

**GOVERNMENT OF INDIA, CENTRAL MARINE
FISHERIES RESEARCH STATION, MANDAPAM
SOUTH INDIA**

**ANNUAL REPORT OF THE CHIEF RESEARCH OFFICER FOR
THE YEAR ENDING 31ST MARCH 1953**

ADMINISTRATIVE AND GENERAL

ALL-round progress in the research programmes of the Central Marine Fisheries Research Station at Mandapam and its subordinate establishments has been maintained during the year 1952-53. These relate to (1) study of marine fishery resources of the country; (2) biology of commercially important groups of marine fishes; (3) introductory studies on salt-water fish farming; and (4) general marine biological studies relating to production of life in the sea. The sardines and the mackerel, which constitute important fisheries of our coasts, received special attention at the Calicut and Karwar Centres. The Prawn Research Unit near Cochin initiated studies on the scientific aspects of prawn farming as prawns form a major fishery in the Travancore-Cochin area. A Research Unit for carrying out investigations on the valuable Molluscan Fisheries in the environs of Madras has been opened in Madras in December 1952. In view of the fact that Bombay is developing as a deep sea fishing centre, arrangements are well on hand for starting an Offshore Fisheries Unit at Bombay. As a beginning in this direction a Survey Assistant has been posted in Bombay to work with the deep sea fishing vessels and he has collected some very useful biological and statistical data on marine fish catches made by the deep sea fishing vessels. Particular attention was paid to the popular table fishes Ghol (Sciænid), Dara & Rawas (Polynemids) and the Wam (*Murænesox* sp.). These trawl fishes constitute more than 50% of the catches made by the deep sea fishing vessels. The compilation and tabulation of data relating to catches made by the cutters "Ashok" and "Pratap" during 1949-50 and 1950-51 were continued.

2. The Fishery Survey work carried out by the Research Station up to the end of 1952 consisted of zonal estimates of production computed at the Headquarters from landings in representative centres reported by the Survey Assistants. From the beginning of 1953 this survey programme has been given a new orientation which lays greater emphasis on the pattern of fish stocks in the zones and at selected centres rather than on making

estimates of landings. This followed an administrative decision taken by the Government. Survey Assistants have therefore been posted at selected observation centres where continual study will be kept up of the trend of annual changes in fisheries and the fluctuations which are likely to affect the total yields. As a preliminary to taking up work on the new lines, the Survey Assistants were given a refresher course for a period of ten days at the Headquarters Station in June 1952. The total landings of marine fish in India for 1952 have been computed at 525,542 tons as compared to 525,482 tons in 1951.

3. Experience in other countries seems to indicate that the Cichlid fish *Tilapia* has possibilities of proving to be a very useful fish for culture in India. While fisheries experts in some of the South-East Asian countries, who were consulted, hold the view that this prolific and fast growing hardy fish might turn out to be useful for introduction in natural waters, very strong doubts have been expressed by others whether this species would prove harmful to our indigenous carps and coastal prawns, etc. An experimental consignment of *Tilapia* has been obtained from Thailand and special observations have been made on their feeding habits, breeding, etc., in experimental tanks and aquaria in this Research Station. This is the first introduction of this fish to Indian waters (August 1952). Some interesting results have been obtained and it is proposed to carry out studies on this remarkable fish on a more extensive scale.

4. Investigations on sea weeds occurring on Indian coasts have opened up the possibilities of producing high quality manure and cattle feed from them. Their usefulness in the preparation of human food and industrial products has also been indicated by laboratory experiments. At the request of several educational institutions, in particular the Madras Government Museum, exhibits of economically important algæ were supplied.

5. One of the principal difficulties experienced by the staff of the Research Station at Mandapam was the absence of facilities for medical treatment for themselves and their families. As a result of negotiations carried out by the Government of India through India High Commission in Ceylon, the Ceylon Government have agreed to make available to the staff of this Research Station and their families the facilities of their Hospital at the Quarantine Camp at Mandapam. This arrangement has been in force since April 1952 and has been working satisfactorily.

6. By erecting a transformer and the necessary transmission lines, power supply from the Pykara-Papanasam h.t. lines has been taken over from August 1952 which now ensures an uninterrupted supply of energy

at a cheaper cost than by working Diesel generating sets. An agreement embodying the terms of power supply will shortly be concluded with the electricity licensees. Gas supply from the existing gas plant has been extended to a few more laboratories by extending the pipe lines. A small breakwater has been constructed during the year and some minor additions and improvements were made to the temporary residential quarters in addition to the construction of a few tube-wells for augmenting freshwater supply to the campus. A centrifugal pump for the sewage system has been installed. Some further progress has been made in the completion of work relating to the sea-water circulating system for the Aquarium.

7. A row boat for inshore plankton collection and an absorptiometer have been acquired during the year in addition to the purchase of essential requirements of chemicals, glassware and other equipment. Better preservation and display of specimens and other exhibits in the Museum room have been made possible by the acquisition of about a dozen museum show-cases and exhibition tables. Valuable additions have been made to the library. Special mention may here be made of a complete set of the very valuable serial publication *Treubia* presented to the Research Station by the Bibliotheca Bogoriensis, Bogor, Indonesia.

8. For the implementation of the Planning Commission's recommendations for expansion of Fisheries Research the Government of India have allotted a grant of about Rs. 10 lakhs for this Research Station under the Five-Year National Plan. This has enabled the Station to plan and initiate some of the programmes originally contemplated but held up so far for lack of funds. The acquisition of a Fishery Research Vessel, a Fish Van and the starting of an Experimental Marine Fish Farm at Mandapam are the more important items included under the expansion programme. The fish transport van has already been acquired.

9. The staff sanctioned during the year under the Five-Year National Plan includes one post each of Assistant Research Officer (Oceanography), and Assistant Research Officer (Marine Biology), three posts of Research Assistants, one post each of Statistical Assistant, Survey Assistant, Head Clerk, and Store Keeper and a few Class IV personnel. Shri T. Joseph, Stenographer to the Chief, has been promoted as Head Clerk. Steps have been taken for filling up the new and vacant posts.

10. Shri P. C. George, who was working as Research Assistant at the Calicut Sub-Station, was appointed as Assistant Research Officer (Ecology), from 12-12-1952. Shri D. M. Punwani and Shri M. G. Dayanandan were appointed as Survey Assistants.

11. Dr. N. K. Panikkar, the Chief Research Officer, represented the Government of India at the 4th Meeting of the Indo-Pacific Fisheries Council held at Manila (Philippines) in October-November, 1952. He was elected President of the Zoology and Entomology Section of the 40th Session of the Indian Science Congress held at Lucknow in January 1953; his Presidential Address was on "A Few Thoughts on the Progress of Zoology in India". The first part of his popular article on "Fisheries Research in India" was published in the special number of the *Journal of the Bombay Natural History Society* (50th Anniversary Volume). Dr. Panikkar also prepared a detailed review of the sub-section "Fish and Fisheries" with a bibliography for publication in the projected volume of the Progress of Science in India during 1938-50. He also continued as the Editor of the *Journal of the Zoological Society of India*. Dr. Panikkar was nominated as the Government of India's representative on Technical Committee I on Biology and Hydrology of the Indo-Pacific Fisheries Council and was elected Rapporteur of the Sub-Committee on Neritic-Pelagic Fisheries. The following members of the staff of the Research Station also received nominations to various Sub-Committees of the Indo-Pacific Fisheries Council:—

Name of Sub-Committee	Name of Officer
Chanos	Dr. N. K. Panikkar
Planktology	Dr. R. R. Prasad
Hydrology	Shri R. Jayaraman
Sea Weed	Dr. (Mrs.) F. Thivy
General Biology	Shri M. Krishna Menon

Dr. Panikkar was also nominated as Member of the Standing Committee on Pacific Oceanography for the 8th Pacific Science Congress and as Convener of the National Committee on Oceanography for the Pan-Indian Ocean Science Congress.

