

ANNUAL REPORT FOR 1971



**Central Marine Fisheries Research Institute
COCHIN-11
INDIAN COUNCIL OF AGRICULTURAL RESEARCH**

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INTRODUCTION

Brief historical introduction and objectives

The main purpose of the Central Marine Fisheries Research Institute is to conduct both short-term investigations for solving specific problems and long-term researches for giving a proper appraisal of the living marine resources and their judicious exploitation. Marine fisheries are largely capture fisheries. These are subjected to fluctuations as a result of such influences of the sea, which are not easy to predict. The vastness of the sea and the inter-play of known and unknown factors which the sea provides, and our inability to control the influence or to increase the production by artificial means, make our capacity to harness the sea at present, severely limited. Luckily for man this natural wealth, though we cannot immediately add to it, is plentiful, and the best we can do is to exploit it without harming it. We can derive maximum benefit out of it while at the same time conserving it for our own future needs. The frame-work, therefore, within which the Central Marine Fisheries Research Institute functions for the fulfilment of these ultimate aims, can be classified as follows:

1. Ensuring maximum sustained yield from the exploited fisheries.
2. Exploring new grounds and untapped resources.
3. Culture of cultivable species to augment natural production.
4. Biological studies on fish populations in relation to their fisheries.
5. Environmental studies in relation to fisheries.
6. Strengthening the co-operation and collaboration with other institutions in scientific investigations.
7. Prompt distribution of information (unclassified) to all concerned agencies and to the public.

Organisational structure and changes

Scientific work of the Institute

During the year 1971, the Institute has undertaken 62 research projects and an all-round progress was maintained in these projects at the

Headquarters and the outstations. The scientific work has been carried out by the Institute's three Divisions namely:

1. Fishery Survey and Statistics
2. Fishery Biology
3. Marine Biology and Oceanography

The important achievements of the three Divisions have been given in the various sections under 'progress of research'. In the other sections of the Institute the progress was as follows:

Library

During the year, 89 new books and about 500 periodicals were received in the library including 10 additional journals which were started from 1971. A documentation service entitled "Fishery and Marine Science Abstracts" was started and two numbers under Vol. 1 were issued. The Institute has received letters of appreciation from different institutions for starting such a service to Marine Science. Volume 12 (No. 2) and Volumes 13, 14 and 15 of the *Indian Journal of Fisheries* were published during the year. The printing of the Proceedings of the Symposium on Living Resources of the Seas Around India has made considerable advance, and it is hoped that the volume will be out soon.

As usual the library continued its services to give loan of books and periodicals to different Universities, Institutes, State departments and other interested organisations. Many visitors from colleges and universities have made use of the library consistently throughout the year.

Distinguished visitors to the Institute during the year

1. Dr. Spencer P. Davis, Department of Zoology, University of Glasgow, U. K.
2. Dr. D. H. Kuhlmann, Museum of Natural History, Berlin, GDR.
3. Dr. Theodore H. Bullock, Professor of Zoology, University of California, Los Angeles, U. S. A.
4. Prof. Martin W. Schein, Department of Biology, West Virginia, U. S. A.
5. Shri K. K. Shah, His Excellency the Governor of Tamil Nadu.
6. Mr. A. R. Noble, Department of Physiology and Biochemistry, University of Southampton, U. K.
7. Dr. Sathiavani Muthu, Minister for Fisheries, Tamil Nadu.

8. Dr. R. Altevogt, Zoologische Institute der Universitat, West Germany.
9. Prof. Jules Brunel, University of Montreal, Montreal, Canada.
10. Prof. Robert Fenaux, Station Zoologique. Villefranche-sur-mer, France.
11. Prof. J. E. A. Godeaux, University of Liege, Belgium.
12. Dr. V. F. Kanaev, Institute of Oceanology, Moscow.
13. Dr. W. Klauswitz, Senkenberg Museum, Frankfurt, West Germany.
14. Mr. Willard S. Moore, U. S. National Oceanographic Office, Washington D. C., U. S. A.
15. Mr. V. G. Neiman, Institute of Oceanology, Moscow.
16. Mr. Michael Pichon. Station Marine d'Endoume, Marseilles, France.
17. Dr. Alain Sournia, Museum National d'Histoire Naturelle, France.
18. Mr. A. J. P. Mzumara, Fisheries Training Centre, Mangochi, Malawi.
19. Dr. T. Wyatt, Fisheries Laboratory, Lowestoft, U. K.

Research collaboration with other organisations

1. Survey of chank and pearl oyster beds in collaboration with Department of Fisheries, Tamil Nadu.
2. Collection of data on marine biology and oceanography and exploratory surveys conducted in collaboration with the Indo-Norwegian Project and Deep Sea Fishing Stations.
3. Survey of seaweed resources of Tamil Nadu coast in collaboration with Tamil Nadu Government and Central Salt and Marine Chemical Research Institute (CSIR).

Advisory/Consultancy service received and provided

1. Dr. S. Z. Qasim, Director was appointed a member of the Advisory Committee for Marine Resources Research (ACMRR) of the FAO. He participated in the 6th session of the ACMRR held in Rome. In the same Session he was elected Vice Chairman of the ACMRR.
2. As an invited speaker, Dr. Qasim attended the Symposium on "The Biology of the Indian Ocean" held at Kiel, West Germany, from 31-3-1971 to 6-4-1971 and contributed a paper. The

Symposium was organised jointly by SCOR, IBP/PM, the UNESCO, FAO and IABO.

3. Dr. Qasim was appointed Chairman of the Working Conference of the IBP/PM and attended the Conference of the IBP/PM held in Rome from 4-8 October, 1971 and contributed a paper.
4. Dr. Qasim served as a Member of:
 - (i) Faculty of Science, Annamalai University,
 - (ii) Advisory Committee, Centre for Advanced Study in Marine Biology, Annamalai University,
 - (iii) Board of Governors, Indian Institute of Technology, Bombay,
 - (iv) Board of Studies, Marine Biology and Oceanography, University of Kerala,
 - (v) Faculty of Studies in Fisheries and Faculty of Fisheries, University of Calicut,
 - (vi) Task Force on Marine Survey (Living Resources), Planning Commission,
 - (vii) Working Group on Prawn Fishing, National Commission on Agriculture.
 - (viii) Advisory Committee of the University of Cochin, and
 - (ix) The Senate, University of Cochin.
5. Dr. Qasim was elected as the President of the Marine Biological Association of India and was also appointed as Honorary Professor of the Madurai University.
6. Dr. E. G. Silas, Senior Fishery Scientist, served as General Convener for the "Symposium on Indian Ocean and Adjacent Seas-Their Origin, Science and Resources" held under the auspices of the Marine Biological Association of India, from 12-18 January 1971 at Cochin.
7. Dr. E. G. Silas represented the Institute at the first meeting of the Central Advisory Committee on Exploratory Survey of Marine Fisheries held on 17-4-1971 at Bombay.
8. Shri K. H. Mohamed, Fishery Scientist served as the member of the IOFC Special Working Party on the Stock Assessment of Shrimps in the Indian Ocean area and attended its first meeting held at Bahrain during November-December 1971.

The Institute extended its consultancy service to individuals, scientific organisations and industries and answered many more queries than in previous years.

Fellowships and scholarships provided and received

Six Research Scholars underwent training in research under the scholarships scheme introduced by the Government of India, Ministry of Education and Social Service.

Two members of the staff, Shri V. Sriramachandra Murty and Shri A. Chellam who had been selected for the ICAR Fellowships in fisheries have intensified their studies during the year.

Conferences and Symposia

1. The staff of the Institute participated in the Symposium on 'Indian Ocean and Adjacent Seas' organised by the Marine Biological Association of India and held at Cochin during January 1971.
2. The Institute participated in the 'Open House' Exhibition organised by the Indo-Norwegian Project, Cochin in October 1971.

Finance

The budget allotment of the Institute for the financial year ending 31-3-1972 has been Rs. 13,83,000 under Plan and Rs. 26,70,700 under Non-Plan.

PROGRESS OF RESEARCH

FISHERY SURVEY AND STATISTICS

Summary of salient findings

During 1971, the total marine fish production in the country was provisionally estimated at 1,154,822 tonnes as compared to 1,085,607 tonnes during 1970. The increase in production from last year, was about 6%. The landings from the mechanised boats showed a minor decline from those of 1970 and this was because of reduced catches by the mechanised boats in the states of West Bengal, Orissa, Tamil Nadu, Kerala and Gujarat. As compared to 1970, no significant change was noticed in the landings during the night. All the maritime states except West Bengal and Orissa, recorded increased catches. The variations in the input of effort, catch per unit effort and other related aspects were studied in detail.

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The oil sardine, mackerel, prawns and Bombay duck together constituted about 53% of the total marine fish production during the year. The remarkable recovery of mackerel fishery during the years 1969 and 1970 was maintained in 1971, with an all time record catch of nearly 185 thousand tonnes. A record quantity of 75 thousand tonnes of non-penaeid prawns was caught in the Maharashtra State. The catches of oil sardine and penaeid prawns showed some decline during the year.

Researches in hand

ANNUAL PRODUCTION OF MARINE FISH

During 1971, the total marine fish production in India was provisionally estimated at 1154822 tonnes as compared to 1085607 tonnes during 1970. The increase from last year was about 6%. For comparison the statewise marine fish production for the years 1970 and 1971 are shown in Table 1. The distribution of the total catches obtained from mechanised and non-mechanised crafts and the relationship between day and night catches have been given in Table 1.

From Table 1 it is seen that the percentage of landings from the mechanised crafts during 1971 showed a minor decline over that of 1970. This was due to lower landings by the mechanised units in the states of West Bengal and Orissa, Tamil Nadu, Kerala and Gujarat. As compared to 1970 no significant change was noticed in the landings during the night. Barring West Bengal & Orissa, Mysore and Gujarat all the maritime states of India recorded increased landings. While the landings in Kerala and Maharashtra were significantly higher than those of the previous year, Andhra and Tamil Nadu showed only a slight increase. No significant change was noticed in the landings of the centrally administered territories of Pondicherry, Goa, Andamans and Laccadives.

In West Bengal and Orissa the landings decreased by about 4000 tonnes (13%). The decline in landings resulted from less input of effort as compared to 1970. The landings of lesser sardines and penaeid prawns were comparatively poor.

The total landings in Andhra Pradesh showed an increase of about 8800 tonnes (12%). The landings of other clupeoids, sciaenids and pomfrets were significantly higher. The catches of anchovies and whitebaits, however, suffered a minor decline. The total input of effort which was higher than that of last year, resulted in an increase of about 4700 tonnes (3%) in the total fish landings in Tamil Nadu. The fisheries of lesser sardines, flying fish, ribbon fish and seer fish were better than those of last year. A decline in the catches of elasmobranchs, *Achoosiella*, sciaenids *Leiognathus* and penaeid prawns was, however, noticed.

†TABLE 1. State-wise marine fish landings

State	Provisional estimate of landings (in tonnes) during						Total	
	Day				Night			
	By non-mechanised units		By mechanised units		1971	1970	1971	1970
	1971	1970	1971	1970	1971	1970	1971	1970
1. West Bengal & Orissa	26541	30567	558	600	156	236	27255	31403
2. Andhra Pradesh	80760	72278	2201	1867	328	314	83289	74459
3. Tamil Nadu	125263	111063	28698	36783	6253	7670	160214	155516
4. Pondicherry	8338	9979	1451	395	664	250	10453	10624
5. Kerala	381685	322196	47291	52571	16629	18123	445605	392880
6. Mysore	86286	100598	16565	14742	1127	1596	103978	116936
7. Maharashtra	81513	72478	110531	98280	24296	21603	216340	192361
8. Gujarat	29890	32135	30725	40528	24326	16364	84941	98027
Percentage	72.46	70.66	21.03	23.12	6.51	6.22	100	100
9. Goa							21000	20736
10. Andaman Islands							547	500
11. Laccadive Islands							1200	1165
Grand Total							1154822	1085607

In spite of a reduction in the input of effort in Pondicherry, the total marine fish landings remained more or less stationary. While the catches of *Anchoviella* and penaeid prawns showed some decline, *Caranx* and elasmobranchs recorded an increase in yield.

The total landings in Kerala showed an increase of about 53000 tonnes (13%). The significant increase in the landing of mackerel during the period, January to March 1971, was largely responsible for the increase in the total catch. The landings of oil sardine also improved slightly and so were the fisheries of lesser sardines and ribbon fish. The fishery of penaeid prawns was relatively poor. The input of effort during the year 1971 for prawns was much higher, than that of last year.

In Mysore, in spite of a higher input of effort, the total landings declined by about 13000 tonnes (11%). The decline was mainly due to the reduction in the yield of oil sardine and penaeid prawns. The landings of mackerel were significantly higher.

In Maharashtra the landings showed an increase of about 24000 tonnes (12%). There was a significant increase in the total input of effort resulting into a decrease in the catch per unit effort. A record increase in the landings of non-penaeid prawns during the year deserves a special mention. The landings of penaeid prawns and mackerel, however, showed some decline although the catch of *Bregmaceros* almost doubled.

In Gujarat the increase in the input of effort did not produce any significant effect and the total catch declined by about 4000 tonnes (5%). The landings of *Hilsa* showed some increase, but the fishes of *Harpodon nehereus* registered a slight decline. No significant changes in the landings were seen in respect of other varieties of fish.

VARIETY COMPOSITION

The marine fisheries of India, which are based on more than 200 different species of fish, have been grouped and presented in Table 2 for the years 1970 and 1971.

It is clear from Table 2 that the principal fisheries of India are oil sardine, mackerel, *Harpodon nehereus* and prawns. These together constituted about 53% of the total marine fish production during 1971 as compared to 52% during 1970. Among the principal fisheries, the landings of mackerel and non-penaeid prawns increased significantly, but those of oil sardine, *Harpodon nehereus*, and penaeid prawns showed decline. As regards the other fisheries, the catches of lesser sardines and ribbon fish increased considerably, but the landings of *Leiognathus* and *Gazza* decreased. A summary of the main fisheries is as follows:—

TABLE 2. *The composition of total marine fish landings in India during 1970 and 1971 (quantity in tonnes)*

Sl. No.	Name of fish	1971	1970
1.	Elasmobranchs	42061	44048
2.	Eels	4130	6983
3.	Cat fishes	49197	50631
4.	<i>Chirocentrus</i>	9996	9158
5. a)	Oil sardine	208982	226997
b)	Lesser sardines	63775	55220
c)	<i>Hilsa ilisha</i>	1855	1050
d)	Other <i>Hilsa</i>	10500	9492
e)	<i>Anchovtella</i>	19509	24400
f)	<i>Thrissocles</i>	10929	14087
9)	Other clupeids	29462	26439
6. a)	<i>Harpodon nehereus</i>	71415	78443
b)	<i>Saurida & Saurus</i>	3759	2813
7.	<i>Hemirhamphus & Belone</i>	993	1814
8.	Flying fish	9185	2844
9.	Perches	13077	13913
10.	Red mullets	3836	2118
11.	Polynemids	7464	7168
12.	Sciaenids	36518	41903
13.	Ribbon fish	45336	26984
14. a)	<i>Caranx</i>	21474	18412
b)	<i>Chorinemus</i>	2126	2120
c)	<i>Trachynotus</i>	17	143
d)	Other carangids	523	966
e)	<i>Coryphaena</i>	60	254
f)	<i>Elacate</i>	347	518
15. a)	<i>Leiognathus</i>	32591	49275
b)	<i>Gazza</i>	32	154
16.	<i>Lactarius</i>	5511	4697
17.	Pomfrets	21831	17589
18.	Mackerel	184815	139206
19.	Seer fish	18433	13410
20.	Tunnies	5835	3015
21.	<i>Sphyraena</i>	1278	1530
22.	<i>Mugil</i>	3727	2428
23.	<i>Bregmaceros</i>	4345	2196
24.	Soles	11112	13364
25. a)	Penaeid prawns	73320	89857
b)	Non-penaeid prawns	76648	31834
c)	Other crustaceans	9592	10832
26.	Cephalopods	1561	1184
27.	Miscellaneous	37665	36118
	Total	1154822	1085607

(a) **Oil sardine:** Table 3 gives the State-wise landings of oil sardine in India.

