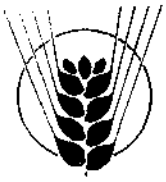
annual report
1972

central marine
fisheries research institute
cochin-18



INDIAN COUNCIL OF AGRICULTURAL RESEARCH

CONTENTS

INTRODUCTION

Brief historical introduction

During the year 1972 the Central Marine Fisheries Research Institute completed twenty five years of fruitful researches on marine fisheries. This occasion was marked by the Silver Jubilee of the Institute in December 1972 which included the following functions:

(i) Foundation stone laying ceremony

The foundation stone of the permanent building of the Institute was laid by Shri C. Achutha Menon, Hon'ble Chief Minister of Kerala on the morning of 11th December 1972 amidst a distinguished gathering which included the Hon'ble Minister for Fisheries and Local Administration, Kerala; the Director General of the Indian Council of Agricultural Research, the Mayor of Cochin, Deputy Director-General and Assistant Director General, ICAR; District Collector of Ernakulam, Directors of other Institutes and Directors of State Fisheries and other distinguished guests.

(ii) Release of the handbook on marine fisheries research

Shri Avukaderkutty Naha, Minister for Fisheries and Local Administration, Kerala, released a handbook entitled "25 years of Marine Fisheries Research" at the inaugural function of the Silver Jubilee Celebrations.

(iii) The Director Genral of ICAR, Dr. M. S Swaminathan, F. R. S. delivered the inaugural address.

Symposium on pelagic fisheries resources

A symposium on 'Pelagic fisheries resources of the seas around India' was held from 11th to 13th December 1972. Dr. M. S. Swaminathan F. R. S., Director-general, ICAR presided over the inaugural session of this symposium. The Symposium was attended by nearly 400 delegates including scientists, technologists and administrators from different parts of the country. Fiftyone papers were pesented and discussed The occasion provided an opportunity to discuss the work of the Institute on Pelagic resources.

Objectives of the Institute

The main objectives of the Institute are:

(i) to estimate the catches of the marine fishes and other animals from the seas around India throughout the year by different types of vessels and gears.

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

(iii) to locate new fishing grounds; to conduct environmental studies in relation to fisheries; and to generate additional resources by mariculture, and

(iv) to recommend measures for the rational exploitation of the various resources

Organisational structure and changes

During 1972, the Institute has undertaken 29 research projects and all-round progress was maintained in these projects at the headquarter and the outstations. The scientific work has been carried out by the three divisions of the Institute namely,

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

The works of the three divisions have been given in the various sections under 'Progress of research'. The progress in the other activities of the Institute was as follows:

Library

During the year, Volumes 16, 17, 18 and 19 of the *Indian Journal of Fisheries* was published. Volume (1) Nos. 3 & 4 and Volume (2) Nos. 1 to 4 of the *Fishery and Marine Science Abstracts* were also published and issued. The printing of the *Proceedings* of the *Symposium on Living Resources of the Seas around India* was completed.

About 250 books and 500 new numbers of the periodicals were added to the library. As usual the library continued its services of loaning books and periodicals to different Universities, Institutes, State Departments and other interested organisations. Many visitors from colleges and universities made use of the libray consistently throughout the year.

List of distinguished visitors to the Institute.
Headquarters, Cochin

1. His Excellency, the Governor of Kerala, Shri V. Viswanathan and Shrimati Viswanathan visited the CMFRI Pavilion at the All India Exhibition.
2. Shri C. Achutha Menon, Hon'ble Chief Minister of Kerala
3. Shri Avukaderkutty Naha, Hon'ble Minister for Fisheries and Local Administration, Kerala

4. Shri A. C. Jose, Mayor of Cochin
5. Dr. M. S. Swaminathan F. R. S., Director-General of the Indian Council of Agricultural Research
6. Dr. N. K. Panikkar, Director, National Institute of Oceanography, Panaji, Goa.
7. Shri Tukuy Kikuchi, Fishery Agency, Ministry of Agriculture and Forests, Japan.

Regional Centre, Mandapam Camp

1. Shri K. K. Shah, His Excellency the Governor of Tamil Nadu
2. Shri K. Rajaram, Minister for Tourism, Tamil Nadu
3. Shri G. Rangaswamy, Vice-Chancellor, Tamil Nadu Agricultural University, Coimbatore.

Substation, Bombay

1. Obe I. Ostveot, Institute of Marine Research, Bergen, Norway.

Substation, Karwar

1. Shri B. P. Kadam, Deputy Speaker, Mysore Legislative Assembly.

Substation, Vizhinjam

1. Shri K. Avukaderkutty Naha, Hon'ble Minister for Fisheries and local Administration, Kerala.

Substation, Madras

1. Mrs. Sathyavani Muthu, Hon'ble Minister for Fisheries, Tamil Nadu.

Substation, Waltair

1. Dr. Leonarae Ejsymont, Istitute of Iehthyology, Poland
2. Dr. T. Wyatt, Fisheries Laboratory, Lowestoft, UK.

Substation, Mangalore

1. Shri B. P. Kadam, Deputy Speaker, Mysore Legislative Assembly.

Research collaboration with other organisations

1. Survey of chank and pearl oyster beds in collaboration with Department of Fisheres, Tamil Nadu including the project on the development of cultured pearls.

2. Sea cruises and exploratory surveys conducted of fishery resources were carried out in collaboration with the Integrated Fisheries Project and the Deep Sea Fishing Stations of the Government of India.

3. Survey of seaweed resources of the Tamil Nadu coast was carried out in collaboration with the Government of Tamil Nadu and the Central Salt and Marine Chemicals Research Institute (CSIR).

Advisory / Consultancy service received and provided

Dr. S. Z. Qasim, Director 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) Board 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,

(ix) Indian National Committee on Oceanic Ressearch (INCOR),

(x) National Commission on Science and Technology

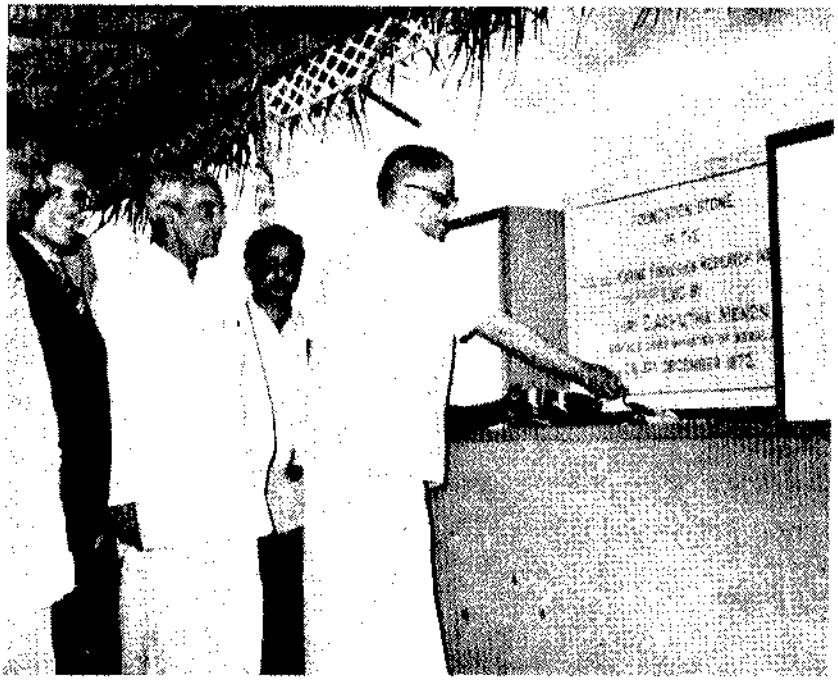
(xi) The Senate, University on Cochin and

(xii) Board of Studies and Faculty of Marine Sciences, University of Cochin.

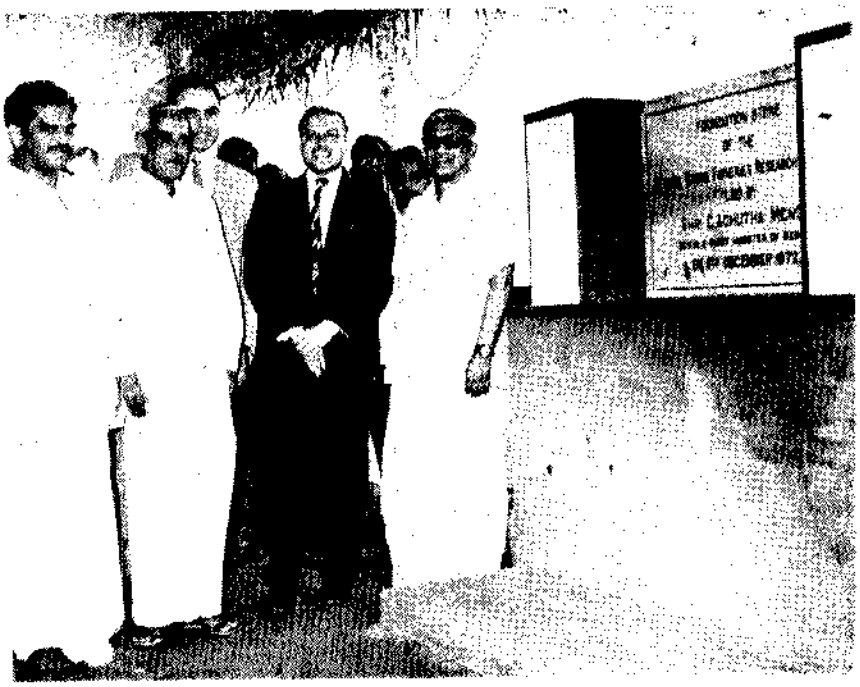
2. Dr. E. G. Silas, was deputed by the Government to participate in the FAO/SIDA International Training Course on Marine Pollution from 2-5-1972 to 3-6-1972. He also participated as a member of the Indian delegation in the first U. N. International Conference on Human Environment held at Stockholm, Sweden. from 5-6-72 to 16-6-1972.

3. Sarvashri K. Venkata Subba Rao and M. H. Dhulkhed were deputed by the Government to participate in the Training Centre organised by the FAO/DANIDA at Friderikshavn, Denmark, from 28-8-1972 to 22-9-1972 on the "methodology in Fisheries Science."

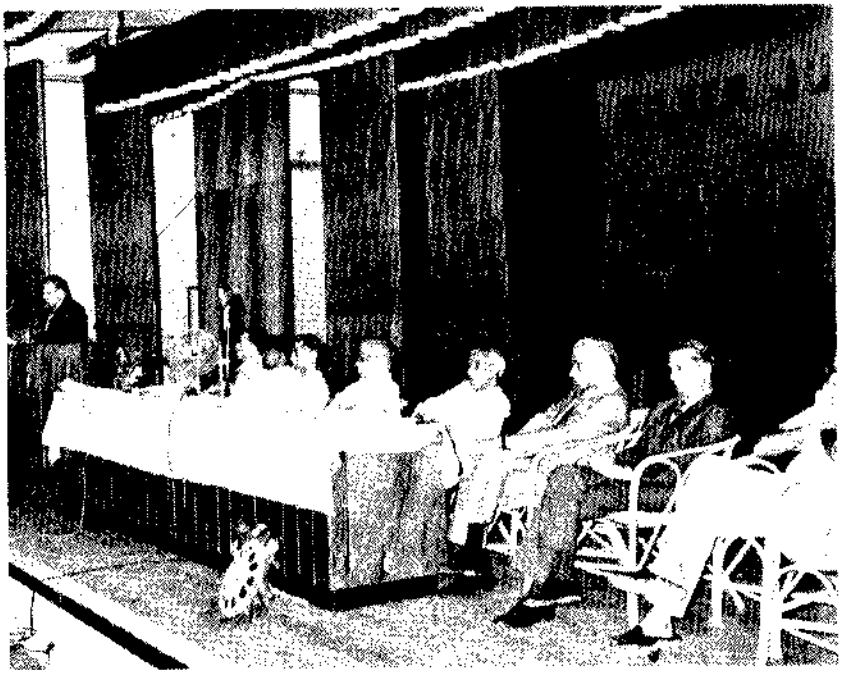
4. Dr. M. D. K. Kuthalingam was deputed as a FAO Fellow for



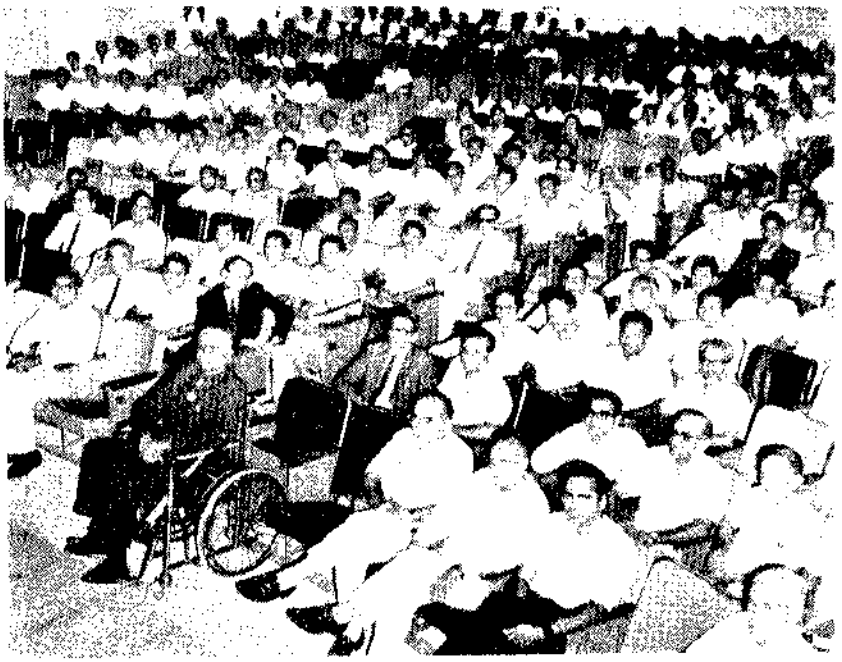
Shri C. Achutha Menon, the Hon'ble Chief Minister of Kerala laying the foundation stone of the permanent buildings of the Central Marine Fisheries Research Institute at Cochin on 11-12-1972.



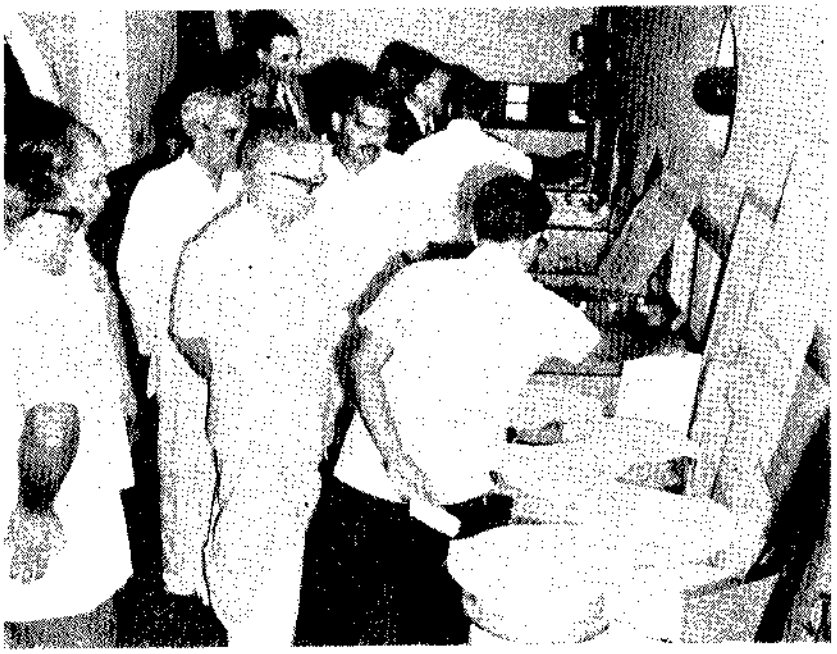
At the time of foundation stone laying ceremony. L to R: Shri A. C. Jose, Mayor of Cochin; Shri Avukaderkutty Naha, Minister for Fisheries, Kerala; Dr S. Z. Qasim, Director, CMFRI; Dr. M. S. Swaminathan, Director General, ICAR and Shri C. Achutha Menon, Chief Minister of Kerala.



Dr. M. S. Swaminathan, F. R. S., Director General of ICAR delivering the inaugural address of the Symposium on "The Pelagic Fisheries Resources of the Seas Around India" organised in connection with the Silver Jubilee of the Institute.



A view of the delegates and scientists attending the Symposium



The Chief Minister of Kerala and other visitors at the Exhibition organised during the Silver Jubilee of the CMFRI

A view of the exhibition organised from 15th to 17th August 1973 in connection with the Silver Jubilee of India's Independence.

His Excellency Shri V. Viswanathan, Governor of Kerala and Shrimathi Viswanathan visiting the CMFRI stall at the All India Exhibition organised by the Corporation of Cochin

Visit of Dr. Shrimathi Sathyavani Muthu, Minister for Fisheries, Tamil Nadu to the CMFRI.

training in Fisheries Biology at Fisheries Laboratory, Lowestoft, U. K, for a period of six months, commencing from the 2nd week of December 1972.

5. Dr. E. G. Silas served as a member of the National Committee on Science and Technology subgroup on living Marine Resources.

6. Dr. K. V. Sekharan, Served as a Member of the board of Studies and Faculty of Marine Sciences, University of Cochin.

The Institute extended its consultancy service to individuals, scientific organisations and industries and answered hundreds of querries on fisheries problems.

Fellowships and scholarships

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

Mrs. Vishnu Dutta joined the Institute as an ICAR Senior Fellow.

Conferences, Symposia and Seminars

Apart from the Symposium on the 'Pelagic fisheries resources of the seas around India' mentioned earlier, the Institute conducted a Seminar on 'Marine Fisheries and their Problems' on the occasion of the Silver Jubilee celebrations of India's Indepedence on 17th August 1972. An 'Open House' and exhibition were organised on 14, 15, and 16 August 1972. Similar exhibitions, seminars and lectures highlighting the activities of the Institute were organised at the Regional Centre, Mandapam Camp and at other substations of the Institute.

On the 'Garibi Hatao' day which was held on 19-11-1972, the staff at headquarters and outstations conducted practical demonstrations to the fisherman community and to the public on research and developmental activities of the Institute. On these occasions, suitable hand-bills, leaflets and folders were distributed.

The Institute participated in the All India Exhibition organised by the Corporation of Cochin from December 1972 to February 1953 and the stall was visited by hundreds of thousands persons from all walks of life. The pavilion of the CMFRI was very well liked by the students and industrialists.

Finance

The actual expenditure under the budget allotment of the Institute for the financial year 1972-73 has been Rs. 11.47 lakhs under Plan and Rs. 27.26 lakhs under Non-Plan.

PROGRESS OF RESEARCH

FISHERY SURVEY AND STATISTICS DIVISION

Summary of salient findings

The marine fish production in the country during the year was provisionally estimated as 974,456 tonnes as against 1161,389 tonnes during 1971. While Kerala and Mysore recorded reduced landings, no large scale fluctuations were seen in other maritime States of India. The percentage of landings from mechanised crafts showed a significant increase during the year. Among the major fisheries, the yield from the oil sardine, mackerel and Bombay duck declined, whereas the catches of both penaeid and non-penaeid prawns increased.

Data on effort in terms of 'number of operations of unit gear' showed that Tamil Nadu and Kerala have expended the maximum effort along the east and west coasts repectively when compared with other maritime States.

Stock assessment studies on oil sardine and mackerel have shown that no substantial increase in the catch of these two species is possible by a further increase in the fishing effort as long as the fishery is restricted to the inshore waters.

