

GOVERNMENT OF INDIA
CENTRAL MARINE FISHERIES RESEARCH INSTITUTE,
MANDAPAM CAMP
ANNUAL REPORT OF THE DIRECTOR FOR THE YEAR ENDING
31st MARCH, 1963

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I. ADMINISTRATIVE AND GENERAL

During the year under report, the Institute made good progress in the implementation of the various research programmes under the normal and Five Year Plan schemes at the main Research Institute and its subordinate establishments. The random sampling scheme of collection of catch statistics of fishes was extended to the centres in the Madras and Andhra coasts during the year and five new survey centres at Nellore, Amalapuram, Mahabalipuram, Pundis and Colachel were opened.

The total marine fish landing during the year 1962 was 6,44,244 tonnes as compared to 6,83,569 tonnes during 1961 showing a decrease of about 39,325 tonnes.

Vol. VIII No. 1 of the "*Indian Journal of Fisheries*" was published during the year. It has been decided to publish the Journal in two parts—Part A on Fisheries Biology and Part B on Fisheries Technology. This decision is being implemented from Vol. IX onwards.

The budget allotment for the year under the heads 'recurring' and 'non-recurring' amounted Rs. 3,23,000 and Rs. 3,50,000 respectively.

The annual requirements of scientific equipment and stores were procured.

The Library of the Institute was considerably strengthened by purchasing new books, publications etc. and by increasing the subscription for a number of periodicals. A list of Research Publications of the year from the Institute is appended at the end of the report.

The following gazetted appointments were made during the year.

Dr. R. Raghu Prasad (Senior Research Officer) as Deputy Director.

Shri P. C. George (Assistant Research Officer) as Research Officer (Junior).

Shri P. R. S. Tampi (Assistant Research Officer) as Research Officer (Junior) (leave vacancy).

Shri P. V. Ramachandran Nair (Research Assistant) as Assistant Research Officer.

Shri C. P. Ramamirtham (Research Assistant) as Assistant Research Officer.

Shri A. V. S. Suryanarayana Murthy as Assistant Research Officer.

Shri S. Rajagopalan, (Superintendent) as Accounts Officer (stop-gap basis).

Dr. R. Subrahmanyam, Research Officer (Junior) and Shri R. Jayaraman, Assistant Research Officer relinquished charge of their posts to take up the posts of Botanist, Central Rice Research Institute and Assistant Professor, Central Institute of Fisheries Education respectively—the latter has since gone to Council of Scientific and Industrial Research as Senior Scientific Officer, Indian Ocean Expedition.

Eighty-six temporary (Class II, III and IV) posts in the Institute were converted into permanent ones and appointments against many of these posts have been made. Confirmations were made against 3 posts of Research Officers (Junior) and 4 posts of Survey Assistants (Selection Grade) also during the year.

Under the Third Five Year Plan Schemes 49 (Class I, II, III & IV) posts were sanctioned for the second year of the Plan period and action has been taken for filling up these post speedily. The post of Fish Farm Engineer has been abolished since no suitable candidate was available for appointment against that post.

Dr. S. Jones, Director, participated in the Kerala State Fisheries Research Committee meeting held at Trivandrum. At the invitation of the Indian National Committee on Oceanic Research, Dr. R. Raghu Prasad, Deputy Director, took part in the meeting of the working groups of the Indian National Committee on Oceanic Research held at Bombay and the consultative committee meeting of the Indian Ocean Expedition Biological Centre held at Ernakulam.

Members of staff of this Institute actively participated in the experimental oceanographic cruises undertaken by the research vessels of the Indo-Norwegian Project (R. V. VARUNA) and Indian National Committee on Oceanic Research (I.N.S KISTNA).

The Research Scholars under the Ministry of Scientific Research and Cultural Affairs Research Training Scholarship Scheme and the Council of Scientific and Industrial Research Pool Officer attached to the Institute made considerable progress in their work.

A number of scientists from the United States of America visited the Institute during the year in connection with U.S.A.'s participation in the International Indian Ocean Expedition.

The construction of 12 units of Class IV residential quarters was complete during the year. Renovation of the Stores and Guest Room buildings, black-topping the roads at Mandapam Camp and rethatching of kutchra quarters were also completed during the year. Work on the renovation of the Administrative Block of the Institute has been taken up and has made considerable progress. Execution of some of the capital works of the Institute had to be deferred during the year in view of the National Emergency.

Besides the facilities given to the general public in visiting the Aquarium and Museum the Institute continued to extend help and facilities to a number of student parties from various universities, colleges and schools who wanted to acquaint themselves with the investigations carried out here. Lectures were given by the members of the scientific staff of the Institute to the students of the Central Institute of Fisheries Education and the employee-trainees of the Gujarat State Fisheries Department. Among the various visiting institutions may be mentioned Sainik School, Madras, Providence Women's College, Kozhikode, Hindu College, Guntur, Government Arts College, Cuddappah, Thiagaraya College, Madras, R. N. College, Chirala, Lady Doak College, Madurai, St. Joseph's College, Kozhikode, Nirmala College, Coimbatore and Ethiraj College, Madras.

II. FISHERY SURVEY

The analysis of data collected in 1962 was completed during the year under review—the total landings of marine fish during 1962 were estimated at 6,44,244 tonnes as compared to 6,85,569 tonnes in 1961 showing a decrease of about thirty-nine thousand tonnes. The Statewise break up of the total landings for 1962 and 1961 are given in Table I.

TABLE I

States	Marine fish landings in tonnes	
	1962	1961
1. West Bengal & Orissa	7,948	8,924
2. Andhra	60,027	54,506
3. Madras (including Pondicherry)	1,11,435	1,23,501
4. Kerala	1,91,421	2,67,498
5. Mysore	43,904	17,248
6. Maharashtra	1,23,708	11,839
7. Gujarat	97,751	91,396
8. Goa	not available	452
9. Andamans	155	131
10. Laccadive group of islands	178	872
11. Trawlers	7,717	7,207
TOTAL	6,44,244	6,83,569

It will be seen from the above table that while Mysore registered considerable increase in landings, a significant fall in catches was recorded in Kerala and Laccadive islands. Landings in other maritime States were more or less of the same order as last year's.

There was no significant change in the landings in West Bengal & Orissa. Some improvement in the catches of penaeid prawns, sciaenids, ribbon fish and *Anchoviella* was recorded. A slightly reduced yield of other sardine, *Hilsa*, *Caranx* and other clupeids was, however, noticed in these States.

There was some increase in the total landings in Andhra. Good landings of other sardines, seer fish and cat fishes in North Andhra and the increase in the catch of pomfrets in Central Andhra augmented the total yield of the State. While *Hilsa* registered a better catch the landings of penaeid prawns showed a decline in this State.

Though landings in Madras were higher than those in 1960 they declined in comparison to last year's figures. In 1961 there had been exceptionally good fisheries of *Caranx* in North Madras and also a very good fishery of perches in the Gulf of Mannar region. But in 1962, the poor fisheries of perches, *Anchoviella* and mackerel together with the poor fishery of *Caranx* resulting from not so successful 'Mada-vala' operation in North Madras lowered the catch by over 12,000 tonnes. The fisheries of flying fish and ribbon fish, however, registered a significant improvement.

Despite the comparatively better fisheries of oil sardine and mackerel in Cannanore area, the poor yield of these fisheries in the area South of Calicut coupled with a general decline in the landings in Vizhingam area, caused a fall in the annual catch in Kerala by 76,072 tonnes. The fisheries of soles, pomfrets and penaeid prawns registered a better return toward the latter part of the year in this State.

Unlike last year's failure of mackerel and oil sardine fisheries in Mysore, their success in North and South Mysore contributed to the enhanced landings in the State. Apart from these, there was an improved yield of sciaenids, *Leiognathus* and penaeid prawns in Mysore during 1962.

Non-penaeid prawn fishery was good in Maharashtra during the first half of the year. In addition, the better catches of oil sardine and mackerel in Malvan area and that of *Harpodon nehereus* in Bombay area augmented the total catch of the State. It had been observed that, towards the end of the year, fishing in South Maharashtra was greatly hampered by the occurrence of jelly fish in large quantities, otherwise the catches in this area would have been higher than the reported figure.

The poor fishery of penaeid prawn in Kutch along with lower catch of *Harpodon nehereus* caused a decline of about 3,500 tonnes in the over-all landings in Gujarat. But this decrease was more than compensated by better landings of elasmobranchs, cat fishes, sciaenids and *Hilsa*.

2. The following table shows the overall composition of the total marine fish landings in India during 1962. For comparison, the corresponding figures of 1961 are also given.

TABLE II
Composition of Marine Fish Landings

	Quantity landed in tonnes	
	1962	1961
1. Elasmobranchs	40,761	33,554
2. Eels	8,879	1,1380
3. Cat fishes	19,321	10,928
4. <i>Chirocentrus</i>	8,898	6,748
(a) Oil sardine	1,10,299	1,67,884
(b) Other sardines	19,551	19,764
(c) <i>Hilsa ilisha</i>	1,649	1,050
(d) Other <i>Hilsa</i>	9,044	6,475
(e) <i>Anchoviella</i>	19,168	22,103
(f) <i>Thrissoles</i>	5,872	4,962
(g) Other clupeids	12,054	15,256
6. (a) <i>Harpodon nehereus</i>	83,933	93,844
(b) <i>Saurida</i>	1,307	865
7. <i>Hemirhamphus</i> & <i>Belone</i>	149	493
8. Flying fish	4,154	1,206
9. Perches	8,958	15,377
10. Red mullets	1,596	2,165
11. Polynemids	2,802	5,920
12. Sciaenids	32,439	29,917
13. Ribbon fish	20,586	19,515
14. (a) <i>Caranx</i>	7,364	22,551
(b) <i>Chorinemus</i>	3,517	3,517
(c) <i>Trachinotus</i>	14	7
(d) Other carangids	537	113
(e) <i>Coryphaena</i>	172	138
(f) <i>Elecate</i>	225	185
15. (a) <i>Leiognathus</i>	18,104	15,763
(b) <i>Gazza</i>	164	201
16. <i>Lactarius</i>	7,656	8,898
17. Pomfrets	25,678	16,488
18. Mackerel	29,103	34,485
19. Seer fish	10,941	11,449
20. Tunnies	2,297	7,805
21. <i>Sphyræna</i>	1,120	1,389
22. <i>Mugil</i>	880	862
23. <i>Bregmaceros</i>	3,164	3,900
24. Soles	17,644	7,730
25. (a) Penaeid prawns	48,251	39,083
(b) Non-penaeid prawns	34,984	23,685
(c) Other Crustaceans	1,013	2,038
26. Cephalopods	95	94
27. Miscellaneous	19,871	13,782
TOTAL	6,44,244	6,83,569

The characteristic features of the 1962 fisheries were as follows :

1. The oil sardine fishery was very good in some regions but not so successful in other areas. The fishery was exceptionally good in North Mysore and in southern part of Maharashtra and was fairly good in North Kerala and South Mysore. The fishery was extremely poor in Central Mysore and in most parts of Kerala South of Calicut. The net result was a shortfall of about 58,000 tonnes in the landings of 1962.

2. As in the case of oil sardine, the mackerel fishery was mainly confined to North Kerala, South Mysore and North Mysore. The season commenced erratically but the fishery became steady by the last quarter of 1962. Due to the rather unsteady condition in the beginning of the season, there was a small short fall of about 5000 tonnes in the annual landings of mackerel in 1962.

3. *Caranx* and perch fisheries, suffered a sharp decline in 1962 which was mainly due to reduced landings of these fishes in Madras State. The landings of *Caranx* showed a decline in Kerala also to some extent. The poor fisheries of *Caranx* and perches in Madras State were mainly responsible for bringing down the total landings in the State.

4. The Bombay duck landings showed a decline of about 10,000 tonnes. In Maharashtra, the landings of Bombay duck were higher than in the last year but they were lower in Gujarat. The shortfall was mainly due to the late commencement of the Bombay duck season in Jaffrabad-Rajpara area in Gujarat.

5. There was all round decline in the tuna landings. The landings showed decrease in all regions where tunnies are landed. The decline in Madras State was to the extent of about 1,000 tonnes, in Kerala State about 4,000 tonnes and about 500 tonnes in Minicoy.

6. Considerable increase was noticed in the landings of elasmobranchs, other *Hilsa*, flying fish, pomfrets, soles and prawns and some increase was also seen in the landings of sciaenids.

Some decline was noticed in the landings of elasmobranchs in Kerala but this was offset by improved landings in Madras, Mysore and specially Gujarat. The improvement in the landings, of *Hilsa* during the year was mainly due to increased landings of the fish in Andhra and Gujarat. The flying fish fishery along the Madras Coast was comparatively better than that of last year but was not so good as in 1960. The increase in the landings of pomfrets was mainly due to better yield of the fish in Kerala and Andhra despite slightly reduced landings in Maharashtra and Gujarat.

There was phenomenal improvement in the sole fishery of Kerala. The landings in 1962 exceeded that of 1961 by more than 10,000 tonnes. Similar improvements were noticed in the landings of prawns in Kerala, Mysore and Maharashtra, although the prawn fishery in the Gulf of Kutch was almost a failure.

7. The table given below shows the seasonal variations in the catch landed in different maritime States of India.

TABLE III
Seasonal Variations in Catch
(Figures in tonnes)

States	I Quarter	II Quarter	III Quarter	IV Quarter	Total
West Bengal & Orissa	2,310	1,219	1,105	3,314	7,948
Andhra	22,522	16,846	8,129	12,530	60,027
Madras	30,176	74,475	31,282	25,169	1,11,485

Mysore	5,991	756	13,028	24,129	43,904
Maharashtra	26,845	33,106	5,112	58,645	1,23,708
Gujarat	33,720	2,260	2,892	58,879	97,751
TOTAL	1,63,674	90,957	96,508	2,85,055	6,36,194
PERCENTAGE	25.73	14.30	15.17	44.80	100.00

From the above table it will be seen that about 45% of the landings were made during the last quarter of the year. Excepting in Andhra and Madras, the bulk of landings was made in the fourth quarter. In Andhra the highest were obtained during the first quarter. This was due to successful fisheries in North and Central Andhra. In Madras the third quarter landings were the highest.

4. *Catch per unit of effort.*—The following table shows the total effort in man-hours expended in each State and also the catch per effort expressed in Kilogramme. The corresponding figures for 1961 are also shown for comparison.

TABLE IV
Effort in Man-hours and Catch per Effort in Kilogrammes

States	Effort in 1000 man hours		Catch per man hour in Kilogrammes	
	1962	1961	1962	1961
1. West Bengal & Orissa	4,743	5,895	1.68	1.51
2. Andhra	60,566	46,138	0.99	1.10
3. Madras	72,940	68,713	1.53	1.80
4. Kerala	32,279	37,869	5.93	7.06
5. Mysore	5,640	5,702	7.78	3.02
6. Maharashtra	22,633	20,876	5.47	5.36
7. Gujarat	19,043	24,654	5.13	3.71
8. All-India	2,17,844	2,09,847	2.92	3.22

The above table shows that while total effort expended during 1962 was higher than that in 1961, the catch per unit of effort registered a slight decline. In Mysore, the amount

III. FISHERY BIOLOGY

1. Oil sardine

The Fishery : The oil sardine fishery along the west coast as whole for 1962-63 may be said to be moderate while there has been fluctuations at the various important fishing centres with some differences from the previous season. For example, at Karwar the fishery this year has been the highest ever recorded for that place. The fishery was likewise good at Ullal (Mangalore). But at Cannanore, Kozhikode and Cochin the fishery was relatively poor. It may be of interest to point out here that the landing figures for Ullal are much below those at the other centres or compared to those of the previous figures. This has been due to the fact that the fishery was not fully exploited in this place for fear of a possible glut as it happened in the previous years. Thus, it is reported that the *rampani* has not been operated this year for the oil sardine fishery during this season. Special mention may also be made of the low landings at Kozhikode where the total for the year amounted to only half that of the previous two years. The estimated landings at these important centres are given below :

Karwar	382 m. tons
Ullal (Mangalore)	77 ..
Cannanore	1794 ..
Kozhikode	3365 ..
Cochin	1203 ..

The peak period of the fishery was generally September to December in most of the places although the actual month when the maximum catches were obtained varied from centre to centre. Thus, December was the peak period for Karwar while the best season at Mangalore extended from December to February. At Cannanore, Kozhikode and Cochin the peak season almost coincided and was during October to December whereas far south in Vizhingam a good catch of oil sardine was recorded in the beginning of the season in September. It may be pointed out here that in the southern zones the height of the fishing season was comparatively earlier to that in the northern areas. While the fishery has been dwindling in Kozhikode and the south, the northern fishing centres continued to have some good landings, with the result that even during the close of the season carrier boats have been bringing moderate quantities of oil sardine to Kozhikode from places like Quilandy.