TABLE 3. *Landings of oil sardine during the years 1970 and 1971*
(Landings in tonnes)

Year	Kerala	Mysore	Other States	Total
1970	191683	33834	1480	226,997
1971	195478	11903	1601	208,982
Average (1960-1971)	177,005	28,495	1,370	206,870
Percentage (1960-1971)	85.56	13.77	0.67	100

Table 3 will show that nearly 86% of the oil sardine landings came from Kerala. It is therefore evident that the total oil sardine catch in the country always depends on the success of this fishery in Kerala. The fishery of oil sardine was by and large satisfactory in all the years of the last decade except in 1962 and 1963. The fluctuations in these years were attributed to the differences in the availability of the fish within the limited fishing region along the coastal belt.

A preliminary assessment of the effect of fishing on the oil sardine, has shown that the maximum value of yield per recruit Y/R is obtained at a fishing effort corresponding to the fishing mortality rate $F=1.4$ as against the present average fishing mortality $F=0.75$. However, the computed yields at these two levels show that by almost doubling the fishing effort, the yield will increase only by about 12%. This indicates that no substantial increase in oil sardine is possible by a further increase in the fishing effort, as long as the fishery remains restricted to the inshore waters.

(b) **Mackerel:**—Table 4 gives State-wise landings of the mackerel in India.

The mackerel fishery of India is mainly confined to the coastal waters of the west coast between Quilon (Kerala) and Ratnagiri (Maharashtra). This fishery is equally important for Kerala and Mysore (Table 4). The annual landings of mackerel fluctuate widely. The landings in 1960 was 133655 tonnes but during the subsequent 8 years, barring ofcourse 1963, the landings fluctuated between 21 to 43 thousand tonnes. The mackerel fishery made a remarkable recovery in 1969 and this was maintained in 1970 and 1971. A significant increase in the catches of mackerel was recorded in 1971, which was provisionally estimated at 184815 tonnes. It is an all time record.

TABLE 4. Landings of mackerel during the years 1970 and 1971
(Landings in tonnes)

Year	Kerala	Mysore	Other States	Total
1970	54659	46336	38211	139206
1971	95045	64641	25129	184815
Average (1960-1971)	28552	24187	17273	70012
Percentage(1960-71)	40.78	34.55	24.67	100

The annual fluctuations in the mackerel fishery are well known. For mackerel, the existing fishery mortality rate was estimated as $F=1.40$ and the maximum yield per recruit Y/R was obtained at $F=1.55$. This shows that we are almost putting in the maximum effort and are nearer to the optimum yield. From this it is also clear that any further increase in the fishing effort within the inshore fishing area exploited at present may give rise to only a nominal increase in the catch.

(c) **Bombay duck:**—The Bombay duck fishery is based on a single species, *Harpodon nehereus* which exists predominantly along the coasts of Maharashtra and Gujarat. Some stray catches of this fish are also being caught along the West Bengal, Orissa and Andhra coasts.

Table 5 shows the total landing of Bombay duck during the years 1970 and 1971.

TABLE 5. Landings of Bombay duck in India during the years 1970 and 1971
(Landings in tonnes)

Year	Maharashtra	Gujarat	Other states	Total
1970	33730	43618	1095	78443
1971	33994	35706	1715	71415
Average (1960-1971)	27681	53892	1292	82865
Percentage (1960-1971)	33.40	65.04	1.56	100

From Table 5 it is clear that while the annual landings of Bombay duck in Maharashtra did not show much change, those in Gujarat showed some decline. A critical study is being carried out in collaboration with the Fishery Biology Division to determine whether the decrease is accompanied by an increase in fishing effort or not.

(d) **Penaeid prawns:** The penaeid prawns formed only about 46% of the total landings of crustaceans during the year. This was mainly due to reduced landings in most of the States. Large quantities of penaeid prawns were landed during 1970 in Kerala, Maharashtra and Mysore. Table 6 shows the landings of penaeid prawns in the three states during 1970 and 1971.

From Table 6 it can be seen that the landings of penaeid prawns during 1971 declined considerably in Kerala, Maharashtra and Mysore.

TABLE 6. Landings of penaeid prawns in India during 1970 and 1971
(Landings in tonnes)

Year	Kerala	Maharashtra	Mysore	Other States	Total
1970	36940	28920	7538	16459	89857
1971	31288	19490	4635	17907	73320
Average (1960-1971)	26402	12242	2528	15988	57160
Percentage (1960-1971)	46.19	21.42	4.42	27.97	100

(e) **Non-penaeid prawns:**—The percentage contribution of non-penaeid prawns among the crustaceans was about 48% during the year. This was mainly due to a bumper catch of non-penaeid prawns in Maharashtra State.

Table 7 shows the landings of non-penaeid prawns during 1970 and 1971.

It is seen from Table 7 that Maharashtra contributed about 94% of the total non-penaeid prawn catch in India.

TABLE 7. Landings of non-penaeid prawns in India during the years 1970 and 1971
(Landings in tonnes)

Year	Maharashtra	Other States	Total
1970	28425	3409	31834
1971	74637	2011	76648
Average (1960-1971)	35299	2088	37386
Percentage (1960-1971)	94.42	5.58	100

(f) **Lesser sardines:**—As compared to 1970, the landings of lesser sardines showed an increase of 8555 tonnes. This was mainly because of a good fishing season along the coasts of Tamil Nadu and Kerala.

(g) **Ribbon fish:** During 1971, the catch of ribbon fish registered an increase of 18376 tonnes mainly because of the successful fishing seasons in the States of Tamil Nadu, Kerala and Maharashtra.

(h) **Lelognathus & Gazza:**—The yield of *Lelognathus* and *Gazza* declined by 16806 tonnes. The poor fishery in the States of Tamil Nadu and Kerala was the main factor which led to this decline.

SEASONAL VARIATION

About 46% of the total marine fish production in India was obtained in the fourth quarter (October-December). Maximum yield in all the maritime States was synchronized in the fourth quarter, along the west coast of India, but it was not so in the different States of the east coast of India. In West Bengal, Orissa and Andhra Pradesh the maximum catch was recorded in the fourth quarter, but in Tamil Nadu and Pondicherry maximum catch was obtained in the first quarter.

INPUT OF EFFORT

(a) Man hours expended and return per unit effort

The catch per unit effort for the country as a whole remained more or less the same as last year. Except for the West Bengal, Orissa and Pondicherry all the other maritime States of India expended a greater effort in terms of man-hours. From the States of the west coast, Kerala recorded the highest catch per unit effort, which was followed by Mysore and Maharashtra. Tamil Nadu and Pondicherry put in the highest catch per unit effort along the east coast of India.

(b) Effort in terms of number of operations of unit gear during 1970 and 1971

The number of operations of trawl net during 1971 increased significantly in the States of Andhra Pradesh, Tamil Nadu, Kerala and Maharashtra. The 'dol' net operations were relatively greater in the States of Maharashtra and Gujarat as compared to last year. No significant change from last year was noticed in respect of the operations of other gears.

Personnel associated with the projects

S. K. Banerji, SFS; V. Sadasivan, FS; M. G. Dayanandan, AFS;
S. K. Dharmaraja, AFS; SRAs, RAs and other field staff.

OFFSHORE FISHERIES

Exploratory fishing operations were carried out by several fishing establishments both in the private and public sectors at different places. The progress achieved during the year was as follows.

BOMBAY

The catch data from the mechanised vessels operating from the Bombay base was studied. The New India Fisheries vessels which were operating during the year were *Akashimaru 23 & 25*, *Sudha I, II, IV, VI, VII, VIII* and *Konchu* and those of Government of India were *Meenakhajini* (200 H.P.) *M. V. Meena Sangraha* (200 H. P.) and *M. V. Meenabharathi* (262 H. P.).

The vessels of the New India Fisheries were doing trawling in waters off Bombay at a depth range of 6—73 metres. The vessels altogether spent 2895.32 hours in trawling which gave a total catch of 310020 kg. of 'all fish'. The catch rate came to 107.07 kg/hr. The prawn component of the catch was 67248 kg. at a catch rate of 23.22 kg/hr. The fish component of the catch mainly constituted of *Dhoma*, cat-fishes, ribbon fishes, pomfrets, elasmobranchs and other smaller miscellaneous fishes.

The results of trawling by the vessels of Government of India, Deep Sea Fishing Stations are given in Table 8.

TABLE 8. *Trawling operation of Government of India vessels for 1971*

Depth range in metres	Fishing effort in hours	Prawns in Kg.	Fish in Kg.	Total 'all fish' in Kg.
12-75	223.00	1435	30181	31616
		(6.43)*	(135.34)*	(141.77)*
*Catch/hour (Kg)				

In addition to trawling one vessel *Meenakhajni* operated purse-seine for four hours, bagging a total catch of 12335 kg. of mackerel.

COCHIN

The Government of India vessels based at Cochin continued their fishing operations during the year. Four vessels viz., *M. V. Flying fish* (56 H.P.) *M.L. Durga* (56 H.P.) *M.T. Matsyavigyani* (578 H.P.) and *Meena Sangraha* (200 H.P.) operated from this base. Of the four vessels, the latter two big vessels were available at Cochin only for a small period. All the vessels largely operated trawl nets in waters off Cochin, Quilon and Alleppey at a depth range of 6-91 metres. The fishes caught were mainly *Nemipterus japonicus*, elasmobranchs, cat fishes, *Lactarius lactarius* and a few of the smaller miscellaneous varieties. Prawns largely included *Metapenaeus dohsoni*, *Parapenaeopsis stylifera* and *Penaeus indicus*. The analysis of prawn and fish catches is given in the Table 9.

TABLE 9. *Catch particulars of Government of India vessels for 1971*

Fishing effort in hours	Prawns in Kg.	Fishes in Kg.	Total	Total for 1970
780 67	5058	46814	54872	52909
	*(10.32)	*(59.17)	*(70.29)	*(65.13)
*Catch/hour (Kg)				

It is clear from this table that the total catch for 1971 was slightly better than that of the previous year 1970.

Fishing operations of the medium sized vessels of the Indo-Norwegian Project which carried out trawling and purse-seining and of the

bigger vessels which performed both trawling and hand line operations can be summarized as follows:

Medium sized vessels-Trawling operations

Five medium sized vessels M.11, M.12, M.13, and M. 14 (48BHP) and M.V. *Karwar* (90BHP) carried out commercial trawling in waters off Cochin at a depth range of 6-38 metres. These vessels altogether spent 3150.70 hours in actual trawling and landed a total catch of 177542 kg. of 'all fish'. The average rate of catch of 'all fish' comes to 56.35 kg/hr which was an improvement over last year's catch rate (52.16kg/hr). Total prawns caught during the year were 33120 kg. and their catch rate was 10.54 kg/hr which was much lower than that of last year which was 24.12 kg/hr. Fish components included *Nemipterus japonicus*, elasmobranchs, *Lactarius lactarius*, cat-fishes and few other smaller miscellaneous varieties.

Medium sized vessels-Purse-seine operations

Two medium sized vessels operated purse-seine in waters off Cochin for pelagic fishes. The depth of operation was between 9-22 metres. After spending 466.75 hours of fishing, they obtained a total catch of 185117.5 kg. of fish. The overall catch rate was 396.6 kg/hr which was much lower than that of the previous year, 742.10 kg/hr. The catch included oil sardine, mackerel, tunas and cat-fishes.

Larger vessels -Trawling operations

Larger vessels like *M. V. Velameen*, *M. V. Tuna*, *M. F. Kalava*, and *M. V. Klaus Sunnana* did commercial trawling in shallow depths and exploratory trawling in deeper waters. Using different types of trawl nets, they fished in waters off Cochin, Ponnani, Quilon, Alleppey and Cape Comorin (Wadge-Bank). These vessels altogether spent 752.02 hours of trawling and bagged a total catch of 178665 kg. of 'all fish'. The average catch rate of these vessels comes to 237.58 kg/hr which was almost similar to that of the previous year(244.23kg/hr). Prawn catch were only 844 kg. The use of bobbin trawl over the rocky perch grounds seems worth mentioning. Nearly 12421 kg. of perches (*Pristipomoides* sp.) were caught by the operation by bobbin trawl. The other fishes in the catch were cat fishes, *Nemipterus* sp. small quantities of sand lobsters and several smaller fishes.

Larger vessels-Exploratory trawling

Exploratory trawling operations were carried out in deeper waters off Cochin, Alleppey, Quilon, Cape Comorin at a depth range of 118-387 metres. The larger vessels altogether spent 325.49 hours of trawling and landed a total catch of 72488.2 kg. of 'all fish'. The catches were mainly

of deep sea prawns, deep sea lobsters, deep sea fishes, perches, elasmobranchs and cat-fishes. The deep sea fishes mainly included *Chlorophthalmus* sp., *Myripristis* sp., *Chascanopsetta* sp., *Bembrops caudimaculata* and a few other species of rat-tails and deep sea crabs. Deep sea prawns largely included the following species; *Heterocarpus wood-masoni*, *Parapandalus spinipes* and *Heterocarpus gibbosus*. Of the total catch of 72488.2 kg. of 'all fish' the component of the deep sea prawn was 3680 kg. and that of the deep sea lobsters 43729.6 kg. The latter constituted a major portion of the total catch.

Larger vessel-Handline operations

Along the rocky coasts off Cochin, Quilon, Ponnani, Chetwai etc., there are potential fishing grounds of rock cods (perches). These fishes are normally caught by the hand-lines, which has proved to be extremely profitable. At present, no regular exploitation is being done. During the year an effort of 103.75 hours of hand lining was put in at a depth range of 75-93 metres. This resulted in the total catch of 10380 kg of 'Kalava' at the rate of 192.28 kg/hr.

MANGALORE

The mechanised boats of the training centre and those of the extranees based at Mangalore conducted trawling operations in waters off Mangalore, Mulki, Malpe, and Ganguli. The total catch from all these vessels came to 9052439 kg of 'all fish'. The Prawn portion of the catch was 2623682 kg. The over all catch per unit was calculated as 136 kg. Prawn catches mainly consisted of the following species, *Metapenaeus dobsoni*, *Parapenaeopsis stylifera*, *Metapenaeus monoceros* and the fish portion was mainly composed of *Leiognathus* sp., *Caranx* sp., *Opisthopterus* sp., *Cynoglossus* sp., and a few other smaller miscellaneous fishes.