12. Dr. B. S. Bhimachar, Research Officer and Officer-in-Charge of the Calicut Sub-Station, was sent abroad for advanced training in Fisheries subjects in the United Kingdom under the Colombo Plan. Dr. Bhimachar left for England early in September 1952 and returned to India by the middle of April 1953, on completion of the training and after visiting some of the laboratories in Norway, Sweden and Denmark.

13. At the request of the F.A.O. Shri S. K. Banerji, Assistant Research Officer (Statistics), was deputed to Bangkok in June 1952 as additional instructor for the F.A.O. Fisheries Statistical Course conducted at Bangkok. On completion of his work Shri Banerji rejoined duty at this Research Station early in August 1952.

14. Shri V. Krishna Pillai and Shri A. V. Natarajan, the two Research Scholars, who are being given training in research methods under the Ministry of Education Research Training Scholarships Scheme, actively pursued their work at this Research Station. An additional Senior Research Scholarship has also been sanctioned for this Institution on a semi-permanent basis. A suitable candidate is being selected for the award of this Scholarship.

15. Shri Rafi Ahamed Kidwai, Minister for Food and Agriculture, Government of India, visited the Calicut Sub-Station on 24th July 1952. Among various other visitors to the Headquarters Station may be mentioned Sir Kanthiah Vaidyanathan, Secretary to Defence and External Affairs Ministry, Ceylon. The Assistant Fisheries Research Officer, Andamans, visited and worked in the laboratories of this Research Station for about six weeks in December 1952, and January 1953, during which he was given every opportunity to learn some of the recent advances in Fisheries Research. Several parties of students from various Universities and Government institutions visited the Headquarters Station at Mandapam and the Calicut Sub-Station and made use of the facilities available.

16. A large number of scientific enquiries have been answered during the year by the Research Station. Close collaboration was also maintained with the Indo-Pacific Fisheries Council, the Central Board of Geophysics and other scientific bodies. A scheme was prepared for initiating work on the collection and analysis of water samples from different areas of the Arabian Sea and the Bay of Bengal as a beginning in the systematic collection of hydrological data in relation to Indian seas and this scheme has been accepted by the Central Board of Geophysics for the execution of which an annual grant of Rs. 20,000 is likely to be made available by the Ministry of Natural Resources and Scientific Research. Dr. N. K. Panikkar was invited to participate in the Defence Science Conference discussion, held at New Delhi, on 10-3-1953. As he was unable to participate in the Conference a note on "Fouling and corrosion of ships' bottoms with special reference to tropical waters" was prepared and forwarded for being read and discussed at the Conference. At the request of the Director, Zoological Survey of India, a note on procedures to be adopted in the collection of plankton and water samples during the re-survey of the Chilka Lake was prepared and forwarded to him. A number of original scientific papers by the staff of the Station have been published during the year in various Indian and foreign scientific journals. A list of papers published so far by the Institute is given elsewhere in this issue of the journal. Several other papers are in various stages of publication.

FISHERY SURVEY

The analysis of data collected during 1952 was completed during the year under review. It is estimated that the total quantity of marine fish landed in India in 1952 was 525,542 tons (1 ton=2,240 lb.) as against 525,482 tons in 1951. As in the previous year, the West Coast contributed 82% of the total catch. The landings of marine fish in tons zone by zone and the composition of the zonal landings in terms of the main groups of fishes are given as an Appendix. The percentage yields of these main groups of fishes in 1952 are tabulated below together with the corresponding figures for 1951 and 1950.

Name of Fish	Percentage of yield		
	1950	1951	1952
1. Mackerel	15.91	20.49	15.33
2. Prawns and other crustaceans	13.36	15.00	15.12
3. Sardines	19.56	13.60	11.99
4. Whitebaits	4.39	11.63	8.18
5. Elasmobranchs	3.10	5.76	7.47
6. Sciaenids	5.32	6.49	7.32
7. Ribbonfish	3.23	3.31	6.98
8. Bombay-duck and <i>Saurida</i>	2.53	1.42	4.84
9. Other clupeoids	4.13	2.62	4.20
10. Cat-fish	2.10	3.39	3.68
11. Silver-bellies and <i>Lactarius</i>	2.72	3.90	2.80
12. Perches	4.59	0.55	2.57
13. Carangids	1.09	1.92	1.90
14. Soles	5.39	0.38	1.27
15. Seer-fish	1.23	1.38	1.23
16. Pomfrets	0.87	1.80	1.13
17. <i>Bregmaceros maccllelandi</i> .. .. .	..	0.94	0.63
18. <i>Chirocentrus</i>	1.42	0.25	0.42
19. <i>Sphyrana</i> (Barracuda) .. .. .	..	0.04	0.30
20. Flying-fish	0.36	0.42	0.27
21. Red mullets .. .. .	..	0.30	0.21
22. Polynemids .. .. .	..	0.16	0.21
23. Tunnies	0.84	0.17	0.17
24. <i>Mugil</i> spp. .. .. .	..	0.01	0.06
25. Miscellaneous	7.86	4.07	1.72

The percentage yields of various groups of fishes show that mackerel, sardines, prawns and whitebaits formed nearly half of the total catch. The average annual return per indigenous boat in 1952 was 15,328 lb. The corresponding averages in 1951 and 1950 were 15,392 and 16,845 lb. respectively. The average annual production per active fisherman was 1,515 lb. in 1952

as against 1,522 lb. in 1951 and 1,665 lb. in 1950. From the analysis of the seasonal variations of the landings it is seen that almost $\frac{2}{3}$ of the total catch were landed during the six months from October–March and only about $\frac{1}{3}$, in the remainder of the year. It is further revealed that fisheries on the East Coast in 1952 did not show any marked departure from those of 1951. On the West Coast, production had increased all along the coast except in the Malabar region where considerable decline in fish landings was noticed. The decrease was due to the general failure of the oil-sardine and mackerel fisheries in this region. The sole fishery which was a phenomenal success along the Malabar coast in 1950 failed again this year. There were heavy landings of whitebaits and ribbon-fishes along the Travancore-Cochin coast.

FISHERY BIOLOGY

18. *General Fishery Conditions in the Mandapam Area.*—The fish landings around Mandapam were poorer when compared to last year, though the fishing effort in terms of the number of boats and men engaged was more or less the same. The decline was felt more especially in the Clupeoid fishery and mackerel fishery. It was observed that the Clupeoid fishery was supported mostly by juvenile fishes, of which *Sardinella albella* and *Sardinella gibbosa* were more important than others. The biology of these fishes is under investigation. The major length-group that entered the mackerel fishery during this year was 22–23 cm. Operations conducted at night landed more mackerel than diurnal operations. The studies on the mackerel are being continued. The *Hemirhamphus* fishery was normal as far as the total catches were concerned.

19. The detailed survey of the Rameswaram Island is progressing satisfactorily and would greatly aid in the formation of a correct picture of the fishery resources of this region. The total amount of fish landed during the eight months (July 1952 to February 1953) was found to be 779·8 tons out of which 553·8 tons were landed on the northern or Palk Bay side of the island and 225·5 tons on the southern or Gulf of Mannar side. The predominant species in the catches were the silver-belly *Leiognathus splendens* (24·66% of total) and the seer-fish, *Scomberomorus guttatus* (20·77%). A preliminary study of the biology of the former species has been published in the *Proceedings of the Indo-Pacific Fisheries Council* and a detailed study of the biology of the latter species is in progress. The biometrical study of the big-jawed jumper *Lactarius lactarius* is nearly complete and the data are being consolidated.

