ANNUAL REPORT FOR 1976

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

COCHIN

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

CONTENTS

INTRODUCTION

The research programmes of the Institute were considerably re-oriented during the year 1976 in keeping with the objectives of the Fifth Five Year Plan as proposed by the Institute and later approved by the Council. The research projects were modified with specific time-targeted problems and in all, 68 such problems were handled during the year and very good progress was shown in the investigations taken up by the scientific staff. The important features of the work done during the year are summarised below:

Marine fish landings in India during the year 1976 have been estimated at 1.35 million tonnes as against 1.42 million tonnes in 1975. The landings along the west coast accounting for about 68.7 per cent showed a decline by about 6.3%. Those along the east coast amounted to 31.3% showing an decrease of 1.8 per cent. The landings of oil sardine and mackerel showed improvement while in the case of Bombay duck and shrimps the decline was noticeable.

The forecast made that the relative abundance and catch of oil sardine will be less in the first half of 1976 than that during the first half of 1975 has been found to be true in Kerala which normally accounts for the bulk of the catch of this species but not in Karnataka. An important development has been the introduction of purse seines commercially for the oil sardine fishery in Goa and Karnataka. The occurrence of oil sardine shoals in Bombay has indicated the possibility of developing a fishery there.

The forecast made that the abundance and catch of mackerel would be better in the first half of 1976 than in the first half of 1975 has been found to be true in Karnataka but not in Kerala

as a whole. After April the main shoals had withdrawn from the coastal waters and had either dispersed or taken to sub-surface layers and were then operated by gill-nets, hook and line and trawl nets. In the case of mackerel also, purse seine has been introduced into the fishery in Goa and Karnataka.

Fish culture work in the salt pan area at Tuticorin has been progressing satisfactorily and thousands of mullet fry and *Chanos* fry have been stocked in 5 ponds. Crabs have also been stocked. Elver resources survey were undertaken in 68 centres in Tamil Nadu and 47 centres were found suitable for collection of elvers. Experiments have shown that live elvers could be transported over a period of at least 10 hrs. in specially made wooden frames or polythene bags.

In the Prawn Culture Laboratory at Narakkal, techniques of controlled spawning of commercially important species of prawns and rearing of larvae on a large scale to stocking size have been further improved. The results of experiments have indicated the feasibility of initiating large scale production of seed of desired species for wider propagation.

Experiments on air-lifting of the larvae of *Penaeus indicus* and *Metapenaeus dobsoni* reared in the Narakkal laboratory for propagation in far off places have proved successful. The Director, CMFRI presented a consignment of air-lifted prawn larvae to the Chief Commissioner of Andaman administration for initiating prawn culture in the brackish waters of the Territory.

At Madras success has been achieved in rearing pueruli and post-pueruli of certain species of commercially important Indian spiny lobsters. The larvae were observed to grow readily on the food provided and are proved to be sufficiently hardy to withstand the controlled conditions. Scientists are now exploring the possibility of economically culturing these lobsters in suitable marine enclosures by largescale stocking of these early larvae which could be collected with the aid of specially devised pueruli collectors.

The feasibility of culturing mussels on suspended substrata along the open coastal waters has been established at Calicut. The yield of mussels after an interval of 5 months was observed to be as high as 600 kg from 66 kg of young seeded mussel.

Similarly experiments on the domestication of edible mussels yielded excellent results at Madras where culture of these molluscs

were carried out on rafts in the open sea. Good growth rate of the seeded mussels were observed during the subsequent months.

The continued investigations on the mud-bank formation along the Kerala Coast is leading to the conclusion that mudbanks are formed as a result of subterranean mud brought up in the form of 'Volcanoes' or huge mud cones. The impact of the mud bank formation on the fisheries of this region has been comprehensively studied.

Fishery oriented environmental studies have been intensified at all the centres. Special emphasis has been given on pollution aspects in relation to protection of living resources.

Resources survey of commercially important molluscs was undertaken along the east and west coasts. The southeast coast was observed to be rich with populations of wedge clam, *Donax cuneatus*. Near Kakinada, window pane oysters were abundant.

Studies on Pearl oysters and chanks brought to light the occurrence of considerable number of oyster spats in the south west coast at Vizhinjam and large population of chanks off Porto Novo. The Palk Bay chank fishing industry was a great success, landing about 4,25,000 chanks along the coast upto Point Calimere.

Seed resources surveys conducted along the Kerala Coast revealed luxuriant growth of mussels on the sea walls erected in the sea as part of sea erosion work.

Brief history of the Institute

The Central Marine Fisheries Research Institute was established in February 1947 under the Union Ministry of Food and Agriculture. In October 1967 the administrative control of the Institute was transferred to the Indian Council of Agricultural Research, New Delhi.

Objectives of the Institute

i. To estimate the catches of marine fishes and other animals from the seas around India throughout the year by different types of vessels and gears and the effort expended,

ii. to conduct researches on marine fisheries resources in order to step up their production to the maximum possible extent.

iii. to locate new fishing grounds and untapped resources; to conduct environmental studies in relation to fisheries,

iv. to recommend measures for the rational exploitation of the various resources,

v. to develop techniques for the culture of suitable species of marine animals and plants for augmenting natural production, and

vi. to organise suitable education, extension and training programmes so as to transfer the technology to the masses.

Organisational set-up

The Institute has five divisions, *viz*. Fishery Resources Assessment, Fishery Biology, Crustacean Fisheries, Molluscan Fisheries and Fishery Environment. The subordinate establishments include Regional Centre at Mandapam Camp and Research Centres at Veraval, Bombay, Karwar, Mangalore, Calicut, Vizhinjam, Tuticorin, Madras, Waltair, Kakinada, Minicoy and Port Blair; and 30 Field Centres along the east and west coasts of India.

Library

During the year, the *Indian Journal of Fisheries* Vol. 21 No. 2, CMFRI Bulletin No. 27 entitled 'Exploited Marine fishery resources of India : A synoptic survey with comments on potential resources' and CMFRI News letter Nos. 3 and 4 were published.

About 558 books and 500 new numbers of periodicals were added to the library. As usual the library facilities were utilized by different Universities, Institutes, Central and State departments and interested individuals.

Training offered

A six month Pearl Culture Technicians Training Course under the Scheme on Pearl Culture was successfully conducted by the Institute at Tuticorin from 24–9–76 and 7 trainees received certificates on the completion of the course on 14–3–1977.

Shri Bidyadar Nayak of Sterling Chemicals, Calcutta, was given training in the preparation of Agar-agar by different processes.

Deputation abroad

Shri S. K. Dharmaraja, Scientist S-I was deputed to undergo 6 month training in population dynamics at CSIRO, Cronulla, Australia under the Colombo Plan Training Programme.

Advisory/Consultancy service provided

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

1. ICAR representative on the General Council and Executive Committee of the Kerala Agricultural University, Mannuthy, Trichur.
2. Member on the joint ICAR-ICSSR Scientific Panel for Social Sciences and Agricultural Extension.
3. Member, Programme Priorities and Cruise Committee for the National Institute of Oceanography, Goa.
4. Member, Research Advisory Committee of the Kerala Agricultural University, Trichur.
5. Member, Kerala State Fisheries Research Committee.
6. Member, Central Advisory Committee on Exploratory Survey of Marine Fisheries.
7. Member, Tamil Nadu State Fisheries Research Council.
8. Member, Regional Committee No. 8 (constituted by the Governing Body, ICAR).
9. Member, Scientific Panel for Fisheries Research, ICAR.
10. Member, Kerala State Fishery Advisory Board.
11. Member, High Level Aquarium Committee—Construction of a Marine Aquarium at Cochin.
12. Member in the Committee on Fisheries and other Aquatic Resources of the State Committee on Science and Technology, Kerala.

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

14. Member, Faculty of Marine Sciences, University of Cochin.

15. Member, Executive Council and Vice-President, Indian Society of Ichthyologists, Madras.

16. Member, the Board of Management of Konkan Krishi Vidyapeeth, Dapoli, Maharashtra.

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

18. Member, Scientific Panel for Fisheries of the ICAR for a period of three years from 1-3-'76.

19. Member, Board of Studies in Zoology (post-Graduate) and Zoology (General and Pass) of the University of Madras for a period of three years from 20-3-76.

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

II. Dr. K.V. Sekharan, Senior Fishery Scientist, served as a member of the Review Committee on the work of the Research Stations of the Kerala State Fisheries Department. He also served as Examiner for M.Sc. Degree examination in Marine Biology, Department of Marine Sciences, University of Cochin.

III. Dr. P. V. Ramachandran Nair, Junior Fishery Scientist, served as member of the panel for marine disposal of effluents of the Indian Standards Institution.

IV. The Institute extended its consultancy service to the various departments of the Government at the Centre and at the States, the International bodies such as, the FAO, to Scientific organisations, to the Industry and individuals on various kinds of fisheries problems and answered hundreds of queries.

Fellowships and Scholarships

5 Research Scholars under the Government of India, Ministry of Education Scholarship scheme and 18 Research Scholars under ICAR Fellowship scheme were carrying out research work on various problems.

List of distinguished visitors

1. Dr. P. R. Pisharodi, Director, Physical Research Laboratory, Ahmedabad, visited the Institute on 16–1–76.

2. Mr. Rodney Jonklaas, Underwater expert, Sri Lanka, visited the Institute on 19–3–76.

3. Mr. John Christiensen, Norwegian Ambassador to India visited on 15–3–76.

4. Dr. Agmam Aga, Chief of Fisheries and Animal Husbandary Division, Indonesia, visited on 31–1–76.

5. Dr. Soegirato, National Agency for Export Development, Indonesia visited on 31–1–76.

6. Prof. S. Rajagopal, Professor of Geography, Grambling State University, Grambling, visited on 13–7–76.

7. Mr. K. H. Alikunhi, Project Manager, Brackishwater Project, UNDP, Indonesia, visited on 2–8–76.

8. Mr. T. Nischimura, Mr. S. I. Keda and Mr. Y. Konna representing Marine Products Export Association and Government of Japan, visited the Institute on 20–8–1976.

9. Dr. Leigh H. Hammond, Assistant Vice-Chancellor, North Carolina State University, Raleigh, N. Carolina U.S.A., visited on 13–7–'76.

10. Mr. G. B. Debling, Grimbsby College of Technology, U. K., visited on 23–9–'76.

11. Dr. M. S. Swaminathan, FRS, Director General, ICAR, Shri M. L. Shahare, Chairman, ASRB, Shri K. P. Singh, Secretary, ICAR, most of the Directors of the ICAR

Institutes, Deputy Directors General and other senior officers of the ICAR who visited Cochin in connection with the ICAR Directors' Conference visited the Prawn Culture Laboratory at Narakkal on 6-11-76.

Participation in Exhibitions/Symposia/Seminars

1. The Prime Minister, Shrimathi Indira Gandhi visited the exhibition conducted by the Institute at Waltair in connection with the Indian Science Congress during January 1976.

2. The Institute put up a stall at the exhibition conducted at the CIFT in connection with the inauguration of its new building in June 1976. The stall was visited by Dr. Jagjivan Ram, Union Minister of Agriculture, Shri K. Karunakaran, Home Minister of Kerala and many other distinguished personalities.

3. The Institute participated in the 'Open House' and Fisheries Fair conducted by the Integrated Fisheries Project at Cochin during January 1976.

4. The Institute participated in the exhibition organised in connection with the Diamond Jubilee celebrations of the CPCRI at Kasargode during December 1976.

5. The scientists of the Institute participated and presented papers at the National Seminar on environmental pollution conducted at Cochin during 6-8, May 1976.

6. The Director attended the 2nd Indian Seafood Trade Fair organised by the MPEDA and Seafood Exporters Association at Madras.

7. The Director attended the Seminar on 'Management of Research' held for the Directors of ICAR Institutes at the Administrative Staff College of India, Hyderabad during 27-4-76 to 1-5-76.

8. The Director delivered a lecture on 'Environmental Conservation' at Bharat Refineries, Cochin on 6-4-76.

9. The Director and other scientists participated in the Symposium on Warm Water Zooplankton held under the auspices of UNESCO/CSIR/NIO at Goa on 14–19 October, '76.

Retirement

Dr. R. V. Nair, Deputy Director has retired voluntarily with effect from 29–2–1976. Dr. Nair has served the Institute since 2–4–1947 in various capacities and officiated as Director on three occasions between 1964 and 1975.

Staff strength

The staff strength on 31–12–1976 was 862 sanctioned posts out of which 196 represented Scientific staff.

Budget

The actual expenditure incurred during the financial year ending March 1977 was:

Non-Plan	Rs. 48,19,500
Plan	Rs. 1,22,03,000

Staff Position — Appointment/relief, etc.

1. Dr. G. S. Sharma, Junior Fishery Scientist has been deputed to the University of Cochin to take up the post of Professor.

2. Shri G. P. Kumaraswamy Achari, Senior Research Assistant is deputed to Kerala Government to take up the post of Assistant Project Officer, Pilot Project on Pearl Culture, Vizhinjam.

3. Shri K. J. Joseph, RA, deputed to the University of Cochin to take up the post of Lecturer.

4. Smt. P. R. Krishnakumari Amma, Computor, deputed to Kerala Agricultural University to take up the post of Junior Statistician, Rice Research Station, Moncompu.

5. Shri M. Bhaskaran, RA, relieved at his request.

6. Shri A. R. Pawaskar Kadir, LFA, has resigned.

7. Shri M. P. Khadtale, LFA, service terminated.

8. Shri S. Rajagopalan, Administrative Officer has been appointed as Senior Administrative Officer w.e.f. 9–10–'76.

9. Shri P. Ramamurthy, Assistant Administrative Officer has gone on deputation as AAO in the National Bureau of Soil Survey, Nagpur.

10. The following persons have been appointed as Junior Scientific Assistants either on promotion or selection:

S/Sri. K. Ramasomayajulu, K. P. Viswanathan, C. T. Thankappan Pillai, Joseph Andrews, K. Chittibabu, S. Russel Conrad Samuel, N. Jayabalan, P. Radhakrishnan, V. Selvaraj, K. Dharmaraja, Joseph Xavier Rodrigo, V. A. Narayanan Kutty, S. Vijayabaskar, V. Sivaswamy, N. Palaniswamy, K. B. Waghmare, N. Sundaram, Kumari A. Kanagam, S/Shri. D. Vincent, K. Muniandi, K. Ramadoss Gandhi, J. R. Ramalingam, T. Chandrasekhara Rao, D. Sundrarajan, Y. D. Sivaraia, G. Subramanya Bhat, N. Salunke Madhukar, K. Muthiah, K. Balachandar, and M. Najmudeen.

11. The following persons have been appointed as Laboratory cum Field Assistants either on promotion or selection:

S/Shri S. Palanichamy, M. Gopala Prabhu, M. Seetharaman, Kumari K. Uma Kumari, S/Shri. N. S. Viswanath, Sapan Kumar Ghosh, Hameed Batcha, N. Surendranath, S. Subramanian and G. Krishna Murthy.

PROGRESS OF RESEARCH

FISHERY RESOURCES ASSESSMENT DIVISION

Salient findings

The marine fish landings in India during the year 1976 have been estimated at 1.35 million tonnes against 1.42 million tonnes in 1975. The landings along the west coast accounting for about 68.7% showed a decline by about 6.3% while those along the east coast accounting for 31.3% showed an decrease by about 1.8%.

Among the commercially important varieties of fishes, the landings of oil sardine and mackerel showed improvement while in the case of Bombay duck and shrimps a decline was discernable.

The effort expended in 1976 was 250,282,000 manhours against 284,625,000 manhours of 1975. Suitable mathematical models are being attempted to study the impact of fishing on the stock.

The census of Fishermen population has been completed in about 1600 fishing villages. Census in the remaining villages is expected to be covered in a short time.

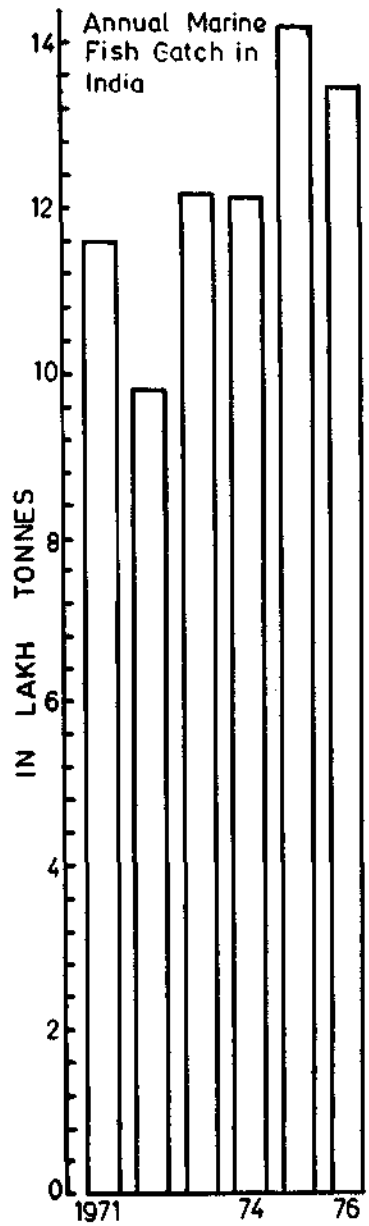
As the first phase of introducing ADP System in the Data Centre, three sets of Punches and Verifiers have been installed in the Division.

Sample survey for estimation of the marine fish production and effort expended to get the production from A-non-mechanised boats and B-mechanised boats (FSS/FRA/FS.1.1)

(M. S. Prabhu, M. G. Dayanandan, C. R. Shanmughavelu, S. K. Dharma Raja, P. Karunakaran Nair, Varughese Philipose K. Narayana Kurup, B. Prasanna Kumary, K. Balan, U. K. Satyavan, K. Vijayalekshmi, G. Balakrishnan, Computors & field staff)

Annual production of Marine Fish

The total marine fish production in India during the year 1976 was estimated at 1.35 million tonnes as against 1.42 million tonnes during 1975. The total landings in 1976 thus



Annual Marine fish landing in India during 1971–1976

showed a decline of about 4.3% as compared to 1975. This decline was mainly due to considerable decrease in total landings from

Kerala. The States of West Bengal, Andhra Pradesh, and Gujarat also exhibited declining trend in their marine fish landings. However, the total marine fish landings in Orissa, Tamil Nadu, Pondicherry, Karnataka, Goa and Maharashtra showed an increase over their landings in 1975. (Table 1).

Table 1. *State-wise marine fish landings in India (in tonnes)*

	State	1976	1975
1.	West Bengal	25,411	27,725
2.	Orissa	29,823	18,036
3.	Andhra	131,321	155,638
4.	Tamil Nadu	226,078	221,215
5.	Pondicherry	10,123	8,150
6.	Kerala	331,047	420,836
7.	Karnataka	95,283	87,494
8.	Goa	34,968	29,170
9.	Maharashtra	293,601	256,619
10.	Gujarat	171,294	193,775
11.	Andamans	1,334	1,104
12.	Lakshadweep	2,572	2,931
	Total	1,352,855	1,422,693

The landings in West Bengal decreased by about 2,300 tonnes during 1976 as compared to 1975. This forms about 8% decrease in the landings. Lesser catches of other clupeids and miscellaneous varieties were responsible for this decline.

However in Orissa an increase of about 12000 tonnes was noticed in 1976 over the landings in 1975. This was mainly due to increased catches of pomfrets and elasmobranchs. Other sardines showed a delcine in their catches.

In Andhra Pradesh a fall in estimates to the tune of about 25,000 tonnes was shared by other sardines, (10,000 tonnes) Leiognathus, (8,000 tonnes) cat fishes (3500 tonnes) Elasomobranchs (3,000 tonnes) and perches (3,000 tonnes). Declining trend was also noticed in the case of pomfrets, *Chirocentrus dorab*, seer fishes, eels, *Lactarius* sp. However anchovies showed an increase of about 4,000 tonnes in 1976 as compared to 1975.

In contrast to Andhra Pradesh, landings, in Tamil Nadu, during 1976, are about 5,000 tonnes more than the landings in

1975. In spite of lesser landings of other sardines, cat fishes, perches, and other fishes such as red mullets, *Lactarius* sp. etc., the higher landings of *Leiognathus* spp, other clupeids, makerel, crabs and ribbon fish maintained the increase in the overall landings in this State.

Pondicherry did not experience much fluctuation in its contribution as seen in other States. There was a slight increase in the total landings during 1976.

In Kerala the estimates for 1976 fell to 331,047 tonnes as compared to 420,836 tonnes in 1975. This sharp decrease (90,000 tonnes) was mainly due to decreased prawn landings. (43,000 tonnes). Other notable decreased landings were that of cat fishes (20,000 tonnes) perches, (12,000 tonnes) *Saurida & Saurus* spp(11,000 tonnes) Sciaenids (10,000 tonnes) and ribbon fish (7,500 tonnes). Miscellaneous species also contributed less in 1976. The notable feature was an increase in the landings of oil sardines the increase being 27,000 tonnes over that of in 1975. Increasing trend was also noticed in the landings of mackerel, tunnies, seer fish red mullets, *caranx* spp etc.

In Karnataka during 1976 the marine fish landings were more when compared to the estimates for 1975. Inspite of decrease in the catches of oil sardine and prawns the over all increase was maintained mainly by the increased landings of mackerel. Increased landings of *Leiognathus* spp, Sciaenids, cat fishes and miscellaneous fishes also contributed to offset the decrease in the landings of oil sardines and prawns as mentioned earlier.

In Goa the total estimates of marine fish landings showed an upward trend. The increase was to the tune of about 6,000 tonnes in 1976 when compared to 1975. Here also, though oil sardines showed deceasing trend, increase in catches of other sardines, prawns, ribbon fish, and crabs, resulted in the over all increase in the fish landings of this State.

The landings in Maharashtra in 1976 were higher by about 37,000 tonnes when compared to 1975. This increase was mainly due to the increase in the landings of penaeid prawns, pomfrets, eels and miscellaneous species.

In Gujarat also a decreasing trend in the landings in 1976 was clear when compared to 1975. This decrease was mainly due to

lesser catches of sciaenids, Bombay duck, *Pomfrets*, elasmobranchs and miscellaneous species. However increase in the landings of ribbon fish and *Lactarius* was also noticed.

Variety composition

The specieswise estimates of total marine fish landings during 1975 and 1976 are presented in table 2. As there are more than 200 commercially important species of fish landed in India specieswise estimates are given for major groups only.

The contribution of principal fisheries of India such as oil sardine, mackerel, *Harpodon nehereus* and prawns to the total catches was 513,348 tonnes (38%) during 1976 as compared to 5,25,552 tonnes (37%) during 1975. The decrease in these catches was mainly due to lesser landings of *Harpodon nehereus* and prawns. Landings of oil sardine and mackerel were comparatively better in 1976.

Table 2 The composition of total marine fish landings in India during 1975 and 1976 *(in tonnes)*

Sl.No.	Name of fish	1976	1975
1.	Elasmobranchs	54,605	65,230
2.	Eels	8,296	5,710
3.	Cat fishes	43,540	68,689
4.	*Chirocentrus*	10,368	11,813
5.	(a) Oil sardine	169,262	159,240
	(b) Lesser sardines	100,000	112,117
	(c) *Hilsa ilisha*	7,842	8,897
	(d) Other Hilsa	8,482	7,567
	(e) *Anchoviella*	30,069	30,744
	(f) *Thrissocles*	17,660	9,997
	(g) Other clupeids	57,164	52,786
6.	(a) *Harpodon nehereus*	87,075	99,614
	(b) *Saurida* and *Saurus*	5,292	14,323
7.	*Hemirhamphus* and *Belone*	1,169	1,980
8.	Flying fish	1,439	1,832
9.	Perches	18,162	35,232
10.	Red Mullets	5,216	2,641
11.	Polynemids	14,573	14,044
12.	Sciaenids	87,581	114,535
13.	Ribbon fish	64,542	57,330

Table 2 (contd).

Sl. No.	Name of fish	1976	1975
14.	(a) *Caranx*	25,745	23,005
	(b) *Chorinemus*	3,322	3,380
	(c) *Trachynotus*	35	64
	(d) Other carangids	1,572	207
	(e) *Coryphaena*	261	411
	(f) *Elacate*	383	221
15.	(a) *Leiognathus*	42,445	39,813
	(b) Gazza	966	424
16.	*Lactarius*	12,045	11,848
17.	Pomfrets	37,701	24,987
18.	Mackerel	65,497	45,947
19.	Seer fish	20,159	18,897
20.	Tunnies	19,322	11,285
21.	*Sphyraena*	2,388	2,150
22.	*Mugil*	2,613	3,515
23.	*Bregmaceros*	380	1,043
24.	Soles	10,088	12,044
25.	(a) Penaeid prawns	114,640	141,713
	(b) Non Penaeid prawns	76,787	79,038
	(c) Lobsters	2,532	2,991
	(d) Other Crustaceans	19,999	19,893
26.	Cephalopods	10,826	7,889
27.	Miscellaneous	90,812	97,607
	Total	1,352,855	1,422,693

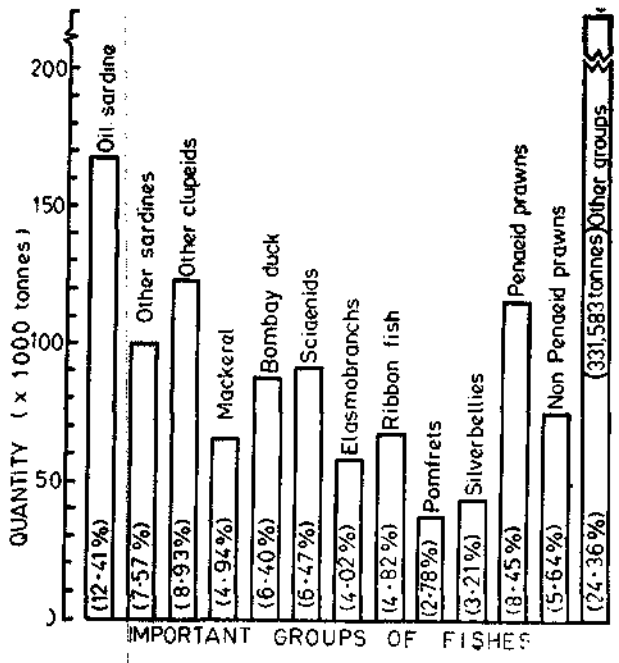
Oil Sardine: Overall total landings of this species recorded an increase of about 10,000 tonnes during 1976 when compared to 1975. This increase was mainly due to the better catches in Kerala. However in Karnataka and Goa oil sardine catches declined in 1976.