Length-Frequency & Modal Size Groups : In the first quarter of the year two dominant size groups were available, a younger generation of 125-150 mm group and an older one of 160-170 mm group in the Cannanore-Kozhikode zone. But at Karwar and Ernakulam only the younger fish were met with while at Mangalore, the older were present. But during July-August both the groups were encountered at all the centres except at Ernakulam where the younger generation continued, the modal size shifting to 145-160 mm representing the younger group and 165-175 mm constituting the older. In September the picture completely changed, for the earlier mature group disappeared giving place to the juvenile recruits. It is interesting to note that the dominant size classes were progressively increasing from south to north. The 45 mm group formed the majority at Ernakulam and further south, 60 mm at Kozhikode, 65 mm at Cannanore, 75 mm at Manglore and 105 mm

at Karwar. During October-December the dominant size classes of the immature stock varied between 100 and 125 mm at the different centres but by March '63 the modes remained almost uniformly at 130—140 mm. Since this group can be steadily traced through all the months after its entry into the fishery, it is probable that these are recruits from the 1962 stock.

It is of some interest to find another dominant group at 135 mm in the immature stock only at Karwar and Mangalore in the month of September. While this group failed to form an appreciable percentage of the catches at Karwar after September, this was present in the fishery at Mangalore throughout until March. However, its contribution as compared to the more dominant immature group was dwindling from November onwards. This group may be the recruits from the earlier spawners, probably belonging to the older generation which entered the spawning season for the second time. Since this spawning class formed only a minor percentage during the spawning season. It is likely that their contribution to the recruitment would have been of lesser magnitude and hence the immature stock mentioned above failed to form the main stay. The modal size of this group remained at 140 mm by March end.

Sexual Maturity & Sex Ratio : The year witnessed two distinct size groups representing two different year classes entering the spawning season. The younger generation belonged to 145 and 155 mm groups and the older one to 170 mm group. However, judged from the availability, the contribution by the latter was comparatively less than the former. This was only to be expected since the latter was entering the spawning season for the second time. The signs of development of the gonads were first noticed in May at Karwar and Kozhikode where stages II, III & IV were encountered. While in June there had been a general nonavailability of fish, in July and August the fish had advanced to stages IV and V. Spent fish in stage VII were available in August at Karwar and Cannanore while at Kozhikode they were available only in October. From September to March the fishery was mostly made up of immature sardine. The spent-resting individuals were available largely during January to March '63 at all the centres except at Cannanore where they occurred from October to December.

Among the spawning individuals males were found to be in higher proportion in July. But in August the females outnumbered the males in the spawning stock. During October to December it was again seen that the males were relatively numerous among the immature group that constituted the commercial fishery. During the remaining period from January to March '63 no such uniformity was noticed especially because the spent-resting class was also found mixed up with the immature stock. However, it was seen that there was some general similarity in the sex ratio records from Karwar and Mangalore. Similar resemblance in the sex ratio data collected at Ernakulam and Kozhikode was clear.

From the last week of September 1962 catches of the Government of India vessels contained small quantities of oil sardine and were available in the daily catches of the vessels for about four weeks. The local catches of bag net also contained sardine in lesser numbers during the same time. The size of oil sardine observed ranged from 10.3 to 12 cm and they were immature.

Prospects for the '63-'64 Fishery : Judging by the various factors connected with the sardine fishery for the current year, the season for '63-'64 is not expected to show any major

improvement in general and a deterioration may be ruled out. However, the behaviour of the ensuing monsoons and its impact on the fishery for the next season cannot well be predicted. It is expected that the two-year-old fish will continue to occur from July onwards at Ullal (Mangalore) since the maximum possible catch has not been taken during the current year. While some improvement in the fishery can be expected in Cannanore and other centres in the north no significant change for the Kozhikode area is envisaged.

Other Aspects : Analyses of the stomach contents of the fish during the various seasons and at different stages of the fish were being continued at some of the observation centres. These were mostly of a routine nature and no significant changes from those already reported previously have been found.

Studies on the oil sardine scales conducted at the Ernakulam showed that oil sardines measuring 130-150 mm in total length possess one 'ring' and those 160-180 mm long have two. As the ring formation in this fish is believed to be an annual feature it may be contended that these two size groups have completed one and two years of life respectively. The results when confirmed will have great significance in fixing the actual age and life span of the fish stock that are being exploited.

It has been possible to conduct a few preliminary echo surveys off Mangalore during the cruises of R. V. VARUNA in August and December in the 20-60 meter depth. Although no oil sardine shoals could be located during these surveys, experience has shown that more extended surveys of this type will be helpful for mapping shoals and determining their movements.

2. Mackerel

The mackerel fishery on the West Coast, in general showed improvement over last year. The highest annual landings of 80,700 kg were recorded from Karwar. This figure was, however, one-half the average annual catch for that place. The landings at Kozhikode though ranked second, in the order of abundance, were less than last year. The respective landings for 1961-62 and 1962-63 were 4,89,948 kg and 4,64,352.20 kg. The landings in the descending order at other fishing centres may be given as Cannanore—1,39,260 kg; Ernakulam—91,423 kg; Mangalore—79,600 kg and Vizhingam—27,426 kg. At Portonovo, on the East Coast, it was 13,692.61 kg. This year there was not much heavy shoaling in inshore waters of Karwar. The fishermen reported that shoals of *Rastrelliger* were generally moving outside the normal fishing zone of Rampan operation. North of Mangalore too, mackerel shoals failed to approach shore and the Rampan fishery was a failure. It was reported that during one of the cruises of R. V. Varuna, a large shoal was located in 20 fathom area off Muttom (1700 hrs, 23-3-1963 08° 03' 30" N, 77° 12' 25" E to 08° 05' N 77° 11' E). This existence of shoals in offshore waters may have resulted in the comparative poor landings in inshore waters at Karwar. The percentage composition of *Rastrelliger* in the total catch though showed an increase of about 10% from 1961-62 were remarkably below average at 68.45. The catch per unit of effort of 5,242 kg was lowest figure ever recorded at Karwar. An unusual feature of this year's fishery at Karwar was that large quantities of *Sardinella longiceps* were landed by Rampan. The fish formed 30% of the total catch. This may have also affected the fishery to some extent.

There was no *Rastrelliger* fishery at Karwar during the off-season months from April to September. At Mangalore, the catch during this period was negligible amounting to 11 kg as against 8228 kg of last year for the corresponding period. The landings for the same period at Cannanore were 60,564 kg. A total of 1,93,851.09 kg was recorded from Kozhikode during April-September months. There were no landings in April-June month at Ernakulam. In the next quarter July-September, 86,100 kg were recorded of which 51,400 kg in August and 34,400 kg in September.

Mackerel fishery, in Andamans, started by about May, the peak season being from June to August. Thereafter their catches gradually dwindled. While *R. canagurta* was caught mostly along the open coast and the bays in shore seines, *R. brachysoma* was caught mostly in the creeks along the shore in drag nets. The former species contributed more to the mackerel fishery in Andamans than the latter.

Size composition : The mackerel fishery during 1962-63 season was constituted by large sized fish in the 20—22 cm group except the catches from the Government of India vessels off Bombay as well as the catches by bag nets around Bombay. These composed of fish from 17.0 to 22.5 cm and in immature condition. At Karwar, the dominance of the 21 cm group in October was recorded for the first time. Mackerel in the 20—22 cm group contributed 73.12 lakh numbers (91.07%) out of the total 80.27 lakhs. At Ullal, in *Pattabale* catches, the modes were at 195.99 mm and 205.09 mm in October, 210—14 mm in November and 215—19 mm in February. In *Kanthabale*, the modes were at 225—29, 220—24 mm and 215—19 mm in January, February and March respectively. The size range at Cannanore landings was 19.5—22.5 cm with the modal size at 21.5 cm, in October-December months. In December another size group 17.5 cm entered the fishery. At the close of the season, the length of mackerel varied from 16.5 cm to 23.5 cm with the modal size at 17.5 cm and 22.5 cm. The latter group persisted in January and March. There were no landings in February. At Kozhikode three dominant size groups were present, namely 19.5 cm, 20.5 cm and 21.5 cm. In October, the dominant size class was 20.5 cm. In November, the *Ailachalavala* landings were dominated by 21.5 cm group and those of *Pattenkolli* by 19.5 cm class. In January and February 1963, the 21.5 cm group persisted in the *Ailachalavala* and *Mathikolli* landings. At Ernakulam, during October-December, the minimum and maximum sizes recorded were 13—22 cm with the 14, 19 and 21 cm dominant size groups. In February and March the length of fish varied from 19 to 22 cm with the modal size at 22 cm in February and 21 cm in March. The size of fish available at Vizhingam in June, July, August and October was 4 to 21 cm. Few specimens observed in March were in 23.5 cm and 24 cm.

Juvenile mackerel measuring 91 mm and 100 mm were recorded for the first time at Karwar in October. At Cannanore, juveniles with a modal size at 9.5 cm were first recorded in August. One notable feature of the fishery at Kozhikode during August-September months was the disappearance of smaller 10—16 cm group which normally dominated the fishery during these months. This is replaced by a larger 18—21 cm group at the commencement of the season—September-October. *R. canagurta* caught during the year off Andamans, ranged from 171 to 337 mm in total length, peak numbers being present between 220 to 239 mm and 280 to 299 mm (TL) the former being more important in its contribution to the fishery.

Maturity stages : The mackerel fishery during the season was supported mainly by juvenile fish (Stage I & II) though at the beginning of the season stages IV—VI at the close of the season stages III, IV were dominant. It was reported from Karwar that the fishery was contributed by fish in stage II of sexual maturity and that they were not virgins. Observations off Andamans indicated that *R. canagurta* were spent recovering and immature during June to September, immature and maturing during December and partially spent during February and March.

A single specimens of *Rastrelliger canagurta*, 26.9 cm, male running, was reported from the trawl catches of M. F. V. Bumili taken on 6-5-1962 from off Bombay at 27 m depth.

Food : Mackerel were found to feed actively when they were maturing. The main food items were crustaceans, copepods and pelecypod larvae, *Evadne*, polychaete large and tintinnids among the zooplankton and *Coscinodiscus*, *Thalassiothrix*, *Rhizosolenia*, *Biddulphia*, *Ceratium*, *Dinophysis*, *Planktonella* in phytoplankton group. Fish scales, sand and organic debris were present in plenty in samples caught in the Rampan and Yendi.

Off Andamans, analysis of the stomach contents of the partially spent fish revealed that they feed on mostly copepods (Calanoids, *Corycaeus* spp.) and their nauplii, *Lucifer*, decapod larvae (Mysis) small fish (Sardinella, Anchoviella, and *Leiognathus*) and other decayed matter which looked more like scum known to grow at the bottom of the shallow areas. The miscellaneous matter in the stomachs consisted of fragments of *Sagitta*, salps jelly fish, foraminifera, algae, diatoms, fish eggs and sand grains.

At Andamans, scale studies of *R. canagurata* yielded interesting results. The scales of 150 fish sampled during the June-August fishing season (ranging in size from 200 to 311 mm (TL)) have been examined. While fish up to 274 mm (TL) did not show any growth checks, the percentage occurrence of the recently formed growth checks gradually increased from 275 mm (TL) onwards and from 295 mm (TL) almost all fish had the growth checks. These checks ranged in number from 1 to 3 in close proximity, probably suggesting the intermittent spawning of the fish in a single season.

5. Prawns and Lobsters

During the year under review, the prawn fishery along the Kutch coast was quit seasonal in its fluctuations. The monsoon fishery of the inner gulf was almost a failure and is attributed to the late commencement of the monsoon rains during July-September. The winter prawn fishery in the open gulf area was successful and the catch is estimated to be about 240 m. tons. The monsoon fishery which commenced late, mostly comprised *Metapenaeus monoceros*. Only immature prawns were available during the entire period in the inner gulf. At the commencement of the fishery during August, 51-70 mm size remained dominant. A slightly smaller size group entered the fishery in September. Thereafter, a steady increase in the modal length was observed. *Penaeus indicus* and *M. brevicornis* were the other species that supported the winter fishery of the Kutch Coast. *P. indicus* was more dominant at Tekkro during the first half of the fishery and was supported by the 116-135 mm size group during the latter part of the period.

The magnitude of the inshore prawn fishery along Bombay Coast was better than that of last year though the catch of larger prawns in September-October registered a downward trend. As in the previous years, among prawns, *Palaemon tenuipes* continued to be

dominant in the "dol" net catches of Bombay. The peak fishing season was April, May and June, when it constituted 71.6%, 71.4% and 58.8% respectively of the prawn landings. There was a sudden decline in July. From September onwards *P. tenuipes* fishery was pushed down due to the predominance of the larger prawns. The same sequence of its relative abundance was observed during last year. Mature prawns of 40 to 60 mm formed the majority throughout the year, with a good number in various breeding stages.

Acetes indicus constituted 20.8% and 33.5% of the total prawn catches in the month of June and July respectively. Thereafter, its fishery declined and recovered again from December onwards, forming the most dominant component of the catches.

Metapenaeus which every year migrates shoreward by the last week of September forming a valuable and immense fishery, started occurring in large quantities by the last week of August. In September and October it was the major fishery in Bombay comprising 52% and 53.3% respectively of the total prawn landings at Versova and Sassoon Docks. The magnitude of the fishery as a whole was considerably less than that of the previous year. In the other months of the year under report it occurred only in small numbers. Majority of the catches comprised of adults, a few with maturing ovaries.

Of the three species of *Parapenaeopsis* (vi. *hardwickii*, *sculptilis* and *stylifera*), *P. stylifera* supported a considerable fishery in the months of September and October when it formed 21.7% and 22.6% respectively of the total landings. *Solenocera indicus* started coming in large quantities from December onwards, in certain weeks forming as much as 25% of the Versova catches. A few females were found in the spent condition.

Hippolytina ensirostris constituted a sizeable fishery in July and August, particularly in Sassoon Docks. Of the other prawns occurring sporadically in Bombay, *Atyopenaeus compressipes* sometimes formed as much as 10% of the Versova prawn catches.

At Bombay bull-trawl catches showed that prawn fishery from the off-shore area commenced from early June. *Metapenaeus affinis* and *M. monoceros* were the dominant species. The fishery remained active up to early October, but declined thereafter as in the previous year. At Versova and Mahim adult prawns were not abundant. Juveniles were caught in "Bokshi" net, whereas the larger size groups were landed by the mechanised vessels. The catches of prawns were comparatively poor in the mechanised catches during the season.

There was an unprecedentedly heavy fishery of prawns in the Karwar Bay, immediately after the South-West monsoon. A detailed study of this fishery revealed that as regard the species involved, dominant size groups etc., this fishery was an extension of the fishery of *Metapenaeus dobsoni* characterists of the Cannanore-Mangalore belt.

Along the Mangalore Coast the monsoon fishery for prawns was active from September 1962 and was supported mostly by *Metapenaeus dobsoni* in the indigenous fishery. The catches from the mechanised boats were dominated by *M. affinis* and *Parapenaeopsis stylifera*, in addition to *M. dobsoni*. There appears to be a succession of species that enter the fishery *M. affinis* dominated in December and was followed by *P. stylifera* and *M. dobsoni* in the succeeding month. During November to March the modal size group for *M. dobsoni* was 71 to 80 mm with a secondary mode at 101-105 mm as far as the males are concerned. The modal range for females was 91 to 100 mm. Mature specimens were available throughout

the post monsoon period. *M. affinis* dominated the Offshore catches during November and December with a minor revival of the fishery in March. *P. stylifera* dominated the catches from the mechanised boats from January onwards.

Fishing with mechanised boats at Cannanore has yielded very encouraging results. The prawn landings were uniformly good during the season. *Metapenaeus affinis*, *M. dobsoni* and *P. stylifera* were the main species that supported the fishery. The Indo-Norwegian Project mechanised boats operated between 5 and 12 Fathom area and the trawling ground was the muddy bottom area within 4-5 miles from Cannanore. An analysis of the catch data has shown that the Cannanore zone is proving to be one of the best prawn trawling grounds of this coast, both from the quantity of the catch as well as the nearness of the beds to the shore.

