि मात्स्यन से प्राप्त आय कम होने के कारण मछुए अपना कर्ज नहीं दे पाया है। धन श्रोत की दृष्टि से मछुए देशीयकृत बैंकों को अधिमान देना चाहते हैं। उधार की वापसी देय में शिक्षा का स्तर' कुटुम्ब के सदस्यों का व कमाऊ सदस्यों की संख्या में कोई विशेष संबन्ध नहीं देख लिया।

पुस्तकालय और प्रलेख प्रभाग

वर्ष के दौरान संस्थान के अत्यावश्यक किताबों और पत्रिकाओं के अतिरिक्त मुख्यालय के पुस्तकालय में 60 किताबें 2639 पत्रिकायें और 24 अन्य पाठ्य वस्तुयें खरीदी गयीं। अन्तर पुस्तकालयीन उधार सहयोग और सन्दर्भ सुविधायें जारी रखीं।

इस अनुभाग से निम्नलिखित प्रकाशनें जारी किये गये।

1. इन्डियन जर्नल ऑफ़ फिशरीज खण्ड 34 (3 व 4)
2. सी. एम. एफ. आर. आइ स्पेशल पब्लिकेशन 41–44

3.	सी. एम. एफ. आर. आइ बुलेटिन	41 व 42 (1 व 2)
4.	मरैन फिशरीज इनफरमेशन सर्विस	76–90
5.	सी. एम. एफ.आर. आइ न्यूजलेटर	36–39
6.	आर. आन्ड डी सीरीस	17 व 18
7.	रिसर्च हाइलैट	1987–88
8.	सी. एम. एफ. आर. आइ वार्षिक रिपोर्ट	1986–87 व 1987–88

समुद्री संवर्धन में स्नातकोत्तर शिक्षा और अनुसंधान कार्यक्रम

वर्ष के दौरान कोचीन विज्ञान और तकनोलजी विश्वविद्यालय से 3 छात्रों को पी एच डी की उपाधि दी गयी। पी एच डी के एक छात्र ने उनका थीसिस और दूसरे ने सिनोपसिस प्रस्तुत किया। पाँचवाँ बैच के वरिष्ठ अध्येताओं ने उनके अनुसंधान कार्यक्रम पूरा किया। छठवीं और सातवीं बैच के छात्र अब अनुसंधान कार्य शुरु कर रहे हैं। 4 वरिष्ठ अध्येताओं को नबार्ड में ए. डी. ओ. के पद पर और 3 को वैज्ञनिक एस–1 के पद पर नियुक्ति मिली।

सातवीं बैच ने नवंबर में कोर्स पूरा किया जबकि नवीं बैच दिसंबर में दाखिल हुये। आठवीं और नवीं बैचें अब अध्ययन जारी कर रहे हैं। नवीं बैच से पुनरीक्षित पाठ्यक्रम लागू की गयी है।

कृषि विज्ञान केन्द्र और प्रशिक्षकों का प्रशिक्षण केन्द्र

कृषि विज्ञान केन्द्र के अधीन झींगा/मछली कृषि, झींगा/मछली बीज संग्रहण, संयोजित मत्स्य कृषि मछली संसाधन, प्राणी उत्पादन, उद्यानकृषि समूह वन विज्ञान और गृह विज्ञान में प्रशिक्षण कार्यक्रम चलाये गये। इस में कुल 995 कृषकों को प्रशिक्षण दिया गया। इसके अतिरिक्त पर-भक्षियों का निराकरण और मछली पकडने के बाद का तकनोलजी आदि पर निर्देशन दिया गया जिस में 125 कृषक भाग लिये। खारा पानी में मेटापेनिअस अफिनिस का संवर्धन करने की कोशिश की गयी लेकिन इनका अच्छा बढ़ाव न होने से अच्छा उत्पादन हुआ।

पकडी गयी समुद्र मत्स्य संपदा के निर्धारण केलिये प्रशिक्षण केन्द्र में मछली का हैचरी में उत्पादन, मछली पकडने के बाद का तकनोलजी और पकडी गयी मछली का प्रतिचयन तकनीकी पर प्रशिक्षण कोर्स चलाये गये। इन प्रशिक्षण कार्यक्रमों में आंध्रादेश, तमिलनाडु, केरल, महाराष्ट्र, गुजरात, के. वी. के और टाटा केमिकलस लिमटड के अफ़सरें भाग लिये।