In addition to trawling, a few trainees boats at Mangalore. numbering 22 units, operated gill nets and got a total catch of 852 kg. of fishes like cat-fish, tuna, sharks, seer fish, mackerel etc., The catch rate was 38.72 kg. per unit.

VISAKHAPATNAM

There was not much trawling activities during this year. Only one vessel *M. V. Champa* (135 H. P.) operated from here. The vessel spent 293.34 hours in trawling and brought a total catch of 8725 kg. of 'all fish'. The prawn portion of the catch was 903.45 kg. The overall catch rate for 'all fish' combined for the year was 29.74kg/hr. The catch rate of prawns was only 3.08 kg/hr. Fish components of the catches were mostly miscellaneous species consisting of elasmobranchs, cat-fishes and few other smaller fishes.

KARWAR

About thirteen medium sized vessels belonging to different agencies did trawling here at depths 2 to 31 metres. All vessels combined, got a total catch of 314709 kg of fish. Prawn catches were poor and amounted to 3045 kg.

TUTICORIN

During the year, M. V. *Meenaprayas* and M. V. *Jheenga* of the Off-shore fishing station were engaged in trawling off Tuticorin. The areas covered were 8.78/4B, 4C, 5B, 5C, 5D and 6C and landed a total of 99405 kg. of fish after a total fishing effort of 444.20 hrs. The catch rate was 223.88 kg/hr. M. V. *Meenaprayas* conducted fishing for 77 days during the year and expended a total effort of 267.40 hrs at a depth range of 8.50 metres. The area covered was 8-78/4B, 5B, 5C, 5D and 6C. It landed a total catch of 39554 kg of fish and the catch rate was 144.75 kg/hr. M. V. *Jheenga* was out of the port for 48 days and conducted fishing operations at a depth range of 10-40 metres in the areas 8 - 78/4B, 4C, 5B and 6C. It expended a total effort of 176.40 hrs and landed a total catch of 59849 kg. of fish. Its catch rate was 338.12 kg/hr.

In addition to trawling, one vessel did some purse-seining. Four hauls were made which gave a total catch of 4890 kg of sardines and mackerel. The catch per haul came to 1222.5 kg.

Besides the operations of the mechanised vessels mentioned above, total assessment of the catches obtained from the mechanised vessels working at several other places like Madras; Cuddalore, Azhikode Neendakara, Mandapam Camp and Kakinada was continuously made during the year.

Personnel associated with the project

S. K. Banerji, SFS; T. Tholasilingam, FS; V. Sadasivan, FS;
B. Krishnamoorthi, JFS; M.V. Pai, JFS; M.D.K. Kuthalingam, JFS;
S.J. Rajan, AFS; D.M. Punwani, AFS; Syed Basheeruddin, AFS;
K. Venkatasubba Rao, AFS; M.G. Dayanandan, AFS;
V. Ramamohana Rao, AFSP. Mojumder, AFS; S. K. Dharmaraja,
AFS; SRAs, RAs and other staff.

Researches contemplated

All the projects which were undertaken during 1971, will be continued during 1972. The work on the establishment of a Fishery Data Centre which was initiated during 1971 will be intensified next year.

FISHERY BIOLOGY

Summary of salient findings

During the year, 34 research projects were undertaken by this division and a steady progress was maintained in all the investigations carried out at the various centres. Detailed informations on species-wise catch trends and on biological aspects such as size composition of the catches, age and growth, sex ratio, maturity stages, spawning behaviour, migration and feeding habits were collected on the oil sardine, mackerel and on different species of prawns which constitute the major fisheries of the country. Similar informations on other groups such as the elasmobranchs, Bombay duck, tunas, perches, lesser sardines, anchovies and other miscellaneous fishes were collected at the different centres where their occurrence was of some fishery importance.

Ecological surveys of the pearl oyster and chanks were continued at Tuticorin. Investigations on other molluscs of commercial importance were undertaken at Vizhinjam and Mandapam. Systematic studies on fishes collected from Andaman and Nicobar islands have revealed that nearly 28 species of fishes are new records for the Eastern Indian Ocean.

Researches in hand

MAJOR FISHERIES

Oil sardine

Fishery

i) **Catch:**—As pointed out earlier, there was a general reduction in the landings of the oil sardine all along the coast except at Baikampady (Mangalore) and Cochin areas as compared to 1970. Table 10 gives month-wise landing figures during the year at different centres. It shows not only the temporal/spatial variations in the abundance of fish but some departures noticed from normal trends. While generally the catches were greater during the last quarter, along the Kerala coast landings were more during the first quarter indicating that the take-off from the 1970 fishery continued to be good during the early part of 1971. But the current season's fishery recorded a decline. This trend was further shown by the landings during the second half of the year (Table 11). The reduction was of the order of about 60% at Ullal (Mangalore) and 40% at Calicut. However, it is interesting to note that at both the areas where *Rampani* net was operated that is Karwar and Baikampady (Mangalore) and also at Cochin there was a slight increase in the catches. The current season's fishery was supported by distinctly smaller sized fish as compared to the

last season except at Cochin. From this it seems that there was practically no reduction in their numerical strength of the fish recruited in the populations.

ii) **Effort:**—From the four different gears operated off Karwar, *Rampani* accounted for 90% of the total landings at the rate of 219 kg. per unit. At Baikampady area, the same gear gave 92% of the catch, with a catch of 3373 kg. per unit effort. At Ullal, the gill net *Chalabale* netted 73% of the yield with an average rate of 28 kg. per unit. At Calicut, the *Pattenkolli* (boat seine) almost exclusively exploited the fishery to the extent of 99% realising 421 kg. per unit effort. At Cochin, the only gear operated, *Thanguwala* (boat seine), gave an average catch of 329kg. during the season.

iii) **Forecast:**—The forecast of reduced catch during the 1971 fishery given by the institute has proved right. The same trend is expected for the remainder of the season i.e., during the early part of 1972.

TABLE 10. *Month-wise landings (in tonnes) of the oil-sardine at different centres during 1971 and the total catch for 1970 and 1971*

Month	Karwar	Mangalore		Calicut		Cochin Manassery boats
		Ullal	Baikampady	Vellayil	Carrier boats	
Jan	0.005	9.100	8.333	13.849	23.285	990.379
Feb	0.355	0.536	15.600	863.940	171.907	389.096
Mar	—	12.588	12.000	1013.655	180.537	181.734
Apr	—	19.745	0.107	72.558	30.035	101.215
May	—	4.876	0.300	156.782	24.992	139.789
Jun	—	—	—	496.204	4.440	40.092
Jul	—	—	—	482.534	18.075	39.643
Aug	1.210	0.704	0.553	233.487	8.470	56.290
Sep	0.046	1.411	0.029	181.809	9.960	9.094
Oct	7.313	15.124	220.195	679.566	279.283	241.453
Nov	16.470	1.560	19.240	633.835	102.817	692.982
Dec	29.360	5.250	70.786	635.300	159.252	1757.762
Total						
1971	51.759	70.894	347.143	5463.519	1013.053	4639.529
1970	156.144	149.695	278.649	6767.356	1352.752	2705.430

TABLE 11 *Comparison of landings (in tonnes) in the first and second half-year periods of 1970 and 1971*

Centre	1970		1971	
	I	II	I	II
	Karwar	142.04	14.10	0.36
Mangalore-Ullal	92.61	57.09	46.85	24.04
Mangalore-Baikampady	68.65	210.00	36.34	310.80
Calicut	2125.25	4642.11	2616.99	2846.53
Cochin	589.35	2116.08	1842.31	2797.22

Biology

i) **Size composition:**— The modal sizes in the beginning of the year were at 135, 150 and 180 mm. The former two belonged to 0-year class and the latter, 1+ year class. These three groups appeared to reach 165, 175 and 185 mm respectively by June. These increased further to 170, 180 and 195 mm by the end of this year. Thus a very rapid rate of growth was recorded in the fish which were recruited during the year 1970. By the end of one year, they seem to have attained a length of 165/175 mm. The current year's recruits were characterized by several broods which started appearing from August onwards and supported the fishery during the remaining part of the year. Among these, 3 major groups could be recognized: The first entered the fishery in August and exhibited a modal size of 105/120mm. This group probably reached 145 mm by December. The second group appeared in September at 65/80 mm and progressed to 135 mm by the year end. The third, appeared towards the end of October with a modal size of 65/80 mm and reached 115mm in December. All these juveniles were probably born from June to September. Those born in August and September probably appeared in the fishery in a greater strength than earlier ones. Three unusually large-sized fish measuring 228, 224 and 217 mm respectively were obtained in November at Karwar whereas at other centres the largest size was 104mm. Only twice in the past, specimens belonging to 220 mm group have been recorded, both these were from Calicut. The specimens recorded at Karwar were the largest ever recorded.

ii) **Maturity:**—At Karwar juveniles in stage I and adults in stage IIb were available in January and February. From August to October the stages recorded were IV, VII, IIb. The stage VII a was predominant in August, VIIb in September and IIb in October. Both pre-and post-spawning atresia was found to be heavy, which indicates that spawning was probably impaired in a large number of fish. From the newly recruited juveniles all those that could be sexed during August to December were found to be in Stage I. In the Mangalore area, stage II from January to March, stage V in August, stage VIIa in September/October and stage IIb in November and December were predominant. The juveniles were in stages I-II from September to December. At Calicut, the stages I and IIb were obtained during January-March. In addition to these stages III, IV and V were also recorded during the subsequent three-month period. During July- September stages IV and V were dominant, while in the final quarter the adults were in spent-resting stage. The juveniles were in stage I from October to December. At Cochin, the stage IIb was dominant during the first quarter, stage IV in the second and VIIa during the third, and stages I and IIb in the fourth.

iii) Sex ratio:—At Karwar, the females were predominant among the adults during February, August and September while in October both sexes were found in equal numbers. Among the juveniles the two sexes were represented in equal number during January and February. The females formed a higher percentage in October and November but in December the males were in the majority. The indeterminates constituted 88%, 100%, 80% and 60% in August, September, October and November respectively. At Ullal (Mangalore) females were more numerous in January, November and December; the indeterminates formed 100% during August and October 27% in November and 40% in December. At Baikampady, the percentage of females was greater in March, October and November; the determinates constituted 100%, 60%, 31% and 5% in September, October, November and December respectively. At Calicut the percentage of indeterminates were 19, 20, 8, 39, 92, 59, 80 and 68 in January, February, March, August, September, October, November and December, respectively. From January to June and in December the females outnumbered the males. There were no significant difference between the two sexes at Cochin during the different months. The indeterminates formed 30% and 59% of the catches in August and September respectively.

iv) Scale studies:—Generally one ring was present in the size groups 135 to 155mm, 2 rings in 160 to 180 mm and 3 rings in 180 to 200mm, indicating that the maximum longevity of fish is about 3 years.

Personnel:

B. T. Antony Raja, JFS., V. Balan, JFS., M. H. Dhulkhed, AFS, G. G. Annigeri, SRA, V. S. Rangaswamy, RA., R. Raghu, JSA.

Mackerel

As already stated the mackerel catch for the year was estimated as 1,84,815 tonnes and this is an alltime record. The estimated catches at the centres selected for biological studies are given in Table 12. The mackerel fishery during the first half of the year was much better than that of the second half. Considerable uniformity in the size composition of mackerel in the commercial catches was noticed at different centres during the first half of the year. Only medium sized mackerel and juveniles dominated the catches in the second half of the year. However, at Vizhinjam and Mandapam relatively large sizes were reported. Studies on the maturity stages carried out at different centres of west-coast revealed that the main spawning period was from June to September. Maturing and immature fishes were common in the post-monsoon months. Regional, seasonal and year-wise variations in the food items of mackerel showed that the species fed on both phyto- and zooplankton including larvae of fish and post larvae of shrimps.

Studies on the scales of mackerel carried out at Calicut and other centres showed that the two zones on the scales correspond to the process of growth, maturity and spawning. Narrow zones were noticed in fishes with an advanced stage of maturity. The marginal scales in these fishes were very thin. This thinness probably marked the commencement of ring formation. Studies on the annuli on the scales in fishes measuring from 100 to 259 mm in length showed a good correlation between the length of the fish and the number of annuli. Based on the data collected so far, the indications are that the bulk of the catches along the west-coast of India are composed of specimens which are about 2 years old (200 mm-240mm). The fish seems to attain 110-150 mm to the end of first year.

A comparative study of the biological data collected from Mandapam, Vizhinjam and other centres, north of Vizhinjam, showed that considerable difference exists in some biological aspects of mackerel species occurring along the east-coast and west-coast. In the area near Vizhinjam some intermediate features like the early maturity and spawning and the occurrence of bigger fishes were noticed when the fishing season began.

Personnel:

G. Seshappa, FS., M. V. Pai JFS., V. Balakrishnan, JFS., A. Noble, AFS., V. N. Bande, AFS., and others.

TABLE 12. *Estimated total catch of mackerel at the various centres during 1971*

Month	Karwar	Ullal	Baikampady	Calicut	Cochin	Vizhinjam
January	118.93	21.25	72.50	257.30	167.28	0.87
February	329.15	7.17	1.06	150.41	123.82	3.13
March	827.77	5.14	46.75	224.30	132.53	18.03
April	926.41	9.34	70.37	65.43	209.03	14.54
May	4.20	0.19	0.12	70.63	212.02	21.53
June	—	—	—	28.84	—	—
July	0.09	—	—	6.75	—	18.59
August	—	—	—	7.41	0.09	10.12
September	0.17	0.53	4.63	438.79	12.03	15.29
October	—	4.50	2.35	412.81	85.56	45.15
November	—	0.03	2.60	306.04	189.55	7.07
December	977.29	3.67	—	258.40	63.48	—
Total	3184.01	51.82	200.38	2227.11	1195.39	154.32

Prawns and other crustaceans

Fishery:

The estimated landings of marine crustaceans in India during 1971 amounted to 1,59,560 tonnes which was 13.8% of the total marine fish production. Although the overall crustacean landings of this year showed an increase of 13.6%, diverse trends were observed in the three constituting groups viz., penaeid prawns, non-penaeid prawns and the other crustaceans. The penaeid prawn landings showed a decrease of 13.3% from the previous year, but the non-penaeid prawns and other crustaceans showed a substantial increase.

The decrease in the catches of penaeid prawns during the year was noticed in all the states except Andhra and Gujarat. It was most pronounced in Kerala where the decrease was to the extent of 16.6%. The overall landings of non-penaeid prawns increased substantially, by about 100% during the year. The Maharashtra State contributed largely to this increase. Landings of other crustaceans also showed a significant increase in Tamilnadu, Mysore and Kerala.