The inshore fishery from indigenous crafts was also good. More than 50% of the catch with *M. dobsoni* as the dominant species was landed during the period of the South-West monsoon. The boat seines (*Arakolli*) and shore-seines landed very little prawns during the summer months, except for, the nominal quantity of *M. dobsoni* and *P. stylifera*. It has been found that the larger species (*M. affinis* and *M. monoceros*) go buried in the mud during summer months and the indigenous gear is not efficient enough to fish these out during this season. This appears to be one of the main reasons of the mechanised boats landing the larger species from the same area of fishing.

The Offshore prawn fishery at Ernakulam commenced quite early by middle of September and the catches were fairly good. As in the previous year *Parapenaeopsis stylifera* is the dominant species in the catches in October. *Metapenaeus affinis* is predominant in the next two months and from January onwards *M. dobsoni* becomes predominant. The absence of *M. monoceros* in large numbers in the month of November and the continued predominance of *M. affinis* in December are features of difference from observations of previous years. As usual *M. dobsoni* exhibits 2 modes in the length frequency groups, one in between 71 and 95 mm and the other 96 and 120 mm probably representing the first and second year groups. The second mode is noticed to disappear as the season advances. The prominent modes of *M. affinis* fall between 121-130 mm for males and 126-145 mm for females. In *P. stylifera* the prominent lengths are between 81-85 mm and 91-95 mm.

Analysis of previous years' data on the offshore prawn fishery shows that 6 to 12 fathom area is most productive for prawns, with two distinct zones, 6 to 8 fathom area with *M. dobsoni* as the predominant species and 9 to 12 fathom area with *M. affinis* predominating.

In the inshore prawn fishery at Manassery shore-seines operated on some days in some months and small quantities of prawns were landed. In November-December months these catches show similarity with the catches of the offshore vessels, *M. affinis* with 126-135 mm groups predominant. In March on the other hand these shore seines landed prawns of very small sizes.

In the back water fishery the stake net catches were very poor in June to August months and also in October and January. The percentage of prawns in these catches was less in the months May through November. The chinese net yielded maximum catches from December through April. The number of post larvae in the backwater plankton samples in the first half of the year was comparatively less.

The fishery of the giant backwater prawn *Macrobrachium rosenbergii* was of a lesser magnitude during the year under review. The fishery started late, both at Kumarakom and at Ramankari. At both these centres the O-year class prawn was poorly represented. The causes of the poor fishery are not clearly understood.

At the commencement of the fishery males dominated the catches, but it was reversed in later months. Berried forms appeared late and were comparatively poorly represented. Spent and berried specimens were found to possess well developed ovaries even in November indicating repeated breeding at the far end of the season. Males alone were obtained from the river centres during off-season months. It was possible to confirm the tentative conclusion reported in the previous two years that there is a concentration of juveniles near Pulikkizh area during the period January to May. This information should prove to be of help in the location of centres for the stocking of prawn farms and for selection of field centres in mark-recovery experiments.

Studies on the systematic and seasonal fluctuations of the larval crustaceans from the inshore and offshore areas are continued. Large numbers of Penaeid and Sergestid larval and post larval stages were obtained and are being studied in details.

The prawn fishery exhibited wide fluctuations on the Madras Coast and at Pulicat. *Penaeus indicus* and *Metapenaeus monoceros* contributed to the bulk of the fishery. The fishery of Pulicat lake was mainly supported by O-year class species and a study of the sex-ratios revealed the high dominance of females in the catches. Large numbers of post larvae of *Penaeus indicus* were obtained from the Bar-mouth during July to September, indicating that this period was the peak season of breeding of *P. indicus* for the Madras Coast.

The lobster fishery of Kanyakumari District commenced very late in December this year and the catches have been comparatively poor. The length groups in the catches at Muttom during February showed slightly smaller sizes than those of previous years. Percentage of berried females in this month was also comparatively less.

4. Pomfrets

Brown Pomfret (Parastromateus niger): At Veraval the species appeared in large shoals in March '62 and the fishery continued till the end of May, when fishing was discontinued because of South west monsoon. The landings in the first season were very good and the size range was 220-460 mm. the dominant groups being 340-360 mm in March, April, May. The second season, August-October, commenced somewhat earlier than in the previous year and landings were also comparable to the earlier season. However there was remarkable difference in the size range and the dominant size groups available in the two seasons. The size range in the second season was 180-480 mm and the dominant groups were 260-280, 280-300 mm in August, September and October.

450 specimens were examined during this year for biological studies. Analysis of the stomach contents of 419 fish by the points method revealed that the fish is a carnivore, feeding on Salps, Amphipods, young prawns, Crustacean larvae, polychaetes, Cuttlefish, fish scales etc. Occurrence of mature fish (Stage IV) during May- November of ripe and running

ones (Stage V and VI) during September-October and of spent recovering ones during August-November, suggest a protracted spawning period for this fish from June to October. This is substantiated by the occurrence of juveniles during September-December. Scales from 461 fish were collected for age determination. 2238 fish were measured for length frequency studies. Morphometric measurements and meristic counts were taken for the study of stocks.

5. Other Fishes

At Kandla, biological studies of the following fishes were continued :—

(a) *Hilsa tili* : There was good fishery for this species during April 1962 at the meeting point of the Kandla and Hanstal creeks, as during the previous year. Subsequently there were no catches of *Hilsa tili* during the year.

Experimental fishing was undertaken during April 1962 off Sangat, on board the Gujarat State Fisheries Launch using the nylon gill net. A summary of the tow hauls made is given below.

Haul No.	Date/time of haul	Size-range (L.C.F.)	Maturity Index	Sex-ratio	No. of fish examined
I	14-4-1962, 04-00 hrs.	342—518 mm	VI	4:6	28
II	14-4-1962, 13-00 hrs.	345—500 mm	VI	3:7	10

At Navlakhi, the fish varied in length from 320-545 mm L.C.F. and were in the penultimate stage of sexual maturity. The males were comparatively much smaller in size. The fishery for the species commenced from mid-March during the current year. The fishery of the species coincides with its spawning period which means a destruction of parent fish which is about to add to the stock of the population.

There was an unusual occurrence of this species (size range 160-183 mm LCF) at Adesar Camp, in the Little Rann of Kutch during May 1962. There was a high mortality of this fish at this centre probably due to the high water temperature (32.9 C) and also due to the shallow and muddy water prevalent at this time of the year.

(b) *Hilsa ilisha* : The fishery for the species commenced in the last fortnight of June 1962 in the Lambidui—Bawadi area, with the onset of the monsoons. The size-range varied from 307-352 mm L.C.F. and the gonads were in the penultimate stage of sexual maturity. The fishery continued up to August 1962. During August 1962, the dominant size-group fluctuated between 360 mm to 426 mm LCF, and the sex-ratio was observed to be 35♂ : 40♀. The staked gill net was the main gear that accounted for the commercial catches. Observations made on board the Gujarat State Fisheries Launch during July 1962 by fishing with the nylon drift net off Sossoria are summarized below. The entire catch in each haul was more or less examined.

Haul No.	Date/time and duration of haul	Size-range (L.C.F.)	Sex-ratio $\frac{\delta}{\text{♀}}$	No. of fish examined
I	19-7-1962 15.30 hrs.—16.30 hrs. Rising tide.	338—416 mm	11:14	25
II	19-7-1962 17.00 hrs.—18.00 hrs. 06.56 hrs.—08.00 hrs.	338—430 mm	7:6	13
III	20-7-1962 06.45 hrs.—08.30 hrs.	345—424 mm	9:5	14
IV	20-7-1962 08.30 hrs.—09.45 hrs.	335—423 mm	11:15	26
V	20-7-1962 14.00 hrs.—15.30 hrs.	320—423 mm	13:5	18
VI	20-7-1962 16.30 hrs.—17.15	345—423 mm	10:7	17

The gonads were in the penultimate stage of sexual maturity, and the weight varied between 670-1128 gm of the sample analysed. The males were relatively smaller in size.

Stray specimens of *H. ilisha* caught from Sangat and Lyni during December 1962 were also examined. They varied in length from 266 mm to 395 mm and were in stage I of sexual maturity.

There were no catches of *H. ilisha* in the Little Rann of Kutch during the period under review, as reported in the previous year.

(c) *Polydactylus indicus* : There were practically no landings of this species on the Kutch coastline during the period under review. Four juveniles were collected from the trawl catches of M.F.V. Jheenga in September 1962 during its operations in this area.

(d) *Polynemus tetradactylus* : There were fairly good catches of this species during April 1962 in the Tuna-Sangat region. The fish varied in length from 430 to 468 mm L.C.F. and whole weight 1336 to 1355 gm. There were in stage IV-V of sexual maturity. At Adesar Camp (Little Rann of Kutch) the species varied in length from 216-233 mm L.C.F. and were all males in stage II of sexual maturity. Subsequently there were no systematic catches/landings of 'Rawas' in this region. Stray samples were however, analysed. Studies on the food of the fish indicated that teleostean fish, penaeid prawns and crabs constituted the main diet. In several cases the guts were completely full of zoeae.

During one of the cruises of R. V. *Varuna* (19-5-1962 to 24-5-1962) a large number of the deep sea fish *Cimropsodaon capensis* Regan were collected from a trawl catch taken from 210 to 220 m off Dahanu. This is probably the first record of the species from Bombay waters.

Studies on *Cynoglossus semifasciatus* were continued at Kozhikode, during the year, based on departmental collections made from the inshore fishing grounds off West Hill. The length frequency studies showed that during September and October 1961 the mode was in the 13-13.9 cm group. During 1962 the fishery commenced earlier in August the mode being in the 15-15.9 cm group in both August and September. Thus a larger size group dominated the fishery at

the commencement of the season in 1962, than in 1961. However as many as three modes were seen in the size distribution in October, this peculiarity being perhaps a consequence of intermittent spawning activity during the previous season. During 1961, juveniles of 5 to 8 cm sizes occurred unusually as early as September; they were absent in the catches of October and November but started occurring regularly from December onwards. During 1962 there were no such juveniles in the catches of the peak fishery months and they started to occur regularly only from November onwards as in other normal years. The mode of the new brood during 1962-63 was below 5 cm in November, in the 6-6.9 cm group in December, in the 8-8.9 cm group in January in the 9-9.9 cm group in February and in the 10-10.9 cm group in March. The larger sizes represented by the 15-15.9 cm mode of September dwindled in numbers subsequently and only occasional large specimens were obtained during the later months of the year.

The maximum number of indeterminates were found in December. The proportion of the two sexes was variable from month to month, the number of females per 100 males being as small as 64.3 in November and as high as 150.9 in March.

Among females examined for maturity, stages I and II did not occur until November; stage IV was dominant in the catches during August, September and October while stage I was dominant from December onwards. Stage V was relatively frequent in October. Stage VI (Spent) occurred as occasional instances throughout from August onwards except in November and December. The occurrence of this stage as early as August-September is an interesting feature.

At Waltair, studies on the biology of *Cynoglossus macrolepidotus* which was the main representative of the flat fish group of fishes were initiated during the period. However the catches were very poor and consequently the samples were also poor. The food of this fish was observed to be mainly composed of crustaceans like Amphipods, small crabs, *Lingula*, polychaetes, Echinoids and traces of Foraminifera. Most of the fishes were in stage IV with a majority of females. The length frequency analysis reveals that 40-45 cm and 15-20 cm size groups were dominant in June, 25 to 30 cm in July and August, 30-35 cm in November, and 20 to 25 cm in December.

At Waltair, investigations on the biology of *Nemipterus japonicus* and *Upeneus* spp. were continued during the year under report.

(a) *N. japonicus* : Specimens examined ranged in size from 7.4 to 22.0 cm (Standard length). Length-frequency study shows that 11.0 to 13.0 cm groups were dominant in the catches during April '63 to February '63. A second mode formed by 16-17 cm fish was observed during July and October to January. Female fish ranged in size from 9.7 to 19.2 cm and they were in stages I to IV. Mature fish in stage VI were observed in large numbers during October to April indicating a prolonged spawning period for the fish. Ova-diameter measurements were made of ovaries in stages IV to VI, and material for the fecundity studies was collected. Food analysis showed that juvenile crabs, stomatopods, juvenile and postlarval fish, Cephalopods and juvenile prawns were the major items of food in the order of importance. Polychaetes, amphipods, ophiurids, ostracods, isopods and gastropods were the other constituents. Data on length-weight relationship have been collected. Morphometric and meristic characters were taken of some samples of this species.

(b) *Upeneus vittatus* : 13-13 cm group fish were dominant in the catches during this year. Females measured from 10.5 to 14.0 cm. and were in stages I and II. Stage IV fish were collected in August. Males ranged between 10.2 and 15.0 cm and were in stages I to IV. No fully mature fish has been collected.

(c) *Upeneus sulphureus* : The fish examined ranged from 7.2 to 13.6 cm in length. Small sized juveniles measuring 4.0 to 7.0 cm were collected in September and October. Samples collected were inadequate for length-frequency studies.

Food-analysis of *Upeneus* spp. has shown that juvenile prawn, portunid crabs, *Squilla* spp. and fish (*Bregmaceros*) formed the chief diet of the fish. Polychaetes, amphipods, ophiurids, mysids, *Sepia* and decapod post-larvae being the other constituents of the food.

At Mandapam investigations on the tuna live-bait fishes of Minicoy Islands were continued during the year. A study on the food of the major tuna live-bait fishes of the island was taken up and completed. This study relates to ten species, namely, *Lepidozygus tapeinosoma* Gunther, *Archamia lineolatus* (Cuvier), *Caesio caeruleaureus* Lacepede, *Dipterygonotus leucogrammicus* Bleeker, *Gaasio tile* Valenciennes, *C. chrysozona* Cuvier, *Apogon sangiensis* Bleeker, *Chromis caeruleus* (Cuvier), *Spratelloides delicatulus* (Bennett), and *S. japonicus* (Houttuyn).

6. Molluscs

The programme of underwater survey of the pearl and chank beds in the Gulf of Mannar was continued during the course of this year also. The work was done in collaboration with the Madras State Fisheries.

There was an absence of pearl oysters in the rocky areas. The presence of full sized chanks beyond the 12 fathoms limit (22 metre zone) in certain sandy zones is a feature which may help in augmenting the commercial exploitation by means of mechanical diving equipments. Local skin divers do not dive in these areas normally and hence this area may be considered as a good replenishment centre.

Detailed examination of the rocky areas encountered in the central sector lying between 8°35'N—8°45'N continued to progress till the end of May 1962 when south west monsoon set in and stopped the work. By that time almost all the rocky areas lying between lines I to XXXI had been completed. A total of 22 voyages had to be made to cover by Aqua-lung divers 217 stations lying between lines XII to XXXI. It may be mentioned here that in the previous year lines I to XII had been investigated.

With the help of the information and data gathered during the second phase of the underwater exploration work a map showing the area surveyed was drawn and the location of the rocky bottom and their extent were determined. Out of the 307 sq. km. of area surveyed during the first phase of the survey work in the central sector consisting of 1100 stations, only 534 stations revealed rocky substratum. Sand samples and samples of fauna and flora were collected from 417 stations and are being studied in detail.

It was evident from the present survey work that in the central sector there are 10 patches of rocky bottom which are of considerable extent. These patches occupy a total area of about 18.5 sq. km. Of this the largest one is located at a stretch running north to south on the offshore region between lines I to X occupying an area of roughly 7 sq. km. This is only the

southward extension of a continuous rocky bed lying in the northern sector which will be studied subsequently. The second area of importance lies between lines XXIV to XXXI on the shoreward side running north to south occupying 4.95 sq. km in area. This again is a continuous rocky extent extending still further south and hence is to be further investigated. A complete picture of the pair area can be obtained on completion of the survey work.

The other patches noticed in central sector are isolated pairs and occupy areas ranging from 0.36 to 1.12 sq. km.

From the point of view of pearl oyster settlement in the rocky zones it was recorded that except for a small patch in line XII to XIV the rest was completely barren of oysters or spat. Hence it was suggested that a pearl fishery could not be conducted in 1963 and in subsequent years also unless spat settlement replenishes the region in future months. The prolific settlement of *Modiolus* spp. seems to have had the effect of smothering and choking the remaining oysters. But the *Modiolus* population itself has perished late in May 1962.

Another important observation which came to light was the thinness of the population of *Pentaceros linckii* which is not as great and predominant as was originally supposed by pearl fishery specialists. It would seem unlikely that *P. linckii* is a potential enemy of the Tuticorin beds considering the fact that on an average only one or two of these are found within an area of about 100 sq. metres.