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Shri. K.S. Krishnan
Shri. P. Thankappan — Foreman

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Shri. A. Ganapathy
Shri. V. Edwin Joseph — *Sr. Lib. Asst.*
Shri. T.K. Sudhakaran — *Bosun*

T-I-3

Technical Assistants

Shri. J.R. Ramalingam
Shri. M. Najmuddin
Shri. Hameed Batcha
Shri. M.R. Arputharaj
Shri. A. Muniyandhi — *Artist*

Motor Drivers

Shri. K. Karuppaiah
Shri. P. Krishnan
Shri. O. Muthukaruppan
Shri. R. Marimuthu — *Painter-cum-Polisher*

T-2

Jr. Technical Assistants

Shri. P. Thillairajan
Shri. R. Subramanian
Shri. M. Bose
Shri. S.M. Meerasa
Shri. M. Mohideen Abdul Kader — *Boat Driver*

Deckhands

Shri. V. Vedanayagam
Shri. Muniswamy
Shri. M. Ibrahim
Shri. T.P. Haridasan — *Carpenter*

T-1

Shri. N. Ramamurthy — *Museum Asst.*
Shri. R. Sekhar — *Deckhand*
Shri. M. Rengan — *Boat Cook*
Shri. A. Gandi

Ministerial Staff

Shri. M.P. Lakshmanan — *Asst. Adm. Officer*
Shri. A. Sethubhaskaran — *Supdt.*

Assistants

Shri. V. M. Mariappan
Shri. P.K. Sakkarai

Senior Clerks

Shri. A Kajendran
Shri. K. Margathavadivelu
Shri. S. Nagarajan
Shri. V. Chandran
Shri. P. Selvaraj
Ms. N. Gomathy — *Jr. Stenographer*

Junior Clerks

Shri. A. Yagappan
Shri. N. Natarajan
Shri. S. Muthumari
Shri. S. Parisa
Ms. M. Rameshwari
Ms. Santha Prasad

Supporting Staff

SSG-IV

Lab. Attendants

Shri. S. Mohamed Yousuff
Shri. K. Muthuramalingam
Shri. K. Gopalakrishnan

SSG-III

Lab. Attendants

Shri. M. Chinnasamy
Shri. R. Vellayan
Shri. S. Muthuramalingam
Shri. M. Ibrahimsha
Shri. A. Muniasamy
Shri. E. Natarajan

Fieldmen

Shri. A. Raman
Shri. A. Subramanian
Shri. S. Mani
Shri. R. Nagan
Shri. S.S. Pitchai — *Daftry*

SSG - II

Shri. J. Balasubramanian — *Daftry*
Shri. M. Athimoolam — *Cook*

Watchmen

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

Safaiwala

Shri. L. Sathan
Shri. R. Thottichi
Shri. G. Ankaiah
Ms. J. Kondamma
Shri. R. Sevugan
Shri. M. Muthu
Shri. R. Alagan
Shri. M. Vellayan
Shri. V. Sanathanan
Shri K. Kuruvan
Shri. A. Mari
Shri. K. Gurusamy
Shri. S. Nagammal
Shri. R. Sonaimuthu

SSG - I

Lab. Attendants

Shri. S. Muruga Boopathy
Shri. N. Ramakrishnan
Shri. C. Ramadas

Fieldmen

Shri. M. Kuberaganeshan
Shri. K. Thangavel
Shri. A. Vairamani
Shri. N. Boominathan

Messengers

Shri. A. Palanichamy
Shri. M. Sahul Hameed
Shri. J. Padmanathan — *Lascar*
Shri. S. Kaliappan — *Khansama*

Pump Drivers

Shri. J. Hameed Sultan
Shri. G.K. Rajan

Watchmen

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

Safaiwala

Shri. K. Subramanian
Shri. S. Arumughan
Shri. V. Narasimmabharathi
Shri. U. Rajendran
Shri. S. Murugan

Nagapattinam Field Centre

Shri. V. Sivasamy — T-I-3
Shri. V. Thanapathi — T-2
Shri. A. Somu — T-2

Pattukottai Field Centre

Shri. A.P.P. Mudaliar — T-4
Shri. P. Palani — T-2
Shri. K. Muthiah — T-2
Shri. A. Kumar — T-1