Mackerel: The landings of mackerel during 1976 were higher than the landings in 1975. The increase was about 20,000 tonnes. States of Tamil Nadu, Kerala and Karnataka recorded higher landings of this fish, whereas in Pondicherry lesser landings were recorded.

Bombay duck: An overall decrease amounting to about 12,000 tonnes was noticed during 1976 over the landings in 1975.

This decrease was mainly due to poor landings of this fish in Gujarat coast and Maharashtra accounting for the rest.

Penaeid prawns: A decline to the tune of about 27,000 tonnes was noticed in this fishery too. This was mainly due to the poor catches of this species from Kerala. The decline in the catches of this fish in Gujarat was nominal. However there was an increase in the landings of this fish in Goa and Maharashtra coasts.



Contribution of important groups in the marine fish landings for the year 1976

Non-penaeid prawns: The estimates of landings of this group also showed a downward trend in 1976, the decrease amounting to about 2,000 tonnes over the landings during 1975. This was mainly due to lesser landings of this group in Maharashtra coast. In the States of Andhra Pradesh and Kerala the landings of this group are lesser in 1976, when compared to 1975. However Gujarat recorded a higher catch in 1976,the catch being 5,500 tonnes more than that of in 1975.

Sciaenids: A heavy decline amounting to about 26,000 tonnes in the catches of this species was recorded during 1976. This was

mainly due to poor landings of this species in Gujarat, Kerala and Maharashtra in the order of their decreased catches.

Lesser sardines: The decline in the estimates of the landings of these species during 1976 was about 12,000 tonnes. This was mainly due to lesser catches from Tamil Nadu.

Silver bellies: There was an increase of about 3,000 tonnes in the estimates of this group during 1976 as compared to 1975. The increased landings of this group in Tamil Nadu accounted for this increase in 1976. However States such as Andhra Pradesh and Kerala recorded lesser catches during 1976.

Elasmobranchs: A decrease of about 11,000 tonnes was seen in the estimates of landings under this group during 1976 as compared to 1975. This was mainly due to lesser landings in Andhra Pradesh, Gujarat, Maharashtra and Kerala during 1976. Orissa, however recorded an increase of about 2,000 tonnes in 1976.

Perches: The total landings of perches declined to 17,000 tonnes in 1976 from 35,000 tonnes in 1975. This decline was mainly due to the poor landings in Kerala, Andhra Pradesh and Tamil Nadu. Maharashtra also recorded lower catches during 1976.

Cat fishes: This group also suffered a heavy fall in the landings during 1976 when compared to 1975. This fall to the tune of about 25,000 tonnes, was mainly accounted for by the poor catches of this group in Kerala. States of Andhra Pradesh, Tamil Nadu and Maharashtra also recorded lower landings during 1976.

Saurida & Saurus: The estimates of landings of this group during 1976 were about 5,300 tonnes only whereas during 1975 they were about 14,000 tonnes. This decline was mainly due to poor landings in Kerala.

In spite of the decline in overall estimates during 1976 groups such as *Thrissocles* spp tunnies and pomfrets showed an increase in their landings in 1976, the increase being about 8,000, 7,000 and 13,000 tonnes respectively. Tamil Nadu mainly contributed to the increase in Thrissocles landings. Similarly Kerala contributed to the increase in the landings of tunnies, whereas Orissa contributed mainly for the increase in the landings of pomfrets.

Input of fishing effort

Total fishing effort was estimated 250,282 thousand man hours during 1976 as against 284,625 thousand man hours in 1975. Except Orissa and Goa all other States expended lesser efforts in 1976 as compared to 1975. Decrease in catch per unit effort during1976 was noticed in West Bengal, Andhra and Kerala, whereas in other States there was an increase in catch per unit effort. It is however worth noting that in Kerala, both effort and catch per unit effort decreased during 1976. This does not seem to be good for exploited fisheries in this State (Table.3).

Table 3 State-wise effort expended and catch per unit reffort

States	1976 Effort in '000 man hours	1975 (in 1000 man hours)	Catch per unit of effort (kgs) 1976	1975
West Bengal	11623	11923	2.18	2.31
Orissa	16447	15727	1.81	1.07
Andhra	45106	47151,	2.91	3.30
Tamil Nadu	62448	70246	3.62	3.15
Pondicherry	1812	2844	5.59	2.86
Kerala	62948	73342	5.26	5.74
Karnataka	9431	10186	10.10	8.59
Goa	4007	2809	10.77	10.38
Maharashtra	23021	32417	12.75	7,92
Gujarat	13439	17,980	12.75	10.78
Total	250,282	284,625	5.27	4.98

To conclude, in the traditional narrow zones the fisheries such as prawn fishery, sciaenid fishery, Bombay duck fishery etc. are still under heavy fishing pressure. Even small sized prawns, for instance, are indiscriminately exploited by mechanised trawlers in Kerala in particular. The state may occur when there may not be enough prawns to replenish the exploited stock. Hence the present trend warrants immediate attention of the fishing industry for the proper management of fishery resources.

Frame Survey: (FSS/FRA/FS 1.2)

(M. S. Prabhu, S.K. Dharmaraja, Varughese Philipose, K. Narayana Kurup, K. Balan and others)

The census on fishermen population in 1960 out of 1882 maritime villages has been completed. The census in the remaining 273 villages is expected to be completed very shortly. An interim projection is made on the fishermen population in village where census is not over.

Table 4 gives the total fishermen population in the maritime States as arrived at by census and estimation.

Table 4. Census of Fishermen population

Name of the State	Total population
West Bengal & Orissa	61082
Andhra Pradesh	232661
Tamil Nadu	292253
Kerala	408828
Karnataka	94296
Goa	21048
Maharashtra	201423
Gujarat	147057
Total	1458648

Table 5 gives the classified fishermen population

Table 5 Census of Fishermen population

Name of the State	Population of				
	Male	Female	Children	Total	Activemen
1. West Bengal & Orissa	17769	17284	26029	61082	15076
2. Andhra Pradesh	73802	70231	88628	232661	63527
3. Tamil Nadu	94398	91684	106171	292253	70506
4. Kerala	131629	131073	146126	408828	87473
5. Karnataka	28380	29041	36875	94296	20562
6. Goa	9114	7770	4164	21048	6162
7. Maharashtra	47803	50046	103574	201423	41539
8. Gujarat	34907	37659	74491	147057	27164
Total	437802	434788	586058	1458648	332009

A comprehensive report on the census will be published in the form of a bulletin as soon as census is completed.

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

(M.S. Prabhu, S. K. Dharmaraja, K. Narayana Kurup, K. Balan, B. Prasanna Kumary, K. Vijayalekshmi)

Data on length measurements of samples from commercial catches in respect of commercially important fishes viz, Oil sardine, Mackerel, Bombay duck and Penaeid prawns were collected. The data were analysed for their size composition. Suitable mathematical models are being attempted to study the impact of fishing on stock.

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

(M. S. Prabhu, M. G. Dayanandan, C. R. Shanmughavelu, S.K. Dharmaraja, Varughese Philipose, K. Narayana Kurup, U. K. Satyavan, P. Karunakaran Nair & others)

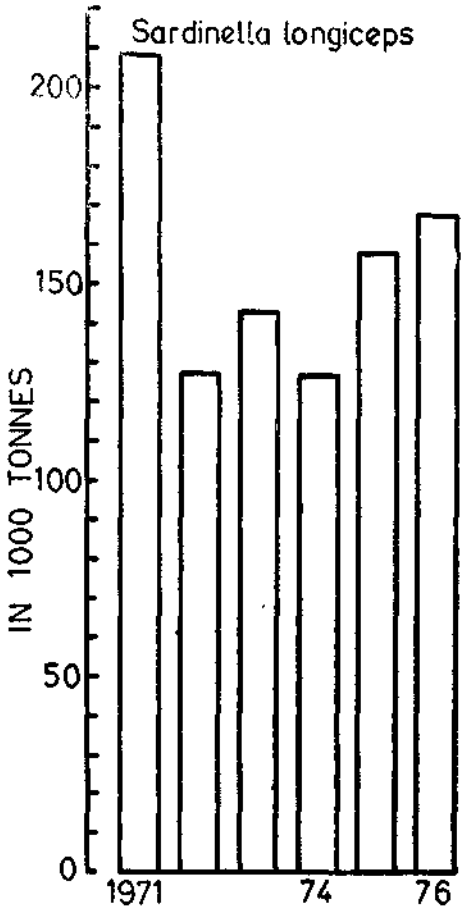
Fishery Data Centre functions as the store-house of data on marine fish production in India including the catch data of mechanised vessels operated by Exploratory Fishery Project, Integrated Fishery Project and other private agencies. The data so collected were disseminated to various government and private agencies.

For the speedy processing of the voluminous data so collected, A.D.P. System is expected to be installed in the Division. In the first phase, three sets of punches and verifiers have been installed and a few persons have been trained on the operation of machines.

FISHERY BIOLOGY DIVISION

Investigations on the clupeoid fishery resources (FB/MF/1)

(Late) K. V. Sekharan, V. Balan, P. Vijayaraghavan, M. H. Dhulkhed, G. Annigeri, N. Gopinatha Menon R. Reghu.



Landings of Oil Sardine during 1971—1976.

Oil sardine:

Salient findings:

The forecast made that the relative abundance and catch of oil sardine would be less in the first half of 1976 than in the first half of 1975 has been found to be true in Kerala, which normally accounts for the bulk of the catch of this fish, but not in Karnataka.

In 1976 spawning commenced in May in the Calicut-Vizhinjam region. However the delay in the onset of the monsoon seems to have interrupted the spawning process, to some extent. Recruitment during the new season has been moderate in the beginning and improved later in the season resulting in better catches.

An important development has been the introduction of purse seines commercially in the fishery. About 25 purse seines are operating in Goa and 10 in Karnataka this year. Reports from Bombay indicate the occurrence of oil sardine shoals there, showing the possibility of developing a fishery. The fishermen are already exploiting this resource on a small-scale. Small quantities of oil sardine were also landed in the Tuticorin area. Maximum spawning activity seems to have occurred in Calicut-Mangalore area extending from March to November.

Unit stocks of oil Sardine (FB/MF/1.2)

M. H. Dhulkhed, G. G. Annigeri; N. Gopinatha Menon, R. Reghu.

Salient findings

Serological investigations which revealed the presence of blood group A, AB and O indicated the possibility of the occurrence of genetically different groups of oil sardine in the Mangalore and Kerala area.

Investigations on vertebral counts of oil sardine at Karwar, Mangalore, Calicut and Cochin revealed that the majority of individuals possessed 47 vertebrae and that the range of variation in the vertebral number was narrow in the southern centres of observation.

I. Serological investigations

The preliminary results of the serological investigations for identifying genetically different stocks, if any, of oil sardines of Karwar and Mangalore which were begun in 1974 have been consolidated. The investigation consisted of blood group isoagglutinin studies on live oil sardine from Rampani catches and an anti 0 serum was raised in a healthy rabbit free from isoagglutinins against A, B and O panel cells.

It was found that while O group predominated in Mangalore and Karwar area, fish belonging to A and B groups were comparatively more in the Mangalore area. B group was absent in both

the areas Isoagglutinin tests showed the existence of reciprocal relationship both with A and B antigens.

II. Investigations on vertebral counts

For identifying the unit stocks, if any, in the oil sardine population, investigations on the vertebral counts of the species were initiated during the year under review at the research centres of Karwar, Mangalore, Calicut and Cochin.

It has been found that, in general, the number of vertebrae varied from 44 to 48. In the northern centre of Mangalore the range of variation was greatest (44–48) whereas in the southern centres of Calicut and Cochin it varied from 45–48. At the Mangalore and Cochin centres it was found that the variation was greater among the smaller fish. The most dominant vertebral count was 47 in all the centres of observation.

Work Contemplated

Observations in both the problems have to be carried out in greater detail.

Evaluation of resources of lesser sardines and other clupeoids and anchovies (FB/MF/1.3)

V. Balan, P. Sam Bennet, S. Lazarus, P. Radhakrishnan Nair, C. Muthiah, G. Luther, R. Thiagarajan.

Salient finding

The anchovy landings at the observation centre Vizhinjam was twice the quantity (174 tonnes) that was caught last year.

Lesser sardines

The estimated landings at the important observation centres during the year 1976 along the south east coast were: Vizhinjam: 250 tonnes, mainly by gill net and boat seines; Tuticorin: 2 tonnes entirely by gill net; Palk Bay: 64 tonnes entirely by boat seines; Gulf of Mannar centre: 91 tonnes entirely by gill net. Thus, an estimated total of 409 tonnes of lesser sardines were landed in these centres which is twice that of last year. As in the previous year *Sardinella gibbosa, S. albella* and *S. sirm* were the most important constituents of the landings. The reversal in the species dominance from that of *S. albella* over *S. gibbosa* to the dominance of

the latter in the Palk Bay fishery which was observed last year persisted. As in the previous year, the landings were composed of 0-year-old fish, with respect to all species except *S. sirm* which were mainly one-year-old, and *S. longiceps* which were 0-year-old to one-year old at Tuticorin and one-year-old and above at the Gulf of Mannar centres.

Anchovies

The anchovy fishery showed an upward trend in 1976 in Vizhinjam, the annual catch being 174 tonnes as against 84 tonnes landed last year. The boat seines landed 68.45% of the catches, the shore seines 14.99% and the Netholi vala 16.56%. The fishery was mainly supported by *Stolephorus devisi* and *S. bataviensis*. Compared to the previous year, larger sized fish entered the fishery, the recruitment *S. devisi* at 40–44 mm and *S. bataviensis* at 45–115 mm. The growth rate in both the species was found to be 10–15 mm in smaller sizes and 5–10 mm in the larger ones.

Oil sardine fishery atlas (FB/MF/1.4)

(Late) K. V. Sekharan, P. Vijayaraghavan, Varughese Philippose, R. Reghu.

The monthwise zonewise figures of oil sardine catch of all the maritime States of India except that of Goa and Andamans have been compiled. Information on the distribution of eggs and larvae of the species has been compiled. Relevant information on the biology of the fish is being compiled.

The present status of the oil sardine fishery (FB/MF/1.5)

(Late) K. V. Sekharan, P. Vijayaraghavan, Varghese Philippose V. Balan, M. H. Dhulkhed, G. G. Annigeri, N. Gopinatha Menon R. Reghu.

Salient findings

A review was made of the oil sardine fishery of 1950–1974. The annual catch has been varying between 76,000 tonnes (1956) and 301,000 tonnes (1968), It formed 1–9% of the annual catch of all fishes from 1950–56 and 10–33% in later years, the highest percentage having been recorded in 1968. The total catch of oil sardine in the country has been declining since 1968.

That the catch fluctuations are fishery independent has been recognised generally. The year class strength may vary by a

factor of 10. The total instantaneous mortality Z, has been estimated as 1.66, M as 1.12 and F as 0.54. Based on these the average annual standing stock during 1960–71 off the west coast was computed as about 390,000 tonnes. The estimate of the standing stock made later by the Pelagic Fishery Project for 1972–75 is 56,000–700,000 tonnes (average 383,000 tonnes).

The estimate of mortality mentioned above referred to the period before 1966 and has to be revised since fishing effort has increased.

Taking the standing stock estimate as 380,000 tonnes and using Gulland's Formula $Y_{max} = 0.5\ M \times B_o$ where Y_{max} = the maximum annual potential catch and B_o the unfished biomas, Y_{max} may be estimated as 212,800 tonnes which is equal to the estimate of 213,000 tonnes arrived at by Banerji from the analysis of the catch and effort data.

The study of recruitment in the second half of 1975 indicated that the stock is likely to have a lower level of abundance in 1975–76 than in 1974–75. It was therefore concluded the landing in the first half of 1976 may not reach the same level as that of the corresponding period of 1975. This expectation has been realised on the west coast as a whole, the oil sardine catch in the first half of 1976 and 1975 being 84,500 tonnes and 98,600 tonnes respectively. During July-September 1976 the recruitment has been atleast equal to it if not higher than that of the corresponding period of 1975 in the Cochin–Calicut area; off the Karnataka coast it appears to be lower. The data are being scrutinised again. The preliminary analysis would indicate that off Kerala atleast the catch of oil sardine is likely to be higher than in the first half of 1977 than in the first half of 1976. Fish, one year or more in age were absent at Cochin but were abundant at Calicut in July; their abundance decreased in Calicut but increased at Cochin in August. This could indicate a southward movement of spawners. This conclusion is also supported by the observations on maturity stage. The Calicut catch of adults in July comprised fish in the pre-spawning, partly spent and spent stages whereas the August catch at Cochin comprised mostly spent fish. In September there was a heavy concentration of spent fish in the Cochin area and southward upto Vizhinjam. In fact the July-September catch at Cochin surpassed that at Calicut; perhaps for the first time in the history of the oil sardine fishery. At Varkala near Trivandrum also very

heavy catch of oil sardine was recorded. In the last week of September again indicating the possibility that the spent fish had migrated south.

The present status of the fishery of Anchovies (FB/MF/1.6)

P. Vijayaraghavan, M.M. Meiyappan, V. Ramamohana Rao, G. Luther, R. Reghu.

Salient findings

A review was made of the anchovy fishery in India over the last 25 years. Prior to 1957 the Central Marine Fisheries Research Institute used to collect the data of anchovies as a single group, but since then the statistics are compiled separately for (a) *Stolephorus* spp. and (b) *Thryssa* spp. and *Thrissina* sp. The data on *Coilia* another important anchovy are included under "Other clupeoids". Only the genera *Stolephorus, Thryssa* and *Thrissina* are included in this review.

The average annual catch of anchovies in the country was 37,350 tonnes which forming 6.6% of the catch of all fishes in 1950–54 but declined to 35,000 tonnes forming 3.2% of the catch of all fishes in 1969-73. The decline was obviously due to the fact that no specialised fishery exists for this group on most sections of the coast and that there is diversion of effort to other fishes of greater unit value.

The average annual catch in 1970–74 of *Stolephorus* spp. was about 26,000 tonnes, forming 2.2% of the landings of all fishes the catch comes almost entirely from Andhra Pradesh (18%), Tamil Nadu (32%), and Kerala (44%). Recent investigations show that the anchovies form potentially one of the richest resources of the seas around India. In the IIOE egg collections, those of anchovies formed 13% of the total number in the coastal and intermediate zones but are not so abundant in the oceanic zone. The report of the Pelagic Fisheries Project show that the standing stock of *Stolephorus* spp. off the south west and south east coasts between latitude 6°N and 17 °N varies between the 232,000 tonnes and 520,000 tonnes in different months. The average annual standing stock may then be estimated as 376,000 tonnes.

The average annual catch of *Thryssa* and *Thrissina* sp. in 1970-74 was 12,000 tonnes forming 1% of the landing of all fishes. The commercial distribution is similar to that of *Stolephorus* spp.

Andhra Pradesh, Tamil Nadu and Kerala landing 13%, 44% and 20% respectively of the all India catch.

The catch of *Stolephorus* spp. consists mainly of the 0-year-class and of the other anchovies of the 0-year and one-year fish. The mean age of the *Stolephorus* spp. may be regarded as 0.5 year in which case the annual natural mortality co-efficient (M) would be 2.0. As an approximation the mean age of the other anchovies can be regarded as 1.0 year which gives an estimate of M as 1.0 on annual basis. Using Gulland's formula $Y_{max} = 0.5 \times M \times B_o$ and average standing stock estimate(B_o) 376,000 tonnes, the potential annual catch of *Stolephorus* can be estimated as 376,000 tonnes which is about 18 times the estimate made by Banerji, who gave the figure as about 20,000 tonnes for Tamil Nadu, Kerala and Karnataka.

A review was also made of the work done in India on the food of anchovies and analysis made of their catch from the point of view of the concept of ecological efficiency. With reference to food, anchovy can be classified into two groups (a) Zooplankton feeders and (b) Carnivores. *Stolephorus* spp. come under first group and *Thryssa* sp. and *Thrissina* sp. under the other. From the nature of the food the ratio of the biomass of the two groups may be expected to be about 10:1, if the transfer efficiency between trophic levels (ecological efficiency) is regarded as 10% on the average. The question would then arise whether the catches approximate this ratio. The ratio of the catches of the two groups (Zooplankton feeder: Carnivores) during 1969–74 is 2:1 for the country as a whole, 1:1 for the West Bengal and Orissa, 3:1 for Andhra Pradesh, 1.6:1 in Tamil Nadu and Pondicherry, 5:1 in Kerala, 0.2:1, in Karnataka, 0.3:1 in Maharashtra, 0.4:1 in Goa and 0.007:1 in Gujarat. The ratio in favour of *Stolephorus* spp. is highest in Kerala which also has the highest catch of this group among the various States.

The greater importance of carnivores, as against the Zooplankton feeders on the north west coast is surprising. This could not be due to the exclusion of *Coilia* spp. from the data. What is important to note is that the theoretical ratio is not reached in any of the States. This could indicate the existence of unexploited stocks of Zooplankton feeders in the country, a view which gains support from the Pelagic Fishery Project report referred to above.

Reports from Norway, (under Indian Ocean Fishery and Development Programme) indicate that good concentration of the

Buccaneer anchovy (*Stolephorus buccaneeri*) are found off Pakistan The length range being 30–80 mm. This species is also on important constituent of the anchovy catch in Vizhinjam area. Similarly pelagic trawl operated off the Pakistan coast hos recorded a catch per hour of 440 kg in 1975.

Investigations on mackerel fishery resources (FB/MF/2)

(Late) K. V. Sekharan; G. Seshappa; M. V. Pai; V. Balakrishnan, A. Noble; R. S. Lal Mohan; N. S. Radhakrishnan; T. M. Yohannan; M. H. Dhulkhed, A. A. Jayaprakash; P. Nammalvar; K. Rajasekharan Nair.

Salient findings

The mackerel fishery in the country was better than that of the previous year. The recruitment in the year commenced earlier in the south than the north along the west coast. A few broods of fish appeared to have entered the fishery in this season and growth in them was comparatively poor. In general the one-year old fish dominated the catches in the year's season in place of the 0-year old fish of the season of last year.

Progress of work

Since 1974, the fishery shows steady improvement. The respective landings in 1975 and 1976 were 45,947 and 67,309 tonnes. As usual, the fishery in the first part of the year was an extension of the season of 1975. The recruitment of the new year class marking the commencement of the 1976 season began by May at Vizhinjam, June at Cochin, August at Calicut, September at Mangalore and so on.

Excepting a slight decline in Goa the landings in 1976 season was better than that of 1975 season throughout the country. The increase seen in Tamil Nadu and Pondicherry was good and in Kerala it was remarkably high. On the other hand, the season of 1975 showed remarkable increase in Karnataka and Goa.

From the c.p.u.e. of the different age groups seen in Table 6 it becomes apparent that the I-year old fish were more than the 0-year old in the fishery of this year. In 1975, the 0-year old were more abundant than the older fish. A few broods of fish seem to have entered the fishery in the current season. The growth in them, on the whole, appears to be around only 5 mm per month.

However, through length frequency studies as also the studies on the scales in the fish of 1975 season which continued to appear in the catches in the first half of the year, the growth was faster.

Table 6: The c.p.u.e. of the mackerel of different age groups at important centres of observations in the second halves of 1975 and 1976.

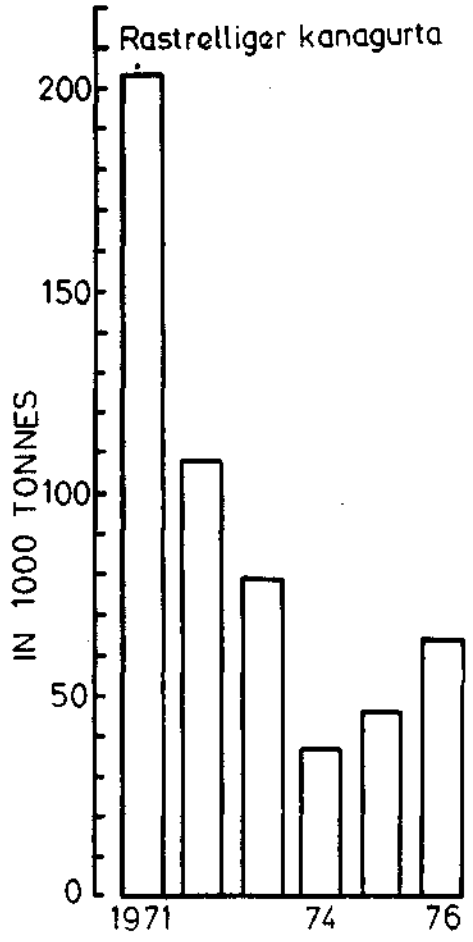
Centres	c.p.u.e. of different age groups							
	1975				1976			
	0 year	1 year	2 year	3 year and above	0 year	1 year	2 year	3 year and above
Vizhinjam (Boat seine)	21	1	0	0	61	13	0	0
Cochin (Thanguvala)	783	6	0.1	0	24	168	1	0
Calicut (Pattenkolli)	173	355	102	1	420	363	14	0
Ullal (Pattabala)	0	255	5	0	0	1201	108	0
Baikampady (Rampan)	No sample				100	26415	1151	0
Karwar (Rampan)	0	52750	3354	0	—	—	—	—

Maturity studies indicate the spawning to be around September this year. However, there are indications of another spawning also off Vizhinjam during March-April.

Regarding the present status of the mackerel fishery, from an estimated unfished biomass of 283,000 tonnes during 1972–75 an annual potential yield of 127,000 tonnes is expected, and the average actual catch during 1969–74 was 110,216 tonnes closely approximating the potential yield.