Centre-wise assessment of the prawn fishery based on the observations made on the off-shore, inshore and estuarine catches, are given in Table 13. Along the northern sector of the west-coast of India, both the offshore and inshore fisheries were active throughout the year except during the monsoon months. *Parapenaeopsis styliifera* and *Metapenaeus affinis* were the species landed by the mechanised fishing vessels, whereas *Acetes indicus*, *Palaemon tenuipes* and *P. styliiferus* were the dominant species in the inshore catches. In the southern sector, the catches were poor at most of the centres, except for the offshore catches at Malpe and the inshore catches at Mangalore and Calicut. *M. dobsoni*, *P. styliifera*, *M. affinis*, *M. monoceros* and *P. indicus* formed the major portion of the catches. At Cochin, where the mechanised fishery for prawns is best organized, the catches of prawns were generally poor. The failure of the mud-bank prawn fishery in Kerala during this year added to the decline of the prawn catches from the area. Along the south-east coast, the prawn fishery, chiefly supported by *P. semisulcatus*, was exceptionally good.

The estuarine prawn catches at Calicut and Cochin showed a decline, similar to the marine fishery of the other two areas. Juveniles of *M. dobsoni*, *M. monoceros*, *M. affinis*, and *P. semisulcatus* contributed to the fishery. Prawn yield from the paddy fields at Cochin was also poor. Along the east coast, the juvenile prawn fishery at Kakinada (Godavary estuary) was active throughout the year and the catches were good. *M. monoceros*, *M. brevicornis*, and *P. indicus* were the predominant species in the catches.

The attention of the industrialists and the administrators was drawn towards the decline in catches of penaeid prawns in most of the maritime states and particularly in Kerala. The matter has been examined in detail several times and it is found that the reduction of 14% noticed in the overall catches of this category of prawns is within the normal fluctuations associated with this fishery. During the past 20 years, the year to year fluctuations of penaeid prawns were \pm 60—70%. The recruitment of post larvae of penaeid prawns into the inshore and backwater regions of Cochin was also found to be less in 1970 as compared to 1969.

Biology of Important species

Penaeus Indicus

In the fishery (marine) of Mangalore, the dominant size of the species in the first quarter was 131—135 mm for males and 136—145 mm for females; and 141—145 mm and 161—196mm for male and females respectively in the second quarter. Off Alleppey and Quilon, the modal size of the species was at 136—155 mm for males and 141—170 mm for females. Most of the females observed in May and June were in mature condition. In Kanyakumari District, this species formed the mainstay of the fishery. When the fishery commenced in May, the dominant size was at 86—90 mm and as the season progressed, large sized prawns having modal size of 166—170mm formed the major portion of the catch. The distribution of the species in the offshore catches at Madras showed a steady progress from 126—130mm in April to 181—185 mm in September in females. In males 121—125 mm size group was shifted to 161—165 mm during the same period. Towards September the females were found to be in an advance stage of maturity.

In estuarine catches of Calicut and Cochin, this species was well represented. Its mean size varied from 31.4 mm in February to 123.0 mm in September. Peak of recruitment of juveniles into the backwaters was observed in February. In the Pulicat lake, the modal size of *P. indicus* fluctuated between 66—70 mm and 111—115 mm in various months. The largest size group 111—115 mm was observed in January. In the backwater landings at Kakinada, the juveniles of *P. indicus* (40-90mm) were found mainly in June.

Penaeus merguensis

Species formed about 78% of the prawn catches landed by the mechanised vessels at Karwar. The modal sizes of males and females were at 111—150 mm and 106—155 mm respectively. In the estuarine catches the juveniles of this species contributed about 1% of the prawn catches. The principal size range of these juveniles was 86—105 mm.

TABLE 13. Particulars regarding the prawn fishery at different observation centres during the year 1971

	Veraval	Bombay	Karwar	Mangalore	Calicut	Cochin	Colachel	Mandapam	Madras	Kakinada	
Offshore prawn catches in tonnes	584.57	—	21.1	802.0 1326 (Malpe)	1062.3	—	—	356.9	92.7	603.0	
Catch/effort (Kg/hr)	—	—	—	31.6	15.6	—	—	—	—	10.8	
Important species*	6,9	—	6,5,9,2	5,9,1,6,7	5,9,6,1,7	—	—	4	1,4,7,5	5,8,7,6,9,3,1	
Peak fishing season**	1,2,11,12	—	1 to 5, 11,12	4,9,10	1,2,3	—	—	7 to 11	3,4,7,8,9	5,6,8 to 11	
Inshore prawn catch in tonnes	129.4	3222.63	1.2	27.3	295	3.6	4.5	—	—	13.9	
Catch/effort (Kg/hr) per boat unit	—	—	—	28.4	—	—	—	—	—	8.66	
Important species*	10,9,12, 14,15	15,13,9, 6,11,12	2,3,5,9	5	5,1,9	1,5	1	—	—	8,3,10,5	
Peak fishing season**	1,3,10, 11	2 to 6, 9, 10, 11	7,8,9	8,9	—	7,8	5.10	—	—	3,7,8,9	
Estuarine prawn catch in tonnes	—	—	5.0	—	31.6	1116.8+	622.6@	—	—	230.0	415.0
Catch/effort	—	—	—	—	7.24	—	—	—	—	—	19.4 (Drag net only)
Important species*	—	—	7,5,2	—	7,1,5,3	5,7,1,4	—	—	1,7,5	7,1,8,5,3	
Peak fishing season**	—	—	7 to 11	—	4,5,6	4,5,6,10,11	—	—	1,2,4,5,6	5,6,8,9	

*Species numbered: 9: *Parrpenaeopsis stylifera*

1. *Penaeus indicus*

2. *Penaeus merguensis*

3. *Penaeus monodon*

4. *Penaeus semisulcatus*

5. *Metapenaeus dohsoni*

6. *Metapenaeus affinis*

7. *Metapenaeus monoceros*

8. *Metapenaeus brevicornis*

10. *Penaeus sculptilis*

11. *Solenocera indica*

12. *Hippolysmata ensirostris*

13. *Palaemon tenuipes*

14. *Palaemon styliferus*

15. *Acetes indicus*

+ Open estuary

@ Prawn field

**Months of the year:

1. January 7. July

2. February 8. August

3. March 9. September

4. April 10. October

5. May 11. November

6. June 12. December

Penaeus semisulcatus

Biology of this species was mainly studied at Mandapam Camp, where its size ranged from 71-206 mm. Majority of the males were between 111-135 mm long and the females between 116-180 mm. Smaller specimens (91-100 mm.) were generally encountered in September and October, probably indicating their recruitment to the fishery. The distribution of mature females in different months of the year showed that the species spawned actively in February, March, May, July and August.

Metapenaeus dobsoni

At Mangalore, where the species contributed nearly 59.6% of the catch (marine), the modal size increased from 71-75 mm, in January to 101-105 mm, in October in males and from 91-95 mm to 111-115 mm, during the same period, in females. The smaller specimens 66-70 mm entered the fishery in November and December. Wide fluctuations in the sex composition of the catches were noticed. Percentage of mature and gravid females was highest in October. In the trawl fishery of Calicut, the sizes of *M. dobsoni* increased quickly, from 76-80 mm in January to 96-100 mm in April in females and from 66-70 mm to 81-85 mm in males. In the inshore fishery of July and August, larger prawns than those caught by trawl were seen. Spent females were seen from February to April and July to August.

M. dobsoni ranked first in the estuarine catches of Mangalore. The juveniles of this species had a modal size at 21-30 mm during the first half of the year and at 41 - 55 mm during the second half of the year. Appreciable numbers of small sized *M. dobsoni* also occurred throughout the first half of the year indicating their continuous recruitment in the fishery. At Korapuzha, Calicut, the principal mode was at 41-50 mm during the first half of the year and 51-60 mm in October November. Juveniles were abundant from March to August and then the maximum number was in May. In the backwater fishery at Cochin, the size of the species ranged from 50 mm-54 mm during January - April and between 56 - 57 mm during June - October. In May and November it was below 50 mm. Specimens in the smaller size range (18 - 30 mm) were common in January, April, May and October. In the Pulicat lake, juveniles of *M. dobsoni* of the size range 41 - 65 mm appeared in the catches.

Metapenaeus affinis

At Veraval, the size of the species varied between 121 and 140 mm in the first half of the year, while in the second half relatively smaller specimens measuring 76-115 mm dominated the catches. Recruitment of juveniles into the fishery was observed in October. Maturing and mature females were commonly seen during January-April. At Bombay, the size distribution of the species was more or less similar to that at Veraval.

At Mangalore the species occurred in the fishery during March-May with its modal size at 121-125mm for males and 141-145 mm for females. Recruitment of smaller size groups 86-95mm into the fishery commenced from April and reached its peak in May. The catches of *M. affinis* landed at Calicut showed two principal size groups in January, 81-85 mm mode in females and 86-90 mm in males. The larger groups disappeared from the fishery in latter months. Spent females were encountered in March. Off Alleppey and Quilon the species was represented in the catches only in small quantities and their modal sizes were between 111 and 125mm. Observations made on the food and feeding habits of the species at Veraval showed fish scales, crustacean appendages, debris and sand particles in the gut contents.

In the backwater fishery at Cochin the species was caught from January to September. Its size ranged from 33 to 83 mm. Smaller specimens were generally caught in June.

Metapenaeus monoceros

Small quantities of this species were landed from Mangalore and Calicut. Off Quilon, the species was generally fished from May to October and their modal sizes were at 126-135 mm for males and 141-145 mm for females.

In Korapuzha estuary, near Calicut, this species formed 36% of the prawn catches. Its size ranged from 51-120mm. A gradual increase of modal size, from 66-70 mm in January to 21-95 mm in June was noticed. In July, the principal size mode was at 76-80 mm and this shifted to 81-90 mm in November. In the Cochin Backwater, the species occurred throughout the fishing season. The mean size was found to vary between 55 and 88mm. Smaller juveniles (18-43mm) were abundant in January February, July and November. In Pulicat Lake *M. monoceros* was represented in the catches in all the months and their size ranged from 46 to 95mm, the predominant size being at 61- 65 mm. At Kakinada, the species was represented mostly by 40-65 mm. juveniles. Smaller juveniles, 20-30 mm made their appearance in May.

Metapenaeus brevicornis

In the offshore catches of Kakinada the species was the second in importance and dominated the catches in April-June and September-December. The mode of the species was at 90-120 mm for females and 75-85mm for males. Progression of modal sizes was not very pronounced from month to month. In June, spent females were dominant in the catches. The inshore prawn fishery at Dummulupettah was predominated by this species, but here its size was small (65-80 mm males, 75-95mm females). These were generally immature, but in June mature females measuring 100-120 mm were also landed. The species was poor in the backwater catches.

In the first quarter 35-50 mm length group dominated the catches, 21-40 mm in the second quarter and 30-75 mm in the third quarter. Recruitment of juveniles into the fishery started in April and continued till May and June.

Parapenaeopsis stylifera

At Bombay, in the inshore and offshore fishery the species was common in October, November and December. Large sized prawns (81-115 mm females and 66-100 mm males) formed the major portion of the landings. In the offshore catches at Mangalore, the species was second in the order of importance from March to May and November. Size groups measuring 76-115 mm (both sexes) constituted the bulk of the catch although smaller sized shrimps (66-75 mm) entered the fishery as a secondary group in March. Females generally outnumbered the males and mature females were found in the months of March and May.

Parapenaeopsis hardwickii

This species was commercially fished only in Bombay where an estimated total landing of 40 tonnes was recorded. The fishery was maximum in March and the catch was mainly composed of adults of the size groups of 86-115 mm (females) and 51-55 mm (males).

Solenocera indica

This species was mainly fished at Veraval and Bombay. In Bombay the species had two size groups (56-60 mm and 86-90 mm) for both the sexes and the monthly succession of size modes was found to be irregular. The breeding period extended from January to May and after the south-west monsoon (September) the juveniles seemed to enter the fishery.

Acetes indicus

A. indicus accounted for the bulk of the prawn landings from Bombay. It occurred in the commercial catches in all the months of the year with an estimated total quantity of 1674 tonnes. The peak landings was in January, July and November. The predominant size group of the species was 17-28 mm. All maturity stages were well represented in all the months of the year indicating almost continuous breeding throughout the year.

Hippolyasmata ensirostris

In the inshore catches at Veraval the size of the species ranged from 36 mm to 105 mm with the dominant mode at 66-70 mm from January to April. The mode was at 76-80 mm in October. Small quantities of this

species were landed in all the months of the year at Bombay and the catch was mainly composed of prawns of size groups, 31-35mm and 76-80mm. In Versova, berried females dominated the catch throughout the year, while at Sassoon Dock immature shrimps supported the fishery in the first quarter of the year.

Palaeomonetes

An estimated total catch of 738 tonnes of this species was recorded at Bombay and it formed the second most important constituent of the prawn catches there. At Sassoon Dock, the main size mode was at 21mm in January which gradually progressed to 63 mm in October showing a growth of 42 mm in 10 months. The breeding season of the species, as indicated by the distribution of the berried females in the catches lasted from February to September with two peaks, one in March and the other in July/August. In the trawl catches larger specimens (45-72 mm) were recorded.

Macrobrachium rosenbergii

During the last few years, the fishery for this species was a failure in the Pamba river system. However, during this year some indications of its revival were noticed and fair amount of this species was also seen in the local markets and in the shrimp processing plants.

Macrobrachium idella

Complete larval history of *M. idella* has been worked out in the laboratory. Berried females obtained from the Cochin Backwater were brought to the laboratory and kept in aquarium tanks containing brackish water. The species spawned readily in captivity. The eggs were hatched and the zoea larvae thus obtained were reared in the laboratory right through until the juvenile stage was reached. *M. idella*, which is an endemic species in the backwater systems is fished only in small quantities at present. With the perfection of the rearing techniques, it would be possible to farm this species extensively in the backwater areas.

Deep-sea prawns

Exploratory trawling for the deep-sea prawns was conducted only very occasionally during this year. A few hauls taken by the Indo-Norwegian Project vessel 'Tuna' from 180 to 503 metre depth in the first half of the year landed nearly 4 tonnes of deep-sea prawns. The trawling operations were carried out between Quilon and Calicut. The chief constituents of the catches were *Aristeus semidentatus*, *Heterocarpus wood-masoni*, *H. gibbosus* and *Parapandalus spinipes*.

Larval and juvenile stages of prawns

In the inshore plankton samples taken from Cochin a preponderance of eggs and early larval stages of the commercially important penaeid

prawns were seen from October to December. The rate of occurrence of larvae and post larvae of penaeid prawns was about 9.7 larvae per haul as against 10.1 in 1970. The larvae of *M. dobsoni* occurred almost throughout the year while those of *P. indicus*, and *M. monoceros* were seen only during the first half of the year. The larvae of *M. affinis* were absent for most of the year. Protozoa and mysis larvae of *P. stylifera* were found in January, March and November. The plankton collections from the backwaters showed a considerable reduction in the number of post larvae as compared to 1970. The number of post-larvae during the year was 2.06 per haul as against 30.0 in 1970. This reduction was mainly observed in *M. dobsoni*.

In the Korapuzha estuary near Calicut, the post-larvae and early juveniles of *P. indicus*, *M. dobsoni* and *M. monoceros* were very abundant during the first three quarters of the year. From the monthly preponderance of the post-larval and juvenile stages, it would appear that the peak recruitment is taking place from May to August in all these species.

At Madras, post-larval stages of *P. indicus* were found in greater numbers in the inshore plankton during June. Mysis and post-larval stages of *M. dobsoni* were abundant during the period March-June and those of *P. semisulcatus* in April.