Researches in hand

ANNUAL PRODUCTION OF MARINE FISH

The total marine fish production in India during the year 1972 was provisionally estimated at 974,456 tonnes as against 1161,389 tonnes during 1971. The total landings in 1972 declined by about 16% as compared to 1971. While in the states of Kerala and Mysore the total fish catch declined considerably, no large scale fluctuations were seen in other maritime states of India. The statewise marine fish production along with the distribution of total catch obtained from mechanised fishing crafts and also the day and night landings are shown in Table 1.

From Table 1, it is seen that the percentage of landings from the mechanised fishing crafts during 1972 showed a significant increase as compared to 1971. This was due to higher landings from the mechanised crafts in the states of West Bengal and Orissa, Andhra, Mysore, Maharashtra and Gujarat. Night landings also showed a slight increase during 1972. While West Bengal and Orissa and Maharashtra recorded higher landings in the night, the same in the States of Andhra, Tamil Nadu, Pondicherry, Kerala, Mysore and Gujarat declined sharply. A remarkable feature noticed during 1972 was a significant increase in mechanised catches and night fish landings in Maharashtra.

Table - 1

Statewise Marine Fish Landings in India

	Provisional estimate of landings (in tonnes) during							
	Day				Night		Total	
	By non-mechanised units		By mechanised units					
	1972	1971	1972	1971	1972	1971	1972	1971
1. West Bengal & Orissa	11,319	17,318	932	558	1,952	156	14,203	18,032
2. Andra Pradesh	79,532	81,481	4,104	2,201	234	328	83,870	84,010
3. Tamil Nadu	126,015	125,668	25,920	28,698	3,329	6,253	155,264	160,619
4. Pondicherry	8,295	8,339	672	1,451	13	664	8,980	10,454
5. Kerala	240,758	381,427	42,109	47,291	9,092	16,629	271,957	445,347
6. Mysore	61,613	86,032	21,227	16,565	617	1,127	83,457	103,724
7. Maharashtra	17,034	80,478	163,632	110,531	38,472	24,296	219,138	215,305
8. Gujarat	25,352	27,108	37,478	30,725	13,016	24,326	75,846	82,159
Percentage	61.10	72.15	31.75	21.26	7.15	6.59	100.00	100.00
9. Goa							39,980	39,980
10. Andaman							569	369
11. Laccadives							1,190	1,190
Grand Total							974,456	1161,389

N. B: Since data for 1972 are not available for Goa, Andamans and Laccadives, figures for 1971 are taken.

The landings in West Bengal and Orissa decreased by about 4000 tonnes (21%) inspite of the increase in the total fishing effort. (Vide Table 9). The decrease was due to reduced landings of lesser sardines, other clupeids and sciaenids. The landings of *Anchoviella* and silver bellies, however, showed an increase.

In Andhra, the total fish catch remained more or less stationary. The increase in the input of fishing effort could not yield higher landings resulting in marginal decrease in the catch per unit effort as compared to 1971. While the landings of lesser sardines, ribbon fish and penaeid prawns declined, those of elasmobranchs, *Hilsa* spp, other clupeids, sciaenids, mackerel and seer fish showed a significant increase.

The decline in the total landings in Tamil Nadu was only marginal (3%). The catch per unit effort also declined due to reduced landings in spite of higher effort put in. The landings of silver bellies, mackerel, prawns and other crustaceans increased significantly. But some increase in the landings of elasmobranchs, lesser sardines and flying fish was also noticed.

In Pondicherry, the total yield as well as the effort expended decreased slightly. The catch per unit effort did not change substantially. While the landings of mackerel increased significantly, the catch of lesser sardines, *Caranx* and flying fish was poor.

The landings in Kerala declined by about 34%. The increased input of fishing effort could not yield higher catches. The catch per unit effort fell sharply. The traditional fisheries of oil sardine and mackerel suffered a set back, the catches of these two fishes showed a decline of about 90,900 tonnes and 60,700 tonnes respectively. The landings of prawns, *Caranx* and sciaenids, however, increased substantially.

In Mysore, the total fish production showed a decrease of about 20,300 tonnes (20%). Here, the fishing effort put in was comparatively lower. The catch per unit effort did not show any significant change. The landings of mackerel declined sharply. The catch of oil sardine, cat-fishes, elasmobranchs, prawns and lesser sardines, however, improved significantly.

There was a marginal decrease in the input of fishing effort in Maharashtra. This, however, did not affect the catch as the total yield and catch per unit effort increased slightly. While the catches of prawns, ribbon fish and *Bregmaceros* increased significantly, those of Bombay duck and cat fishes suffered a set back.

In Gujarat, the lower input of effort affected the total catch only marginally. No significant change was noticed in the catch per unit effort

in this State. The fisheries of Bombay duck, pomfret and penaeid prawns are comparatively poor. The landings of *Saurida, Saurus* and perches increased substantially.

Variety Composition

The marine fisheries of India, which consist of more than 200 different species of fish, have been grouped and presented in Table 2 for the years 1971 and 1972.

Table 2 shows that the principal fisheries of India are oil sardine, mackerel, *Harpodon nehereus* and prawns. These together contributed about 47% of the total marine fish production during 1972 as compared to 55% during 1971. The reduction in the percentage was due to the failure of oil sardine, mackerel and

Table 2. *The composition of total marine fish landings in India during 1971 and 1972. (Quantity in tonnes)*

Sl. No.	Name of fish	1972	1971
1.	Elasmobranchs	45,225	41,348
2.	Eels	4,430	4,056
3.	Cat fishes	41,161	48,858
4.	*Chirocentrus*	9,848	9,366
5. (a)	Oil sardine	125,413	209,261
(b)	Lesser Sardines	42,489	61,283
(c)	*Hilsa ilisha*	1,393	1,769
(d)	Other *Hilsa*	12,298	10,361
(e)	*Anchoviella*	18,517	19,516
(f)	*Thrissocles*	11,102	10,801
(g)	Other clupeids	28,659	24,100
6. (a)	*Harpodon nehereus*	51,496	71,508
(b)	*Saurida & Saurus*	4,460	3,687
7.	*Hemirhamphus & Belone*	681	1,018
8.	Flying fish	1,412	9,179
9.	Perches	14,450	12,993
10.	Red mullets	5,892	3,881
11.	Polynemids	7,051	7,252
12.	Sciaenids	39,099	36,903
13.	Ribbon fish	36,275	44,690
14. (a)	*Caranx*	26,869	20,592
(b)	*Chorinemus*	2,928	2,109
(c)	*Trachynotus*	2	17
(d)	Other carangids	319	304
(e)	*Coryphaena*	223	59

Table 2 *(Contd).*

Sl. No.	Name of fish	1972	1971
	(f) *Elacate*	397	347
15.	(a) *Leiognathus*	32,503	32,510
	(b) *Gazza*	76	156
16.	*Lactarius*	6,632	5,313
17.	Pomfrets	18,940	21,000
18.	Mackerel	124,171	204,575
19.	Seer fish	21,211	18,339
20.	Tunnies	5,990	6,032
21.	*Sphyraena*	2,358	1,271
22.	*Mugil*	1,523	3,737
23.	*Bregmaceros*	5,488	4,345
24.	Soles	9,346	11,380
25.	(a) Penaeid prawns	74,268	72,109
	(b) Non-penaeid prawns	85,488	76,734
	(c) Other crustaceans	11,541	9,612
26.	Cephalopods	991	1,505
27.	Miscellaneous	41,841	37,513
	Total	974,456	1611,389

Bombay duck fisheries. The landings of both penaeid and nonpenaeid prawns, on the other hand, increased substantially. As regards other fisheries, the catches of lesser sardines, ribbon fish, flying fish and cat fishes decreased considerably. However, the landings of *Caranx*, other clupeids and elasmobranchs increased significantly. A summary of the principal marine fisheries is as follows:-

(a) Oil Sardine

Table 3 gives the State-wise landings of Oil sardine in India.

TABLE 3. *Landings of oil sardine during the years 1971 and 1972 (Quantity in tonnes)*

Year	Kerala	Mysore	Other States	Total
1971	194,977	11,836	2,448	209,261
1972	104,070	15,610	5,733	125,413
Average (1963-1972)	178,449	33,919	1,726	214,094
Percentage (1963-1972)	83.35	15.84	0.81	100

It will be seen from the table that nearly 83% of the oil sardine landings come from Kerala. This is based on the average for the 10 year period 1963-1972. The fishing prospect of oil sardine for the country as a whole depends on the success of this fishery in Kerala. After a steady increase upto 1968, the landings of oil sardine began to fluctuate between 1969 and 1972. The landings during 1972 was far below the average of the 1963-1972 decade. The fluctuations in the landings were largely due to the decrease in the availability of the fish within a limited fishing region along the coastal belt.

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

(b) Mackerel

The mackerel fishery of India is based on a single species, *Rastrelliger kanagurta* and is mainly confined to the coastal waters of the west coast, between Quilon (Kerala) and Ratnagiri (Maharashtra). Table 4 gives state wise landings of mackerel for the years 1971 and 1972 and also the average for the ten year period 1963-1972.

Like oil sardine, the mackerel fishery is equally important for the states of Kerala and Mysore. The annual landings of mackerel also flutuate widely. During 1972, the catch of mackerel was poor both in Kerala and Mysore. Both the States together contributed about 68% of the total mackerel production in India. After a record increase in the landings during 1971, the landings during 1972 declined considerably.

TABLE 4. *Landings of mackerel during the years 1971 and 1972. (Quantity in tonnes)*

Year	Kerala	Mysore	Other State	Total
1971	95,164	64,047	45,364	204,575
1972	34,483	32,251	57,437	124,171
Average (1963-72)	30,976	22,830	24,877	78,683
Percentage (1963-72)	39.37	29.01	31.62	100

The annual fluctuations in the mackerel fishery are well known. For mackerel, the existing fishing mortality rate is estimated at F = 1.40 and the maximum yield per recruit Y/R is obtained at F = 1.55. This shows that in the existing fishing zone we are almost exerting the maximum effort and are nearer to the optimum yield and that any further increase in the fishing effort, within the inshore fishing area exploited at present, may fetch only a nominal increase in the catch.

(c) Bombay duck

The Bombay duck fishery is based on a single species, *Harpodon nehereus* and is mainly confined to the coasts of Maharashtra and Gujarat. The fish is also caught in small quantities along the West Bengal, Orissa and Andhra Coasts.

TABLE 5. *Landings of Bombay duck during the years 1971 and 1972 (Quantity in tonnes)*

Year	Maharashtra	Gujarat	Other States	Total
1971	33,993	35,680	1,835	71,508
1972	21,246	29,011	1,239	51,496
Average (1963-1972)	26,810	47,686	1,468	75,964
Percentage (1963-1972)	35.29	62.78	1.93	100

Table 5 shows the total landings of Bombay duck during the years 1971 and 1972 and also the average catch for the ten year period 1963-1972. While Maharashtra contributed about 35% of the total Bombay duck production in India, Gujarat's share as about 63%. During 1972, the total all India Bombay duck catch as well as the catch from the Maharashtra and Gujarat states fell far below the average for the 10 year period 1963-1972. A critical study is being carried out to determine whether the decrease was inspite of an increase in fishing effort or not.

(d) Penaeid prawns

The bulk of the penaeid prawns catch come from the States of Kerala, Mysore and Maharashtra on the west Coast of India. West Bengal and Orissa, Andhra, Tamil Nadu and Pondicherry also contributed substantially on the East Coast of India. Penaeid prawns formed about 43% of the total crustaceans landings in India during 1972.

TABLE 6. *Landings of penaeid prawns during the years 1971 and 1972 (Quantity in tonnes)*

Year	Kerala	Maharashtra	Mysore	Other States	Total
1971	31,294	18,974	4,420	17,421	72,109
1972	35,007	20,112	5,559	13,590	74,268
Average (1963-1972)	28,964	14,098	3,234	17,692	63,988
Percentage (1963-1972)	45.26	22.03	5.05	27,66	100

Table 6 shows the landings of penaeid prawns in Kerala, Mysore and Maharashtra States along with all India total penaeid prawns catch during the years 1971 and 1972. The table also includes the average catch for the ten year period 1963-1972. During 1972, the penaeid prawns landings were comparatively higher. Kerala, Mysore and Maharashtra together contributed about 72% of the total all India penaeid prawns production.

(e) Non-Penaeid prawns

The non-penaeid prawns are mostly landed in the Maharashtra State. During the year these formed about 50% of the total crustacean landings of the country. Table 7 shows the landings of non-penaeid prawns in Maharashtra during the years 1971 and 1972. The table also includes all India landings during the year and the average catch for the 10 year period 1963-1972.

It is seen from Table 7 that Maharashtra contributed about 95% of the total non-penaeid prawn catch in India. The non-penaeid prawns landings in Maharashtra increased steadily from 1968 and touched an all time record figure of abot 84,000 tonnes during the year 1972.

TABLE 7. *Landings of non-penaeid prawns during the years 1971 and 1972 (Quantity in tonnes)*

Year	Maharashtra	Other States	Total
1971	74,637	2,097	76,734
1972	83,952	1,536	85,488
Average (1963-1972)	41,747	2,180	43,927
Percentage (1963-1972)	95.04	4.96	100

(f) Lesser sardines

The landings of lesser sardines showed a decrease of about 19,000 tonnes during 1972 as compared to 1971. The decline was mainly due to reduced landings in the States of West Bengal and Orissa, Andhra, Tamil Nadu, Pondicherry and Kerala.

(g) Ribbon fish

During 1972, the catch of ribbon fish registered a decrease of about 8,400 tonnes. This is due to the failure of this fishery in the States of West Bengal and Orissa, Andhra, Tamil Nadu and Kerala.

(h) Cat fishes

The yield of cat fishes declined by about 7,700 tonnes. The poor fishery in the States of Tamil Nadu, Pondicherry, Kerala and Maharashtra largely contributed to this decline.

(i) Flying fish

The catch of flying fish showed a decrease of about 7,800 tonnes. The flying fish fishery is mostly confined to Tamil Nadu and Pondicherry coasts and in both these States, the catch was very poor during 1972.

Seasonal Variation

Table 8 shows the seasonal variations in the total fish landings in different maritime States of India. It is seen from the table that about 33% of the total marine fish production came during the fourth quarter. Along the west coast of India excepting Goa and Gujarat, the other maritime states recorded higher landings during the first quarter. This rare phenomenon was due to poor landings in the fourth quarter and unusually high landings in the first quarter which comes under the fishery year 1971-1972 when there was really a bumper catch. Along the east coast of India, excepting Tamil Nadu, where the highest landings were recorded during the third quarter, the maximum yield was obtained during the first quarter.

Input of Effort

Table 9 shows the total effort in terms of man hours expended in each maritime state by the indigenous boats (both mechanised and non-mechanised) and catch in kg per man hour during the year 1972. The corresponding figures for 1971 have also been shown for a comparison.

From Table 9 it is seen that for the country as a whole, the catch per unit effort during 1972 showed some decline from that of 1971. Excepting Pondicherry, Maharashtra and Gujarat, all the other maritime States of India recorded lower catch per unit effort. While Kerala expended a

greater effort along the west coast of India, Tamil Nadu put in higher effort along the east coast. Mysore recorded the highest catch per man hour during 1972.

2. Effort in terms of number of operations of unit gear

The choice of unit of effort depends on the purpose for which it is used. The unit 'man hour' is useful from the economic point of view, especially to show if the man-hours effort expended in fishing over the years has increased or decreased. But in fishery biology studies the unit of effort should be such that each additional unit should increase the instantaneous rate of fishing mortality by about the same amount. For this purpose, it is necessary to collect the data on effort in terms of number of operations of different types of gear. Table 10 shows the effort in terms of number of operations of unit gear in different States of India during the year 1972.

It is seen from the Table 10 that Tamil Nadu recorded the highest effort in terms of number of operations of unit gear during 1972 along the east coast of India. The same was highest in Kerala along the west coast

TABLE 8. *Quarterly marine fish landings in different states of India during 1972 (Quantity in Tonnes)*

State	I Quarter	II Quarter	III Quarter	IV Quarter	Total
1. West Bengal & Orissa	6,160	1,191	1,466	5,386	14,203
2. Andhra	27,708	17,508	14,977	23,677	83,870
3. Tamil Nadu	33,600	41,786	43,809	36,069	155,264
4. Pondicherry	3,302	1,891	1,864	1,923	8,980
5. Kerala	88,190	66,771	64,084	72,914	291,959
6. Mysore	47,571	7,838	5,389	22,659	83,457
7. Goa	3,804	1,433	383	34,360	39,980
8. Maharashtra	75,937	50,609	17,648	74,944	219,138
9. Gujarat	13,325	10,414	3,309	48,798	75,846
10. Andamans	124	144	147	154	569
11. Laccadives	521	197	103	369	1,190
Total	300,242	199,782	153,179	321,253	974,456
Percentage	30.81	20.50	15.72	32.97	100

TBLE 9. *Fishing effort in man hours and catch in Kg per man hour*

	Effort in 1000 man hours		Catch in Kg per man hour	
	1972	1971	1972	1971
1. West Bengal & Orissa	14,464	12,904	0.98	2.11
2. Andhra	44,092	40,403	1.90	2.06
3. Tamil Nadu	55,910	46,517	2.77	3.44
4. Pondicherry	2,696	3,355	3.33	3.12
5. Kerala	57,106	45,018	5.11	9.90
6. Mysore	8,861	10,559	9.41	9.88
7. Maharashtra	27,614	28,451	7.93	7.60
8. Gujarat	14,258	19,311	5.31	4.40
Total	225,001	206,518	4.15	5.42

TABLE 10. *Effort in terms of number of operations of unit gear in different States of India during1972*

State	I Quarter	II Quarter	III Ouarter	IV Quarter	Total
1. West Bengal & Orissa	97,275	61,596	62,591	172,253	393,715
2. Andhra	545,303	484,212	500,737	595,792	2126,044
3. Tamil Nadu	803,471	1111,081	882,704	1041,717	3838,973
4. Pondicherry	58,140	64,056	60,561	53,621	236,378
5. Kerala	685,222	709,840	657,000	757,806	2809,868
6. Mysore	184,203	38,923	55,345	56,001	334,472
7. Maharashtra	167,273	150,519	75,521	181,754	575,067
8. Gujarat	236,849	101,185	47,832	176,501	562,367
Total	2777,736	2721,412	2342,291	3035,445	10876,884
Percentage	25.54	25.03	21.53	27.90	100

of India. The maximum effort was expended during the fourth quarter for the country as a whole (28%). Mysore recorded the lowest effort during 1972, on the west coast of India, while Pondicherry recorded the lowest effort on the east coast of India.

Personnel associated with the projects

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* See acbreviations at the end of the Report

FISHERY BIOLOGY DIVISION

Summary of salient findings

During the year the research projects undertaken covered almost all the important marine fisheries resources of the country. The reorientated projects included the study of the characteristics of exploited populations and at the same time, the importance of finding new resources was emphasised. The Division also initiated researches for generating additional food resources through mariculture. The salient features of the work done were as follows:

1) Development of the techniques for culturing mussels on ropes. At the exhibition organised by the Institute in connection with the Silver Jubilee function the techniques were demonstrated. The preliminary results showed that mussel production of the order of 60-70 tonnes/hectare/year can be attained.

2) Work on the development of the cultured pearl has started at Tuticorin. The pearl oysters have been successfully conditioned in cages, as the first step and an indigenous method for the production of nuclei from chank shells has been developed.

3) Successful rearing of eels in running water was done. Young elvers measuring 10 cm had grown to an average size of 40 cm in a year. No cannibalism or mortality was observed and these features make the eels an ideal animal for culture.

4) A new ground for prawns off Chinna Ervadi near Mandapam was discovered.