Regarding the investigations on the unit stock, out of the nine characters studied only 4 morphometric characters like the length from snout to anal, length from snout to orbit, thickness and depth seem to be significant enough to show local variations. The vertebral counts at Cochin and Calicut stood as 31, whereas at Mangalore it was found to be only 30 in all year classes. Electrophoretic studies on the mackerel is being carried out at Mangalore.

In order to study the growth, migration and the rate of exploitation of the mackerel, persistent attempt to tag and release them into the sea was made.



Landings of Mackerel during 1971—1976

Work contemplated

The research on the size, growth and age composition of the catch and the stock, and observations on the c.p.u.e. to be continued. Observations on the maturity and breeding to be carried on. Growth pattern, migrations and rate of exploitation to be studied also by large scale tagging as far as possible. Studies on the unit stock by various methods to be continued. Work on

the status of the mackerel fishery and the atlas of the mackerel to be continued.

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

E.G. Silas, V. Balan, M. D. K. Kuthalingam, M.S. Rajagopalan, K. J. Mathew, P. Livingston, I. David Raj, Pon Siraimeetan.

Investigations on tunas and bill fishes and related species were carried out at Cochin, Vizhinjam, Tuticorin, Calicut and Minicoy. In general, tuna catches on an all India basis is steadily improving during the past five years. The total annual catch during 1975 and 1976 were respectively 11,285 & 19,322 tonnes. The increasing trend has been reflected in the various centres during this year also.

Cochin

Observations were made on the tunas and related species that landed from IFP vessels. IFP medium and large vessels have been employing various kinds of drift nets, purse seines, hand lines and long lines. The inshore and offshore grounds were off Calicut, Ponnani, Cochin, Alleppey, Quilon and Wadge Bank. The research vessel *R.V. Varuna* was rigged for long line operations. Sailfish and sharks predominated the long line catches. From purse seine operations, tunas were landed during the months of April, August and November. The little tunny *Euthynnus affinis* was predominant and the common size range was from 50–66 cm (fork length) and weight from 2.5 – 5 kg.

Vizhinjam

The tuna catches were observed from Vizhinjam, Poonthurai, Colachel, Cape Comorin and Neendakara landing centres. At Vizhinjam the catch during the year was estimated as 576.6 tonnes forming about 12.4 per cent of the total marine fish catch at Vizhinjam. 80 per cent of the catch was landed by drift nets and the fishery was mainly supported by *Euthynnus affinis* and *Auxis thazard*. The species composition was more or less similar to that at Vizhinjam in the other landing centres, except in Poonthurai were yellowfin tuna was predominant.

Calicut

The tuna catches at Calicut were mainly observed from Pattenkolly, driftnet and mackerel gill nets operations. *E. affinis* and

A. thazard mainly contributed to the catch. The modal length from drift net catch were 250-300, 400 & 550. *K. tonggol* and *N. macropterus* were also landing in small quantities.

Tuticorin

Tuna catches at this centres were observed to be poor. *Euthynnus affinis, Auxis thazard* landed in small quantities. *Sarda orientalis* was also recorded from coastal waters. Length frequency studies in *E. affinis* indicated two recruitment periods during the year. Juveniles in the range 64–148 mm occurred during August.

Minicoy

The fishery for tunas at Minicoy yielded lesser catch in the first half of 1976 as compared to the corresponding period of 1975. This was attributed to non-availability of certain bait fishes. The relationship between *Trichodesmium blooms*, stranding of *Canthigaster* and the abundance of tunas was studied in detail. Along with this, the relationship between abundance of tunas and the formation of clouds and appearance of sea birds were also studied. Culture of *Tilapia* has also been undertaken at Minicoy.

Bill fishes

Investigations on sail fish *Istiophorus gladius* have been carried out at Calicut. Sail fishes landed during the month of January, February and November and marlins during September to November. The food of the sail fish consisted of *Anchovies, Sepia, Auxis,* Carangids and mackerel.

Status report on tuna fisheries (FB/MF/3.2)

E.G. Silas, M. S. Rajagopalan.

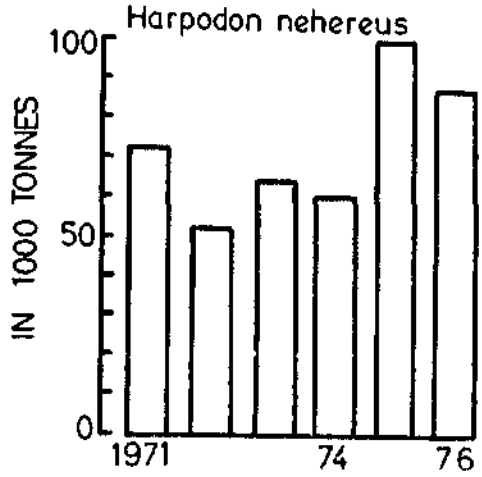
Based on the data available on the tuna fisheries of the Indian Ocean, a status report is being prepared on the tuna fisheries in India. This includes brief account of the distribution of various species, life history, exploitation, fishing grounds, craft & gear employed, catch & effort data, fishery in relation to environmental factors, biological aspects and stock assessments.

Evaluation of the resources of Bombay duck and Lizard fishes (FB/MF/4.1)

S.V. Bapat; A. S. Kaikini; A. Kurian; M. Z. Khan; S. Basheeruddin.

Salient findings

Bombay duck fishery during the year was relatively of lesser magnitude than that of the last year. A reduction in the average size of the fish from 180.7 mm in 1975 to 163.9 mm in the current year was recorded. Biochemical studies on the glycogen content in mature males and females indicated that there was a depletion of glycogen in the mature and spawning females. The fishery for lizard fishes in the Madras waters was poor throughout the year.



Landings of Bombay duck during 1971—1976

Progress of work

Bombay duck:

The Bombay duck landings in India during 1976 was estimated at 87,075 tonnes which showed a decline by 12% from the landings of the previous year. In Maharashtra, the estimated landings were 30,211 tonnes as against 51,645 tonnes in the last year. A similar decrease in the Bombay duck catch was also registered in Gujarat where the present annual catch was 34,998 tonnes, a shortfall of 9556 tonnes from that of the previous year. The general declining trend of the fishery was also reflected in the local fishery at Versova and Veraval where intensive studies on the biology of the species were undertaken.

At Versova, the fishery was generally poor, particularly in the first two months of the year and in November. Labour trouble

delayed the postmonsoon resumption of fishing by one month. In November the cyclone interrupted the fishing for over half of the month. However, the fishery showed a remarkable recovery in December. Besides poor landings, the dominant and maximum size groups showed decline in most of the months. However, for the year as a whole, the average figure for the weight of the observed units and the estimated numbers were relatively better. This was mainly due to the improved fishery in December. The average size of the fish declined from 180.7 mm in1975 to 163.9 mm in the current year. This as well as the fact that almost twice the effort (63.50 average hauls) put in to get the same average weight of the fish (52 kg/haul) did not indicate better fishery. It was noteworhty that when the catch was small it was generally made up of large size specimens, but when the catch was large, it was invariably constituted by smaller fishes.

The fishery at the three observation centres at Veraval, viz. Jaffrabad, Rajpara and Nawabunder, was poor throughout the year. At Nawabunder, the estimated catch in any month was not more than 1000 tonnes. At Jaffrabad and Rajpara, the fishery improved during November after the cyclone. The average size of the fish was better at Jaffrabad and Rajpara and varied between 204–208 mm and 187–196 mm respectively. A large number of juveniles were found during most of the months, the percentage of their occurrence varying from 97 in March to 57 in January. Females predominated in the catches throughout the year except in January. Spent females were present in October, November and December.

A minor fishery of Bombay duck was reported from the Gulf of Kutch.

General biochemical studies

Presence of 22.5 mg glycogen/G liver in mature males and only 2.2 mg glycogen/G in mature females of Bombay duck showed the depletion of glycogen in females during spawning. It also reflected the carbohydrate requirements of the developing ovary. During spawning, muscle lipids decreased from 3.5% to 1.5%. A similar decrease was also witnessed in cortisone concentration in the plasma in spawning females as compared with that in the prespawning fish.

Lizard fishes

Studies on the fishery and biology of lizard fishes were continued on the basis of the data collected from catches landed by the.

Exploratory fishing vessels operating from the Madras base. The catch of the lizard fish, *Saurida tumbil*, was negligible throughout the year, there being no landings in February, March, July, August to October and in December. Highest catch was recorded in June when the percentage contribution of the fish in the total catch was 3.6. Specimens measuring between 160–200 mm in size contributed to the catch in April, and those measuring between 141–210 mm in size in May. Females predominated in the catches throughout the year except in July. However, mature females were encountered only in May. Intensive feeding was observed in May. Small clupeoids, anchovies, *Trichiurus* spp. crabs, *Sepia* and lobsters formed the main items of food as revealed by gut content analysis.

Work contemplated

Studies on the evaluation of the resources of Bombay duck and lizard fishes will be continued. Investigations on biochemical aspects of Bombay duck will be intensified.

Unit stock of Bombay duck (FB/MF/4.2)

S. V. Bapat; V.M. Deshmukh; M. K. George; A. Kurian.

Preliminary starch gel electrophoresis studies to locate dehydrogenase enzyme in muscle and tetrazolium oxidase enzyme in liver showed no variations in Bombay duck samples collected from six centres.

Samples analysed by polyacrylamide and cellulose acetate electrophoresis for variant and invariant genes, lactate dehydrogenase, malate dehydrogenase, alpha glycerophosphate dehydrogenase, a muscle myogens and eye lens proteins were studied. In few cases gel electrophoresis was found to over estimate invariant genes and under estimate variant ones.

The characters such as standard length Vs length snout to anal opening and standard length Vs length snout to origin of first dorsal so far analysed in respect of two samples from Dahanu were found to be non-significant.

Studies on the resources of cat fishes, perches and carangids (FB/DR/1.1)

B. Krishnamoorthi, P. Mojumder, V. Sriramachandra Murty, S. S. Dan; N. Gopinatha Menon, T. Prabhakaran Nair.

Salient findings

Cat fish resource studies at Waltair and Mandapam: At Waltair tagging of cat fishes was undertaken and about 200 fishes were tagged. The catch by both Government vessels as well as private vessels showed a decline compared with that of 1975. At Mandapam, the CPUE was high in I quarter. It was calculated that *Tachysurus tenuispinis* grew to 18, 24, 30,36, 40 cms at the end of 1, 1½, 2, 2½, 3 years respectively.

Perch investigations at Kakinada: The perch fishery was supported mainly by *Nemipterus japonicus* and *N. mesoprion* 77%. of the annual catch came from the I quarter. *N. mesoprion* showed a single spawning and a growth rate of 10 mm per month.

Carangid investigations at Vizhinjam: An estimated 557.6 tonnes were landed. The size of *Alepes mate* ranged from 84 to 284 cms

Work done

Cat fish investigations: Catch, catch per unit of effort, gearwise/ monthwise were calculated both at Waltair and Mandapam. At Waltair biological studies were conducted on *T. thalassinus* and *T. tenuispinis.* For age determination, length frequency and otoliths studies were undertaken. The minimum size and maximum size and mortality rates were calculated. The same type of studies were undertaken at Mandapam on *T. thalassinus, T. dussumieri, T. caelatus* and *T. platysomus.*

Perch investigations: At Kakinada catch, cpue etc. were calculated. Biology and fishery of *Nemipterus japonicus* and *N. mesoprion* were studied. Using length frequency, growth rate and age were determined.

Carangid investigations: Catch, cpue, monthwise/gearwise were calculated. Biological studies on *Megalaspits cordyla* was taken up.

Work contemplated

Since the project is of continuing nature, work on the above lines will be continued at all the above mentioned centres.

Sciaenid and Polynemid resources of the east and west coasts of India (FB/DR/1.2)

T. Tholasilingam, K. Dorairaj; K. V. Somasekharan Nair.

Salient findings

Sciaenid investigations:- At Calicut: an estimated 166.6 tonnes were landed by Paithu vala as well as commercial trawling. Catch and cpue both showed a down-trend. *Johnius sina* had a growth rate of 10 to 20 mm per month and showed a preference for copepods, mysids and juvenile prawns as food. *Otolithes ruber* showed different modes for paithu vala and trawl net. The catch was composed of immature specimens mostly.

At Kakinada: about 10% increase in the over all sciaenid yields was evident compared to that of 1975. The catch was estimated at 873.1 tonnes. Two peaks were noticed in the catches one in January and the other in September. Though 18 species occurred in the catches none of them were dominant or occurring continuously throughout the year. *Johnius carutta* showed a single mode. The length frequency distribution was unimodal in all months for *J. osseous.*

Polynemid investigations:- At Mandapam: The Palk Bay yielded 5.2 tonnes during the second half. Exploratory fishing showed 13.86 kg catch rate in the area 9–76/1A. *Polynemus microstoma* showed 5 mm growth rate per month. Prawns were found to be the chief food items.

Work done

Catch, CPUE for various gears were estimated in all the three centres. Length frequency distribution, sex ratio, maturity stages, food and feeding habits, age and growth were studied on selected important species. At Calicut biological studies were conducted on *Johnius sina* and *Otolithes ruber;* at Kakinada—*J. carutta, J. osseus, J. vogleri* and *J. belengari;* at Mandapam—*Polynemus microstoma* and *P. sextarius.*

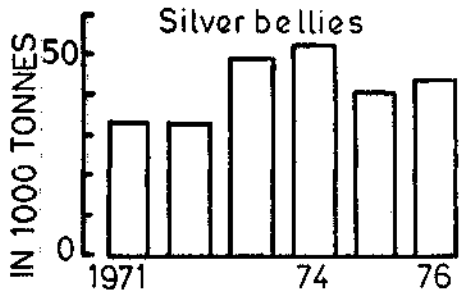
Work contemplated

Work on the above lines will be continued at the above mentioned centres.

G. Venkataraman; P. T. Meenakshisundaram; Y. Appanna Sastry; M. Basheeruddin; J. C. Gnanamuthu.

Salient findings

Fishery: The declining trend in the total catch of silver bellies from the Palk Bay area off Mandapam observed in the past two years was noted this year also. The total catch came down to 2055.29 tonnes in 1976 from 4786.25 tonnes in 1975. Analysis of the catches of silver bellies by day fishing and night fishing separately showed a sharp fall in their catch by day fishing (when higher catches are realised) as compared with that of the previous year the respective figures being 686.30 tonnes and 3626.42 tonnes. There was also a decline in the c.p.u.e. from 633.88 kg in 1975 to 551.24 kg. in 1976. In the Gulf of Mannar side, there was fishing only for a few months in the year and the total catch in the current year was 87.87 tonnes. The preference shown by the fishermen to go for night fishing than for day fishing continued this year also. In contrast to the poor catch of silver bellies during this year in the Palk Bay area off Mandapam, a good fishery of silver bellies was reported from some centres in the northern part of the Palk Bay.



Landings of Silver bellies during 1971—1976

As observed before, *L. jonesi* formed the dominant species among silver bellies in the Palk Bay. The decline in the total catch of silver bellies and in their cpue obtained from the Palk Bay side off Mandapam (as also of *L. jonesi* the dominant species) combined with a fall in the mean size of *L. jonesi* suggests that silver bellies in the Palk Bay area off Mandapam could have been subjected to overfishing in the past few years. However the fall in the mean size by day fishing is only very marginal from 76.42 mm to 76.24

mm. The intensity of fishing on silver bellies has become much reduced this year as day fishing by trawlers was negligible.

The estimated total landings of silver bellies by mechanised vessels at Kasimedu (Madras) during this year were 448.8 tonnes as against 661.8 tonnes in the previous year. The highest catch of 134.4 tonnes was obtained in the third quarter. Except in the month of February, the catch per unit of effort was found out to be more than 10 kg. the maximum being 28.3 kg in November. Silver bellies formed 9.7% of the total catch, the dominant species being *L. bindus* and *L. dussumieri.*

Biology: Analysis of the age composition of *L. jonesi* obtained from Palk Bay showed that 0 + year class constituted 53.2%, 1 + year class 46.5% and 2 + year class 0.3%. Though mature fish (stage IV and above) were observed almost throughout the year, the maximum spawning period extended from January to April and from October to November. The size range of *L.bindus* obtained from the trawl catches at Kasimedu was from 28 to 125 mm, the modal range being from 51–55 mm to 111–115 mm. Mature fish were recorded in all the months except in April. They formed more than 50% in March, September and October. Fish appearing to be spent recovering were recorded in April.

Ribbon fishes

Fishery: The total catch of ribbon fish by mechanised vessels this year at Kasimedu (Madras) amounted to only 66.42 tonnes as against a figure of 143.61 tonnes obtained in the previous year from the same centre. There was a sudden increase in the catches in October. *Trichiurus lepturus* was the dominant species. An estimated catch of 632 tonnes of ribbon fish was landed by mechanised vessels at Kakinada showing an increase of 261 tonnes over that of the previous year viz. 1975 which is a record. It formed 7.9% of the total fish catch. The catch per hour of trawling worked out to 2.67 kg. as against 2.01 kg. in 1975. *Trichiurus lepturus* constituted as much as 75.2% of the ribbon fish catches.

Biology: The size of *T. lepturus* obtained at Kasimedu (Madras) ranged from 115 to 928 mm in total length and the modal sizes were from 150–199 mm to 900–949 mm. The fishery was supported by 1, 2, 3 & 4 age groups. At Kasimedu the fishery of this fish (*T. lepturus*) was constituted by 0–1, 2,3 age groups and also higher to them. The size range was from 181 to 961 mm with

a modal range was from 211 to 841 mm. The size range of *L. gangeticus* was from 211 to 541 mm and the modal variation from 271 to 541 mm. Fish belonging to 1 and 2 age groups and also higher to them contributed to the fishery.

Evaluation of demersal resources of some selected areas (FB/DR/1.4)

C. Mukundan; V. M. Deshmukh; M. K. George; C. Muthiah; G.S. Daniel Selvaraj, M. M. Meiyappan; M. Vijayakumar; P. Sam Bennet; K. Dorairaj; M. Devaraj; P. Natarajan; V. S. Rangaswamy; P. N. Radhakrishnan Nair; P.T. Meenakshisundaram; R. Sarvesan; M. Rajagopal; Y. Appannasastry; W. Venugopalan; B. Krishnamoorthi; V. Ramamohana Rao; S. Reuben; S. S. Dan; P. Mojumder; T. Appa Rao; D.B.James.

Salient findings

During the year the analysis of the catch and effort data of the IFP and EFP vessels, and wherever possible the privately owned mechanised boats, operating off Bombay, Cochin, Tuticorin, Mandapam, Madras, Kakinada, Waltair and Port Blair were continued. In addition, biological studies on the main constituent species were also made at different centres.

Bombay

Three EFP trawlers operated in areas 16–72, 17–71, 17–72, 18–71, 18–72, 19–69, 19–70 and 19–72, for 1938.95 hours to land 295.7 tonnes at the rate of 152.49 kg/h. The catches were mainly of cat fishes, elasmobranchs and dhoma. The catch rates were highest in November and March. The highest catch rate was obtained from 17.71/6E. Biological observations on species of *Tachysurus* and *Nemipterus japonicus* were made.

Cochin

Log sheets for the years 1974 and 75 were analysed. Biological observations were made on *Trichiurus savala, T. haumela, Lactarius lactarius* and *Nemipterus japonicus.*

Tuticorin

Two EFP trawlers trawled for 1415 hrs. to land 137 tonnes at the rate of 94.4 kg. and 100.7 kg. Perches, Rays, *Nemipterus* spp. and carangids made up the catches mainly.

Mandapam

Trawl data of the two Tamil Nadu Fisheries Department trawlers for the year 1974 & 75 were analysed. In 1974 the vessels landed 42.2 tonnes and 57.1 tonnes at the rates of 449.35 kg/h and 430.3 kg/h respectively. In 1976 observations were made on the fishery at Palk bay side of Mandapam. A total of 2231.7 tonnes (inclusive of Crustaceans) at the rate of 18.59 kg/h were landed. Silver bellies ranked first followed by prawns. The biology of six species was studied—*Saurida tumbil, Platycephalus isacanthus, Sillago sihama, Pennahea aneus, Caranx armatus* and *C. kalla.*

Madras

Two EFP trawlers landed 149.6 tonnes at the rate of 112.99 kg/h. The maximum catch and rate were in February. The landings were chiefly of perches and leiognathids.

Kakinada

Three types of trawlers landed 11056 tonnes of fish (including 2429 tonnes of prawns) a 73% increase over that of last year. The interesting point is that with an increase of 26.9% in effort over last year the increase in catch has been 36.2% for fish and 17.7% for prawns.

Waltair

Two EFP vessels caught 120 tonnes at the rate of 72.2 kg/h. The total effort was slightly lower than that of last year's. The 'small-miscellaneous' group dominated the catches this year also making up more than 60% of the catches. January, March, June and December were the months of abundance. The private trawlers landed about 1281 tonnes. Work on the fishery and biology of *Tachysurus thalassinus, T. tenuispinis, Lactarius lactarius, Upeneus sulphureus, Psenes indicus, Polynemus sextarius, Caranx malabaricus, P. aneus* and *J. carutta* was continued.

Port Blair

The two EFP vessels one used for trawling and the other for Tuna long lining & trolling landed about 41 tonnes of catch;39.9 tonnes by trawling at the rate of 103.08 kg/h and 20.3 tonnes by

tuna long lining at the rate of 37.88 kg/h. and 142 kg by trolling at the rate of 0.95 kg/h.

Studies on the resources of flat fishes and pomfrets (FB/DR/1.5)

G. Seshappa, J. P. Karbhari; G. Nandakumar

Pomfret

Veraval: Gillnets locally called 'Cali" and trawlers locally called "Hul" were the main gears used in the pomfret fishery at Veraval during the year. The annual total landings of pomfrets in 1976 was estimated as 1887.859 m.tons by both the gears together. The average length and average weight of the fish were the highest in the month of December (297.80 mm and 441.23 g. respectively), while the average length and average weight were the lowest in the month of April (269.88 mm and 298.8 g. respectively). Females were dominating over males numerically and females with mature ovaries were more numerous than those with immature ovaries.

Flat fish (The large scaled tongue sole)

Mandapam: Fishing was done (trawling by mechanised boats) during nights in Palk Bay throughout the year, some boats operating in Gulf of Mannar during January to March and also in December. The total estimated landings of *Cynoglossus macrolepidotus* at Mandapam during the year was 21306 kg.

The size-range during the year was 91–460 mm, all specimens above 380 mm being however only females. Females were numerically dominant. Maturity stage V was dominant in March while spent fish dominated in April, all fish being spent in May. *C. bilineatus* which occurred in stray numbers was also studied. One male of *C. quinquilineatus* (301 mm) in August and another in October (293 mm) were also noticed in the catches and examined.

Malabar sole

Calicut: The total annual landings of the Malabar sole *Cynoglossus macrostomus* at Vellayil during the year amounted to 485.18 m. tons as against 418.85 m. tons in the previous year.

The size range in the departmental boat-seine collections was 4 cm to 12.9 cm during the first half year with modes at 7-7.9 cm

in January, 9–10. 9cm in February and March, 9–9.9 cm in April and 8–9.9 cm in May. These collections were generally suspended subsequently. In the commercial samples the size-range was 3 cm to 15.9 cm in the year.

The estimated total landings of *C. dubius* at Vellayil during 1976 came to 4100.59 kg. as against 2250.90 kg in 1975 and 885.96 kg. in 1974. The highest monthly catch was made in September (2506.15 kg) in 1976 while it was made in June in 1975 (1389.82 kg).

Other species of *Cynoglossus* that occurred as very occasional specimens in the samples examined included *C. bilineatus, C. puneticeps, C. lida* and *C. macrolepidotus.* Length frequency, length-weight relation, maturity and scale-ring studies were made on these species also along with *C. dubius* and *C. macrostomus.*

Studies on commercially important elasmobranchs resources(FB/OF/1

M. D. K. Kuthalingam, R. Soundararajan, M. E. Rajapandiyan, S. G. Vincent and others.

Salient findings

The shark fishery at Tuticorin showed considerable improvement from that of the previous year. Gravid females of *Loxodon macrorhinus* predominated in the catches landed at Tuticorin. The gut content analysis of the rays, *Amphotistius kuhlii* and *A. imbricatus* revealed that the former species feeds mainly on polychaetes and occasionally on prawns, while the latter feeds principally on small prawns. It was also observed that the young ones of the former species were released as they attained a size of 115 mm and those of the latter at a size of 80 mm disc width.

Progress of work

Studies on the fishery and biology of the commercially importatant elasmobranchs were continued at Vizhinjam, Tuticorin, and Mandapam Camp. In the last quarter of the year, studies were extended to one more centre at Neendakara-Shakthikulangara.

The estimated total catch of sharks, rays and skates at Vizhinjam was 112 tonnes which formed about 2.5% of the total marine fish landings of the centre. The total catch of sharks was 101 tonnes, the important species contributing to the fishery being

Loxodon macrorhinus, Carcharhinus limbatus and *Scoliodon laticaudus*. Drift net and hook and lines were the principal gears employed for the shark fishery. The peak landing was observed in October. Estimated total landings of rays amounted to 10 tonnes during the year. *Himantura bleekeri* formed the bulk of the catch, although *Narcine timlei* was also landed occasionally. Gear-wise landings of rays were 42.8% by boat seines, 31.8% by hooks and lines, 18.1% by drift nets and 7.3% by shore seines. Peak landing was recorded in July. The fishery for skates was poor.

At Neendakara, *Sphyrna lewini* was landed in good quantities. The size of the species ranged between 408 mm and 1540 mm. Males dominated in the catches. Over 50% of the females were found pregnant. Stomach content analysis showed that *S. lewini* was feeding mainly on cephalopods.

The elasmobranch fishery of the Tuticorin region was better during the year as compared to last year. An estimated total catch of 222 tonnes of sharks was landed in the fish landing centres at Pinnakayal, Tutiorin, Vaipar and Kayalpattnam in drift nets and long lines. The highest catch rate (catch per boat per day) of 864.4 kg was registered at Vaipar. The dominant species of sharks recorded in the fishery were *L. macrorhinus, C. limbatus, Rhizoprionodon acutus, Sphyrna blochii* and *Galeocerdo cuvieri. L. macrorhinus* occurred in good quantities in July and August. The size of the species in the fishery ranged between 655 mm and 800 mm and 78% of the females were pregnant. The size of *R. acutus, P. oligolinx, C. menisorrah* and *C. limbatus* ranged between 630–895 mm, 600–740 mm, 610–840 mm and 830–1370 mm respectively.