Veraval Research Centre

Scientific Staff

SCIENTIST S-2

Dr. E. Vivekanandan
Shri. Alexander Kurian
Dr. S. Shanmugam

SCIENTIST S-1

Dr. C. Gopal

Technical Staff

T-I-3

Shri. Y.D. Savaria — *Tech. Asst.*

T-2

Jr. Technical Assistants

Shri. H.K. Dhokia
Shri. B.P. Thumber

T-1

Field Assistants

Shri. Ladani Amruthalal Arjanbhai
Shri. B.A. Ponchabhai
Shri. P. J. Premji
Shri. M.S. Zala
Shri. J. D. Vanvi
Shri. G.N. Chudasama — *Motor Driver*
Shri. M.M. Bhaskaran

Ministerial Staff

Shri. J.N. Jambudiya — *Jr. Clerk*

Supporting Staff

SSG-II

Watchmen

Shri. Asiri Abu Bin Mehsan
Shri. I.M. Waghela
Shri. H. M. Bhint
Shri. M.K. Makvana

Rander Field Centre

Shri. M. Chellappan — T-2
Shri. Yoamisasa — T-1

Jamnagar Field Centre

Shri. B.V. Makadia — T-1

Bombay Research Centre

Scientific Staff

SCIENTIST S-3

Dr. (Ms.) P.V. Kagwade

SCIENTIST S-2

Shri. Kuber Vidyasagar

SCIENTIST S-1

Shri. S.K. Chakraborthy
Shri. K. S. Sundaram
Shri. M. Zaffar Khan
Shri. M. Aravindakshan
Shri. V.D. Deshmukh
Shri. S. G. Raje
Shri. V.V. Singh

Technical Staff

T-7

Shri. J.P. Karbhari — *Field Officer*

T-4

Shri. M. Shriram — *Sr. Tech. Asst.*

T-I-3

Technical Assistants

Shri. K.B. Waghmare
Shri. J.L. Oza

T-2

Jr. Technical Assistants

Shri. C.J. Josekutty
Shri. A.D. Sawant

T-1

Field Assistants

Shri. J. R. Dias
Shri. B. B. Chavan
Shri. K. R. Mainkas
Shri. B. G. Kalpate
Shri. J. D. Sarang
Shri. A. Y. Mistry
Shri. P.S. Gadankush — *Messenger*

Ministerial Staff

Shri. B. Vijayakumar — *Assistant*

Senior Clerks

Ms. P.V. Shanbhag
Shri. M.R. Wadadekar
Ms. A.A. Sawant — *Jr. Clerk*

Supporting Staff

SSG - IV

Shri. B.T. Talpade — *Lab. Attendant*

SSG - III

Shri. R.B. Bhangare — *Fieldman*

SSG - II

Watchmen

Shri. K.G. Tawade
Shri. S.M. Tandel

SSG - I

Shri. P.S. Selvi — *Messenger*
Shri. A. Srinivasan — *Motor Driver*

Malvan Field Centre

Shri. A. Prosper — T-2

Janjira Murud Field Centre

Shri. D.G. Jadhav — T-1

Dhanu Field Centre

Shri. S.D. Kamble — T-1

Ratnagiri Field Centre

Shri. B.N. Katkar — T-1

Karwar Research Centre

Scientific Staff

SCIENTIST S - 3

Shri. M.H. Dhulkhed

SCIENTIST S - 2

Shri. G.G. Annigeri
Dr. V.S. Kakati

SCIENTIST S - 1

Shri. K. Y. Telang
Shri. P. Krishnakumar
Shri. P.K. Asokan

Technical Staff

T-2

Jr. Technical Assistants

Shri. C.K. Dinesh
Shri. N. Chennappa Gowda
Shri. V. Varadaiah — *Motor Driver*

T-1

Field Assistants

Shri. V.M. Dhareshwar
Shri. D.B. Harikantra
Shri. U.V. Arghekar
Shri. S.V. Pai
Shri. K.C. Pandurangachar
Shri. A.N. Bardhotkar
Shri. M.M. Bhaskaran