5) A Symposium on the "Pelagic fisheries resources of the seas around India" was held from 11 to 13 December 1972. It provided an occasion for discussions of the work done during the past 25 years on pelagic resources. The papers presented by the CMFRI staff showed that (a) the catches of oil sardine and other clupeoids can be stepped up considerably by extending the area of operation (b) there is room for improvement of mackerel catches also (c) the catch trends of Bombay duck and the biological characteristics of the catch indicate that the catch needs stabilization (d) fairly large unexploited resources of cephalopods in the seas around India are available, but the economics of their exploitation and utilisation will have to be explored.

Researches on hand

INVESTIGATIONS ON MAJOR FISHERIES

Fishery and biology of the oil sardine, *Sardinella longiceps.*

(FB/MF/1)

During the year, while a gerearal decline at most centres was experienced in the catches of the oil sardine as compared to 1971, at a few centres the catch was higher. At Mangalore and Cochin, the decrease was 20% and 60% respectively, but the catch increased four-folds at Karwar and 70% at Calicut. The increase at Karwar was due to the availability of shoals in the nearshore grounds almost throughout the year. At Calicut, the increase was related to a 60% increase in effort. As may be seen from Table 11, the second half of the year was more productive than the first half at all observation centres except at Cochin.

TABLE 11. *Month-wise landings (in tonnes) of the oil-sardine at different centres during 1972 and the total catch in 1971 and 1972*

Month	Karwar	Mangalore		Calicut	Cochin
		Baikampady	Ullal		
January	14.79	32.52	5.01	674.62	245.13
February	3.19	5.50	—	975.12	361.63
March	22.43	18.86	0.87	713.99	202.78
April	4.61	—	11.02	550.11	242.96
May	—	—	3.32	109.39	205.40
June	1.62	8.94	12.35	16.44	—
July	1.07	0.66	2.85	546.35	45.28
August	15.87	17.10	7.50	870.46	24.20
September	0.86	5.23	8.01	1096.80	88.20
October	97.11	12.50	34.92	1378.44	2.06
November	32.71	71.30	16.77	782.73	256.52
December	6.11	52.41	4.05	1740.09	241.59
Total 1972	200.37	225.02	106.67	9454.54	1885.75
1971	51.76	347.14	70.89	5463.52	4643.53

Shore-seines *(Rampani* and *Yendi)* were the main gear at Karwar and Mangalore, the gill net and cast net at Ullal, the boat-seine *(Pattenkolli)* at Calicut and the boat-seine *(Thangu vala)* at Cochin. The catch per unit also showed a decline in the abundance of oil sardine in 1972, as compared to 1971 at Cochin, Ullal, and Baikampady but the CPUE increased at Calicut and Karwar.

At the beginning of 1972, the previous year's recruitment was represented by three major broods at modal lengths of 145,135 and 115 mm, while the older year-classes were represented by three modal sizes at 170; 180 and 195 mm. The current year's recruits varied from 50 mm to 135 mm during the period August-December and contributed to the fishery. At the centres where shore-seine was operated-Karwar and Baikampady-the 1972-year-class contributed to 55–60% of the annual catch, whereas at Ullal, Calicut and Cochin older year-classes formed the mainstay (70–85%) of the fishery.

An unusual feature noted this year was the occurrence of juveniles in large numbers in the backwaters and river mouths at Cochin, Mangalore and Karwar.

The spawning season was, as usual, June to October. But an examination of mature specimens during this period indicated that their reproduction was impaired probably because of below average monsoon. Based on it, our earlier forecast was that the fishery for juveniles will not be good.

Females were more numerous than the males among the spent and recovering fish at Karwar in October. At Cochin, the sex-ratio was almost equal. While at Mangalore females dominated the catches throughout the year, at Calicut they were dominant in February and May-June and October-December.

Scale studies were continued. The size group 135-155 mm had one ring, 160-185 mm had two rings and 180-205 mm three rings. A total of 314 tagged oil sardine was released at Cochin.

Stock assessment:

It has been estimated that on an average about 30% of the stocks in the grounds is being exploited every year. During the period 1960-71, the average annual stock in the fishing grounds was estimated to be about 810,000 tonnes as against the average annual catch of 210,000 tonnes.

Forecast

According to the forecast made earlier, the catches declined in September-December on the west coast as a whole as compared to the corresponding period of 1971. In the coming half year also (January-June, 1973), the catch is likely to be poorer than that of the corresponding period of 1972.

Personnel

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Fishery and biology of the Indian mackerel, ***Rastrelliger Kanagurta*** **and other species of** ***Rastrelliger.***

(FB/MF/2)

The total mackerel landings during the year showed a sharp decline from the figures for 1971 at all observation centres, except at Baikampady (near Mangalore). From Table 12, it will be seen that the decline was relatively greater in the southern and northern zones than in the central zones. The landings during October-December, the period of peak catches in normal years, was markedly low this year. At all the centres except Calicut, the catches in the first half of the year were greater than those of the second half-again a feature showing deviation from normal years. All the evidence thus indicate a marked reduction in the stock during the year available for exploitation in the traditional fishing ground.

The important gear operated were: shore-seine (major gear) purse-seine and cast-net at Karwar; shore-seine (major gear) *pattabale* (encircling gill net), bottom set gill net and cast net at Mangalore; boat seine *Pattenkolli vala*, major gear) and gill net at Calicut; boat seine (*Thangu vala*, major gear) and gill net at Cochin; shore-seine, boat-seine, drift net and hook and line gear at Vizhinjam. Boat-seine and drift net were equally important at Vizhinjam.

The range of sizes available were: 87-255mm at Karwar: 175-250mm at Mangalore; 110-245 mm at Calicut; 75-289 mm at Vizhinjam. The modal sizes varied mainly between 192 mm and 242 mm from January to May at various centres. In June-July, small fishes with modes from 82 to 92 mm were abundant along Vizhinjam-Cochin area. These were absent at the other centres (northern). In July, fishes with mode at 102 mm were also found at Karwar but not at Calicut and Mangalore (central zone). The continued occurrence of small mackerel at Vizhinjam during July-September clearly indicates that this area forms one of the nursery grounds of mackerel. In October the modes at various centres varied from 127 to 242 mm.

Summing up, the Vizhinjam-Cochin area and the Karwar area (southern and northern zones) had a good abundance of small-sized mackerel (less than 110 mm) in June-September; but these were absent in the central zone during this period. The catch data, on the other hand, indicate a relatively better abundance of commercial size groups in the central zone. There seems a likelihood of a movement of the mackerel population from the southern and northern zones towards the middle zone. This problem will receive a greater attention in subsequent years.

Food studies indicate a greater proportion of phytoplankton and tintinnids in the diet of this fish during this year as compared to years of

TABLE 12. *Estimated total monthly landings of mackerel (in tonnes), at different centres, 1971 and 1972*

Months	Karwar 1971/1972	Mangalore* 1971/1972	Calicut 1971/1972	Cochin 1971/1972	Vizhinjam 1971/1972
Jan.	118.93/274.14	93.75/129.26	257.30/110.55	167.28/47.34	0.87/1.83
Feb.	329.15/458.12	8.23/28.40	150.41/124.03	123.82/14.46	3.13/2.07
Mar.	827.77/6.10	51.89/91.39	224.30/124.71	132.53/144.81	18.03/9.48
Apr.	926.41/0.0	79.71/4.12	65.43/25.53	209.03/103.02	14.54/16.93
May.	4.20/0.0	0.31/1.22	70.63/34.81	212.02/2.91	21.53/4.72
June	0.0/0.0	0.0/0.92	28.84/6.19	0.0/11.28	0.0/1.35
July	0-09/0.04	0.0/0.0	6.75/27.97	0.0/1.15	18.59/7.22
Aug.	0.0/0.01	0.0/0.12	7.41/141.61	0.09/2.66	10.12/5.95
Sept.	0.17/0.19	5.16/0 0	438.79/317.32	12.03/56 01	15.29/4.33
Oct.	0.0/35.77	6.85/4.95	412.81/22.92	85.56/138.47	45.15/0.05
Nov.	1641.92/333.93	2.90/15.12	306.04/23.63	189.55/26.95	7.07/0.0
Dec.	977.29/40.62	20.20/0.13	258.40/86.09	63.48/0.01	6.56/0.04
Total	4855.88/1149.60	269.00/278.23	2227.11/1045.35	1195.39/549.07	160.88/53.95

* Baikampady + Ullal.

high catches when the food consists largely of zooplankton. Maturity studies showed the dominance of maturing, ripe and spent fishes in the catches of March-September, as has been observed in previous years.

Juveniles were recorded in the estuary and backwaters at Cochin in July-September. Scale studies confirmed the findings of previous years. No rings were found in mackerel less than 230 mm in length; one ring was found in mackerel 230-250mm in size, and two rings in mackerel above that size. From the size distribution and scale studies it may be stated that the bulk of catches on the west coast consisted of mackerel which were about 2 years old.

Mackerel in small numbers were also landed at Madras and Port Blair. The estimated catch at Port Blair was 4.4. tonnes in 1972 as against 3.3 tonnes in 1971. In addition to the species *R. kanagurta*, another species *R. faughni* occurred at Madras and *R. brachysoma* at Port Blair. The size range of *R. kanagurta* was 50-290 mm at Port Blair; small fish of the range of 50-120 mm were also available in August; spent fishes were common in July.

At Madras *R. kanagurta* contributed to the fishery in July-December and the length-range was 109-260mm. The majority of fish examined were immature. *R. faughni* formed a fishery only in the first quarter, the size was more than 220 mm; the majority of specimens examined were mature.

Stock assessment

It has been estimated that on an average about 49% of the stock in the fishing grounds off the west coast are exploited every year. During the period 1960-71, the average annual stock in the fishing grounds off the west coast was estimated to be about 133,000 tonnes as against the average annual catch of 65,000 tonnes.

Forecast

As per the forecast made earlier, the fishery of the September-December season off the west coast was poorer than that during the corresponding period of 1971. No improvement is expected during the coming half year (January-June 1973).

Personnel

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Fishery and biology of prawns
(FB/MF/3)

The total landings of marine crustaceans during the year were 171300 tonnes which is the highest annual catch recorded so far. All the three categories of crustaceans, namely penaeid prawns, non-penaeid prawns lobsters and crabs registered an increase during the year. India has now become a leading nation as regards marine crustacean production in the world. The increase in the catch of penaeid prawns was partly reflected in the quantity of prawns exported from the country during the year. This amounted to 31,747 tonnes which is valued at Rs. 53 crores as against 25,729 tonnes, valued at about 35 crores in 1971.

The state-wise figures of the crustacean landings are given in Table 13. A decline in the catch of penaeid prawn is evident in Andhra Pradesh, Pondicherry and Gujarat.

The mechanised vessels operating trawl nets were active almost throughout the year except during the monsoon months on the west coast. There was a general increase in the fishing activity on the east coast mainly brought about by the fishing operations of some private fishing companies which have imported trawlers. Another significant development that took place in the capture fishery for prawns is the widespread use of the gill nets (made of synthetic twine) in the nearshore waters, particularly in the southern states.

The prawn fishery of the mud-bank of Kerala during the monsoon months was relatively poor and lasted only for a brief period at Ambalapuzha and Azhicode-Nattika areas.

TABLE 13. *Statewise landings of crustaceans*

States	Penaeid prawns		Non-penaeid prawns		Other crustaceans	
	1972	1971	1972	1971	1972	1971
West Bengal and Orissa	1400	1414	—	86	3	1
Andhra Pradesh	4866	8917	437	288	243	95
Tamilnadu	4843	3637	148	62	9515	6059
Pondicherry	177	289	5	1	408	178
Kerala	35007	31294	711	1519	135	523
Mysore	5559	4420	17	—	346	1763
Goa	279	279	—	—	11	11
Maharashtra	20112	18974	83952	74637	487	979
Gujarat	2013	2873	218	141	393	3
Andamans	12	12	—	—	—	—
Laccadives	—	—	—	—	—	—
Total	74268	72109	85488	76734	11541	9612

Note: 1972 figures are provisional and subject to correction.

The catches of prawns from different areas pertaining to 9 observation centres are given in Table 14. At Cochin, where prawn fishery was at its peak, the catch-per-hour from the small mechanised trawlers was 15.8 kg as against 14.9 kg in 1971. This shows that in 1972 the level of abundance of prawns was slightly greater than that of 1971. The level of abundance however, at Calicut and Mangalore was much greater than at Cochin.

At Cochin the principal species landed by the mechanised vessels were *Metapanaeus dobsoni* and *Penaeus indicus* during the first half of the year and *M. dobsoni* and *Parapenaeopsis stylifera* during the second half of the year. At Calicut, *P. stylifera* was the dominant species in the trawl catches throughout the year except in December, when *M. dobsoni* became dominant. At Mangalore, the mechanised fishing boats were most active from March to June and in September. *M. dobsoni* and *P. stylifera* were the dominant species during these months. At Mandapam, *Penaeus semisulcatus* formed the fishery. A slight change in the occurrence of some of these species was noticed in the commercial catches at Cochin, where *M. monoceros* and *M. affinis* failed to appear in large quantities in the offshore fishery in Novermber and December.

Estuarine prawn landings from the back waters at Cochin were slightly lower (900 tonnes) than those of the previous year (1,150 tonnes). The percentage composition of *M. dobsoni* showed an increase, while that of *P. indicus* was almost equal to that of the previous year. *M. monoceros*, *M. affinis*, and *P. semisulcatus* on the other hand, showed a decrease. The mass influx of the African weed (*Salvenia* sp) often hindered the operation of stake nets, cast nets and Chinese nets in the estuarine region. The caridean prawn, *Macrobrachium idella*, was found in large quantities (26 tonnes) in the estuarine catch. As compared to the previous year, there has no significant change in the size composition of the commercial species from the estuarine region.

The average catch rate of prawns in the samples obtained from the stake nets and Chinese net at Thevara (Cochin Backwater) were 5.31 kg and 3.59 kg respectively per operation as against 4.51 kg and 2.58 kg during the previous year. This tendency of an increase in the abundance however, was not noticed from the overall landings of the backwaters.

Try net collections were continued to be taken from the Cochin Backwater to study the abundance of juvenile penaeid prawns which enter and leave the nursery areas. Large-scale recruitment of juveniles was noticed during February-July and in October. Over 84% of the juveniles belonged to the genus *Metapenaeus* and the rest belong to the genus *Penaeus*. *M. dobsoni* was the predominant species, but from May to July, *M. affinis* was also common. These juveniles belonging to all the commercial species were within the size range, 11mm to 90mm.

Details of occurrence of different species and their seasonal distribution at different centres have been given in Table 4.

TABLE 14. *Particulars regarding the prawn fishery at different observation centres during the year 1972*

	Veraval	*Bombay*	*Karwar*	*Mangalore*	*Calicut*	*Cochin*	*Mandapam*	*Madras*	*Kakinada*
Offshore prawn catch									
Catch in tonnes	33.5@	600.0	175.8	1538.6	198.0	2141.0	259.9	134.6	865.8
Catch/effort (Kg/hr.)	—	—	—	55.9	93.8	15.8	—	2.2	12.8
Important species*	2,9	16,9,12,11	1,9,?,3	9,1,2,5	1,9,5,2,3	9,1,5,3	8,5,7,2	5,8,3,1	1,3,4,5,2
Peak fishing season**	1	10,11,12	3,4,11,12	5,4,3,9	11,12,1	3,4,10,11	3,4,2	9,5,12	1,2,8,6
Inshore prawn catch									
Catch in tonnes	29.0@	2769.0	2.1	0.039	120.0	—	—	7.4	—
Catch/effort (kg/hr.)	2.14 kg net/day	—	—	—	—	—	—	1.0/unit	—
Important species*	9,13,12	14,16,12, 10,9,2	6	1,5	9,1,5	—	—	5,3,7,1	—
Peak fishing season**	2,3	5,4,11,10,12	6,7	8,9	9,7,6	—	—	12,9,8	—
Estuarine prawn catch									
Catch in tonnes	—	—	3.8	—	32.8	897.8 from open estuary 877.8 from paddy field.	—	—	321.8
Catch/effort (kg/hr.)	—	—	—	111.0+	16.47	303.7 kg/acre	—	—	11.16
Important species*	—	—	3,1	1,5,3,7,6	1,3,5,7	1,3,5,2,8	—	—	3,7,5,4,1
Peak fishing season**	—	—	3,2,12	11,10,9,4	10,12,1	3,2,6,10	—	—	10,12,7,8

** Months of the year @ Estimate for first half of the year. + kg/operation in departmental collection.

*** Species numbered**

1. *Metapenaeus dobsoni*
2. *M. affinis*
3. *M. monoceros*
4. *M. brevicornis*
5. *Penaeus indicus*
6. *P. merguiensis*
7. *P. monodon*
8. *P. semisulcatus*
9. *Parapenaeopsis stylifera*
10. *P. hardwickii*
11. *P. sculptilis*
12. *Solenocera indica*
13. *Hippolysmata ensirostris*
14. *Palaemon styliferus*
15. *P. tenuipes*
16. *Acetes indicus*

Biological details

Penaeus indicus: This species is the most valuable from among the commercial prawns in the country. It was well represented in the marine and estuarine catches from both west and east coasts of India. In Bombay and Karwar, however, the species was rather less abundant. About 6,000kg of this species was landed by the trawlers operating from Mangalore. In the offshore catches at Calicut modal size of *P. indicus* was observed at 136-140mm in the first half of the year but smaller sizes (96-105 mm) supported the fishery in the second half. The prawn fishery at Colachel during the monsoon months was entirely supported by this species which were in late maturing and mature stages. Here the modal size observed at 146-150 mm in May shifted to 186-190 mm in November. *P. indicus* was the most predominant species among the prawns caught by the mechanised vessels at Royapuram, Madras. The modal size of the species at Madras ranged from 111-115 mm to 206-210 mm. In the Kakinada trawl fishery the species exhibited two peaks of occurrence (January-March and June-August) Larger sized prawns (180-210mm) in mature condition constituted the fishery from January to March and smaller sized prawns (130-180mm) predominated from June to August.

In the estuarine catches at Mangalore, Calicut, Cochin and Kakinada, the species was well represented and its size ranged from 43 mm to 128 mm at all these centres. The backwater fishery continued to function throughout the year.

P. merguiensis: In the commercial catches, *P. merguiensis* was recorded only at Karwar and Kakinada. Of the 2.4 tonnes of this species landed at Karwar, the major portion came from the shore seine operations in June and July. In the catches of the mechanised vessels, the species was present only in June. The modal size of the species remained at 141-150mm in the trawler catches, while in the shore seine catches a lower size mode at 111-115mm was seen in the earlier month. They were mostly in early maturing and immature stages. In the trawl fishery at Kakinada, *P. merguiensis* formed only 0.63% of the catches and in the estuarine fishery its composition was 1.28%.

P. semisulcatus: This was the predominant species in the catches landed by the trawlers at Mandapam and nearby areas of the east coast. Over 260 tonnes of *P. semisulcatus* were landed at Mandapam alone by the mechanised fishing vessels. A new fishing ground of this prawn has been found off Chinna Ervadi near Mandapam. Smaller size groups (96-110mm) were predominant in March-April indicating their fresh recruitment. In the later months, the dominant size mode was at 136-145mm. The sex ratio of the species showed irregular and unequal distribution indicating that something like sex segregation occurs in the fishing grounds. *P. semisulcatus* was landed in considerable quantities by the trawlers operating at Madras in July, August, October and November.

