

**GOVERNMENT OF INDIA CENTRAL MARINE
FISHERIES RESEARCH STATION
MANDAPAM CAMP**

**ANNUAL REPORT OF THE CHIEF RESEARCH OFFICER
FOR THE YEAR ENDING 31ST MARCH 1954**

ADMINISTRATIVE AND GENERAL

THE year 1953-54 marked further progress in marine fisheries research work carried out at the Headquarters Station at Mandapam, the Sub-Station at Kozhikode and the Research Units at Karwar for mackerel, Cochin for prawn and at Madras for molluscan fisheries. Programmes of work undertaken at the various centres of study were actively continued.

2. In order to make a scientific study of the Offshore Fisheries of Bombay, now beginning to be exploited by deep sea fishing vessels, a Research Unit was set up there in July 1953. The main work of the Unit is to analyse the biological composition of fish catches obtained by mechanized fishing vessels operating from Bombay and to help in the charting of fishing grounds. The Government of India Cutters M.V. *Ashok* and M.V. *Pratap* were converted for bull-trawling, and the modified type of fishing was started in the latter part of the year with very considerable success. M.F.V. *Kanyakumari* and M.F.V. *Sagarkumari*, the motor fishing vessels belonging to the West Coast Fisheries Ltd., also conducted fishing from Bombay towards the end of the year. The operations of all these vessels resulted in good landings of fish in Bombay during the year, particularly in the post-monsoon period from September to December. For some time during November, even a "glut" may be said to have prevailed and the trawler *Kanyakumari*, after returning from the first fishing trip, remained at port for several days waiting to clear her hold owing to the unprofitable market conditions and the very heavy pressure on the cold storage space available in Bombay.

In addition to general observations, on fish populations as seen in the trawl catches and on the environmental conditions in the fishing grounds, special investigations were initiated by the Unit on the fishery and biology of prime fishes like the polynemids (*Dara* and *Rawas*), the sciaenids (*Ghals*) and the eels (*Wam*). Observations were also made on the temperature and salinity distributions in the surface waters of the Gulf of Cambay and Gulf of Cutch regions of the Arabian Sea.

3. In regard to general conditions of marine fisheries along the coasts of India, it may be said that fish landings on the east coast seemed to have been more or less steady during the past few years while those on the west coast were extremely variable owing to wide fluctuations in the landings of the major shoaling fishes like the sardines and the mackerel which form the main fisheries of the west coast. The decline in the catches at Lawson's Bay (East Coast) in 1953 was due to the fall in the average return per boat. The poor fishery at Vizhingam (Travancore-Cochin) during the year was due to the complete failure of *Sardinella* sp. which was the predominant fish in January-March 1952. The *Lactarius* fishery also failed in 1953 at this place. However, the poor fishery in the early part of the year was compensated to some extent in the latter part of the year. The fish landings at Kozhikode in 1953 were better than in 1952, when there was a general failure of sardine and mackerel fisheries, but poorer than in 1951 and 1950. Generally speaking, the sardine fishery on the west coast of India during 1953-54 was one of the best in recent years. The total catch at Karwar in 1953, though a little lower than that of 1952, was almost the same as that of 1951. At Versova (Bombay) a continuous increase in the annual production has been noticed.

In order to collect fishery data from the Saurashtra zone, a survey centre was set up at Veraval in January 1954. This zone was included in the original scheme, but could not be brought within the scope of work till now, owing to the absence of sanction in former years for a survey assistant in Saurashtra.

4. Studies under laboratory conditions, on the prolific exotic fish *Tilapia*, further indicated that it might prove to be a useful fish for cultivation in Indian waters, where there is no organized fish culture at present. For further experiments on its compatibility with carps, a consignment was given to the Central Inland Fisheries Station for trials at the Cuttack Sub-Station.

Further interesting results have been obtained in the studies on utilization of sea weeds for cottage industries such as agar manufacture, their utilization as cattle and poultry feeds and for the preparation of sea-weed meal. Field experiments carried out have shown the value of sea-weed compost for vegetable and other crops.

5. The Institution was made a permanent Scientific Institute of the Government of India with effect from 13-10-1953. A number of posts that existed on a temporary basis during the past 7 years have been made permanent and a certain number of Class III and Class IV staff who have put in a number of years' service have been confirmed.

6. During the year 6 gazetted and 31 non-gazetted posts were sanctioned under the 5-year National Plan. One of these posts, namely Assistant Research Officer (Oceanography), was temporarily filled by appointing Shri R. Viswanathan, Research Assistant in the selection grade, to officiate in the post until a candidate is selected by the Union Public Service Commission. Steps were initiated for filling the remaining gazetted and non-gazetted posts. In connection with the research scheme on fish curing, one post of Assistant Research Officer and two posts of Assistants were sanctioned. A scheme for the collection of sea-water samples from different parts of the seas around India and their analysis was prepared by Dr. N. K. Panikkar and the work was sponsored by the Central Board of Geophysics for implementation by the Ministry of Natural Resources and Scientific Research. The scheme has been approved and is being implemented.

7. An agreement for the supply of electricity to the Research Station from the Papanasam-Pykara h.t. Lines was concluded with the South Madras Electric Supply Corporation. A few minor items of capital works including certain improvements to the existing temporary residential quarters were carried out during the year. With the completion and putting into effect of a regular system of sea-water circulation for the aquarium in April 1953, facilities now exist for the study of living fish and other animals and plants in the aquarium. As the 7.5 h.p. engine of the departmental motor launch M. L. *Sagitta* was found inadequate for the effective use of the launch in Mandapam waters, it has been replaced by a 15 h.p. engine. For providing internal communication facilities a ten-line inter-communication telephone system has been installed. In addition to the essential scientific equipment, chemicals, glassware and fishing gear, purchase of a small Aerogen gas plant, one refrigerator, some furniture, typewriters, table- and ceiling-fans which were sanctioned by Government, has also been made.

About 50 acres of land have been acquired on the Palk Bay side at Mandapam in order to develop a pilot Marine Fish Farm taking advantage of certain existing natural facilities. It is hoped that actual work relating to the formation of the farm by the construction of the sluices and central canal and other connected earthworks could be started during 1954-55.

8. To meet a long-felt need for the publication of scientific results of fisheries research work in India, the Government of India sanctioned in October 1953 the starting of an *Indian Journal of Fisheries* with the Chief Research Officer as the Managing Editor. Though energetic steps were taken for publishing the first volume of the Journal early during the year, various preliminary details connected with the choice of the press, size and

format of the Journal, selection of material, editing and cognate matters involved some unavoidable delay, so it was not possible to bring out the first issue till some three months after the close of the financial year.

9. Dr. N. K. Panikkar, Chief Research Officer, attended the Eighth Pacific Science Congress held at Manila in November 1953 at the invitation of the National Research Council of the Philippines. He also participated in the meeting of Oceanographic Consultants on the Indo-Pacific Oceanographic Institute as a special invitee of the UNESCO. At this Congress, Dr. Panikkar organized a symposium on "Productivity of Temperate and Tropical Waters" to which several valuable contributions were made by distinguished scientists. The subject was specially chosen in view of its important bearing on development of tropical fisheries and also because of the widely divergent views held by experts on the extent to which tropical waters could support intensive fishing.

The Indian Delegation to the 5th Meeting of the Indo-Pacific Fisheries Council held at Bangkok in January-February 1954 was led by Dr. N. K. Panikkar. Various subjects relating to fisheries research and development in the countries of S.E. Asia were discussed during the session. A resolution urging the F.A.O. to establish training centres for Master Fishermen in the Indo-Pacific area, which was moved by the Indian Delegation, was accepted by the Council. Collaborated projects for the study of the Indian Mackerel, *Rastrelliger*, were recommended to those member-Governments who have this valuable fishery. Emphasis was laid during discussions on fish culture, prevention of water pollution by industrial development, and the need for adequate protection of fisheries during the execution of River Valley Projects. Dr. Panikkar was elected as Chairman of Technical Committee I of the Council on Biology and Hydrology, also as a member of a Special Committee on Fisheries Development. These committees are to organize and develop programmes of work prior to the next session of the Council in 1955.