On completion of the work in the central sector in accordance with the report of the F.A.O. the first phase of the survey work in the northern sector between 8°45'N—8°55'N was begun in the month of October 1962. Sea floor from 10 metre to 27 metre zone was inspected at intervals of 600 metres. Depth sounding was done mostly by Aqua-lung as well as by skin diving. A total of 1100 stations in an area of 350 sq. km were covered by making 32 voyages and the nature of bottom depth etc. were recorded. No echo sounding was done due to non-availability of suitable boat for fixing the echo sounder. Mapping the area based on this preliminary survey was done for this region. With the help of this chart detailed study of the rocky substratum was taken up as the part of the second phase of the survey work. This work began in February 1963. Up to the end of March 1963, 8 lines have been studied (Line I to VIII) in detail by making 16 voyages.

7. Offshore Fisheries

At Veraval three offshore fishing vessels, *M. L. Sagarpavasi* (Trawler), *M. L. Sagarkumari* (Trawler) and *M. L. Sagarihari* (Gillnetter) operated during the period. The data collected by these vessels were analysed and the abundance of fish in different subareas and depth ranges was studied. *M. L. Sagarpavasi* fished in areas 0-70, 20-71, 21-69, 21-70 and 20-69. The vessel fished in depth ranges between 24-60 meters and landed 83925 kg. of fish in 49 trawling hours with an average yield per hour of 170 kg. A remarkable development in this year was the introduction of Russian method of trawling with oval otter boards, bobbin, butterfly and sweeps since January 1963, which resulted in significant increase in catch rate from 140 to 255 kg/hr. The 20 fathom line has been found to be relatively more productive in respect of quality fish. In deeper waters although quality fish was available, the catch rate was poor. In shallower waters, fishes like Dhoma, Skates, Rays and Sharks were abundant while quality fish such as Sea Breams, Tams, Karkara and Ghol are scarce.

M. L. Sagarkumari operated a 12 meter Russian trawl in areas 21-70 and 20-70 in depths ranging between 20-33 meters and landed 9411 kg. of fish in 44 fishing hours. The catch per hour for all fish was 213 kg/hour. The catch rate was highest in 21-70/1A, being 446 kg/hr. Dhoma (53%) Rays (13%) Kati (3%) Skates (3%) and miscellaneous (21.6%) dominated the catch.

M. L. Sagarvihari operated bottom set gill nets in areas 20-69, 20-70, 21-69 and 20-71 in depth ranges between 26-46 meters and landed 15122.7 kg of fish in 867 hours of fishing. The annual average yeield was 17.4 kg/hrs. Sharks, Catfish, Palla, Brown Pomfrets, Choksh and Ghol were dominant in the landings.

Details of catches are as follows :

	M.L.S. Pravasi (Trawler)	M.L.S. Vihari (Gillnetter)	M.L.S. Kumari (Trawler)
Total catch (kg.)	83,925	15,123	9,411
Total effort (in hours)	493	867	44
Catch (kg.)/hour)	170	17	214

At Bombay offshore fisheries data collected by the various exploratory fishing vessel of the Government of India Deep Sea Fishing Station and of the commercial fishing vessels of the New India Fisheries Co. Ltd., during the year 1962 were analysed and the catch intensity of various species of fishes in different areas were studied. Offshore fisheries Data Sheet in respect of the operations of these vessels were regularly prepared every month.

Four vessels belonging to the Government of India Deep Sea Fishing Station were conducting exploratory fishing operations from Bombay during 1962. These vessels were as usual concentrating their activities in areas near about Bombay bringing in more or less similar results as in the previous years.

The largest among these vessels, M. F. V. 'Jheenga' worked in all the months of the year and she was able to take samples from as many as 67 sub-areas distributed in 12 areas. Of the total effort of 922 fishing hours put in by this vessel 596 hours were sent in areas lying very near to Bombay harbour. This is probably because the vessel was engaged in daily fishing trips for considerable length of time. The catch rate in these areas was more than 286 kg. per fishing hour, whereas the overall catch rate of the vessel from all the areas together was only 268 kg/hour. The corresponding figure of overall fishing rate during last year was 252 kg/hr. The catches consisted of Doma, Ghol, Karkara, Catfish and elasmobranchs. The total catch of the vessel during the year amounted to 247, 788 kg of fish.

In the months of August, September and October this vessel carried out exploratory fishing with a 14m. otter trawl using oval otter boards in area 22-69 lying inside Gulf of Cutch. The catch obtained from these areas was very poor and whatever obtained contained un-economic varieties like Doma, Cat-fish and rays. No prawns were obtained during these operations. It was also observed that the current in these areas was too strong for trawling to be conducted by a vessel like 'Jheenga'.

With the exception of one voyage to south of Bombay (Ratnagiri) M. F. V. 'Bumi' was carrying out fishing operation in areas 18-72 and 19-72. A total effort of 590 hours was put in by this vessel to land 128, 149 kg. of fish consisting mostly of Doma, Karkara, Ray Ghol and others. The average catch rate amounted to 217 kg/hour. The vessel was under repair in June, July and August. Large quantities of prawns (*Metapenaeus affinis*) was landed by the vessel in September and October from 14 to 20 metres depth in area 18-72. The operations conducted off Ratnagiri in January-February brought relatively poor returns.

M. L. 'Meera' carried out daily-fishing operations in area 18-72 with a 12 m. otter trawl. The vessel landed a total catch of 71,474 kg. of fish in 1962 by spending total fishing effort of 526 hours. The average catch rate realised by the vessel amounted to 135.8 kg/hour. Doma, elasmobranchs, Ghols and Karkara were the main constituents of the catch. M. L. 'Sagarkanti' was under repairs and therefore her operations were restricted to only 72 fishing hours during the year. 2,180 kgs. of fish was landed by this vessel and the average catch rate amounted to 30.2 kg/hour.

The four bull-trawlers of the New India Fishing Co. Ltd. (Satpati, Pilotan, Arnal and Paj) carried out trawling operations using a bulltrawl with 67.06 m. head rope, 68.58m foot rope and 50.8 mm cod end mesh, in Bombay and Saurashtra Waters. During the year they worked in 26 areas spending total fishing effort of 3,945 hours to land 3,549,540 kg. of fish. The average yield worked out to 899.7 kg/hour. The corresponding figure for the previous year was 852.9 kg/hour, thereby showing an increase in catch rate by 56.8 kg/hour. However the total landings as well as the total fishing effort of these vessels have shown decrease from that of the previous year due to the fact that the vessels remained in dry docks for considerable time. Among the catch rate obtained by these vessels it is seen that Doma, wam, Cat-fish prawns and sharks have shown increase from last year while koth, dara and karkara have shown decrease. The catch rate of Ghol and rays remained more or less steady.

Dara (<i>Polyastylus indicus</i>) investigations	Wt. of Dara in kg.	% in total catch	% last year (1961)
Government of India vessels	3,608	0.58	1.83
New India Fisheries vessels	33,642	0.95	1.62

The quantity of dara in the catches of the trawlers has reduced and its position as an important trawl fish of Bombay has become insignificant. Till 1955 the species used to form more than 10% of the catches of the trawlers; but for the past three years the catch of the species has not exceeded 2% of the landings. It is reported that the catches of this species in the drift fishery at Satpati, Dahanu and Jamnagar continue to be in more or less same magnitude as it used to be. The reduction of this species in the trawl catches can possibly be attributed to the shifting of the fishing grounds of the trawlers. The fishing effort spent in areas K, L, M and N, from where large quantities of daras were generally obtained seems to have been considerably reduced in recent years. The size of daras observed in the catches of the New India trawlers ranged from 50 to 72 cm and they were all immature. Juvenile specimens of daras (12 to 30 cm) were obtained from inshore catches of Sassoon Docks and Versova soon after monsoon.

Ghol (*Pseudosciaena diacanthus*) investigations :

There was a decline in the total as well as Ghol landings over the previous year. In 1962, 183, 545 kg. of Ghol were landed by the New India Fisheries trawlers. Ghol formed 5.17% of the total annual catch. Total and Ghol landings by the bull trawlers during the past 6 years are as follows:

Year	Ghol landings kg.	Total landings kg.	Percentage of Ghol to the total landings
1960	2,82,965	42,47,960	6.66
1961	2,13,144	39,38,547	5.41
1962	1,83,545	35,49,510	5.17

Unlike the previous year (1961) the landings of Ghol were considerably high in the month of October 1962. Government of India Deep Sea Fishing vessels landed 18,714 kg. of Ghol which formed 4.16% of their total annual catch. Most of the big Ghols had extroverted stomachs. Few of them had fish item in their stomachs the important components being *Johnius dussumierii*, *Lactarius lactarius*, *Johnius* sp. The cycle of events of maturation and spawning were more or less similar to those observed in previous years. This species has a protracted spawning extending from June to September. 300 scale samples and some otoliths collected in 1961 were studied for knowing the length of the fish at the time of formation of the different annuli. The data have yet to be analysed.

“Koth” (*Sciaenoides brunneus*) investigations :

Work discontinued when the Assistant Research Officer, Shri M. Narayanan Kutty left on long leave.

“Karkara” (*Pomadourys hasta*) investigations :

	Wt. of Kanara in kg	% in total catch	% last year 1961
Government of India vessels	20,306	4.51	2.9
New India Fisheries Vessels	256,932	7.24	11.4

During the calendar year 1962, 256932 kg. of karkara was landed by New India Fisheries Trawlers and 20306 kg. by Government of India Trawlers, which formed 7.23% and 4.5% of the total catch respectively. It was noticed that there was an appreciable fall in the catches of karkara by New India Fisheries Trawlers when compared to 1961 when it was 4,47,696 kg. forming 11.4% of the total. On the other hand there was an increase in the catch of karkara by Government of India vessels when compared to 1962 when it was 10,487 kg. forming 2.9% of the total.

The general pattern of the fluctuation in monthly catches of karkara both by New India Fisheries Trawlers and Government of India vessels remained more or less same. Good catches were recorded in January, February, March, October, November and December. Months of June, July and August were the months of low catches.

The analysis of karkara landings by New India Fisheries Trawlers revealed that maximum catch of karkara per hour of fishing came from the depth range 30-50 meters. The areas R and Q were more productive.

Wam (*Muraenesox talabonoides*) investigations :

	Wt. of Wam in kg.	% in total catch	% last year (1961)
Government of India vessels	4,638	1.03	1.9
New India Fisheries vessels	382,284	10.76	7.58

As usual eels were scarce in the catches of the Government of India trawlers. This is essentially due to the fact that the major portion of the operations of these vessels were centred around Bombay. In the catches of the New India Fisheries vessels eels were abundant and it formed 10.76% of the total catches of those vessels during the year as against 7.58% in the previous year. Most of these eels were landed from areas lying off Diu Head and Veral in the months of July, August and September. The area 12 gave very high catch rate of eels (604.9 kg/hour) in September. The size range of these eels varied from 127 to 164 cm mode being at 145cms. They were mostly in spent recovering stage.

At Mangalore the four mechanised boats of the training centre and an average of 40 boats of the Extranees of the Fisheries Directorate of the Government of Mysore in Mangalore, were operated off Mangalore region between depths of 5-15 fathoms; an average of 10 boats of the Extranees were also engaged in Fishing off Malpi at depths of 7-13 fathoms. However the Government of India Offshore fishing vessel M. V. "Tarpan" made fishing trip off Mangalore at a depth ranging from 5-20 fathoms.

A total quantity of 1928.942 m. tons were landed from off Mangalore and off Malpe of this fish constituted 1261.575m. tons and Prawns 667.367m. tons. The details of the catches of the various boats of the different centres are presented in the Table V.

TABLE V

Particulars of fishing boats	Area of fishing	Depth range in fathoms	Catch in kg.		Total catch in kg.	Grand total in m. tons
			Fish	Prawns		
Training centre boats	off Mangalore.	5-15	46309.00	39536.00	85845.00	
Extranees Boats	off Malpi	8-12	737358.00	576717.00	1314075.00	
		7-13	439889.00	24963.00	464852.00	1928.942
M.V. "Tarpan" (offshore fishing vessel).	off Mangalore (12-74)	5-20	38019.00	*26151.00	64170.00	

*Includes 440 kg. of lobsters.

Training Centre: Four different types of gear were operated by the training centre boats viz. trawl net, drift net, long lines and bottom set gill nets. Details of the catch composition of these nets are given below.

Trawl net: The trawling operations were conducted at a depth of 5-15 fathoms and a total catch of 72341.00 kg. was obtained of which 47354.00 kg. were fish and 24987.00 kg. Prawns. The catch/day of trawling was calculated as 288.1 kg. Prawns were mainly represented by *Metapenaeus affinis*, *M. dobsoni* and *Parapenaeopsis stylifera*. Stray catches of *Penaeus indicus* were also recorded. About 70% of the fish catches were constituted by miscellaneous varieties viz. *Sciaena* spp., *Leiognathus* spp., *Pellona indica*, *Trichiurus* spp., *Polynemus* spp., *Saurida tumbil*, *Arius* spp., *Cynoglossus* spp., *Anodontostoma chacunda*, *Nemipterus japonicus* *Upeneus indicus* and *Caranx* spp. *Lactarius lactarius* and *Opisthopterus tardoore* formed more or less a regular catch constituting 12 and 8% respectively and 10% of the catch was represented by sharks and rays.

Drift net: A total catch of 5708 kg of fish was caught by drift net and an average catch of 124.2 kg. per day was noted. Sharks and Rays, Sea fishes, *chorinemus* sp. and pomfrets formed the catch constituting 48, 21, 28 and 12% respectively.

Long lines: A meagre catch of 48.00 kg. was by "My 12" in her 3 fishing trips. Cat fish (*Arius* spp.) sharks and rays formed the catch and were represented by 70 and 30% respectively.

Bottom set gill nets: Set nets were operated between depths of 8-13 fathoms and a total catch of 7748.00 kg. of fishes was landed and the catch/day was worked out to be 143.4 kg. Sharks and rays formed the main bulk constituting 50% *Arius* spp., *Elecate nigra*, and *Chorinemus* spp. formed 20, 18 and 12% respectively.

Extrainees: The Extrainees boats operated only trawl nets during the period under review between depths of 8-12 fathoms off Mangalore and between depth of 7-13 fathoms off Malpe. Out of the total catch of 1778927.00 kg., fish found 1177247.00 kg., and prawns constituted 601680.00 kg. Though only an average of 10 boats were operating off Malpe the average catch boat worked out to be 46485.2 kg. whereas the average catch/boat off Mangalore was calculated as 32851.00 kg. with an average of 40 boats with regard to the composition of the catch it was found to be more or less similar to that of the Training Centre catch.

M. V. Tarpan: The results of the trawling operation of M. V. "Tarpan", Government of India offshore fishing vessel are tabulated and presented in Table VI

A total quantity of 64170.00 kg. was brought by "Tarpan" during her 72 fishing trips making a total of 276 hauls in 276 hours during the period, December-March. The vessel brought an average of 891.2 kg/day; 232.5 kg haul and 232.5 kg/hour. The trawling operations were conducted in the Area 12-74-5E, 6E and 6D at depths ranging from 5-20 fathom. At 5E the average catch/hour was 248.7 kg. 6E-227.7 kg. and 6D-145.5 kg. It is generally indicated that region 6E was found to be a rich ground. The catch/hour of prawns, Pomfrets and *Lactarius lactarius* worked out as 463.1 kg. 17.8 kg. and 12.1 kg. respectively. It is also noted that in the area the catch was more between 6-9 fathoms.

Among the total catch prawns constituted 25,711 kg. of which *Metapenaeus affinis* and *M. dobsoni* dominated the catch. 440 kg. of lobster were also caught. The miscellaneous catch

TABLE VI

Area	Depth range in fathoms	Nature of bottom	Fishing effort in hrs.	Total catch in kg	Sharks & Rays	Skates	Pomfrets	Lactarius lactarius	Trichiurus sp	Sciaena sp	Arius sp	Lobster	Prawns	Miscellaneous	Average catch/hour in kgm
5E	5-15	Muddy	70.00	17413.00	1045.00	20.00	225.00	180.00	60.00	30.00	..	1508.00		5375.00	248.7
6E	14-20	Muddy	204.00	46467.00	3491.00	760.00	986.00	742.00	710.00	70.00	80.000	440.00	15203.00	19600.23955.00	227.7
6D	10 $\frac{1}{2}$ -20	Muddy	2.00	290.00	80.00	..	..	40.00	..	..	..	..			145.0

was represented by *Sciaena* spp., *Nemipterus* spp., *Anodontostoma chacunda*, *Upeneus indicus*, *Cynoglossus* spp., *Opisthopterus tardoore*, *Pellona indica* and *Grammoplites scaber*.