Occurrence of post-larval and juvenile prawns in the Godavary estuary was relatively poor in January and February. Early juveniles of *P. indicus*, *M. monoceros* and *M. brevicornis* were found in considerable numbers from March to May.

The occurrence of larval, post-larval and early juvenile stages of penaeid prawns followed the pattern observed during the previous years at all the centres except Cochin. Their occurrence in the inshore waters of Cochin did not show any improvement during this year and their numbers in the backwaters showed a further decline. A higher rate of occurrence of eggs and early nauplii certainly indicate a successful spawning but the reduction in the post-larval stages in the backwaters could possibly indicate a lower rate of survival.

Prawn culture in paddy fields

The estimated catch of prawns from the paddy fields at Vypeen Island was 623 tonnes as against 869 tonnes during the previous year. More than 90% of this catch came from the seasonal fields. Highest yield was recorded in October. *M. dobsoni* (71.5%) *M. monoceros* (12.1%) and *P. indicus* (16.4%) formed the chief components of the catches. Monthly mean size of *M. dobsoni* in these fields was between 59.46 mm and 76.10 mm. and that of *P. indicus* between 118.13 mm. and 136.75 mm. Occasionally large sized *P. monodon* was obtained from these fields in May and June.

Fishery and biology of spiny lobsters .

The fishery for the spiny lobster *Panulirus homarus* was fairly good during this year in Kanyakumari District and the total number of lobsters caught at the three observation centres was 50,552 from January to October. The prominent size range of the species was 191-200 mm. in February and April and 151-160 mm in March. About 24% of the females were to be in berried condition during the period of observation.

During a camp at Muttom which lasted one month in December 1971, attempts were made to obtain the lobster spawn in the laboratory and to rear the larvae through the developmental stages. Selected berried lobsters spawned readily in the aquaria. The spawning took place only in the early hours of the morning. A large number of first stage larvae was obtained by this process. Rearing these larvae to subsequent stages was found to be difficult as they did not take any food. Several experiments were conducted with different food materials but none of them was proved to be successful. Generally the first stage larvae lived only up to 7 days after hatching. During the camp it was possible to obtain the first stage phyllosoma larvae of *P. homarus* and *P. penicellatus* in the aquarium and the second stage phyllosoma larvae from the plankton collections.

Personnel:

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Deep sea lobsters

The fishery for the deep sea lobsters, *Puerulus sewelli* was restricted to the first half of the year. The vessels of I. N. P. and C. I. F. O. together landed 98 tonnes of this lobster. The catch rate was 203.9 kg per trawling hour. The bulk of the catch was restricted to the months February, March and April. Exploratory surveys conducted in May showed potentially rich beds of this species at Chetwai bank. *P. Sewelli* was mainly caught off Quilon and Cochin. Depthwise analysis of the catch showed that the major portion was harvested from 226-250 m depth, though smaller quantities were also obtained from deeper waters from 351 to 375 metres. The size of the lobsters ranged from 96 mm to 207 mm total length with modal size at 161-175 mm for females and 146-160 mm for males. Berried females were common in the catches during February, March and April which appears to be the peak breeding season of the species.

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Commercially important crabs

At Kakinada, 30 tonnes of *Portunus pelagicus* were landed. The total catch was however much lower than that of the previous year. From May to August crabs having carapace width of 130-150 mm dominated the catch and from January to March and from October to December their size range was 140-170 mm. Berried females were seen in the catches throughout the year. Molluscs were the favourite food of this species. The biology of *scylla serrata* was also studied at this centre.

Near Mandapam, peak landings of *P. pelagicus* was observed from March to May and its total annual catch here was about 70 tonnes. Berried females were abundant from April to June. The food of this species consisted of molluscs, fishes and detritus. The biology of both the species *P. pelagicus* and *S. serrata* was also studied at Cochin.

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OTHER FISHERIES

Bombay duck:

Detailed investigations on the biology of *Harpodon nehereus* were carried out for one complete season from 5 centres around Bombay. The season usually commences in October and comes to a close by the end of May in the following year. Biological studies carried out during the year from 5 observation centres indicated the following salient features: At Navabandher, Versova and Dabhol, the average size of the catch varied between 120 and 180 mm in most of the months. At Janjira it varied between 150 and 203 mm and at Dahanu from 137 to 221 mm. The length frequency data collected from all the centres showed that recruitment of exploitable fish in the fishery was a continuous process and no modes could be traced. However, the growth rate determined approximately from size compositions was 8-10 mm per month upto 190 mm length fish. Variations were also noticed in the sex ratio at different places. The main spawning season appeared to extend from November to April.

H. nehereus is a carnivorous and also cannibalistic fish. It feeds on *Acetes indicus*, *Penaeus* spp., *Sciaenids* and *H. nehereus*.

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Lesser sardines

The total catch of lesser sardines was estimated as 63775 tonnes (See Table 2) and this showed an increase of 8555 tonnes over the last year's catch. A good fishing season along the coasts of Tamil Nadu and Kerala was responsible for this. The best area of exploitation was near the tip of the Indian peninsula where the fishery was largely supported by *Sardinella gibbosa*, followed by *S. sirm*, *S. albella*, *S. dayi* and the two species, *S. fimbriata* and *S. clupeioides* formed a negligible portion of the catch. The occurrence of *S. dayi*, at Tuticorin and both *S. dayi* and *S. sirm* at Karwar was an interesting feature. It was generally observed that among the centres selected for biological studies, Vizhinjam provided a more coherent biological picture on different species due to the systematic exploitation with different types of gears. At other centres, only selective fishing was carried out. Data on size composition, sex-ratio, maturity, spawning season, and feeding habits were collected for each species at the different centres. The growth rate of *S. sirm* was observed to be more rapid than those of others. In *S. sirm* and *S. dayi* the spawning season appeared to be short while in *S. gibbosa* the spawning season appeared to be long.

Herklotsichthys punctatus forms a good fishery only at Port Blair. The modal size during the first half year was 100 mm and during the second half, 115 and 125 mm were seen. Males were predominant during the first half and the females during second half. The species spawned during May-June and again during October-November. The minimum size at first maturity was about 120 mm. The average sizes of fishes having 1, 2 and 3 zones on the scales were 113, 122 and 135 mm respectively.

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Anchovies

Biological studies of the different species of anchovies were carried out at Vizhinjam, Waltair and Port Blair. Species-wise catch trends were collected and salient features on the biological aspects are given below.

Stolephorus sp: Investigations carried out at Vizhinjam showed that the size distribution varied from 20 to 94 mm with modal groups at 30 and 85mm supporting the fishery. An average growth rate of about 7.77 mm per month was estimated. Data on maturity stages, spawning period and feeding habits showed similar features as observed during the previous year.

S. bataviensis: At Vizhinjam the size of the fishes in the catches ranged from 40-99 with modal groups 55-75 mm dominating the fishery.

Smaller sizes were seen during March, May and July. An average growth rate of 6.25 mm per month was estimated.

At Waltair, larger modal size groups (65-90 mm) were generally observed except during April when smaller sizes were seen. Generally females were more abundant than the males and the stages of maturity did not give a clear picture on the period of spawning.

S. heterolobus: At Waltair smaller modal sizes (40-50mm) occurred from January to April and larger modal groups (55-60 mm) during the period June-September. Maturing fishes were found from May to September.

Thriissina baelama: This species was studied at Port Blair. Fishery was mainly supported by 110 mm modal size. Smaller fishes fed on zoea and copepods and the adults mainly fed on euphausiids, megalopa, decapod and fish larvae. The fish showed no significant difference in the feeding habit with its maturity of gonads. A positive correlation was found between fecundity, weight of the fish and weight of the ovary.

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Ribbon fishes

At Madras, *Trichiurus lepturus* having modal sizes 100 to 400 mm contributed to the fishery. Maturity stages II to III were very common from June to October.

At Kakinada, the species ranged from 140 to 695 mm with modal sizes varying from 255 to 555 mm. Mature fishes were available from February to July and spent fish from May to December.

At Tuticorin *Eupleurogrammus intermedius* varying in modal size 310-335 mm with maturing stages 1-IV contribute to the fishery during the period January to March.

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Tunas, seer fishes and bill fishes

At Vizhinjam 466 tonnes of tunas were landed mainly from drift net and hook and line operations. *Euthynnus affinis* and *Auxis thazard* mainly supported the fishery forming 61.9% and 36.1% respectively of the catches. Other species occurred as stray catches. There were no tuna landings from June to August.

The size distribution of *E. affinis* in the catch varied from 260-639 mm and modal groups 340 and 380 mm (20 mm groups) formed the main catch from hook and lines.

Recruitment seems to take place twice a year. Females in stage V were recorded during February while the other stages (I-III) were most commonly seen in the other months of the year. Females formed a greater percentage throughout the year. Feeding was observed to be poor during January-April, September and December. Moderate feeding was from March to May. Fishes with gorged stomachs were present only during November. The important items of food were fishes; (*Stolephorus* spp; *Megalaspis Cordyla*, *Carnax malabaricus*, *Nemipterus japonicus*), small quantities of squids, prawns and cuttle fishes.

The sizes of *Auxis thazard* ranged from 260 - 499 mm with modal groups 340 and 380 mm. Smaller sizes were seen during February. Females predominated the catch and advanced stages of maturity were recorded from February to March. The common food of the species consisted of *Loligo*, *Sepia*, *Stolephorus* sp. *Decapterus* sp. and *Leiognathus* sp.

Auxis thynnoides were caught only during February, March and May. Its dominant size was 300, 280 mm in February, 280 mm in March and 400 mm in May. The feeding intensity was generally poor and *Leiognathus* sp, *Sepia* sp. and crustaceans were the common food items.

At Cochin, the tunas were landed from the purse seine operations of the medium boats of the INP. The little tuna, *Euthynnus affinis* was landed during February, March, April and October. Its size ranged from 410 to 600 mm. All stages of maturity from I to IV were present.

At Mandapam Camp, tuna landings were recorded only in the Gulf of Mannar with a total catch amounting to 46.6 tonnes. Of these, *E. affinis*, *A. thazard* and *Thynnus tonggol* formed 58%, 20% and 20% of the catch respectively. Other stray catches were those of *T. albacares*, *Katsuwonus pelamis* and *Sarda orientalis*. Size ranges of *E. affinis* and *A. thazard* were 140 to 797 mm and 98 to 590 mm respectively. Maturing and ripe specimens of these species fed mainly on *Acetes*.

At Minicoy, 464 tonnes of tuna were landed with *K. pelamis* forming the main bulk. The size of the species ranged from 233 to 680 mm with males predominating in the catches. Feeding intensity was observed to vary during the different months.

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Elasmobranchs

Investigations on the fishery and biology of commercially important sharks, rays and skates were undertaken at Bombay, Tuticorin, Mandapam and Chidambaram to find out the regional and species-wise abundance and aspects of biology, which have a bearing on the fishery. During the year, the fishery as a whole and the percentage contribution of each species was studied in detail at the various centres.

Important observations on the biology of various species are as follows:

At Bombay, *Scoliodon sorrakowah* collected from July onwards had 51 cm and 46 cm (6 cm groups) as the most dominant sizes for females and males respectively. The ratio of male to female was 1: 2. Cephalopods especially *Octopus* sp, were found to be the main food. Fishes like sciaenids, *Nemipeterus*, *Platycephalus* sp. crustaceans and squilla were found in the stomach contents. The minimum size at which the fishes bear embryos was observed to be 47 cm. The usual number of embryos borne by a female was 8 with one exceptional case where 14 embryos were observed.

At Tuticorn, *Scoliodon* species commonly known as 'Co-sorrah' was taken up for biological studies. Modal sizes 54, 55 and 58 cm (3 cm groups) were dominant during first, second and third quarter respectively. Females were generally more predominant than the males. Usually one embryo was noticed in each uterus. The sizes of embryos (in standard length) ranged from 40 to 115 mm, 130 to 171 mm and 223 mm and above in the early, intermediate and advanced stages of development respectively.

Among the rays, *Himantura alcockii*, *Amphotistius kuhli* and *Rhinoptera javanica* were taken for biological studies. Occurrence of any single species was not regular throughout the year. The sizes of *H. alcockii* examined, ranged from 203 - 799mm, *A. kuhli* from 147 - 358 mm and *R. javanica* from 709 - 1215 mm (disc lengths). Variations in sex ratio and food items with size were noticed in these species.

At Mandapam, twenty species of sharks were recorded in the catches from the Palk Bay and Gulf of Mannar. *Scoliodon walbheemi*, *S. palasorrah* and *Carcharias limbatus* were selected for biological studies. The peak breeding period was from October to January for all the species. Intra-uterine embryos of all the species were collected for making a comparative study of the development stages.

A preliminary observation on the feeding habits of the deep sea sharks, *Halaelurus hispidus* and *Eridacnis radclaffei* collected from a depth of 230 fathoms off Mandapam was made. It was found that fishes (66%), crustaceans (23%) and cephalopods (11%) formed the major items of its food.

Among the rays, *Cymnura papillura* which landed throughout the year was studied for biological data. The width of disc ranged from 195 to 988 mm. Females were dominant in the catches. The width of foetuses in the females ranged from 40 to 272 mm. The maximum number of foetuses from a single parent was found to be seven.

At Chidambaram, 6 species of sharks, 7 species of rays and 2 species of skates were commonly observed in the catches and the fluctuations in the quality and species composition during different months were studied.

Personnel

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Cat fishes

At Waltair, an estimated catch of 123.3 kg of *Tachysurus thalassinus* were landed during the year from off-shore fishing vessel, M. V. *Champa*. This was the only vessel which carried out exploratory operations during the year along the Andhra and Orissa coasts. The quantity of fish landed was much lower than that of the previous year. But in the inshore landings, cat-fishes amounted to 58,987 kg. The offshore catch were composed of 1 year old fish with a size range 12-42 cm, with 16, 20, 25 and 36 cm modal groups (2 cm groups) dominating in the catches.

At Mandapam, cat-fishes formed nearly 10% of the miscellaneous landings of the area. Of these 10 species, 6 occurred in the catches, *T. thalassinus*, *T. dussumieri* and *T. platysomus* were of greater fisheries importance. These species were caught by trawls, drift nets and purse seines. In September and October heavy landings of *T. dussumieri* were observed in the purse seines hauls. The biology of this species was studied in detail. Different species of *Tachysurus* were collected from Mandapam, Tuticorin, Cochin, Kozhikode and Vizhinjam for taxonomic studies. Biochemical studies on fat and protein contents revealed that fat accumulates in mesenteries of the body cavity and this deposit probably serves a reserve food for males when they carry eggs.

Personnel

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Carangid fishes

At Waltair, 19191 kg of carangid fishes were landed from the

in-shore catches and 187 kg from the off-shore catches. Among the species landed *Chorinemus lysan* formed the dominant catch. *C. malabricus* studied for biological aspects showed that the species grows to a length of about 147 mm. during the first year.

At Vizhinjam 8,47,740 kg. of carangid fishes were landed. Peak catches were during March, September and November. Biological studies were conducted on *Megalaspis cordyla* and *Decapterus dayi*. In *M. cordyla* the size range was 100-455 mm. with mode at 300 mm. The species was observed to feed on *Loligo*, *Lucifer*, pteropods, *Acetes*, Crustacean larvae and *Macrosetella*.