In order to study and report on the research work carried out at the Central Fisheries Institutes and the State Governments Fisheries Organizations, the Government of India set up an *ad hoc* Committee consisting of Dr. B. N. Chopra, Fisheries Development Adviser (Chairman), Dr. W. H. Rich of the Stanford University and Dr. N. K. Panikkar, Chief Research Officer, Central Marine Fisheries Research Station. Dr. Panikkar fully participated in the work of the Committee which commenced its work towards the end of March 1954. A comprehensive note on the work of the Research Station was prepared and submitted to the Government for the use of the Committee.

10. Dr. B. S. Bhimachar, Research Officer (Fishery Biology), who was deputed for overseas training, returned to India in April 1953 after about six months of training in the United Kingdom, and after visiting Fisheries Research Laboratories in Norway, Sweden and Denmark. In December 1953 he was transferred to the Central Inland Fisheries Research Station, Calcutta. Dr. S. Jones, who was transferred to the post of Fishery Biologist formerly held by Dr. Bhimachar, joined in January 1954. Dr. Jones was nominated as a Member of the Panel on Sea Fisheries, Technical Committee I of the Indo-Pacific Fisheries Council.

Miss Mary Samuel and Shri R. Velappan Nair, Assistant Research Officers who were selected for special training in the U.S.A. under the Point Four Programme, left for the United States towards the end of December 1953.

11. The two Research Scholars, who started work here during the previous year, actively continued their studies. Shri K. Ramalingam, who was selected for the additional Research Scholarship, commenced work here in July 1953. Shri N. Radhakrishnan, M.Sc., and Shri M. V. Pai, M.Sc., who were admitted as Honorary Research workers started work in the Institution in August 1953 and February 1954 respectively. Two M.Sc. students in Marine Biology of the Madras University were given facilities of the Research Station. At the instance of the Ministry of Education, Mr. Klaus Sander, a German Scholar working in the Zoology Department of the Aligarh University, was allowed to stay and work in the Institution for a period of about two months from August, 1953.

12. Due attention was paid to the question of close co-operation and proper co-ordination of research work carried out by this Institution and the State Government Fisheries Organizations. A conference of the Director of Fisheries, Madras, and his staff at Kozhikode with the Chief Research Officer and scientific staff of this Station at Kozhikode was held at Kozhikode on the 8th July 1953. The programmes of work carried out by the scientific staff of the two establishments were explained by the respective workers. In continuation of the arrangements made in 1950, ways and means for close co-operation and co-ordination of the work of the two establishments at Kozhikode were formulated. The programme of work of the two establishments for the next few years was chalked out so as to avoid any wasteful overlapping of effort or unnecessary duplication in scientific activities. It was proposed to hold periodic reviews of the programmes of the two Institutions. These have also been subsequently approved by the respective Governments.

13. An Exhibition of Marine Life and Marine Products was organized by the staff of the Research Station at Mandapam on 1-11-1953 in aid of the Prime Minister's fund for Indian Forces in Korea. The Exhibition proved a success, both as an educative and entertaining event, over 800 visitors from neighbouring areas participating in the event. The voluntary contributions received from visitors amounted to Rs. 279-6-0 which was remitted to the Fund.

14. Shri M. V. Krishnappa, Deputy Minister, Food and Agriculture, Government of India, New Delhi, visited the Research Station on the 4th January 1954. The Minister was received by the Chief Research Officer and shown round the Institute on the 5th January, and the various activities of the Research Station were explained to the Minister. The Deputy Minister also addressed a meeting of the staff. Shri M. R. Bhide, the Joint Secretary, and Dr. B. N. Chopra, Fisheries Development Adviser, Government of India, Ministry of Food and Agriculture, visited the Headquarters Station and the subordinate establishments at Madras, Narakkal and Kozhikode in April 1953. Detailed discussions on various matters connected with the needs of the Station were held by the Chief Research Officer with the Officers from Delhi. In December 1953, Dr. D. Bhatia, Deputy Fisheries Development Adviser, also visited the Station.

15. Three Members of the Estimates Committee of the Parliament, namely, Shri Radhalal Vyas, Shri K. Gopala Rao and Shri V. Muniswamy Thirukuralar visited the Research Station between the 16th and 18th June 1953. The Members of the Committee acquainted themselves with the work of the various sections, and discussions were held with officers and staff. Other relevant material and information as required by the Members of the Committee was also supplied to them. In continuation of the above visit, the Members of the Committee inspected the Molluscs Research Unit at Madras on 26-6-1954. The recommendations of the Committee in respect of this Research Station are included in the Estimates Committee's Sixth Report, 1953-54.

16. The well-known British biologist, Prof. Julian Huxley, F.R.S., and Mrs. Huxley, who were touring India at the invitation of the Government of India, visited and stayed at the Research Station for three days in March 1954. Prof. Huxley visited the various laboratories and held discussions with the scientific staff, scholars and officers. Prof. A. C. Hardy, F.R.S., Linacre Professor of Zoology and Comparative Anatomy, University of Oxford, a distinguished scientist noted for his contributions to plankton studies and fisheries, visited the Research Station and stayed here for a few

days. This opportunity was taken for scientific discussions with the officers of the various sections and general review of recent scientific developments in marine fisheries research. Another foreign visitor was Mr. N. A. Holme of the Marine Biological Laboratory, Plymouth, England. The Chairman and Members of the Board of Indian Immigrant Labour, Colombo, visited the Central Marine Fisheries Research Station on 26-3-1954. Dr. Rm. Alagappa Chettiar, the well-known Indian Industrialist, visited the Research Station on the 8th October 1953. A large number of students from various Indian Universities, trainees and other research workers from different parts of the country also visited the Institution during the year and made use of the facilities for sojourn and work here.

17. Scientific inquiries on various aspects of fisheries have been received and dealt with during the year. The Institution also maintained very close collaboration with other scientific organizations such as the Indo-Pacific Fisheries Council, the Central Board of Geophysics, etc. A large number of original scientific papers contributed by the staff of the Station has been published in different scientific journals (list attached).

18. Demonstrations were organized at the Institute to show the public how sea weeds may be utilized, and an extension pamphlet on the subject is being prepared. A broadcast talk on the work of the Institute was given from the Tiruchirapalli Station of the All India Radio by the Chief Research Officer.

Shri A. R. Vyas, Director of Publicity in the Ministry of Food and Agriculture, visited and stayed at the Research Station from the 31st July to the 2nd August 1953 to acquaint himself with the work of the Institution. As a result of this visit and the discussions held by Shri Vyas with the Chief Research Officer and other members of the staff, press releases relating to the organisation and work of the Institution were issued by the Ministry of Information and Broadcasting. Later, the Film Unit of the Publicity Directorate of the Ministry also visited the Headquarters Station and subordinate establishments.

19. The Reference Collection of Fishes and Exhibits has now been arranged in a large hall in suitable showcases which were acquired during the previous year. Substantial additions to the collections have been made during the year.