Ministerial Staff

Shri. G.K. Kudalkar — *Assistant*
Shri. Y. H. Gamanagatti — *Sr. Clerk*

Junior Clerks

Shri. Gangadhar B. Naik
Shri. Ganesh R. Nadig

Supporting Staff

SSG - IV

Fieldmen

Shri. S.B. Harkantar
Shri. G.M. Korar

SSG - III

Shri. G.V. Naik — *Fieldman*

SSG - II

Shri. M.P. Harikantra — *Oilman*
Shri. M.E. Durgekar — *Lascar*

Watchmen

Shri. L.K. Suvarna
Shri. M.R. Kotharkar

SSG - I

Ms. Somi M. Harijan — *Sweeper*

Watchmen

Shri. C. Jogalekar
Shri. Manju M. Gond

Goa Field Centre

Shri. Ramesh B. Kamble — T-1
Shri. Prakash C. Shetty — T-1
Shri. Subash K. Naik — SSG - 1

Mangalore Research Centre

Scientific Staff

SCIENTIST S - 3

Shri. K.V. Narayana Rao
Dr. M. Vasudev Pai

SCIENTIST S - 2

Shri. K.K. Sukumaran
Shri. Madan Mohan

SCIENTIST S - 1

Shri. G.M. Kulkarni
Shri. P.U. Zacharia
Shri. Sunil Kumar Mohamed
Ms. M.P. Molly

Technical Staff

T-1-3

Technical Assistants

Shri. G. Subramanya Bhat
Ms. Alli C. Gupta
Ms. Uma S. Bhat

T-2

Jr. Technical Assistants

Shri. K. Chandran
Shri. B. Shridhara
Shri. D. Nagaraja
Shri. S. Kemparaju

T-1

Field Assistants

Shri. H.S. Mahadevaswamy
Shri. Y. Muniyappa
Shri. H. Vasu
Shri. Baramu S. Melinmani
Shri. C.H. Vaman Naik
Shri. R. Appaya Naik

Ministerial Staff

Shri. Balakrishna Naik — *Assistant*
Shri. K.M. Abdulla — *Sr. Clerk*

Junior Clerks

Shri. K. Rama Naik
Ms. Martha R. Mascarenhas

Supporting Staff

SSG - III

Shri. H. Rajaram — *Fieldman*

SSG - II

Shri. U.B. Sadashiva — *Lascar*
Shri. Mohan S. Puthran — *Oilman*

Watchmen

Shri. G. Sampath Kumar
Shri. Ramanna Sapaliga

SSG - I

Ms. Padmavathy
Shri. P.K. Retnakumar

Watchmen

Shri. A. Keshava
Shri. D. Gangadhara Gowda

Auxilliary Staff

Shri. A. Rajan — *Motor Driver*

Bhatkal Field Centre

Shri. Maruti S. Naik — T-1
Shri. Ganesh Bhatkal — T-1

Calicut Research Centre

Scientific Staff

SCIENTIST S - 3

Shri. M. Kumaran

SCIENTIST S - 2

Dr. R.S. Lal Mohan
Dr. P.S. Kuriakose

SCIENTIST S - 1

Shri. M. Ferozkhan
Ms. P.T. Sarada
Shri. M. Sivadas
Shri. C.V. Mathew

Technical Staff

T-4

Sr. Technical Assistants

Shri. K. Nandakumaran
Shri. K.K. Balasubramanian
Shri. T. Girijavallabhan
Shri. K. Soman
Shri. U. Suresh
Ms. S. Lakshmi
Ms. K. Koumudi Menon

T - 1 - 3

Shri K.P. Vishwanathan — *Tech. Asst.*

T - 2

Jr. Technical Assistants

Shri. M.P. Sivadasan

Shri. V.G. Surendranathan

Ms. P. Swarnalatha

Ms. V.K. Janaki

T-1

Field Assistants

Ms. Lalitha Sekharan

Shri. Ashok Kumar Meena

Ms. Emiliyamma K.G.

Ministerial Staff

Senior Clerks

Ms. C. Kamalakshi

Ms. P. Subhadra

Junior Clerks

Shri. R. Sreenivasan

Ms. Shylaja K.P.