The size of *D. dayi* ranged from 31 to 205 mm. in the catches. Small sized fishes entered the fishery during March, August and October. Fishes in the advanced stages of maturity were seen in March and June. Immature fish were common during November and December. The species was observed to feed mainly on *Leiognathus*, *Stolephorus*, crustacean larvae, *Acetes* and also on *Macrosetella*, *Squilla* and *Loligo*.

Personnel

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Flat fishes

The biology of the flat fish, *Cynoglossus macrostomus* was studied at Calicut and Mangalore. The total catches of flat fish at all these centres were greater during the first half of the year than during the second half. Larger sized fishes were seen in the Mangalore area as compared to Calicut area. Poor numbers of 1 year old fish in the landings at Calicut during the fishing season was a special feature observed during the year. In all the centres, immature and maturing fishes were common in the catches except at Calicut, where spent fishes were observed during the beginning and at the end of the year.

Food of these species studied at Mangalore was found to be fish remains, copepods, polychaetes, some diatoms and large quantities of mud. The biology of *C. dubius*, *C. bilineatus* and other soles were also studied at Calicut.

Personnel

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Sciaenids

Studies on the biology and fishery of commercially important sciaenids were continued during the year, at three centres on the west and three centres on the east coasts of India. At Veraval, two species namely *Otolithes ruber* and *Johnius dussumieri*, at Bombay, *Pseudosciaena diacanthus*, *J. dussumieri* and *Otolithoides brunneus* and at Kozhikode, 4 species *P. sina*, *P. axillaris*, *O. ruber* and *J. dussumieri* were investigated. On the east coast, *P. anetus* was studied at Mandapam, *P. anetus* and *P. vogleri* at Madras and *P. anetus* and *J. carutta* at Waltair. The salient features on their biology are as follows:

P. diacanthus

The length frequency study during the period showed two size groups one ranging from 20 to 30 cm and the other from 90 to 112 cm. The stomach contents showed preferential feeding for prawns and fishes. Juveniles were recorded during the last quarter. Scales and otoliths were examined for age studies.

P. sina: Studies at Callicut showed that there was a small difference in the size range between fishes collected from the departmental 'paithu vala' operated in inshore waters and those operated by the mechanised vessels slightly offshore. In the former, the range was 30 to 169 mm while in the latter it was 50 to 189 mm. Specimens with almost all stages of maturity occurred throughout the year. From November to February, gravid specimens and some with spent gonads were seen. Juvenile fishes were also recorded during this period. Fish and prawns constituted the food of the adults while copepods, amphipods and mysids formed the food of juveniles.

P. vogleri

Work done at Madras showed a prominent modal range from 141 to 160 mm. Specimens with advanced stage of maturity were recorded in July. Deeper waters from January to June, while spent individuals were seen in the inshore collection during the same period. Food items included fish and prawns.

P. anetus

The biology of this species was studied at three centres on the east coast. Fishes with a size range 87 mm to 228 mm were recorded. From July to August, the dominant group was from 87 to 96 mm. The breeding season was found to be from February to March both at Mandapam and Madras, but further north at Visakhapatnam during the same

period, only stages II and IV were recorded. The fecundity of the fish ranged from 29293 to 42720 eggs. Food analysis of various size groups during different months showed that this species prefers fish and prawns. A change in the species of fish eaten was seen from time to time, which was perhaps due to the change in their availability during the various months.

P. axillaris

Length of fish studied varied from 90 to 140 mm. Mature specimens occurred during April and May. Food items comprised of prawns and fishes.

J. dussumieri

Specimens examined at Veraval and Calicut had a length range 21 mm- 212 mm. Stage IV maturity was recorded at Veraval during the first quarter, whereas at Calicut specimens in advanced stages of maturity were recorded during November and December. Food items included prawns, amphipods and molluscs.

J. carutta

Specimens with a size range 86-200 mm were studied. Small size group (86 mm) was obtained in July. Mature specimens were not recorded throughout the year. The food items included *Squilla* sp. and *Neptunus* sp.

Otolithes ruber

The size range from the inshore collections was 30 to 219 mm, while the size range in the offshore collections was 60-289 mm. Specimens in advanced stage of maturity and in spent condition were mostly observed, from May to September. During the first and last quarter, stages II to IV were recorded. The food item of adults consisted of fish, prawns, mysids and decapods. Juveniles had mysids, mysid stages of decapods and copepods in their stomachs.

Otolithoides brunneus

The inshore fishery was supported by juveniles ranging from 90 to 150 mm. The maximum size recorded was 1500 mm. Juveniles were found to enter the creeks during the months of June to August. Females dominated the catch and mature specimens were rarely found in the catch. The fish is a carnivore feeding on fish and prawns. Scale studies were conducted to determine age.

Other studies

Taxonomy and osteological studies on the commercially important sciaenids have been undertaken at Mandapam to find out the variations within the stock of the same locality and the stock of different localities, including some specimens received from Hong Kong.

Personnel

T. Tholasilingam, FS; V. Sadasivan, FS; S. J. Rajan, AFS;
T. Appa Rao, SRA; R. S. Lal Mohan, SRA; P. Devadas, RA;
K. V. S. Nair, RA and K. Prabhakaran Nair, RA.

Silver bellies and related species

The biology of silver bellies and silver biddies were studied at Waltair, Madras and Mandapam. The all India total catch for silver bellies showed a decline over that of the previous year.

At Waltair, the landings of silver bellies were moderate and the dominant species was *Leiognathus bindus*. Studies on growth rate of these species showed that by the end of first year the fish probably attains 90 to 100 mm. A protracted spawning season extending from October to March was observed.

At Madras, fairly good catches of silver bellies ^{were} recorded from the mechanised boat landings. *L. dussumieri* and *Gazza miniata* were the dominant species. The biology of *Secutor insidiator* was studied at this Centre. Copepods and nereid worms were observed as favourite food items. Two spawning periods were observed during the year.

At Mandapam, silver bellies and silver biddies together contributed to about 44 - 55 % of the total catches on the Gulf of Mannar Side and 50 - 95% on the Palk Bay side. *L. dussumieri* was the most dominant species on the Gulf of Mannar side whereas in the Palk Bay catches, *L. jonesi* predominated. The biology of *Gerres filamentosus* was studied from samples collected from Rameswaram. The species seemed to grow to a length of 135 mm in the first 16 months. Preponderance of males was noticed during the different months. Spawning seasons was found to be from October to April

Personnel

G. Venkataraman, JFS; K. Venkatasubba Rao, AFS;
J. C. Gnanamuthu, SRA.

Perches and perch like fishes

The biology of 'Karkara' (*Pomadouris hasta*) was studied at Bombay. This species occurs throughout the year with a peak fishing season extending from October to March. The size of frequency polygon during the year showed some progression of modes from January to June. A fresh recruitment occurred from July to September. The spawning season was found to last from September to November. The size at first maturity was 35 cm. The examination of otoliths indicated that the fish attains the lengths of 18, 25-36, 42, 52 and 57 cm at the end of 1, 2, 3, 4, and 5 years respectively. The food of the species normally consists of crabs, prawns, teleostean fishes and occasionally *Squilla*, gastropods, polychaets, echinoderms, cephalopods and young eels.

The perch, *Nemipterus japonicus*, contributed 1.4% in the total catch of the vessel, M. V. *Champa*. The vessel carried out exploratory fishing only in a restricted area. From the data collected on the biology of the species for the period 4 years (1964-67) an account on the growth, reproduction and feeding habits was completed.

Personnel

B. Krishnamoorthi, JFS; K. Alagarwami, JFS;
P. T. Meenakshi Sundaram, AFS; C. R. Shunmuga Velu, AFS;
M. G. Dayanathan, AFS; P. Namallwar, RA.

Polynemid fishes

Histological studies on the gonads of *Polydactylus indicus* showed the possibility of this species remaining hermaphrodite throughout its life. The activities of the male and female sex elements appear to alternate. Based on the studies of scales, the size of fish at different age groups was calculated. The fish seems to attain 34.5 and 119.9 at the end of 1st and 9th years respectively.

Personnel

P. V. Kagwade, JFS; K. Dorairaj, SRA.

Pomfrets

At Veraval, *Pampus argenteus* formed a good fishery from February to April. The catches were however, low during January, October and November. The most dominant size group was from 291-300 mm. The percentage of females was found to be greater.

Personnel

Kuber Vidyasagar, SRA.

MOLLUSCAN FISHERIES

Chank and pearl oysters

At Tuticorin, the biology of the chank and the pearl oyster was studied by making use of SCUBA diving apparatus. The area investigated was Zone I and II and included the stations, IA, IIA, IB and IIB. A number of underwater photographs were also taken in the areas of investigation. In the rocky areas, fairly good quantities of pearl oysters of the size range 35-50 mm were seen. Depending on the survival of these oysters during the next two years, a good pearl fishery is the forecast for 1974. The inshore port bay was found unsuitable for the population of chanks and oysters. The fauna and flora of this area was studied periodically by making diving operations.

Personnel

K. Nagappan Nayar, JFS; S. Mahadevan, AFS.

Ecology of the edible oyster

The ecology and biology of the edible oyster, *Crassostrea madrasensis* was studied at Mandapam. Oysters of size range 64.8 mm. to 254.8 mm were available in the samples. Continuous study on ground conditions showed that this oyster spawns during summer months. The lipid contents of maturing female oysters varied between 18.8 % and 26.2% dry weight and that of indeterminate oysters between 9.2 % and 50% dry weight.

Personnel

K. Satyanarayana Rao, AFS.

Green and brown mussels

In an area of about 20,000 sq. metre near Vizhinjam the total landings of these two mussels was estimated as 73.317 tonnes. These mussels are caught by diving in all the months of the year except June and July. The size of the mussels landed during the year ranged from 35-110 mm with modal sizes 50-71 mm. Advanced stages of maturity were commonly seen from August to December. Studies were carried out on settlement and growth of these mussels.

Personnel

G. P. Kumarasamy Achari, SRA.

MISCELLANEOUS INVESTIGATIONS

Ichthyofaunal investigations

From the Andaman area, about 340 species of fishes collected earlier were identified. Of these, 134 belonged to the families, *Apogonidae*,

Labridae, Pomacentridae, Callydontidae, Acanthuridae, Blennidae, and Gobiidae. A descriptive catalogue of the fishes is being prepared. Among the fishes, nearly 28 species were found to be new records for the eastern Indian Ocean.

For a systematic study of the fishes belonging to the family Carangidae, samples were collected around Mandapam and 29 species were identified and these belonged to 9 genera. *Carangoides compressus, Caranx stellatus* and *C. lugubris* were not previously recorded from the mainland of India.

Personnel

M. Kumaran, Curator.

Marine and estuarine fish farming

The possibilities of salt water farming of cultivable species of fishes prawns and clams were studied and some preliminary work was carried out during the year. At Narakkal, detailed plans for field experiments in two ponds and the establishment of an experimental laboratory at the site were completed. Mullet fingerlings were collected and the suitability of keeping them in captivity was studied. The growth of the fingerlings in laboratory conditions was also studied.

Personnel

K. C. George, AFS; M. S. Rajagopalan, AFS.

MARINE BIOLOGY AND OCEANOGRAPHY

Summary of salient findings

An all round progress was maintained at the headquarters and outstations in all the 23 research projects undertaken by this Division during the year 1971. Among these there are eight new projects.

Investigations carried out at Cochin on phytoplankton productivity revealed that the organic production rates off Cochin and Alleppey during the year were high. At these stations, the concentration of pigments, especially the chlorophylls, were also estimated. A series of experiments were conducted in the laboratory on cultures of unicellular algae to study the influence of isolated environmental factors on their rates of photosynthesis. Qualitative and quantitative studies on the phytoplankton were continued at Cochin and at Calicut.

The projects dealing with zooplankton have been reoriented to give a greater emphasis on ecological aspects such as the role of

Labridae, *Pomacentridae*, *Callydontidae*, *Acanthuridae*, *Blennidae*, and *Gobiidae*. A descriptive catalogue of the fishes is being prepared. Among the fishes, nearly 28 species were found to be new records for the eastern Indian Ocean.

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Personnel

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The projects dealing with zooplankton have been reoriented to give a greater emphasis on ecological aspects such as the role of

zooplankton groups in the marine food chains. The characteristics of zooplankton occurring in the inshore fishing areas were studied from different centres such as Bombay, Mangalore, Calicut, Madras and Port Blair. At Cochin, the materials collected from the cruises of R. V. *Varuna* was examined, sorted out and studied in detail for the different taxonomic and biological features. Some of the important groups in the zooplankton were copepods, euphausiids, chaetognaths, siphonophores and pelagic tunicates.

At Mandapam, a detailed survey of the seaweed resources of the Tamil Nadu coast was undertaken. Laboratory experiments were also conducted on the spore production of some economically important species of seaweeds.

At Cochin, detailed studies on the fecundity, maturity, and spawning habits of some important pelagic and bathypelagic fishes were continued.

The analysis and processing of the Oceanographic data on temperature, salinity, oxygen and nutrients were continued to develop an understanding on the phenomena of upwelling, sinking, convergence and divergence, occurring along the west coast of India and in the Laccadive sea.

Researches in hand

A. Studies on Phytoplankton Productivity

Primary production measurements were made using C^{14} techniques at fifteen stations during two cruises of R. V. *Varuna*, one in May and the other in July, 1971. The surface waters showed a moderate rate of Carbon uptake, $10 \text{ mg/C/m}^3/\text{hr.}$ in simulated experiments during May. In July, during the peak monsoon, very high production rates ranging from $10-70 \text{ mg C/m}^3/\text{hr.}$ were recorded off Alleppey in the area where mud bank formation takes place annually. This confirms the earlier observations that high production occurs during the monsoon season along the south-west coast of India.

Water samples collected at fortnightly intervals from different depths at five stations of the mud bank area (off Alleppey) were incubated under fluorescent light and the production rates were found to vary considerably from station to station even on the same day.

Standing crop of phytoplankton by pigment analysis

During the cruises of R. V. *Varuna* in May and July, 1971, pigment studies were made at twelve stations along the south-west coast. The concentration of chlorophyll varied from 8.42 to 22 mg/m^3 .

Based on 24 samples from the Cochin Backwater and 54 samples from the mud bank area off Alleppey, the average value of chlorophyll *a* in the Cochin Backwater was found to vary from 2.54 mg / m³ in the month August to 16.32 mg / m³ during November. For the mud bank, the average value was 26.0 mg chlorophyll *a*/m³.

Culture of phytoplankton organisms

Unialgal cultures of *Oscillatoria claricentrosa*, *Tetraselmis gracilis*, *Chlorella marina*, *Pleurosigma directum*, *Synechocystis salina* and *Dicrateria* spp. were maintained. A series of experiments were conducted on the chlorophyll concentration, oxygen production, oxygen consumption and C¹⁴ uptake of different organisms. Another experiment showed that copper ions has no toxic influence on the rate of photosynthesis of some organisms.