20. Acquisition of essential literature for the Library has been maintained during the year. A substantial addition to the Library has been the private collection of books, periodicals, and reprints of Dr. H. S. Rao,

TABLE I. Showing the Composition of Fish Catch in lbs. for 1953 at the nine centres
(Figures in brackets show percentages)

	Gopalpur	Lawson's Bay	Triplicane	Adirampatnam	Tuticorin
Mackerel ..	2,351 (0.35)	8,725 (0.44)	9,341 (1.65)	..	..
Sardines ..	449,586 (66.80)	611,957 (30.87)	17,012 (3.00)	..	661,845 (48.34)
Prawns and other crustacea ..	6,999 (1.04)	66,081 (3.33)	52,414 (9.25)	15,558 (0.72)	..
Ribbon-fishes ..	7,260 (1.08)	153,703 (7.75)	69,834 (12.33)	12,488 (0.58)	186 (0.01)
Bombay-duck ..	..	17,243 (0.87)	2,524 (0.45)	..	..
Whitebaits ..	54,511 (8.10)	66,418 (3.35)	77,334 (13.65)	55,508 (2.58)	41,231 (3.01)
Cat-fishes ..	..	192,918 (9.73)	8,535 (1.51)	797,753 (37.04)	3,598 (0.26)
Other clupeoids ..	71,754 (10.66)	26,298 (1.33)	19,974 (3.53)	178,896 (8.31)	778 (0.06)
Pomfrets ..	4,590 (0.68)	23,078 (1.16)	11,534 (2.04)	1,733 (0.08)	2,163 (0.16)
Sclerids ..	1,055 (0.16)	24,940 (1.26)	40,825 (7.21)	279,579 (12.98)	2,264 (0.17)
Elasmobranchs ..	18,038 (2.68)	169,084 (8.53)	25,551 (4.51)	396,447 (18.41)	97,691 (7.14)
Seer-fish ..	14,229 (2.11)	326,106 (16.45)	29,653 (5.24)	49,681 (2.31)	69,786 (5.10)
Carangids ..	2,314 (0.34)	35,597 (1.80)	44,089 (8.49)	55,389 (2.57)	61,487 (4.49)
Perches ..	..	64,868 (3.27)	27,902 (4.93)	65,387 (3.04)	278,960 (20.38)
<i>Bregmacerus</i> ..	..	..	..	..	..
Silver bellies ..	2,245 (0.33)	14,669 (0.74)	44,398 (7.84)	126,552 (5.88)	1,980 (0.14)
<i>Lactarius</i> ..	48 (0.01)	22,060 (1.11)	17,728 (3.13)	336 (0.02)	48 (..)
<i>Chirocentrus</i> ..	8,653 (1.29)	11,775 (0.59)	6,095 (1.08)	92,769 (4.31)	64,128 (4.68)
Polynemids ..	14 (..)	2,874 (0.14)	6,547 (1.16)	24,023 (1.12)	83 (0.01)
<i>Histiophorus</i> ..	..	27,203 (1.37)	..	..	..
Soles ..	..	..	337 (0.06)	..	..
Eels ..	..	..	164 (0.03)	..	..
Tunnies ..	4,317 (0.64)	1,719 (0.09)	..	..	34,046 (2.48)
Red mullets ..	..	56 (..)	9,449 (1.67)	513 (0.02)	1,930 (0.14)
Barracuda ..	..	216 (0.01)	5,884 (1.04)	..	5,877 (0.41)
Flying-fishes ..	..	18,349 (0.93)	2,706 (0.48)	..	..
Miscellaneous ..	25,117 (3.73)	96,687 (4.88)	32,535 (5.74)	1,258 (0.06)	41,346 (3.02)
Total in lb. ..	673,081	1,982,626	566,365	2,153,870	1,369,127
Total in tons ..	306.48	885.10	252.84	961.55	611.22

	Vizhingam	Calicut	Karwar	Bombay
Mackerel	7,124 (0.11)	1,733,615 (18.46)	2,642,760 (81.11)	..
Sardines	620,309 (9.99)	5,423,933 (57.76)	286,057 (8.78)	..
Prawns and other crustacea	69,596 (1.12)	215,376 (2.29)	16,192 (0.50)	12,035,394 (31.61)
Ribbon-fishes	2,151,185 (34.65)	16,396 (0.17)	3,550 (0.11)	4,524,264 (11.88)
Bombay-duck	..	..	26 (..)	4,953,086 (13.01)
Whitebait	1,463,263 (23.57)	153,201 (1.63)	20,609 (0.63)	611,119 (1.61)
Cat-fishes	449,248 (7.24)	293,683 (3.13)	142,228 (4.37)	356,503 (0.93)
Other clupeoids	128 (..)	30,574 (0.33)	8,679 (0.27)	1,306,961 (3.45)
Pomfrets	197,198 (3.18)	566,189 (6.03)	1,942 (0.06)	1,685,464 (4.43)
Sciaenids	94,442 (1.52)	48,154 (0.51)	53,602 (1.64)	3,501,165 (9.20)
Elasmobranchs	431,110 (6.94)	215,914 (2.30)	10,848 (0.33)	28,920 (0.08)
Seer-fish	20,680 (0.33)	4,131 (0.04)	716 (0.02)	18,418 (0.05)
Carangids	279,731 (4.51)	104,493 (1.11)	2,431 (0.07)	10,545 (0.03)
Perches	27,999 (0.44)	2,738 (0.03)	2,662 (0.08)	3,790 (0.01)
<i>Bregmaceros</i>	..	..	..	2,52,915 (5.92)
Silver-bellies	173,234 (2.79)	48,838 (0.52)	25,876 (0.79)	..
<i>Lactarius</i>	126,696 (2.04)	5,977 (0.06)	24,543 (0.75)	..
<i>Chirocentrus</i>	1,213 (0.02)	230 (..)	187 (0.01)	13,874 (0.04)
<i>Polynemids</i>	..	..	289 (0.01)	37,614 (0.10)
<i>Histiophorus</i>	32,938 (0.53)	..	..	..
Soles	..	495,165 (5.27)	13,953 (0.42)	18,873 (0.05)
Eels	..	175 (..)	245 (0.01)	148,149 (0.39)
Tunnies	48,543 (0.78)	13,239 (0.14)	..	..
Red mullets	..	..	..	40,745 (0.11)
Barracuda	2,582 (0.04)	108 (..)	5 (..)	..
Flying-fishes	..	..	..	..
Miscellaneous	11,323 (0.18)	17,879 (0.19)	877 (0.02)	6,522,499 (17.13)
Total in lb.	6,207,643	9,390,007	3,258,255	38,069,048
Total in tons	2,771.27	4,191.97	1,454.58	16,995.11

who was Chief Research Officer of the Station from 1947-50; it is a valuable gift in token of his association with the Institute. Mr. D. A. Locke presented a telescope to the Institute on his departure from Mandapam, following his retirement from the post of Marine Superintendent, Southern Railways.

FISHERY SURVEY

21. It may be recalled that following a directive from the Ministry, the survey programme was reorientated at the beginning of 1953 and emphasis was shifted from estimates of total fish production to intensive biological surveys. Nine centres distributed along the coastline of India were selected according to the staff then available, and data were collected for the purpose of estimating the total production of each centre, the composition of the catch, the seasonal abundance of species, and the catch per unit of effort. The centres of observations were subsequently raised to eleven. Analysis of data collected in 1953 has been completed and the results are shown in the accompanying Tables (I to III).

22. From the total weights of the various groups of fishes constituting the landings at each centre, it is seen that at Gopalpur and Lawson's Bay, sardines (*Sardinella fimbriata* and *Dussumieria hasseltii*) formed the bulk of the catches. At Triplicane (Madras) the fishery comprised a varied assemblage of fishes such as whitebaits (*Stolephorus* and *Engraulis*), ribbonfishes (*Trichiurus*), silver-bellies (*Leiognathus*), carangids, sciaenids, seer-fish, and prawns. At Adirampatnam, 37% of the total catch consisted of cat-fishes (*Arius* sp.) which were landed mostly in the first two months of the year, normally the elasmobranchs and sciaenids form the bulk of the catches. This year, the elasmobranchs (*Myliobatus*, *Trygon*, *Rhinoptera*, *Sphyrna* and *Carcharinus*) formed 18%, and sciaenids (*Sciaena*, *Otolithus*) formed 13% of the total catch. The fisheries of Tuticorin consisted mainly of sardines (48%) and perches (20%). The species of sardines landed were *Sardinella fimbriata*, *S. sirm*, *S. leiogaster* and *D. hasseltii*. There were also some landings of tuna (*Euthynnus*) which formed 2.5% of the total catch. At Vizhingam the fishery consisted mainly of ribbon-fishes (*Trichiurus*), and whitebaits (*Stolephorus*). The sardines (*S. atricauda*) which formed the important fishery during the early part of the previous year, failed this year. There were also some landings of tuna. At Calicut, sardines (*S. longiceps*, *S. fimbriata*, *S. gibbosa*, and *D. hasseltii*) formed the bulk of the catches. Next in abundance was the mackerel which constituted 19% of the total catch. At Karwar the mackerel (*Rastrelliger canagurta*) was the fish of the year, constituting nearly 81% of the total catch. At Versova (Bombay) the fishery was