20. *Fish Eggs and Larvæ.*—Studies on fish eggs and larvæ in the seas around Mandapam were continued. From the data collected this year

it appears that spawning individuals were less than in the previous years. The waters of the Gulf of Mannar continued to be richer in fish eggs than that of the Palk Bay. A few plankton collections made in the Palk Bay off Pamban further away from the usual place of collection have shown that they are richer in fish eggs than the usual samples. They also indicate that the area between $3\frac{1}{2}$ and 5 miles from the shore forms the main spawning ground. The types of eggs taken from this region in the Palk Bay and those obtained from the Gulf of Mannar were similar during this period.

21. *Perches*.—The studies on the perch fishery in the Gulf of Mannar and Palk Bay around Mandapam have been concluded and the results published.

22. *Clupeoids*.—The *Choodai* fishery of the Mandapam area depends upon the abundance of 0-year class of Clupeoids in the inshore waters of Palk Bay. The fishery is of considerable economic importance in that part of the Palk Bay Coast from Panakulam to Dhanushkodi. About 100 boats with shore-seines, 120 boats with torches and hand-nets and 20 with gill-nets are engaged in the fishery, which usually starts in late March or early April and continues up to October or November. The fishery of this season was poorer than that of the past three seasons. There were marked fluctuations in the catches from week to week during this season. These were not entirely due to changes in the intensity of fishing effort. *Sardinella albella* and *S. gibbosa* formed the bulk of the catches of the period under report. When *S. albella* was more dominant, the catches were generally higher. Similarly, an increase in the proportion of *S. gibbosa* was symptomatic of a period of decreased yield. For a few days prior to and following the new moon day, the catches were generally high. Both *S. albella* and *S. gibbosa* appear to spawn in the first year of their life. The majority of *S. albella* examined during this season had 44 vertebræ; in *S. gibbosa*, 46 was the more common number.

23. Studies on the biology of the Dorab (*Chirocentrus dorab*) are being continued. Observations made from scales regarding the age of the fish appear to be in good agreement with the results obtained from size-frequency studies, and these are proposed to be further checked by observations on otoliths. *C. dorab* is observed to attain sexual maturity during the third year of its life and at a length of nearly 50 cm. In the larger size groups females predominate in numbers indicating that males do not grow beyond a particular length. The species appears to have a restricted breeding period in July-August.

24. *Sharks and Rays*.—Collection of data on catch statistics and information on the shark fishery of the Rameswaram Island with reference

to fishing methods, fishing season and fishing grounds, centres of fishing, the principal species of cartilaginous fishes obtained, utilisation of sharks and rays, economics of the industry and the average yield, were continued during 1952-53, and the results were consolidated into a report. The biology and systematics of the more important species which constituted the fishery were examined in greater detail; the problems connected with the distribution of species in relation to area and depth, size, growth, condition of maturity, sex-ratio of species, breeding habits and life-history studies formed the major part of the investigation.

Studies on the systematics, biology, and life-history of the species of *Carcharhinus*, *Hypoprion*, *Scoliodon* and *Sphyrna* were continued and special attention was paid to the species of *Sphyrna* which are of considerable importance in the shark liver oil industry. Studies on systematics of Indian elasmobranchs have resulted in recording a few new species and others not previously recorded from Indian seas, viz., *Hypoprion* sp., *S. diplana*, *S. bigelow* and *Hemipristis elongatus*. Determination of rates of growth and age groups in the commercial catches by length frequency studies were continued and the data collected on rate of growth have been analysed for a few species. Results of work now in progress on length measurements give a measure for the rate of growth and indicate the need for further length measurements. A review of the elasmobranch fishes of the Indian seas with a Key for their identification has been prepared for publication based on careful examination and study of a large number of specimens collected and observed. A detailed Key to facilitate easy identification in the field of any shark or ray of Indian Seas has been prepared by selecting characters that are most easily visible and measurable.

25. *Off-Shore Fisheries at Bombay*.—A good deal of preliminary and exploratory work has been done on the trawl catches of M.T. *Ashok* and M.T. *Pratap* at Bombay. It is found that the Ghol (Sciænids), the Dara and Rawas (Polynemids) and the Wam (eels) together form nearly half of the total catches and that the detailed study of the biology of these groups would be of considerable value from a fishery point of view. With the opening of the Off-Shore Fisheries Research Unit at Bombay in the ensuing months these studies would be tackled on a bigger scale.

26. *Mollusca*.—The biology of the Palk-Bay squid and its fishery were studied during the year under report. The results are being published. The biology of the wedge clam, *Donax cuneatus* from the Uchippuli area was taken up for study, and is now in progress.

27. *General Fishery Conditions on the Malabar Coast.*—The outstanding feature of the year was that the fishery was generally poor along the Malabar Coast. This was mainly due to the sharp decline as compared to the previous years, in the occurrence of mackerel and oil sardine, and to some extent due to the poor fishery of other commercially important groups of fish, like soles, silver-bellies and whitebaits. During the summer months of April and May, fishing was mostly confined to the inshore area and the bulk of the catches consisted of prawns and crabs with some miscellaneous collections of soles, sciaenids, silver-bellies and clupeids. Good catches of mackerels were recorded for a brief period in April and May. As in other years there was good cat-fish (*Tachysurus dussumieri*) fishery during the early part of May. During the monsoon months of June-September there was a set-back in the fishery with frequent interruptions in the fishing operations owing to unfavourable weather. The month of July was marked by occasional good catches of oil-sardine and mackerel. The fishery of the silver-bellies, which are abundant during the monsoon months, was generally a failure during the year. There were some good catches of the whitebaits (particularly *Anchoviella heterolobus*) during August-September which occurred along with small-sized sardines and mackerel of length 8 to 10 cm. The occurrence of the Malabar Sole, *Cynoglossus semifasciatus*, which forms a major fishery along the Malabar Coast in certain years, was also poor. Only small immature specimens in scanty numbers were obtained in September which is the month of maximum sole landings during normal years.

The commencement of the post-monsoon fishing season which was practically a failure on this coast was marked by intermittent catches of oil-sardine and mackerel. The fishery of the oil-sardine, *Sardinella longiceps* was very poor during the post-monsoon period but for a brief spell in October when large shoals of it of size 14–16 cm. were obtained all along the Malabar Coast. After that it was very scarce and a few intermittent catches of it were obtained at Calicut in January and first week of February. The occurrence of the mackerel, *Rastrelliger canagurta* in the post-monsoon fishing season was also poor and unsteady, but for a brief period in mid-December when there was a slight recovery in its fishery. In the absence of these two commercially important species, the clupeid *S. fimbriata* was obtained in fair numbers during the post-monsoon period. Towards the end of the period occasional good catches of cat-fish (*T. dussumieri*), pomfret (*Stromateus niger*) and prawns were recorded.