Supporting Staff

SSG - IV

Lab. Attendants

Shri. K. P. Haridas

Shri. P. Abdurahiman

SSG - III

Lab. Assistants

Shri. P. Sukumaran

Shri. M. Ravindran

Shri. V.K. Krishnankutty

Fieldmen

Shri. Raveendran Andi

Shri. K. Kumaran

Shri. K. Janardhanan

Shri. K. E. J. Victor — *Watchman*

SSG - I

Lab. Attendants

Shri. P. Dasan

Shri. T. Haridasan

Watchmen

Shri. A. Sivadasan

Shri. A. Chekutty

Safaiwala

Shri. Palaniappan

Ms. N. M. Ponnamma

Shri. B. Raju — *Lab. Attendant*

Auxilliary Staff

Shri. B.K. Velukutty — T-2

Cannanore Field Centre

Shri. T. Krishnan Kutty — T-2

Shri. K.C. Purushothaman — T-1

Vizhinjam Research Centre

Scientific Staff

SCIENTIST S - 3

Dr. C.S. Gopinadha Pillai

SCIENTIST S - 2

Shri. C. Mukundan

Dr. P.A. Thomas

Shri. K.K. Appukuttan

Dr. S. Lazarus

Ms. Rani Mary George

Shri. G.P. Kumaraswamy Achary

Shri. K. Prabhakaran Nair

Shri. G. Gopakumar

SCIENTIST S - 1

Shri. K.K. Philipose

Ms. S. Jasmine

Technical Staff

T-5

Sr. Technical Assistants

Shri. T. Prabhakaran Nair

T-4

Shri. K. Ramachandran Nair

Shri. P.S. Sadasiva Sarma

Shri. R. Bhaskaran Achari

Shri. Jacob Jerald Joel

Shri. S.G. Vincent

Shri. R. Vasanthakumar

T - II - 3

Shri. Thomas Teles — *Bosun*

T-2

Jr. Technical Assistants

Ms. T.A. Omana

Shri. K. T. Thomas

Shri. A.K. Velayudhan

Shri. S. Ramachandran Nair — *Motor Driver*

T-1

Shri. K. Sashidharan Pillai — *Tech. Asst.*

Deckhands

Shri. P. M. Hariharan
Shri. V.P. Bensiger
Shri. P. Hilary
Shri. C. Unnikrishnan
Shri. V.M. Mana Alwaris
Shri. K.C. Gopalan — *Cook*

Ministerial Staff

Senior Clerks

Shri. M. Abdul Salam Sahib
Shri. S. Erishikesan

Junior Clerks

Shri. C. Johnson
Shri. M. Reghunathan

Supporting Staff

SSG - IV

Lab. Attendants

Shri. J. Anselam
Shri. C.M. Rajappan

SSG III

Shri. V. Sasidharan Pillai — *Lab. Asst.*

SSG - II

Shri. A. Ayyappadas — *Peon*
Shri. K. Chandran — *Safaiwala*

Watchmen

Shri. V. Vishwanathan
Shri. R. Madhusudhanan Nair

SSG - I

Shri. V. Kochunarayanan Nair — *Watchman*
Shri. S. Antony — *Messenger*

Tuticorin Research Centre

Scientific Staff

SCIENTIST S - 3

Dr. K. A. Narasimham

SCIENTIST S - 2

Dr. A.C.C. Victor
Shri. A. Chellam
Shri. S. Dharmaraj
Shri. M. E. Rajapandian
Shri. P. Muthiah
Shri. K. Ramdoss
Shri. P. Sam Bennet
Shri. K.M.S. Ameer Hamsa
Dr. H. Mohamed Kasim
Dr. D.B. James
Dr. M. Rajamani
Dr. C.P. Gopinathan
Shri. Pon Siraimeetan
Shri. R. Marichamy
Dr. D.C.V. Easterson
Shri. D. Kandasamy

SCIENTIST S - 1

Shri. T.S. Velayudhan
Shri. D. Sivalingam
Ms. Rani Palanisamy
Shri V.S. Rengasamy

Technical Staff

T-4

Sr. Technical Assistants

Shri. K. Ramakrishnan Nair
Shri. N. Retnasamy
Shri. I.P. Ebenezer
Shri. R. Gurusamy
Shri. C.T. Rajan
Shri. P. Feroz Khan — *Bosun*