TABLE II. Showing the Monthly Landings (in tons) for 1953 at the nine centres

Centre	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Gopalpur ..	47.16	30.09	149.78	23.65	9.07	7.82	6.43	2.84	3.30	2.38	4.52	13.74	390.48
Lawson's Bay ..	167.68	81.45	57.44	30.93	96.03	84.98	112.58	67.22	32.36	43.95	55.37	55.12	885.11
Triplicane ..	11.34	21.95	29.75	22.75	16.11	18.68	24.00	16.18	14.45	25.58	18.67	33.39	252.85
Adiran:patnam	254.96	132.74	58.43	56.03	29.89	21.03	44.18	77.04	49.76	66.22	104.44	67.25	961.57
Tuticorin ..	106.61	103.93	94.76	33.81	24.26	16.90	39.00	49.92	40.10	37.06	20.94	34.05	611.24
Vizhingam ..	31.53	16.73	103.75	103.17	603.12	819.70	293.69	399.39	204.97	61.26	100.48	33.51	2771.30
Calicut ..	861.95	467.01	191.37	103.94	275.44	125.84	76.16	268.49	532.70	194.06	554.76	537.22	4191.94
Karwar ..	206.94	53.23	57.19	4.03	2.75	1.31	1.31	18.68	32.08	70.49	337.05	670.52	1455.58
Versova ..	1808.05	1757.93	1335.37	1424.63	2594.20	856.06	..	2.88	1474.52	727.68	2944.44	2069.35	16995.13

TABLE III. Showing Catch per man-hour for 1953 at the nine centres

Centre	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Gopalpur ..	2.81	2.59	..	..	7.10	4.66	2.06	1.30	1.22	1.18	0.73	1.02
Lawson's Bay..	2.50	1.34	1.14	0.73	0.99	1.13	1.57	1.22	1.04	0.78	0.99	0.73
Triplicane ..	1.88	3.18	2.74	1.69	1.96	2.01	1.61	1.49	1.81	2.83	2.36	1.79
Adirampatoam	4.57	3.12	1.62	1.67	1.16	1.10	1.70	1.78	1.83	1.59	1.25	1.23
Tuticorin ..	2.24	1.98	1.63	0.79	0.67	0.50	0.80	1.25	1.03	1.24	0.93	0.92
Vizhingam ..	1.38	0.56	0.84	1.30	4.85	30.64	9.33	12.35	2.70	1.56	3.84	1.59
Calicut ..	13.75	7.33	2.04	2.71	6.38	7.36	3.07	6.65	7.05	4.02	10.48	9.85
Karwar ..	27.43	3.62	5.79	3.97	3.41	1.55	1.55	7.71	9.77	5.73	17.31	27.15
Versova ..	7.07	8.38	6.61	5.79	9.33	13.33	..	3.29	11.93	13.22	11.32	8.42

constituted mainly of shrimps and prawns (32%), *Harpodon* (13%), *Trichiurus* (12%), sciaenids (9%) and *Bregmaceros maclellandi* (6%).

23. The seasonal occurrence of some of the important fishes at different centres was also studied, and important features are recorded below:

Rastrelliger canagurta was an important fishery at Calicut and Karwar. At Calicut, it was available throughout the year, but heavy catches were obtained during the months of January, February, April, August, October and December. At Karwar the heavy catch of this fish was during January to March and again in November and December, but it was also caught in some quantities during April, August and September. *Rastrelliger* was also caught in small quantities at Gopalpur, Lawson's Bay and Triplicane on the east coast. While it was caught at Gopalpur during January to March and November and December, it was caught intermittently at Lawson's Bay during March, May, June and December. At Triplicane it was caught during February to July and in November.

Sardinella longiceps—The oil sardine figured largely in the catches at Calicut and Karwar. While it was available at Calicut in all the months, heavy landings were made only during January and February and again in November and December. It was landed in Karwar from January to March and during October to December. The fishery taken as a whole for the 1953-54 fishing season was one of the most successful in recent years.

Sardinella fimbriata—On the west coast, this sardine occurred at Vizhingam, Calicut and Karwar, and on the east coast at Gopalpur, Lawson's Bay, Triplicane and Tuticorin. At Gopalpur, Tuticorin, Calicut and Karwar, the species was available from January to April and again from October to December. While at Triplicane it was obtained in small quantities from February to November, it was landed at Lawson's Bay in all months excepting April, August and October.

Dussumieria hasseltii—The rainbow sardine was generally found in small quantities in some of the centres of the east coast. At Gopalpur and Tuticorin it occurred from January to April and in November and December. At Triplicane, it was landed in small quantities from February to November, but at Lawson's Bay it was found intermittently during January, March, June and November.

Trichiurus spp—Good fishing for ribbon-fishes was observed during June to August at Lawson's Bay, Triplicane and Vizhingam. They were obtained at Bombay uniformly throughout the year.

Anchoviella spp.—Good fishing for "*Stolephorus*" spp. was seen at Gopalpur and Lawson's Bay during November and December, at Triplicane during January and February and at Vizhingam from March to May.

Arius spp.—Heavy landings were observed during January and February at Adirampatnam.

Tunnies—Good catches of tunnies were obtained at Tuticorin during July and August. About 13,000 lb. of tunnies were obtained at Calicut during September. They were also obtained in small quantities in various months at Vizhingam.

Hilsa spp.—Hilsa was obtained at Gopalpur and at Lawson's Bay during the months of April to July and at Adirampatnam during the period January to May.

Flying-Fishes—The special survey for flying-fish fisheries carried out along the Coromandel coast showed that only 325 tons of them were landed during this season, which was consequently poor. The fishery commenced in the last week of May and ended in the first week of July. Low catches are partly accounted for by the adverse winds which resulted in fishing fleets being blown out to the open sea off Madras, the fishermen being saved only by the intervention of the Navy.

24. The seasonal variation in the fishery at each place was studied from the total monthly catch at each place and also from the return per man-hour, calculated for each month at each centre. The following interesting features were noticed. At Gopalpur, although the catch was higher between January and March than in other months, the return per man-hour was higher in May and June. This was due to the fact that in May and June the number of fishing units engaged in fishing operation was small but they had good returns of *Hilsa* spp. The heavy catches during January to March were due to the operation of larger number of fishing units. The higher return per man-hour at Lawson's Bay during January was due to good sardine fishery, and that at Adirampatnam during January and February was due to the appearance of shoals of *Arius* spp. Owing to a general failure in fisheries, the return per man-hour was low up to May at Vizhingam. From May to August there was good *Trichiurus* fishery and a higher return per man-hour. The incidence of mackerel fishery yielded better returns per man-hour during November, December and January at Karwar. Similarly, the appearance of *S. longiceps*, *R. canagurta* and *Cynoglossus* sp. will explain the higher return at Calicut in January, February, May, June, August, September, November and December.

FISHERY BIOLOGY

25. *General Fishery Conditions in the Mandapam Area*—There was a marked fall in the fish landings around Mandapam during the period under report, although the fishing effort in terms of the number of boats and men engaged remained practically the same as during last year. The Clupeoid (*Choodai*) fishery, as before, was dependent mostly on the juveniles (0-year class) of *Sardinella albella* and *Sardinella gibbosa*. As compared with previous years, there was a pronounced scarcity of these young fishes, and the catches dropped far below a profitable level. The extent of this decline can be gauged from the fact that for shore-seines, the catch-per-boat during this year was only about 8 tons, whereas during last year, which itself witnessed a poor sardine season, it was about 17 tons. Mackerel formed only an insignificant proportion of the catches of the Gulf of Mannar coast during this year. Shore-seine operations that landed more than 150 mackerel during a single haul, were exceptional. Night catches showed a tendency to be more profitable than daylight catches. The major length-group of mackerel exploited by the fishery was 22–23 cm. The *Hemirhamphus* fishery began about the middle of March 1954 and continued into the next month.