At Mandapam, 192 tonnes of rays were landed by trawlers operating in the Palk Bay during the year. The highest catch was recorded in February and the lowest in March. Of the different species of rays landed, *Himantura alcockii* and *Aetobatus narinari* contributed to the bulk of the catch constituting 26% and 25% of the landings. *Gymnura poecilura* and *Amphotistius kuhlii* were landed in moderate quantities. Other species of rays represented in the catches were *H. bleekeri, H. uarnak, Dasyatis sephen, A. imbricatus, A. zugei, Aetomylaeus nichofii* and *A. milvus. A kuhlii* occurred in good quantities in August and September. The size of the species ranged between 114 mm and 370 mm in disc width. Weight of the individual specimen varied from 70 g to 1300 g. Gut content analysis showed that *A. kuhlii* feeds mainly

on polychaetes and occasionally on prawns. Only a few gravid females were encountered in the fishery. The size of the intra-uterine embryos ranged from 41 mm and 118 mm in disc width. The size range of *A. imbricatus* was from 73 mm to 250 mm. The species was found to feed mainly on small prawns. The size of intra-uterine embyos ranged from 42 mm to 88 mm in disc width. It was observed that in *A. kuhlii* the young ones were released when they attained a size of 115 mm while the young ones of *A. imbricatus* were released when they reached about 80 mm disc width.

Work contemplated

Studies on the commercially important elasmobranch resources will be continued at Vizhinjam, Neendakara, Tuticorin and Mandapam Camp. Detailed biological studies of the common species of sharks contributing to the fishery at Vizhinjam and Neendakara will be undertaken.

Mariculture—Culture of marine fishes (FB/CUL/1.1)

(Late) K. V. Sekharan, P. Bensam, R. Marichamy, V. Ramamohana Rao T.Appa Rao, S. Reuben, M.H.Dhulkhed and others.

Salient findings

The seed of *Sillago sihama* was found to occur abundantly in the upper reaches of the Coondapur estuary from October onwards. The ecological, hydrological and faunistic investigations of the Bhimunipatnam backwaters indicated the potentiality of the area for culture of prawns and mullets. Culture experiments on mullets carried out in the salt pan area of Tuticorin had shown good growth and production of individual fish with maximum growth of 295 mm in length and 220 g by weight during the year. The yard experiments at Veppalodai indicated that to enhance overall production it was essential to give adequate protection to stocks from escapement through water ways and predatory animals. Experiments on the culture of *Scylla serrata* showed that the average increase attained in size and weight by the crabs during a culture period of 10.4 months was 36.6 mm in carapace width and 135 g respectively.

Progress of work

Sillago culture

Fingerlings (5–7 cm in length) of *Sillago sihama* collected from the Coondapur estuary were released in two experimental

ponds (0.2 ha area) at Mulky. The survey of seed resources indicated that the fry and fingerlings were available in considerable numbers in the upper reaches of the estuary from October onwards. A few fingerlings of *Sillago* were released in the aquarium tanks during October and they were seen to thrive well under laboratory conditions. Studies on salinity tolerance of the fingerlings were progressing.

Culture prospects at Bhimunipatnam backwaters

With a view to study the prospects of culture of fishes and prawns at Bhimunipatnam backwaters, pre-farming investigations on the ecology, hydrology and prawn and fish fauna of the backwaters were carried out during the year.

A survey of the estuarine bed indicated that in Bhimunipatnam area the bottom was sandy with shell fragments, the sand content increasing towards north and at Nagamayapalem area, the bottom was predominantly sandy. The fine sediment of the upper layers of the bottom ground contained diatoms such as *Asterionella sp. Pleurosigma* sp., *Thalassiosira* sp., *Biddulphia* sp. and *Coscinodiscus* sp. Hydriods and polycheates were also present. At Nagamayapalem area *Meretrix* bed extended to an area of 3 ha. The average depth of the water was 0.75 m at low tide and 1.4 m at high tide.

The salinity of the backwaters ranged between less than 1‰ and 34.05‰; surface temperature between 24.7°C and 32.0°C, pH between 6.8 and 8.4 and dissolved oxygen between 1.7 and 4.8. ml/l Although certain amount of flutuactions were recorded in all these parameters, salinity showed greater variations. The salinity of the backwaters declined sharply in July and August in Nagamayapalem due to freshwater influx and reached less than 1% in September. In October when the bar mouth was opened and in the subsequent months, the salinity was generally above 26‰ although it decreased whenever there was rainfall, particularly in November.

The fishery of Bhimunipatnam backwaters was supported by *Mugil* sp., *Liza* sp., *Therapon* sp., *Gerres* sp. and *Apogon* sp., Among prawns, *Penaeus indicus, Metapenaeus dobsoni* and *M. monoceros* were important. About 60 tonnes of *Meretrix* were harvested from the backwaters during the year. In the monsoon period (October-November) heavy mortality of clam was noticed due to the influx of freshwater. During this period large size clams were found in the sub-surface layers of the bottom.

Mugil sp. was caught in good numbers in July and September, while *Liza* sp. predominated in the catches from January to March and in November. The size of *Liza* sp. ranged from 10 mm to 135 mm. The monthly length-frequency distribution of the species showed bimodal distribution in all the months. The size of *Mugil* sp. ranged from 32 mm to 165 mm. Larger specimens were encountered in September and October. As in the case of *Liza* sp., the size frequency distribution showed dominance of two size groups.

P. indicus was well represented in the catches in April, August and October, but the species was not encountered in September. The size of the species ranged from 10 mm to 99 mm. *M. dobsoni* occurred in good quantities in April and June. The size of the species in the backwater catches ranged from 10 to 72 mm.

M. monoceros was abundantly caught in June and November. The dominant size group for the species was observed between 27 mm and 42 mm, within a size range of 10 mm to 72 mm.

Fish culture in the salt pan area at Tuticorin

Culture experiments on mullets in Ponds A, B and C, each of 346.9 m^2 area, on *Chanos* and mullets in pond E with a surface area of 2790.75 m and crab (*Scylla serrata*) in pond D (346.9 m^2) were carried out during the year. The production as well as survival rate of mullets cultured in all the ponds was poor due to large scale depletion of the original stock, natural mortality and predatory action. However, the growth rate of individual fish was quite encouraging, the average increment in weight being 71.12 g with a maximum growth of 295 mm in length and 220 gm by weight.

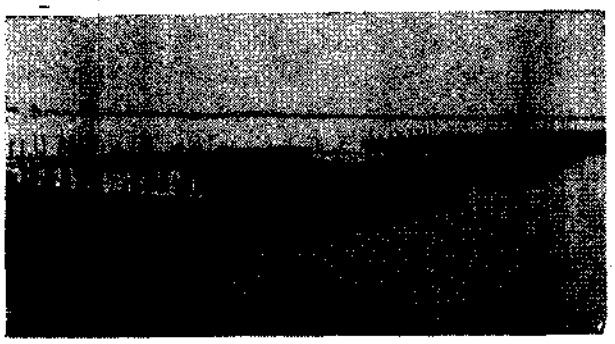
The estimated total weight of seeds of mullets and *Chanos* stocked in pond E was 921.9 g. The fry were fed with rice bran and ground nut oil cake. As the experiments were progressing, it was observed that a section of the stocked population in the pond had moved into the adjoining pond C and hence, it was found necessary to reassess the stock and restock it at a lower rate.

Scylla serrata were cultured in cages. The average size and weight of the crabs at the time of stocking was 67.6 mm carapace width and 53.6 g respectively. At the end of an average culture period of 10.4 months, the increase in size and weight was 104.2

mm carapace width and 188.6 g respectively. The net average increase in size and weight during the culture period of 10.4 months thus amounted to 36.6 mm carapace width and 135 g.

Culture of fishes and prawns in pens

A project on culture of fishes and prawns in pens was taken up during the middle of the third quarter of the year. Three pens each of 20 m x 10 m size made up of split bamboo screens were constructed and erected. Seeds of *Penaeus semisulcatus* were stocked in one of the pens by the end of the year.



Pens for fish culture at Mandapam.

Hydrobiological studies of the fish farms at Veppalodai

Data on salinity, dissolved oxygen, pH, inorganic phosphate and nitrite of the pond waters in Veppalodai fish farm complex were regularly collected. Besides, plankton samples were also collected. Distinct difference in hydrological factors of the waters in the smaller ponds and those in the larger pond was noticed. The smaller ponds were generally more productive than the larger pond.

Work contemplated

Farming studies on *Sillago sihama* will be continued with a view to find out the prospects of large scale culture of the species. It is proposed to culture mullets, *Chanos* and *Scylla serrata* in culture ponds with adequate provisions against entrance of predators and escapement of the stock. Experiments on pen culture of fishes and prawns will be intensified.

Mariculture—running water culture of eel (FB/CUL/1.2)

K. Dorairaj, R. Soundararajan.

Salient findings

Overall growth increment by weight of cultured eel during the year was 42.7% of the initial weight. Elver resources survey carried out along the Tamil Nadu coast from Pullicat Lake to Cape Comorin revealed potential elver grounds at Srivaikundam anicut and Eral causeway on the river Tambraparni, lower anicut on North Rajan Channel on Coleroon river and at Settiya Tope anicut on the river Vellar. Glass eels of *Anguilla bicolor* were collected from the rivers Vaigai and Vembar, and that of *A. bengalensis* from the rivers Vellar, Gadilam, Penniyar and Coleroon. Experiments on the transportation of elvers showed that the elvers could be transported over long distance without any appreciable mortality in polythene bags inflated with air and wooden frames with bolting silk bottom. Elvers could be kept alive in polythene bags inflated with air for about 24 hours in the room temperature of 30–31 5 °C.

Progress of work

Culture experiments on eels in running water were continued at Mandapam Camp. Weight measurements of growing eels were taken five times during the year. The overall increase in weight was from 30,817 g at the beginning of the year to 44,000 g by November, 76, the percentage increase in weight being 42.7 of the initial weight. The average length and weight of 158 numbers of cultured eels of about 3 years old after the elver stage, was 407 mm and 117 g respectively. The percentage of mortality in the culture experiments during the year was 10.5

An artificial feed prepared out of fish meal (66%), dried bean powder (13.7%), yeast powder (6.6%), starch (12.5%), multi vitamin (1%) and binding substance, agar-agar (0.2%) was tested, but it was not favoured by the eels.

The coastal region of Tamil Nadu from Pulicat lake to Cape Comorin covering 68 centres in 43 rivers, 2 canals, 1 tank, 1yeri and 1 lake was surveyed for the elver resource. A specially designed 'Elever net' was operated during the survey. Of the 68 centres, 47 centres were found suitable for elver collection. Glass eels of *Anguilla bicolor* were collected from the rivers Vaigai and

Vembar, and that of *A. bengalensis* from the rivers Vellar,Gadilam, Peniyar and Coleroon. Potential elver grounds at Srivaikundam anicut and Eral Causeway on the river Tambraparni, lower anicut on north Rajan Channel on Coleroon river and Settiya Tope anicut on the river Vellar were located. During November-December large concentration of elvers was noticed in the pools near Mandapam and Seeniyap Dharga. By ten operations in these pools, a total number of 15,500 glass eels and elvers weighing 4662 g were gathered by drag net.

Experiments were also carried out on the transportation of elvers from one place to another and in different types of containers. During the survey of elver resources, glass eels and elvers were transported from the collection centres to the laboratory at Mandapam Camp without any mortality. However in the laboratory, the percentage of mortality varied between 2.97 to 54.4. This mortality was perhaps due to the ecological and environmental changes from natural habitat to laboratory conditions. Elvers were also transported in different containers such as polythene bags inflated with air and wooden frames having bolting silk bottom. Four frames placed one above the other were used. In the top frame crushed ice was placed and in the other frames live elvers were kept. Live elvers were transported in these containers over a distance of 280 km by road in 9½ hours. The results of these experiments indicated that the elvers could be transported in both the containers with 100% survival rate.

An experiment was also conducted to determine how long elvers could be kept alive in polythene bags inflated with air in room temperature (30–31.5 C) and the results indicated that the elvers could be maintained alive in these containers for 24 hours although they were less active.

Work contemplated

It is proposed to undertake elver resources survey in other important centres in Tamil Nadu. Different artificial feed will be compounded and feeding experiments will be carried out to determine the most suitable artificial feed for the culture of eels.

CRUSTACEAN FISHERIES DIVISION

Assessment of Prawn Resources (CF/RE/1.1)

S. Ramamurthy, M. S. Muthu, M. M. Kunju, M. M. Thomas, J. P. Karbhari, M. Aravindakshan, P. A. Thomas, K. Y. Telang, K. K. Sukumaran, K. Devarajan, P. E. Sampson Manickam, K. N. Rajan, N. Surendranatha Kurup, C. Suseelan, M. Kathirvel, S. Shanmugam, G. Nandakumar, G. Sudhakara Rao. and others.

Salient findings

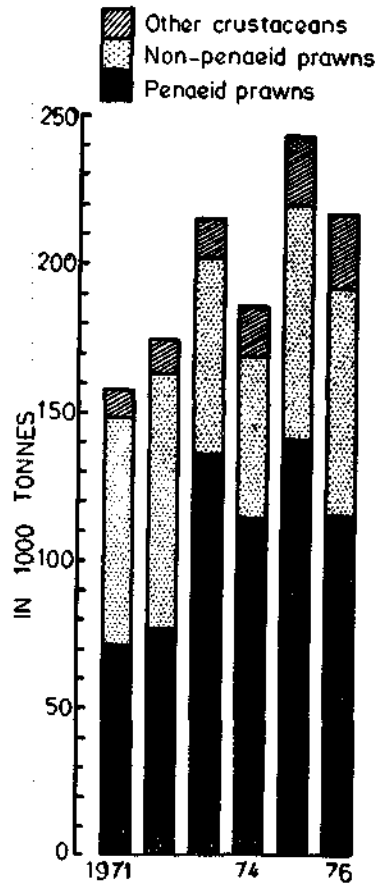
The crustacean landings in India during the year showed a decline of 12% over last year's catch. Of the total catch of 2.14 lakh tonnes the penaeid prawns formed 53.6%, while the non-penaeid prawns and other crustaceans accounted for 35.8% and 10.6% respectively. The state-wise landings are given in the table 7.

The decline in crustacean landings was almost entirely accounted for by the sharp fall in the penaeid catch along the Kerala coast. There was a slight improvement in the penaeid catch of Maharashtra and Goa. The non-penaeid catch declined in Maharashtra while it increased in Gujarat.

The frozen prawns exported during the year amounted to 47,952 tonnes, valued at Rs. 160.65 crores.

The fishing effort for prawns by the mechanised vessels was comparatively more in the east coast centres than in the west coast centres. On the east coast, the catch rate was highest in Kakinada (10.2 kg/hr) and lowest in Tuticorin (1.5 kg/hr). On the west coast it varied from 3.8 kg/hr at Calicut to 8.7 kg/hr at Cochin. The prawn fishery suffered a marked decline at all the centres on the west cost except at Bombay and Veraval. This was mainly due to the failure of the fishery in respect of *Metapenaeus dobsoni* and *Parapenaeopsis stylifera*. Some signs of decline in population were also apparent for *M. dobsoni* at Mangalore; there was a decline in the mean size of *M. dobsoni* during 1976 at Mangalore and

Calicut; the instantaneous mortality rate was also high (6.02). At Bombay, there was a marked improvement in the fishery for *M. affinis*. In the Goa-Calicut region, there was a set back in the catch of *M. affinis*. A redeeming feature was the improvement in the catch of *Penaeus indicus* and *M. monoceros* in the Mangalore/ Calicut areas and in fact, *P. indicus* was the dominant species in the trawler landings at Calicut. Post larvae of *P. indicus* were also abundant in the surf region at Calicut.



Landings of crustaceans during 1971—1976.

On the east coast the prawn fishery was generally better in 1976 than in 1975, except at Tuticorin where there was a marked fall in the catch of *P. indicus*. There was a four-fold increase in the catch of *M. dobsoni* at Kakinada. *P. monodon* contributed to the commercial fishery only at Madras, Kakinada and Waltair.

Table 7. Statewise landings (in tonnes) of crustacea

State	Penaeid Prawns		Non-Penaeid Prawns		Other Crustaceans		Total	
	1975	1976	1975	1976	1975	1976	1975	1976
West Bengal & Orissa	2920	2827	2787	2808	8	23	5715	5658
Andhra Pradesh	7152	8833	3523	2275	707	332	11382	11440
Tamil Nadu	11460	8864	573	169	14361	16938	26394	25976
Pondicherry	62	93	2	—	285	549	349	642
Kerala	77207	34478	755	55	1828	1366	79790	5899
Karnataka	3074	2594	—	—	2552	164	5626	2758
Goa	1762	4981	—	—	233	1065	1995	6046
Maharashtra	24653	40772	69012	63702	795	470	94460	104944
Gujarat	13395	11497	2386	7778	2115	1715	17896	20990
Andamans	28	39	—	—	—	—	28	39
Total	141713	114978	79038	76787	22884	22622	243635	214387
Percentage	58.2	53.6	32.4	35.8	9.4	10.6	—	—

Progress of work

In the trawl fishing at Bombay, *M. affinis* constituted the dominant species unlike in 1975 when *P. stylifera* was the chief species. A sporadic fishery for *Metapenaeopsis stridulans* was reported from Bombay during the second half of May. The occurrence of *M. hilarula, Solenocera alticarinata* and *Parapenaeus longipes* in the trawler catches of Bombay was also noticed. In the Goa-Mangalore region *P. stylifera* was the chief component. At Calicut, Tuticorin and Madras, *P. indicus* was the major species caught. At Cochin and Kakinada *M. dobsoni* was predominant *P. semisulcatus* formed the mainstay of the fishery at Mandapam and to a less extent at Tuticorin.

Indigenous gears landed prawns in appreciable quantities at Bombay, Calicut, Cochin, Tuticorin and Puri. However, the catch was poor compared to 1975 except at Bombay and Tuticorin. The improvement in the Bombay area was mainly due to *Palaemon tenuipes* at Versova and *M. affinis* at Sassoon Docks though *Acetes indicus* remained the overall primary species. The mud bank fishery at Cochin suffered a severe set back due to poor landings of *M. dobsoni. P. indicus* was the dominant species caught at Tuticorin and Puri.

The catch of juvenile penaeid prawns in the estuaries was generally poor compared to 1975 except at Goa and Calicut. One notable feature of the fishery at Mangalore was the dominance of *P. indicus* in the estuarine fishery relegating *M. dobsoni* to a second place unlike in the previous years. *P. indicus* was common during March, May-June and December. Surf collections at Calicut revealed an abundance of the post-larvae of *P. indicus* in the inshore waters during January, March, May and December. These features were reflected in the improvement of the marine fishery for this species in the Calicut/Mangalore regions.

Despite the better recruitment of larval and post-larval stages especially of *M. dobsoni* at Cochin, the prospects of the fishery were belied by the decline in the stake-net catches and the marked fall in the marine fishery, particularly during the last quarter. It is likely that the erratic monsoon might have upset the normal sequence of events in the sea and brackish waters during the current year.

P. indicus: This was the dominant species in the trawler landings at Calicut and Tuticorin. The mean length at the former

centre was calculated to be 147.4 and 157.0 mm for males and females respectively. At Waltair it was 149.0 and 160.0 mm respectively. Recruitment of smaller size groups into the fishery was observed to take place mainly during February at Calicut, April-May and November-December at Tuticorin and April at Waltair. Spawning appeared to have been taken place chiefly during March and November-December at Calicut, May-June and September-October at Tuticorin and April-July at Waltair.

In the juvenile phase, this species was most common in the estuaries at Mangalore (Modal size: 41–80 mm), Madras (56–90mm) and Puri (51–115 mm). In the Vembanad lake (Cochin) about 2.6 tonnes (80–120 mm) were landed during January-March by gill-nets.

P. merguiensis: This constituted a sizable fishery in the gill net landings at Puri as well as in the trawler landings at Goa. Mature and spent females occurred in more numbers during February-March and October-November at Puri.

P. semisulcatus: This was commercially exploited at Mandapam where it formed nearly 99% of the prawn catch. The mean length was estimated to be 112.3 and 133.0 mm for males and females respectively. Males were more during the first half year. Recruitment of younger size groups took place during April-May, July-August and October-November. Spent females occurred in more numbers during March, May-June and December.

P. monodon: Appreciable quantities of this species were caught from the sea around Kakinada during January-February and at Puri during October. In the backwaters, the size group of 51–100 mm supported the fishery at Kakinada,whereas at Puri larger size group (103–173 mm) predominated. Recruitment of juveniles seemed to take place during January-February, July-September and December.

M. dobsoni: A marked decline in the landings was recorded in the Goa/Cochin regions, though it constituted the chief species at Cochin. On the east coast heavy catches were reported from Kakinada where it formed 52% of the prawn fishery, registering a four-fold increase compared to 1975.

The mean length (mm) of the species at Calicut and Mangalore was calculated as below for 1976 and 1975. A reduction in the mean length was evident during the current year.

	Males		Females	
	1976	1975	1976	1975
Calicut	68.7	80.1	80.8	94.0
Mangalore	79.2	85.2	92.2	99.3

Recruitment of small size groups took place mainly during November-December and to a lesser extent during February-March on the west coast.

The estimated total instantaneous mortality was 6.02 for females at Mangalore.

Females were in excess except at Goa. Mature and impregnated females were more during January-March, September and November-December.

In the estuaries, south of Goa, juveniles (36–60 mm) were well represented and constituted the dominant species at Calicut and Cochin.

M. affinis: This was commercially important in the trawl and 'dol'net catches at Sassoon Docks (Bombay). The fishery witnessed a marked decline at Mangalore and Kakinada and virtually failed at Calicut. Entry of small size groups into the fishery was noticed during June and November at Goa. Females were in excess. Peak period of spawning was January-March and December.

M. monoceros: This was commercially important in the Waltair/Kakinada/Madras regions as well as at Bombay. At Mangalore, the fishery picked up well compared to 1975 and formed 14.7% of the prawn landings by the trawlers. Ripe females occurred in more numbers during June-July at Kakinada.

In the estuarine catches at Kakinada, juveniles of *M. monoceros* (41–60 mm) dominated, peak season being, September-November.

P. stylifera: This was one of the principal species of penaeid prawns caught on the west coast between Veraval and Cochin. At Kakinada, this species was exploited in fair quantities during

May-September. The fishery declined compared to 1975 at most of the centres on the west coast. Entry of smaller size groups into the fishery was noticed during March-May and November-December. Ripe females were more during January-May and November-December. Females were in excess except at Goa as in the case of *M. dobsoni.*

The mean length (mm) of the species at Calicut/Mangalore during 1976 and 1975 was as follows: It indicated an overall improvement of the size, except for females at Mangalore.

	Males		Females	
	1976	1975	1976	1975
Calicut	80.7	75.4	86.1	73.6
Mangalore	82.2	81.3	91.8	93.2

The total instantaneous mortality for females at Mangalore was calculated to be 3.02.

Work contemplated: The Project would be continued during 1977.

Estimation of population parameters of prawns off Cochin by research vessel survey (CF/RE/1.2)

M. S. Muthu, M. M. Thomas, N. Surendranatha Kurup, C. Suseelan, M. Kathirvel and others.

Salient findings

Only 4 survey cruises could be carried out under the project during the year as and when the research vessel 'Cadalmin' was available. Stations within a depth zone of 30 m were worked out. Prawns were encountered only on two cruises from 10–15 m depth region. The catch consisted mainly of *M. dobsoni* and *P. stylifera.*

Work contemplated: The project was merged with the Project No. CF/RE/1.1

Assessment of Lobster and Crab Resources (CF/RE/1.3)

P. V. Kagwade, J. P. Karbhari, T. M. Yohanan, M. Kathirvel, S. Shanmugham, K. M. S. Ameer Hamsa and G. Sudhakara Rao.

Salient findings

Till recently, the south-west coast of India was the major producer of lobsters. But now, the Northwest coast (Sourashtra and Bombay) has taken the lead. In Veraval and Sassoon Docks, 500 tonnes and 115 tonnes of spiny lobsters were landed respectively, while throughout Kanyakumari District only about 87 tonnes were landed. The dominant species of lobsters also varied from place to place. (In northwest coast *Panulirus polyphagus* was the dominant species while in the southwest coast, *P. homorus* was the prominent species.) At Mandapam Camp, on the southeast coast, *P. ornatus* was the dominant species. November-April appeared to be the lobster season at all the centres, peak catches being landed during the winter months. While berried females of *P. homarus* and *P. polyphagus* were frequently met with in the commercial catches, berried females of *P. ornatus* were very rare. This fact along with the lesser percentage of females of *P. ornatus* in the commercial catches indicated that this species breeds in deeper waters. Unlike the other species of spiny lobsters, *P. polyphagus* appeared to prefer muddy bottom and were more frequently caught in trawl nets.

Work done

During the year 1976, 513 tonnes of frozen lobster tails valued at Rs. 3.18 crores were exported as against 402 tonnes, valued at Rs. 1.58 crores during 1975.

Veraval: At Veraval landing centre, 500.3 tonnes of lobsters were landed by the trawlers. *P. polyphagus* was the dominant species. The trawlers landed lobsters throughout the year except during the monsoon season (May-September) but peak lobster landings were observed during October-January.

Bombay: Lobsters were caught in trawl nets, bottom set gill nets and lobster traps. Although lobsters occurred in the catch throughout the year, the season appeared to be from November to May, with peak landings in December. At Sassoon docks, 115 tonnes and at Kasasa Bunder 26 tonnes of lobsters were landed during the year. *Panulirus polyphagus, P. homarus* and *Thenus orientalis* were the species caught.

P. polyphagus formed 90% of the lobster catch. The total length ranged from 70 to 345 mm but the majority were between

180–300 mm. Juveniles less than 130 mm were recruited into the fishery from November-January. Sex ratio of females was 2.5 times more than the males. Only 4.9% of females were berried at Sasoon Docks while 33.3% were berried at Kasasa Bunder.