28. *Fish Population Studies and Biological Studies.*—Investigations on the fish populations of the inshore area near Calicut were continued during

the period under consideration for the fourth year in succession. Information obtained on the broad aspects of the inshore fishery was further confirmed as a result of the study continued during the year. This investigation was extended from the first week of November 1952 to deeper waters (8 fathom region) off Calicut Coast with a view to ascertain the species of fish occurring there, their sizes, sexes and seasonal fluctuations and to find whether the catches differed significantly from those of the inshore hauls. The fishing operations were carried out by employing a larger boat seine than hitherto used for the inshore hauls and a gill net and these two were operated simultaneously. Three hauls of half an hour duration each, were carried out from three places in the 8 fathom region. The catches from the two nets were taken together and reckoned as one unit for the purpose of analysis and then analysed for total weights, weights of the individual species, sizes, sexes, etc., as was done hitherto for the inshore hauls.

It is seen from an analysis of these catches that there was no significant difference between the two areas either in the species composition or in the pattern of their occurrence. Considerable fluctuation in the weights of the catches in the boat seine was noticed from week to week. But the weights recorded in the gill net were considerably poorer, barring one occasion and were more or less steady. The weights of the composite catch ranged from 1-38 lb. The bulk of the catches from about mid-December to the end of the period comprised post-larval and juvenile stages of fish like *Pseudosciaena sina*, *Opisthopterus taroore*, *Dussumieria hasseltii*, *Lactarius lactarius*, *Cynoglossus semifasciatus*, etc., and prawns and crabs and uneconomic elements like *Acetes*, *Cavernularia*, *Loligo* and *Squilla*. The composition of the catches was similar to that hitherto obtained in the inshore hauls at this period. This investigation is in progress.

Detailed quantitative estimation of the food of fishes under the *points method* was commenced during the year. This work which required examination of a large number of species common in the inshore catches confirmed in broad outlines the seasonal changes in the food of fish observed during the previous years and was helpful in the quantitative estimation of different types of food taken by fish.

29. *Biology of Sardines*.—The oil-sardine fishery of the 1951-52 season, which was comparable to the former years of abundance declined rapidly during April 1952 and came to a close by the end of the month. There was no landing of oil-sardine during the next two months. The fishery of the 1952-53 season commenced early in July 1952, after the commencement

of the South-West Monsoon. The three-year-old mature oil-sardines mainly contributed to the fishery during this month. Immature one-year-old oil-sardines with the modal sizes at 10.5 and 11 cm. appeared erratically in the inshore waters in the subsequent months of the season and yielded occasional good catches up to the end of September 1952. The fishery showed a remarkable improvement in October 1952 and heavy landings were made up to the middle of the month. These shoals were mainly composed of immature one and two-year-old sardines the sizes of which varied from 10 to 16 cm. An abrupt set-back in the fishery was noticed by the middle of the month when the shoals which were frequenting the inshore waters suddenly disappeared in a southward direction. The shoals were not encountered in the subsequent months and their absence from the fishing grounds resulted in the complete failure of the fishery during the peak months of November and December 1952. Stray shoals reappeared in the coastal waters in January 1953 and the fishery terminated by the end of the month. The fisheries of the other sardines, namely, *Sardinella fimbriata*, *S. brachysoma* and *Kowala coval* also showed a similar decline in their landings during the year under report. *S. fimbriata* and *K. coval* occurred regularly in the commercial catches especially during the post-monsoon months. The routine studies on the food and feeding habits, sex composition, size and age groups of the sardines and the other clupeoid fishes in the catches made from the commercial fishing grounds were continued during the year.

30. *Biology of the Malabar Sole.*—Commercially, the fishery of the Malabar Sole, *Cynoglossus semifasciatus*, was a general failure during the year under report. A decline in the landings was reported even last year, there being particularly poor catches in the Calicut region. It seems very likely that this failure of the fishery is to some extent at least a consequence of overfishing during 1950-51, when the landings of soles broke all records. The species was however, represented in the routine laboratory collections during all months of the year, the months of June-September being the poorest. The post-monsoon appearance of shoals which should have normally occurred in August-September was considerably delayed and poor in strength. Associated with this delay was a delay in the settlement of bottom animals after the monsoon.

Some commercial catches were noticed in the Calicut market during November-January and these consisted almost entirely of juveniles below 6 or 7 cm. in length. The unchecked exploitation of these juveniles, a rapid decline noticed in the recruitment of the new brood, and the scarcity of older individuals in the fishery are all again indicative of a poor fishery during

the coming year. An account of the fishery and biology of the species is being published.

31. *Biology of ThriSSocles mystax*.—The fishery based on the Anchovy, *ThriSSocles mystax*, was a failure for the third year in succession. The trend of the fishery though poor was more or less the same as in the previous years. During the summer months of April and May fair numbers of post-larval and juvenile specimens of modal size ranging 5.1–7.1 cm. were obtained in the inshore hauls. The modal size fluctuated considerably at this period owing to the recruitment of post-larval and juvenile specimens into the inshore area. There was a sharp decline in their occurrence in the inshore collections with the commencement of the south-west monsoon in June and they continued to be scarce during the months of July and August. The post-monsoon fishery of this anchovy was a failure, since after a promising start in September-October, when a few good catches of adult specimens were obtained, it failed to occur in appreciable numbers during the subsequent months of November-March. But large numbers of post-larval and juvenile specimens occurred in the inshore area from about mid-December-March.

The work of analysing the food of this anchovy with special emphasis on the quantitative estimation of the different food elements was continued. The findings on the seasonal fluctuations of the food of this anchovy were in agreement with the observations made during the previous years. During the months of December-May, Prawns, *Acetes*, Stomatopods and fish post-larvæ formed the predominant food of the anchovy as in the previous years. The studies on the gonadial conditions fix its spawning period from September-March.

32. *Biology of Prawns*.—The work of the Prawn Research Unit at Narakkal continues to show steady progress and it is now possible to review briefly the results of the investigations on the paddy field fishery. The fishing operations of the 1951–52 season in the experimental one-acre field came to a close on 18–4–1952 the total quantity of prawns caught being 486 lb. Operations were started in the last week of October in the year under report and the catches up to the end of March have amounted to 560 lb., the fishery this year being thus much better than last year. Experiments in prawn farming, started towards the close of last year, have served to show that prawns can be kept alive and healthy in enclosed fields even in the hottest months of the year and that with proper care the addition of organic fertilizers like groundnut cake and paddy straw may not have any harmful effect on the prawn population therein. One of these experiments

was carried out in a farm made out of a swampy stretch lying close to the sea-shore and typical of the vast areas of similar character scattered in other parts of the coast. It was an experiment in prawn *cum* fish culture and the results obtained indicate that, apart from its economic aspects about 1,200–1,500 lb. of cheap and nutritious food can be gathered from every acre of such unused land. The result of substituting a petromax light for the ordinary kerosene lamp used last year has demonstrated that, up to a limit probably, the power of attraction increases with the intensity. An experiment at culturing *P. indicus* from its fry collected from the canal water is being tried in the smaller experimental field. It is proposed to repeat this in the coming year so as to ascertain the practicability of this method from the point of view of the fishermen. Prawn fishing in the backwaters was carried on continuously throughout the year with stake nets, Chinese nets and cast nets, the operations with the two former types being interrupted only when there were floods and there was a risk of the swifter currents and floating debris tearing them. Except in the size of *P. indicus* the catches do not differ much from those of the paddy fields. The sea fishery started by about the middle of April and continued till the close of September. The catches contained the same four species as were noted along the Malabar Coast. The proportion of *P. stylifera* dwindled considerably in the latter half of the season while that of *P. indicus* gradually rose and made up about 42% of the catches in September. *M. affinis* is seldom caught in such large numbers as the other species. Collection of biological data relating to the various species of prawns by the study of samples both from the marine and backwater catches (including paddy field catches) has been continued in the year under report. Those relating to growth have proved that the vast majority of *M. dobsoni* does not grow beyond 61–65 mm. in the backwaters while *P. indicus* usually grows to 131–35 mm. in the course of an year.