Productivity of microbenthos

Forty samples collected from the mud bank area off Alleppey were incubated with C¹⁴ to determine the productivity of microbenthos. Organic production varied from < 1 mgO/hr to > 200 mgO/hr. Benthic flora was composed of a few littoral diatoms, such as *Melosira sulcata*, *Pleurosigma normanii*, *Nitzschia longissima*, *Thalassiosira subtilis*, *Biddulphia mobiliensis* and different species of *Coscinodiscus* and *Ceratium furca*.

Phytoplankton of the inshore waters

Mangalore

Phytoplankton studies from Ullal showed that among the dinoflagellates only *Ceratium* and *Peridinium* spp. were present in small numbers. *Fragilaria oceanica*, *Nitzschia* spp. *Biddulphia* sp. and *Coscinodiscus* spp. were the most common diatoms. The blue green alga *Trichodesmium* was seen in very small numbers.

Calicut

The standing crop of the inshore phytoplankton off Calicut based on displacement volumes was found to be high during January, April and May and low during February and March. The total cell counts and dry weight estimation showed a similar trend.

The organisms commonly occurring during the year were: *Skeletonema costatum*, *Biddulphia sinensis*, *Fragilaria oceanica*, *Guinardia flaccida*, *Chaetoceros lorenzianus*, *Nitzschia seriata* and *Trichodesmium thiebautii*.

Cochin

Total cell counts were made from the samples collected in the inshore and backwaters of Cochin. Further cell counts were made from 1 litre of water collected from the stations in the inshore and backwaters. In the first quarter, Dinophyceae (mainly *Ceratium* and *Peridinium* spp.) were abundant in the inshore and backwaters of Cochin while Diatomaceae was dominant in April and May, when *Coscinodiscus* sp. and *Skeletonema costatum* were present in large numbers. Blooms of *Ceratulina bergeni* were observed during December.

Phytoplankton from the offshore and oceanic waters

Seventyfive samples collected during the earlier cruises of R. V. Varuna (V29 to V40) were examined. The dinoflagellates were found to be less in numbers than the diatoms. Common organisms present in the samples were *Thalassiosira subtilis*, *Coscinodiscus gigas* var. *paetexta*, *C. excentricus*, *C. centralis*, *Fragilaria oceanica*, *Rhizosolenia alata*, *R. styliformis*, *R. robusta*, and *R. calcarea-vis*. In addition to these, a few diatoms namely, *Coscinodiscus reniformis*, *Hemidiscus cuneiformis*, *Asterolampra marylandica*, *Asteromphalus heptactis*, *Lauderia borealis*, *Stephanophysis nipponica*, *Chaetoceros pendulum*, *Thalassiothrix mediterranea*, *Pseudocunotia doliolus*, *Actinocyclus ralfsii*, and *Streptothecha thomasis*, were also recorded as new or rare forms from these waters.

Personnel associated with the projects

P. V. Ramachandran Nair, JFS; N. S. Radhakrishnan, AFS;
V. S. K. Chennubhotla, AFS; C. P. Gopinathan, SRA;
K. J. Joseph, RA and others.

ZOOPLANKTON INVESTIGATIONS

Zooplankton biomass and the role of major zooplankton components in the marine food chain

The following observations were made at various centres during the year.

Bombay

Zooplankton samples obtained from the lighthouse area and Versova Creek showed that copepods, lucifers, chaetognaths and decapod larvae were abundant during the first quarter (January to March).

Marked differences in the occurrence of hydromedusae and pteropods were observed during the year.

Mangalore

The average zooplankton biomass was found to be poor except during October to December when the volume was fairly high. Copepods were fewer in numbers except in November. Among the cladocerans, *Eubina tergestina* was extremely rare during January-May, but occurred in good numbers during the months of October, November and December. *Penilia avirostris* was totally absent during the first half of the year and was present in small numbers during October and November.

Calicut

The estimated range and the mean values of the zooplankton biomass along the inshore waters of Calicut for the year 1971 was follows :

	Range	Mean
Displacement volume (ml)	2.8-74.4	17.0
Dry weight in (mg)	300-8400	2030
Count (X1000)	66- 418	151

The zooplankton biomass during the year was generally poor as compared to the previous year. However, two peaks were observed in the standing crops one in April and the other in November when the total volumes became as high as 27.5 ml and 31.8 ml respectively. But these peaks were of a very short duration. The major constituents of zooplankton such as copepods, cladocerans, *Lucifer* and fish eggs and larvae were also poor.

Cochin

From the samples collected during the cruises of R. V. *Varuna* studies were made on the biology of the following important groups :

Pelagic Copepods

a) Calanoida

Fifty two samples collected during the year from the inshore and backwaters of Cochin were analysed for the seasonal variation in the abundance of Calanoid copepods. The influence of salinity and temperature on the seasonal occurrence and abundance of larval and adult copepods in the inshore and backwater areas of Cochin were also studied. Quantitative distribution of *Candacia* copepods were

studied from 77 samples, collected from the neritic and oceanic waters of the Arabian Sea. The abundance of calanoid copepods varied during the different seasons in the coastal and oceanic waters. The different water masses seem to have their own characteristic species. The post-naupliar developmental stages of *Labidocera pectinata*, *Candacia pachydactyla*, *Temora turbinata* and *Euchaeta marina* were also studied.

b) Cyclopoids

Taxonomic studies of the species belonging to the genera *Copilia*, *Corycaeus*, *Farranula*, *Oncaea*, *Oithona*, *Lubbockia* and *Vetoria* were carried out and 5 species of *Farranula*, 5 species of *Oncaea*, 3 species of *Oithona* and one species each of *Lubbockia* and *Vetoria* were identified. Of these, *V. longifurca* was a new distributional record from the Indian Ocean.

Plankton samples and hydrographic data were collected regularly from the Cochin Backwater to study the distribution and biology of the dominant species of cyclopoid copepods. Eight species of *Oithona*, 4 species of *Oncaea*, 7 species of *Corycaeus* and one species of *Farranula* were identified from these collections.

Euphausiids

Forty six zooplankton samples collected during the earlier cruises of R. V. *Varuna* from the continental shelf waters, between Calicut and Karwar, were examined for the distribution and seasonal variation of euphausiids. The larval euphausiids were abundant during the pre-monsoon period. The common species were *Thysanopoda tricuspida*, *T. monacantha*, *Euphausia diomedea*, *E. tenera*, *Pseudeuphausia latifrons*, *Nematoscelis gracilis* and *Stylocheiron carinatum*. During the monsoon period, *E. distinguenda* and *S. affinis* were abundant.

Further studies to complete the post-naupliar stages in the life history of *E. tenera*, *P. latifrons*, *Stylocheiron carinatum*, and *S. affinis* were also carried out during the year.

Chaetognaths

Seventy five zooplankton samples collected earlier between Calicut and Karwar during the R. V. *Varuna* cruises were examined for the quantitative fluctuation and abundance of chaetognaths. Fourteen species belonging to 3 genera (*Sagitta*, *Pterosagitta* and *Krohnitta*) were identified from the collections. The dominant species were *S. inflata* (53%) and *S. bedoti* (24%). One interesting finding was the presence of the mesoplanktonic species *S. decipiens* only in the samples collected during the months of October and December. This species formed 16% of the chaetognaths in October and 2% in December. It was completely absent in the other samples.

Pelagic tunicates

Sixty nine zooplankton samples were examined for the taxonomy, biology and distribution of pelagic tunicates. *Salpa cylindrica*, *Thalia democratica* were common both in the oceanic and coastal waters, whereas *Cyclosalpa pinnata* was found only in coastal waters. Among the doliolids, *Doliioletta gegenbauri* was found in large numbers and *Doliolum denticularum* occurred sporadically.

Gut contents of *Salpa fusiformis*, *S. cylindrica*, *Pegea confederata*, *Thalia democratica* and *Doliioletta gegenbauri* were also analysed. Microfauna and flora formed about 60-70% and detritus 30-40% of the food content.

Ostracods

Four hundred and seventy seven plankton samples from R. V. *Varuna* cruises were examined for ostracods and from these forty four species were identified. Some of the species were those which have not been previously recorded from the Indian waters. Regular collections and examinations of ostracod material from the Cochin Backwaters have brought to light at least 5 species belonging to the families Cytherididae and Trachyleberididae.

Siphonophores

Sixty eight zooplankton samples of R. V. *Varuna* were analysed for the taxonomy and seasonal abundance of siphonophores. Some rare and interesting structures like complete form, eudoxid stages and posterior nectophores of certain species were identified.

Madras

Monthly mean displacement volumes of plankton were high during January and April. Swarming of the following zooplankters was observed:

Zooplankton	Period
<i>Thalia democratica</i> and <i>Doliolum</i> sp.	January, April and May
<i>Pleurobrachia</i> sp.	April and September
<i>Lucifer</i> sp.	March, April and May
<i>Evadne</i> sp. and <i>Penilia</i> sp.	April, May and August
<i>Sagitta</i> spp.	August
Siphonophores	August
<i>Bougainvillia</i> spp.	February

Personnel associated with the project:

E. G. Silas, SFS; K. N. Krishna Kartha, AFS; N. S. Radhakrishnan, AFS; K. G. Girijavallabhan, SRA; P. Dhandapani, SRA; P. Parameswaran Pillai, SRA; R. Marichamy, SRA; K. J. Mathew, SRA; M. Srinivasan, RA; M. M. Meiyappan, RA; D. C. V. Easterson, RA; K. Rengarajan, RA; C. M. James and P. K. M. Thompson, Research Scholars.

MISCELLANEOUS INVESTIGATIONS

Laboratory culture of important seaweeds

Experiments were conducted on the tetrasporic and cystocarpic plants of *Gracilaria corticata* to estimate the tetraspore and carpospore production in this agar-yielding red algae and also to study the factors influencing the liberation of spores. The effect of exposure to air on the spore liberation and the diurnal and monthly changes in the spore liberation were also studied. Maximum spore output was seen when the tetrasporic fronds and cystocarpus were submerged under water throughout the period of experiment (24 hrs). With one hour exposure to air, tetraspore output decreased considerably and the carpospores were not liberated. Spore liberation was maximum during the night.

Maximum spore liberation occurred in February, March and April and again in November and December. Large number of spores were liberated from the terminal part of the thalli.

Seaweed resources of the Tamil Nadu

To study the seaweed resources of the Tamil Nadu Coast, 16 stations were fixed in the Palk Bay from Rameswaram to Athankarai, 16 stations in the Gulf of Mannar, from Thonithurai to Kilakarai and 18 stations all round the 10 small coral islands from Shingle to Appa. The algal samples from all these stations collected at different depths were sorted out and weighed to determine the species-wise biomass data. Some hydrological data from these stations were also collected.

Two surveys were conducted in the Palk Bay and one in the Gulf of Mannar. The composition and density of the algal biomass varied from one station to another. In 15 out of the 34 stations surveyed in the Gulf of Mannar, the algal biomass was found to be less than 1000 grams.

Plankton samples and hydrological data were also collected from these stations for correlating these with the seaweed biomass.

Personnel associated with the project:

M. Umamaheswara Rao, AFS; P. S. Kuriakose, RA; N. Kaliaperumal, RA and others.

Ecology of pelagic and bathypelagic fishes

Investigations on the biology of *Chascanopsetta lugubris* were continued. Their total length ranged between 133 to 324 mm, and weight between 4.6 to 176.0 grams. Males were more abundant (58%) than the females (42%). The number of the teeth increased with the size of the

fish and ranged between 143 and 217 (in both jaws). About 150 specimens were examined for the gut contents and it was found that *C. lugubris* mainly feeds on *Parapandalus spinipes*, *Chlorophthalmus agassizi*, *Clupeisoma* sp. and myctophids. Fecundity studies on 21 mature ovaries indicated an average number of 238488 ova per ovary. Immature specimens and adults were found to be in equal numbers in March and September. Mature specimens were abundant in the Quilon Bank.

More than 200 specimens of *Emmelichthys nitidus* were collected and examined for biological studies. The size of the material ranged between 161 to 255 mm and weight from 40 to 167 gms. Fecundity varied between 13600 to 32000 eggs. About 185 specimens of *Epinnula* sp. were examined for biological studies. Its size ranged from 103 to 220 mm. Sex ratio of females to males was 2:1 and the males were found to be in an advanced stage of maturity.

Morphometric measurements and meristic counts were taken from 206 specimens of *Bembrops caudimacula* varying from 87 to 221 mm in total length. The fecundity was found to vary from 7590 to 72004 eggs. (mean = 19664). An analysis of the stomach contents of 206 specimens revealed that shrimps namely, *Plesionika ensis*, *P. martia*, *Heterocarpus woodmasoni*, *Hymenopenaeus aequalis*, *Penaeopsis rectacuta*, and *Parapenaeus investigatoris*, were the chief constituents of the food.

Personnel associated with the project

E. G. Silas, SFS; M. S. Rajagopalan, AFS; V. Kunjukrishna Pillai, SRA; G.S.D. Selvaraj, RA; A. Regunathan, RA and M. Rajagopalan, RA.

Mud banks of the Kerala coast

Eleven collection trips were made during the year to the mud bank area south of Alleppey. Plankton and hydrographic data were collected from the surface and bottom at fixed stations. The temperature varied from 25.0 to 28.0°C, salinity from 28.9 to 34.37‰ and dissolved oxygen from 1.7 to 3.7 ml/l. Phosphate, silicate, nitrite and nitrate values were 3.3, 57.0, 1.28 and 18.6 µg-at/l respectively. These concentrations were found from June to late October. Thereafter, the temperature varied from 29.5° to 30.1°C, salinity from 34.4 to 35.6‰, oxygen from 4.3 to 3.1 ml/l, phosphate from 0.7 to 1.25 µg-at/l, nitrite from 0.01 to 0.06 µg-at/l, nitrate from 0.36 to 1.80 µg-at/l and silicate from 11.5 to 19.5 µg-at/l.

The nutrient content during the south-west monsoon was high. The dinoflagellate, *Noctiluca miliaris* which is well known to have an adverse effect on the fishery was dominant during the south-west monsoon. In August a high abundance of *Fragilaria oceanica* Cleve, was seen. In October–November Diatomaceae formed the dominant components

of phytoplankton, while in December, Dinophyceae were the major elements, especially the species of *Ceratium*, *Peridinium* and *Dinophysis*. From the middle of August to December, the zooplankton biomass was very poor. Swarms of cladocerans and *Pleurobrachia* were observed in the mud bank area on 10-8-1971 and large numbers of pleurobrachians were found washed ashore. Mud samples contained a high percentage of foraminiferan shells. The fishery in the mud bank area was very poor.

Personnel associated with the project:

A. V. S. Murty, FS; D. S. Rao, AFS; C. P. Gopinathan, SRA; K. J. Mathew, SRA; C. K. Gopinathan, SRA and A. Regunathan, RA.

Environmental studies of the Vembanad Lake

Monthly cruises were conducted between Alleppey and Azhikode and hydrographic data were collected from 28 stations and plankton samples were collected from 8 stations. C^{14} assimilation and plant pigments were measured at those stations from where plankton samples were also collected. Temperature and salinity values were found to be high in March and April and low in July and August. Nutrients were high in June and low in August.