Government of India vessels 'Durga', 'Samundra' and 'Tarpan' continued shrimp trawling operations off Cochin from April to July 1962. Two more vessels 'Flying fish' and 'Bangda' joined the fishing fleet after the monsoon, in September 1962, while 'Tarpan' was transferred to Mangalore.

The details of the operations of Government of India vessels off Cochin from April 1962 to February 1963 are shown in the table given below.

Details of landings of Government of India vessels from April 1962 to March 1963.

Months	Depth in metres	Fishing effort in hrs.	Total landings in kg.	Catch per hour of trawling in kg.	Catch per hour in kg.	
					Fish	Prawns
1962						
April	15-55	198.17	24,419	123	82	41
May	13-40	240.25	24,771	103	56	47
June	11-28	233.58	19,814	85	43	42
July	13-18	28.83	1,065	37	19	18
September	18-51	29.58	8,876	300	234	66
October	13-46	150.00	35,039	234	189	45
November	13-46	374.42	77,181	206	174	32
December	13-49	279.83	32,647	117	66	51
1963						
January	13-57	387.75	46,080	119]	98	21
February	15-35	253.67	31,626	125	86	39

During the premonsoon months of April and May 1962 the Government of India Vessels, operating off Cochin in areas 9-76 and 9-75, carried out shrimp trawling for a period of 438.42 hours realising a total catch of 49,190 kg. of fish and prawns as against 1,37,706 kg. over a period of 493.08 hours in the corresponding months of the previous year. The overall catch rate showed a decline from 279 kg./hr. in the previous year to 112 kg./hr. in the current year. This decline was due to a steep fall in the catch of fish from 1,10,885 kg. in April-May 1961 to 29,663 kg. in April-May 1962. However the prawn landings remained more or less steady, their respective catch rates being 54 kg./hr. and 45 kg./hr. Considerably higher fishing effort was spent in June 1962 (233.48 hours) compared to June 1961 (78.25 hours) yielding a total catch of 19,914 kg. as against 3,724 kg. in the previous year and the respective catch being 85 kg./hr. and 48 kg./hr. In June 1962, better prawn catches were realised compared with June 1961 the catch rate (42) being almost thrice of June 1961 (15).

The total landings of these vessels in the post monsoon months from September to February 1963 amounted to 2,31,449 kg. as against 2,49,876 kg. in the corresponding period of the previous year. The average return showed a sharp decline from 202 kg. per hour to 157 kg. per hour. The average catch rate for prawns for this period (36 kg./hr.) was also less, compared with the corresponding period of the previous year (58 kg./hr.). Though there was a good prawn catch in the earlier months of September-December (at a catch rate of 32 to 66 kg. per hour) it showed a decline in the subsequent months. This is in contrast to what has been observed in the previous years when the catch rate for prawns was low in the months of September and October, with marked improvement in the latter months. The catch rate realised in January was only 21 kg./hr. which however rose to 39 kg./hr. in February. The yield of fish was also noticed to be higher in September-November period, the catch per hour of fishing ranging from 174 kg. to 234 kg. which however showed a sharp fall in December-February the average return being only 85 kg. per hour as against 196 kg. per hour in the corresponding period of the previous year.

TABLE VII
Percentage Composition of 'Podimeen'
(September 1962 to March 1963)

Depth in meters	0-13		14-27		28-42		43-57	
	%	Size range	%	Size range	%	Size range	%	Size range
Species	2	3	4	5	6	7	8	9
<i>Lactarius lactarius</i>	10	9-15	5	9-23	1	9-18	8	12-23
<i>Nemipterus japonicus</i>	1	13-17	8	8-18	12	8-23	37	14-21
<i>Otolithus argenteus</i>	10	9-24	9	9-52	3	10-12	..	..
<i>Pseudosciaena sina</i>	10	6-15	5	8-17	1	10-17	..	..
<i>Pseudosciaena axillaris</i>	2	6-10	1	7-13	..	9	..	..
<i>Opisthopterus tardoore</i>	21	11-23	11	9-23	5	13-18	4	16-20
<i>Caranx kalla</i>	1	7-14	5	8-18	1	12-13	2	12-13
<i>Saurida tumbil</i>	8	24-30	7	10-36	22	18-34	5	14-25
<i>Platycephalus scaber</i>	16	12-25	17	7-25	5	10-22	2	13-22
<i>Trichiurus haumela</i>	5	17-45	9	11-52	5	40-50	13	43-46
<i>Leiognathus spp.</i>	3	7-13	5	1-17	6	7-10	2	8-10
<i>Pristipoma</i>	..	..	5	5-14	2	9-11	1	10-11

The analysis of the species of 'Podimeen' taken from different depths, given in the Table, VII showed a similar distribution pattern as was noticed in the previous year. In shallower waters up to 13 m, the Sciaenids *Otolithus argenteus* and *Pseudosciaena sina*, *Opisthopterus tardoore*, *Platycephalus scaber* and *Lactarius lactarius* formed the most common catch.

The middle zone (14-27 m) was characterised by a greater variety of species contributing to a good catch, their percentage varying from 5 to 17. In the deeper waters (28-57 m), *Nemipterus japonicus* formed the most dominant species, the other important fish being *Saurida tumbil*, *Trichiurus haemela* and *Leiognathus* spp. It is interesting to note that *P. scaber*, *S. tumbil* and *T. haemela* occurred in good percentage in all depths. Relatively larger specimens were caught in deeper water. *Metapenaeus dobsoni* and *M. affinis* were the most common prawns in shallower depths.

The data of the Indo-Norwegian Project Vessels at Cochin were regularly collected and analysed with a view to assessing the fluctuation in abundance, species composition, size variations, recruitment etc. Routine voyages on board the trawlers were intensified during the present season, for more detailed on-the-spot observations.

The results of the vessels' activities during 1962-63 are given in the Table VIII. The results of the previous year are also given for comparison.

TABLE VIII
Operation of Indo-Norwegian Project Vessels

Months	Effort (Hrs.)	Depth range (metres)	Total catch (in kg.)	Catch per hour of trawling (in kg.)	Prawns (in kg.)	Catch per hour of trawling of prawns	Fish	Catch per hour of fish
1	2	3	4	5	6	7	8	9
1962-63								
March	315.16	9-20	28,654	91	17,012	54	11,642	37
April	372.40	11-27	40,526	110	25,127	68	15,399	42
May	499.50	4-28	52,439	105	33,324	67	19,115	38
June	129.67	5-24	13,309	103	9,670	75	3,639	28
September	62.34	20-50	26,713	429	5,703	92	21,010	337
October	243.00	9-50	48,913	201	18,532	76	30,381	125
November	325.58	7-50	45,060	138	21,160	65	23,900	73
December	146.16	5-24	10,918	75	5,346	37	5,572	38
January	137.50	..	12,360	89	3,756	63	3,604	26
February	101.17	11-18	14,743	146	11,709	116	3,034	30
TOTAL	2332.48	4-50	2,93,635	126	1,56,339	67	1,37,296	59
1961-62								
March	236	7-33	37,984	161	9,235	39	28,749	122
April	233	15-27	41,311	178	17,594	76	23,717	102
May	240	11-29	46,089	192	12,865	54	33,224	138
June	19	..	863	45	216	11	647	34
September	72	36-55	14,569	202	264	4	14,305	198
October	166	18-36	14,983	90	3,307	20	11,676	70
November	234	5-29	46,017	196	12,040	51	33,977	145
December	387	9-18	85,040	222	54,684	143	30,354	79
January	301	8-35	42,526	141	25,430	85	17,096	56
February	251	13-33	40,695	162	24,135	96	16,560	66
TOTAL	2135	5-55	3,70,077	173	1,59,772	75	2,10,905	98

The areas of operation were as usual 9-75, 9-76 and 10-76, all adjacent to Cochin. M. V. 'Kalava', however, made few longer trips exploring some new grounds. Although the total time spent in actual fishing (1316.75 hours) during the post monsoon months (March-June) was almost double that of previous year the total catch (1,34,928 kg.) showed but a slight improvement. This was due to the low catch rate of fish, for the over-all rate of catch of prawns nearly exceeded that of last year, particularly, during June when it was 75 kg. per hour of trawling compared to 11 kg. of the corresponding month of the previous year.

The trend of fishery of the post-monsoon period of the reporting year was seen to be different from any of the past years observed, in that, the season started with a good prawn fishery. The high catch rate obtained during September and October 1962 (92.76 kg. respectively) is rather unusual. The general trend of prawn fishery hitherto observed is that starting from a very low catch rate somewhere in September-October, it attains a marked fishery only some where in December-February. Because of this relatively greater availability of prawn in the earlier months the distribution of effort was shifted from its normal pattern : the boats left the deeper 'Kilimeen' grounds early this year and migrated inshore pursuing the prawn. *Metapenaeus dobsoni* and *M. affinis* were the two species of prawns that contributed most.

M. V. 'Kalava', during March 1963, did some exploratory trawling in the depths between 270 to 360 metres along the continental slope between Purakad and Ponnani. The ground, hitherto unknown, proved to be productive during the period of exploration. A total of 5 cruises were made of which one was off Ponnani and the rest between Alleppey and Purakad. So far as the composition of catch is concerned, these grounds were found to be the same. Catches composed of fish (mainly), Lobster (one species) and prawns. Crabs, squids and stomatopods also occurred. About 40 species of fish were recorded of which half a dozen occurred in commercial quantities. Most of these fishes appear to be first records from Indian waters and a few even new to science. A detailed study of this hitherto unknown population is in progress.

Quantitative and qualitative analysis of the landings of the mechanised fishing centre at Azhikode were carried out during the period under report. The distribution of different species and their length frequency etc. were also studied.

Altogether 24 mechanised Pablo boats are based at this Centre. 8924 hours of actual trawling landed a total catch of 615473 kg. composed of 449393 kg. prawns and 166079 kg. fish, thus giving 68.98 kg. per hour of effort during March 1962 to February 1963. The maximum yield per hour of fishing was observed in May *i.e.*, 101 kg./hr. and the lowest in February *i.e.*, 52.2 kg./hr. of effort.

Details of landings of the vessels of the Mechanised Fishing Centre, Azhikode. (Operations limited to 10-20 m. depth range)

Months	March	April	May	October	November	December	January	February	
Effort (hours)	600	712	588	792	1980	1676	1520	1056	8924
Total catch in kg.	39930	58712	59365	61239	138252	123137	79697	55151	615479
Catch/hr. of trawling kg.	66.5	82.5	101.00	77.3	69.8	73.4	52.4	52.2	68.96
Total prawns kg.	26848	33463	36700	43667	111681	93136	58286	45612	449393
Prawns catch per hour of trawling in kg.	44.7	47.00	62.4	55.1	56.4	55.5	38.3	43.1	50.35
Total fish in kg.	13081	25249	22665	17572	26571	30001	21401	9599	166079
Total catch per hour of trawling.	21.8	35.5	38.5	22.2	13.4	17.9	14.1	9.1	18.61

Prawns catches were mainly composed of *P. indicus*, *M. affinis*, *M. dobsoni* and *P. stylifera* and the fish catches—Scleractinids, *Cynoglossus*, sharks, rays and miscellaneous group. During the premonsoon season *M. dobsoni* and *P. stylifera* dominated in the prawn catches, while during the post monsoon *M. affinis* was the major species in the prawn landings.

More than 40 privately owned mechanised Pablo boats are also operating from this area. These boats land their catch at various points on either side of the Cranganore river. Approximately double the quantity of fish and prawn might have been landed by these boats the data of which could not be collected. An enumeration (of the total number of boats operating from this area other than those attached to the centre) the various points of their landing etc. are also now being conducted.

At Tuticorin, during the year under report, six mechanised vessels and two sailing canoes of the offshore Fishing Station, Tuticorin operated in the offshore waters and landed 1,78,060.0 kg. of fish (exclusive of 123.0 kg. of Dolphin and 45.0 kg. of Turtle). Trawl nets were operated in areas 8-78 and 9-78 by three vessels—M. V. 'Meenalochani', M. V. 'Sagar-sundari' and M. V. 'Sagarkumari'; a total effort of 1047 hours yielded 1,32,794.5 kg. of fish, with an overall catch rate for a 'all fish' at 126.8 kg./hr. in area 8-78; in area 9-78, an infinitesimal effort of Hr. 2-45 Min. yielded 2.0 kg. of fish, with a catch rate for 'all fish' at 0.72 kg./hr. Bottom-set gill nets were operated in area 8-78 by three vessels—M. V. 'Sardinella', M. V. 'Meenakshi' and the Dan Boat 'Choodai'; a total effort of 740 sets of nets yielded 40,010.0 kg. of fish (exclusive of 123.0 kg. of Dolphin and 45.0 kg. of Turtle) with an overall catch rate for 'all fish' at 54.0 kg./set. Surface gill nets were operated by M.V. 'Meenakshi' and the Dan Boat 'Choodai' in area 8-78; a total effort of 12 sets of nets brought in 413.5 kg. of fish, with an overall catch rate for 'all fish' at 34.5 kg./set. Hooks and lines were operated by two sailing canoes in area 8-78; a total of 1980 hooks were operated (with sardines as bait) which brought in 4840.0 kg. of fish, with an overall catch rate for 'all fish' at 80.7 kg./unit (a unit comprises 33 hooks).

Of the three trawlers, M. V. 'Meenalochani' expended the maximum effort during the year—an effort of Hr. 539-15 min. in area 8-78 at 10.9—38.4 metres depth, yielded 63,190.5 kg. of fish (which incidentally is the highest catch) with an overall catch rate for 'all fish' at 117.2 kg./hr. Sub areas 2A, 3A, 4B, 4C and 6B of area 8-78 were fished; sub areas 4B and 4C were fished more intensively—of the total effort of Hr. 539-15 Min. Hr. 517-40 Min. were expended in 4B and 4C alone. Area 9-78/1E fished to a negligible extent. The vessel operated only during the first three quarters.

M. V. 'Sagarsundari' operated trawl nets in sub areas 4B and 4C of area 8-78 at 14.0—36.6 metres depth and an effort of Hr. 358-30 Min. yielded 49,809.0 kg. of fish with an overall catch rate for 'all fish' at 138.9 kg./hr. The vessel operated only during the first three quarters.

M. V. 'Sagarkumari' operated trawl nets only during the first two quarters of the years in area 8-78/4B and 4C; an effort of Hr. 149-15 Min. during the year at 14.0—36.0 metres depth, yielded 19795.0 kg. of fish, with an overall catch rate for 'all fish' at 132.6 kg./hr.

Area 8-78/2A received an effort of Hr. 8-30 Min. and yielded 135.0 kg. of fish, with a catch rate for 'all fish' at 15.9 kg./hr. The catch comprised predominantly of Sciaenids—68.0 kg. (8.0 kg./hr.), *Pomadasys* spp.—21.0 kg. (2.5 kg./hr.), Pomfrets—17.0 kg. (2.0 kg./hr.), *Lactarius lactarius*—13.0 kg. (1.5 kg./hr.) and Leiognathids—11.0 kg. (1.3 kg./hr.). Area 8-78/3A received an effort of Hr. 8-35 Min. and yielded 163 kg. of fish with a catch rate for 'all fish' at 18.9 kg./hr. The catch comprised predominantly of Sciaenids—65.0 kg. (7.6 kg./hr.), *Arius* spp.—40.0 kg. (4.7 kg./hr.), 'Others'—20.0 kg. (2.3 kg./hr.) and Rays—15.0 kg. (1.7 kg./hr.). Area 8-78/6B received Hr. 4-30 Min. and yielded 19.0 kg. of fish with a catch rate for 'all fish' at 4.2 kg./hr. The catch comprised of 'Others'—14.0 kg. (3.1 kg./hr.) and *Pomadasys* spp.—5.0 kg. (1.1 kg./hr.). Area 9-78/1E received an effort of Hr. 2-45 Min. and yielded 2.0 kg. of fish ('Others') with a catch rate of 0.72 kg./hr.

Area 8-78/4B and 4C received the maximum effort of Hr. 1025-25 Min. and yielded 1,32,477.5 kg. of fish, with a catch rate for 'all fish' at 129.2 kg./hr. The catch comprised predominantly of 'Others'—39,250.0 kg. (38.2 kg./hr.), Sciaenids—27,022 kg. (26.3 kg./hr.), Rays—16,427.0 kg. (16.0 kg./hr.), Prawns—14,582.6 kg. (14.2 kg./hr.), Leiognathids—12,982.0 kg. (12.6 kg./hr.), Skates—4696.0 kg. (4.5 kg./hr.), Clupeids—4126.0 kg. (4.0 kg./hr.), *Arius* spp.—3581.0 kg. (3.5 kg./hr.) *Polynemus* spp.—3067.0 kg. (2.9 kg./hr.) *Drepane punctata*—1930.0 kg. (1.8 kg./hr.), Perches—1529.0 kg. (1.4 kg./hr.) and *Trichiurus* spp.—1330.0 kg. (1.2 kg./hr.).