Weekly samples of the canal plankton have been regularly studied and the occurrence of penæid post-larvæ and other major groups of its constituents has been recorded. The salinity and the surface temperature of the canal water have also been noted. The remarkable fact about the salinity is that it has varied from about 1.5‰ in August to 31‰ in April.

33. *Mackerel Investigations at Karwar.*—The mackerel fishery at Karwar was a partial failure, the landings totalling 736 tons as compared to about 1,500 tons in 1951. The oil-sardine fishery on the other hand was very good, the landings totalling approximately 153 tons. About 3,200 gallons of sardine oil was extracted at Majali and about 80 gallons at Karwar.

Sixteen Rampan nets were operated in Karwar waters during the mackerel season 1952-53. The first Rampan operation was on 25-10-1952 and the last on 16-3-1953. The total number of days in the season was 143, of which 60 were fishing and 83 non-fishing days. During the season 86 Rampan hauls were taken of which the largest number 22 was registered in February 1953. The total landings of mackerel during the season were 735.71 tons. The largest catch of 508 tons was made in November 1952 alone. The unit of effort of fishing, that is the catch per piece of Rampan net works out to 552 in November, 112 in December, 65 in January, 58 in February and 69 in March. The intensity of fishing was the greatest in November 1952, and it progressively decreased in the succeeding months of the season. A total of 6,113 mackerel was measured during the mackerel season 1952-53. The dominant size-class in October 1952 was 17.5 cm. and in all other months it was 19.5 cm. The monthly average size of mackerel during different months of the season was found to be 18.57 cm. in October, 19.83 cm. in November, 19.89 cm. in December, 19.26 cm. in January, 19.51 cm. in February and 19.26 cm. in March. It is observed that the same size-classes may appear at certain intervals, for example, the 20.5 cm. group constituting the fishery in 1948-49 also contributed to the fishery of 1951-52. Likewise the 19.5 cm. size-group entering the fishery of 1949-50 mackerel season is also seen contributing to the fishery of 1952-53 season. There appears to be some relation between the average size of fish and the total landing during the season. It is observed that when the average size of fish was small the total seasonal catch was also poor as can be seen from the results of the two seasons, 1949-50 and 1952-53. The total landings in the former season were 750 tons as against 735.71 tons of the latter. In both these years, the average size of fish was small, being 19 cm. for most of the season, the dominant size-class being 19.5 cm.

MARINE INVESTIGATIONS

(i) *At Mandapam*

34. A comparative study of the plankton characteristics at inshore stations in the Gulf of Mannar and the Palk Bay was continued for the second year and it is now possible with the additional data collected during 1952-53 to substantiate the results obtained in the previous year. This comparative study has revealed the significant fact that the waters of the Palk Bay are richer and more productive than those of the Gulf of Mannar as indicated by the higher standing crop and diatom populations.

Although there were differences in the occurrence and succession of species of diatoms between these two regions, the bulk of the diatom

population was composed of several species belonging to the genera *Chaetoceros*, *Bacteriastrium* and *Rhizosolenia*. In the Palk Bay as well as in the Gulf of Mannar the diatoms and copepods showed two maxima during this period and there were similarities in the general trends in fluctuations.

A most interesting feature during the period under review was the swarming of *Noctiluca* and the consequent effects on the pelagic shoaling fish. There was an abrupt set-back in the "choodai" fishery of this year evidently due to the presence of dense patches of *Noctiluca* in the areas where the fish normally shoal and their avoiding these patches. Therefore, it was suggested that *Noctiluca* could be used as an indicator of poor choodai fishery. The swarming of *Noctiluca* had effects on other zoo-planktonic elements as well, especially the copepods. An inverse relation between the diatoms and the dinoflagellates was observed which in all probability was due to the effects of grazing. When swarms of *Noctiluca* appeared, a regular succession of *Noctiluca*, diatoms and copepods was observed.

In addition to these planktological investigations, the work on the biology and relative growth of *Neptunus pelagicus* was completed and two papers embodying the results were prepared for publication.

35. *Chemistry of Sea Water*.—Studies on the hydrological conditions of the inshore waters in the neighbourhood of Mandapam were continued and a few offshore investigations were also carried out. A fairly clear picture of the conditions prevalent in the local waters has been obtained. There was a regular cycle of salinity as in the previous years: high salinity during the months of south-west monsoon—summer months, and low salinity during the north-east monsoon season—winter months. The salinity recorded in January 1953 in Palk Bay was the lowest so far recorded in these waters. The rise and fall of salinity were more sharp in the Gulf of Mannar than in the Palk Bay, one of the reasons being the semi-enclosed nature of the former. The seasonal cycle of dissolved oxygen followed more or less closely the prevalence of calm or turbulent conditions in the sea, the variations being more regular in the Palk Bay than in the Gulf of Mannar. The nature of distribution of phosphates and nitrates was almost similar to what was observed in the previous years. The silica content was very high during the months, June-October and its probable relationship to the swarming of *Noctiluca* in the local waters during the same period has been indicated.

The conditions in the offshore waters were found to be similar to those prevalent in the inshore waters. The order of magnitude of the nutrient salts was almost the same as in the inshore waters. The differences between the surface and deeper waters in the offshore areas of the Gulf of Mannar

and Palk Bay as regards the distribution of salinity, nutrient salts, etc., were found to be not appreciable.

(ii) *On the Malabar Coast*

36. *Bottom Fauna and Connected Investigations.*—Studies were continued on the bottom fauna of the West Hill Sea. Sampling was restricted to the 2 and 10 fathom regions and weekly samples were available for examination throughout the year except for a few weeks in December-January. Considering the year as a whole, the inshore sea bottom was extremely poor in animals, the shallower or near-shore zone being much poorer than the deeper zone. Despite the extreme poverty of the fauna, the observations made during the year have confirmed the findings of previous years in regard to the general ecological features of the inshore sea bottom. While there may be considerable variation in the species composition and the density of the fauna from year to year, a zonation is always strictly maintained in the distribution of the different elements on the sea bottom and a close connection is noticed between the occurrence of the south-west monsoon and the annual biological cycle of the area.

Associated with the relative scarcity of polychaetes and other food animals of the soles in the area, it was noticed that the sole fishery was also a failure this year.

The physico-chemical studies on the mud banks were continued. These studies have shown that the mud banks are of considerable importance in the biological and nutrient cycles of the inshore sea along this coast. Large quantities of interstitial and adsorbed phosphates are retained in these mud banks particularly during the calmer months of the year. While the agitation of the mud during the south-west monsoon releases large quantities of interstitial phosphates into the overlying water, the environmental conditions of that period also seem to be suitable for the desorption and release of the adsorbed phosphates. Studies on the phosphate content of the bottom water have shown that the mean phosphate values were remarkably high during the months of July-October and low or very low during other months. Examination of estuarine samples from Korapuzha during and after the south-west monsoon of 1952 has indicated that the river water does not bring any large quantities of dissolved inorganic phosphates as such into the sea during the floods.

37. *Phytoplankton.*—During the year under report much of the time was devoted in giving shape to the data collected at Calicut over a period of three years. The seasonal fluctuation in the quantity of

phytoplankton and its relationship to the hydrological and other factors have been investigated. The production of phytoplankton in the sea here, as of crops on land, appears to depend principally on the monsoons. The annual production in a tropical coastal area such as the present one under investigation on the west coast of India compares favourably with the annual production in the temperate regions (subject to limitation of the methods and inevitable errors). The seasonal succession of several species which occur in considerable numbers has been worked out. Work on taxonomy has also progressed.