P. homarus formed less than 5% of the catch. The total length varied between 135 and 325 mm and 32.7% of the females were berried.

Thenus orientalis occurred in the trawl nets only in April-May and November-December. The length varied from 85–225 mm and 35.2% were berried.

Calicut: The bottom set gill net fishery for lobsters at Thikkodi, north of Calicut, landed 1.9 tonnes during the year. *Panulirus homarus* (77.9%) and *P. polyphagus* (22.1%) were the species caught. Lobsters were caught throughout the year except during the monsoon season (June-September). The catch of *P. homarus* increased from October to December and then declined after January when *P. polyphagus* became the dominant species constituting 70.2% of the catch in May. *P. polyphagus* ranged in size from 150–270 mm and berried females occurred only in March and October. *P. homarus* ranged in size from 130–265 mm and berried females occurred throughout the year.

Puerulus larvae were collected from the gill nets in May.

Cochin: The deep sea lobster *Puerulus sewelli* was caught by the larger trawlers in 235–270 m. off Quilon only during April-June when five tonnes were landed, the catch rate being 44.3 kg/hr. The modal size for females was 166–170 mm and for males 156–160 m. 61% of the females were berried, indicating that the fishery was based on a spawning population.

In the Kanyakumari District, 86.9 tonnes of spiny lobsters mainly *P. homarus,* were landed during the year by gill nets and lobster traps. This was an improvement compared to 1975 when only 38.5 tonnes were landed. The lobster season extended from November to April, with peak catches in November and a minor peak in April. The modal size was 151–160 mm during-January-March. Smaller lobsters (121–130 mm) entered the fishery in November.

Tuticorin: At Kayalpatnam, bottom set gill nets landed 17.5 tonnes during the year. Although lobsters were caught throughout the year, larger quantities were landed during August-January

and April-May; the peak season was in November. *P. homarus* (70%) and *P. ornatus* (30%) formed the fishery. *P. homarus* had modal lengths ranging from 161–170 mm to 201–210 mm. Smaller sizes were recruited into the fishery in October-November. Females were dominant in the fishery in June-August and berried females were found throughout the year. In the case of *P. ornatus* the modal size was 241–260 mm. Smaller specimens were recruited into the fishery in October-November. Males were more common than the females. Absence of berried females throughout the year indicated that the species spawns in deeper waters.

Mandapam Camp: The bottom set gill-net fishery for spiny lobsters realised 8.9 tonnes during the year. In addition, 5.4 tonnes of sand lobsters were also caught by trawl nets and gill nets . Among the spiny lobsters, *P. ornatus* (70%) was the dominant species ranging in size from 240–344 mm. Peak landings were observed in October-December. *Thenus orientalis* occurred in the gill net catches only during June-August, but was caught in trawl nets throughout the year; the size ranged from 90–200 mm.

Crabs: At Cochin, small quantities of the crabs, *Portunus pelagicus* (111–120 mm) and *P. sanguinolentus* (71–90 mm) were caught by the trawlers. Better catches were observed in December. At Mandapam Camp *Portunus pelagicus* was caught in trawl nets (86.6 tonnes) and gill nets (67.7 tonnes). In trawl nets better catches were obtained from January to June. The males showed multiple modes in the size frequency distribution, while females exhibited bimodal size distribution.The gill net season extended from March to May. Generally smaller crabs were caught; the males had a modal length at 135–139 mm and the females had modes at 100–104 mm and 135–139 mm.

At Kakinada the gill net fishery landed 30.4 tonnes of crabs during the year. *Portunus pelagicus* (83.6%) and *Scylla serrata* (14.7%) formed the bulk of the catch. The peak season for *P. pelagicus* was January-March. Majority of males measured between 130 mm and 170 mm in size, while females between 120 and 160 mm. Smaller crabs were recruited into the fishery in May-August. Males were generally more common than the females. Although berried females occurred throughout the year they were more common in February-March and August-November. *Scylla serrata* occurred in larger numbers in April-June.

Work contemplated: Collection of data on fishing effort, size composition, sex-ratio and other biological aspects would be intensified at all centres.

Prawn Fishery Atlas (CF/RE/1.4)

E. G. Silas, Director, M. S. Prabhu, M. S. Muthu, S. K. Dharmaraja, K. Rengarajan, and I. David Raj.

Salient findings

A model copy of the Prawn Resources Atlas (72 x 56 cm) was prepared and additional drawings are been drawn to fill up the gaps.

Work contemplated

The project would be completed in the ensuing year.

Status Report on Prawn fishery (CF/RE/1.5)

M. S. Muthu, C. Suseelan and M. Kathirvel.

Salient findings

State-wise, season-wise and species-wise distribution and abundance of the exploited prawn resources of the country for the years 1965–75 were analysed and consolidated. Salient features of the biology of the commercially exploited prawns from different centres along the coast were briefly reviewed. Based on the above studies a draft report was being prepared.

Work contemplated

Final report would be prepared and completed in 1977.

Culture of prawns and crabs (CF/Cul/1.1)

M. S. Muthu, S. Ramamurthy, N. S. Radhakrishnan, K. A. Narasimham, V. Sriramachandra Murthy, N. N. Pillai, K. V. George, K. K. Sukumaran, K. Devarajan, G. Sudakara Rao and others.

Salient findings

All the six commercially important species of penaeid prawns viz. *M. dobsoni, M. affinis, M. monoceros, P. indicus, P. monodon* and *P. stylifera* were spawned in the prawn culture laboratory

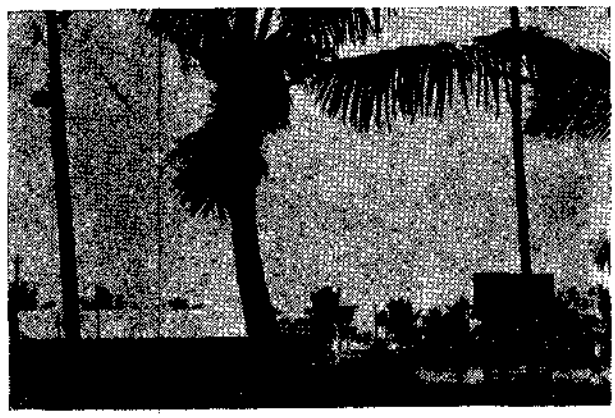
at Narakkal and the eggs were successfully mass reared through all the larval stages upto the early juvenile stage when they could be stocked in the ponds. *M. dobsoni* matured in the farm, spawned successfully in brackishwater and the larvae reared upto the juvenile stage in brakishwater medium. Growth rate in the ponds was inversely proportional to the stocking density; optimum stocking density for *P. indicus* appeared to be 5 prawns per $m.^2$ A technique for maintaining *Artemia* continuously was perfected at Narakkal. Mahua oil cake was successfully used for eradicating unwanted fish from the brackishwater ponds.

At Kakinada, the feasibility of utilizing salt pan reservoirs for raising short term crops of *P. monodon* was demonstrated.

At Mangalore, growth of *M. dobsoni* was studied in laboratory tanks using mussel flesh as food.

Work done

Cochin: During the year under report, excellent progress was made in the artificial propagation of all the six species of commercially important penaeid prawns of the Kerala coast viz. *Penaeus indicus,*



Prawn Culture Laboratory at Narakkal

P. monodon, M. dobsoni, M. affinis, M. monoceros and *Parapenaeopsis stylifera.* A simple and inexpensive technique was evolved to make the prawns spawn in the laboratory and to mass culture the larvae through the various larval stages upto the stocking size. Detailed morphological features of all the larval stages of six species

of prawns were illustrated and described. A wealth of new information on the identification of penaeid larvae and postlarvae was brought to light.

Experimental Ponds at Narakkal

M. dobsoni was "domesticated" as it was spawned in the farm and reard upto the stocking size in the brackishwater medium. *M. dobsoni* that were spawned and reared in the laboratory reached a size of 51–55 mm. in the ponds 3 months after they hatched from the eggs.

Mahua oil cake was used successfully in the ponds to eradicate predatory fish. The prawns were not affected by the oil cake, and in fact, they were found to feed on it.

Rearing of prawn larvae at Narakkal

Mangalore: The early juveniles of *M. dobsoni, P. indicus* and *P. monodon* collected from the estuary were reared in the

laboratory on a diet of clam meat. In a period of six months the males and females of *M. dobsoni* which had mean length of 51.4 mm and 53.4 mm respectively at stocking time attained mean length of 71.7 mm and 76.8 mm. In another experiment,males (41.9 mm) and females (44.7 mm) attained a length of 84.0 mm and 90.5 mm respectively within a period of one year.

Juveniles of *P. indicus* (45-62 mm) grew to 10-17 mm in 4 weeks time. A 14 mm postlarvae of *P. monodon* reared in the laboratory tank grew to a length of 122 mm in 3½ months.

Towards the end of the year prawn culture was started in a 800 sq. m. pond at the Mulki Farm.

Kakinada: A salt pan at Neelarevu (about 7000 sq. m) was stocked with juveniles of *P. monodon* (av. size 71.2 mm) at a stocking density of 13,300/ha. After 108 days 15 kg of *P. monodon* were harvested and their average size was 145.2 mm; the prawns had grown 74 mm in 108 days. *P. indicus* present in the pond showed a growth increment of 46.6 mm during the same period.

The local salt pan operators are now supplementing their income by growing prawns in the salt pans for short periods. By increasing the stocking density and by supplying artificial feed, it is suggested that the prawn yield from these salt pans could be improved considerably with very little additional expenditure.

Work contemplated

Work at Narakkal would be intensified to improve the survival rate of the larvae and to standardize mpond anagement techniques. Polyculrure of penaeid prawns and fishes such as *Chanos* and mullets will be tried. Domestication of *Penaeus indicus,* i.e., making them attain maturity under controlled condition will be tried. Prawn culture work at Mangalore and Kakinada will be intensified.

Development of artificial feed for prawn larvae and juveniles (CF/CUL/1.2)

M.M. Thomas, D.C.V. Easterson and M. Kathirvel.

Salient findings

Feeding experiments with four different types of artificial feeds having varying contents of protein and carbohydrates indicated

that the feed with a composition of 41.67% by weight of fishmeal, 33.33% of tapioca powder, 16.67% of rice bran and 8.33% of mineral supplement gave the best growth rate in the postlarvae as well as juveniles of *M. dobsoni* and *P. indicus*. The assimilation efficiency of this feed was 81%, with gross and net conversion efficiencies of 39.62% and 49.34% respectively. The intake of feed per day was 12.16% of body weight and the average growth per day was 8.51% of the body weight.

Work done

The protein and carbohydrate requirements of penaeid prawns with special reference to *M. dobsoni* and *P. indicus* were determined during the period. Feeds were prepared with different composition of protein and carbohydrates to determine the most suitable feed for enhancing the growth of prawns. Experiments were also conducted in aquarium tanks as well as plastic pools to find out the difference in growth rates in different sizes of container. Energy conversion of the best feed on juveniles of *M. dobsoni* was estimated and the energy budget was prepared.

Work contemplated

The best feeds are to be fortified with vitamins in different proportions to determine the vitamin requirement of penaeid prawns during the coming year. It is proposed to conduct feeding experiments in ponds with some of the better feeds tested already in the laboratory with a view to determine the most suited feed for commercial application.

Investigations on salinity tolerance of penaeid prawns (CF/CUL/1.3)

C. Suseelan.

Salient findings

Poor survival of early juveniles of *Parapenaeopsis stylifera* and *Metapenaeus affinis* in the media having salinities less than 25‰ and 14‰ respectively was recorded. Field studies showed that *M. dobsoni* was distributed in all the salinity gradients in the Vembanad Lake, while the occurrence of *M. affinis* and *Penaeus monodon* was restricted only to salinities upto 11.05‰ and above in this habitat.

Work done

The salinity tolerance of juvenile penaeid prawns was studied by a series of laboratory experiments and by examining the distribution of wild population in relation to varying salinity conditions on the Vembanad Lake.

In the laboratory early juveniles of *Parapenaeopsis stylifera, M. affinis,* and *Penaeus indicus* were repeatedly reared, after proper acclimatisation, in different salinity grades ranging from 2.0 to 32.0‰. Data on temperature of the rearing media, size of the experimental animals, moulting frequencies, duration of survival etc. were recorded. The distribution of wild population of these prawns in relation to salinity conditions of the natural habitat was studied by periodic examination of their occurrence in try net hauls taken at 4 selected stations in Vembanad Lake viz. Thevara, Vaikom, Thannirmukkom and Pathiramanal. These places showed marked differences in salinity at the bottom. Sampling at these centres were made twice a month and details on the number and sizes of prawns werere corded against salinity and temperature parameters.

Work contemplated

It is proposed to carry out further experiments to confirm the results of earlier experiments and to extend the experiments on larvae and post-larvae of different species.

MOLLUSCAN FISHERIES DIVISION

Resources survey of commercially important molluscs (Mol/Re/1.1)

K. Nagappan Nayar, S. Mahadevan, T. Appa Rao, K. A. Narasimham, K. Satyanarayana Rao, V. Sriramachandra Murthy, Y. Appanna Sastry, R. Sarvesan, K. S. Sundaram, P. V. Sreenivasan, M. M. Meiyappan, D. Sivalingam, P. Natarajan, K. Ramadoss, K.K. Appukuttan, T. Prabhakaran Nair, P. S. Kuriakose and others.

Salient findings

Survey of the edible molluscan resources along the east and west coast to a distance of 300 km was completed which brought to light the existence of extensive *Donax* population.

Work done

At *Vizhinjam:* 49 km stretch between Kovalam and Eaayampozhi was surveyed. In *Tuticorin* 133 km stretch from Cape Comorin to Tuticorin was studied. The average density of *Donax* population was 70/m^2. Survey along Palk Bay coast from Thonithurai to Alongulam covering a distance of 25 km revealed rich population of not only *Donax cuneatus* (av. 413/Sq. m^2.) but also *D. faba* 88/ m^2 (and *D. incarnatus.* At Porto Novo Vellar estuarine region was studied over an area of 350 ha. in which dense population of the clams *Meretrix casta* and *Katelysia opima* was noticed. At Madras, the zone from Palavakkam to Ennore was investigated. *Paphia textile* and *Donax cuneatus* were seen inhabiting the coastal area. *M. meretrix* and *M. casta* were the other important clams.

A detailed study of the window-pane oysters (*Placenta placenta*) bed extending over 130 sq. km in the Kakinada Bay was undertaken and an estimated population of 6572265 kg of live specimens out of a total of 23056095 kg was known to exist in this bed. At Vizagapatnam the survey made from Waltair to Annavaram did not show much of edible molluscan population.

Work contemplated

During 1977 the survey work in respect of the first phase of work will be intensified in all the centres and it is hoped to take up phase II of the work dealing with estuaries, lagoons and backwaters.

Investigations on the Cephalopod Resources (Mol/Re/1.2)

E. G. Silas, M. V. Jadhav, Kuber Vidyasagar, M. M. Meiyappan, K. Prabhakaran Nair, K. Satyanarayana Rao, P. Natarajan, P. V. Sreenivasan, R. Sarvesan, Y. Appanna Sastry, B. Narayana Rao.

Salient findings: Cephalopod landings in the country were estimated as 10826 tonnes, an increase of 35.6% over that of last year. Mostly the catches were obtained from shrimp trawlers. *Sepia aculeata* was dominant (among cuttle fishes) in the east coast whereas in the west coast different species were noticed in different centres. *Veraval:* 332 tonnes. *Sepia prashadi* dominant. *Bombay:* 226 tonnes at Sasoon docks. *Loligo duvauceli* in the first half and *S. aculeata* in the second half were dominant. 215.7 tonnes at Kasara Bunder. From the dol net catches at Versova juveniles of *L. duvauceli* and *Sepiella inermis* were noticed. *Cochin:* 33.7 tonnes. cpue 1.02 kg/hour. Peak in October. *Sepia elliptica* and *L. duvauceli* were dominant. *Vizhinjam:* 107.6 tonnes by boat seines, shore seines and hooks and lines. Boat seine landings comprised of squids and hooks and lines —cuttlefishes. *Sepia pharaonis* dominant. *Mandapam:* 42.3 tonnes by trawlers and 3.7 tonnes by shore seines at Mandapam area. *Sepioteuthis arctipinnis* dominant. Peaks in February, May to July and October. Rameswaram: 76.1 tonnes by trawlers. *S. aculeata* dominant, Peaks in February, May, July, November and December. *Porto Novo:* 2.1 tonnes. *S. aculeata* dominant species. *Madras:* 205 tonnes. cpue 1.14kg/hour. Peaks in June-July. Off Sriharikotta (13–80/6B) juveniles of *Loligo sp.* were collected. *Kakinada:* 105. 6 tonnes. A 20% increase over that of last year. *S. aculeata* and *L. duvauceli* were dominant. *Waltair:* 37.9 tonnes. *Sepia aculeata* dominant.

Work done: Catch, Catch per unit of effort— gearwise/monthwise/specieswise were estimated at all centres. Biology of all important species were studied. In some centres, experimental light fishing was attempted.

Work Contemplated: Since the project is of continuing nature work on the above lines will be continued at all the centres mentioned above.

K. Nagappan Nayar, S. Mahadevan, K. Satyanarayana Rao, P. V. Srinivasan, K. Ramadoss, Pon. Siraimeetan, P. Natarajan, D. Sivalingam, K. K. Appukuttan, T. Prabhakaran Nair and others.

Salient Findings

The Pearl Oyster population in the Paars off Tuticorin was so poor that it is not possible to expect any pearl fishery during the next one or two years. Chank fishery in the traditional Tuticorin beds was not conducted on a large scale but Kannirajapuram fishery and Palk Bay fishery was brisk.

Work done

Tuticorin: Chank fishing was conducted in March, 1976 at Tuticorin area and measurement of 268 full sized chanks and 113 under sized chanks was taken in the first quarter. Chank fishing could be done only for ten days altogether in this year. 4,402 full sized chanks 3,159 wormed chanks and 5,606 undersized chanks were commercially fished during the first quarter.

The chank fishery was conducted in Kannirajapuram in an organised manner by the merchants from Kilakarai engaging divers from places like Mullimunai, Karangad, Thirupalakudi, Periapatnam, Tuticorin and Colachel. The fishery commenced from the beginning of October and lasted till the end of February.

At Kilakarai during the year ending December, 1976 3,554 numbers of *Xancus pyrum* were landed; out of the total catch,235 numbers were under size and 187 wormed ones.

The chank fishing was conducted by diving off Vedalai from January to May and from October to December. In the period July-September chanks were got in crab nets and lobster nets. 6,082 chanks were landed at Vedalai in the year. Of these 2,625 were got in the period January-March, 1,731 in April-June, 577 in July-September and 1,094 in October-December. Of the total chanks fished 5,454 chanks were of *acuta* variety, 171 of *Obstusa* variety.

Mandapam: It has been estimated that 59,412 chanks were fished off Rameswaram in 1976. The chank diving season began

in first week of March and extended till end of April. The chanks belonged to the variety *acuta*.

Chank fishery at Pamban and Devipatnam started in February and March respectively. The season of chank fishery at Pamban was confined only to the first quarter of the year whereas at Devipatnam the fishing season was prolonged upto August, 1976. All the chanks landed were of the variety *Xancus pyrum* var. *obtusa*.

At Mullimunai the chanks were mostly obtained by diving. The chanks also got entangled in "Thirukkai Valai", An estimated total of 35,413 chanks were landed during the year of which 3,607 were under size chanks and 122 were wormed by *Cliona*.

An estimated total of 2,813 chanks were landed in Karangad, of which 115 were wormed by *Cliona*. The chanks were got in crab net. Karangad divers disposed of their catches in Mullimunai.

Landings of Sacred Chank at Tuticorin

At Tondi during the year under report, 10,712 numbers of *X. pyrum* were landed; out of the total catch, 144 numbers were wormed ones and 92 were under size.

At Sethubavachatram 5,152 numbers of chanks were landed totally, during this year under report, of which only 4,438 numbers were full size chanks. 256 numbers of chanks were wormed ones and 458 numbers of chanks were under sized.

A total of 7213 numbers of chanks were landed at Porto Novo The chanks belonged to the "patt" variety of *Xancus pyrum* locally called Pal Chanku (Tamil). Since the agents engaged by chank

merchants usually go directly to the boats anchored in the sea to purchase the chanks and then bring collectively to the shore, maintenance of data on unit wise catch was not possible.

Proposed work:

The work will be continued in 1977 also as a part of monitoring programme of the Institute.

Pearl Oyster Atlas (Mol/Re/1.4)

Shri. K. Nagappan Nayar, S. Mahadevan, A. Bastian Fernando.

Work on the preparation of the pearl oyster Atlas progressed satisfactorily and Part I and II were completed during the year.

Work done

Tuticorin: A preliminary format of pearl oyster atlas has been prepared, dividing it into 3 parts of which the first two have been completed.

With the available pigments, from the local market, diagrams were drawn. Thus collection of materials, data and upto date references for the preparation of the pearl oyster atlas was completed during the year and dummy of part I and part II of the Atlas was prepared and got approved by the Director for transfer to colour diagrams and illustration. Fifteen sheets in full colour have been completed, viz: 1) worldwide distribution of pearl oyster, 2) various species of pearl oyster, 3) grounds of *Pinctada fucata*, 4) grounds of other oysters. 5) viscera in situ, 6) pearl sac-sites, 7) food of oyster, 8) early development 9) anatomy of shell-two sketches, 10) substratum, 11) predators—two sheets, 12) destroyers —two sheets.

Dummy preparation of part III is in progress. This includes details of pearl fisheries and fishing operations, historical record of pearl banks for the past 100 years, structure of pearl, culture methods, kinds of pearls and pearl culture industry in India. This part is expected to be completed in 1977 and the Atlas will be ready by the end of next year.

Work contemplated

Work will be continued during 1977 in preparing dummy of part III of the Atlas.

Edible Oysters: (Mol./Cul/1.1)

K. Nagappan Nayar, S. Mahadevan, K. Ramadoss, M.E. Rajapandian, C.T. Rajan, Sri. A. Sreenivasan, K. Satyanarayana Rao, D. Sivalingam, Ashok Kumar Unnithan.

Culture of edible oyster *Crassostrea madrasensis* at Tutiocrin and Mandapam Camp and the green mussel *Perna viridis* at Vizhinjam, Kozhikode and Madras was initiated on a large scale. Farming was successful and yielded valuable results.

Work done

Culture of edible oysters:

(1) Tuticorin:

Work was intensified during this year. Oyster rack of the size of 42 x 1.5 metres was erected during the first quarter, to accommodate 80 cages and 8,000 oysters for culture. Since this platform was positioned across the creek, silt deposition created problems resulting in mortality of oysters. It was decided to remodel the racks and to construct them across the river. Three platforms of size of 35 x 1.5 metres were put up, each rack accommodating 4 trays with 2,400 oysters. Positioning of racks was so manipulated as to expose the oysters during the low tides for few hours. By this method, settlement of fouling organisms was drastically cut down. Jet cleaning of oysters with creek water pumped by a 0.5 HP engine was also periodically done. The farm was further enlarged in August, bringing the total to 15 racks with a stock of 30,000 oysters. A separate spat collecting platform was set up on the northern side of the creek. By the end of the year, the farm was extended to contain 20 racks with a stock of 40,000 oysters.

Spat collection work was actively done in April and September, the period of intense spawning. Lime coated tiles, bamboo screens and cocoanut shells were used as collecting agents. The most efficient cultch material was found to be the lime coated tile in which 10-15 spats were found on an average. The spat so settled were cleaned periodically and measured. Transplantation of these to the farm site can be done only when they are sufficiently grown. The growth rate of spat was seen to be 12-14 mm per month. It was seen that the mortality rate of oysters was negligible in the oyster farm.

Statement showing progress of the oyster culture farm during 1976

Months.	No. of racks	No. of cages	No. of oysters	Remarks
January	1	60	6,000	
February	2	48	4,800	Remodelled
March	3	72	7,000	across the creek
April	4	96	8,000	
May	4	96	8,000	
June	4	96	8,000	
July	4	96	8,000	
August	9	196	10,000	
September	9	196	10,000	
October	15	316	30,000	
November	15	316	30,000	
December	20	366	32,000	

During this year 50 samples of plankton were collected from the Karapad creek once a week. Regarding the zooplankton, *copepods* and *Nauplii* were available throughout the year. *Tintinnids* were found in the samples collected in April to December. Larval gastropods were found in all samples except in those collected in January and March. Medusoid were present throughout the year except in January. Lamellibranch larvae were available in all the months except January and March. The quantity of lamellibranch larvae was more in May, June, August and September when compared to other months.

As the growth rates differ with different size, the sizes were sorted out and each size group comprising 75 Nos. oysters were reared in separate trays. About 15,000 oysters were sorted out into 15 size groups, ranging from 41 mm to 190 mm and placed in 24 trays and reared in the farm. Before placing the oysters in the trays, the oysters were cleaned.

The growth rate at different size range varied from 2.5 mm to 11.0 mm. Very high growth rate was observed in the size range of 41–50 mm group.

Induced breeding

Series of repeated experiments were carried out to make the oyster breed in the laboratory so as to develop a hatchery technique for laboratory culture.

a) Thermal stimulation

Fifty oysters were reared in separate glass troughs. Thermal stimulation was provided. The temperature of the water was maintained around 36°C for 57 days. But under these conditions the oysters did not breed though under examination they were found to have mature gonad.

b) Salinity change

Mature oysters were put in low salinity water ie. two parts sea water and one part distilled water to find out the effect of lowering the Salinity in making the oyster breed. But so far no positive results have been obtained.