Bottom-set gill nets were operated in subareas 4B, 5B, 5C, 5D and 6C of area 8-78. Subareas 4B and 6C were fished only during the second and the first quarters of the year respectively to a negligible extent—efforts of 2 sets and 6 sets at 16.5 metres and 23.8 metres respectively, yielded 49.0 kg. and 360.0 kg. of fish respectively with respective catch rates at 24.5 kg./set and 60.0 kg./set for 'all fish'. The catch in the former comprised predominantly of sharks—30.0 kg. (15.0 kg./set) and *Lutianus* spp.—9.0 kg. (4.5 kg./set); in the latter area, the catch comprised predominantly of Sharks—130.0 kg. (21.7 kg./set), *Arius* spp.—110.0 kg. (18.3 kg./set), 'Others'—28.0 kg. (4.7 kg./set), *Caranx* spp. 24.0 kg. (4.0 kg./set), Rays—23.0 kg. (3.8 kg./set) and *Chorinemus* spp.—22.0 kg. (3.7 kg./set).

TABLE IX

Resume of trawling operations during the year ending March, 1963

Period	Vessel														
	M.V. 'MEENALOHAN'					M.V. 'SAGARSUNDARI'					M.V. 'SAGARKUMARI'				
	First quarter	Second quarter	Third quarter	4th quarter	The year	First quarter	Second quarter	Third quarter	Fourth quarter	The year	First quarter	Second quarter	Third quarter	Fourth quarter	The year
Areas	8-78/2A, 3A, 4B, 6B; 9-78/1E	8-78/4B & 4C	8-78/4E and 4C	..	8-78/2A, 3A, 4B, 4C 6B; 9-78/1E	8-78/4B & 4C	8-78/4B & 4C	8-78/4B & 4C	..	8-78/4B	8-78/4B & 4C	8-78/4B & 4C	..	..	8-78/4B & 4C
Depth (Metres)	13-0-33-0; 17-0	12-8-34-8	10-9-38-4	..	10-9-38-4; 17-0	14-0-33-0	18-3-29-3	20-1-36-6	..	14-0-36-6	14-0-36-0	14-0-36-0	..	..	14-0-36-0
Effort (Hr.-Min.)	168-30; 2-45	203-10	167-35	..	539-15; 2-45	54-55	213-10	90-25	..	358-30	85-10	64-05	..	..	149-15
Total catch (Kg.)	8089-0; 2-0	30,389-5	24,712-0	..	190-5; 2-0	4483-0	29,705-0	15,621-0	..	49,809-0	10,935-0	8860-0	..	..	19795-0
Catch/hour (kg./hr.)	48-0; 0-72	149-6	147-4	..	117-2; 0-72	81-6	139-3	172-7	..	138-9	128-4	138-3	..	..	132-6

Total trawling effort during the year :—Hr. 1047-00 m-in. in area 8-78 and Hr. 2-45 Min. in area 9-78.

Total catch during the year :—1,32,794-5 kg. in area 8-78 and 2-0 kg. in area 9-78.

Total average catch/hour during the year :—126-8 kg./hr. in area 8-78 and 0-72 kg./hr. in area 9-78.

Subarea 5D was fished only during the first quarter of the year—27 sets at 20.0—36.6 metres yielded 3,343.0 kg. of fish with a catch rate for 'all fish' at 123.8 kg./set. The catch comprised predominantly of sharks—2373.5 kg. (87.9 kg./set) perches—332.5 kg. (12.3 kg./set), *Arius* spp. 158.0 kg. (5.9 kg./set) and rays—152.0 kg. (5.6 kg./set). Subarea 5B was fished during all the four quarters of the year—473 sets operated at 10.9—32.9 metres depth yielded 25,697.5 kg. with a catch rate of 54.3 kg./set. The catch comprised predominantly of *Arius* spp.—6861.5 kg. (14.5 kg./set), sharks—4351.5 kg. (9.2 kg./set), perches—3457.5 kg. (7.3 kg./set), rays—2223.0 kg. (6.8 kg./set), *Chorinemus* spp.—2274.0 kg. (4.8 kg./set) and 'Others'—1502.5 kg. (3.2 kg./set). Subareas 5C was fished only during the first three quarters, to the extent of 232 sets of nets, which yielded from 12.8—32.9 metres depth 10,560.5 kg. with a catch rate of 46.0 kg./set. The catch comprised predominantly of sharks—3430.55 kg. (15.0 kg./set), Rays—1546.0 kg. (6.6 kg./set) and *Arius* spp.—1471.5 kg. (6.5 kg./set).

Surface gill nets—11 sets were operated in 8-78/4C, 4D, 5C and 6D at 16.5—64.0 metres depth during the last quarter; in 8-78/5B only one set of surface gill nets was operated at 15.5—18.3 metres depth during the first quarter. In the area 8-78 as a whole, 12 sets of nets brought in 413.5 kg. with a catch rate of 34.5 kg./set. The catch comprised predominantly of rays—242.5 kg. (20.2 kg./set), and sharks—93.5 kg. (7.8 kg./set).

Hooks and lines were operated in the second quarter of the year; a total of 1980 (6B) hooks using sardines as bait brought in 4840.0 kg. from 8-78, 5C (at 36.6—91.5 metres depth), with a catch rate of 80.7 kg./unit (per unit of 33 hooks). The catch comprised predominantly of *Epinephelus* spp.—1838.0 kg. (30.6 kg./unit), *Lethrinus* spp.—722.0 kg. (12.0 kg./unit) *Caranx* spp.—559.0 kg. (9.3 kg./unit) and *Aprion virescens*—550.0 kg. (9.3 kg./unit).

During the year under review 7 voyages by Ashok/Pratap and 33 voyages by Sea Horse/Champa, which yielded 23,321 kg. and 1,910 kg. of fish respectively, were undertaken by the Scientific Staff of the Unit. The total time spent by the respective units being 191.75 hrs. (Ashok/Pratap) and 138.92 hrs. (Sea Horse/Champa), the catch returns accordingly were 121.62 kg./hr. and 13.74 kg./hr. While the area of fishing for Sea Horse/Champa was limited between Sq. 17-83/B-4 in the South to Sq. 17-83/D6 in the North, Ashok/Pratap conducted fishing over a wider ground covering areas between Sq. 17-82/D1 in the South to Sq. 18-84/C²D³ in the North.

Among the 11 squares viz., (Sq. Nos. 17-83/B⁴, C⁴, C⁵, C⁵, B⁴, C⁵, C⁴, C⁵/D⁶, D⁶, D⁵/C⁵, D⁴, D⁵/D⁵, D⁶) covered by Sea Horse/Champa, the most fished area was Sq. No. 17-83/C and the fishing time was 53 hrs. whereas only 2½ hrs. were spent in Sq. Nos. 17-83/D⁵/D⁶ and D⁶ and the total catches ranged from 169 kg. in Sq. No. D to 3,254 kg. in Sq. No. 17-83/C⁵. But the catch returns in kg./hr. ranged from 152 kg./hr. in Sq. No. 17-83/D⁵/D⁶ to 34.18 kg./hr. in Sq. No. 17-83/C⁵/B⁵ Sq. No. 17-83/C⁵, the most fished area, yielded only 61.39 kg./hr.⁴ Although fishing was done by Ashok/Pratap in 30 squares viz., (Sq. Nos. 17-82/D¹, D¹/E¹, E¹/E², D¹E²/E², E²/D², F²; 17-83/B³/17-82/F³, 17-82/F; 17-82/F², 17-83/A, 17-83/A/17-82/F, 17-83/B⁴, B⁴, C⁵, C⁵/C⁴, C⁴/D⁵, E⁶, E⁶/D⁶, E⁶/18-83/F¹, 18-83/F¹, F/17-83/F², 18-84/B¹, A², C²/B³, C²/D⁴) intense fishing over 10 hrs of fishing time was confined to a few areas only viz., Sq. Nos. 17-82/D¹ (13 hrs); E² (15 hrs); 17-83/C⁵ (16 hrs); D⁵ (17.50 hrs) and 17-83/E⁶/18-83/E¹ (14 hrs). In the rest of the areas fishing

time ranged between 2 hrs to 9½ hrs Accordingly the catches ranged from 30 kgs (Sq. No: 18-84/A³) to 3,982 kg (Sq. No. B³/C³). Among the more intensely fished areas, the yield in kg. per hour of fishing, was the maximum in Sq. No. 17-83/D (188 kg/hr) and minimum in Sq. No. 17-83/E⁵/18-83/F⁶ (33.71 kg/hr). The most productive area was Sq. No. 18-84/B³/C³ where a catch of 3,982 kg of fish, returning 527 kg/hr., was realised over a period of 7.75 hrs. of fishing time.

A total of 23 sp. of fish were recorded in the catches of Sea Horse/Champa. However only 13 sq. were of fishery importance and they were, in the order of importance, as follows: *Johnius* spp. (12.03 kg/hr); 2. Prawns (7.64 kg/hr); 3. *Rhynchobatus* sp. (6.47 kg/hr); 4. *N. japonicus* (6.19 kg/hr); 5. *Arius* sp. (5.79 kg/hr); 6. *U. sulphureus* (4.02 kg/hr); 7. *Pellona* sp. (3.76 kg/hr); 8. *T. haumela* (1.75 kg/hr); 9. *Caranx* spp. (1.69 kg/hr); 10. Skates (1.64 kg/hr); 11. Sharks (1.50 kg/hr); 12. *P. sextarius* (1.23 kg/hr); and 13. *Leiognathus* spp. (1.09 kg/hr). The rest of the species hardly contributed 1 kg per hour of fishing. While Sq. No. 17-83/C⁵/D⁶ appeared more productive for *Johnius* spp. (32.21 kg/hr), areas which yielded good returns for other species were as follows: Prawns sp. 17-83/D⁵/D⁶ (80 kg/hr); *Rhynchobatus* sp. Sq. No. 17-83/B⁴ (19.72 kg/hr); *N. japonicus* Sq. No. 17-83/C⁵ (12.01 kg/hr) *Arius* sp. Sq. No. 17-83/C⁵/D⁶ (19.43 kg/hr); *U. sulphureus*: Sq. No. 17-83/C⁵/D⁶ (9.6² kg/hr); *Pellona* sp. Sq. No. 17-83/C⁵/C⁴ (21.67 kg/hr); *T. haumela* Sq. No. 17-83/C⁵/C⁴ (15.59 kg/hr); *Caranx* spp. Sq. No. 17-83/D⁵ (5.6 kg/hr); Skates Sq. No. 17-83/D⁵ (12.80 kg/hr); Sharks Sq. No. 17-83/D⁵/D⁶ (18-kg/hr); *P. sextarius* Sq. No. 17-83/D⁵ (11.51 kg/hr. and *Leiognathus* spp. Sq. No. 17-83/C⁴ (6.55 kg./hr). Similarly, only 15 species out of 25 species that composed the catches of Ashok/Pratap, were of importance and they contributed as follows: *Arius* sp. (36.83 kg/hr); *N. japonicus* (12.78 kg/hr); *Johnius* spp. (12.73 kg/hr); Rays (7.05 kg/hr); Prawns (5.95 kg/hr); *Caranx* spp. (5.35 kg/hr); *P. maculatus* (3.76 kg/hr); *Pomadys* spp. (3.31 kg/hr); *U. sulphureus* (3.08 kg./hr); Sharks (2.06 kg. hr.) *Leiognathus* spp. (2.67 kg/hr); Perches (2.13 kg./hr.) Pomfrets (1.83 kg./hr.) *S. sumbil* (1.16 kg./hr.) and *Pellona* sp. (1.08 kg/hr). They were respectively abundant in the following areas: Sq. No. 18-83/F³ (108.7 kg/hr); 18-84/B¹ (168 kg/hr); 17-82/E² 111.8 kg./hr. 17-83/A³ (83.33 kg/hr); 17-83/A³ /17-82/F² (24.61 kg/hr); 18-84/B¹ (60.0¹ kg/hr); 17-82/D¹/F¹ (83.99 kg/hr); 18-84/B³/B³ (21.63 kg./hr.) 17-82/F² (17 kg./hr.) 17-83/A³ (16.66 kg./hr.) 17-82/E²/D¹ (43.33 kg/hr); 87 kg./hr. 17-83/B⁴/B³ 17-83/A³ 17-83/D⁵ (12.57 kg/hr); 17-83/D⁵ (9.54 kg/hr) and 17-83/E⁶/D⁶

At Calcutta, the West Bengal Government trawlers undertook 20 fishing voyages during the year 1962-63. "Kalyani IV" performed 11 voyages and "Kalyani V" 8 voyages. There was one unproductive voyage by "Kalyani III" in April.

Since Kalyani IV and V are identical vessels using the same type of net (the haddock trawl) the data for both the vessels were pooled together and the Catch/Hour of trawling the different groups of fishes composing the catches were analysed monthly and as far as possible area-wise. The data are presented in Table X.

It was observed that fishing was mainly concentrated in the Sandheads region (Eastern Channel and off the mouth of the Matla river) in 18-60 meters of water. The area next in importance as far as expenditure of fishing effort was concerned was the sea off Mahanadhi river mainly in 18-30 meters of the water, followed by Puri coast (20-40 meters) and the area off the mouths of Devi and Prachi rivers in the Orissa Coast (20-40meters).

During the year under report, except along the Puri coast in November and off Mahanadhi river mouth in January, the catch per fishing hour has been uniformly poor when compared to the previous years. This is especially true of Sandheads where last year (1961-62) the average catch in December and January exceeded 500 kg/hr. But the fairly good catch of 242.2 kg/hr off the Matla river mouth in May 1962 a month which is generally considered as a poor fishing season is worthy of note.

At Sandheads sciaenids formed the bulk of the catch except during April and May 1962. *Pseudosciaena aneus* was the dominant species. Large *Muraenesox talabanoides* occurred in good quantities in April (11.8 kg/hr) May (27.3 kg/hr) and again in November (11.4 kg/hr), December (9.3 kg/hr) and January (104.3 kg/hr). *Arius* sp., appeared in good numbers in April (17.0 kg/hr), May (85.4 kg/hr) December (9.1 kg/hr) and March (9.1 kg/hr) *Pomadasys hasta*, *Lactarius* and juvenile specimens of *Caranx malabaricus* occurred in fair quantities east of Eastern Channel and off Matla estuary. Pomfrets were generally scarce at Sandheads unlike in 1961-62 when very good catches of *Pampus argenteus* were obtained from this area.

The area off Mahanadhi was noted for the very good quantities of *Pampus argenteus* in the catches. In fact in November 1962 (32.7 kg/hr) and January 1963 (79.2 kg/hr) it was the most important single species in the catches from this region even eclipsing the ubiquitous sciaenids and *Ilisha*. Hence this area is a very good fishing ground for quality fish. The species of sciaenids common in this area were *Johnius dussumieri* and *Pseudosciaena sina*, *P. aneus* being virtually unrepresented. *Lactarius* occurred in fair quantities in November (10.5 kg/hr) and January (37.5 kg/hr).

Puri Coast area was rich in *Leiognathus* and small species of *Pomadasys* (*P. maculatus* and *P. argyreus*). Sciaenids are of lesser importance in this region.

Only about 10 hours of trawling was done in the area off the estuaries of Devi and Prachi rivers.

During the year under report the log sheets of the fishing voyages undertaken by the West Bengal trawlers for the three previous years 1959-60, 1960-61 and 1961-62 were also analysed and compiled. The total number of voyages for each year and the number of voyages for which log sheets are available are tabulated below :

Year	Total No. of voyages	No. of voyages for which log sheets are available
1959-60	25	10
1960-61	23	20
1961-62	30	27

For each area the yield in terms of Baskets/hour of trawling (one basket is equal to about 37 kg.) is determined monthly for the depth zones 1-10 fathoms, 11-20 fathoms, 21-30 fathoms, 31-40 fathoms etc. The various depth zones have been fairly adequately fished only at Sandheads. In this area it is generally found that the best catches are made in 11-20 fathom zone, whereas in March-April the lesser depths were more productive. This trend was particularly noticeable in the year 1961-62 when the maximum number of depth zones were fished. It is suggested that this trend might represent an offshore migration of the fish population at Sandheads during the winter months December to February followed by a shoreward migration in the subsequent months March-April.