38. *Zooplankton*.—The planktological investigations of the year under review have revealed a general succession of phytoplankton by zooplankton and edible zooplanktonic organisms by inedible ones towards the end of the period. But the peak in each of these cases has been less steep than in the preceding years and with a wider base, greater time-span and considerable overlap. *Rhizosolenia setigera* was the commonest diatom to occur. The time of inception of phytoplankton dominance was delayed and so was the inception of the dominance by copepods and other groups of organisms. The early part of September witnessed the death and disruption of swarms of Chloromonadineae causing mortality to fish and other faunal elements of inshore waters and contributing to a depression of the fishery. *Noctiluca miliaris* harbouring swarms of minute green flagellates has been occurring in repeated swarms from November 1952 to March 1953.

39. *Copepoda*.—The various lines of work based on the copepods and the part they play in the Fisheries and the Marine Biology of the West Coast of India were proceeded with in the year under review and carried to a more advanced stage. A taxonomic account of the copepoda of the West Coast is in course of preparation. A general key for the identification of the commoner species of copepoda occurring in the plankton of Indian seas is being revised and amplified. The studies on the cycle of occurrence of the copepoda in the West Hill area have elucidated the main features in which the present year is different from the earlier years and also its agreement with the previous years in regard to the general sequence of planktonic organisms and the place of the copepoda in this sequence. The study of the copepods as a constituent in the food of the mackerel was continued although the mackerel fishery was a failure this year and comparatively few specimens only were available for examination.

40. *Hydrological Conditions at Calicut*.—The variation in the temperature during the year was about 5° C., the maximum being reached in April and the minimum in August after the commencement of the south-west

monsoon. The oxygen values were generally steady varying between 80% saturation and 100% but fluctuated more widely during the monsoon months. Salinity values fluctuated as usual with a maximum prior to monsoon (34‰ monthly average) falling steeply during the rainy season to 24‰ in August and rising gradually thereafter. The values for silicates showed a steep rise with the advent of the monsoon but a fall after October. After January 1953, very low values were recorded, lower than any observed till then. On some days the surface water was without any trace of silicates. The nitrate values were high during the pre-monsoon months and fell gradually thereafter except for a brief period of rise in August.

PHYSIOLOGY

41. From samples of *Chanos fry* collected during the year, it was observed that the earlier stages appeared first in the middle of March and continued to make their appearance till the early part of May. The length of the collected fry varied from 12-14 mm. in March and April, from 20-40 mm. in May and from 40-50 mm. towards the end of the season. Fry of average length 20 mm. could be collected again during the last week of November, thus confirming the previous findings that the fish breeds twice a year. But this latter season is relatively insignificant and is not of much value for the collection and stocking of fry. No fry could be observed in the few lagoons near Palk Bay, presumably because the sand bar closed early and most of the lagoons had dried up. A survey of the coastline in the vicinity for other possible places of occurrence of *Chanos fry* also yielded negative results.

The growth of *Chanos* fingerlings in small ponds near the foreshore was found to be unsatisfactory. This could be traced to the absence of blue green algæ and other microflora in these ponds. Evidence was obtained to show that this deficiency in these ponds might be overcome by the application of organic fertilisers.

42. The habits of the African mouthbreeder, *Tilapia mossambica*, were studied. This fish tolerates direct transfer from fresh to salt water. It is omnivorous but does not seem to be an active predator. It starts breeding when about 70 mm. long. Oral incubation of the embryos is not essential since the embryos can be hatched independently of the parent fish. Observations on its habits are progressing.

43. Preliminary studies were carried out on the histology of the thyroid gland in *Chanos* and also on the influence of the thyroid on the activity of the fish. Work was continued on micromethods of analysis, especially on

the quantitative and taxonomic aspects by the application of partition chromatography.

BACTERIOLOGY

44. Studies on the quantitative distribution of bacteria in the inshore environment at Mandapam were continued. A three-year study of the Gulf of Mannar area within the chain of islands was completed and investigations on the Palk Bay area were intensified. The seasonal abundance of denitrifying bacteria in the sea-water, in association with plankton and in the muds was examined. Denitrification to some extent is considered possible in the area in view of the shallow depths, more or less protected nature of the waters, and the tropical temperature. Bacterial counts on the muds from Palk Bay were comparatively lower during this year. The moisture content of the muds was low (about 30%) indicating its sandy nature.

45. Detailed examination of a number of bacterial cultures isolated during the quantitative studies was carried out. The genera *Pseudomonas*, *Vibrio*, *Achromobacter*, *Flavobacterium*, *Chromobacterium*, *Micrococcus* and *Bacillus* were present. Bacteria in muds were mostly the same as those in the waters, a noticeable difference being the absence of chromogens in the muds. The bacterial flora was predominantly proteolytic and non-fermentative in character.

46. A trial production of fish hydrolysate using small-sized Clupeids, similar to the product marketed in the Far Eastern countries was carried out. A product comparable in quality to high grade fish sauce from Thailand was obtained. Further pilot-scale experiments for studying the quantitative aspects of the process are in progress.

47. A study of nitrogenous extracts from fresh fish muscle in relation to the general problem of bacterial spoilage of fishes was commenced. The level of protein nitrogen in the cold, aqueous muscle extracts of a number of fishes was determined. The ratio of the non-protein nitrogen to the total nitrogen of the muscle varied from 8-43% in different fish, being generally low in the perches.

ALGOLOGY

48. At the requests of several educational institutions, in particular the Madras Government Museum, exhibits of economic algæ were supplied, chief among which was *Gelidium micropterum*, which recent work at this Station has proved to be a highly valuable agarophyte outranking in yield the pre-eminent Japanese agarophyte, namely *G. amansii*. It is estimated that aside from other agars, one ton of refined agar from *G. micropterum* originating from the Pamban area may be obtained annually. The Andamans

and Laccadives are also probably rich in *G. micropterum*. Several demonstrations were given on the method of manufacture of refined agar.

49. From the point of view of plant nutrients, likewise from that of humus formation, seaweed compost has undoubted significance. With precautions for sealing in all the intermediate products of decomposition, composting with cowdung in the ratio of 6:1 by volume for two months ensures a stable and final manurial material.

50. Seaweeds have possibilities as supplementary cattle feed. They are washed in fresh water, treated with weak solutions of acid or alkali as may be necessary, sun-dried and stored. They may be added to the usual rations (after moistening) in the ratio of 1:10 by volume of seaweed to the usual ration.

51. Visiting reasearch students carried out quantitative assays of vitamins A and C in a series of local seaweeds. Efforts have been made to popularize seaweed preparations and for this purpose suitable recipes for dry *Gracilaria lichenoides* have been worked out and demonstrated.