Metapenaeus dobsoni: This species was most dominant in the commercial catches from Karwar to Cochin on the west coast and at Kakinada on the east coast. At Karwar, *M. dobsoni* formed nearly 50% of the total prawn catches landed by the mechanised vessels. Peak landings were noticed in April and December. The modal size of this species increased from 66-70mm in January to 116-120mm in November. The Smaller size groups entered the fishery in January and November. The catch was poor from June to September (the monsoon period). In the stake net catches from the backwaters at Kagal, juveniles of the species (31-50mm) were present in all the months except April, July, August and September. *M. dobsoni* formed nearly 48.4% of the prawn landings from the mechanised vessels at Managalore. The modal size of the prawn increased from 71-75mm in January to 116-120mm in October. From June to August, there was no fishing. Smaller sizes, with mode at 71-75mm entered the fishery in December. Juveniles of *M. dobsoni* (16-20mm to 61-65mm) were most predominant in the catches of the departmental shore seine operated at Bengre, Mulki and Kasargod. At Calicut, the species formed the major portion of the trawl catches only in December and formed the bulk of the boat seine catches during the monsoon months. The size distribution on the catches was identical with what was observed at Mangalore and Karwar. Large sized *M. dobsoni* were caught in fair quantities in the gill nets during the monsoon months. At Cochin, it formed 33.8% of the offshore catches. Its mode varied from 71-75mm in the first half of the year to 81-85mm in the second half of the year. In general, no significant change in the pattern of occurrence of this species along the west coast was noticed during the year. At Kakinada *M. dobsoni* occupied the formost position in the trawl catches forming nearly 37% of the total. Its peak landing was observed in January and February. The fishery for this species was mainly supported by 70-90mm and 85-105mm size groups. Smaller size groups were predominant in January and February, and the larger ones in October-December. Mature and spent females were found throughout the year with a peak in November-February indicating that it spawns continuously.

In the estuarine catches at most of the centres, *M. dobsoni* was the predominant species. It was caught throughout the year from the estuarine centres at Kagal near Karwar, Bengre near Mangalore, Korapuzha near Cailcut, Cochin backwaters and paddy fields and at Bengara Venkata Palem, near Kakinada. At all these centres, the catch consisted of juveniles which were below 70mm in length.

Metapenaeus affinis: Although not caught in very large quantities, this species was present in the commercial catches at all centres of observation, particularly at Bombay, Karwar and Cochin. At all the centres, the higher size groups (121-125mm) noticed in the first half of the year, were replaced by the smaller size groups (91-95mm) in the second half of the year. In the estuarine catches, juveniles of this species were

observed only at Cochin and Kakinada. At Cochin, the species was most abundant among the monsoon months (May, June and July).

Metepenaeus monoceros: In the catches of the mechanised vessels along the west coast, the species was observed only at Karwar and Cochin. At Karwar, it appeared only in January and at Cochin it was more common in the first half of the year. In the normal pattern of succession, the species should appear in the commercial catches at Cochin in fairly large quantities in October/November, but the catch during this period was not significant. The modal size of the species was at 121-125mm indicating that prawns of the larger size groups were not abundant. In the trawler landings at Kakinada, the species formed about 13.62% of the total catches. While the species was fished throughut the year, its peak landing occurred from April to August. Size groups of 130 to 160mm dominated the fishery during March-July and juveniles of 70-100mm in the later part of the year. Mature and spent females were observed throughout the year with a peak in March-July. Females generally predominated the catches. Juveniles of this species formed a significant part of the commercial catches in all the estuarine centres.

Metapenaeus brevicornis: This species is commercially exploited at Kakinada and adjacent areas. A total quantity of 107 tonnes forming nearly 12.3% of the prawn catches were landed by the mechanised trawlers operating from Kakinada. This species also occurred throughout the year but its peak landings were from August to November From the estuarine centre at B. V. Palem, 17 tonnes of juveniles, were landed by the drag net, forming 8% of the landings. The trawl fishery of *M. brevicornis* was mainly supported by females of 100-135mm and males of 70-85mm. Females predominated the landings in all the months. Mature and spent females were often seen from June to December. In the estuarine catches, juvenile of 31-65mm were predominant.

Parapenaeopsis stylifera: *P. stylifera* was the most predominant species of prawn in the commercial catches at all centres in the first half of the year. In almost all the centres, the modal size of the species remained steady within 86-120mm. At Karwar, Mangalore and Cochin, smaller prawns (71-80mm) formed another mode, particularly in May and June. In the catches of the mechanised boats at Kakinada, the species formed 2.5% of the catches landed during the second half of the year.

Acetes indicus and Palaemon tenuipes: Both these species together accunted for 923 tonnes of the landings from Sassoon Dock and Versova at Bombay, forming 68% of the prawn catches at these centres. Peak landings of *Acetes indicus* were in February and those of *Palaemon tenuipes* in April-May. Neither of these two species contributed to commercial catches at the other centres. Although the size range of *A. indicus* was 14-36mm, the larger prawns (24-36mm) were predominant from February to May and smaller sized (14-24mm) in the post-monsoon months. The

females were predominant throughout the year. The fishery of *P. tenuipes* was supported by 15-35mm size groups at Sassoon Docks and 24-72mm size groups at Versova. Mature specimens were observed from January to June and berried females were common from September to November.

Larval and juvenile stages of prawns: Regular plankton collections were made from the inshore sea and from the backwaters to study the rate of recruitment of larval and post-larval stages of prawns in the estuaries. The larval recruitment was found to be relatively high throughout the year both in inshore and backwater plankton, particularly during the last quarter of the year. The highest larval count (245.88 per haul) was recorded in December 1972 from the inshore station. The average larval count for the whole year was 74.8 per haul, as against 3.5 perhaul in 1971 from the inshore waters. Larval forms of *M. dobsoni* were the most predominant and these occurred throughout the year. Older larvae and post-larvae were common in February-March and September. Larval forms of *P. indicus* were absent while all the other species were represented in fair numbers.

Backwater plankton also contained relatively larger numbers of larvae and post-larvae of prawns. The average larval count was 56.2 per haul, as against 3.4 per haul in 1971. Similar trend of occurrence, was noticed in the inshore waters. A few advanced stages of post-larvae of *P. indicus* were seen in collections. The reduction of larvae and post-larvae in the backwaters, as compared to what was noticed at the marine station, was not very significant and as such the larval mortality at this stage does not seem considerable.

In the Korapuzha estuary, near Calicut, peak post-larval recruitment was observed in the first and third quarter of the year. Larval and post-larval forms of *P. indicus*, *M. dobsoni* and *M. monoceros* were predominant.

Larval rearing in the laboratory: Three species of commercially important brackishwater prawns *Macrobrachium rosenbergii*, *M. idella* and *M. equidens* and the shrimp *Leandrites celebensis* were reared successfully from zoea to juvenile stage. In the life history of *M. rosenbergii*, there are 8 stages and within 31 to 42 days it becomes juvenile and acquires all adult characters. The larval developments of *M. idella* and *M. equidens* were almost identical and both the species passed through 11 stages within a period of 41 days before transforming to juvenile stage. *L. celebensis* took a minimum period of 12 days to complete its life history.

Laboratory experiments showed that *M. idella* can be made to breed in captivity at any time of the year if suitable environmental conditions are given. *M. idella* measuring 42mm in total length obtained from a brood hatched on 3-10-'72, after the various stages were reared in the laboratory, became berried on 1-2-'73.

Prawn culture in paddy fields: The prawn culture activity in paddy fields was observed in the Vypeen Island. A total quantity of 878 tonnes of juvenile prawns was obtained from the paddy fields. Of this, 783 tonnes came from the seasonal fields and the rest from the perennial fields. The highest catch was obtained in February and the lowest in December. The yields for seasonal and perennial fields were 305.38kg per acre and 290.97kg per acre respectively. *M. dobsoni* (53%), *P. indicus* (42.4%) and *M. monoceros* (3.8%) were the main components of the catches. The mean size of these prawns was: *M. dobsoni*, 55.89mm; *M. monoceros* 74.25mm; *P. indicus* 100.0mm. Relatively larger sized prawns were obtained from the perennial fields.

Forecast: From the significant increase in the recruitment of larval and post-larval prawns this year in the Cochin-Calicut area, it seems that the backwater catches in the second quarter and the sea catches in the third and fourth quarters of 1973 would be better than those of the corresponding periods of the last year.

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Investigations on Other Fisheries

Fishery and biology of commercially important elasmobranchs

(FB/OF/1)

The investigations were carried out at Bombay, Tuticorin, Mandapam and Porto Novo. At Tuticorin and Mandapam many fishermen have switched to prawn and lobster fishing and so there has been a fall in the catches of elasmobranchs.

The important species of the sharks caught were: *Caracharhinus limbatus* at Bombay, *Loxodon macrorhinus*, *Scoliodon* spp., & *Carcharhinus* spp., at Tuticorin, *Rhizoprionodon oligolinx* and *R. acutus* at Madapam and *Carcharhinus dussumieri* at Porto Novo. Regarding skates, *Rhynchobatus djiddensis* was the important species at Bombay, Tuticorin and Porto Novo. The important species of rays were: *Dasyatis* sp. at Bombay, *Himantura alcockii* and *Dasyatis sephen* at Tuticorin and *Gymnura poecilura* at Mandapam.

Elasmobranchs were caught throughout the year. The shark catches were good during the first, second and third quarters of the year at Mandapam and from March to July and September at Porto Novo. Rays were landed in large numbers during the second half of the year in the

Tuticorin area and during the first and third quarters in the Mandapam area. Driftnets, trawl and hooks and lines were the main gears employed.

Biological studies were undertaken on the important species. At Bombay, the catches of *Scoliodon sorrakowah* were supported mainly by the size range 150-550mm. Small sharks of the size range 160-300mm were dominant in June. The ratio of male to female was 1:3 from January to October, but 1:1 in November and December. Gravid females were observed from March to May and in November, December. The embryos usually 8 in numbers measured 12-65mm in size. Cephalopods were the main food. At Tuticorin the size range of the shark *L. macrorhinus* was 415-750mm. Females formed 70-90% of the catches. Gravid females were most common in June and August, there being a maximum of only 2 embryos in each female. The food consisted mainly of fishes, cephalopods and prawns. At Mandapam, the shark, *R. oligolinx* had the size range 270-720mm and *R. acutus* 271-890mm. Gravid females were common from April to June in the former and June and July in the latter, the number of embryos varying from three to six in the former and two to four in the latter. Both species fed mainly on fishes (silver bellies and sardines), cephalopods and crustaceans. At Porto Novo, the parturition period was March-May in *C. dussumieri*, September in *Sphyrna tudes* and March-April in *S. blochii;* fishes, cephalopods and prawns formed the food of all sharks.

Personnel

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Fishery and biology of Bombay duck, anchovies and lesser sardines.

(FB/OF/2)

Bombay duck

Observations were carried out at 5 fishing centres in Maharashtra and 2 fishing centres in Gujarat. In general, the 1972 fishery was poorer than that of 1971. The size ranges recorded at different centres are indicated below:-

	State	Centre	Length range
1.	Maharashtra	Dahanu	75-330mm
		Versova	15-330mm
		Alibage	30-345mm
		Murud	30-360mm
		Dabhol	15-345mm
2.	Gujarat	Nawabunder	35-338mm
		Jaffrabad	25-338mm

The catch was supported mainly by immature fish (less than 210mm) from January to May and by adults (more than 210mm) in November and December at Dahanu and Versova. At Alibag, Murud and Dabhol, the catch comprised mainly of adults. In Gujarat at Nawabunder and Jaffrabad, the catch comprised of immature fish up to the end of November and of adults in December. The average length of the fish during 1972 varied from 167 to 219mm at different centres as against 161-182mm in 1971, thus showing a slight improvement in the size during the year 1972. However, except at Dahanu, the average size was still below the minimum size at maturity, i. e. 210mm. Thus the overall picture of the size of the fish in the commercial catch was not very encouraging.

At Dahanu the percentage of mature fish showed a substantial improvement in 1972 as compared to 1971 during November and December. However, a substantial decrease occurred in January and February. At Versova, there was no change in the percentage of mature fish, compared to 1971. At Murud and Dabhol, some increase in the percentage of mature fish was noted. The maturation studies showed that the species spawn throughout the year with a peak from November to March. As in earlier years, the food consisted mainly of *Acetes spp. Palaemon spp., Polynemus spp., Bregmaceros sp. Coilia spp.* and *Harpodon nehereus.*

The fall in total catch and catch per unit of effort in 1972 and the trends noted in recent years in regard to the average sizes and percentage of mature fish in the catch give room for continued anxiety in regard to the problem of overfishing. A close watch on the catch trends is being maintained.

Personnel

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Anchovies

The fishery of anchovies in general was good. At Vizhinjam, the total catch was about 430 tonnes and at Waltair about 7.5 tonnes. *Stolephorus devisi* contributed about 72% of the catch at Vizhinjam and *S. bataviensis* about 25%. The important species at Waltair were *S. bataviensis* (forming about 56% of the catch) and *S. heteralobus* (forming about 40%). The period of maximum catches was October at Vizhinjam and November and December at Waltair. At Vizhinjam, the size range of the two species was 35 to 115mm; the dominant monthly modal sizes varied from 40 to 89mm. At Waltair the size range of *S. bataviensis* was with modal sizes varying from 50-to 99mm; the size range of *S. heteralobus* was 30 to 84mm, and the modal sizes 45-69mm in different months. At Vizhinjam, *S. devisi* in advanced stage of maturity were observed throughout the year, with 2 peak seasons: one from April to June and the other from October to November. Mature specimens of *S. bataviensis* were rare at

Vizhinjam but were dominant in the March catches at Waltair. *S. heteralobus* in advanced stages of maturity were found in large numbers in November and December at Waltair. Copepods and bivalves were the important items in stomach contents of the anchovies at both the places in most months, but in September and October, polychaetes formed the dominant food item of *S. bataviensis* at Vizhinjam.

Personnel

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Lesser sardines

While the fishery was good at Karwar, Tuticorin and Mandapam Camp, a sharp decline was noticed at Vizhinjam and Waltair. The bulk of the catches was landed during the second half of the year at Karwar, but during the first half at Vizhinjam, Mandapam and Waltair. The principal species were: *Sardinella fimbriata* at Karwar and Waltair; *S. gibbosa* and *S. sirm* at Vizhinjam, and *S. albella* and *S. gibbosa* at Mandapam and Tuticorin. The other species represented in the fishery around the peninsular tip were *S. clupeoides, S. dayi* and *S. fimbriata.* The fishery was exploited largely by shore-seines and gill nets. From the studies on the size composition, it would appear that the size at one year was as follows: 150mm in *S. fimbriata;* 140mm in *S. dayi* and *S. gibbosa;* 125mm in *S. albella.* All species, except *S. fimbriata,* appear to spawn in the first half of the year. The spawning season in *fimbriata* extends from February to April at Vizhinjam, and May to November at Karwar and Waltair. In the sardines at Karwar and Waltair, males outnumbered the females. However, generally females were in the majority in the case of *S. fimbriata, S. gibbosa* and *S. albella* at Vizhinjam, Tuticorin and Mandapam. In *S. sirm,* males registered a higher percentage both at Vizhinjam and Tuticorin. Food studies indicate that the sardines feed largely on small crustaceans.

Personnel

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Fishery and biology of tunas, seerfishes and bill fishes

(FB/OF/3)

Tunas and billfishes

Tunas in appreciable quantities were landed at Minicoy and at Vizhinjam and Tuticorin. At Minicoy, the total estimated catch was about 424 tonnes, about 96% of it consisted of the skipjack, *Katsuwonus pelamis* and 4% of the yellowfin, *Thunnus albacares.* The period of peak catch was January-April for the former and December and April for the latter. May-October was the period of low catches. The stomach contents of the

skipjack consisted mainly of baitfishes. Other items included juveniles of other fishes, crustaceans and cephalopods. During January-March males dominated the catches.

Scarcity of bait fishes has affected the catches adversely during the year.

In the Vizhinjam area, the fishery was good this year. Driftnet was the main gear employed and the catch rates were good in October-December. The main catch was of the little tunny, *Euthynnus affinis*. The size range, in the case of first species, was 260-650mm and in the case of the other 260-510mm.

In Tuticorin, tunas were caught in driftnets and by hook and line. The important species were *Katsuwonus pelamis* and *Euthynnus spp.*

At Mandapam, tunas in appreciable quantities were observed only on the Gulf of Mannar coast. At an observation point at Mandapam, about 26 tonnes of tunas were landed exclusively by driftnets, the period of high catch rates was February-April. The main species was *Euthynnus affinis*.

The catch of bill fishes was negligible. These fishes occur with the other scombroids, mainly during the second half of the year. At an observation point near Mandapam, they formed about 0.2% of the catches from driftnets.

Personnel

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Seer fishes

Studies were conducted at Mandapam. An estimated quantity of 308 tonnes of seer fishes was landed at Rameswaram Island during the year (101 tonnes from the Palk Bay and 207 tonnes from the Gulf of Mannar) as against 172 tonnes in 1971. The main gear employed was drift net. The important species caught were *Cocmberomorus commersan*, *S. lineolatus* and *S. guttatus*.

In *S. commerson*, the breeding season extended from March to July. Food consisted mainly of fishes and crustaceans. No decrease in the rate of food consumption was noticed with the advancement of maturity.

Personnel

M. Devaraj, SRA.

Biology of cat-fishes, perches, carangids and lizard fishes

(FB/DR/1)

Cat-fishes

At Waltair, there was an improvement in the availability of the cat-fish, *Tachysurus thalassinus*, in the trawling grounds as evidenced by the fact that the Government of India Vessel, *M. V. Champa*, obtained a catch per hour of 1.5kg this year, as against 0.5kg last year. The other Government of India Vessel *M. V. Meena sohdahak*, recorded a catch per hour of 1.5kg this year. Peak catch rates were recorded in June, October, and December. However there was a decline in the inshore catch of this species.

In the Mandapam area, the fishery for cat-fishes is of developing nature. The main gear used here is the purse seine and drift nets. Catches were high during March, June and August-October. Large shoals were sighted and exploited from the Palk Bay in August-October.

The main species contributing to the fishery at Waltair are *Tachysurus thalassinus* and *T. tenuispinis*, the former forming about 30% and the latter about 70% of the cat-fish landings of the Government of India vessels. The size range of *T. thalassinus* was 120-140mm. The annual length frequency distribution showed two modes, 180-200mm and 340-360mm. The catches were supported mainly by one-year-old fish having modal size of 180-200mm.

The important species at Mandapam were, *Tachysurus thalassinus* and *T. dussumieri*. The first species was dominant in the first, second and fourth quarters, and the other species in the third quarter. Some differences in the modal size of *T. thalassinus*, as compared to the Waltair area, were observed. The modal sizes at Mandapam were 240-260mm and 360-380mm, in October, 160-180mm and 220-240mm in November and 180-200 and 280-300mm in December. In the spine sections of this species measuring 300-320mm in length, one ring was found. The food of *T. dussumieri* was studied. The fish was found to be bottom as well as column feeder. It fed on crabs, prawns, echiurids and fishes; the smaller size groups feed entirely on bottom, while the large ones ascend to the column waters.

Personnel

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Perches

In the Bombay area, the relative abundance of the *Karkara, Pomadasys hasta*, was better this year as compared to last year. Although the catches occurred throughout the year, the peak season was October-March. At Cochin, the threadfin bream, *Nemipterus japonicus* was an important constituent of the catches of the mechanised vessels. At Madras, the catch of *Lactarius lactarius* was poor. The Government of India vessel, *M V. Meenasitara,* started operating off Madras in November. *Lactarius* formed 5% of the catches of the vessel in November and December from the depth-range 9.20m. At Mandapam, the *Lactarius* fishery was poorer this year than that of the last year. The main gears employed were drift net and trawl net.