Off Matla fishing has been fairly good in the 21-30 fathom zone.

On the Puri Coast fishing has been good in the two zones 11-20 and 21-30 during the months October to January. Off Mahanadhi and Devi and Prachi estuaries the most productive depth zones were 1-10 and 11-20 fathoms.

More systematic fishing in which the fishing effort is more or less uniformly distributed among the various depth zones is bound to be of great practical value.

Biological investigations.—During the three voyages, (one each in November, December and January) in which the staff of this Unit participated a detailed log of the fishing operations was maintained, surface water temperature recorded, surface plankton of the fishing grounds collected with a half-meter organdy net and the species composition of each haul determined. Further, random samples of *Pampus argentus* and dominant Sciaenids like *P. anu*, *Johnius dussumieri*, *P. bleekeri* and *Sciaenoides biauritus* were measured and the sex stage of maturity determined. Stomach and gonad samples were preserved and brought to the laboratory for study. These samples are being analysed. Measurements for total length were also taken at Shore Base station at the time of unloading.

During the year the data on the biology of *Johnius dussumieri* (*Sciaena glaucus*) collected during 1959-62 were compiled and are being analysed. The salient features are recorded below.

The length-weight relationship was $W = 0.0059293 L^{3.23}$. First maturity is attained at a total length of 15-16 cm. probably at the end of the first year of life. The ova diameter measurements revealed that the spawning season of the fish was restricted to a short period, but it seems likely that the species spawns twice a year once in January-February and a second time, probably, in July-August. The fecundity was found to vary from 16,200 to 116,200 eggs depending upon the size of the fish. The trawl fishery for this species is mainly on fish in their 1st and 2nd year of life. The fish is a bottom feeder, feeding mainly on prawns, *Acetes*, copepods, *Squilla*, polychaetes, crabs and fish.

TABLE X (1962-63)

Month	April	May	June	September	November	November	November	December	December	January	January	February	February	March
Vessels	Kalyani IV, V	Kalyani IV	Kalyani IV	Kalyani IV	Kalyani V	Kalyani IV	Kalyani IV, V	Kalyani IV, V	Kalyani IV, V	Kalyani IV	Kalyani V	Kalyani IV	Kalyani V	Kalyani IV
Area	Sand-heads (Eastern channel)	Sand-heads (Matla)	Sand-heads (Eastern channel)	Sand-heads	Maha-nadhi	Puri Coast Devi Prachi Maha-nadhi Matla	Sand-heads	Sand-heads	Sand-heads Maha-nadhi Puri Coast Matla	Sand-heads (Eastern channel)	Maha-nadhi Puri Eastern channel	Sand-heads Maha-nadhi	Maha-nadhi Devi River sand-heads Puri	Sand-heads
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Depth range in metres	13-42	36-68	40-68	27-36	18-22	20-51	18-44	15-54	36-46	18-40	18-22	11-46	18-48	18-46
Fishing effort in hours	68.08	35.3	29.4	26.6	48.5	48.08	35.0	99.0	79.3	11.9	55.08	39.25	59.00	24.30
Total catch in kg.	5372.00	8556.00	670.00	912.00	6910.00	17600.00	4838.00	15299.00	12322.00	1672.00	16686.00	2361.00	5235.00	908.00
	Catch composition in Kg per Trawling Hours													
<i>Pomus</i>	0.2	0.3			32.7	24.2	0.29	2.5	18.0		79.2		0.84	
<i>Penaeus</i>		0.41						0.09			0.4			
Small prawns							1.4							
<i>Pomadour</i>	1.4	4.4				8.9	0.06	2.1	1.03		1.40	1.14	2.84	2.83
<i>Pomadour</i> (small)						43.0					10.7		5.18	
<i>Lutjanus</i>											0.2			
<i>Lutjanus</i> (small)											1.0			
<i>Serranus</i>										10.4	2.0			
ciacnids	17.0	69.2	15.3	22.2	31.5	154.6	68.2	87.5	69.9	6.5	57.7	9.57	3.48	15.10
<i>Drapans</i>	2.0	4.3											3.48	
<i>Scorpaenomor</i>								0.09	1.5					
<i>Lyngnathus</i>	4.8	5.3					35.7	0.49			4.6	14.36	24.42	
<i>Racoda</i>					5.2			1.5	0.33	1.1	9.6			
<i>Yisha</i>	5.9	12.6	2.7	2.1	36.7	50.0	5.4	25.5	33.1		98.9	14.36		3.04
<i>Opisthopterus</i>											1.3			
<i>Scipinna</i>								3.9	0.51		0.6			
<i>Upeneus</i>	0.5		1.0			0.8		3.1	3.8	6.4	8.5		6.76	
<i>Caranx</i>	7.3	16.3				8.5		4.0			8.6	2.39	8.68	2.40
<i>Carus</i>					5.2		25.6		0.51	19.5	2.3			
<i>Polynemus</i>						0.4					1.9			
<i>Lactarius</i>					10.5	6.0		10.2			37.5			
<i>Arius</i>	17.0	85.4		3.6			0.4	0.61	9.10		2.5	4.76	5.18	9.10
<i>Muraenon</i>	11.8	27.3	1.7	3.1	2.3	11.5	11.4	9.3	8.6	104.3		5.77	2.49	1.20
<i>Nemipterus</i>	4.8						8.4							
<i>Ephippus</i> * (<i>Sparus spinifer</i> *)											6.0*		8.68*	
Sharks	0.2	1.1							0.1		7.6	3.61	9.55	
Rays	4.1	10.6				9.9		2.2	0.2		5.6	1.78		2.80
Skates					2.2									
<i>Tripturus</i>								0.6						
Miscellaneous	1.1	5.0	2.0	3.1	15.7	12.6	8.2	3.45	4.5		10.2	2.39	6.76	0.50
Total catch per hour	79.0	242.2	22.7	34.4	142.4	366.6	138.2	153.5	154.8	140.5	302.9	60.15	88.70	37.63

8. Marine Fish Farm and Physiology

The work on the live-fish transport was in progress during the year under report. First phase of the fingerling transport *i.e.* the study of the basal metabolism of the mullet *Liza tade* in different salinities, was completed. The second phase of the project, namely, the behaviour and reactions of mullet fingerlings in different concentrations of anaesthetics is in progress. Up to the end of March 1962, 400 mullets were experimented on with four concentrations of Chlorobutanol. Work is in progress.

Regarding the transport of *Chanos* fry in polythene bags, extensive data have been collected by laboratory experiments. In all, 17,420 fries were employed for the experiments. Based on these laboratory findings, future experiments on the actual transport have been planned for the *Chanos* fry season in 1964.

Collection of data on the spawning and growth of the clam *Meretrix meretrix* in the Marine Fish Farm has been completed. The data are based, both on the random samples as well as on the numbered clams. During the period of last 20 months, 17,000 clams were measured for this study. The study on the physiological condition of this clam in different ponds in relation to mud qualities has also been completed.

IV MARINE BIOLOGY

1. Planktology

At Kandla phytoplankton was poor in premonsoon months, but were better represented during monsoon samples. Peak was reached in November, December and January and the common forms were *Biddulphia*, *Coscinodiscus*, *Thalassiothrix*, *Thalassionema*, *Pleurosigma*, *Bellerochia*, *Chaetoceros*, *Gyrosigma* and algal filament. During January and February *Microcystis* was dominating. This year also phytoplankton peak was observed along with nutrient peak in November and December and was closely followed by zooplankton peak in March-April.

It has been observed that Mundra plankton collections were richer both in qualitatively and quantitatively. Phytoplankton maximum was in post monsoon months and the common forms were *Thalassiothrix*, *Rhizosolenia*, *Pleurosigma*, *Coscinodiscus*, *Biddulphia*, algal filaments and *Microcystis*.

Zooplankton peak was in March-April as in 1961-62 followed by a secondary abundance in August-September this year. Most common forms noted during studies in the order of abundance were as follows. During premonsoon quarter *i.e.* April to June *Centropages* sp. *Acrocalanus*, *Eucalanus*, Copepod nauplii, *Zoea*, *Euchaete*, *Pseudodiaptomus*, *Coruceaeus* etc. and during monsoon *Acartia*, *Oithona* cladocerans, *Euterpina*, *Acrocalanus*, *Centropages*, *Paracalanus*, *Eucalanus*, *Zoea*, Copepod nauplii, Forminifera, Cirripede nauplii, Polychaete larvae, *Sagitta* Crustacean eggs, Hydromedusae, Bivalves, fish eggs and larvae.

Off Karwar the plankton displacement was high showing good production volume immediately after the monsoon and again in March. During other months it was poorer and in the rainy season it was negligible.

Diatoms were abundant in August-September, common in November-January and predominant, particularly at Karwar in March. The most common forms were *Chaetoceros* spp. (mostly *C. coarctatus*) and *Coscinodiscus* spp. (mostly *C. jonesianus*). Many other forms were present in the collection. Some like *Fragilaria oceanica*, *Rhizosolenia* spp., *Thalassiothrix frauenfeldii* and *Nitzschia seriata* were occasionally dominant. Compared to the previous years *Trichodesmium erythraeum* was scarce.

Dinoflagellates were abundant after the monsoon period. Many forms were present as in the previous years. Tintinnids occurred better this year, and they were also abundant after the monsoon. *Noctiluca miliaris* occurred in poor numbers only. Many larval forms were abundant during August-March. On one occasion in March at Karwar inshore area the plankton contained prawn eggs in abnormal numbers. Many other organisms like pteropod, *Cavolina* sp., *Lucifer hanseni*, etc., were also present in the plankton in good numbers. Appendicularians were more common in the north than in the south. Cladocerns were common in the plankton after the monsoon. They were abundant in October and November. As usual the beginning, *Evadne tergestina* was dominating *Penilia avirostris* and later vice-versa. Copepods occurred in plenty during September-March and they predominated in the plankton in most of these months. Unlike the previous year *Acartia erythraea* dominated *Acrocalanus longicornis* at the south. *Paracalanus aculeatus*, *Oithona oculata* and *O. plumijera* were the most abundant. *Acartia erythraea*, *Acrocalanus longicornis*, *Corycaeus* spp., *Euterpina acutijrons* and *Temora turbinata* were very common. *Oncea* sp. were abundant in the offshore collections. Copepods from the offshore area were bigger in size and big forms like *Ecualanus* spp., *Centropages* spp., *Pontella* sp., *Nannocalanus* sp. and *Labidocera* sp. were more common offshore than in inshore. Besides these, many other species of copepods were present in the plankton in various numbers. Chaetognaths occurred in poor numbers and were more common in the offshore waters than in the inshore area. As in the previous year, *Sagitta bedotei* was the dominant species all along this coast. Fish eggs and larvae also occurred in poor numbers. Eggs and larvae of *Caranx* and clupeids were common. Some eggs and larvae of Anchovy were found at Karwar. A few larvae of *Elops saurus* were collected from Kumta in May.

At Mangalore, regular weekly plankton collections at the four fathom area off Ullal were made almost throughout the year except during the period April-July 1962 when unfavourable weather conditions prevailed.

The displacement volume of the surface hauls was low during the south-west monsoon period. From August onwards there was an increase in trend till the end of the year, and maximum volume was observed in March.

In April and May the phytoplankton was comparatively rich and the common diatoms were species of *Hemidiscus* and *Coscinodiscus*. In the July-September period the monsoon bloom of phytoplankton like the corresponding period the last year was observed. In August *Coscinodiscus marginatus* bloomed and in September *Fragilaria oceanica*. The other dominant diatom were *Chaetoceros*, *Rhizosolenia* and *Tyalassiothrix*. Dinoflagellates viz. *Ceratium trichoceros* and *C. massiliensis* were noticed in lesser numbers. In the latter half of September *Noctiluca miliaris* swarmed. During the October-January period the phytoplankton was generally poor and the bulk was contributed only by diatoms. In February *Skeletonema* sp., *Streptotheca* sp., and *Bel-*

larochea malleus were dominant. In the latter half of March, there was a minor bloom of phytoplankton, caused by *Hemidiscus* sp., *Biddulphia* spp. and *Pleurosigma* sp. The oil sardine fishery at Ullal coincided with this bloom.

In August though the salinity was low copepods were well represented both qualitatively and quantitatively and this indicates the presence of upwelling processes. During the same month swarming of Noctilucae and red water were noticed. In September swarms of Cladocera accounted for the major portion of the plankton volume and this group continued to be dominant in November and December also. Copepods were present in fairly large numbers from November onwards and gradually they became dominant in the plankton and Cladocera progressively diminished in numbers, and became insignificant by January 1963. Copepods remained dominant in the plankton till the end of the year. The important copepods were *Acartia erythraea*, *Centropages furcatus*, *Temora turbinata*, *Pseudodiaptomus danglishii*, *Paracalanus* spp., *Acrocalanus* spp., *Eucalanus subcrassus*, *Oithona rigida*, *Euterpina acutijrons*, *Schmaeckeria serriicaudatus* and *Labidocera pectinata*. The other groups found in moderate numbers were Penaeid zoea, *Lucifer* and its zoea, *Sagitta*, Pteropods and Heteropods, larval bivalves and gastropods. Polychaete larvae, fish eggs and larvae (clupeoid, carangoid and *Cynoglossus* type), medusae, Ctenophores, Salps and Appendicularia occurred in small numbers.

At Kozhikode, the pre-monsoon months were characterised by the relatively poor availability of zooplankton, small numbers of copepods, chaetognath and *Lucifer* being the main consistently occurring forms. Ctenophores, radiolarians and medusae also were obtained in still less numbers. Phytoplankton was dominant in most samples thereafter up to the latter half of second quarter. Then small swarms of cladocerans started coming in into the inshore collections, thereby marking the beginning of the revival of zooplankton abundance. *Eoadne* appeared earlier, but *Penilia* lasted longer. Swarms of the latter continued sporadically up to November-December. From the close of the third quarter to the end of the fourth, copepods appeared dominant, the bulk being made up of the same major forms as in previous years. Polychaete larvae were available in numbers in some collections in August, but were abundant only in September. Swarming of *Noctiluca* was a common feature in second and third quarters and that of *Trichodesmium*, of many days in fourth. The close of the third quarter also marked the beginning of the influx of the larger oceanic forms of *Sagitta*, medusae and siphonophores, salps, pteropods and heteropods, fish eggs and larvae were commonly obtained, mainly during the second and third quarter. December-January was also the period of occurrence, in good number of a variety of invertebrate larvae, decapod and stomatopod larvae, molluscan, veligers, actinotrocha and echinoderm larvae.

At Tuticorin, experiments to evaluate the primary production in the fishing area were continued whenever facilities permitted and in areas where the depth ranged from 6 to 10 fathoms. The values observed during the year under report ranged from 0.048 to 0.36 gm. C/m³ /day in the surface waters.

No wide fluctuations were observed in the displacement volumes of the plankton samples collected during the year and in general the phytoplankton formed a greater percentage. The occurrence of phytoplankton was regular throughout the year. Certain noteworthy features were:—There were small blooms of *Trichodesmium erythracum* from July to December 1962 and in March 1963. Diatoms as represented by species of *Coscinodiscus*, *Thalassiothrix*,

Guinardia, *Rhizosolenia*, *Ditylum*, *Biddulphia* and *Chaetoceros* were common throughout the year with occasional blooms of the some of species, particularly *Rhizosolenia* and *Chaetoceros*. Species of *Ceratium* and *Dinophysis* were occurring in small numbers during the year. Sporadic abundance of *Noctiluca miliaris* was noticed in the months of September 1962 and March 1963. Small numbers of Tintinnids were observed in the summer months April to June 1962. Copepods were observed to predominate as usual and species of *Paracalanus*, *Canthocalanus*, *Acrocalanus*, *Eucalanus*, *Calanopia*, *Acartia*, *Temora*, *Candacia*, *Pontella*, *Corycaeus*, *Oithona*, *Euterpina* and *Microsetella* were commonly met with. Among these the Calanoids formed a greater percentage than the rest. Cladocerans were observed in good numbers in the month of August 1962. Crustacean larvae, species of *Sagitta* and *Oikopleura* were occurring in small number in the samples. The occurrence of medusae and doliolids were sporadic. Bivalve veligers were observed in small numbers in some months.

At Mandapam, studies on primary production in the inshore waters of the Gulf of Mannar and Palk Bay were continued.