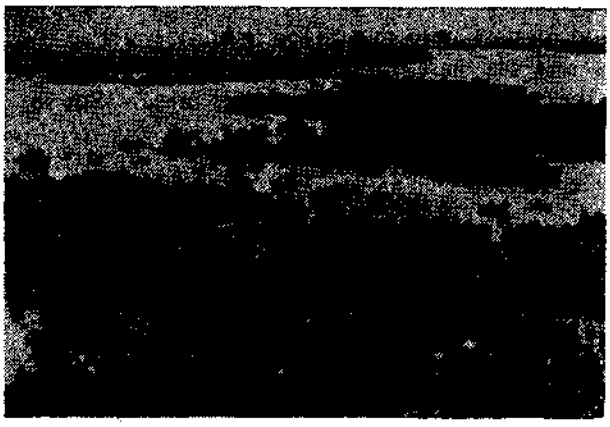
c) Stripping method

Live oysters were brought to the laboratory and their gonadial condition was examined. Oysters with mature gonads were chosen. After removing the outer membrane of the gonad the gonadial content of both male and female were separated. Tissue pieces and tissue fluids were separated by series of filteration. Nylon bolting cloth No. 25 and Whatman No. 1 & 2 filter paper were used for filtration. They were mixed together in culture vessels along with filtered sea water. The fertilized eggs were periodically observed under microscope for the developments. Time taken to reach the different developmental stages was also noted. The different cleavage stages, blastula stage, gastrula stage and trochophore stage and straight hinge stage were drawn with camera lucida. The straight hinge stage were fed with algal mixture cultured in the laboratory. Due to the attack of ciliates present in the water further developments were arrested and the young ones died. At present, different methods of sterilizing the medium including the addition of chlorophenical and streptomycin sulphate are being tried.

(2) Mandapam Camp

The culture of the edible oyster, *Crassostrea madrasensis*, was carried out in Athankarai estuary. Three types of cultches, viz. concrete pieces about 12 cm x 9 cm in size, specially prepared concrete blocks 17 cm x 15 cm x 2.5 cm and oystershellswere kept tied

to hanging nylon ropes in the estuary. During the first quarter of the year sixty nylon ropes with cultch were kept suspended in the estuary from horizontal bamboo poles. In the second quarter thirty three ropes with cultches were set for collection of spat. In April a raft made of bamboo poles and G.I. drums suitably anchored was set in the estuary, with thirty nylon ropes having concrete blocks as clutch for collection of spat. There was good spatfall in the first quarter, January, March and 409 spat were recorded. In the second quarter only stray number of fresh spat were recorded. It was observed that spat set in large numbers on clutch in the middle portion of the estuary and only small numbers set near the mouth and in the upper portion of the estuary.



Edible oyster beds at Athankarai

Size frequency analysis of spat and young oysters showed a single mode at 25 mm in January, 1976 which shifted to 35mm in February. It shifted to 45 mm in April and 55 mm in May. A mode was observed at 55 mm in July and there was no shift in modal size in September, 1976. Cultured oysters were transferred from Athankarai estuary in August, 1976 to Palk Bay and reared there as there was rise in salinity of the estuary leading to mortality. 2,000 oysters spat and oysterlings 26 mm to 73 mm in size were collected from Kancharangudi estuary and reared in the inshore waters in twenty six welded mesh cages mounted on two racks near C. M. F. R. Institute jetty. The oysters exhibited growth in size towards end of December.

Work contemplated

The farm at Karapad will be further expanded so as to enable to maintain a stock of 15 tonnes of oysters. Similarly the farm

at Athankarai estuary in Mandapam area will be reestablished. Intensive spat collection programme will be under taken using different types of spat collectors.

Culture of Mussels (Mol/Cul./1.2)

K. Nagappan Nayar, S. J. Rajan, K. Rangarajan, T. S. Naomi. S. Muthuswami, S. Srinivasarengan, K.K. Appukuttan,T.Prabhakaran Nair, N. Radhakrishnan Nair, P.S. Kuriakose and others.

Salient Findings

Mussel culture work at Kozhikode yielded very encouraging results indicating the possibility of producing 230 tonnes/ha of open sea in a period of 6 months. Similar work undertaken at Vizhinjam revealed the feasibility of establishing mussel culture industry in the area. Based on the results obtained by us earlier the Governt ment of Kerala have started a pilot project on mussel culture. At Madras mussel culture experiments were hampered because of the cyclone and fresh attempts were made to float new rafts at Kovalam. Mussel spat collection attempts were highly successful in this area.

Work done

Culture of green mussel

Kozhikode

The experimental mussel culture work in the open sea at Kozhikode was started in November, 1975. The raft used for the experiment measured 6 x 5 metres in surface area and was floated about 1.5 km away from the shore at a depth of 5 metres. 35 numbers of (14 mm) nylon and (20 mm) coir ropes of 4 metres length were used for seeding juvenile mussels. The collection of seed for the culture experiments was made from a marked area of the natural mussel bed near Elathur, so that periodic observations can be made on the rate of growth of mussels in that area of the natural bed and compare it with that of the same stock cultured in the farm. The size of the mussel seed at the time of transplantation ranged from 20–32 mm with an average weight of 1–48 gm. per individual. A total of 2,000 to 2,500 such juvenile mussels were seeded in each rope. Monthly growth rate was determined by sampling 100 specimens collected from 5 ropes. From

each rope 20 numbers of mussels were taken out at random from top to the bottom of the suspended rope and measured. Total live weight with shell was determined after draining the mantle water completely and uniformly. The shell weight and meat weight were determined in wet condition immediately after sampling. Growth rates of the mussel in the natural bed was also studied every month by measuring 100 specimens collected randomly from the marked area of the natural bed.

Rafts for open sea mussel culture at Calicut

Seed mussels having an average length of 26.7 mm and a total live weight of 1.48 gm. transplanted on 15th November, 1975 grew to a size of 80 mm. weighing 28.7 gm. at the time of the harvest on 6th April, 1976. The average monthly growth rate calculated was 12 mm. per month. The average meat yield of the "seed" was 0.64 gm (forming 43.25 per cent of the total live weight) which increased to 14.95 gm by the time of the harvest, registering 52.09 per cent of the total weight. During the corresponding period young mussels with an average length of 26.7 mm weighing 1.48 gm. in the natural bed grew to 68.5 mm by the end of April, 1976, when they weighed only 17.8 gm. The percentage of meat weight of the mussels in April was only 38.20.

Production: It was observed that by the open sea rope culture method 1 kg of mussel "seed" can be grown to 7 kg within a period of 145 days.

101 kg of mussel seed transplanted on 35 ropes from 30 sq. metre area produced 706.44 kg of mussels, the average production per rope of 4 metre length being 20.18 kg.

Calculating on this rate of production, the yield per hectare by suspended culture method in the open sea for a period of 145 days amounts to 235.46 tonnes.

One interesting observation made in the present study relates to the gonad development in the case of cultured mussels. The seed mussels transplanted from natural bed to the culture raft showed signs of gonad development within a period of 30 days. By the end of December, 1975 the gonads of all the mussels in the raft were in the developing stage and within a period of 2 months all of them had attained sexual maturity. Spawning of the cultured mussels started in February, 1976, and 35 per cent of the mussels were found to have spawned before the harvest on 7th April, 1976. Mussels less than 10 mm in length were found attached all over the submerged part of the raft materials and among the adult mussels on the suspended ropes. In the case of the mussels in the natural bed, gonad development commenced only in the last week of April, 1976 and the development of the gonad was found to be very slow. By the end of June, 81 per cent of the mussels in the natural bed were found with developing gonads.

As a part of the expanded programme of the Institute, large scale mussel culture work was started in the open sea at Kozhikode in October, 1976. The farm is located at 10 metres depth, about 4 km away from the shore, due west of the C.M.F.R.I. Research Centre building. The rafts covered a total area of 500 square metres in the open sea. Altogether 300 ropes (both Nylon and coir ropes) of 8 metres length, seeded with young mussels were suspended from the rafts. The collection of the seeds for the culture work was made from the natural bed near Elathur. The size of the seed used ranged from 13 to 28 mm with an average length of 21.7 mm. A total of 5,000 to 6,500 numbers of mussels (weighing 4 kg) were seeded in each rope.

b) Vizhinjam:

Periodical examination of natural bed in June revealed that spat ranging from 5 mm to 15 mm have settled in the rocks with modal length of 3.5 to 4.5 mm and 6.5 to 8.5 mm. Analysis of the settlement pattern in natural bed showed that the settlement was poor. Settlement pattern in various cultches such as tile blocks, bamboo splits, cocoanut shells and cement blocks was studied.

During May and June there was heavy settlement of mussel spat in the farm area also on cocoanut shells and tile blocks. Good

settlement was noticed mainly in the cultches hung in the one metre depth from the rafts. In cocoanut shells the settlement was high in the inner side rather than the outer side.

Four new teakwood rafts were fabricated and to start with 4 ropes were seeded in July and 6 in August with spat of size 14–28 mm. 32 mm ropes were added in October with 25-40 mm size spat transplaced on them. A further instalment of 54 ropes were added by December end. In all 123 ropes were suspended during the year.

One year old mussels were retained in the old rafts and samples were being taken for growth studies. 170 kg of cultured mussels were harvested and sent to C.I.F.T. Cochin for processing. Two nylon ropes with cultured mussels were taken again to Cochin on 1–6–1976 for the exhibition conducted in connection with the inauguration of the C.I.F.T's new building. Live mussels were transported by jeep trailor filled with sea water and they survived well for 4 days at Cochin. On 9–12–1976 nine kg of cultured mussels were sent to Madras in plastic tubs with sea water by air on a trial basis and it was found that the mussel survived well and was retained at Madras Research Centre of CMFRI. On 29–12–1976 ten kg of live mussels were again sent by air to Madras which was to be taken from there to Buvaneswar for exhibition. On 25–12–1976, one full rope of cultured mussels, 4 metre length cut into three pieces, were taken by jeep to Kasargod for exhibition in live condition.

Analysis of peak modes showed 45 mm growth for one year. Another important factor noticed was that the top portion of the rope registered maximum growth while in lower portion growth rate was reduced. The maximum weight of cultured mussel per one metre of rope was 15 kg. Maximum percentage of flesh weight was 46.8% in June. Condition index showed gradual increase from July to November.

Number of mussels ranging from 68–90 mm were spawned in the laboratory during first half of July. Mussels examined from ropes were all in ripe condition. Samples of egg and sperm were collected and mixed in sea water to study the early developmental stages. Mature eggs were fertilized within 15 minutes and first division started after ten minutes. Within ten minutes second division was completed and morula stage was obtained after two hours. Trochophore stage was observed after eleven hours and

free swimming veliger was formed within 20 hours. Typical trochophore was with apical flagellum and the body completely covered with minute cilia. Free swimming veliger with well developed velum were swimming for four days in the laboratory. Due to heavy ciliate attack further stages could not be traced.

c) Madras

During the year the culture of the green mussel, *Perna viridis* was commenced in the open sea at Kovalam about 45 km south of Madras. The bay opposite the Kovalam village is calm for most part of the year, the depth varying from 2 to 4 fathoms. The bay was surveyed and a suitable spot between two broken series of rocks, at about 2 km from the shore, was selected to anchor the culture raft.

After preliminary field trials a standard design was evolved for the quick fabrication of the raft with locally available cheap materials. The raft provided an area of 25 sq. metres from which about 50 ropes could be suspended. The raft was anchored with four graphel type anchors, weighing about 20 kg, at each corner using mild steel tested chain.

20 ropes were seeded with the mussel spats using bags made of mosquito netting cloth. 2 kg of mussel seeds were used to seed a rope. In about a week's time the mussels attached firmly to the ropes and thrived well in the raft. Attachment was found to be firm on coir ropes than nylon ropes. The seeded mussels showed an increase in weight of 2.0 to 2.5 kg per metre/per month. The mussels showed a growth rate of 10–12 mm per month.

Mussels spawned by the end of February, 1976 and by the middle of March, 1976, mussel spats measuring 4–5 mm in length were noticed on the spat collectors. Mangalore tiles proved to be the most suitable material for the collection of spats. The intensity of spat fall during May, June and September was so heavy that both sides of the tiles were completely covered by the spats.

Sea water samples from area around the culture raft were collected from zero to 8 metre depths.

An upward trend in salinity observed from March lasted till May. June witnessed the on set of a gradual decrease that proceeded upto July. A slight lowering of salinity observed in

September is relatively insignificant whereas the increase noted in October is perceptible. It is significant that a steep fall was recorded in November, December registered an appreciable increase.

The mussel culture area was rich in dissolved Oxygen content throughout the period.

Withdrawal of Inorganic phosphate and Nitrate from the waters off Kovalam proceeded upto May. A process of replenishment that was observed from June lasted till August. A gradual decrease in the phosphate content was noted from September to November. It was followed by a perceptible increase observed in December. Whereas Nitrate showed a steady increase from October to December.

A gradual increase in the Nitrite content was observed from March to July. August recorded a slight decline. The values for Nitrate remained more or less steady during the rest of the period except in November when a greater concentration of Nitrite was encountered at 8 metre depth and in December when a moderate decline was registered at Zero metre depth.

Barring a slight reduction in the silicate content noted in May a steady incease was observed upto August. September-October recorded a decline and it was followed by a considerable increase registered during Novemberr and December.

Variations in the qualitative abundance of the phyto elements and the zooplankters of the Kovalam Bay were also studied from March 1976. The plankters which were represented more frequently in significant numbers are given below in the decreasing order of their abundance.

Phytoelements:

Rhizosolenia styliformis and *R. alata* in March, *Skeletonema costatum* and *Thalassiothrix frauenfeldii* in April were represented in considerable numbres apart from the commonly occurring *T. nitzchioides* and *Asterionellla japonica* in these two months. During May and greater part of June, most of the phytoplankters were less abundant. The last week of June witnessed an enormous increase in the phytoplankton content as almost all the constituents appared in large numbers. The qualitatively significant phytoplankton have become scarce during July and August, while the

common forms continued to occur with little variations in their abundance. Throughout September all except a few of the constituent phytoplankters abounded in the waters off Kovalam. Only a few constituent phytoplankters were separately represented in the collections during October and *S. costatum, T. frauenfeldii* and *T. nitzchioides* occurred in large numbers and almost all the less common forms appeared and added impressively to the total phytoplankton content. December recorded a decline in both quality and quantity of the floral elements.

Zooplankton:

Organisms except the copepods were relatively scarce from March to the middle of April. The later half of April witnessed a marked increase in the zooplankton content as Lucifers were encountered in large numbers along with other forms which showed considerable improvement. It is highly significant that the bivalve larvae appeared in May but the quality of the plankton was comparatively poor throughout the month. Most of the plankters occurred in relative abundance in June. A dearth of variety of organisms was noticed in July as most of the qualitatively significant forms were absent. During August and September all the common forms occurred in abundance and the less common ones were also well represented. Not only most of the less common forms disappeared from the collections in October, but the common forms also were less abundant causing an overall reduction in the zooplankton content. Copepods appeared in large numbers in November along with other constituents which also showed remarkable improvement. December recorded a general decline and especially that of Copepods was marked.

Bivalve larvae:

Bivalve larvae occurred more frequently in appreciable numbers from May and seldom disappeared from the plankton samples throughout the five month period extending from August to December.

Contemplated work

The mussel farming will be intensified at Madras, Vizhinjam and Kozhikode.

Culture of Clams and cockles: (Mol/Cul/1.3)

K. Nagappan Nayar, K.A. Narasimham, Y. Appanna Sastri, P. V. Srinivasan.

Work on the culture of clams and window pane oyster was initiated on an experimental scale. "Cage" type growing of cockles was also attempted at Kakinada.

Work done

Porto Novo

Culture of clam, Meretrix casta:

Experimental growth studies were taken up on the backwater clam *Meretrix casta* (Chemnitz). Firstly, a small dealwood cage was released in the Vellar estuary with 50 numbers of *M. casta* in the size range of 18 mm to 29 mm with a mean length of 24.3 mm on 3–9–1976. After 27 days, the size range of the clams found were 24 to 35mm indicating a growth of 6mm and the mean length was 28.8 mm thus showing an average growth of 4.5 mm in a month. Encouraged by the result, two more cages have been released.

The growth rate of the clams was slower in cage 2. This was probably due to the effect of monsoon floods. The reduction in mean size in the third month was due to heavy mortality to the extent of 95 – 96% mainly by predation by the crabs of the genera, *Scylla, Charybdis* and *Portunus.*

Work Contemplated:

Clam transplantation work at Porto Novo will be started in 1977. It is proposed to take up culture of *Anadara granosa* also at Kakinada Bay.

Orders were placed to procure the material required for floating rafts for the off-bottom culture of the cockle, *Anadara granosa.* In consultation with the port authorities suitable site was located for this purpose off Kakinada. Concurrent with off - bottom culture, for a comparative study, a piece of one hectare of land was located near Yetimoga in the intertidal zone to culture the cockles on the bottom.

FISHERY ENVIRONMENTAL DIVISION

OCEANOGRAPHY

Environmental studies—Physical and Chemical aspects (MBO/ES 1.1)

A.V.S. Murty, C. P. Ramamirtham, D. Sadananda Rao, N.S. Radhakrishnan, G.G. Annigeri, R. Marichamy, V.S.K. Chennubhotla, K. G. Girijavallabhan, P. Mojumder and others.

Salient findings

The studies on sea water characteristics revealed seasonal contrasts in the Laccadive region. Based on dynamic calculations, the region between Calicut and Cannanore was found to be the region of intensive upwelling off the west coast of India. The region of intensive evaporation was located in the middle of the Eastern Arabian Sea.

A salient feature of the Karwar waters was lack of upwelling in the area during the period of southwest monsoon which was generally the season of upwelling in the area.

A surface unit of transparency meter was designed and fabricated and found useful for percentage studies of transparency of seawater.

Progress of work

The Laccadive region was studied for its temperature, salinity and dissolved oxygen characteristics during different seasons of the year. The behaviour of the thermocline in this region was also studied.

Oceanographic conditions were monitored from various places like, Bombay, Karwar, Mangalore, Calicut, Mandapam Camp, Tuticorin, Madras and Waltair.

Work contemplated

Monitoring would be continued for oceanographic parameters such as temperature, salinity, dissolved oxygen, hydrogen ion concentration and nutrients from various research centres along the west coast as well as east coast of India. Regular observations

could be carried out and various charts would be prepared to analyse the data.

Ecological conditions of Vembanad Lake (MBO/ES/1.2)

A.V.S. Murty, V. Kunjukrishna Pillai, A. Regunathan, R. Vasanthakumar.

Salient findings

The nutrient content in the Vembanad Lake waters did not show any marked changes, while the temperature varied between 29.7° C and 32.0° C and the salinity from 2.9‰ to 15.61‰. Dissolved oxygen values were found not lower than 3 ml/1. In the samples collected during March, ctenophores and medusae were abundant north of Thannirmukkom bund and south of the bund they were conspicuously absent. In samples obtained by try net catches fishes were abundant in November. During the fourth quarter there was a thick layer of *Salvinia* sp. at the surface of the lake throughout the area.

Work contemplated

Regular observations would be carried out, to analyse the environmental factors controlling the species-wise distribution of fishes in the lake.

Preparation of Fishery Oceanographic Atlas (MBO/ES/3.)

A. V. S. Murty, C. P. Ramamirtham, D. S. Rao.

Salient findings

The format of the fishery oceanographic atlas was finalised. It was envisaged:

i) to present the vertical distribution pattern of average parameters of temperature, salinity, dissolved oxygen and density in a quasi meridional plane along the southwest coast of India from Cape Comorin to Karwar for a whole year period.

ii) to present the vertical distribution pattern of the above parameters in zonal sections at various places across the coast.

iii) to present the detailed monsoon features in the area Cape Comorin to Ratnagiri.

iv) to present the horizontal distributions of the above parameters in the mixed layer in relation to the distribution of sardine and mackerel fisheries.

Work contemplated

Preparation of charts would be carried out. More stress would be given to the conditions of the euphotic zone where the plankton flourishes.

Investigations on the mud banks of the Kerala Coast and their influence on fisheries (MBO/MB/1.1)

A. V. S. Murty, D. S. Rao, K. J. Mathew, C. P. Gopinathan, A. Regunathan, V. K. Balachandran.

Salient findings

A noteworthy observation was made on fisheries of the mud bank regions. The fishery started and good fishery persisted for about ten days at the beginning of the season (June). Due to very late onset of monsoon during 1976, there was no monsoon when the fishery started and flourished. Subsequently the fishing was a failure although the monsoon rains started and the mud bank formed. Thus, the formation of mud bank was delayed due to the late onset of monsoon, while the fishery advanced but ended in a failure when the mud bank actually formed. This observation is a natural indication that the fishery has nothing to do with the formation of mud bank whereas the formation is dependent upon the southwest monsoon. It has thus been established for the first time that the formation or existence of mud banks and the fishery are independent factors. The mud bank acts as a safe port for the canoes which bring their catches usually from outside the mud bank limits and rarely from within the mud bank.

Progress of work

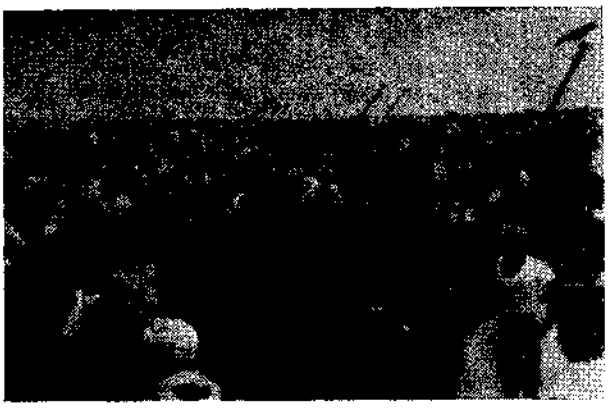
During the period under review, the study of the whole work carried out during the past years was taken up in order to make a comprehensive picture of the mud banks and their associated fisheries.

During the late monsoon period in August formation of mud bank at Korapuzha river mouth at Elathur (8 km north of Calicut) was noticed and investigations were carried out on the ecological features of that mud bank.

The following papers were prepared for the purpose of bringing out a bulletin.

1) Theories on mud banks.

2) Mud cones observed at the mud bank region of Ambalapuzha.
3) Ecological studies of the mud banks. Part -I - Seasonal variations.
4) Ecological studies of the mud banks. Part-II—Diurnal variations.
5) Studies on the bottom fauna of the mud banks.
6) Fish and fisheries of the mud banks.



Landing centre at Ambalapuzha during mud bank season

Bumper catch of prawns at Purakkad

Work contemplated

1) To bring out the bulletin on mud banks incorporating all the results of investigations carried out so far.

2) To concentrate investigations on the mud banks in the northern region of Kerala coast.

Currents and upwelling in the region Cochin-Cape Comorin. (MBO/ES/2.1)

C.P. Ramamirtham, D. S. Rao and others.

Salient findings

As far upwelling along the west coast is concerned, it appears that the phenomenon starts in the southern regions and with progress of season, the northern regions are also affected. The divergence of the coastline towards southwest also helps in this connection. Thus, although it was observed that the upwelling in 1965 was weaker than that in 1964, during August (later part of monsoon) the northern regions also seems to be affected, by upwelling in both the years. The southward currents along the coast are conspicuous during July only, in 1964, and a noticeable variation in the intensity of the current patterns were observed from year to year. Thus the southward current conspicuous during 1964, is not at all well defined during 1965. The incursion of the offshore subsurface waters in the coastal regions during upwelling is observed to a much greater extent during 1964. Upwelling, being a phenomenon controlling the fertility of the oceanic region, its intensity and variation yearwise are of great significance. As a preliminary clue it is possible that the stronger upwelling during 1964 has a greater effect in fertilising the coastal waters, than that occurred during 1965. The variation of current pattern also will contribute towards the variation in abundance of migratory and other plankton species which form the primary food material of the fish.

Work done

The processing and analysis of oceanographic data along the southwest coast of India from Cochin to Cape Comorin was carried out. The temperature, salinity and density distribution patterns were charted out and the data were available from the monthly cruises conducted in the region during previous years. The distribution patterns were drawn for the oceanographic parameters at depths of 0,10,20,30,50,75 and 100 m for all the available months mostly comprising the monsoon, post monsoon, and the summer seasons. Many of the vertical sections off the coast at selected land marks were also charted out for the parameters. Quite a large number of such charts have been prepared to have a clear

picture of the three dimensional distribution pattern of the oceanographic parameters required for the study of the various phenomena such as upwelling, sinking and circulation.

The post monsoon conditions during September revealed that the southward flow along the coast was still persistent in a weak manner. This was observed at the depths of 20–50 m. At 100 m a northward counter current was noticeable outside the shelf and during October the movements could not be inferred.

During summer season the surface layers in the Cochin-Cape Comorin region are mostly stagnant upto 50 m. But in the region Quilon-Cape specifically, weak southward movements are observed at 75m depth. In the northern regions weak eddy movements develop during summer. At 100 m, (region of the thermocline) during April, southward movements could be observed with a strong temperature gradient in the Quilon Bank area. In the region north of Quilon, cyclonic eddy formations with moderate intensity are observed. These may refer to subsurface divergence in the areas concerned. Lateral sections of temperature were charted out for period Feb.-March and the temperature gradients mentioned during April were absent and a remarkably uniform pattern of temperature distribution was observed. The change-over in thermal conditions appear to begin in April as observed from the analysis. It is possible that these subsurface divergence during premonsoon helps the monsoon upwelling in the subsequent season.

Work contemplated

A detailed study of the upwelling areas along the west coast of India in the regions due north of Cochin is to be made from the data available in the Institute.

Current patterns in the region north of Cochin along the west coast of India (MBO/ES/2.2)

C. P. Ramamirtham, D. S. Rao and others.

Salient findings

The influence of the Laccadives islands in modifying the circulation patterns in the area are marked. During winter, temperature gradients were sharp in the area at the depths of 50–100 m and there is observed a sort of divergence at these depths. The presence of a northwestward drift at the levels of 75 and 100 m

between 10 and 12° N within the meridians of 73 and 75° E, was observed. In the upper layers, mostly eddy formations were conspicuous. Considering the depth of 75 m it could be observed that a northwestward drift around 74° E and a southward one due west of 73° E amount to a sort of large cyclonic gyre in the Laccadive area. A lull region was observed towards the centre of the gyre. The surface layers from 0-50 m were mostly stagnant during winter and at 159 m the patterns of circulation suffered a change. Here the divergence mentioned previously appears to have disappeared and instead large eddy formations are found along the 72 and 73° E meridians.