APPENDIX: COMPOSITION OF FISH-LANDINGS IN 1952

Zones	Landings in tons	Percentage composition of the landings
(1) West Bengal and Orissa	6,031	<i>Sardinella</i> spp. 30·47, <i>Dussumieria</i> spp. 13·96, <i>Polynemus</i> spp. 11·11, <i>Cybium</i> spp. 7·55, <i>Otolithus</i> spp. 5·95, <i>Engraulis</i> spp. 4·46, <i>Hilsa</i> spp. 4·16, <i>Sillago</i> spp. 3·28, <i>Stromateus</i> spp. 2·54, Prawns and lobsters 2·45, Sharks 2·14, Rays 1·27, Skates 0·40, <i>Chirocentrus dorab</i> 1·77, <i>Arius</i> spp. 1·39, <i>Stolephorus indicus</i> 1·19, <i>Trichiurus savala</i> 1·12, <i>Coilia dussumieri</i> 0·67, <i>Caranx</i> spp. 0·66, <i>Harpodon nehereus</i> 0·63, <i>Equula</i> spp. 0·61, <i>Pellona brachysoma</i> 0·52, <i>Lates</i> spp. 0·35, <i>Mugil</i> spp. 0·29, <i>Euthynnus</i> spp. 0·21, <i>Therapon</i> spp. 0·21, <i>Hemirhamphus</i> spp. 0·13, <i>Tetrodon</i> spp. 0·10, <i>Upeneus</i> spp. 0·05, <i>Sciana</i> spp. 0·05, <i>Lactarius lactarius</i> 0·04, <i>Rastrelliger canagurta</i> 0·03, Miscellaneous 0·24.
(2) Andhra coast (from south of Gopalpur to north of Vishakapatnam)	27,013	<i>Sardinella fimbriata</i> 33·50, <i>Arius thalassinus</i> 14·96, <i>Cybium</i> spp. 14·88, Sharks, 8·91, Rays 0·14, Skates 0·11, <i>Stolephorus</i> spp. 2·98, <i>Trichiurus haumela</i> 2·91, <i>Lutjanus</i> spp. 2·69, <i>Cypsilurus</i> spp. 2·66, <i>Chorinemus sanctipetri</i> 2·11, Prawns 1·66, <i>Sciaena</i> spp. 1·40, <i>Stromateus</i> spp. 1·31, <i>Engraulis</i> spp. 1·21, <i>Equula fasciata</i> 1·11, <i>Pellona</i> spp. 0·94, <i>Caranx</i> spp. 0·82, <i>Lactarius lactarius</i> 0·70, <i>Chirocentrus dorab</i> 0·61, <i>Hilsa</i> spp. 0·32, <i>Dussumieria hasselti</i> 0·30, <i>Hemirhamphus</i> spp. 0·28, <i>Rastrelliger canagurta</i> 0·27, <i>Synagris</i> spp. 0·23, <i>Serranus</i> spp. 0·22, <i>Histiophorus brevirostris</i> 0·17, <i>Chatæssus chacunda</i> 0·07, <i>Pristipoma</i> spp. 0·03, <i>Polynemus</i> spp. 0·02, <i>Harpodon nehereus</i> 0·02, <i>Elacate nigra</i> 0·01, Miscellaneous 2·45.
(3) Andhra coast (from south of Vishakapatnam to Masulipatnam)	22,603	<i>Sciana</i> sp. 11·08, <i>Engraulis</i> spp. 10·68, Crabs 8·93, Shrimps and Prawns 8·18, Sharks 5·55, Rays 1·42, Skates 0·15, <i>Hilsa</i> spp. 5·10, <i>Lactarius lactarius</i> 3·67, <i>Arius</i> spp. 3·25, <i>Stromateus</i> spp. 3·00, <i>Pellona</i> spp. 2·97, <i>Rastrelliger canagurta</i> 2·57, <i>Kowala</i> spp. 2·53, <i>Chatæssus chacunda</i> 2·25, <i>Upenoides vitatus</i> 1·87, <i>Caranx</i> spp. 1·53, <i>Chirocentrus dorab</i> 1·45, <i>Cybium</i> spp. 1·32,

- Harpodon nehereus* 1·27, *Otolithus* spp. 1·27, *Trichiurus* spp. 1·14, *Pristipoma maculatum* 0·66, *Stolephorus* spp. 0·44, *Sillago* spp. 0·43, *Umbrina* spp. 0·38, *Equula* spp. 0·36, *Kurtus indicus* 0·35, *Polynemus* spp. 0·33, *Dussumieria* spp. 0·31, *Cypsilurus* spp. 0·23, *Lutjanus* spp. 0·22, *Chorinemus* spp. 0·18, *Saurida tumbil* 0·13, *Serranus* spp. 0·09, *Opisthopterus tartoor* 0·07, *Coryphaena hippurus* 0·07, *Muranesox* sp. 0·06, *Sardinella fimbriata* 0·06, *Hemirhamphus* spp. 0·05, *Cynoglossus* spp. 0·04, *Euthynnus* spp. 0·02, Miscellaneous 14·34.
- (4) Andhra coast (south of Masulipatnam to north of Pulicut Lake) 954 *Stromateus niger* 19·59, *Lates calcarifer* 18·59, *Trichiurus haumela* 14·80, *Sciæna* spp. 11·71, Prawns and Shrimps 6·86, *Dussumieria hasselti* 5·67, *Carcharius* spp. 5·13, *Cybium guttatum* 4·80, *Engraulis* spp. 2·60, *Coilia dussumieri* 2·47, *Chirocentrus dorab* 2·08, *Equula* spp. 0·62, *Arius* spp. 0·75, (Data as of 1950).
- (5) Coromandel coast (Pulicut Lake to Cuddalore) 8,846 *Stolephorus* spp. 49·46, *Dussumieria* spp. 16·3, *Stromateus* spp. 8·18, Shrimps and Prawns 4·70, *Cypsilurus* spp. 3·66, *Engraulis* spp. 3·37, *Sciæna* spp. 2·55, *Equula* spp. 2·20, *Lactarius lactarius* 1·89, *Trichiurus haumela* 1·68, *Caranx* spp. 1·27, Sharks 0·81, Rays 0·07, *Cybium* spp. 0·56, *Rastrelliger canagurta* 0·53, *Chirocentrus dorab* 0·52, *Upenoides sulphurus* 0·38, *Sardinella fimbriata* 0·36, *Synagris* spp. 0·23, *Saurida tumbil* 0·17, *Therapon* spp. 0·12, *Arius* spp. 0·12, *Sphyræna* spp. 0·11, *Pellona* spp. 0·11, *Sillago* spp. 0·11, *Chorinemus* sp. 0·10, *Cynoglossus* spp. 0·09, *Belone* spp. 0·09, *Polynemus* spp. 0·05, *Euthynnus* spp. 0·04, Crabs 0·03, *Hemirhamphus* spp. 0·02, Miscellaneous 0·07.
- (6) Coromandel coast (south of Cuddalore to Devipatnam) 9,769 Rays 18·91, Sharks 6·63, Skates 2·10, *Caranx* spp. 11·50, *Equula splendens* 8·89, *Otolithus argenteus* 7·60, *Sciæna* spp. 6·39, *Chirocentrus dorab* 5·80, *Stromateus* spp. 4·08, *Pellona brachysoma* 3·65, *Engraulis* spp. 3·48, *Clupea* sp. 2·94, *Arius* spp. 2·80, *Cypsilurus* spp. 2·63, *Dussumieria* spp. 2·46, *Lactarius lactarius* 2·35, *Trichiurus haumela* 1·53, *Chataëssus* spp. 1·48, *Cybium guttatum* 1·43, *Sillago sihama* 1·20, *Hilsa* spp. 0·46, *Polynemus* spp. 0·44,

APPENDIX—(Contd.)