The size range of *P. hasta* at Bombay was 50-559mm in the local country-craft trawl net, barrier net and shore-seine, 110-659mm in the trawl nets operated by the vessels of the Deep Sea Fishing Station and New India Fisheries, and 210-659mm in the hook and line and gill net catches. The modes varied from 35-585mm. In the lower ranges (35-335mm) the mode occurred in the first type of gear, those in the upper ranges (435-583mm) in the second type and those in the middle ranges (435-535mm) in the third type of gear. The study of otoliths showed the number of rings to vary as follows: One ring in the size group 130-240mm; 2 rings in the size group 250-333mm; 3 rings in the size group 370-470mm, 4 rings in the size group 480-530mm; 5-6 rings in the size group above 570mm. The study of food indicated the fish to be a carnivorous and bottom feeder.

The size range of *Nemipterus japonicus* at Cochin was 71-250mm. Small fishes occurred during the period December-April. The dominant food item included crustaceans.

At Madras, very small fishes *(Lactarius)* with mode 25-30mm were recorded in shore-seine in April. Most of the fish examined in November-December were in advanced stages of maturity. The fish fed mainly on anchovies, other small fishes and prawns.

At Mandapam, this size ranges of *Lactarius* was 140-240mm. In the scales of specimens ranging from 210 to 240mm, two rings were found. Mature fish were seen in large numbers in October-December. There were more females than males in the catches.

Personnel

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Lizard fishes

The mechanised boats at Royapuram (Madras) landed about 92 tonnes of lizard fishes, which formed about 4% of all the fishes caught. The catch and catch rates were high in February, July and October-November.

The catches were supported by two species: *Saurida tumbil* and *S. undosquamis*. The size range of the first species was 141-390mm and of the other 141-220mm. The majority of specimens of *S. tumbil* examined in January-April were found to be partially spent. From July to October the majority of fish were immature/maturing. There was a preponderance of males in the samples of *S. tumbil* collected in January, March, April, July and October. Both the species fed mainly on clupeoids, (sardines, anchovies, *Hilsa* sp.), crustaceans (prawns and crabs) and cephalopods (*Sepia* sp.)

Personnel

S. Basheerruddin, AFS.

Carangids

Carangids formed about 4.3% of the catches of Government of India trawlers and 4.2% of the catches of the indigenous commercial craft (non-mechanised) at Waltair. Their abundance was better this year as compared to the last year. The bulk of the commercial catches in the inshore area (fished by non-mechanised boats) was landed by the gill net (about 60%), and by hook and line (34%). The peak catch rates were recorded in April, June and October-November by the trawls and September and November by the gillnets.

In the Vizhinjam area also, the relative abundance of carangids was higher this year, than last year. They formed about 13% of the catches from the indigenous gear. About 51% of the catches of carangids was landed by the hook and line, 36% by drift nets, and 11% by boat-seine. The catch per unit effort was high in March-April June-July and October-November.

At Waltair, *Carangoides malabaricus* was the most important species. Fish with modal sizes at 127mm, 142mm, 157mm and 167mm dominated the catches. Males outnumbered the females in most months. Feeding intensity was high during the first and the last quarters. At Vizhinjam, *Megalaspis cordyla* formed 44%, *Carangoides malabaricus*, 12%, and *Decapterus* spp. 8% of the total carangid catches. *M. cordyla* had the size range 157-438mm. The mode at 250-259mm in March could be traced to 350-359mm in October. Fish with modal size at 220-229mm were recorded in November. Females outnumbered the males. Immature and spent recovering individuals dominated the fishery. Feeding intensity was high in May and November; the most important item of the diet was *Stolephorus*

spp. The length range of *Decapterus dayi* was 37-222mm. The mode at 130-139mm in January could be traced to 190-199mm in July. In August a new mode at 70mm was observed and it could be traced to 130-139mm in December. Females dominated in all months except in January and December. Feeding intensity was fairly high throughout the year. Fishes, crustaceans and polychaetes formed the important items of food.

Personnel

S. Reuben, AFS; P. V. Sreenivasan, RA.

Biology of sciaenids, flat-fishes and polynemids (FB/DR/2)

Investigations were conducted at Bombay, Karwar, Mangalore, Calicut, Mandapam, Madras and Waltair and the commercially important species under each group were studied.

Sciaenids

The fishery of the large-sized sciaenids such as 'Koth' and 'Ghol' at Bombay was not very good as most of the trawlers continued to operate in the inshore areas. Very good catches of the '0'-and one-year-classes were, however, recorded during November and December. At Madras, the fishery was more or less stable except during the later half of the year, when fishing effort was reduced due to cyclonic conditions. At Waltair, an increase of 84% in the catches, over the previous year, was recorded. In the Mandapam area about thirty tonnes of sciaenids were landed. At Calicut, the fishery was very good this year as compared to last year.

The ghol. Pseudosciaena diacanthus

At Bombay representatives of almost all the size groups were encountered during March-April and September and December. The medium size groups in the range of 41 to 85 cm were absent in January and February and July, August and November. The juveniles fed on crustaceans, while fishes above 61cm were largely fish eaters. Females dominated the catches throughout the year.

P. sina

At Calicut its size ranged from 31 to 219mm. Specimens in almost all the stages of maturity occurred throughout the year, and large numbers with spent gonads were recorded during January-February and November-December. Prawns and fish formed its main food.

P. aneus

Fish measuring 128 to 205mm were recorded at Madras. Peak breeding activity was noticed in March-April. Food items included fish

and prawns. At Waltair the modal sizès were 150mm in February, 170mm in April and 180mm to 190mm during July and September. The length frequency studies conducted at Mandapam showed five-year classes with modal length at 87mm 119mm, 150mm, 174mm and 195mm. These studies were supported by otoliths and scale readings. It would appear from these studies that the fishery at Mandapam was supported mainly by the second and third year-classes. Food items of this species consisted mainly of fishes and prawns. At Mandapam, spawning appeared to take place from December to April; Ripe fishes were collected in April and juveniles were recorded from July to September.

P. vogleri

The length of the fish measured at Madras varied from 63 to 168mm. Breeding was prolonged with a peak between January and June. Food items consisted of fish and prawns.

P. axillaris

The few specimens examined at Calicut were in the size range of 80 to 169mm. These were mostly immature. In April and June, spent individuals were recorded. Prawns, fishes and polychaetes formed the main food items of this species.

Johnius spp.

A common fish belonging to this group from the Bombay coast has been sent to the British Museum for species identification. This species formed 30% of the small sciaenid landings at Sassoon Docks. Fish in advanced stage of maturity were noticed during the last quarter. Food items included fishes, prawns, crabs, bivalves, *Octopus* and sea anemones.

J. dussumieri

At Bombay, this species formed 5% of the small sciaenid catch. Food items included *Squilla*, prawns and fishes. Females dominated the samples from September to November, while in December, males dominated the samples. At Calicut, the size range recorded was 24 to 222mm. Specimens in all the stages of maturity were recorded throughout the year.

J. carutta

Specimens examined at Waltair varied in length from 135 to 193mm. Their stomach contents consisted mainly of *Squilla* spp. The percentage of males in the catches was more than that of the females. Fish in all the stages of maturity were recorded.

Otolithes ruber

At Calicut, the size range was 50-279mm. Mature individuals and specimens with spent gonads were recorded in January February, June, July and August.

Otolithes argenteus

The preliminary study at Madras showed that this fish formed less than 0.5% of all the sciaenids landed during the first half of the year. It increased to 2% during the second half of the year. Its stomach contained *Acetes*, prawns and fishes.

Otolithoides brunneus

At Bombay, the fishery was poor during the first half of the year. It was dominated largely by O-year-2-year classes. A monthly growth of 23mm was noticed in the first year group and 28mm in the O year group. Females dominated the catch. Food items included fishes and prawns. Feeding intensity was high during April and May and again in November.

Personnel

T. Tholasilingam, FS; S. J. Rajan, AFS; T. Appa Rao, AFS; S. Lal Mohan, AFS; K. V. Somasekharan Nair, RA; K. S. Sundaram, RA; A. A. Jeya Prakash, RA; C. Muthiah, RA; S. Srinivasarangan, RA.

Flat-fishes

The Malabar sole, Cynoglossus macrosomus

The season for this fish on the west coast by the indigenous craft and gear was August-September. This is the traditional season of fishing. At Calicut, during the year 594 tonnes were landed by non-mechanised boats of which 566 tonnes were caught in September. At Baikampady (near Mangalore), the indigenous gear caught 1.5 tonnes in September. but practically nothing in the other months. Mechanisation has however led to the expansion of the fishery into non-traditional seasons also. Thus at Malpe and Mangalore, small mechanised boats using trawls landed soles in almost all the months; at Malpe peak catch rates were recorded in February and October. In the Mangalore area, trawl catches were relatively good but the catches by indigenous gears were poorer than last year. At Calicut, however, the catches by indigenous gear (mainly *Pattenkolli*) were better than last year. At Calicut again, soles continued to occur in small numbers in the departmental boat-seine (*Paithu vala*) collections even in the months when they were absent in the commercial catches.

Size range in the Mangalore zone was 85-164mm, the modal size groups varied from 90-94mm to 140-144mm. At Calicut, the size range was 30-169mm; the monthly modes varied from 50-59mm to 150-159mm.

Both at Mangalore and Malpe, the males were more numerous than the females; fish in the immature and pre-spawning stages dominated the catches. At Calicut, both sexes occurred in almost equal proportions. In September during the period of high catches, the majority of females were

in the maturing stage although a few were in spent condition also. The food of the species consisted mainly of polychaets, copepods and diatoms.

The fishery of the other soles was not very good in the Calicut area.

Personnel

G. Seshappa, FS; A. C. C. Victor, RA.

Polynemids

The biology and fishery of the polynemids were studied at Mandapam. Six species have been recorded from the trawl catches in that region. These dominated the catches during the first and last quarters of the year. Detailed study on *Polynemus microstoma* are being conducted. The investigation of the Indian polynemids has also been undertaken and a key for their identification is being prepared.

Personnel

K. Dorairaj, AFS.

Biology of silver bellies, silver biddies, ribbon fishes, pomfrets and eels.
(FB/DR/3)

Silver bellies and silver biddies

At Waltair, boat-seines recorded an average catch per unit of 2.4kg and shore seines 9.1kg of silver bellies during the year. The Government of India trawler *M. V. Meenashodhak* registered a catch-per-hour of 17kg and *M. V. Champa* 0.7kg. The period May-June, August and November were of high catch rates.

At Royapuram (Madras), trawl nets recorded very good catches of silver bellies, forming nearly 75% of the total silver belly catch at that place. The period of good catches was April-June.

The fishery for silver bellies by the mechanised boats is now well established at Mandapam. About 7660 tonnes were landed, (7570 tonnes from the Palk Bay and the rest from the Gulf of Mannar) during the year. The catch-per-trip per boat varied from 20 to 2400kg during the year. Day fishing yielded 11-18 times greater catch per trip as compared to night fishing. The silver belly component formed 90-99% of the "all-fish" catch during the day-time operations as against 27-79% in the night operations. Nevertheless, the fishermen prefer to go for night fishing because of good catches of prawns. May-August were the best months for the silver belly fishing. That the silver belly stocks of the Mandapam area have been able to sustain the increasing fishing pressure is seen from the fact that the average catch-per-trip per boat has not declined but has gone

up from 1300kg in 1970 to 1800kg in 1972. The fish meal plant at Mandapam received about 1100 tonnes of silver bellies during the year.

Catch of silver biddies in the Mandapam area (in mechanised boats) was about 9 tonnes.

At Vizhinjam, only non-mechanised boats are employed for this fishery. The total annual catch was about 220 tonnes (3.7% of the all fish catch); the bulk (94%) being landed by boat seines. The months of high catch rates were April and September.

The results obtained at Mandapam clearly demonstrate the inadequacy of indigenous gear in exploitating the silver belly resources.

Leiognathus bindus was the dominant species at Waltair. It had a growth rate of 5-10mm per month. Its spawning takes place from October to March. At Madras, the biology of *Secutor insidiator* was investigated. The size range of this species in the catches was 25-100mm, with modes in different months varying from 38 to 88mm. The species fed on zooplankton (copepods, *Acetes*, *Oikopleura* etc.) Ripe fish were recorded in January and May. Juveniles measuring 25mm and above were available in February-March. At Mandapam, *Leiognathus jonesi* formed the bulk (70-87%) of the catches. This species had a size range 25-120mm in the landings. The dominant mode was at 80mm from May to October in the Palk Ray and 100-115mm in the Gulf of Mannar. There was a predominance of females in the catch. Mature fish were found in large numbers in February-April and August-September. As at Waltair, in Vizhinjam also the dominant species was *Leiognathus bindus*. Its size range in the catch was 71-107mm. Sex ratio showed the distribution of males and females in equal numbers. Maturing and mature fishes occurred throughout the year.

Personnel

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Ribbon fishes

At Kakinada, the catches were poor in the first three quarters but improved in the last quarter. At the fishing harbour, 116 tonnes of ribbon fishes were landed, forming about 4% of the total landed fishes. At Madras, (Royapuram), also the fishery was poor in the first two quarters. During October-December, about 44 tonnes of ribbon fishes were landed, and this comprised about 8% of all fishes. The Government of India vessel, *M. V. Meenasitara*, operated at depthrange 9-20m in November-December and the catch per hour was 3.5kg. The percentage of ribbon fishes in the catches was 4 and 18% respectively. The dominant species

was *Trichiurus lepturus* both at Kakinada and Madras. It size range was 20-100 cm. Immature, maturing and spent fish were common in the first half of the year and immature and spent fish the second half. Its food consisted mainly of fish and crustaceans.

Personnel

P. T. Meenakshisundaram, AFS; K. A. Narasimham, AFS.

Pomfrets

The fishery was studied at Veraval. The catches were poor from January to September, but improved during October-December when each fishing unit landed on the average 40-50kg. *Pampus argenteus* was the dominant species. It had a size range 166-385mm, with modal sizes at 221-225 and 291-295mm in January, 311-315mm in February, 291-295mm in April, 196-200mm in October, 201-205 in November and 326-330mm in December. At Mangrol, (Gujarat) the size range in September-December was 151-325mm. the dominant size groups being 211-225mm, 191-195mm, 156-160mm and 276-280mm in September, October, November and December respectively. In the samples collected, about 90% were females. Immature, mature and ripe specimens were observed from January to April, but from September to December only immature fish were found.

Personnel

Kuber Vidyasagar, SRA.

Eels

The important species at Bombay was *Muraenesox talabonoides*. The size-range was 102-234 cm at Satpati and 99-221 cm at Crawford market. The dominant size-groups varied from 121-130 to 161-170 cm in different months. About 86% of the specimens examined had empty stomachs while the stomachs of the others contained *Harpodon nehereus*, sciaenids, flat-fishes, prawns and other crustaceans. Females were dominant in the samples in October-Novemder and males in December. Maturing specimens were observed in the catches of October-December. Occurrence of elvers has been observed in the last quarter of the year. Eels were successfuily reared in running water at Mandapam. Elvers measuring 10 cm had grown to an average size of 40 cm in a year. No cannibaliam or mortality was observed and these features make the eel an ideal animal for culture.

Personnel

M. Jaffar Khan, RA,

Evaluation of demersal resources of some selected areas

(FB/DR/4)

a) Cochin

Shrimp trawling and purse-seining operations by the medium vessels and exploratory trawling in the shallow as well as deeper waters were carried out by the INP vessels off the south-west coast. There was also some perch trawling off Calicut, Ponnani and Quilon, as also some handline operations off Ponnani and Calicut by the larger vessels.

For shrimp trawling by medium size vessels (36 footers) off Cochin, there were no operations during November-December; but, for the rest of the year the results were:

Depth (m)	Effort (hr)	Catch and (Catch/hour) in kg.							
		Prawns	Elasmo-branchs	*Nemip-terus*	*Lacta-rius*	Perches	Cat-fish	Misc.	Total
1	2	3	4	5	6	7	8	9	10
5.5-38	1596.09	15902	642	2061	60	8	1503	39829	60085
		(9.96)	(0.40)	(1.29)	(0.04)	(0.005)	(0.99)	(24.95)	(37.64)

The purse-seine operations by the medium sized vessels (30 and 36 footers) off Cochin were carried out in all the months excepting July, September and October and the details are given below:

Depth (m)	Effort (hr)	Catch and (Catch/hr) in kg.				
		Oil sardine	Mackerel	Tuna	Misc.	Total
7.20	1175.5	48926	3471	464	4	52865
		(416.39)	(29.54)	(3.95)	(0.03)	(449.91)

Perch trawling by larger vessels in depth ranging 108-135m landed 435kg of perches, 50kg of elasmobranchs, 19kg miscellaneous fishes in February. An effort of 18 hours gave about 293kg of perches and an effort of 21.73 hr. in March gave 4kg of miscellaneous fish. Similarly hand line operations in 75-125m caught 4230kg of 'Kalava' in 28.25 hr. in February and 846kg within 11 hr in March.

Exploratory trawling by larger vessels were carried out in all the months in the shallower regions (22-57m) off Cochin, Muttom, Cape Comorin and in the wadge Bank area. These operations fetched a total of

Month	Area fished	Depth (m)	Effort (hr)	Catch and (C/H) in kg							
				Prawn	Lobster	Elasmo-branch	*Nemip-terus*	Perches	Catfish	Misc	Total
Jan.	Off Cochin	29-50	65.5	—	—	1692	—	916	1509	3220	7337
	Off Cape					(25.83)		(13.98)	(23.04)	(49.16)	(112.01)
Feb.	Cochin	27-47	98.99	—	—	4571	207	982	469	6527	12756
	Muttom					(46.18)	(2.09)	(9.92)	(4.74)	(65.93)	(128.86)
March	Cochin	27-36	122.72	145	—	5503	184	2793	560	12032	21217
	Wadge Bank			(1.18)		(44.84)	(1.50)	(22.76)	(4.56)	(98.04)	(172.88)
April	Cochin	23-47	198.37	1	—	3822	320	13335	956	5935	24381
	Wadge Bank					(19.27)	(1.61)	(67.22)	(4.82)	(29.97)	(122.90)
May	,,	22-47	90.39	—	12	3191	7	2378	28	7275	12891
					(0.13)	(35.30)	(0.08)	(26.31)	(0.31)	(80.48)	(140.61)
June	,,	33-57	164.47	127	—	12505	1908	6	5219	22720	42485
				(0.77)		(76.03)	(11.60)	(0.04)	(31.73)	(138.14)	(258.31)
July	,,	41-54	69.25	—	5	58	1182	6	960	4287	6498
					(0.07)	(0.84)	(17.07)	(0.07)	(13.86)	(61.91)	(93.83)
August	,,	22-56	84.40	340	3	1555	3623	1355	629	11044	18549
				(4.03)	(0.03)	(18.42)	(42.93)	(16.05)	(7.45)	(130.86)	(219.77)
September	,,	25-54	226.10	283	20	24849	2250	18312	10102	6867	62683
				(1.75)	(0.09)	(109.90)	(9.95)	(80.90)	(44.68)	(30.37)	(277.23)
October	,,	32-50	168.0	187	117	17836	3661	3828	11907	8731	46267
				(1.11)	(0.70)	(106.17)	(21.79)	(22.78)	(70.87)	(51.97)	(275.39)
November	,,	32-47	285.02	—	53	13853	2929	6510	4539	8602	36486
					(0.19)	(48.60)	(10.27)	(22.84)	(15.93)	(30.18)	(128.01)
December	,,	23-47	125.48	39	61	8323	1484	1062	2240	6886	20095
				(0.31)	(0.69)	(66.33)	(11.83)	(8.46)	(17.85)	(54.87)	(160.14)
Total:			1698.67	1122	271	97758	17571	51483	39118	104310	311633
				(0.66)	(0.10)	(57.55)	(10.84)	(30.31)	(23.03)	(61.41)	(183.46)

Month	Depth (m)	Effort (hr.)	Catch and (C/H) in kg.					
			Prawns	Lobster	Elasmobranchs	Perches	Misc.	Total
January	198-279	73.51	—	9615 (130.80)	268 (3.65)	6 (0.08)	2182 (29.68)	12071 (164.21)
February	198-270	180.06	676 (3.75)	14687 (81.57)	50 (0.28)	—	731 (4.06)	16144 (89.66)
March	216-252	255.69	—	25416 (99.40)	95 (0.31)	—	705 (2.76)	26216 (102.38)
April	216-270	176.10	50 (0.28)	17260 (98.01)	210 (1.19)	17 (0.097)	406 (2.30)	17943 (101.88)
May	225-243	56.40	—	7694 (136.42)	56 (0.99)	—	—	7750 (137.40)
June	225-261	46.82	9 (0.19)	5917 (126.27)	—	—	2110 (45.07)	8031 (171.53)
July	225-234	5.00	—	46 (9.2)	—	—	47 (9.4)	93 (18.6)
November	135-150	29.66	80 (2.60)	821 (2.68)	—	—	873 (29.43)	1714 (57.79)
December	110-135	49.86	—	4112 (82.47)	—	—	—	4112 (82.47)
Total		816.70	815 (0.99)	85563 (104.77)	679 (0.83)	23 (0.03)	7048 (3.68)	94134 (115.26)

311, 633 kg in 1698.7 hr, this works out to a catch rate of 183.46 kg/hr. The details are given in the following table.