26. *A Fishery Survey of Rameswaram Island*—Study of the fishery resources of Rameswaram Island started last year was continued. During the year under review, analysis of data collected during the year 1953 was completed. Nearly 1,700 tons of fish was landed on the Island during 1953. A total of 30 species comprised the catch, but the species which contributed to the bulk of the fishery were silver-bellies (*Leiognathus* spp.), seer-fish (*Cybium* spp.), silver-bars (*Chirocentrus dorab*), sharks, and sardines (*Sardinella gibbosa* and *Dussumieria hasselti*). The percentage yield of the various species was as follows:

		%
<i>Leiognathus splendens</i>	.. ..	52.59
<i>Cybium guttatum</i>	.. ..	15.84
<i>Chirocentrus dorab</i>	.. ..	6.15
Sharks	.. ..	5.68
<i>Sardinella gibbosa</i>	.. ..	5.29
<i>Dussumieria hasselti</i>	.. ..	3.23
<i>Caranx</i> sp.	.. ..	2.94
<i>Lactarius lactarius</i>	.. ..	2.92
<i>Gerres filamentosus</i>	.. ..	1.76
<i>Hemirhamphus georgii</i>	.. ..	0.98

	%
<i>Therapon quadrilineatus</i>	0.76
<i>Sillago sihama</i>	0.55
Cat-fishes	0.34
<i>Rastrelliger canagurta</i>	0.31
Others	0.66

27. *Clupeoid fishery*—The growth of the young *Sardinella gibbosa* and *S. albella* contributing to the *Choodai* fishery was studied by the length-frequency method. The shift in the position of the modes from month to month was taken to represent the rate of growth of the juveniles. The growth was found to be rather rapid from May to September and to slow down considerably thereafter. The rate of growth was higher during 1953-54 than during 1952-53. The two species of *Sardinella* appear to spawn from February or March to June or July. The young fish were found to have fed (from May to August) largely on copepods; *Microsetella rosea* figured prominently in the list of organisms identified in the gut-contents. The catches of sardines were definitely better during the waning periods of the moon than during the waxing periods. Though the catches were generally better when copepods were more numerous in the plankton, a strict correlation between the two does not seem to exist. Further work on these aspects is in progress.

28. *Dorab fishery*—Studies on various aspects of the biology of *C. dorab* were in progress and were continued mainly with a view to checking some of the results already obtained. Size-frequency distributions of *C. dorab* indicate that the young dorab of the 0- and 1-year classes migrate into inshore waters in small numbers from July up to January, although they do not form a significant part of the dorab fishery. The movement of modes representing the other year-classes was studied in detail with the help of the size-frequency distribution graphs for April 1953 to March 1954. Observations on some general aspects of the biology of *C. dorab* were published. A study of the vertebral counts in *C. dorab* collected from its landing places around Mandapam has not yielded any conclusive results regarding the occurrence of more than one species or race. It is proposed to collect material from fish landing places along the west coast, and to correlate the data on morphological differences (if any) with variations in the vertebral counts, in the hope that new data will become available on the question whether more than one race of this fish is involved in the Indian dorab fishery.

29. *Sharks and Rays*—In the earlier quarters of the year under review, the programme of work covering the detailed investigations on the shark fisheries of the Rameswaram Island was being followed. Data were gathered on fishing methods, fishing season, fishing grounds, principal landing grounds for elasmobranchs, the chief species obtained, details of their utilization, and economics of the industry on Rameswaram Island. The fishing season in Palk Bay commenced in April 1953 but the total boat-seine landings of the first three months were less in the aggregate than in the corresponding period of 1952. The reduced landings could be ascribed partly to the cholera scare in May which resulted in poor fishing activity, especially gill-net operations, and partly to the stormy weather from April to July which caused repeated interruptions in fishing operations and reduced the number of days of fishing. The hook-and-line catches were fairly good at Rameswaram, consisting mainly of species of *Carcharhinus*, *Scoliodon*, *Trygon* and *Stegostoma*. Bag-net catches at Thangachimadam showed a predominance of *Pristis cuspidatus*. Studies on the systematics of sharks and rays were proceeded with and the keys for the field-identification of elasmobranchs were revised. A new species of *Hypoprion* was discovered (to be described in due course) and an abnormal specimen of the common skate, *Rhynchobatus djeddensis* was obtained from the shore-seine catches on the Palk Bay side of Dhanushkodi. During the last quarter of the present year the Assistant Research Officer (Sharks and Rays) was away in the U.S.A. having been deputed by the Government of India to undergo advanced training in the fisheries laboratories of the Pacific Coast of North America.

30. *Offshore Fisheries at Bombay*—The present year witnessed the opening of the Offshore Fisheries Research Unit at Bombay and the initiation of a comprehensive programme of investigations on the biology of the major species occurring in the trawl catches brought by the vessels operating from the Government of India Deep Sea Fishing Station. The catches of the Japanese Trawler, "*Taiyo Maru 17*", from the fishing grounds north of Bombay, were also subjected to detailed examination. Fourteen voyages were made by this trawler from the commencement of operations in September 1953 to the end of March 1954, the vessel staying out at sea for an aggregate of 172 days. The areas fished ranged in depths from 24 to 48 metres. While in the earlier months the operations were confined to the area nearer Bombay, they were extended in the later months to the Gulf of Cambay, to the area off Veraval on the Kathiawar coast and finally to the Gulf of Cutch. The analysis of the fishing operations is given in the Table below. It may be pointed out here that during all the operations in the Gulf of Cambay area, a fairly high percentage of fish—mostly rays and

Monthly Summary of the Fishing Operations of the Taiyo Maru 17
 Voyages 38 to 50 — September 1953 to February 1954

		Sept. 1953	Oct. 1953	Nov. 1953	Dec. 1953	Jan. 1954	Feb. 1954
		<hr/>					
Total No. of hauls ..		2	10	..	..	..	..
		<hr/>					
I Bombay Region Areas 43-31	Total No. of fishing hours	H.M. 540	H. M. 33 50	..	..	..	..
	Total catch in lb. ..	1,450	11,100	..	..	..	..
	Catch per hour in lb. ..	255.9	327.9	..	..	..	..
	Total No. of hauls ..	88	131	12	..	..	..
		<hr/>					
II Gulf of Cambay Region Areas 26-11	Total No. of fishing hrs.	H.M. 30755	H. M. 447 30	H. M. 42 55	..	..	..
	Total catch in lb. ..	187,500	161,000	10,700	..	..	..
	Catch per hour in lb. ..	644.0	352.3	233.6	..	..	..
	Total No. of hauls ..	11	..	1	..	..	2
		<hr/>					
III Kathiawar Coast Area 3	Total No. of fishing hours	H. M. 38 40	H. M. ..	H. M. 3 55	..	..	..
	Total catch in lb. ..	32,580	..	850	..	..	..
	Catch per hour in lb. ..	842.5	..	217.0	..	..	..
	Total No. of hauls ..	..	..	94	129	95	89
		<hr/>					
IV Gulf of Cutch Region K, L, M & N	Total No. of fishing hours	..	..	H. M. 335 00	H. M. 456 00	H. M. 323 15	H. M. 308 40
	Total catch in lb. ..	..	..	234,550	234,550	195,000	71,000
	Catch per hour in lb. ..	..	..	663.2	513.5	603.6	539.2

cat-fish and a few Dhoma (small sciaenids)—were thrown out as commercially unacceptable. In area 3, off Veraval, although relatively fewer hauls were made and the "rejects" formed a fairly high percentage, the catch per hour was found to be very good. There were negligible "rejects" in the Gulf of Cutch operations.