Zones	Landings in tons	Percentage composition of the landings
		<i>Coilia dussumieri</i> 0·44, <i>Therapon jarbua</i> 0·20, <i>Upenoides sulphurus</i> 0·31, <i>Gerres</i> spp. 0·11, <i>Penaeus</i> spp. 0·10, <i>Lutjanus</i> spp. 0·09, <i>Chorinemus</i> spp. 0·07.
(7) Palk Bay and Gulf of Mannar (south of Devipatnam to north of Cape Comorin)	13,385	<i>Trichiurus</i> spp. 38·89, <i>Sardinella</i> spp. 10·96, <i>Arius</i> spp. 7·53, <i>Lactarius lactarius</i> 5·28, <i>Serranus</i> spp. 4·84, <i>Cybium</i> spp. 4·33, <i>Sciæna</i> spp. 5·32, <i>Chirocentrus dorab</i> 3·80, <i>Lethrinus</i> spp. 2·37, <i>Lutjanus</i> spp. 2·27, Sharks 2·20, Rays 1·12, Skates 0·37, <i>Caranx</i> spp. 1·86, <i>Diagramma</i> spp. 1·02, <i>Engraulis</i> spp. 0·75, <i>Stromateus</i> spp. 0·55, Tunnies 0·35, <i>Otolithus</i> spp. 0·34, <i>Chorinemus</i> spp. 0·32, <i>Stolephorus</i> spp. 0·31, <i>Sphyrana</i> spp. 0·25, <i>Dussumieria</i> spp. 0·16, <i>Upenoides</i> spp. 0·14, <i>Aprion pristipoma</i> 0·11, Shrimps and Prawns 0·09, <i>Synagris tolu</i> 0·07, <i>Sillago sihama</i> 0·07, <i>Pellona</i> spp. 0·05, <i>Equula</i> spp. 0·05, <i>Elacate niger</i> 0·05, <i>Rastrelliger canagurta</i> 0·04, <i>Therapon</i> spp. 0·04, <i>Saurida tumbil</i> 0·03, <i>Drepane punctata</i> 0·02, <i>Balistes</i> spp. 0·01, Miscellaneous 4·01.
(8) Travancore-Cochin and south Malabar (Cape Comorin to Ponnani River)	147,588	<i>Stolephorus</i> spp. 20·53, <i>Trichiurus</i> spp. 16·99, Sharks 18·67, <i>Clupea atricauda</i> 6·54, <i>Sardinella fimbriata</i> 5·23, <i>Arius</i> spp. 4·54, <i>Sardinella</i> sp. 2·97, <i>Sardinella longiceps</i> 2·56, <i>Lactarius lactarius</i> 2·29, Squids 2·28, <i>Leiognathus</i> spp. 2·52, <i>Chorinemus</i> spp. 1·84, <i>Caranx</i> spp. 1·79, <i>Synagris</i> spp. 1·48, <i>Rastrelliger canagurta</i> 1·55, <i>Lutjanus</i> sp. 1·34, Prawns 1·11, <i>Scianoides</i> spp. 1·01, <i>Sphyrana</i> spp. 0·93, <i>Otolithus argenteus</i> 0·86, <i>Sillago sihama</i> 0·62, <i>Euthynnus</i> spp. 0·51, <i>Cynoglossus</i> spp. 0·35, <i>Clupea lile</i> 0·33, <i>Stromateus</i> spp. 0·24, <i>Sepia</i> , 0·17, <i>Engraulis mystax</i> 0·15, <i>Opisthopterus tartoor</i> 0·15, <i>Mugil</i> spp. 0·11, <i>Cybium guttatum</i> 0·09, <i>Sciæna</i> spp. 0·06, <i>Dussumieria</i> spp. 0·07, <i>Ambassis</i> spp. 0·04, <i>Chirocentrus dorab</i> 0·04, <i>Sardinella melanura</i> 0·02, <i>Chactxssus chacunda</i> 0·02.
(9) Malabar and South Kanara (north of Pon-	50,709	<i>Rastrelliger canagurta</i> 50·37, <i>Sardinella longiceps</i> 9·64, <i>Cynoglossus</i> spp. 7·67, <i>Penaeus</i> spp. 7·21, <i>Sardinella fimbriata</i> 5·41, <i>Leiognathus</i> spp. 4·07, <i>Clupea</i>

26 nani River to Mangalore).

			<i>lile</i> 3·24, <i>Sciana glauca</i> 3·09, <i>Caranx</i> spp. 2·40, <i>Arius</i> spp. 1·27, <i>Stolephorus</i> spp. 1·03, Sharks 0·78, Rays 0·11, Skates 0·02, <i>Trichiurus haumela</i> 0·66, <i>Stomateus</i> spp. 0·36, <i>Cybium</i> spp. 0·21, <i>Otolithus ruber</i> 0·06, <i>Ambassis</i> spp. 0·06, <i>Dussumieria hasselti</i> 0·06, <i>Elacate niger</i> 0·07, Miscellaneous 2·21.
(10)	Kanara, Karwar and Konkan coast (north of Mangalore to south of Ratnagiri)	87,287	<i>Rastrelliger canaguria</i> 55·27, <i>Sciana</i> spp. 20·47, <i>Sardinella longiceps</i> 5·74, <i>Arius sona</i> 5·27, <i>Sardinella fimbriata</i> 2·79, <i>Scianoides brunnus</i> 1·42, <i>Otolithus ruber</i> 1·19, Sharks 1·18, Rays 0·14, Skates 0·05, <i>Equula insidiatrix</i> 1·03, Crabs 0·71, <i>Sardinella brachysoma</i> 0·66, <i>Cynoglossus</i> spp. 0·61, <i>Dussumieria hasselti</i> 0·61, <i>Opisthopterus tartoor</i> 0·44, <i>Engraulis</i> spp. 0·44, <i>Lactarius lactarius</i> 0·35, Prawns and Lobsters 0·31, <i>Cybium</i> spp. 0·28, <i>Caranx</i> spp. 0·19, <i>Stromateus</i> spp. 0·15, <i>Mugil</i> spp. 0·13, <i>Chirocentrus dorab</i> 0·08, <i>Sphyrana</i> spp. 0·06, <i>Chatessus</i> spp. 0·06, <i>Gerres</i> spp. 0·05, <i>Polynemus</i> spp. 0·05, <i>Therapon</i> spp. 0·03, <i>Trichiurus savala</i> 0·03, Miscellaneous 0·21.
(11)	Bombay and Gujarat (Ratnagiri to Broach)	127,699	Prawns 47·78, <i>Harpodon nehereus</i> 18·70, <i>Coilia</i> spp. 12·56, <i>Synagris</i> spp. 3·81, <i>Sciana</i> spp. 3·61, <i>Bregmaceros maclellandi</i> 2·47, <i>Trichiurus savala</i> 2·28, <i>Stromateus</i> spp. 2·03, <i>Cynoglossus</i> spp. 1·11, <i>Otolithus</i> spp. 0·97, <i>Upenoides</i> spp. 0·44, Sharks 0·40, Rays, 0·06 Skates 0·01, <i>Thrissocles</i> spp. 0·32, <i>Sardinella sirm</i> 0·27, <i>Arius</i> spp. 0·27, <i>Sardinella</i> spp. 0·25, <i>Chirocentrus dorab</i> 0·20, <i>Scianoides</i> spp. 0·21, <i>Polynemus</i> spp. 0·17, <i>Cybium</i> spp. 0·11, <i>Psettodes erumei</i> 0·11, <i>Hilsa</i> spp. 0·05, <i>Opisthopterus tartoor</i> 0·03, <i>Lutjanus annularis</i> 0·02, <i>Chorinemus</i> spp. 0·02, <i>Sphyrana</i> spp. 0·02, <i>Euthynnus</i> spp. 0·02, <i>Muranesox</i> spp. 0·02, <i>Congrellus</i> sp. 0·02, Miscellaneous 1·68.

TOTAL .. 501,884*

* This total does not include the figures for the Saurashtra Zone or the figures for landings by mechanised vessels.