Based on the results of about 530 oxygen experiments spread over a period of four years and C^{14} experiments conducted at random, the magnitude of organic production for the inshore area of the Gulf of Mannar, normally frequented by the fishermen, was calculated. A comparison of organic production and fish landings indicated that the trend and magnitude of organic production were well reflected in the fishery. The results of estimations confirmed the earlier observation that the present yield from this zone is only about 1/7 to 1/10 of a possible exploitable stock as compared to intensely exploited waters. These observations as well as the results of exploratory fishing conducted by R.V. *Varuna* in the area of investigations suggest the possibility of stepping up production with a little more effort.

In Palk Bay, however, it has not been possible to obtain a complete picture of the annual cycle of organic production due to lack of data during rough seasons. Oxygen experiments conducted regularly at 2, 4 and 6 fathom lines as well as C^{14} experiments conducted at different stations spread over a distance of about 30 kilometers have given general idea of the magnitude of production in Palk Bay. Though the depth of the photosynthetic zone is less than that of the Gulf of Mannar the rate of production per unit volume especially at the surface is much higher than that of the Gulf of Mannar. In July, the surface waters off Mandapam showed a very high rate of production (ca 1600 mgC/M³/day). This could be indicative of higher fishing potential in Palk Bay.

2. Hydrology

During this year studies on hydrology were conducted at the following centres in the Gulf of Kutch (i) Kandla (ii) Luni (Mundra) (iii) Modhwa (iv) Adisar Camp and in addition salinity pH and temperature data in inner Gulf of Kutch (Surbari) have also been noticed. In all 81 samples from all the centres were collected during the period under review. From Kandla 47 samples, Mundra 13, Modhwa 11 and Adisar Camp 10 samples.

TABLE XI

Month & Year	Phosphate ug at/L	Nitrite ug at /L	Silicate ug at/L	Dissolved Oxygen cc/L	Salinity 0/00	Temp. 0C	pH	No. of samples
1	2	3	4	5	6	7	8	9
KANDLA CENTRE (Monthly average values)								
1962								
April . . .	0.984	0.258	16.10	4.483	38.63	24.4	8.57	∞
May . . .	0.878	0.206	13.94	4.414	38.88	28.5	8.70	..
June . . .	1.238	0.260	20.07	4.139	39.25	29.25	8.60	..
July . . .	0.594	0.202	24.19	4.260	38.68	26.15	8.50	..
August . . .	0.795	0.126	21.88	4.466	38.46	28.20	8.50	..
September . . .	0.814	0.168	19.08	4.911	38.68	28.70	8.50	..
October . . .	0.900	0.252	21.25	4.912	39.64	26.80	8.6	..
November . . .	0.855	0.279	18.36	4.974	39.28	24.50	8.62	..
December . . .	1.872	0.156	18.83	5.635	39.29	19.40	8.60	..
1963								
January . . .	0.633	nil	20.56	5.635	40.19	17.825	8.40	4
February . . .	0.715	0.529	13.49	5.122	39.85	20.225	8.20	4
March . . .	no data	no data	no data	5.298	40.935	23.50	8.45	4
MUNDRA CENTRE (Monthly average values)								
1962								
April . . .	0.733	0.105	25.00	4.397	37.23	26.5	8.5	1
May . . .	0.400	0.190	16.60	4.741	38.31	30.5	8.5	1
June . . .	0.400	0.105	14.29	4.534	37.12	28.9	8.5	1
July . . .	0.595	0.100	16.13	4.397	37.90	28.9	8.6	1
August . . .	0.625	Nil	20.41	4.878	37.36	28.2	8.5	1
September . . .	0.320	0.410	17.86	4.604	38.18	27.9	8.5	1
October . . .	0.250	Nil	27.78	4.741	37.95	26.2	8.6	
November . . .	0.641	0.100	14.71	5.428	37.41	24.5	8.6	1
December . . .	0.440	0.090	11.45	5.755	41.93	19.5	8.6	2
1963								
January . . .	0.240	Nil	11.91	6.030	37.14	18.5	8.6	1
February . . .	0.180	0.110	20.88	5.961	37.92	21.21	8.1	1
March . . .	0.220	Nil	11.91	5.276	37.39	22.0	8.4	1

TABLE XI—*contd.*

Month & Year	Phosphate ug at/L	Nitrite ug at/L	Silicate ug at/L	Dissolved Oxygen cc/L	Salinity 0/00	Temp. 0C	pH	No. of Samples
1	2	3	4	5	6	7	8	9
MODHWA CENTRE (Monthly average values)								
1962								
April . . .	0.395	Nil	06.20	5.153	35.35	25.0	8.5	1
May . . .	0.270	0.025	13.51	4.878	35.47	28.0	8.5	1
June . . .	0.420	0.160	12.20	4.496	38.29	28.9	8.7	1
July . . .	0.450	0.090	11.37	4.441	37.52	29.0	8.7	1
August . . .	1.250	0.556	20.41	4.397	35.59	26.2	8.6	1
September . . .	0.862	Nil	13.16	4.878	35.95	27.5	8.5	1
October . . .	0.270	0.100	11.11	5.222	37.61	24.5	8.6	1
November . . .	0.160	0.100	12.20	4.260	36.51	29.2	8.6	1
December . . .	0.180	0.100	10.42	6.030	37.18	18.5	8.0	1
1963								
January . . .				No sample.				
February . . .	0.170	0.105	22.73	6.030	36.55	17.5	8.6	1
March . . .	No data	No data	No data	5.140	37.99	23.0	8.1	1

Off Karwar, temperature, pH and salinity were high in the beginning of the year. After a steep fall during the monsoon period they again started rising from September. The temperature and salinity again fell during the third quarter of the year. But towards the close of the year they kept rising. pH had a slight fall in the month of February.

It was observed in the previous years that there occurs a period of transition during the post-monsoon months when temperature, pH and salinity ascend from their minimum values of the summer months, and it is during this period that the mackerel appear in shoals in the inshore waters to contribute to the commercial fishery. A study of the year to year temperature changes indicates that the length of this transition period characterized by moderate temperature, pH and salinity of the sea water as well as the mackerel fishery could be predicted by noticing the lowest water temperature in the inshore area during the preceding monsoon. In 1959, the lowest temperature was 24.4 C and the transition period as well as the mackerel fishery was a prolonged one. In 1960, the lowest temperature of the sea water was 25.5° C and the transition period and the mackerel fishery occurred for a shorter period. In 1961, the lowest temperature of the sea water was still higher, namely 26.2° C and both the transition period and the mackerel fishery existed for a very short period and the fishing was a failure. Lowest temperature of the sea water during the current monsoon season was 25.3 C

From the correlation seen in the previous years the transition period and the mackerel fishery of the year under report were predicted to be as short one and the prediction was found fruitful in the actual study of the sea water and the fishery.

Dissolved oxygen in the sea water was slightly high at the time of the South West monsoon. Concentrations of dissolved inorganic phosphates, and Nitrite-nitrogen were very high during this year. At Karwar phosphates had exceptionally high values, in the month of August. During monsoon period the sea water was rich in silicates. Silicates in the offshore waters were comparatively poor.

At Mangalore seawater samples were collected once a week in the four fathom area off Ullal. From middle of May onwards the sea became rough and hence samples could not be collected till the middle of July.

During the summer months *i.e.*, April and May the surface seawater temperature as compared to the corresponding months of last year was high. During the south-west monsoon period (July to September) the average temperature was comparatively low as can be seen from Table XII. During the November-March period the average temperature fluctuated considerably and these values as compared to the corresponding period of 1961-62 were low.

TABLE XII

Months	Minimum		Maximum		Average				
	Temp. °C	Salinity ‰	Temp. °C	Salinity ‰	1962-63		1961-62		
					Temp. °C	Salinity ‰	Temp. °C	Salinity ‰	
1962									
April	31.5	35.35	31.5	35.35	31.5	35.35	29.6	32.99	
May	31.4	35.31	31.4	35.31	31.4	35.31	29.1	34.37	
June	..	..	..	..	..	..	..	..
July	25.9	9.60	25.9	9.60	25.9	9.60	..	..
August	24.4	1.97	25.8	17.95	25.2	11.34	..	..
September	24.7	2.63	26.7	22.32	25.7	13.63	27.4	19.33	
October	25.8	14.47	29.3	25.26	28.1	20.21	29.2	28.12	
November	27.8	32.77	28.0	33.98	27.8	33.37	28.2	32.04	
December	28.0	30.23	29.0	30.72	28.4	30.51	28.5	33.90	
1963									
January	27.1	31.31	28.0	32.12	27.7	32.20	27.2	34.49	
February	26.5	31.96	27.6	35.52	27.6	32.26	28.1	35.12	
March	29.0	32.52	30.1	33.58	29.5	33.26	29.9	35.23	

During April and May the average salinity values were 35.35 ‰ and 35.31 ‰ respectively, and these values as compared to those months of the last year were high. During the south-west monsoon period the average salinity was low. In the first week of August the lowest value of 1.97‰ for the year was recorded. In the last week of August heavy catches of oil sardine were made at Ullal when the salinity was 9.60 ‰. From August to November, salinity gradually increased. In December, the average value went down to 30.51 ‰ (as can be seen from the table), and the corresponding value for the last year was 33.30‰. During the January-March period was low as compared to the corresponding period of the last year.

During April and May the pH was 8.6. In July and August it was 7.6 and 8.2 respectively. From September to March the pH was fluctuating between 8.4 to 8.6.

During the year under review four hydrographic surveys, the first three along the west coast and the fourth and the recent one along the east coast, were completed. The first survey which was a part of general fishery programme was made during 3-1-1962 to 28-5-1962, and the entire west coast from Veraval to Cape Comorain was covered in all eight research cruises. Prior to this survey, hydrographic work was limited to the Malabar coast from Mangalore southward and no systematic work of this nature was done in the northern part of the coast. Therefore this survey has given an understanding of the hydrography of the waters along this coast and thereby allowing comparison with the waters of the southern coast. The second survey, the first of its kind in this country, was made from 11-6-1962 to 7-9-1962 and it covered the coast from Ratnagiri southward to Cape Comorin inspite of rough sea conditions and thus making available very interesting data. As a participation in the International Indian Ocean Expedition (1960-65) and as apart of the Indian Programme, a broad programme of oceanographic research was formulated and was carried out during 14-9-1962 to 12-1-1963 the area covered being bounded by longitude 70-80° E and latitude 1S-17° N, and the samplings were made up to a maximum depth of 3500 m. Thus, it may be pointed out that with the completion of these three surveys it is now possible to study the distribution of various hydrographic properties as temperature, salinity dissolved oxygen and density in all the three seasons *viz.* premonsoon, monsoon and post monsoon, and the relationship to each other, if any. These studies also shall reveal details of the dynamics of the water of the area under investigation. The fourth survey was made recently along the east coast from 20-2-1963 to 24-3-1963, the area investigated over the shelf between Waltair to Tuticorin with a more detailed investigation of the Palk Bay.

The analysis of the wind data during monsoon period stipulated interest and it was decided to undertake a thorough analysis of the winds and to find possible relationship with the occurrence of the distribution of hydrographic properties. A seeming relationship between these two have been definitely found and is included in the forthcoming publications. This study reveals very interesting features and therefore, it has been decided to make monthly frequency as well as average distribution of wind for every year from 1959 onward.

The physico-chemical conditions of the sea water in the pearl bank and fishing areas off Tuticorin were deduced from the analyses of surface samples only. The surface temperature was observed to fluctuate from 28.3-30.1 °C during April to June 1962; from 26.8—28.7 °C during July to September 1962; from 23.0-29.00 °C during the last quarter.

The pH values during the whole year ranged from 8.2 to 8.45. The Salinity values varied from 34.13‰ to 35.8‰.

The dissolved oxygen content ranged from 4.31 cc/l to 5.6 cc/l.

3. Bottom Fauna

Studies on the bottom fauna and bottom plankton off Kozhikode in relation to the feeding in bottom commercial fishes have been continued during the year. Samples have been taken on 31 occasions during the year.

During the first quarter the bottom fauna was moderately rich due to the delay in the onset of the south-west monsoon. The 2 fathom area was generally poor and the 6 fathom are the richest. *Disoma* and *Clymene* were the commonest among the representatives. Nuculanida were abundant at 6 fms. on the 19th June. During the second quarter the bottom fauna was poor. The complete absence of *Disoma* was significant. Nuculanidae were the commonest among representatives. *Eumbriconereis bifaria* was also frequently found at all depths. During the third quarter the characteristic post-monsoonic abundance of bottom mud organisms was not noticed. However, the fauna during this quarter was richer than during the earlier quarter. There was an exceptional abundance of *Pholas orientalis* at 4 fms. on 4th December and a moderate abundance of *Prionospio pinnata* at 6 fms. on 27th November. During the last quarter the fauna has been moderately rich with no significant abundance of any representative.

The bottom plankton has been moderately rich throughout the year, but meroplankton have not been abundant at any time. Young nereidae were observed on 17th April and 19th June; annelid trochophores, polynoid, and polidora, larvae, other spionid larvae, planulae lamellicorn and gastropod veligers have been occurring in small numbers at regular intervals.

The Malabar Sole (*Cynoglossus semifasciatus*) was found to be feeding on the organisms common in the bottom mud at that time. During the first quarter *Phyllochaetopterus*, *Clymene* and *Lumbriconereis bifaria* were common in the stomachs. Nuculanidae, *Prionospio pinnata*, *L. bifaria* and *Nephtys* were common during the second and third quarter. *P. Pinnata*, *Pholas orientalis*, *L. bifaria*, *Disoma*, *Nephtys*, *Diopatra* and *Coscinodiscus* were common during the last.

At Mandapam, studies on the bottom fauna of Palk Bay inshore waters were continued. The selected area for observation lies between $N9^{\circ} 17'$ to $9^{\circ} 21'$ and $E79^{\circ} 07'$ to $79^{\circ} 10'$. Fortnightly collections of water samples from different depths and bottom fauna have been made from arbitrary stations I, II and III situated at a depth of 4 metres, 8 metres and 11 metres respectively. The samples of water have been analysed and their temperature, oxygen-salinity and phosphate content have been recorded. The bottom deposits and their associated fauna were collected with the aid of Petersen's grab. The bottom at 4 m. depth consisted of pieces of dead corals, shingles and coarse sand. The following are the common polychaete that are met with in this region: *Eunice indica*, *Lumbriconereis simplex*, *Nephtys oligobranchina*, *Capitellethus dispar*, *Paraheteromastus tenuis*, *Ammotrypane aulogaster*, *Prionospio cirrifer*, *Cirratulus cirratus*, *Tylonereis bogoyawlenskyi* and *Ceratonereis* sp.

At station II, located at a depth of 8m. the substratum consisted of soft clay with an admixture of medium sand and dead broken molluscan shells. The following polychaetes are common at this station: *Cossura delta*, *Ancistrosyllis tentaculata*, *Podarke angustifrons*, *Prionospio cirrifer*, *Nereis (Ceratonereis) burmensis*, *Glycera alba*, *Mesochaetopterus* sp.

The substratum at Station III which is located at a depth of 11m. consisted of soft, grey clay with an admixture of few empty molluscan shells. The following polychaetes have been recorded from this station. *Tylonereis bogoyawlenskyi*, *Ancistrosyllis tentaculata*, *Nereis (Ceratonereis)*

mirabilis, *Dorvillea incerta*, *Sabellastrate* sp., *Mast obrarshus* sp., *Prionospio pinnata*, *Parasphaerosyllis* sp., *Laonice* sp., *Loimia montagui*, *Lepidasthenia ohshimai*, *Clymene (Euclymene) santanderensis*.

4. Algology.

The final survey of the algal beds of the Gulf of Mannar-Pamban area is completed. In this survey, investigations were confined to depths less than 7 meters, as it was found in the preliminary survey that below depths of 7 metres no vegetation existed in the area under study. In all 441 stations were examined. At each station three samples were taken, each sampling being done from a 30cm. sq. area. For the final analyses, these stations were grouped into three sections, the Hare Island section consisting of Hare Island, Manoli Island and New Islet; the Kurusadai Island section consisting of Pulli Island, Pullivasal Island, Kurusadai Island and Shingle Island; and the remaining portion of the area. A total of 234.25 sq. km. is covered in this survey, of which the Hare Island section is 40.98 sq. km. and the Kurusadai Island section is 17.89 sq. km. In the remaining portion, only 77 stations in an area of 175.38 sq. km. had any economic seaweeds and hence these are not included in the total estimates, because, their inclusion would not give a true picture of the area as a whole. Further, among the two sections of the Islands, (Sections separated on the basis of the Puma Channel) Hare Island section is more productive but *Gelidium* is found only in the Kurusadai Island section.

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