Trawling in the deeper regions was carried out from January to July and again in November-December off Cochin and off Quilon (mainly for deep sea lobster). In the total landings of 94,134kg, the deep sea lobster made up 85,563 kg. which worked out to a catch rate of 104.77 kg/hour for lobster and 115.26 kg/hour for all other fish. The detaile are given below:

b) Kakinada

Three types of boats, Viz, *Pablos* (30' with 20.30 HP), *Pomfrets* and *Royyas* 32-33.5' with 45-60 HP) and *Sorrahs* (37' with 60-67 HP), conducted daily fishing using the other trawls (2 seam cotton trawl) off Kakinada (lat. 16° 50' N-17° 10' N and long 82° 20' and 30' E) in the depth range of 5-45 m. The catches were poor in the last quarter mainly due to bad weather.

During the year, an estimated 2869 tonnes of fish were landed. The main components were prawns (30.1), sciaenids (15.40%), *Upeneoides* and *Nemipterus* (9.1%) silver-bellies (6.8%), clupeoids (5.5%), ribbon fish (4.1%) and elasmobranchs (4%). Prawns occurred throughout the year and penaeids were dominant, forming over 90% of the total prawn catch. The important species were *Metapenaeus dobsoni, M. monoceros, M. affinis, M. brevicornis, Penaeus indicus* and *P. monodon.* The larger prawns (161-300 mm) formed 17.4%, medium sized ones (101-160 mm), 49% and small prawns made up the rest.

The details of the catch and catch/hour of the important groups landed at Kakinada are given in the table below:

	Type of boat		
	Pablo	Pomfret and Royya	Sorrah
1	2	3	4
Prawns	428,480	241,171	194,684
Crabs	39,764	13,934	9,776
Cephalopods	21,676	11,695	10,894
Sharks, skates & rays	46,617	26,915	41,237
Catfish	25,588	26,612	22,340

1	2	3	4
Clupeoids	78,904	41.148	38,351
Scianids	164,229	143,502	134,346
Upenoides	67,766	40,238	41,114
Nemipterus	41,622	34,734	36,383
Leiognathus	103,821	48,122	43,332
Ribben fishes	48,947	38,974	28,470
Other fishes	238,826	163,292	151,955
Total (in kg)	1306,240	830,337	732,882
Prawn catch	428,480	241,171	194,684
Effort (hours)	35,028	18,406	14,072.5
C/H all fish	37.3	45.1	52.1
C/H Prawns	12.2	13.1	13.8
Percentage of prawns	32.8	29.0	26.6

c) Andamans

Of the three vessels operating in these waters, M. T. *Matsyavigyani* and M. V. *Meenakhojini* remained idle for five months and M. V. *Meenaprayas* for six months. A total of 49,557 kg of fish was caught by the vessels during the year in 406 nours and 45 minutes of trawling time (226 hauls). The areas fished were 11-92/5E, 11-92/6E, 11-92/6F, 12-92/1E, 12-92/2E, 12-92/1F, 12-92/2F and 11-93/5A.

The square 11-92/6E was visited more frequently and accounted for nearly three-fourths the total fishing effort. This is not because of fact that the grounds were rich here, but because if offered level ground for operations. It yielded 39981 kg of fish (103 kg/hr). The area 12-92/2F was least exploited. Area 11-93/5A was fished for 2 hours but failed to yield any catch. The highest catch/hour was 343 kg for the area 12-92/1F. The second most exploited area, 12-92/1E, gave 3782 kg of fish. Areas other than 12-92/1E and 12-92/6E were visited only rarely on account of their uneven bottom and thus proving hazardous to the gear. About 18.54% of the total fish were landed in May, 18.39% in January. Elasmobranchs made up 18.91% of total fish landed and 'miscellaneous fish' formed 66.84%.

The details of the catch and effort are as follows:

Month	Area fished	Effort (hr)	Catch and (C/H) in kg. Elasmobranchs	Clupeoids	Perches	Other fish	Total
January	11-92/6E						
	11-93/5A	49.00	2884	10	3562	3209	9115
	12-92/1E						(186.02)
	12-92/1F						
February	11-92/6E	35.30	1140	—	67	2272	3479 (98.0)
March	11-92/5E						
	11-92/6E	63.25	1960	100	70	4505	6635
	12-92/1E						(104.90)
	12-92/2E						
April	11-92/5E						
	11-92/6E	73.23	1310	—	25	4361	5696
	12-92/1E						(77.76)
May	11-92/6E						
	12-92/6F	70.50	475	18	90	8603	9186
	12-92/1E						(121.01)
June							
July							
August	11-92/6E	5.00	119	—	—	877	996 (199.2)
September	11-92/6E	34.50	610	—	40	2747	3397 (98.47)
October	11-92/6E	3.25	15	—	—	170	185 (56.92)
November	11-92/5E						
	11-92/6E						
	12-92/1E						
	12-92/1F						
	12-92/2F	38.25	855	—	40	5540	6435 (16.83)
December	11-92/6E						
	11-92/6F	34.25	548	—	365	3520	4433
	12-92/1F						(129.43)
		486.75	9366	128	4259	35804	49,557 (121.83)

Personnel

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Miscellaneous Investigations

Fishery and biology of other crustaceans

(FB/Misc/1)

Spiny lobster

The fishery for the spiny lobster *Panulirus homarus* was exceptionally good during this year in the Kanyakumari District (Tamil Nadu). The total number of lobsters caught at 23 observation centres in the district was 9,62,120 during the period January-May and October-December. The considerable increase in the overall landings of crustaceans, other than prawns, in Tamilnadu is largely because of the very good landings of this lobster. The size of the lobsters ranged from 70 to 375mm total length with modal size at 131-140mm for males and 191-200mm for females.

Deep-sea spiny lobster

The fishery for the deep sea lobster *Puerulus sewelli* was confined to the first half of the year. The exploratory vessels of the Integrated Fisheries Project and Central Institute of Fisheries Operatives together landed a total catch of 85.6 tonnes of this species. The catch rate was 104.77 kg/hour. The bulk of the catch was restricted to the months of February, March and May. *P. sewelli* was mainly caught off Quilon and Cochin, the major portion being harvested from 207-253m depth. The size of the lobsters ranged from 82 to 202mm with modal size at 166-170mm for females and 156-160mm for males. The size of lobsters was generally found to be slightly smaller than that of the previous year. Berried females were more common during the period January-April.

Commercially important crabs

Scylla serrata

The estimated catch of this estuarine crab at two observation centres in Kakinada amounted to 16.6 tonnes. This was much lower than that of the previous year. Crabs with 160-210mm carapace width contributed to the fishery. Berried females were rare in the catches. At Cochin, 2.24 tonnes of this species was landed from one observation centre. Crabs with 71-90mm carapace width, contributed to the fishery here. Berried females were found in the catches during the first half of the year.

Portunus pelagicus

Estimated catch of this crab at Yetimoga (Kakinada) was 30 tonnes; with crabs of 150-170mm dominating the fishery. Berried females were observed throughout the year indicating an all the year round spawning of the species in these waters. At Mandapam, about 4.22 tonnes of *P. pelagicus* were landed by gillnet and trawl. Major portion of the catch was obtained during the first half of the year. The size of the crabs ranged from 60-194mm in carapace width with the modal size at 141-145mm for both the sexes. At Cochin, a record catch of 2.1 tonnes of this species was obtained from one observation centre. The size range of the specimens was between 29 and 154mm. The smaller size with a mode at 31-35mm was observed in the beginning of the season. The size progressed to 106-110mm in May thereby showing a fast growth here. Berried females were seen in the first quarter of the year.

Personnel

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Biology, Fishery and stock Assessment of Molluscs of commercial importance (FB/Misc/2)

Diving work using SCUBA apparatus, was undertaken at Tuticorin. In all 18 sea trips were performed. The zone IIB (Offshore rocky formation) was studied in detail. The results show that the density of the pearl oyster had gone down (due to reasons other than biological) and so the chances of declaring a pearl fishery became rather remote. There was no settlement of *Modiolus* sp. (mussel). The density of oyster was 5-10/m^2 in the northern portion and 1-5/m^2 southwards. Oyster in the size range 56-65mm formed 90% of the collected samples. This was close to fishable size. Earlier observations had shown that no spat fall had taken place in the second half of 1971.

The rocky bottom towards the north had a thin sand-wash over the hard inner core. The bare parts of the rock not covered with sand were black brown in colour and traversed by broing molluses and *Clione*. The rocky stretch southwards showed a good abundance of algae, particularly *Sargassum*, *Caulerpa*, *Padina* and *Ulva*.

At Attankarai near Mandapam, observations were conducted on the edible oyster, *Crassostrea madrasensis*. Ripe oysters were found from May to October and partially spawned ones in February-March and May-October. Males were dominent in February, May, June and October and females in March and July. Hermaphrodites showing sex-change formed 6-26% of the total. Spat fall was poor during the year.

The cephaloped resources were studied at Madras. The mechanised boats at Rayapuram landed about 101 tonnes of cephalopods during 1972. Peak catches were in June and September. The important species were *Sepia pharaonis*, *Loligo duvaucelli* and *Sepiella inermis*, of which, the first one is at exportable standard. *S. pharaonis* ranged from 160-280 mm, *L. duvaucelli* from 50 to 120 mm and *S. inermis* from 6-90 mm in size. Femals of *L. duvaucelli* measuring more than 98 mm in mantle length were mature.

An intensive study of the mussel beds at Vizhinjam was made. The average annual yield has been estimated as 4,000 kg/hectare. One-year-old mussel formed the bulk of the catches. The peak spawing period of the mussel is June-July and spats produced during this spawning attained a size of about 60 mm by November. The studies further show that silting seriouly affects the settlement of the mussels. To overcome this difficulty, transplantation of the mussels from the intertidal to deeper areas is the only answer. Experiments conducted showed that such transplantation can be made quite successfully. It is also seen that the mussel harvest can be increased substantially by providing additional substracts. Mussel culture on ropes proved to be quite successful and the preliminary results show that production can be enhanced considerably using this technique.

Personnel

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Experiments on pearl culture

(FB/Misc/3)

Experiments on pearl culture initiated at Tuticorin during the year. A field laboratory was organised at Veppaledai and a pearl oyster farm was set up at suitable spot, about 25 km north of Tuticorin (in the Gulf of Mannar) One raft of 6.5 m x 5.5 m was launched in the farm and steps have been taken for the launching of several more rafts.

Pearl oyster ranging 8 mm to 62 mm DVM (dorso ventral measurement) were available for farming. Although mortality was high when the oyster were kept in captivity in the laboratory aquaria, they thrived well once they were arranged in the pearl-nets and suspended in the raft. Studies on the biology of pearl oyster are in progress.

The development of shell-nuclei indigenously for pearl culture experiments has also made satisfactory progress. Roughly sperical shell beads were cut from the shelles of *Yancus*, *Turbo*, *Trochus* and *Tridacna*.

The last three shells were obtained from Andamans. Fabrication of suitable tools for shaping and polishing the shell nuclei is in progress.

Personnel

K. Alagarswamy, JFS.

Ichthyofaunal investigations

(FB/Misc/4)

A study of the distribution pattern of sciaenids along the west coast was undertaken. The commercially important species in different areas were as follows

Veraval: *Otolithes ruber* (60%); *Nibea diacanthus* (10%)

Bombay: *Johnius glaucus* (30%); *Nibea diacanthus* (20%); *Otolithes ruber* (20%)

Goa: *Johnius glaucue* (30%); *Nibea diacanthus* (30%); *Otolithes ruber* (18%); Mangalore: *Johnieops osseus* (60%); *Otolithes ruber* (25%).

Family scombridae, which is now assuming more and more importance, formed the subject of another study. At present only three species of *Scomberomorus* are known from the Indian coasts and these are *S. commerson*, *S. lineolatus* and *S. guttatus*. Another species *S. koreanus* has now been found in the Palk Bay. The work done also indicate that *Scomberomorus* should be retained as a distinct subfamily of Scombridae. The studies made on Xiphiidae and Istiophoridae also show that these are not related to the suborder Scombroidei and their relation to other suborders of Teleostei is not quite certain.

Personnel

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Researches contemplated

Since the monitoring of exploited stocks will have to be repetitive from year to year, the researches on the important fisheries will be continued. Stock assessment study with reference to the effect of fishing especially on four resources namely oil sardine, mackerel, prawns and Bombay duck will be intensified. Whenever facilities exist, the Division will collaborate with other Institutes/Organisations in the work of exploring new grounds and preparing an inventory of new or under-exploited resources. Greater emphasis will be given to the development of mariculture techniques. It is also proposed to bring out fishery maps soon.

Summary of Salient findings

An allround progress was maintained in the ten Projects undertaken by the Division. Under the Project 'Environmental studies-physical and chemical aspects', hydrographic data collected from Bombay, Karwar, Kozhikode, Cochin and Madras, where boat facilities are available, have been analysed for a better understanding of the environmental factors which influence the fishery.

Based on Ekman's equation of wind driven currents, a theoretical approach was made to express the frictional force communicated to the lower layer of the sea from the surface. Distributional charts pertaining to the current pattern in the Maldive region have been prepared. Studies on upwelling along the west cost of India showed that this phenomenon commences first in the south at a depth of about 90 metres in early March, and gradually extends to the upper layers and to the north. Sinking sets in during September. The speed of upwelling has been calculated from the vertical shift of the isopycnal with time and the average horizontal divergence has been estimated to be in the order of 1.5×10^{-3} and 1.8×10^{-3} cm sec^{-1}, respectively.

Phytoplankton investigations were carried out at Bombay, Mangalore, Kozhikode and Cochin. Qualitative studies on plankton samples from the south west coast and the Laccadive Sea have shown the occurrence of 22 species of Dinophyceae which are new to the Indian Seas.

Estimations of primary production using C^{14} indicated higher productivity in areas off Alleppey, where mud banks are formed, as compared to the adjacent inshore areas.

About 45 maps showing the monthly fluctuations of the standing crop of zooplankton along the south west coast and the Laccadive Sea, between 7°N and 17°N have been completed. The maps highlight the high standing crops of zooplankton in the inshore waters of the continental shelf, especially during June-October.

The seasonal abundance of zooplankton were studied from different centres such as Bombay, Mangalore and Cochin for developing an understanding of the fluctuations of major commercial fisheries. Qualitative studies on zooplankton to aid in such investigations have also been carried out from Cochin.

About 24 different kinds of fish eggs have been sorted out and a few were identified from the inshore waters of Kozhikode. Besides, specific identification of eggs by stripping the oozing females have been made for eight commercially important species of fishes.

The second survey of the seaweeds resources along the Tamil Nadu coast carried out in collaboration with the Government of Tamil Nadu and Central Salt and Marine Chemicals Research Institute has covered 45 km of coastline of Mandapam to Kilakarai. This has helped in charting out the productive seaweed beds along the 4 metres depth contours.

At Cochin, detailed follow up studies on the spawing, maturity and related aspects of pelagic and bathypelagic fishes obtained during exploratory surveys were continued.

Valuable environmental and biological data have been obtained from the mud banks off Alleppey before, during and after the formation of the banks.

In the Cochin Backwater the contamination of water resulting by coliform bacteria, *Escherichia coli* has been studied.

Researches in hand

Environmental studies-Physical and chemical aspects

(MBO/ES/1)

OFF KANDLA, GULF OF KUTCH

Hydrological conditions in the Gulf of Kutch at Kandla showed wide variations in the values of different parameters such as temperature, salinity, pH, dissolved oxygen, phosphate, nitrate and silicate from season to season and from year to year. The temperature variations showed a unimodal pattern with maximum values in June-July (28.85-29.93°C) and minimum in January (15.32-16.72°C). Salinity values showed very little fluctuations, the monthly average values showed an upward trend from September to May with a maximum in May (42.88‰) and thereafter a decline from June to August, the average values for June to September were generally above 34‰. Dissolved oxygen remained below saturation level during the southwest monsoon (about 3.75ml/l), but the values were near saturation point during post-monsoon period (in January about 6.30ml/l). Lower temperature and higher phytoplankton production during post monsoon months probably give rise to higher dissolved oxygen. Phosphate values varied from 0.31-1.87 μg-at-P/l and nitrite values from 0.10-0.75 μg-at-N/l. Phosphate and nitrate values showed definite seasonal cycle with well-defined maxima during October-November and a secondary peak during the southwest monsoon. No definite trend was noticed in the silicate values which ranged from 12.85 to 29.92 μg-at-Si/l.

Bombay

During 1972, hydrographic investigations were undertaken from the inshore waters off Colaba Light House from January to May. Observations were also made from Offshore Fishing vessels from April to December, 1972.

Surface temperature off Colaba Light House showed an increase from 24.2°C during January, to 29.7°C during April-May. The temperature at 10m depth fluctuated from 24.7°C to 28.3°C during the period. During the same period, the surface salinity varied from 35.13‰ to 36.27‰ and at 10m depth from 35.40‰ to 36.34‰. Dissolved oxygen of the surface waters varied from 3.5ml/l to 4.4ml/l. The inorganic phophate of the surface waters varied from 0.313 μg at/l to 0.598 μg at/l. The secchi disc observations indicated extinction coefficient of light (K_{10}) from 2.43 to 3.08.

The hydrography of the fishing grounds in areas marked as 19-71, 18-72 and 17-72, showed that there is a gradual decrease in temperature from April (28.5°C) to December (23.6°C), except in October when it was 29.1°C. The salinity values were high in April (36.09‰) May (36.19‰) and October (36.14‰) and lowest in July (34.94‰). The values for phosphates (0.480-0.592 μg at/l) fluctuated within a narrow range. Dissolved oxygen (4.25-5.17 ml/l) was lowest in December and phosphates recorded a minimum in September. The coefficient of light extinction was 1.63 in April, but minimal in July (0.35).

A cruise was undertaken along the coast up to Kandla from 26th October to 3rd November, 1972, from 20° 10′N, 71° 15′E to 19° 38′N, 71° 47′E. The surface temperature and salinity in the area varied between 27.3°C to 28.6°C and 34.82‰ to 36.05‰ respectively. The surface inorganic phosphate and silicate ranged from 0.50 to 3.20 μg at/l and 17.1 to 38.2 μg at/l respectively.