Sixty seven plankton samples (phytoplankton and zooplankton) were collected and analysed. In June, July and August, freshwater organisms such as *Pediastrum*, a few volvocales and *Scenedesmus* were abundant. The values of chlorophyll *a* varied from 1.15mg/m³ to 35.22mg/m³. High values of chlorophyll and primary production had no correlation with forms (nanoplankton). Zooplankton volumes were very high in February and low in July. The zooplankton was mainly composed of decapod larvae and copepods. In February, March and April, hydromedusae were common. Prawn samples included *Penaeus indicus*, *M. dobsoni* and *M. monoceros*. Dense patches of *Salvinia* sp. covered the lake from October to December causing considerable obstruction to fish migration and net operations.

Personnel associated with the project:

V. Kunjukrishna Pillai, SRA; K. V. George, RA; K. J. Joseph, RA and Pon. Siraimetan, RA.

Studies on marine pollution

Marine pollution is becoming more and more deleterious to our coastal fishery resources. The Institute's investigations on pollution were primarily concerned with substances introduced by man into the environment, which have an adverse effect on living resources.

During the year, investigations were made on the biochemical oxygen demand (B. O. D), oil pollution, and quantitative abundance of microflora. Samples were collected from 2 stations in the Cochin Backwater. The five day B. O. D. at the two stations in the Cochin Backwater was found to be 0.72 ppm, and 0.99 ppm. The analysis was carried out till 8 and 9 days and the B. O. D. on these days was found to be 1.45 ppm and 2.39 ppm respectively. The situation needs monitoring, for, with the lesser dilution of sewage and other effluents during the summer months, the condition may change.

Oil pollution was measured on two occasions in the samples collected from the surface at two stations. At one station, a value of $13.5 \mu\text{g/l}$ was obtained while at the other station a very high value of $64.6 \mu\text{g/l}$, was recorded which was probably due to the discharge of heavy duty oils from the boats in the vicinity.

The quantitative abundance of microflora, as determined by agar-plating technique, was of the order of 2×10^{16} and 1.8×10^5 per ml at one station and 1×10^8 and 4.5×10^5 per ml at the other station. The second station also showed coliform bacteria amounting to 2.0×10^5 per ml, indicating possible faecal contamination.

Personnel associated with the above project:

S. Z. Qasim, Director; P. V. Ramachandran Nair, JFS; M. S. Rajagopalan, AFS; C. K. Gopinathan, SRA; V. Chandrika, RA; and C. Thankappan Pillai, LFA.

Energy flow in some selected ecosystems

To determine the ecological efficiency at different trophic levels, two ecosystems were selected: (1) inshore waters off Cochin and (2) a paddy-cum-prawn field.

In the inshore environment, temperature, salinity, dissolved oxygen, phosphate-P, nitrate-N and Silicate-Si, C^{14} uptake, chlorophyll and phaeopigments were measured to determine the seasonal variations in primary production and the factors influencing the rate of primary production. Vertical hauls of zooplankton were made to estimate the biomass of the herbivores and other groups. Respiratory requirements of copepods were determined in the laboratory to estimate the energy loss and the energy reserve.

The inorganic nutrients showed a wide variation in the water column with a range of $0.65-2.2 \mu\text{g-PO}_4 - \text{P/l}$, $0.163 - 1.065 \mu\text{g-at NO}_3 - \text{N/l}$ and 7.5 to $11.4 \mu\text{g-at SiO}_3 - \text{S/l}$. The chlorophyll *a* concentration was high during November ($7.55 \mu\text{g/m}^3$) and low during December ($0.95 \mu\text{g/m}^3$). The values of chlorophyll were $1.57 \mu\text{g/m}^3$ when

phaeo-pigments were totally absent. The rate of primary production was 0.12 c/m² /day. In fresh copepods, carbohydrates-carbon varied from 0.13- 2.2 µg C/ copepod, and oxygen consumption varied from 7.0 to 40 ml/copepod.

In the paddy cum prawn field, salinity was low but the phosphate and silicate concentration were found to be very high in November. In the river adjoining the paddy field, very high concentrations of phosphate were recorded. The organic carbon and phaeophytin were higher in the field as compared to the adjoining channel and the river. The prawn filtration from the field commenced by the end of December when there was a change over to brackish water conditions. The prawn yield is under study.

Personnel associated with the project:

P. V. Ramachandran Nair, JFS; D. C. V. Easterson, RA;
Kumari Vinci, RA; P. G. Jacob, RA; C. V. Mathew, RA;
T. Chandrasekhara Gupta, and
Thampi Cherian, Research Scholars.

Hydrology of the inshore waters

Karwar

In the Karwar Bay the annual variations in the hydrological features were as follows:

Temperature	24.2 - 31.5°C
Salinity	22.59 - 34.67‰
Dissolved Oxygen	2.8 - 5.2ml/l
Inorganic Phosphate	0.2 - 1.1. µg-at/l.
Nitrite	0.0 - 2.5 µg-at/l
Silicate	8.8 - 94.1 µg - at/l.
pH	7.8 - 8.5

Mangalore

There was a steady rise in the surface temperature from January to April (27 to 31°C). Lowest values were obtained in October (26.2°C). The salinity ranged from 25.10‰ to 36.45‰ with a maximum in April and minimum in October. The pH ranged from 6.9 to 8.5. The dissolved oxygen varied from 3.26 to 5.18 ml. The silicate values were low during January to May and very high from October to December.

Calicut

Weekly water samples were collected from surface and bottom at 3 stations off West Hill, Kozhikode. These gave the following results:

The surface temperature increased from 27.7 to 30.3°C, 27.5 to 29.6°C and from 27.0 to 29.4°C at the 3 stations from January to April. A steady rise in surface and bottom salinities from January to May was observed at all the stations. The dissolved oxygen at the surface was greater than at the bottom in all the months except during May. At the deeper station the dissolved oxygen at the bottom was greater than at the surface in January and April. At the still deeper station the surface values of dissolved oxygen was lower than that of the bottom in February and April. The reactive phosphorus was generally higher between 8.0 and 8.5 throughout the year.

Minicoy

The temperature and salinity of the surface waters of the lagoon varied from 27.1°C to 32.0°C and 33.13‰ to 36.38‰ respectively during the period April to December. The dissolved oxygen variations for the same period were from 4.4 to 6.6 ml/l.

Waltair

The surface and bottom temperatures gradually increased from their minimum (Surface - 26.40°C; bottom - 25.30°C) in February to maximum (Surface - 29.30°C and bottom - 28.85°C) in May. The salinity varied from 11.1‰ to 32.5‰. The salinity minimum was in October. The dissolved oxygen ranged from 3.0 to 4.8 ml/l. Silicate varied between 5.0 to 12.5 µg-at/l and the phosphate between 0.2 to 1.2 µg-at/l

Port Blair

The seasonal variations of temperature at Marine Bay and South point indicated a double maxima during the year; a major peak of 30.5°C occurring in April and a minor peak of 29.2°C in September. Lower temperature values were found in December - January (27.5°C) and June-July (28.0°C). The monthly mean salinity values increased from January (31.7‰) to April (33.1‰), and thereafter showed a gradual fall to 30.6‰ in October.

Personnel associated with the project:

A. V. S. Murty, FS; K. Rangarajan, AFS; N. S. Radhakrishnan, AFS; P. Mojumdar, AFS; G. G. Annigeri, SRA; R. Marichamy, SRA; M. M. Meiyappan, RA and others.

Oceanographic parameters and Fisheries

Oceanographic data related to temperature, salinity, dissolved oxygen and sigma-T pertaining to 2270 stations were plotted in 1° squares depth-wise, month-wise and year-wise. The study of the monthly averages of the oceanographic features such as temperature, salinity, dissolved oxygen and sigma-T in the region off Cochin for the period of 1957 to 1969 in 1° squares were correlated with the catch data of major fisheries.

Studies on nutrient concentration along the west coast

The nutrient values from surface and 100 metres during the pre-monsoon and monsoon seasons, from Cochin to Cape Comorin (Coastline) were found to be as follows:

Inorganic phosphorus	0.18	0.66 μg —at P/L	0.60	1.54 μg —at P/L
Silicate	0.66	2.97 μg —at Si/L	2.13	17.80 μg —at Si/L
Nitrite	0.02	0.45 μg —at N/L	0.28	0.84 μg —at N/L
Nitrate	0.36	6.00 μg —at N/L	7.56	39.76 μg —at N/L

Studies on water circulation

The current pattern in the Maldive region was studied by isentropic analysis. A large divergence zone was noticed in the region, 4°N and 8°N latitude and 76°E and 78°E longitude. A convergence zone was also noticed south of this. Both these features were confirmed from the temperature distribution.

Personnel associated with the project:

A. V. S. Murty, FS; G. S. Sharma, JFS; C. P. Ramamirtham, AFS and D. Sadananda Rao, AFS.

Researches contemplated

Most of the investigations which were in progress during the year will be continued in 1972, but the existing number of projects will be re-grouped into fewer comprehensive projects.

POPULAR SUMMARY OF THE REPORT

The total marine fish production in India, which exceeded one million tonnes for the first time in 1970, continued to increase during 1971. The total production for the year was estimated as 1.15 million tonnes. This showed an increase of 6% over that of 1970. The catch per unit effort for the country as a whole remained more or less similar to that of 1970. Except for the West Bengal, Orissa and Pondicherry, in all the other maritime states, a greater effort in terms of manhours was expended. Kerala recorded the highest catch per unit effort.

During the year a record catch of mackerel (184185 tonnes) in the country, and a record quantity of nonpenaeid prawns (74637 tonnes) from the state of Maharashtra, were the chief features. The catches of oil sardine and penaeid prawns showed some decrease. The total export of prawns from India was of the order of 35 thousand tonnes.

Detailed information on the species-wise catch trends, biological aspects such as the size composition, age, growth, breeding and feeding habits were collected on the oil sardine, mackerel and on different species of prawns which together constitute the major fisheries of the country. Similar informations on other groups of fishes like the elasmobranchs, tunas, lesser sardines, anchovies and miscellaneous fishes were collected at the various centres.

The fishery and biology of commercially important molluscs were studied at Vizhinjam, Tuticorin and Mandapam. Ecological surveys of the pearl oyster and chanks were carried out at Tuticorin in collaboration with the State Fisheries Department (Tamil Nadu).

Studies on fishes collected from Andaman and Nicobar islands were carried out at Mandapam and a number of species were found to be new records for India.

Investigations on phytoplankton productivity showed that the total production sustained by the shelf waters of the west coast of India continued to remain high during the year. The concentration of plant pigments, showed a similar trend.

The characteristics of zooplankton occurring in the inshore waters were studied from different centres on the east and west coast. The material collected from the research cruises of *R. V. Varuna* were examined, sorted out and studied in detail for taxonomic and ecological aspects. Oceanographic data on physical and chemical factors in the sea were suitably processed to study the influence of various environmental factors on fish populations.

The survey of economically important seaweed resources of the Tamil Nadu coast progressed well and valuable data on the quantitative and qualitative distribution of seaweeds were collected.

PERSONNEL

Appointments

The following appointments to the posts equivalent to gazetted status were made during the year:-

- | | |
|------------------------------------|---------------------------------------|
| 1. Shri T. Tholasilingam | - as Fishery Scientist |
| 2. Shri V. Sadasivan | - as Fishery Scientist |
| 3. Dr. M. Vasudev Pai | - as Junior Fishery Scientist |
| 4. Dr. K. Alagarwami | - as -do- |
| 5. Dr. V. Balakrishnan | - as -do- |
| 6. Shri V. Balan | - as -do- |
| 7. Shri P. V. Ramachandran
Nair | - as -do- |
| 8. Dr. S. Ramamurthy | - as -do- |
| 9. Shri M. Mydeen Kunju | - as -do- |
| 10. Dr. P. Vijayaraghavan | - as -do- |
| 11. Dr. M. D. K. Kuthalingam | - as -do- |
| 12. Dr. N. Radhakrishnan | - as -do- |
| 13. Dr. (Mrs) P. V. Kagwade | - as -do- |
| 14. Shri M. S. Muthu | - as -do- |
| 15. Shri P. Vedavyasa Rao | - as -do- |
| 16. Shri V. N. Bande | - as Assistant Fishery
Scientist |
| 17. Shri S. Rajagopalan | - as Senior Administrative
Officer |
| 18. Shri S. Swaminathan | - as Administrative
Officer |

Retirement

Dr. R. Subrahmanyam, Fishery Scientist retired on 14-1-1971

**LIST OF SCIENTIFIC PAPERS PUBLISHED BY THE STAFF
OF THE CENTRAL MARINE FISHERIES RESEARCH
INSTITUTE DURING THE YEAR 1971**

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4. Balan, V. 1971. The fecundity and sex composition of *Sardinella longiceps* Val. along the Cochin coast. *Indian J. Fish.*, 12(2) : 473-491 (1965). 994
5. Bennet, P Sam 1971. Some observations on the fishery and biology of *Sardinella fimbriata* (Val) at Vizhinjam. *Indian J. Fish.*, 14(1&2) : 145-158 (1967). 995
6. Bennet, P. Sam 1971. Length and age composition of the oil sardine catch off Calicut coast in 1964 and 1965. *Indian J. Fish.*, 12(2) : 507-529 (1965). 996
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8. Bensam, P. 1971. On a few post-larval stages of *Anodontostoma chacunda* Hamilton. *Indian J. Fish.*, 14(1&2) : 48-53(1967). 998
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12. Durve, VS. 1971. On the growth of the clam *Meretrix casta* (Chemnitz) from the marine fish farm. *J. mar. biol. Ass. India*, 12(1&2) : 125-135 (1970). 1002
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15. Gnanamuthu, J. C., 1971. Osteology of the Indian mackerel *Rastrelliger kanagurta* (Cuvier) *Indian J. Fish.*, 13 (1&2) : 1-26 (1966). 1005
16. James, D. B. 1971. Studies on Indian Echinoderms—III. *Ophiuridium pictum* (Muller and Troschel) (Ophiuroidea : Ophiocomidae), a new record from the Indian Ocean with additional notes on the species. *J. mar. biol. Ass. India*, 12 (1&2) : 136-138 (1970). 1006
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29. Kagwade, P. V. 1971. Hermaphroditism in a teleost, *Polynemus heptadactylus* Cuv. and Val. *Indian J. Fish.*, 14 (1 & 2) : 187-197 (1967). 1019
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33. Kuthalingam, M. D. K., S. Ramamurthy, K. K. P. Menon, G. G. Annigeri and N. Surendranatha Kurup, 1971. Prawn fishery of the Mangalore zone with special reference to the fishing grounds. *Indian J. Fish.*, 12 (2) : 546-554 (1965). 1023
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54. Rao, K. Venkata Subba, 1971. Trend of Ghol landings by the New India Fisheries Bull Trawlers for 1959-1962 operating in Bombay and Saurashtra waters. *Indian J. Fish.*, 12 (2): 555-580 (1965). 1044
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Abbreviations used throughout the Report:

SFS-Senior Fishery Scientist; FS- Fishery Scientist;
JFS- Junior Fishery Scientist; AFS- Assistant Fishery Scientist;
SRA-Senior Research Assistant; RA-Research Assistant;
JSA- Junior Scientific Assistant.

26. Shri S. Mahadevan, AFS
27. Shri M. H. Dulkhed, AFS
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