T-II-3

Technical Assistants

Shri. J. X. Rodrigo
Shri. T.S. Balasubramanian
Shri. A.D. Gandhi
Shri. M. Manikaraja
Shri. N. Palanisamy

T-I-3

Technical Assistants

Shri. D. Sundararajan
Shri. O.J. Habeeb Mohamed
Shri. M. Selvaraj

Drivers

Shri. A. Dasman Fernando
Shri. F. Soosai V. Rayan
Shri. K.C. Dandapani — *Serang*

T - 2

Jr. Technical Assistants

Shri. N. Vaidyanathan
Shri. K. Sreenivasagan

Shri. M. Enose
Shri. G. Arumugham
Shri. S. Rajapackiam
Shri. Xavier Mohandoss — *Motor Driver*
Shri. E. Shivanandam — *Boat Cook*
Shri. N. Jesuraj — *Driver*

T-I

Field Assistants

Shri. K. Shanmugasundaram
Shri. S. Mohamed Sathakthullah
Shri. A. Athipandian

Motor Drivers

Shri. A.K. Alagirisamy
Shri. K. K. Gurusami

Deckhands

Shri. D. Bosco Fernando
Shri. S. Enasteen
Shri. R. Arockiasamy
Shri. D. Anandan

Ministerial Staff

Shri. M. Subbiah — *Superintendent*
Shri. D. Ganajebamani — *Assistant*

Senior Clerks

Shri. N. Sivaramakrishnan
Shri. S. Jeyachandran
Shri. J. Uthamanabbi
Shri. B. Bavanandam
Shri. S. Antony George Ratnam

Junior Clerks

Ms. Kamala Venkataraman
Ms. S. Sarada
Ms. C. Rajeshwari
Ms. S. Leelavathi — *Jr. Stenographer*

Supporting Staff

SSG - IV

Shri. A. Francis — *Lab. Attendant*

SSG - III

Lab. Attendants

Shri. M. Ramadoss
Shri. P. Krishnan
Shri. Selvaraj Gomez

SSG - II

Shri. D. Motcham — *Daftry*

Watchmen

Shri. P. Mahalingam
Shri. S. Mani
Shri. M. Alfred
Shri. M. Thangavelu
Shri. K. Thangaraja
Shri. P. Muthumalai
Shri. V. Samayamuthu
Shri. B. Thangaraj — *Lascar*
Ms. S. Daisy — *Safaiwala*

SSG - I

Shri. R. Uchimahali — *Lascar*
Shri. Y. Balu — *Oilman*

Fieldmen

Shri. Y. Satyawan Neelraj
Shri. M. Muthuvel
Shri. P. Kandan
Shri. M. Sankaran
Shri. G.S. Rayappan
Shri. I. Ravindran
Shri. K. John James — *Gardener*

Safaiwala

Shri. P. Villiam
Shri. K. Kadarkarai

Auxilliary Staff

Shri. S.K. Guruswamy

Madras Research Centre

Scientific Staff

SCIENTIST S - 3

Dr. S. Ramamurthy
Dr. K. Satyanarayana Rao
Shri. M. S. Muthu

SCIENTIST S - 2

Shri. N. S. Radhakrishnan
Shri. R. Thiagarajan
Dr. P. Devadoss
Dr. P. Nammalwar
Shri. J.C. Gnanamuthu
Shri. G. Mohanraj
Shri. K. Devarajan
Shri. E. V. Radhakrishnan
Shri. M. Kathirvel

Shri. R. Sarvesan
Dr. P. Srinivasan
Shri. M. Vijayakumaran
Shri. K.G. Girijavallabhan
Shri. M. Rajagopalan
Dr. R. Paulraj

SCIENTIST S - 1

Shri. S. Srinivasarengan
Shri. Thangaraj Subramanian
Shri. P. Natarajan

Technical Staff

T-6

Shri. A. Bastian Fernando—*Field Officer*

T-4

Sr. Technical Assistants

Shri. K. Kandaswamy
Shri. M. Mohamed Sultan
Shri. S.K. Balakumar
Shri. A. C. Sekhar
Shri. P. Ramadoss