During May-August, the circulation patterns were different. The temperature gradients were mostly confined to the surface layers upto 30 m depth and thus in the northern and western sectors of the region, cyclonic eddy formations were conspicuous and over the continental shelf a southward drift is visualised. At 100 m again, the cyclonic movements of a localised nature are observed. This type of eddy movements will probably have reference to the divergence and convergence in the area with juxtaposition according to the field of mass. The influence of the islands and the associated bottom topography have also to be considered in this connection.

During March-April period, at surface, weak anticyclonic eddy movements were observed in the northwestern parts which dissipated at subsequent depths. At 75 m, a weak anticyclonic movement was observed which again dissipated at subsequent depths and appeared to be transformed into more or less southward movements in the western parts.

Work carried out:

The circulation patterns in the Laccadives area were mainly analysed in conjunction with detailed hydrography, in order to study any possible correlation with the plankton abundance of the area. The required material was available from the data collected by the Institute in the Laccadive region during the previous years. The region from 72 to 76°E within the latitudes of 10 and 12°N was investigated. The processing and analysis of the data for the hydrographic stations was carried out for three different seasons of the year. The distribution patterns of temperature, salinity and dissolved oxygen content at depths of 0,20,50,75,100, and 150 m were charted out for the three different seasons viz. March-

April, Dec. -Feb., and May-Aug. Nearly sixtyfive distribution charts were prepared. The circulation patterns were mainly deduced from the temperature distributions, now and then availing clues from the salinity distribution patterns as well.

Work contemplated

From the available oceanographic data in the Institute, the following lines of work have been contemplated.

Possible seasonal variations of circulation patterns in the Laccadive sea are to be studied, preferably in relation to plankton abundance. A preliminary study has already been made correlating the hydrography with plankton abundance. Wherever coastal as well as deep sea data are available for the same season, the differential aspects of the current patterns in these two regions are to be investigated, in all possible cases. Such features will be most prominent as regards the oceanographic features during the monsoon season.

MARINE BIOLOGY

Investigations on phytoplankton and primary productivity of the shelf and adjacent waters (MBO/PP/1.1)

P. V. Ramachandran Nair, C. P. Gopinathan, K. G. Girija vallabhan, G. Ragothaman, V. K. Balachandran and others.

Salient findings

Investigations on the primary production using C^{14} were conducted off Cochin upto 50 m depth. Samples were incubated in constant light and in *simulated in situ* conditions. It was found that in January to March, the rate of production on the surface was high especially at stations of 10 and 15 m compared to the bottom regions (55–125 mgC/m³/hr and 50 mgC/m³/hr repectively). In July and August the rate of production at the surface was (100 mgC/m³/hr) and with slight increase in the benthic productivity (80 mgC/m³/hr).

An unusual feature observed saw the relatively high dark fixation of carbon at the surface, amounting in 64%. This phenomenon was observed during the first quarter when dark fixation exceeded 200% at the surface. However, the benthic production estimated from the mud samples showed very low rate of production. In the bottom dark fixation upto the order of 10 in relation to the

light fixation was observed. Causes for this unusual phenomenon is being investigated.

In addition to the stations off Cochin, investigations were carried out at Madras, Tuticorin and Calicut.

Work contemplated:

Additional data to be collected from Vizhinjam, Waltair and Narakkal where personnel have been trained.

Investigations on secondary production of the shelf and adjacent waters (MBO/PL/1.1)

K. J. Mathew, K. Rengarajan, K.G. Girijavallabhan, S. Muthuswamy, S. Krishna Pillai, R. Marichamy, Pon. Siraimeetan and others.

Cochin

Zooplankton samples from Laccadive area were analysed for the studies on Siphonophora. Ten more species of siphonophores have been recorded from the Indian Seas and with this the total recorded species for the Indian Seas including the Lakshadweep sea come to 47. Distribution maps for the different species have been drawn up.

It has been known that the larval development of some species of euphausiid distribution in different ecological realms follow different courses towards their adulthood. This phenomenon has created a lot of confusion among workers who dealt with local collections only. In the light of the investigations conducted in the Institute on the euphausiid larval development a critical review on the different problems raised by various workers regarding the euphausiid development is being prepared.

Calicut

Regular zooplankton collections were made from 3 stations having depths ranging from 10 to 25 m. At the 10 m station,the maximum abundance of zooplankton was noticed in March while at 15 m and 25 m stations, the abundance was in December. The minimum biomass was observed in May at 10 m depth, in June at 15 m depth and in April at 25 m depth station. Simultaneous with the zooplankton collections, studies on hydrography were also carried out.

Bombay

The zooplankton biomass of the offshore fishing grounds varied from 1.6 ml to 70 ml. Two peak periods were noticed; one in March/April and the other in December/January. Copepods, Salps, siphonophores, chaetognaths, alima larvae, lucifer and *Acetes* sp. dominated the samples.

Madras

Monthly zooplankton collections were made in different fishing grounds off Madras coast. The maximum biomass observed was 18.2 ml per 15 minute haul in January. The minimum of 2.55 ml was observed in February. There were two peak seasons one in January and the other in April.

Tuticorin

At Tuticorin, even though *Trichodesmium* sp. bloom was observed in August, it had no bearing up on the zooplankton distribution of the area. The copepods and chaetognaths dominated the samples.

Survey of economically important seaweed resources (MBO/SW/1.1)

P. V. Ramachandran Nair, V. S. K. Chennubhotla, P. S. Kuriakose, N. Kaliaperumal, G. Ragothaman, Radha Krishnan and others

Mandapam

Data collected during the survey of the seaweed resources of Tamil Nadu coast from Kanyakumari to Melamidalam(Phase V) in the months of November and December 1975 were consolidated.

Tuticorin

Seaweed survey was undertaken in coastal area of Tuticorin in the bay area and island. It was found that the species of *Ulva, Chaetomorpha, Dictyota, Gracilaria* and *Padina* were present throughout the year.

Vizhinjam

Qualitative survey of seaweeds has been carried out along the coast extending from Neendakara to Thengapattanam during

the year. In the surveyed coastline, the main centre for seaweed is Vizhinjam, giving a wide variety of weeds which are economically important. From Vizhinjam to Adimalathura the coast is almost rocky and the rocks in the inter-tidal zone is covered by seaweeds. Beyond Adimalathura in the south only at Poovar, seaweeds are available. In north, Kovalam, Varkala, Chilakkoor, Odayam, Thankassery, Thirumullavaram and at Neendakara, some species of *Sargassum* and *Gracilaria* are available.

At Vizhinjam, agarophytes and alginophytes formed a major constituent among other seaweed resources. The coastline extending from Vizhinjam to Adimalathura is inhabited mainly by *Gracilaria corticata, Hypnea musciformis, Ulva fasciata* and *Sargassum wightii.*

At Poovar, there is a small ground for *Ulva fasciata* and *Sargassum tenerrimum.* The algal flora at Kovalam, Chilakkoor, Varkala and Thangassery show no variations in its constituents from the flora of Vizhinjam.

In addition to the qualitative survey carried out as mentioned earlier, a quantitative survey of seaweeds has also been carried out to study the resources of Vizhinjam, during the period April-June. From this study it is understood that 48.5% of the rock surface of the inter tidal region of Vizhinjam coast is covered with *Sargassum* spp., while 44.5% of the surface is covered by *Gracilaria corticata.* Average yield of *Sargassum* per square meter at Vizhinjam was reaching upto 2370 gms and that of *Gracilaria corticata* 3520 gms.

Calicut

The seaweed resources survey of the Malabar coast was started during the year. Thirty stations were surveyed between Calicut and Thikkodi. Among these 10 stations showed luxuriant growth of *Ulva fasciata,* while the submerged laterite rocks near Thikkodi showed thick growth of Sargassum spp. During December about 5 tonnes of Sargassum spp. were collected from this area by local people. Green alga such as *Ulva* sp. *Chaetomorpha* sp., and *Caulerpa* sp. are also present in moderate numbers. Agarophytes were found to be negligible.

Work contemplated

Survey to be conducted along Kerala coast.

Culture of economically important seaweeds (MBO/SW/1.2)

V. S. K. Chennubhotla, P. S. Kuriakose, N. Kaliaperumal, G. Ragothaman, S. Kalimuthu, Radhakrishnan and others.

During the year, field culture of economically important agarophytes and alginophytes was tried at various centres–Mandapam Camp, Vedalai, Seeniappa Dharga, Kalimangundu and Kachirangudi river mouth in the gulf of Mannar side and Rameswaram, Devipattinam and fish farm area on Palk Bay side, with a view to finding out the relative suitability of these areas for seaweed culture work. Wooden culture frames of 1 x 1 metre size interwoven with 1″ and ½″ thick coir ropes were introduced at Rameswaram. In all the other places, G. I. pipe culture frames of 2 x 2 metre size, fabricated with 1″ and ½″ thick coir ropes were introduced.

Field trials on seaweed culture in and around Mandapam have given good results. Apical portions of *Gracilaria edulis* used as starting material have grown to harvestable size earlier than those from other portions of the mother plant. On the average a four-fold increase was noted in 30–40 days.

Culture of seaweeds at Mandapam

During October and November, 76 frames with *Gracilaria edulis*, 8 frames with *Gelidiella acerosa* and 2 frames with *Gracilaria corticata* were introduced. Besides, 2 frames with *Sargassum wightii* and 3 frames with *Turbinaria conoides* were also introduced. An average growth rate of 2.4 cm from the initial height of 8.3 cm was noticed in *Sargassum*.

Culture at Seeniappa Dharga

Two frames with *Gelidiella acerosa*, two frames with *Gracilaria edulis*, one with *Sargassum wightii* and one mixed with *Sargassum wightii* and *Turbinaria ornata* were introduced in the inshore waters where the wave action is less and the bottom is sandy. *Gelidiella acerosa* frames in which fragments obtained from apical portion of the plants were inserted in both frames as in the case of the seedlings. The apical portion with 6.6 cm length grew to a size of 7.0 cm after 4 months. The *Gracilaria edulis* yielded a harvest of 6.17 kg for an initial 1.1 kg of seed material.

Culture at Rameswaram

Culture of *Gracilaria edulis* introduced in the inshore waters of Rameswaram has yileded 2.4 kg (fresh weight) and 1.5 kg at the two stations for an initial seed material of 0.4 kg after 55 days and 67 days respectively.

Culture experiments at Kanchirangudi river mouth and Devipattinam were not successful due to silting.

Culture at Tuticorin

During the first half-year, culture expriments of *Gracilaria edulis* in the Tuticorin harbour area have given good results and the yield was found to be 4 times. In the third quarter, the yield was observed to be $4\frac{1}{2}$ times the original weight within 65 days. In the last quarter, the yield was found to be four times the original weight. The length attained by the seaweed was found to be 45.5 cm in 3 months period.

At Vizhinjam

Culture of *Gracilaria corticata* and *Sargassum wightii* carried out in aquarium tanks has shown satisfactory growth. *G.corticata* in different sets of experiments has shown a growth of 39.5 mm within a span of 90 days and 19.68 mm in 30 days respectively. *Sargassum wightii* has shown an average growth rate of 0.854 mm per day.

Field culture experiments in Vizhinjam Bay using rectangular boxes in which ropes transplanted with *G. corticata* fragments were suspended showed good growth within a span of 30 days, the seed material has doubled its weight. This bamboo box was used in

preference to a wooden or G. I. pipe to prevent grazing to the possible extent. The seed in the case has shown an average growth of 0.7 mm per day.

Cages introduced with *Sargassum* and *Gracilaria* species have shown a growth of 30.8 mm and 105 mm for a period of 40 days.

Ecological energetics in cultivable marine organisms MBO/EE/1.1

P. V. Ramachandran Nair, D. C. V. Easterson, C. V. Mathew & M. Vijayakumaran.

Cochin

During the year, studies on energy conversion were carried out with the post larvae, *Metapenaeus dobsoni* from the Narakkal farm using compounded feed. The mean moisture content was 76.38% and protein content was 71%. The mean food consumption in percentage of body weight per day was 29.22% and mean growth rate in percentage of body weight per day was 3.02%.

Metabolic faecal nitrogen in the fish *Etroplus suratensis* was estimated as 1059 x 10^{-7} mg N in % body weight per day, which is equal to 6618 x 10^{-7} mg protein.

The population dynamics and production of the copepod, *Oithona* sp. in the Cochin Backwater was studied. The plankton samples made during the year 1971 were made use of in the estimation of biomass. The duration of development was calculated by maintaining a culture of gravid females. During this time the animals were fed with a mixed culture of *Chlorella* sp. and *Synechocystis* sp. Tetracycline hydrochloride at a concentration of 45. mg/l was found good to control the predatory protozoans and other micro-organisms, In the determination of mean individual weight copepods preserved in 5% neutral formalin were pooled and weighed. The mean weight was found to be 0.0045 mg/copepod. The instantaneous birth rate of copepods varied from 1.64 to 6.81, the population growth rate from 1.06 to +0.39 and the mortality rate from —6.51 to +6.11. The mean monthly production vary from 0.346 to 0.882 mg/m^3/day. The yearly mean production works out to 0.24 mg/m3/day. The rate of production was maximum in December and minimum in July.

Calicut

During the period, experiments were done to estimate the energy conversion in green mussels. The increase in length was recorded at monthly intervals. The maximum growth rate was recorded in the first quarter (11.148 gms to 21 432 gm) and a minimum was recorded from 3.151 gm to 3.309 gm for a period of 3 months

Work contemplated

Energy conversion studies will be conducted at the oyster beds at Tuticorin.

Investigations on the production cycles (primary to tertiary levels) in the fishing grounds off Cochin MBO/EE/1.2

P V. Ramachandran Nair, C.P. Ramamirtham, C.P. Gopinathan, I. David Raj, V. K. Balachandran and R. Vasanthakumar.

In order to determine the efficiency of transfer from one step to another in the food chain, leading ultimately to the 2nd and 3rd stage carnivores which are being commercially exploited at present, observations were taken off Cochin as a reference point upto 50 m depth. These studies carried out by a team of scientists, covered all aspects of the production cycles from primary to secondary and tertiary levels. Due to adverse weather conditions and non-availability of the vessel, continuous monitoring could not be undertaken.

It was found out that in January, the rate of production of the surface waters especially at 5,10 and 15 m stations, were very high (55–125 $mgC/m^3/hr$). Similarly the total cell counts of phytoplankton showed high values at the surface for these stations. The benthic production showed gradual decrease in the rate of production from 5 to 20 mm depths, with high dark assimilation rates. In March and May, the surface and benthic production showed moderate values.

The hydrological conditions during the period of observation showed that during January, surface temperature values ranged from 26.5 to 27.0°C. The convection layer upto 40m depth showed more or less isothermal features although inversion of temperature was noticed at some depths. The surface salinity

values were low in the near shore region ranging from 30.6 to 31.6‰. In general, the whole column of water in the area was comparatively of low salinity ranging from 31–33‰. The dissolved oxygen values in the whole area ranged from 4.1 to 5.2 ml/l. Distribution of nutrient factors such as phosphates and nitrate was more or less uniform, phosphate values ranging from 2.3 to 3.0 ug at/l and nitrate values being 1.3 to 1.9 ug at/l.

During March, summer conditions were evidenced by the distinct increase in the surface temperature which attained a maximum of 29.5°C. Subsurface layers also were much warmer during March than in the previous season. Drastic increase in salinity was observed in summer and the values ranged from 34.6 to 35.4‰ and dissolved oxygen content were also high attaining 80–85‰ of the saturation value. The nutrient factors as such showed a decrease in summer, phosphate values ranging from 1.3 to 1.4 ug at/l and nitrate values ranging from 1.05 to 1.36 ug at/l. During May also the temperature values were high, the maximum for the month being 30.2°C. Dissolved oxygen content varied from 3.4 to 4.6 ml/l. Phosphate contents were little higher than the March values. Analysis was conducted for silicate also and the values ranged from 5.7 to 7.0 ug at/l. The salinity values were also high ranging from 34.7 to 35.8‰.

Trawling operations were also conducted along with these observations. The fish samples were analysed for species composition, and yield per haul, 10–15 m depth range yielded the maximum quantity.

Investigations on the Benthos of the fishing grounds off Cochin with particular reference to their relation to fisheries. MBO/BF/1.1

V. Kunjukrishna Pillai, C. P. Gopinathan, A. Regunathan and others.

Investigations under the project were initiated from January with an aim to understand the influence of the benthos together with the environmental changes taking place in the fishing grounds and to evaluate their relation to the fishery of this region.

Qualitative and quantitative studies of the benthos of the fishing grounds off Cochin were started from January. Stations were fixed from 10 to 40 m and samples were collected to study primary and secondary production, hydrography and benthos(both mud and dredge samples). Trawling were also conducted wherever possible and their composition and quantity were noted. The

food of prawns were also studied from selected samples. During January, the benthic production, estimated from the mud samples, showed gradual decrease from 5 to 20 m depths—the rate being 8 to 2 mgC/m^3/hr. One anomalous feature observed was that at the first station(5m), dark assimilation rates were high(25 mgC/m^3/hr). It was observed that in July and August, the benthic production notes showed low values.

The benthic fauna was rich except in January and were constituted by gastropods, echinoderms, polychaetes and coelenterates. Echiroids were abundant in the samples collected during the first quarter.

The data obtained by the try-net fishing revealed comparatively higher catch during April and July. Prawns included the species of *Penaeus indicus, Metapenaeus dobsoni,* and *P. stylifera.* Fishes like caranx, sciaenids, nemipterus, stolephorus, cynoglossus and anchovies were also present in the catch.

During January, it was observed that at the benthic region in the fishing grounds off Cochin, there was a thick layer of decaying *Salvinia,* which was probably brought down by the tidal flow from the estuarine and backwater areas. It was also observed that the benthic population and the production rate was also comparatively less. The low dissolved oxygen content observed in the bottom waters during the same period confirms this observation. However, this phenomenon was observed only during January and not in the subsequent months.

Mass culturing of Plankters (MBO/MCP/1)

E. G. Silas, Director, P. V. Ramachandran Nair, K.J. Mathew, D. C. V. Easterson & V. K. Balachandran

Already isolated species of phytoplankters were mass cultured and maintained in the laboratory for feeding and toxicity experiments. Fresh collections were taken for developing mass cultures of the following organisms; *Acetes, Sagitta* and egg bearing Lucifer. *Acetes,* fed on prawn meat, artemia nauplii and small copepods were maintained for two over weeks at an ambient temperature of 24–25° C and at 35.5‰ salinity. Chaetognaths and Lucifer survived only for four days. Artemia fed with phytoplankters (*Synechocystis* and *Chlorella* species) lived for one to two weeks.

One more species of calanoid copepod, *Pseudodiaptomus* was reared in the laboratory. The duration of development for

each stage was noted. The animals were maintained up to F_3 generation.

Marine Pollution in relation to protection of living resources MBO/MP/1.1

E. G. Silas, Director, P.V. Ramachandran Nair, M. V. Pai, G. G. Annigeri, M. S. Rajagopalan, V. Kunjukrishna Pillai, C. P. Gopinathan, V. Chandrika and others.

LC50 in fishes, crustaceans & molluscs were determined for selected pesticides and hydrocarbons.

Cochin

Laboratory studies and field work were carried out intensively during the year in order to study the effect of pesticides in the aquatic environment.

Field investigations were conducted to assess fish mortality due to pesticides in the Kuttanad area of Alleppey Dist. It was observed that the systemic poisons applied in large scale to control the brown hopper attack when pumped out into the canals caused the mortality of fishes in the surroundings.

Toxicity testing experiments were conducted in the laboratory with pesticides (D.D.T. and 'Furadan') using shrimps as well as phytoplankton cultures. While DDT in comparatively lesser concentrations showed lethal effects both on phytoplankton and shrimps, 'Furadan' had on immediate toxic effect on these organism.

Bacteriological investigations of the water samples collected from Cochin Backwater showed the abundance of indicator bacteria near the oulets of sewage effluents. Distal areas near the bar-mouth remained more or less free from bacterial pollution.

Based on these studies four papers were presented in the National Seminar on Environmental Pollution held at Cochin during 6–8th May 1976.

Karwar

Water pollution monitoring programme of the Binage Bay was continued. There was mass fish mortality on 8th April due to the collapse of hydrochloric acid storage tank of M/s. Ballarpur Industries and its consequent spillage. The effect of pollution appeared to be limited to the area of Baittikol cove only. An

estimated quantity of two tonnes of fish comprising the following species: *Muraenesox talabanoides, Thyrsoidea macrura, Acanthopagrus berda*, serranids and crabs were killed due to this incident.

The first report on the Monitoring Programme of the Karwar region has already been prepared and the second report is under progress.

Mandapam

Water pollution monitoring programme was initiated from May. Samples were collected from stations in the vicinity of the fish meal plant. Analysis of the samples revealed very low dissolved oxygen in the immediate locality of the effluent discharge.

Tuticorin

The incidence of water pollution in the Punnakayal estuarine system due to the effluents from Dhrangadhara chemical works was investigated. The polluted water appeared orange-red in colour and was reported to contain hydrochloric acid, ferrous chlorides and ferric chlorides. The affected area will be about 25 km. The colouration was noticed from 50 m to 1 km from the shore. The polluted part of the estuary was devoid of any living organisms.

Work contemplated

Intensification of the work on L.C. 50 determinations and monitoring at Calicut. Pollution studies in oyster beds in Tuticorin.

Investigations on the Coral reef resources (MBO/CR/1.1)

C. S. Gopinatha Pillai and K. K. Appukuttan

A survey of the fringing reefs of Gulf of Mannar with special reference to zonation of corals and associated animal communities was carried out. Two reef areas, one at Rameswaram and another at Karachalli Island near Tuticorin was studied at low tides. The major reef building and reef associated animals were collectd for subsequent studies. The identification of the corals collected during the survey was completed.

This survey revealed that the reefs of the southern parts of the Gulf of Mannar are better developed than those of the southern side around Rameswaram. There is a paucity of economically important massive corals near Tuticorin.

The damage to marine ecosystem due to large scale quarrying of corals for industrial purpose was further assessed.

Survey of Turtle resources (MBO/CR/1.2)

C. S. Gopinadha Pillai, A.A.P. Mudaliar & Bastian Fernando.

Data on the turtle landings along the east coast of India was collected regularly throughout the year from Mandapam and Tuticorin. A total of 301 turtles were observed to have been caught at Mandapam and adjacent places and the price for these was estimated to the tune of Rs. 11463/-. The total weight was approximately 14072 kg. A toal of 421 turtles were observed from the butchery shops around, Tuticorin. The species caught included *Chelonia mydas, Lepidiochelys olivacea* and *Eretmochelys imbricata.* It was estimated that more than 91% of the total landings was composed of *C. mydas.*

Rarely *Caratta caratta* was obserbed at Pamban. As already reported males contributed only less than 10% of the population.

In December, a nest was reported at Dhanushkodi by local fishermen. No nest could be observed near Mandapam or Tuticorin area. During October-January specimens of *Lepidoichelys olivacea* bearing matured eggs were observed at Tuticorin. In one of them there were fully formed eggs during the 3rd week of November. A specimen of *E. imbricata* butchered on 28th November had 256 developing and 55 fully developed eggs. Though large number of mature specimens of (87) *C, mydas* were studied none was found to bear any eggs.

Analysis of the gut contents showed that the turtles feed on algae like *Gelidium pisillum, Hypnea* sp., *Dicyota dichotoma, Ulva, reticulata, Sargassum sp., Halimeda macroloba, Caulerpa fergusoni Cheatomorpha* sp. and sea-grasses like *Halophila ovalis* and *Cymodacea serrulata.* It was also observed that *Halophila ovalis* formed the major item of food of *C. mydas.*

Fishery

The green turtles are caught in trawl nets and hooks and lines occasionally other than in trigon nets and turtle nets. At Kuttankuli near Tuticorin where a rich turtle fishery in last year existed, no effort was made during the year under report by the local fishermen since they diverted their attention to more lucarative fish and prawn fishery.

Size range: The dominant size mode was 65–75 cms of carapace width in *C. mydas* and 58–65 cm in *L. olivacea.* The largest one observed was 69 cm. The smallest *C. mydas* was observed during the year showed 9 cm in width.

Ecological studies on mangrove swamps (MBO/MS/1.1)

C. S. Gopinadha Pillai, M.S. Rajagopalan, C.P.Gopinathan, G.S. Daniel Selvaraj and P. M. Aboobaker

The project was started in the first quarter of the year with a view to study the ecological conditions of the mangrove swamps as well as utilising them for mariculture. As a beginning, work was started at Cochin and Tuticorin. Fortnightly and monthly data on hydrography, primary productivity and resident and migratory fauna and the vegetation of the area was collected. In the backwaters of Cochin, a clear succession of migratory fauna was observed in relation to prevailing ecological conditions. During January to April, the five stations under investigation in the Backwaters were found to harbour larvae and juveniles of fish and prawn, the latter mainly of *Penaeus indicus* and *Metapenaeus dobsoni.* A similar phenomenon of abundance of prawn larvae was also noticed at Tuticorin.

Hydrography and primary production

Salinity in the swamp waters of Cochin fluctuate between 24 to 32‰ in different months, while in Tuticorin, it is mostly stable since there is little influx of fresh water. Temperature ranged from 28 to 40°C. Primary production rates ranged from 50–250 $mgC/m^3/hr$ in different stations investigated which showed a slight increase than the open waters.

Flora and Fauna

The low wooded mangroves of Tuticorin is composed mainly of *Avecenia marina* while around Cochin, many species are seen, the dominant ones being *Acanthus ilicifolius, Clerodendron enerme, Aegeceros corniculatum* and species of *Rhizophora, Pandanus* and *Brugueira.*

The resident fauna of the mangroves of Tuticorin is mostly of *Cerethedia fluviatilis* and *Cerethium* spp. At the higher zone, fiddler crabs are plenty. Gobiid fishes are very common. At Cochin, *Terebralia* is present at certain sites with fiddler crabs at the higher zones.

Several species of fishes and prawns visit the mangroves at high tide. During October to May, the larvae of prawn and fishes are abundant at both places. The juveniles of prawns uses the mangroves as a nursery ground.