Karwar

Hydrological conditions at three stations near Karwar were as follows:

		Karwar Bay	Devgad Island	Off Devgad Island (12-14m)
Temperature	S	25.5 - 31.8	25.6 - 30.8	28.3 - 30.6
°C	B	25.5 - 31.6	26.5 - 30.8	28.2 - 30.6
Salinity ‰	S	21.90 - 35.41	32.74 - 35.48	33.80 - 30.29
	B	20.09 - 35.50	32.83 - 36.17	34.05 - 36.29
Dissolved	S	2.8 - 5.4	3.9 - 4 6	3.5 - 5.2
Oxygen ml/l	B	0.1 - 5.2	3.4 - 6.4	4.2 - 6.9
Inorganic	S	0.25 - 0.79	0.32 - 0.77	0.35 - 0.63
phosphate μg at/l	B	0.40 - 1.92	0.39 - 2.50	0.40 - 1.11
Nitrite	S	0.02 - 3.13	0.03 - 2.50	0.02 - 0.98
/ug at/l	B	0.07 - 5.00	0.05 - 3.57	0.02 - 0.86
Silicate	S	8.16 - 66.67	8.64 - 14.40	10.88 - 13.28
/ug at/l	B	10.24 - 30.20	10.72 - 15.52	12.16 - 15.36

S = Surface; B = Bottom

Kozhikode

Weekly water samples collected from three stations off West Hill were analysed. At all stations the surface temperature was higher than the atmospheric temperature throughout the year. The lowest surface salinity was recorded at all three stations in August (27.39‰ at Stn 3) and the highest values (35.81‰ at Stn 2) during June.

The dissolved oxygen at the surface fluctuated between 4.8 ml/l in February and 2.6 ml/l in September at Stn 1; 4.8 ml/l in January and 2.5 ml/l in June at Stn 2; and 5.2 ml/l in November to 3.4 ml/l in September at Stn 3. Near the bottom, the values were between 4,8 and 2.1 ml/l at Stn 1; 5.0 and 2.3 ml/l at Stn 2. The surface pH at Stn. 1 fluctuated from 8.1 in September to 8.4 in October November/December. At Stns 2 and 3, the surface pH was minimum in September. The lowest values for reactive phosphorous at the surface were recorded at Stn 1 and 3 in October and at Stn 2 in November, Maximum values were in June at Stn 1, in February at Stn 2 and in July at Stn 3. The values at the bottom were high in August at Stns 1 and 2 and in June at Stn 3. At the surface the nitrite values range from 0.05 μg at/l in March to 0.74 μg at/l in December at Stn 1 for and from 0.07 in March/September to 1.02 μg at/l in September to 0 66 μg at/l in December for the surface and from 0.09 μg at/l in September, to 1.22 μg at/l in November for the bottom. At Stn 3, it varied from 0.04 μg at/l in September to 0.29 μg at/l February for the surface and from 0.04 μg at/l in March to 2.54 μg at/l in November for the bottom water. The reactive silicate for the entire region ranged from 7.25 μg at/l (March) to 36.74 μg at/l (July) at the surface and from 3.72 μg at/l (March) to 38.83 μg at/l (August) at the bottom.

Cochin

Hydrological observations were made in the backwaters between Alleppey and Azhikode at monthly intervals. During the year, surface temperature varied between 24.5°C (July) to 33.0°C (April/Sept.); salinity values ranged from 0.17‰ (July) to 32.58‰ (April); dissolved oxygen fluctuated from 1.4 ml/l (November) to 5.6 ml/l (September). Inorganic phosphate varied between 0.04 μg at/l (August) and 8.5 μg at/l (November). The nitrite values were 0.01 μg at/l (August) and 1.00 μg at/l (September).

The processing and analysis of the data for temperature, salinity and dissolved oxygen, along the west coast, from Cape Comorin to Cochin, was under progress. Monthwise horizontal distribution charts have been prepared for standard depths from surface to 150 m.

The hydrographic features in a vertical quasimeridional plane, extending from surface to about 400 m depth, between 8°N and 15°N were taken up for detailed study. The average values of temperature, salinity

and dissolved oxygen for each standard depth were computed. The averages for each of these parameters up to 300 m depth were calculated for every calander month and the arbitrary distribution patterns were studied.

Along the Gujarat Coast during the summer period the waters seem mostly isothermal within the continental shelf and a thermocline could be seen only outside the shelf. Maximum salinity value was observed in the region of minimum temperature and maxmium dissolved oxygen. A southward decrease in temperature was associated with a southward decrease in salinity also.

Chlorinity, salinity and electrical conductivity of sea water

Measured values of chlorinity and conductivity from the Cochin Backwater when compared with the values computed from the International Oceanographic tables, showed maximum disparity in the lower range, indicating that the backwater samples give a lower conductance. Lower chlorinity samples (below 16.5‰) on which the International Oceanographic Tables are based were largely obtained from the Baltic Sea where the surface samples are known to give higher conductance. In the lower range, except for the Baltic Sea, practically nothing is known about the chlorinity, salinity and conductivity interrelationship from other parts of the world. The work carried out draws attention to the pressing need for such investigations.

Silting in Cochin harbour area

The distribution of suspended material and sedimentation rates are important in harbour areas where engineering works have been undertaken. Measurements of silting rates were made in the Cochin Backwater. Suspended material was found to vary with the seasons and state of tides. The maximum suspended material was present in the channel during the monsoon period, but during pre and post mansoon months its quantity gradually declines. During these seasons the total material transported from the sea into the backwater amount to about 900 tonnes/day. The total material dredged annually from the navigational channels is estimated about $2 \times 10^6 m^3$. Of this, nearly $1.2 \times 10^6 m^3$ per year is dredged from the approach channels to the harbour. At one point where maximum silting takes place, the bed of the channel rises 1.2–1.8 m every year.

Attenuation coefficient of light in Sea water

A theoretical approach to the attenuation coefficient of light in sea water has been made. The attenuation coefficient of sea water is derived from a formula and from the mean values of the secchi disc readings. The theoretical concept developed was found to be in accordance with the expressions based on field data.

Hydrology of the Arabian Sea

Observations on the hydrological features of the Arabian Sea off the northern and Central west coast of India during the winter months showed that the thermocline is found at shallower depths shorewards in the northern regions especially off Bombay. A steady increase in the salinity was observed northwards. North of 17°N, the flow is mainly eastwards which deflects towards south with an increase in depth. At 50m, a continuous southwards drift was observed. More or less uniform distribution was found in the dissolved oxygen content at surface and 20m depth, and at 50m depth an eastward gradient was noticed. The nature of isotherms and isolines of oxygen indicate the presence of upwelling in the region off Bombay. The pattern of distribution of phosphorous content showed an inverse relationship with the oxygen distribution.

SURFACE TEMPERATURE AND MACKEREL FISHERY

The temperature observed at surface in the inshore sea water during the south west monsoon period exhibits an inverse relation to the duration of the mackerel fishery at Karwar. When the temperature is high the season is short and *vice versa*. The lowest temperature values during 1954-55 to 1964-65 ranged between 23.6-26.2°C. In 1958-59 when the value was the lowest the mackerel season was the longest extending from the last week of October to the end of third week of April. In 1961-62, when the temperature was 26.2°C the season was the shortest, extending from late October to the second half of December only. As the low temperature appears earlier than the period of the fishery, it can possibly be used in predicting the length of the latter. The landings show an inverse relation to the local rainfall which precedes the fishing season, and the observation of it may help in telling something in advance about the magnitude of a year's catch in comparison to that of the previous year. The need for extending the observations to other centres is stressed.

Madras

Values of salinity, dissolved oxygen and pH were determined for the surface waters off Madras from May 1972 to December 1972. The salinity varied between 28.34‰ (December) and 34.28‰ (June). The dissolved oxygen ranged from 3.8ml/l (May) to 5.0ml/l (September). The pH values remained unchanged at 8.4.

Personnel associated with the project

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Environmental studies-circulation and related phenomena

(MBO/ES/2)

Cochin

Based on Ekman's equation of wind driven currents, a theoretical approach was developed to express the frictional force communicated to the lower layers of the sea from the surface.

Distributional charts pertaining to the sea-currents of the Maldive region were prepared.

Studies on the upwelling off the west coast of India showed that this phenomenon commences first in the south at a depth of about 90m in early March and gradually moves up to the upper layers and towards the north. The process continues vigorously till June, until the southwest monsoon winds become strong enough to counteract the upward movement of the subsurface waters. From then onwards the intensity of upwelling reduces and finally comes to an end, by the end of July-August, when the South-west monsoon winds reached their maximum strength. Sinking sets in during September.

The speed of upwelling calculated from the vertical shift of the isopycnal with time and the average horizontal divergence is found to be of the order of $1.5X10^{-3}$ and $1.8X10^{-3}$ cm sec^{-1} respectively.

Personnel associated with the Project

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Studies on Phytopankton Productivity

OFF KANDLA, GULF OF KUTCH

Phytoplankton production was relatively low but annually two maxima were noticed, confirming early observations. The occurrence of a maximum peak during the latter half of the northeast monsoon appears to be a regular feature coinciding with the low water temperature and higher saline conditions. The secondary maximum occurred regularly during the southwest monsoon period.

Bombay

Plankton samples were collected from the offshore fishing grounds and off Colaba lighthouse. Ten samples were also collected during the cruise

from the Gulf of Cambay to the Gulf of Kutch. In the inshore waters of the Colaba area, phyto plankton standing crop was poorer (maximum 331 cells/litre in February) and in the offshore waters a maximum of 663 cells/ litre was observed in April. Among the constituents, *Chaetoceros* was most abundant followed by *Coscinodiscus*.

In the offshore fishing grounds during the period April to October, maximun cell count of 1975/litre of water was observed in October, while the minimum 655 cells/litre was in September. Detailed analysis of plankton which is in progress for the Gulf of Cambay and Gulf of Kutch area showed that the phytoplankton and zooplankton biomass are richer there than in Bombay waters.

Mangalore

The dinoflagellates *Noctiluca* and *Ceratium* were observed to bloom during the first fortnight of September and in the first week of October respectively. The diatoms were present in good number during the latter half of the year. Blooms of *Fragilaria oceanica* were observed on three occasions during July and August.

Kozhikode

During the first quarter, weekly samples were collected from the surface and above the bottom where the depth was 20 m and analysed quantitatively. From September to December, the water were collected from 2 more stations having 2.5m and 5m depths. Phytoplankton was more abundant in July, August and September confirming the observations made earlier.

Studies on primary production using C^{14} were continued at Cochin, Calicut, Bombay and Mandapam. Samples from the surface and mud samples from the mud-bank area off Alleppey (Ambalapuzha) were incubated in the laboratory to determine the rate of carbon assimilation. Determination of plant pigments and phytoplankton counts were also made along with productivity measurements High rates of primary production were observed especially when the mud-banks were under formation (during the monsoon period), as compared to the inshore areas of the west coast.

To determine the contribution of nannoplankton to the total primary production, experiments were conducted with fractionated samples collected from an inshore station and from the Cochin Backwater. The results showed that the contribution of nannoplankton to the total primary production amounts to approximately 54% in the Cochin Backwater and 73% in the inshore area.

Qualitative and quantitative studies on phytoplankton and chlorophyll '*a*' estimation from the Vembanad Lake revealed that chlorophyll '*a*' was

minimum in July and maximum in September. During July, the standing crop of phytoplankton also was considerably low in the Lake. However, in the Cochin Backwater towards the Harbour area there was an increase of phytoplankton (mainly nannoplankters) during the same period.

Qualitative and quantitative studies on the samples from 15 cruises of *R. V. Varuna* (178 samples covering 12 months of the year) were analysed. Dinoflagellates dominated in all the samples collected during May to September. *Trichodesmium* was noticed in abundance during June-July. The displacement volume of phytoplankton was higher during July-August confirming the earlier observations on higher productivity during the peak monsoon period in the shelf waters. Twenty two species of Dinophyceae were recorded as new to the Indian seas.

Unialgal cultures of *Tetraselmis*, *Chlorella*, *Synechocystis*, *Oscillatoria*, and *Pleurosigma* were maintained in the laboratory and experiments on the uptake of concentrations of nutrients were conducted on them for the determination of growth requirements. Growth kinetics was found to vary with the type of nutrients used.

Abundance and distribution of phytoplankton along the west coast

Isolines were plotted to indicate the quantitative distribution patterns of phytoplankters along the west coast of India. Phytoplankton was found to be abundant in the months of May and June in the areas between 8°-10°N and 75°-77°E.

Personnel associated with the Project

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Studies on secondary production and related aspects

(MBO/PL/1)

Off Kandla, Gulf of Kutch

Copepods and planktonic larvae constituted the bulk of the zooplankton standing crop. The copepods showed more than one peak during March-September and these peaks generally occurred soon after the phytoplankton maxima. The primary peak was observed, however, during the south-west monsoon.

Bombay

Zooplankton biomass was highest during October (44ml/1). The major constitutents of the zooplankton were copepods, fish eggs and larvae,

salps, chaetognaths and siphonophores. Cladocerans, amphipods and pteropods were poorly represented.

Mangalore

Plankton and water samples were collected from different depths (8 and 16m) of two stations located off Ullal. The standing crop of plankton was high during September and October. Copepods were observed in moderate numbers in October and December. Swarms of cladocerans were observed in the first week of October.

Cochin

Fortyfive maps showing the monthly fluctuations in the standing crop of zooplankton (wet volume in ml/1000m^3 of water filtered by the IOS Net) along the south-west coast, between 7°N and 17°N and extending to the adjacent oceanic waters, based on the material collected during the cruises of *R. V. Varuna* in the past years, have been completed. The maps highlight the biomass of zooplankton in the inshore waters of the continental shelf. In some areas very high biomass values, (900 ml of zooplankton/1000 m^3) were recorded from June to October. In oceanic waters, the biomass in 200m column of water was low (about 100ml/1000m^3). The maps for the months during which *R. V. Varuna* cruises were made, are as follows:

Year	Jan.	Feb.	Mar.	Apl.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
1963	—	—	—	—	—	—	—	X	X	X	X	X
1964	—	X	X	X	X	X	X	—	—	X	—	X
1965	X	—	—	X	X	X	—	—	—	X	X	X
1966	X	X	—	X	X	—	—	X	X	—	X	X
1967	—	X	X	X	X	X	X	X	X	X	X	X
1968	X	—	—	X	X	—	—	—	X	—	—	—
1969	—	—	X	X	—	—	—	—	—	—	—	—

Zooplankton samples collected from the Cochin Backwater showed maximum biomass in April (6.8 ml) and minimum in November (0.2 ml). Copepods and decapod larvae were the dominant constituents in the plankton.

A total of 50 plankton samples from the Laccadive Sea were analysed for the seasonal occurrence and distribution of pelagic tunicates. Salps and pyrosomes were rare in the samples. Among the doliolids, *Doliolum denticulatum* was dominant followed by *Doliopsis* sp. On the whole, the species of doliolids were poorly represented. "Nurse" forms

were present in almost all the samples. *Doliolum separata*, *D. obscura*, *Doliopsis* sp. and *Pyrosoma aherniosum* were found to be new records for the Indian Ocean.

The gut content analysis of samples revealed that microflora and microfauna constituted about 70% of the total (ingested food) while the suspended particulate matter (detritus) formed about 30%. Host specificity of a gregarine parasite for the salp, *Pegea confoederata* was also observed.

Analyses of zooplankton samples collected from the different areas along the west coast of India revealed the occurrence of cyclopoid copepods as follows: 28 species belong to 5 genera from the Cochin backwater, 16 species belonging to 6 genera from the mud bank at Ambalapuzha and 16 species belonging to 6 genera from the *Varuna* collections. A new 'type' of cyclopoid copepod belonging to the genus *Saphirella* has been recorded for the first time. Two more 'types' of the same genus have been recorded for the first time from the Indian Ocean.

In addition to the investigations on Siphonophora from the zooplankton collections made during the cruises of *R. V. Varuna*, plankton samples collected from the Cochin backwater were also examined for their occurrence and seasonal abundance. Siphonophores occur only in the months of November, December, January and February, in the Cochin backwater.

The ostracods from *Varuna* collections indicate that *Diasterope bisetosa* and *Asteropina nodulifera* are new records to the Indian coast having been previously recorded only from Red Sea; and *Parasterope nana* is a new record for the Indian Ocean, since it was earlier known only from the Gulf of Siam. The species-wise estimates of abundance of ostracods from along the south west coast showed that species of *Conchoecia* were rare below 50 m depth, but these were abundant in the oceanic waters. Larval stages and adults of *Cypridina dentata* were found to be more abundant along the continental shelf than in oceanic waters. The plankton samples from the Cochin backwater made during 1970–71 showed that ostracods were not represented in the area except during the monsoon period, when a few specimens of the bottom living *Cythere* sp. were obtained.

Ecological studies were carried out on the relationship between the seasonal variation in abundance of copepods and hydrographical properties based on material collected from the estuarine, neritic and oceanic waters of the west coast of India. In the estuarine habitat, marine forms were abundant during post-monsoon months and brackish water forms during pre and post-monsoon months. During monsoon months, strictly oligohaline forms dominated the copepod populations.

Quantitative distribution of copepods was studied from the neritic and oceanic waters. Affinity indices of different species were calculated

using 'Fager-McGoven Model' to select species groups which could be used as biological indicators of changes in the hydrographical properties of the environment. Calanoid copepods were found to show characteristic distribution pattern facilitating their identification in neritic and oceanic waters.

Chaetognaths were found to be abundant in estuarine waters around Cochin during the post-monsoon months. Quantitative data were collected on their seasonal variation in distribution from neritic and oceanic waters. Zooplankton samples collected outside the continental shelf, between Calicut and Karwar, were examined to study the quantitative fluctuations in the abundance of chaetognaths. Maximum number of chaetognaths was found in the samples collected during February and minimum in June. In the order of abundance, their occurrence in percentages (%) was as follows: *Sagitta inflata* (35); *S. decipiens* (15); *S. pacifica* (12) *Pterosagitta draco* (9-7); *S. bedoti* (9.2); *S. regularia* (3.8); *S hispida* (6.0); *S. robusta* (3.0); *Krohnitta pacifica* (2.5); *S. pulchra* (0.7); *S. ferox* (0.6); *S. hexaptera* (0.6); *S. lyra* (0.2) and *Krohnitta subtilis* (0.2). Of special interest is the occurrence of *Sagitta decipiens*, a mesoplanktonic species in all the collections made during the months December, February, April, June and August.

Studies on the larval development of different groups of zooplankters were carried out during the period particularly as they form an important component of the total zooplankton biomass and also as an essential link in the food chain. The post-naupliar developmental stages of three species of euphausiids, *Euphausia diomediae, E. distinguenda* and *Stylocheiron carinatum;* the developmental stages of two species of copepods, *Labidocera pectinata* and *Temora turbinata* and the planktonic ostracod *Cypridina dentata* were studied. Data collected on the distribution of sex ratios of different copepod species showed that during the period of maximum abundance of any species, the females dominated the population. Size variations in the maturity stages of *Sagitta inflata* from adjacent estuarine and neritic waters were studied in detail which revealed that salinity reduction plays a major role in such phenomena.

Species diversity of copepods in estuarine waters was studied and a statistical model developed to interpret the relationship between copepod diversity and hydro-biological features of the environment. Simple, partial and multiple correlation coefficients were calculated and correlation matrix prepared between species abundance and temperature, salinity and food supply. Diversity indices were found to be dependent upon density. Food supply was not a limiting factor for copepods in the estuary.