Studies on the biology of the *Ghol* (*Sciaena diacanthus*) and the *Khot*, [*Sciaenoides biauritus* (?)] have been initiated. Several individual-haul samples were examined during three of the voyages of the M.V. *Taiyo Maru* for length-frequency, sex-distribution and state of sexual maturity. Landings of this trawler and also of the cutters M.V. *Ashok* and M.V. *Pratap* were examined, and biological data on these two species were gathered. Very interesting observations have emerged regarding the occurrence of sciaenids in all the grounds, the percentage of sciaenids in the catches, the percentage of juveniles in the total catch of each species, the dominant size of the bigger *Khot* and *Ghol* and also the possible occurrence of a partial segregation of the sexes in the two species. Scale-studies are being attempted and the size-distribution figures are being worked out and analysed.

The heavy landings of eels by trawlers operating in Bombay waters indicated the importance of the scientific study of the *Wam*: consequently detailed investigations on the biology of the eel, *Muraenesox talabonoides*, have been started. The size-frequencies of the eels in the trawl catches, their distribution according to localities and seasons, their time of maturity and breeding season, food and feeding habits, growth, etc., are all being studied. The polynemids constituting the *Dara* fishery are also of great importance in view of their dominance in the trawl catches, and detailed investigations on their biology have also been initiated.

31. *General Fishery Conditions on the Malabar Coast*—The salient features of the fishery along this coast during the period under consideration, were the distinct improvement in the oil-sardine landings compared with the previous year, and the almost complete failure of the mackerel fishery. The mackerel were caught intermittently in small quantities during the post-monsoon fishing season. The oil-sardine landings were greater in North Malabar than in South Malabar. From reports received, it was also a good fishery on the North-Travancore coast. During the summer months of April and May the fishery was mainly miscellaneous in character comprising soles, sciaenids and prawns. Occasionally, good catches of the cat-fish, *Arius dussumieri*, and the black pomfret, *F. niger*, were obtained. During the monsoon period the whitebait, *Anchoviella tri*, was abundant in the commercial catches. The silver-belly, *Leiognathus splendens*, was

practically absent in the commercial catches but for a brief period in August. The fishery for the sole, *Cynoglossus semifasciatus* was also poor. During August-November fair quantities of sharks, rays and cat-fish were landed by line fishermen. During July and August some intermittent but good catches of mature oil-sardines (about 19 to 22 cm. in size) were obtained along the Calicut coast which gave place by September to juvenile oil-sardines (about 10 to 12 cm. in size). By the middle of October the juvenile oil-sardines disappeared from the fishery. Larger sardines of size 15 to 16 cm. and 21 to 22 cm. occurred abundantly at Calicut towards the close of November for a brief period, after which only small quantities of them were intermittently recorded till the close of the season. During January to March the fishery was mostly miscellaneous in nature comprising a few clupeids, soles and prawns. In February a heavy catch of the cat-fish, *Arius dussumieri* was obtained at Calicut and at other centres. The analysis of the fish collections from the 8 fathom region off Calicut was continued during the earlier half of the period. The collections were analysed for total weights, weights of individual species, sizes, and sexes. It was seen from this investigation that the trend of the fishery in this region was similar to that of the regions closer to the shore. No significant difference could be made out either in the composition of the catches or the period of the fishery. Complete enumeration of fish landings at Calicut was carried out for a period of six months from October 1953 to March 1954 and this investigation has yielded valuable data on the trend of the commercial fishery at Calicut. Detailed studies of the food of inshore fishes were carried out during the period under report.

32. *Biology of sardines*—In the earliest months of the year under review, the appearance of oil-sardine shoals was erratic and very poor catches were registered during April and May. Thence fishery showed steady improvement, and by the beginning of June the first large shoals of sardines approached the coast and the 1953-54 fishing season had begun. The noteworthy feature this year was the appearance of the shoals even before the onset of the monsoon which began in the middle of June. The plankton collections of the pre-monsoon days of the month showed an abundant occurrence of diatoms, the increase of which was probably caused by the monsoon which was already active along the southernmost region of the coast. The relation between the early approach of the sardine shoals towards the coast and the early appearance of diatom blooms in coastal waters is noteworthy. The catches were exceptionally heavy on the 19th and 25th of June, comprising mature adults ranging in size from 17 to 20 cm. with a modal size of 18.5 cm. Examination of their stomach contents showed

that *Thalassiothrix frauenfeldii* and *Fragilaria oceanica* formed the main food. These mature sardines dominated in the catches of July and August, although the fishery was not uniform or steady. The second week of September showed an abrupt change in the composition of the catches, the adult stock disappearing entirely from the fishing grounds and a new stock of juveniles entering the grounds in enormous numbers. The latter formed the bulk of the fishery for two weeks with exceptionally heavy landings on all the days. This new stock of one-year-old sardines was composed of indeterminates with sizes ranging between 7 and 13 cm. and the modal size also fluctuating between 9 and 11 cm. The food of these juvenile sardines was found to be composed mainly of *Nitzschia pelagica* and *Fragilaria oceanica*; the approach of these shoals of juvenile forms towards the coast could be related to the abundant occurrence of the latter species of diatom in the coastal waters at this time. Heavy catches of these juvenile sardines were recorded along the Calicut coast during the early half of October after which they became scarce. In the third week of November heavy landings occurred once again, comprising individuals of two distinct size-groups, 15 to 16 cm. and 21 to 22 cm. The oil sardine fishery declined in Calicut after this spell, although heavy shoals continued to be reported from North Malabar. In the first months of 1954 the principal sardine investigator was away in the United States on deputation, but the maintenance of records on sardines was continued by interim arrangements.

33. *Biology of the anchovy, ThriSSocles mystax*—The fishery of the anchovy, *ThriSSocles mystax* was generally a failure along this coast during the year. There has been a general decline of this fishery during the past few years. The total landings of the anchovies from July 1953 to February 1954 was only 1,300 maunds. The trend of the fishery during the year was more or less the same as in the previous years. During April and May good numbers of post-larval and juvenile anchovies were obtained from the inshore collections. But for a brief period in July, the catches of this fish were generally poor during the monsoon months. During the post-monsoon period its occurrence was intermittent, small quantities being obtained along with adults and juveniles of *Sardinella fimbriata* and *Dussumieria hasseltii*. Specimens showing advanced stages of maturity appeared by September 1953 and continued to occur till March 1954, by which time most of the specimens examined were immature.

34. *General Fishery conditions at Karwar*—The recording of observations on general fishery conditions, besides observations on the mackerel fisheries, was begun in July 1953.

During the time of the south-west monsoon, from July onwards, the fishing operations at Karwar were confined to inshore waters, and only shore-seines and cast-nets were operated. When weather permitted, the range of operations was extended up to two or three miles from the shore when the drift-net also was brought into use. The commonest fishes in the July catches were *Otolithus*, *Opisthopterus*, *Sciæna* and *Engraulis*. In the succeeding months, *Lactarius* and *Cynoglossus* also figured prominently in addition to above species, but *Sciæna* became scarce towards the end. In August and September, the boat-seines, *maribale* and *chitbale* were also operated in addition to the cast-nets which were in use throughout the period. Except for the first half of October when fair catches of cat-fishes, silverbellies and sardines were obtained, the quarter from September to December was poor in general fisheries and the use of boat- and shore seines and cast-nets was replaced by the Rampan operations for mackerel which extended into January and February. *Pattebale* and *yendi* were employed again in March 1954 and the catches for the month included *Cybium* sp., *Chirocentrus dorab*, and *Equula* sp.

In January 1954 about 95,000 mackerel (19,000 lb.) were landed. The total number of pieces of Rampan nets in operation was 8,940 and the catch per piece (with an average area of about 324 sq. ft.) worked out to 111 mackerel. In January, 18 Rampan hauls were taken but the fishing days numbered only 11. In February, the total catch was 76,000 mackerel (15,200 lb.). The total number of pieces of Rampan net in operation was 2,600, and the catch per piece of Rampan net was 29 mackerel. In this month there were only 6 fishing days and 6 Rampan hauls. In March the Rampan net was operated for one day only, on the 3rd, and the total landings of mackerel in two hauls were 24,700 mackerel (4,940 lb.). The total number of pieces operated was 1,000 and the catch per piece was 24 mackerel.