T-II-3

Technical Assistants

Shri. S. Palanisamy
Dr. R. Thangavelu

T-I-3

Technical Assistants

Shri. L. Jayashankaran
Shri. V. Rangacharylu
Shri. K. Kader Batcha
Shri. S. Subramani
Shri. K. Seetharaman
Shri. G. Natarajan — *Motor Driver*

T-2

Jr. Technical Assistants

Shri. M. Manimaran
Shri. S. Chandrasekhar
Shri. A. Ramakrishnan
Shri. K. Shahul Hameed
Shri. P. Thirumulu
Shri. P. Poovannan
Shri. G. Sreenivasan

Motor Drivers

Shri. K. Ratna Kumar
Shri. K. Pandi
Shri. D. Padmanabhan — *Boat Driver*
Shri. Voli Mohamed — *Boat Cook*

Deckhands

Shri. K. Parasuraman
Shri. C. Manipal

T-1

Field Assistants

Shri. S. Mohanan
Shri. Ahmed Kamal Basha

Ministerial Staff

Assistants

Shri. K. Narayanan
Shri. K. M. Karuppiah

Senior Clerks

Ms. S. Mangalam
Shri. S.K. Murali
Shri. S. Balasubramanian
Ms. M. Parvathy
Ms. G. Abitha

Junior Clerks

Ms. B. Lalitha
Ms. P. Thankaleelal
Ms. Rosy Joachim — *Stenographer*

Supporting Staff

SSG - III

Lab. Attendants

Shri. V. Ramachandran
Shri. G. Soundararajulu
Shri. M. Vellayan

Messengers

Shri. M. Ravindran
Shri. S. Rajan

SSG - II

Safaiwala

Shri. G. Vijayarengan
Ms. Merry Rayalamma

SSG - I

Watchmen

Shri. A. Janakiraman
Shri. N. Ashokkumar
Shri. G. Chakrapani

Shri. T. Nagalingam
Shri. S. Inbamani

Fieldmen

Shri. V. Manoharan
Shri. R. Sundar
Shri. R. Vasu
Shri. P. Selvaraj — *Safaiwala*

Auxilliary Staff

Shri. Joseph Xavier — *Deckhand*

Cuddalore Field Centre

Shri. A. Srinivasan — T-I-3

T-2

Shri. M. Manivasagam
Shri. T. Dhandapani
Shri. M. Radhakrishnan

Pondicherry Field Centre

Shri. L. Chidambaram — T-I-3

Mahabalipuram Field Centre

Shri. S. Manivasagam — T-4

Ongole Field Centre

Shri. A. Hanumantha Rao — T-I-3
Shri. T. Chandrasekara Rao — T-I-3

Nellore Field Centre

Shri. G. C. Lakshmaiah — T-4

Kovalam Field Centre

Shri. S. Sankaralingam — T-2

SSG-II

Messengers

Shri. M. Anbu
Shri. D. Pakkiri
Shri. M. P. Chandrasekar — SSG-I
— *Watchman*

Kakinada Research Centre

Scientific Staff

SCIENTIST S-2

Dr. V. Sriramachandra Murty
Shri. C. Muthiah
Dr. G. Syda Rao
Dr. (Ms.) S. Lalitha Devi

Technical Staff

T-II-3

Technical Assistants

Shri. P. Ramalingam
Shri. K. Chittibabu

T-I-3

Shri. K. Dhanaraju — *Tech. Asstt.*

T-2

Shri. K. Dharma Rao — *Motor Driver*

T-1

Shri. T. Nageswara Rao — *Field Asst.*

Ministerial Staff

Shri. E. Appa Rao — *Junior Clerk*

Supporting Staff

SSG - III

Shri. K. Narasimhamurty — *Lab. Att.*

SSG - II

Shri. R.V.S. Subramanyan — *Watchman*

SSG - I

Shri. S. Tatabhai — *Messenger*

Machalipatnam Field Centre

Shri. K.V.S. Seshagiri Rao — T-4

Narsapur Field Centre

Shri. P. Ananda Rao — T-4

Visakhapatnam Research Centre

Scientific Staff

SCIENTIST S-3

Dr. K. Radhakrishna
Dr. G. Luther

SCIENTIST S-2

Dr. T. Appa Rao
Shri. S. Reuben
Dr. Sudhakara Rao
Shri. Appanna Sastri

SCIENTIST S-1

Shri. G. Radhakrishnan
Shri. K. Vijayakumaran

Technical Staff

Sr. Technical Assistants

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

T-II-3

Technical Assistants

Shri. B. Narayana Rao
Shri. U. Alagamalai

T-I-3

Shri. K. Ramasomayajulu — *Tech. Asst.*

T-2

Jr. Technical Assistants

Shri. K. Narayana Rao
Shri. J. B. Varma
Shri. M. S. Sumithrudu
Shri. S. Satya Rao
Shri. M. Chandrasekhar