Personnel associated with the Project

E. G. Silas, SFS; K. G. Girijavallabhan, SRA; P. Dhandapani, SRA; P. Parameswaran Pillai, SRA; K J. Mathew, SRA; M. Srinivasan, RA;

M. M. Meiyyappan, RA; K. Rengarajan, RA; C. M. James, RS; P. K. Martin Thompson, RS; and others.

Studies on fish eggs and larvae from the plankton

(MBO/Pl./2)

Kozhikode

From the surface zooplankton samples, 24 types of fish eggs were identified. Eggs of *Anodontostoma chacunda*, *Kowala coval*, *Chirocentrus dorab* and *Oxyporhamphus* sp. were identified. Descriptions of eggs obtained by stripping the oozing females of the following species were made: *Sardinella longiceps*, *Pseudosciaena sina*, *Otolithus ruber*. *Cynoglossus macrostomus*, *Cypselurus opisthopus*, *Thryssa hamiltoni*. *T. mystax* and *Opisthopterus tardoore*. Quantitative assessment of the fish eggs and larvae in the plankton revealed that except in the months of March and June, fish eggs occurred in fairly large numbers throughout the year. Many fish eggs were found to be infected presumably with fungus during September-December.

Cochin

Fortyfive maps on the occurrence and abundance of fish eggs and larvae along the southwest coast of India and the Laccadive sea based on the plankton collections made during *R. V. Varuna* cruises are nearing completion.

Fish eggs and larvae from the Cochin backwater are under study. These were most abundant during March-April. Quantitative and qualitative studies are in progress. The fish eggs and larvae from the mud bank regions off Ambalapuzha have been sorted out from the plankton samples and these are being studied.

Personnel associated with the Project

E. G. Silas, SFS; P. Vijayaraghavan, JFS; K. G. Girijavallabhan, SRA; V. Kunjukrishna Pillai, SRA; P. Karuppaswamy, RA; G. S. Daniel Selvaraj, RA; M. M. Meiyappan, RA; K. Rengarajan, RA; M. Rajagopalan, RA; Pon. Siraimeetan, RA.

Survey and culture of economically important seaweeds
(MBO/Misc/1)

Thirteen stations were surveyed for the second time in the Gulf of Mannar in the first section of the 45 km coast line from Mandapam to Kilakarai along the Tamil Nadu coast. The data collected from the different stations on agarophytes, alginophytes, edible seaweeds, other weeds, sea grasses, plankton and bottom fauna are being analysed.

Seaweed survey work in the second section of the Tamil Nadu coast from Kilakarai to Vaipaar was started from December, 1972 and data on seaweeds, plankton, bottom fauna and hydrological conditions were collected from six stations.

In view of the importance of the nature of the substratum for the settlement and growth of seaweeds, investigations on the bottom conditions and benthos in areas were seaweeds occur were carried out. In all eighty bottom samples and forty five plankton samples were analysed. On the basis of this, the substrata at 4 m depth have been classified as sandy, muddy, rocky and sand and mud mixed. The composition of the fauna varied markedly in relation to the nature of the substrata as summarised in the following table.

Data of 80 bottom samples analysed

Groups	Substrata			
	Sand	Mud —	Rock	Mixture of Sand & Mud
Sponges	C	C	R	C
Tubiculous polychaetes	A	A	R	C
Burrowing polychaetes	C	C	R	A
Dentalium	A	C	—	C
Eromea	C	—	—	C
Bursa	C	R	—	R
Murex	R	R	—	R
Docemia	C	C	—	C
Oliva	C	R	—	—
Cerithedia	R	R	—	R
Turritella	R	R	—	R
Conus	—	C	—	—
Paphia	A	—	—	—
Catalysia	C	—	C	R
Lucernia	R	R	—	—
Latermula	C	R	—	—
Solemya	—	R	—	R
Oysters	—	—	—	—
Mytilids	—	—	C	—
Salmasis	R	C	A	C
Echinodiscus	R	C	—	C
Ophioconex	R	C	—	C
Amphipods	R	C	R	C

A = Abundant, C = Common, R = Rare.

To study the productivity of the seaweed beds, plankton samples were also collected and analysed. *Trichodesmium* was abundant in all the plankton samples (constituting nearly 50% of the total volume) in September and November, 1972. In the other months also the percentage of *Trichodesmium* was comparatively higher than species of *Ceratium*, *Chaetoceros*, *Coscinodiscus* and *Biddulphia*.

Personnel associated with the project

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

Investigations on deep water fishes

(MBO/Misc/2)

The follow up studies of the exploratory surveys from the edge of the continental shelf and the upper continental slope along the southwest coast were continued.

The morphometric measurements and meristic counts were taken from 46 specimens of *Chascanopsetta lugubris*. The gut content analysis of this species revealed that they feed mostly on deep water prawns such as *Parapandalus spinipes*, *Panaeopsis rectacuta* and fishes such as *Chloropthalums agassizi* and myctophids.

Fortytwo samples of bathypelagic sharks of the family Scylliogaleida were examined.

The reproductive potential of *Epinephelus tauvina* (Total length 2115 mm) in a season based on the ova counts were estimated as 258.9 million. Ripe ova constituted about 76% of the total and the ovary 17 kg. The study showed that spawning in this species takes place only once in the season (November or December).

Detailed investigations on meristic counts, morphometric characters, length frequency analyses, sex ratio and length-weight relationship of *Cubiceps natalensis* and *Epinnula* sp. and *Epinnula orientalis* are in progress.

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; M. Rajagopalan, RA; I. David Raj, RA; K. Nandakumar, JSA and others.

Investigations on the Mud banks of Kerala coast and their influences on the fisheries

(MBO/Misc/3)

During the year, data on various aspects of the mud bank at Alleppey were collected intensively. The depth soundings carried out at the region,

prior to the formation of the mud bank showed thick deposits of mud getting localized at one place. At the commencement of the south-west monsoon, the localized mud gets dispersed and forms loose suspension in the entire water column. The slow movement of the mud bank is related to the coastal currents.

Hydrological investigations carried out on the samples collected from the mud bank showed that during the months January to March, the temperature varied from 19.5° to 30.1°C; salinity from 34.5 to 35.8‰; dissolved oxygen content from 4.5 to 5.0m l/l; reactive phosphate from 0.7 to 1.3 μg-at-p/l; nitrite nitrogen from 0.01 to 0.06 μg-at-N/l; nitrate nitrogen from 0.35 to 1.80 μg-at-N/l and reactive silicate from 8.2 to 16.5 μg-at-Si/l. During April-May the temperature values were mostly around 29.8°C and salinity values were higher than the previous months (35.0-35.6‰). Dissolved oxygen values ranged from 4.50 to 3.50 ml/l. Nutrients values were generally lower (reactive Phosphate 0.6 to 1.15 μg-at-P/l; nitrite nitrogen 0.01 to 0.06 μg-at-N/l; nitrogen 0.3 to 1.8 μg-at-N/l; reactive silicate 10.8 to 18.2 μg-at-Si/l. From June to August the temperature (27.5°-28.06°C), salinity (31.5 to 34.8‰) and dissolved oxygen values (4.0 to 3.5 ml/l) were lower than the previous months. However, the nutrients values showed an increasing trend later on.

During these investigations "mud cones" were observed in the water and in the beach area of the mud bank regions off Ambalapuzha.

Standing crop of phytoplankton was very high during June to August in the mud bank area. Qualitative studies showed that in almost all the samples collected during the first half year, Diatomaceae dominated, while during the bank season Dinophyceae formed the major constituent. Discolouration of the water at the mud bank due to the blooming of *Noctiluca miliaris* was observed during August. However, no fish mortality was noted in such areas of 'Red water'. Among the zooplankters, cladocerans were dominant in the months June-July. Zooplankton biomass was found to be less when *Noctiluca* was in bloom.

The mud samples were analysed for their faunistic composition. Foraminiferans and nematodes were found to constitute a sizeable percentage of the biomass. Copepods, cypris larvae and tardigrades formed minor constituents of the samples. Fish samples were also collected during the period.

Personnel associated with the project

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

Marine environmental damage (pollution, engineering works and other man-made changes)

(MBO/Misc/6)

Studies on marine microbial flora were carried out in the Cochin backwater, with a view to determining the role of bacteria in recycling the inorganic materials in the environment.

For the study of heterotrophic bacteria from the surface waters of Cochin backwaters, samples were collected from 5 stations at fortnightly intervals for 8 months (April to December, 1972 except August). Bacterial densities ranged from 124 x 10^3/ml in July, 72 to 13122 x 10^3/ml in December, 72. Gram negative rods constituted 99% of the isolates. Six genera were identified but 96.2% of these were *Achromobacter*, *Pseudomonas* and *Vibrio*. The types varied seasonally, but proteolytic, lipolytic and amylolytic activity appeared independent of the season.

For pollution studies, analysis was carried out in 4 different selective media to culture *Escherichia coli*, faecal *Streptococci* and *Staphylococci* (Coagulus +).

E. coli densities ranged from 2 to 72/ml of sea water. High *E. coli* counts (in station 1 and 3) were found from September, December due to constant discharge of sewage into this area.

The low organic matter and saline water contribute significantly to the death of cells of *E. coli* in the estuary. Sea water has bactericidal property which is particularly effective against pathogenic organisms. This may be the cause of *E. coli* being completely absent in some of the collections.

Coliform densities were determined by MPN method and ranged from 0 to 19,000/ml of sea water. May and June contained no coliforms but significant coliform densities were found in September, '72.

Bacteriological and pollution studies were also carried out in the Mud bank area at Ambalapuzha. Sea water samples and 11 mud samples were analysed. The surface bacterial population remained in the range of 10^5 - 10^6. The coliform counts were found to be 1.7 x 10^3 and *E. coli* 10^3. Aerobic bacterial counts of the mud varied from 1000/ml to 8000/ml per gram (wet basis). A few denitrifiers were isolated from the mud. In addition, the agar digesters were also found to be present in the mud samples. The latter may be associated with relatively richer phytoplankton from the area.

Average fortnightly plate counts of Heterotrophic bacteria and E. coli (from April, 72 to December, 72) from Cochin Backwater

Average counts/ml		Station 1	2	3	4	5	Average
Month							
April	A	133	301	39	No sample		158
	B	No data			-	-	
May	A	320	700	360	300	50	346
	B	8	14	36	30	20	21
June	A	92	160	584	776	732	470
	B	Nil	20	16	Nil	36	24
July	A	111	264	114	69	63	124
	B	13	23	25	Nil	24	21
September	A	64	496	368	408	328	335
	B	50	144	104	56	6	72
October	A	80	620	276	120	122	243
	B	24	77	41	53	31	45
November	A	No sample	53	120	No sample	108	95
	B	No sample	106	60	No sample	50	72
December	A	1000	2200	56800	5200	5400	13122
	B	94	14	64	42	66	56

A = Total counts (10^3) B = *E. coli*

Personnel associated with the Project

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

Energy flow in some selected ecosystems

(MBO/Misc/5)

The fish resourcee form a part of an ecological system in which physical, chemical and biological forces operate and fluctuate. Hence the studies on energy flow in a few selected ecosystems such as the inshore regions, prawn-cum-paddy field and Cochin Backwater were initiated. Energy flow studies are being carried out from different angles both in the field and in the laboratory. Collection of data is being undertaken on nutrients; phyto-and-zooplankton; primary productivity; determination of organic carbon in fishes and prawns from selected environments. In addition, studies on conversion efficiency of some fishes and prawns by conducting feeding and respiration experiments are being carried out. Energetics of dissolved carbohydrate metabolism in the Cochin backwater are also being studied.

Organic carbon

From the stand point of transfer of energy from one trophic level to the other, the knowledge of the energy content of food is of much value. It is also useful in determining the food conversion efficiency or ecological efficiency. The organic carbon contents of a few fishes and prawns and their food carbon were analysed and full working instructions were provided so that the method could be used by all research workers. The results are summerised below:

	Body carbon % dry wt.	Food carbon % dry wt.
Sardinella longiceps	43.14-46.74	6.96-7.94
Mugil macrolepis	50.34-51.00	7.74-7.68
Rastrelliger kanagurta	36.60-37.02	29.52-30.05
Nemipterus japonicus	33.18-35.04	26.64-28.20
Etroplus suratensis	32.04	21.18
Metapenaeus dobsoni	23.92	—
Metapenaeus monoceros	25.29	—

It was found that in phytoplankton and detritus feeders, the ratio of body carbon to food carbon is between 5-7 and in zooplankton feeders and carnivores this ratio ranged from 1-1.5. The calorific estimation of some of the economically important fishes is in progress. The calorific value of *Etroplus suratensis* was found to be 3000 cal/gm dry wt and for the prawn *Metapenaeus dobsoni* it amounts to 2148.79 cal/gm dry wt.

Mud samples collected from the mud bank area off Ambalapuzha were also analysed for total organic carbon. The values ranged from 2.1 to 19.8 mg C/gm dry wt. In the prawncum-paddy fields the values ranged from 1.2 to 27.6 mg C/gm dry wt.

Metabolic activity

As part of the studies on energetics, respiration rates in 5 species of teleosts were determined. The standard metabolic rates of *Caranx carangus* and *Synagris furcosus* amounted to 155 and 134mg/kg/hour. Maximum tolerance of low oxygen was found in *Gerres lucidus* and *Chanos chanos* which frequently live in low-oxygenated waters.

The rates of oxygen consumption (Q) in relation to live body weight (W) in *Etroplus suratensis* and *Mugil macrolepis* were found to be $Q = 0.509\ W^{0.839}$ and $Q = 0.603\ W^{0.723}$ respectively. As compared to the oxygen consumption rate of other tropical fishes such as *Cynoglossus*, *Pleuronects Synaptura* and *Brachiurus*, both *Etroplus* and *Mugil* recorded higher oxygen consumption.

Dissolved carbohydrates (DCHO)

Dissolved organic acids and carbohydrates (DCHO) occur in large quantities in natural waters. These substances are of much ecological significance and play a role in the food chain. The dissolved carbohydrates provide a ready source of energy for the primary producers and consumers in nature. Preliminary studies in the Cochin Backwater have shown that the DCHO comes from various sources apart from being the extra cellular product of algae. Detailed investigations on this aspect are in progress.

Personnel associated with the project

S. Z. Qasim, Director; P. V. Ramachandran Nair, JFS; Sumitra Vijayaraghavan, AFS; D. C. V. Easterson, RA; Gobi Kumari Vinci, RA; P. G. Jacob, RA; C. V. Mathew, RA.

Aquaculture, its potential and practical applications

(MBO/Misc. 4)

At Cochin

Efforts were made during the year to utilize two ponds at Narakkal for prawn culture. New sluices were fixed and other improvements made in the ponds for prawn culture.

A series of experiments were conducted in the laboratory for studying the suitability of artificial food for prawns during culture operations. These food preparations had varying proportions of carbohydrates, proteins and fats. The prawn, *Metapenaeus dobsoni* with an initial size of 32 mm exhibited different growth rates when offered different types of food preparations. Similar studies were conducted on the post larvae of *Penaeus indicus* also.

At Tuticorin

The potentialities of culturing fishes and prawns in the salt pan areas were studied at Veppalodi. Four small ponds were modified for fish and prawn culture. Preliminary studies on the characteristics of plankton, fishes and prawns in relation to varying salinities were carried out.

At Mandapam

Attempts were made to collect spats of the edible oyster, *Crassostrea madrassensis* for culture operations. Three types of cultch tile and oyster shells dipped in a slurry of cement were placed in the vicinity of oyster beds in the Athankarai estuary (near Mandapam). During October to

December oyster shells were tied to bamboo poles and placed in the estuary. Spat fall was rather poor although sexually ripe or partly spent oysters were found in the oyster beds throughout the year. A few spats measuring 7.5 to 8 mm settled during the month of September on shells not coated with cement.

Personnel associated with the project

S. Z. Qasim, Director; R. V. Nair, Deputy Director; P. Bensam, AFS; K. Satyanarayana Rao, AFS; M. M. Thomas, AFS.

Researches contemplated

Most of the investigations which were in progress during the year will be continued in 1973 and new projects on the charcteristics of the benthos of the fishing grounds and on coral reef resources will be taken up.

Popular Summary of the Report

During the year 1972, the Institute completed twenty five years of fruitful researches on marine fisheries and its Silver Jubilee was celebrated in the month of December 1972.

The Institute has undertaken 29 research projects during the year and an all round progress in these projects was maintained throughout the year.

The marine fish production in the country during the year was provisionally estimated as 974,456 tonnes as against 1161,389 tonnes during 1971. While Kerala and Mysore recorded reduced landings, no large scale fluctuations were seen in other maritime States of India. The percentage of landings from the mechanised crafts showed a significant increase during the year. Among the major fisheries, the yield from the oil sardine, mackerel and Bombay duck declined, whereas the catches of both penaeid and non-penaeid prawns increased.

Detailed information of the biological aspects such as size composition, age and growth, breeding and feeding habits were collected on oil sardine, mackerel, prawns and other important fishes. The Institute initiated researches for generating additional food resources through mariculture. Work on the development of the cultured pearls has started at Tuticorin. The pearl oysters were conditioned in cages and an indigenous method for the production of nuclei from the chank shells has been developed. The nuclei are introduced into the body of the pearl oyster for the development of cultured pearls. Eels were successfully reared in running water and the growth rate of the elvers was directly determined.

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The important findings in marine biology and oceanography include the time, occurrence and the rate of upwelling along the west coast of India. Several new records have been made of the species of phytoplankton from the Indian seas, and studies were conducted on the highly productive areas of the mud banks of Kerala. About 40 maps showing monthly fluctuations of the standing crops of zooplankton along the southwest coast and the Laccadive Sea, betwen 7°N and 17°N have been completed and these showed the occurrence of high standing crop of zooplankton in the inshore waters of the continental shelf, especially from June to October.

The second survey of the seaweed resources along the Tamil Nadu coast has been covered along the 45 km of coastline from Mandapam to Kilakarai and this has helped to chart out productive seaweed beds along the 4 metres depth contours.

Personnel

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

1. Dr. K. V. Sekharan - as Senior Fishery Scientist
2. Shri S. Mahadevan - as Junior Fishery Scientist
3. Shri J. C. Gnanamuttu - as Assistant Fishery Scientist
4. Shri T. Appa Rao - as Assistant Fishery Scientist
5. Shri G. G. Annigeri - as Assistant Fishery Scientist
6. Shri S. Reuben - as Assistant Fishery Scientist
7. Shri M. M. Thomas - as Assistant Fishery Scientist
8. Shri R. S. Lal Mohan - as Assistant Fishery Scientist
9. Dr. C. S. Gopinadha Pillai - as Assistant Fishery Scientist
10. Shri K. Dorairaj - as Assistant Fishery Scientist
11. Dr. (Miss) Sumitra Vijaya-raghavan - as Assistant Fishery Scientist

List of Scientific Papers Published by the Staff of the Central Marine Fisheries Research Institute during the Year 1972

S. No.

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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
LFA — Laboratory cum Field Assistant
RS — Research Scholar

STAFF POSITION AS ON 31 - 12 - 1972

Director : S. Z. Qasim

Deputy Director : Dr. R. Velappan Nair

I. Fishery survey and statistics division

1. Shri S. K. Banerji, SFS
2. Shri V. Sadasivan, FS
3. Shri M. G. Dayanandan, AFS
4. Shri S. K. Dharmaraja, AFS

II. Fishery biology division

1. Dr. K. V. Sekharan, SFS
2. Shri K. H. Mohamed, FS
3. Dr. G. Seshappa, FS
4. Shri T. Tholasilingam, FS
5. Dr. S. V. Bapat, JFS
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43. Shri K. Dorairaj, AFS

III. MARINE BIOLOGY AND OCEANOGRAPHY

1. Dr. E. G. Silas, SFS
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3. Shri G. S. Sharma, JFS
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14. Shri G. G. Annigeri, AFS
15. Dr. C. S. Gopinadha Pillai, AFS
16. Dr. (Miss) Sumitra Vijayaraghavan, AFS

IV. CURATOR

Shri M. Kumaran

V. ADMINISTRATION

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2. Shri S. Subramanian, Accounts Officer
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