35. *Mackerel Fishery*—The mackerel season started at Karwar in the first week of November 1953 and closed in the first week of March 1954. The total mackerel catch during the season was 1,203.5 tons. The peak period of the fishery was in November 1953 when the maximum monthly catch was recorded. The relative intensity of fishing was the highest during December 1953. The dominant size-class for this season was 19.5 cm. The monthly average lengths of mackerel for different months of the season were as follows: October 1953—18.06 cm.; November—18.89 cm.; December—19.40 cm.; January 1954—19.38 cm.; February—19.61 cm.; and March—19.71 cm. The average length of mackerel for the entire season was 19.5 cm. The number of mackerel measured for dominant size class during the present season was 5,826.

The results of mackerel work done so far at Karwar are being consolidated for publication.

36. *Prawn Fisheries at Narakkal (Cochin)*—The paddy-field fishery of last year ended on 21-4-1953 and the total yield from the one-acre field amounted to 716 lb. as against 485 lb. in 1951-52. The experiment in prawn culture, of capturing fry from the canal and planting them in the smaller field, yielded the rather poor total of about 175 lb. per acre; but valuable data on their growth, especially that of *Penaeus indicus*, have been collected. Some variation from the normal method was introduced in the paddy-field operations of the year under report, with the object of allowing a period of 4-6 weeks for the prawns, especially the fry, to grow, care having been taken to retain the latter in the field every time water was let out, by using a cloth screen in combination with the bamboo grating. Fishing was done twice, capturing a total of about 275 lb. Until the full results of the fishing of this year are known, a comparison with the catches of the two previous years will not be possible. With the two years' observations on the marine fishery it is possible to draw inferences regarding the best months for each species. July, August and September are the months when the largest numbers of *P. indicus* are captured, while in April and May *Parapenaopsis stylifera* occurs abundantly. *Metapenaeus dobsoni* forms a good portion of the catches in all months from April to September. In regard to the studies on the biology of prawns, a re-examination of the data on *M. dobsoni* collected during the last four years was undertaken during the year under report with a view to gathering further facts regarding its growth, migration and some other aspects of its bionomics. These, together with the observations made on its fishery, have been set down in a brief paper for publication. From November, a more intensive study has been started on the biology of *P. indicus*, since the observations made hitherto have been found to be not quite adequate.

A quantitative study of the plankton was undertaken this year in order to determine the relationship, if any, between the remarkable variations in the salinity of the canal water and the appearance and numbers of the various groups of planktonic organisms, especially of prawn larvæ.

37. *Molluscan fisheries at Madras: Observations on Oysters*—Seasonal gonadal changes in the adults of the Indian backwater-oyster were studied during the course of the year. For this purpose regular collections of oysters from Ennore and Adyar backwaters were obtained. Water samples were analysed and temperatures, as well as pH values, were recorded. The proportions of the sexes in each sample were also observed. The gonads

Tabulated Observations on Ostrea madrasensis in 1953-54

	Summer period April to June	Pre-monsoon period July to September	Monsoon period October to December	Post-monsoon period January to March
Salinity	34.2‰ to 37.9‰	Mostly 37.9‰ in Sept. 25.2‰	Commencing with 25.2‰ falling to 10‰ or 4.6‰	25.2‰ to 31.6‰
Temperature of water	29.5° C. to 32.0° C.	Mostly 30° to 32° C. falling in Sept. to 29° C.	From 29.0° C. fall- ing to 26.5° C.	25.7° to 29° C.
pH	8.2 to 8.4	8.2 to 8.4	8.2 to 8.8	8.1 to 8.7
Sandbar (Adyar river)	Closed	Closed	Open	Closed
Percentage of:				
males	59.6	37.8	46.5	50.77
females	38.6	54.6	53.5	42.00
hermaphrodites	1.7	1.5	0.3	1.56
indeterminates .. ..	..	5.8	1.24	5.40
Gametogenetic activity	Follicles far from full	Commences and reach- ing its peak (Earlier in ♂ than in ♀)	Full to spawning to partially spent	Second peak of in- crease followed by diminution

of the oyster have been observed to undergo pronounced seasonal changes. Taking the sum-total of observations on the histological changes and the fluctuating environmental conditions, it has been found convenient to divide the year into four periods as shown in the table on page 396. Based on these studies, it is found that the oysters are at their best from March to June and in September–October. The main spawning season being November–December. It has been observed that in the east-coast backwaters and estuaries this oyster has a supplementary spawning period during March–April, which may not always be effective.

Studies on edible clams.—Studies on the growth and breeding of the wedge clam, *Donax cuneatus*, started in February 1952, were completed during the course of the year. It was observed that spawning commenced in January and lasted till about April. The young ones which settled on the beds from about February grew to the adult size of about 14 mm. by November and merged with the older clams. Most clams seem to die after attaining an average length of 19 mm., when they are in their second year. The length-breadth, length-thickness and length-weight relationships were studied. Mortality of the adult clams was very high during the periods of October–November and June–July, which were preceded by the highest salinity and temperature conditions of the inshore waters respectively. Cessation of growth is indicated by the presence of a ring on the shell which seems to have been formed during unfavourable conditions of salinity in November–December, when they are nearly one year old. There seems to be a correlation between the extent of zones on the shells and variations in temperature during the course of the year. Studies on the seasonal gonadal change in *Meretrix casta* were commenced in October 1953 with a view to finding out the suitable size limits, seasons of fishing for clams and seasons for closing the natural beds, as a precautionary measure to avoid undue exploitation. Samples of clams from the Adyar Estuary were being examined regularly for this purpose.

MARINE INVESTIGATIONS

38. *Plankton Studies at Mandapam*—A comparative study of the plankton characteristics at two inshore stations, one in the Gulf of Mannar and the other in the Palk Bay, revealed the following general features: (1) The fluctuations in the net-plankton volumes were greater in the Gulf of Mannar from month to month, and during several months the standing crop was relatively lower in the Gulf. (2) The phytoplankton cycle in the Palk Bay appeared to be unimodal, whereas in the Gulf of Mannar it showed more than one peak. Judging from the relative standing crop of phytoplankton

the total annual production in the Palk Bay was of a distinctly higher order. The abundance and succession of many species of diatoms showed differences in varying degrees between, and within, stations. *Trichodesmium erythraeum*, found in large numbers especially during summer months in the Gulf of Mannar, was relatively scarce in the Palk Bay. From both the stations the same species of Dinophyceæ were collected but greater numbers of individuals were seen in the Palk Bay collections. Dinophyceæ showed two maxima, the primary one being in the summer months. (3) The distribution pattern of total zooplankton for the two stations differed widely from one another. A comparatively richer zooplankton was characteristic of the Palk Bay during several months. A concentration of several species of Hydromedusæ and the regular appearance of certain species of Scyphomedusæ were observed during the summer months. Distinct differences were noticed in the time of occurrence of chætonath maxima. The copepods showed a dicyclic distribution in the Gulf as against a unimodal one in the Palk Bay. The total annual copepod population in the Palk Bay was only three-fourths or slightly less than that of the Gulf of Mannar. A study of the planktonic invertebrate larvæ of this area showed that the breeding season of the invertebrates may be classified into three types. (1) Protracted breeding extending over several months or the whole year but with smaller intensive period or periods distinctive of the group. (2) Breeding restricted to some definite part of the year. (3) Discontinuous breeding occurring almost throughout the year, breeding taking place at irregular intervals with periods of quiescence in between. No instance of continuous breeding at a uniform rate has been observed so far, and the study has indicated the possible relationship between phytoplankton production and the larval maxima, the latter corresponding somewhat with periods of abundant phytoplankton production.

39. *Chemistry of Sea-Water at Mandapam*—The analyses of water samples from the Gulf of Mannar and Palk Bay for salinity, dissolved oxygen, phosphates, etc., were continued but no major departures were observed from the values recorded for the earlier years. Minor shifts from the previous year's peaks were observed in regard to the salinity maxima, and values were a little lower than in the last year in regard to dissolved oxygen and phosphates.