T-1

Field Assistants

Shri. S. Chandrasekhar
Shri. M. Prasad Rao
Shri. James George — *Engine Driver*
Shri. A.K. Unnikrishnan — *Cook*

Deckhands

Shri. S. Ganeshan
Shri. P.M. Abdul Moheedu
Shri. S. Hemasundara Rao

Ministerial Staff

Shri. R. Appa Rao — *Assistant*
Ms. B. Gowri — *Jr. Clerk*

Supporting Staff

SSG - III

Shri. V. Mohana Rao — *Lab. Asst.*

SSG - II

Shri. Rajan — *Peon*

Watchmen

Shri. R. Kanakaraju
Shri. V. Demudu
Shri. P. Krishna Rao
Shri. S. Appa Rao
Shri. R. Dalayya — *Safaiwala*
Shri. L. Appa Rao — *Messenger*

Auxilliary Staff

Motor Drivers

Shri. P. Pashupathi Rao
Shri. S. Doraipandian

Contai Field Centre

Shri. S.S. Dan — T-7
Shri. Sapan Kumar Ghosh — T-I-3
Shri. Pulin Behari Dey — T-1
Shri. Prasanta Kumar Das — SSG-1

Puri Field Centre

Shri. P.V. Krishna Rao — T-2
Shri. Sukdev Bar — T-1

Gopalpur Field Centre

Shri. Ch. Ellithathayya — T-2

Palasa Field Centre

Shri. V. Achutha Rao — T-2

Srikakulam Field Centre

Shri. N. P. Chandra Kumar — T-1

Minicoy Research Centre

Scientific Staff

SCIENTIST S-3

Dr. P. Parameshwaran Pillai

SCIENTIST S-2

Shri. T. M. Yohanan

Supporting Staff

SSG - III

Shri. D. Kojan Koya — *Fieldman*

Lab. Attenders

Shri. C. Mohammed Koya
Shri. K. Kunjukunju

SSG - II

Watchmen

Shri. P.I. Koya
Shri. N. Pookoya
Shri. O. Ismail

Agathi Field Centre

Shri. K.P. Said Koya — SCIENTIST S-1

Krishi Vigyan Kendra/ Trainers' Training Centre

Scientific Staff

SCIENTIST S - 3
Dr. M.M. Thomas

SCIENTIST S - 2
Shri. N. Kalaimani

Technical Staff

T-6

St. Training Asst.

Shri. P. Karunakaran Nair
Shri. K. Ashokakumaran Unnithan
Shri. K.N. Rasachandra Kartha
Dr. P.K. Martin Thomas

T-5

Training Assistants

Shri. A. N. Mohanan
Shri. P. Radhakrishnan

T-4

Training Assistants

Shri. K. Purushothaman Kani
Ms. P. Sreelatha

T - II - 3

Shri. N. B. Gopalakrishna Menon — *Bosun*

T-2

Shri. M. N. Appukuttan Nair — *Motor Driver*

T - 1

Shri. K.K. Bose — *Boat Driver*
Shri. K. Raju — *Cook*

Ministerial Staff

Superintendents

Shri. N. Rajamuniswamy
Shri. P. Aaithappa Naik
Shri. C. Balamanundinathan — *Asst.*
Ms. Christina Joseph — *Jr. Steno*
Shri. N.K. Mohanan — *Jr. Clerk*

Supporting Staff

SSG - III

Fieldmen

Shri. K.P. John
Shri. N. K. Asokan

SSG - 1

Watchmen

Shri. P. K. Chellappan
Shri. K.C. Rajappan
Shri. K.G. Bhaskaran Nair — *Messenger*
Ms. Chinnamma Anjelo — *Safaiwala.*