Utilisation

Around Cochin, many swampy areas are cleared for agricultural operations. Several sites are used for conventional prawn culture. In Tuticorin, there is a small scale capture fishery of prawns by cast net and drag nets. The samples of prawns thus caught is mostly of the size range 20 to 40 mm. These include *P. indicus*, and *P. semisulcatus*. It was estimated at Tuticorin that an annual catch of about 7200 kg of prawn juveniles from an area of nearly 200 ha. If these are allowed to grow in the swamps by culturing them, the production could be increased seeral folds.

INTER DIVISIONAL PROJECTS

Survey of Molluscs (Bivalves), Prawn and Fish seed resources (CMFRI/IDP/1)

E. G. Silas, Director, K. Rengarajan, M. Rajagopal, K. S. Sundaram, K. M. S. Ameer Hamsa, P. Nammalwar, R. Thiagarajan, G. Nandakumar, P. Bensam, S. Shanmugham, Bastin Fernando, K. Prabhakaran Nair, S. Lazarus, K. J. Mathew, G. S. D. Selvaraj, K. N. Gopalakrishnan, R. S. Lal Mohan, K. V. Somasekharan Nair, V. S. Rengaswamy, P. Ramadoss.

Progress of work at various centres

At Madras 30 stations were established and worked out between point Calimere and Kalangai river mouth. Hydrographic parameters were also studied alongwith biological aspects. The seed sampling was done using various types of gears such as cast net, drag net, Vellon's screen and plankton net.

Four cycles of the survey were completed at Tuticorin during the year and area covered was from Keelakarai to Kanyakumari. The whole region was divided into 43 sections. Different gears such as fish fry net, drag net, plankton net and surf nets were used for the seed sampling.

70 field surveys have been conducted during the year for the assessment of the seed resources at Mandapam. The area covered was from Chiunapalam to Thangachimadam. The sampling was also done in the backwaters of Chinnapalam creek, tidal pools at Pamban, Athankarai estuary etc.

From Vizhinjam the area surveyed was from Kanyakumari to Neendakara. Various types of gears such as a rectangular mosquito cloth net, cast net, shore seine etc. were used during the surveys.

The area covered from Cochin was from Neendakara to Ponnani. About 40 stations have been fixed along the coast

including barmouths, river mouths and inside estuaries and rivers. Six bimonthly collection trips have been undertaken and a total of 212 stations have been worked out for seeds and hydrography.

At Calicut 560 stations were engaged during 7 trips from Ponnani to Kasargod. Alongwith the seed samples hydrography samples were also collected.

Salient Findings

1. Madras

It was found that the larvae of *P. indicus* was abundant at Point Calimere, Velanganni, Karaikal and a few other places. Edible oyster beds have been noticed near Karaikal and Thirumulla vasal. Thick growths of mussels have been found on the retaining walls of the Cudallore harbour.

2. Tuticorin

Seeds of *P. indicus* were present all along the surveyed area so also the seeds of mullets, *Therapon* and *Gerres*. The occurrence of the seeds of *Chanos* and *Tilapia* was seasonal. Mussels were present on the rocks between Kanyakumari and Athankarai. The edible oyster, *Crassostrea* was observed in the central and northern sectors. *Meretrix* sp. were common in Punnaikayal and Karapad.

The chemical pollution of the Kayalpatnam backwaters has been a serious problem which caused large scale mortality of the fauna and flora over a wide area.

3. Mandapam

Chinnapalam creek at Pamban was found to be the most important and potential ground for the seeds of mullets, Chanos and prawns. Here the salinity of the water was comparatively higher than in other places. Two peak seasons have been noticed for the abundance of the seeds ie. April to June and October to November. The maximum number of fingerlings of prawns(4303 per hectare) was recorded in February, *Chanos* (12398 per hectare) in April and mullets (14058 per hectare) in May and June at Chinnapalam creek. Athankarai estuary has been noted for its *Crassostrea* and *Meretrix* resources.

The seaweeds of the genera *Padina, Enteromorpha, Codium, Hypnea, Scinapea* and *Ulva* were found to be abundant in the coastal waters.

4. Vizhinjam

Mullet fry of varying lengths were abundant at Manakudi lake, Kadiapattinam, Thengapattinam, Perithiyoor, Puthiathura, Perumthara, Colachel and Rajakkamangalam, Prawn larvae were scarce. Young ones of Palaemonid prawns *P. indicus, Metapenaeus* sp. and *Parapenaeopsis* sp. were obtained. A pearl oyster bed is observed at Muttom. Edible oysters and mussels were present at Muttom, Kadiapattanam and Colachel. Mussel spats of 2–3 mm size were obtained at Kadiapattinam.

5. Cochin

The seed samples contained eggs and larvae of fishes and prawns. The common fish larvae present were those of mullet, Anchovies, clupeids etc. The post larvae of *P. indicus, M. dobsoni, M. monoceros* etc. were also present. In May at Thrikunnapuzha, it the surf area 506 prawn larvae were found distributed in one cubic metre of water. The fish larvae were comparatively less and the highest number was obtained from Chavara in March which was 268 larvae per cubic metre of water.

It has been found that the edible mussel of the genus *Mytilus* grew luxuriently wherever there is present some substratum suitable for their growth such as the groynes laid at the intertidal region. Hence it has been reported that the entire coast line from Ponnani to Neendakara could be converted into high yielding farms for mussels.

At Anthakaran Azhi about 15 acres of water logged area divided into three ponds is available for brackish water fish culture.

Heavy settlement of mussel spats was observed at Chavara soon after the south west monsoon. The spats were settled on to the groynes laid at the intertidal zone to prevent sea erosion. In October the spats were grown to 15–20 mm in length and by December the mussels were of the size range from 30–40 mm in length.

6. Calicut

Fry of *Ambassis* sp. was found to be present in all the mouths with a peak in September to October. It was found that culturable fish seeds like *Sillago sihama, Elops indicus* and *Megalops cyprinoides* were present in considerable numbers. The seeds of *P. indicus*

were also present throughout the year, with the maximum occurring in March-April period. *M. dobsoni* occurred towards the later half of the year. Other species like *M. monoceros, P. monodon* and *M. idella* were also present at various stations. Extensive beds of green mussels were observed in the region between Azhikode and Kadalundi. Edible oyster beds were found in the regions between Azhikode and Badagara.

The effluents from the Mavoor Rayons factory have polluted the Chaliyar river and this has resulted in the extermination of the fauna and flora over a wide area of the river.

Works Contemplated

The estimation of the seed resources available at all the centres will be continued. Instead of bimonthly surveys monthly surveys will be undertaken. A uniform method for the quantitative assessment of seed resources will be adopted in all the centres. Analysis of the previous year's data and the preparation of a detailed report incorporating all the salient findings are also contemplated.

Investigations on fish and Shellfish diseases

(CMFRI/IDP/2)

S. Mahadevan, K. J. Mathew, G. S. D. Selvaraj, M. Kathirvel, C. Thankappan Pillai, K. Rangarajan, P. Bensam, S. Lazarus, K. Dorairaj.

Salient Findings

Investigations on the diseases of fishes and shell fishes, particularly the culturable groups like edible oysters, mussels, mullets, milkfish, prawns, crabs etc., were initiated during the year under report, at Cochin, Vizhinjam, Tuticorin, Mandapam and Madras. Satisfactory progress was made in all the centres during the year. In the meeting of the Principal Investigators convened at Cochin in the end of the year, the progress of work in this project was discussed and plans were given for intensifying the work further in the different centres.

Progress of work

At Cochin: Myxobacterial infection of commercially important prawns (*Penaeus indicus, P. mondon, Metapenaeus dobsonii*

M.affinis and *Parapenaeopsis stylifera*) cultured was observed to be caused by *Chandrococeus* sp. After giving timely treatment, most of the specimens recovered to normalcy. Mortality of *P. indicus* larvae was found to be caused by enteric forms. Diseased specimens of *M. monoceros* were observed in the commercial catches. Among fishes, diseased specimens of *Etroplus maculatus* were found to cause infection on healthy specimens of the same species and on *Tilapia mossambica* by contact. The affected portion of the skin developed white patches and the mucous membrane showed a red tinge. White patches were also noticed on the elvers of *Anguilla bicolor* reared. The unaffected individuals also developed the disease subsequently, leading to death later.

At Vizhinjam: A specimen of the Indian mackerel *Rastrelliger kanagurta*, with a suspected "Ulcer disease" caused by Vibrio infection was collected in the beginning of the year. The same specimen showed a reddish black inflammation also. In the end of the year, a specimen of the pomfret *Parastromateus niger* from the commercial catches showed discolouration in the nape, resembling a fungal disease, apart from these cases, no other instances of disease among fishes or shellfishes were recorded.

At Tuticorin: Mullets cultured in the ponds at Veppalodai have not indicated signs of any disease, but some of the crabs *Scylla serrata* cultured in cages, appeared to have died by parasitic action of amphipods eating up the flesh. Also, in a few cases, algal growths appeared to have arrested the normal functions of the specimens, ultimately leading to their deaths. Measures were undertaken to reduce mortality caused by these factors. The cause for the deaths of a few more crabs, in the process of moulting, could not be determined.

At Mandapam: Among the cultured eels (*Anguilla*) which diedthecausefor the deaths of a few specimens was believed to be asphyxation. In a few others, there was unusual secretion of mucous on the body and eye. Large number of bacteria was also detected in the fluid of the gall bladder. In some specimens the heart was found to be empty, while in others, the body cavity contained a yellowish fluid with bacteria. In one case fin rot disease was recorded.

At Madras: Examination of mussels cultured in rafts in the open sea as well as from natural beds has not shown indications of any disease during the year under report.

National programme of tagging oil sardine, mackerel and prawns (CMFRI/IDP/3)

P. Vijayaraghavan, A. Noble, M. M. Thomas and others.

Salient findings

During the first quarter, 16 tagging sea trips involving 190 scientists were performed during which 3879 oil sardines, one mackerel and 5571 prawns belonging to the species *Penaeus indicus, Metapenaeus dobsoni, M. affinis, M. monoceros* and *Parapenaeopssi stylifera* were tagged and released off the Cochin coast. During this quarter 97 tagged prawns were recovered, all of them from the trawling grounds off Cochin. The interval between their release and recapture ranged from 2 to 36 days. While the majority were recovered within 2 to 3 days, 7 specimens were recaptured between 2 to 5 weeks of their release. Three oil sardines were captured 35 km north of Cochin within one or two days of their release.

In the second and third quarters, tagging operations remained suspended due to rough seas and the onset of monsoon. In this period a single male specimen of *Penaeus indicus* which measured 110 mm at the time of release off Cochin was recaptured, having registered a growth of 30 mm during its 70 days of liberty.

In the last quarter, tagging and releasing of juvenile prawns in the backwaters was initiated. To begin with, Nediyathuruthu area near Perumbalam island in the Vembanad lake was selected as the location for tagging and release. The releases were made in the open backwater as well as in confined site, the latter in order to study in particular the growth rate. Accordingly, 636 *M. dobsoni*, 53 *M. monoceros* and 1 *P. monodon* were marked and released. During the first two of these operations it was directly observed that the yellow tags instantneously attracted predators leading to massive mortality. Hence red tags which were less conspicuous have been used in all subsequent taggings.

A hitherto unknown shoaling habit of oil sardine could be observed during the tagging of this fish. Hundreds of the tagged sardines used to be held in large holding nets in the sea and they were released soon after the day's tagging was over. The shoals from which the fish were captured for tagging broke up initially, but reformed and swam around the holding net in which the tagged fish also were held and joined them as soon as they were

released and swam away as a single shoal. This shows that the shoals have a tendency to reform although they may break up as a result of fishing operation or any serious disturbance.

Though the data in hand is not sufficient to theorize on the movement or growth of oil sardine or of the prawns, it seems that the prawns do not move far from their habitat. The single *P. indicus* which was recaptured after up 70 days showed a growth rate of 0.4 mm per day. The recovery of oil sardines indicated that they can travel at the rate of 35 km per day.

I. C. A. R. SCHEMES

Scheme on pearl culture

K. Alagarswami, A. Chellam, and Others.

Chief Findings

The fourteen items of investigations under the Scheme on Pearl Culture made good progress during 1976 in spite of the handicap of lack of the full complement of regular scientific staff. While the associates were responsible for the investigations on the biology of pearl oyster, fouling and boring organisms,environmental studies and larval rearing, the principal investigator undertook the remaining investigations dealing with farming of oysters, pearl production, diversification of techniques, spat collection, nuclei and tools. He also took up the responsibility of conducting the Training course in Pearl Culture.

Two pearl culture farms were maintained —the main farm at Veppalodai and a secondary one at the harbour basin of the Port of New Tuticorin. Six rafts were in use for rearing of oysters. Improvements were effected in the buoying system of rafts. Preliminary results showed that the oysters grow faster and remain healthier in the harbour farm than at Veppalodai.

The programme of collection of pearl oysters from the natural pearl banks was intensified. Eight 'Paars' were visited during February- April but they resulted in the collection of only 1085 oysters with an average yield of 49 oysters per trip. Two 'Paars' — Devi and Fernando were visited during November-December and 10,685 oysters were collected. The yield rate was 1069 oysters per sea trip. Devi paar was the most productive bed which yielded 1289 oysters per trip. It was been seen that, strangely, there has been an incursion of lesser oysters (*P. sugillata, P. anomioides* etc.)

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on the pearl banks which have traditionally been known for monospecific *P. fucata* populations. The incursion was more on the beds in the northern limits of the sector than on the beds immediately south. The lesser oysters accounted for 15.5% and 70.9% of the collections in the first and second seasons respectively. The multispecies composition resembled that of the populations in the harbour basin. All oysters were young with a modal size of 30–35 mm.

For the collection of pearl oyster spat, June proved to be the best month, yielding 84% and 88% of the collections from the harbour basin and Veppalodai respectively. The spat consisted of several species of pearl oysters as in the previous year. The culturing units and oysters proved to be better spat collectors than others.

Biological studies were taken up as a full-time programme. Observations on growth, maturity and spawning, sex ratio,condition index, food etc. were made. An interesting feature was the presence of eggs and shelled larvae of bivalves in the stomach of oysters. Invstigations on the fouling of oysters were continued and observations recorded. The study on the hydrography of the pearl culture farms and neighbouring areas was continued. In the plankton samples, bivalve larvae occurred in moderate numbers. They were relatively more abundant in the vicinity of the Veppalodai farm site than at other places. The larvae were segregated according to shell characters. Laboratory rearing of larvae was successfully completed upto the spat stage.

Experimental production of shell-bead nuclei from conch shell wastes was taken up at Tuticorin. The production of surgical tools indigenously which was taken up during the previous year was completed. The tools proved satisfactory for the surgical operation on oysters.

In nucleus-implantation, it was sought to diversify the techniques for further improvement in pearl production. Multiple-implantation, re-use of oysters and inter-specific grafting were carried out. These experiments aimed at increasing the per-oyster production rate and improving the quality of pearls in the lesser oysters. Further operations were done under the Training Programme. Studies on Pearl-sac formation and histology of mantle were taken up.

The duration of post-operative culture ranged from 180 days to 497 days, the maximum being the longest duration given so far.

Mortality of *P. fucata*, between operation and harvest, was 15.9% at Veppalodai and 23.2% at the harbour. The lesser oysters suffered a very heavy mortality, presumably due to the prolonged cultivation.

A significant breakthrough was achieved in pearl production rate through multiple implantation. Oyster-wise, pearl production was 180.6% through multiple implementation as compared to 59.0% obtained through single implantation. Nucleus-wise, the production was 68.3% in the former category. The growth of pearl was as good in multiple implantation as in single implantation. Pearls produced by the lesser oysters were generally dull and watery in lustre.

A major step towards the development of pearl culture as a new industry in our country was taken by starting a six-month Pearl Culture Training course on September 24, 1976. Officers deputed by the Governments of Tamil Nadu, Kerala and Gujarat were given training in all aspects of pearl culture.

Marine Prawn Culture and Propagation Scheme.

Salient findings under this scheme is reported along with the progress of work under Crustocean Fisheries Division.

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STAFF POSITION AS ON 31-12-1976

Director: Dr. E. G. SILAS

1. Fishery Resources Assessment Division

Scientist-S 2
- Dr. M. S. Prabhu
- Dr. K. Alagaraja

Scientist-S 1
- Shri S.K. Dharmaraja

Assistant Fishery Scientist
- Shri M. G. Dayanandan
- Shri C. R. Shanmugavelu

Scientist-S
- Shri K. Narayana Kurup
- Mrs. B. Prasanna Kumari
- Shri K. Balan
- Mrs. K. Vijayalakshmi

Research Assistants
- Shri P. Karunakaran Nair
- Shri G. Balakrishnan
- Shri Varghese Philipose
- Shri U. K. Satyavan

Junior Scientific Assistants
- Shri K. Ramachandran Nair
- Shri S. Kandaswamy
- Shri A. C. Sekar
- Shri P. K. Mahadevan Pillai
- Shri K. Ramakrishnan Nair
- Shri R. Bhaskaran Achary
- Shri N. Retnaswamy
- Shri K. C. Yohannan
- Shri T. Girija Vallabhan
- Shri R. Guruswamy
- Shri M. Babu Philip
- Shri A. A. Thankappan
- Shri K. Nandakumaran
- Shri S. Manivasagam
- Shri P. Ananda Rao
- Shri T. G. Vijaya Warriar
- Shri M. Mohammad Sultan
- Shri Jacob Jerald Joel
- Shri A. Hanumantha Rao
- Shri C. V. Seshagiri Rao
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- Shri K. V. Seshagiri Rao
- Shri A. Raju
- Shri K. Soman
- Shri D. Kandaswamy
- Shri E. K. Raveendran
- Shri S. B. Chandragathan
- Shri G. C. Lakshmanaiah
- Shri I. P. Ebenezer
- Shri C. K. Krishnan
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- Shri N. Jaya Balan
- Shri P. Radhakrishnan
- Shri Selvaraj
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- Shri V. A. Narayanan Kutty
- Shri K. Muniandi
- Shri N. Sundaram
- Shri S. Vijayabaskar
- Shri V. Sivaswamy
- Shri N. Palaniswamy
- Shri K. Muthiah
- Shri K. Ramadoss Gandhi
- Shri K.B. Wagmare
- Shri Y. D. Savaria
- Shri G. Subramanya Bhat
- Shri T. Chandrasekhara Rao
- Shri K. Bala Chandran
- Shri D. Sundararajan

Computors:

Shri Varughese Jacob
Shri Krishnan Kutty Nair
Shri P. Sivaraman
Shri V. Rajendran
Mrs. V. P. Annam
Shri A. Kanakkan
Shri S. Haja Najjemudeen
Shri C. J. Prasad
Shri T. A. Sankaran Kutty
Miss P. L. Ammini
Miss K. Santhakumari

Laboratory cum field Assistants

Shri C. Balasundaram
Shri L. Jayasankaran
Shri L. Chidambaram
Shri O.M.M.J.Habeeb Mohamed
Shri T. S. Balasubramaniam
Shri V. Thanapathi
Shri M. R. Arputha Raj
Shri H. Kather Batcha
Shri Madhusudan Manohar Sare
Shri M. Gopala Prabhu
Shri S. Setharaman
Shri N. S. Viswanath
Shri Sapan Kumar Ghosh
Shri Hameed Batch
Shri S. Surendranath
Shri G. Krishnamoorthi

II. Fishery Biology Division

Scientist-S 3

Dr. K. V. Sekharan

Scientist-S 2

Dr. G. Seshappa
Shri T. Tholasilingam

Scientist-S 1

Dr. S. V. Bapat
Shri G. Venkataraman
Dr. B. Krishnamoorthi
Dr. M. Vasudev Pai
Dr. V. Balakrishnan
Shri V. Balan
Dr. P. Vijayaraghavan
Dr. M. D. K. Kuthalingam
Shri K. Rangarajan
Shri M. H. Dhulkhed
Shri G. Luther
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Shri P. Sam Bennet
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Shri A. Noble
Shri J.C. Gnanamuttu
Dr. T. Appa Rao
Shri S. Reuben
Shri R. S. Lal Mohan
Shri K. Dorairaj
Dr. V. Sriramachandra Murty
Shri P. V. Sreenivasan
Shri N. Muthiah
Shri A. Chellam

Assistant Fishery Scientists

Shri S. J. Rajan
Shri A. S. Kaikini
Shri P.T. Meenakhi Sundaram
Shri Syed Basheeruddin
Shri S. S. Dan
Shri J.P. Karbhari

Scientist-S

Shri D.B. James
Shri M. Devaraj
Shri P. Devadoss
Shri K. V. Somasekaran Nair
Shri Alexander Kurian
Shri T. M. Yohanan
Shri P. Livingston
Shri R. Thiagarajan
Shri S. Shanmugam
Shri P. Natarajan
Shri P. Nammalwar
Shri S. Lazarus
Shri A. A Jayaprakash
Shri V. S. Rengaswamy
Shri R. Soundararajan
Shri Appanna Sastry
Shri N. Gopinatha Menon
Shri M. E. Rajapandian
Shri P. N. Radhakrishna Nair

Research Assistants

Shri K. Rajasekharan Nair
Shri G. M. Kulkarni

Shri W. Venugopalam

Junior Scientific Assistants:

Shri P.S. Sadasiva Sarma
Shri R. Reghu
Shri M. Badrudeen
Shri V. Suresh
Shri S. G. Vincent
Shri M. Vijayakumaran
Shri S. Dharmaraj

Laboratary-cum-Field Assistants

Shri A. Deivendra Gandhi
Shri S. K. Karunakaran
Shri R. Thangavelu

III. Crustacean Fisheries Division

Scientist-S 2

Shri K.H. Mohamed
(On deputation to FAO)
Dr. P. Vedavyasa Rao

Scientist-S 1

Dr. S. Ramamurthy
Shri M. Mydeen Kunju
Dr. (Mrs.) P.V. Kagwade
Shri M.S. Muthu
Shri V.M. Deshmukh
Dr. M.M. Thomas
Shri G. Sudhakara Rao

Scientist-S

Shri N. Surendranatha Kurup
Shri N. Neelakanta Pillai
Shri M. Aravindakshan
Shri K. Y. Telang
Dr. P.A. Thomas
Shri C. Suseelan
Shri K. N. Rajan
Shri V. Thangaraj Subramanian
Shri K. M. S. Ameer Hamsa
Shri P. E. Sampson Manickam
Shri K. Devarajan
Shri K. K. Sukumaran
Shri M. Kathirvel
Shri G. Nandakumar

Research Assistant

Shri K. V. George

Junior Assistants:

Shri K. N. Rasachandra Kartha
Shri K. K. Balasubramanian
Shri K. N. Gopalakrishnan
MIss. K. Koumudi Menon
Miss. S. Lakshmi
Mrs. C.Nalini

Laboratory-cum-Field Assistant

M. Manicka Raja

IV. Molluscan Fisheries Division

Scientist- S 2

Shri K. Nagappan Nayar

Scientist-S 1

Shri S. Mahadevan
Dr. Satyanarayana Rao
Shri K. A. Narasimham

Scientists-S

Shri Kuber Vidyasagar
Shri D. Sivalingam
Shri R. Sarvesan
Shri K. S. Sundaram
Shri K. K. Appukuttan
Shri K. Prabhakaran Nair
Shri K. Ramadoss
Dr. P. S. Kuriakose

Research Assistants

Shri T. Prabhakaran Nair
Shri S. Srinivasa Rangan

Junior Scientific Assistants:

Shri C. T. Rajan
Shri A. Bastin Fernando
Shri K.AsokaKumaranUnnithan
Shri P. Ramadoss
Shri B. Narayana Rao

Laboratory-cum-Field Assistant

Shri A. Srinivasan

V. Marine Biology And Oceanography Division

Scientist S 2

Dr. A. V. S. Murty

Scientist S-1

DR. P.V. Ramachandran Nair
Shri C. Mukundan
Shri C. P. Ramairtham
Shri D. Sadananda Rao
Shri V.S.K. Chennubhotla
Shri N.S. Radhakrishnan
Shri M.S. Rajagopalan
Shri G.G.Annigeri
Dr. C. S. Gopinadha Pillai

Assistant Fishery Scientist
Shri P. Mojumder

Scientist-S
Shri K. G. Girijavallabhan
Shri R. Marichamy
Shri V. Kunjukrishna Piiali
Shri C. P. Gopinathan
Dr. P. Parameswaran Pillai
Shri K. J. Mathew
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Shri S. Krishna Piiali
Shri M. Rajagopal
Shri K. J. Joseph
Mrs. T. S. Naomi
Mrs. V. Chandrika
Shri I. David Raj
Shri C.V. Mathew
Shri N. Kaliaperumal
Shri Pon Siraimeetan

Research Assistant:
Shri P. Karuppaswamy

Junior Scientific Assistants:
Shri A. Agastiesa Pillai Mudaliar
Shri N. P. Kunhi Krishnan
Shri Kunhi Koya
Shri M. Ayyappan Pillai
Shri V. K. Balachandran
Shri P. M. Aboobacker
Shri S. Kalimuthu
Shri R. Vasantha Kumar
Shri K.P. Viswanathan
Shri C. Thankappan Pillai
Miss A. Kanagam
Shri D. Vincent
Shri J. R. Ramalingam
Shri M. Najmuddin

Laboratory-cum-Field Assistants:
Mrs. C. M. Allikunju
Shri M. Selvaraj

A. R. S. Probationers

Miss. R. Padmini
Shri E.V. Radhakrishnan
Miss. Gracy Mathew
Dr. E. Vivekanandan
Shri M. Rajamani
Shri G. Gopakumar

VI. I. C. A. R. Schemes

1. Scheme on Pearl Culture, Tuticcorin

Principal Investigator: Dr. K. Alagarswami (Scientist S-2)

2. **Marine Prawn *Culture and Propagation* Scheme, Cochin**

Principal Investiator: Dr. E. G. Silas (Director)

VII. Technical Cell

Scientist S-1 K. N. Krishna Kartha

VIII. Administration

Senior Administrative Officer: S. Rajagopalan

Administrative Officer: S. PL. Sethu

Accounts Officer: D. Raghava Kurup