40. *Hydrology of Bombay Waters*—Investigations on the distribution of temperature and salinity in the surface waters of the offshore fishing grounds of the Gulf of Cambay and Gulf of Cutch were commenced in September 1953 after the close of the south-west monsoon. Collections of water samples and essential data were made on board the *Taiyo Maru 17*

during every fishing cruise. For the period of six months, 120 samples of water were analysed. It should be feasible to draw inferences from the accumulated data when work has continued over a longer period of time. For the present it might be said that the values for salinity in the Gulf of Cutch appear to be higher than the values for the Gulf of Cambay and this is probably to be attributed to the absence of any major rivers flowing into the former, whereas the Narbada and the Tapti rivers flow into the latter.

41. *Hydrological and Planktological Studies at Karwar*—Work on the plankton and hydrology of Karwar waters with a view to correlating the results with the mackerel fishery of Karwar was started by the end of November 1953.

42. *Hydrological Studies at the Calicut Sub-Station*.—There was very little difference between the temperature of surface sea-water and the temperature of air, as seen from a comparison of monthly mean values. The values for the former, however, were slightly higher compared with the previous year. Salinity fluctuations were similar to those of earlier years; the variations in the salinity of the bottom water were not so sharp as those of the surface layers. There were fewer instances of oxygen saturation this year. From the low values prevailing in April, the phosphate values reached a peak in June; in the succeeding months the values were oscillating at a lower level. Nitrate estimations were carried on, except for some interruptions. Silicate-content remained unusually high this year and the probable reasons are being explored.

43. *Phytoplankton Studies*—During the year under report, work on the quantitative, qualitative, taxonomical, ecological and life-history aspects of phytoplankton was in progress. The most interesting observation this year was the sudden drop in the quantity of phytoplankton from September onwards, lasting till November. This may have been caused by the lack of one or more of the essential nutrients acting as a limiting factor. The peak in the occurrence of phytoplankton was in August, and November recorded the poorest catches. Occasionally, there were some correlations between a diminution in the quantity of phosphates and silicates and a sudden increase in the quantity of phytoplankton. The constitution of the flora showed a resemblance to that of 1949–50. Several species showed auxospore-formation, of which the observations on *Fragilaria oceanica* are interesting and noteworthy. This species appeared to have a cyclical occurrence as regards abundance, which perhaps has an influence on the oil-sardine fishery. Some tentative views on the cycles of the sardines in relation to the cycle of *Fragilaria* have been put forward. Experiments were conducted in order

to study the "infection" of *Noctiluca* by *Protoeuglena noctiluca*. An account of this flagellate has been published. The paper on *Hornellia marina*, the chloromonadine flagellate, which affects marine organisms adversely, has also been published. Work on the compilation of the data collected so far has progressed further.

44. *Ecological Investigations at Quilandy Bay*—During the year under review, investigations were started on the ecological conditions of the Quilandy Bay (an important fishing centre of the Malabar coast) with special reference to fish and fishery fluctuations, with a view to understanding the probable reasons for its support of a continuous and extensive fishery. Field data on fish catches, plankton, hydrology and bottom fauna were collected and analysed. The bay supported a fairly good fishery of immature oil sardines during September to November along with moderate catches of cat-fishes, soles and prawns. The plankton fluctuations were found on examination comparable to conditions of the Calicut coast, but the displacement volumes remained much higher, indicating higher productivity. The bottom fauna got stabilised by November and was rich in post-larval and adult polychaetes, bivalves, amphipods and post-larval crustaceans, which are important items of food for bottom feeders, especially *Cynoglossus*.

PHYSIOLOGY

45. During the year under report, work was continued on the physiology of respiration in *Chanos*. The exponential relationship between the number of fish that can be transported and the time of survival of the fish in limited volumes of water was in reasonable agreement with similar relationships described for other species by workers in Indonesia. Metal containers, more handy and convenient than those in current use, were employed with advantage in the transport of fish fry. Narcotics at standardised concentrations were successfully used for the measurements of length and weight of live fish without injury to the fish. The response of fish to narcotics was found to be influenced by the addition of thyroid preparations to the water in which the fish were kept. Work was completed on the application of paper chromatography to the separation and estimation of physiologically important ions (sodium, potassium, sulphate), and on the extension of the chromatographic technique to the differentiation of species among sardines.

In 1953-54 the period of *Chanos* fry collection at Pamban lasted for nearly three months. Observations made so far have indicated that there might be some relationship between the abundance of fry during the different days of the season and various factors like tides, rainfall, etc. Some data have accumulated in this direction and analysis will be carried out before

drawing definite conclusions. The secondary season for fry during this year (1953-54) was a failure. Judging from observations made along the coast it seems probable that a connection between the lagoons and the Palk Bay during March-June would help in enhancing the fry resources of this area. Mature male and female *Chanos* were obtained for the first time from the fishing village at Puthumadam on the Gulf of Mannar coast. Large numbers of lamellibranchs and some gastropods besides algal matter were noticed in the stomach contents of these fish. This is somewhat contradictory to existing information that the fish is mostly a vegetable feeder. A full account of observations carried out here and elsewhere on *Tilapia mossambica*, with particular reference to its suitability for culture in Indian waters, was drawn up and published. A preliminary series of experiments on the fry of this fish was conducted to study the endocrine physiology of the fish.

BACTERIOLOGY

46. Studies on the bacterial flora of the inshore environment were continued. A three-year seasonal survey of the Palk Bay station was completed. Bacteria were present in the sea-water to the extent of a few hundred per ml., the water from near the bottom contained fewer bacteria than the surface water. The bacterial population tended to be relatively high during July-December. Nitrifying, denitrifying, sulphate-reducing and agar-digesting bacteria were usually present in the sea-water and/or muds. Bacterial counts of the muds ranged from 2.6×10^4 to 2.2×10^7 per gram, usually being below 10^6 per gram. The majority of the mud bacteria were aerobes as indicated by low anaerobic counts. Bacteria in association with plankton were of the order of 10^4 to 10^6 per ml. Studies on the spoilage of fish were carried out, preliminary to an investigation of the quality of fish preserved in cold storage under commercial conditions. The course of spoilage was followed by bacterial counts and determination of the trimethylamine and total volatile nitrogen content of the fish muscle, up to the stage when organoleptically detectable spoilage set in. The duration of the period of storage at 2° C. to 5° C. till the spoilage threshold was reached, varied in the different samples from less than two weeks to over six weeks. A number of bacterial strains were isolated from seer, mullet, pomfret and dorab. Micrococci, aerobic spore-forming rods and gram-negative asporogenous rods were present. The kinds as well as the numbers of bacteria present probably influence the condition of the fish. Further work on these lines is in progress. In continuation of previous work a pilot scale production of protein hydrolysate from fish, mainly *Sardinella* sp., was carried out and

satisfactory results were recorded. Further investigation is necessary for standardising the conditions for obtaining the maximum yield of a high grade product.

ALGOLOGY

47. During the year 1953-54, possibilities of seaweed utilization were investigated and it was possible to finalise various processes on cottage industry lines, as follows:

- Agar manufacture from *Gelidium micropterum*;
 - Agar manufacture from various species of *Gracilaria* of the Indian coast;
 - Agaroid manufacture from *Hypnea*, *Spyridia* and *Sarconema*;
 - Cattle and poultry feeds from seaweeds;
 - Seaweed meal for use in preparation of conji, porridge, puddings, etc.
 - Seaweed glue from residues of agar manufacture;
 - Cattle and poultry feed from residues of agar manufacture;
 - Compost manure from algæ washed up in quantity at certain seasons;
 - Field experiments to show the value of seaweed compost in the case of vegetable crops.
- A pamphlet on seaweed utilization is being prepared for publication.

CENTRAL MARINE FISHERIES RESEARCH
STATION, MANDAPAM CAMP,
November 3, 1954.

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