GOVERNMENT OF INDIA
CENTRAL MARINE FISHERIES RESEARCH STATION
MANDAPAM CAMP

ANNUAL REPORT OF THE CHIEF RESEARCH OFFICER FOR THE YEAR ENDING 31st MARCH 1956

ADMINISTRATIVE AND GENERAL

1. Studies on the sea fishery resources of India and their utilization were continued during the year by the Central Marine Fisheries Research Station. In addition to the work at the Headquarters Station at Mandapam, Sub-Station at Kozhikode, Research Units at Bombay, Karwar, Ernakulam (Cochin) and Madras and at the existing fishery survey centres, a new Research Unit to study the fisheries of the Andhra Coast was set up at Waltair in March 1956. As a preliminary to the setting up of a Research Unit at Calcutta a nucleus staff has been posted there. The Research Units at Ernakulam and Karwar have been strengthened and accommodated in more suitable buildings. Additional Survey Centres have been established at Ratnagiri and Mangalore and the Survey Centre at Adirampatnam has been shifted to Nagapatnam. Further progress has been made on the scheme on the collection and analysis of oceanographic data. Three more numbers of the *Indian Journal of Fisheries*, Volume II, Nos. 1 & 2 and Volume III, No. 1, were published during the year.

2. The total catch of marine fish in India during 1955 was estimated at 5,86,315 tons as compared to 5,78,966 tons in 1954 showing a slight increase of over 7,000 tons over the previous year. Among the groups forming the major fisheries, prawns, mackerel and oil-sardine all registered a slight decline. There was an enormous increase in the Bombay-Duck landings and some appreciable improvement in the catches of other sardines, polynemids, eels, ribbon-fish, flying-fish, carangoids, sharks and rays, perches and other miscellaneous varieties. These were mostly offset by a decline in the total yield of sciænids, cat-fishes, pomfret, silver-bellies, anchovies and whitebait. Nearly 43% of the catch was landed in the last quarter, October to December, while the third quarter, as usual, was the poorest with 14% of the total. On the Andhra Coast both zonal landings and the catch per unit of effort increased in 1955 pointing to the availability of more fish in that region. The figures relating to catch per unit of effort in zones like West Bengal, Orissa, Travancore-Cochin, Malabar, Kanara and Bombay Coasts go to indicate the possibility of over-fishing or the

operation of the law of diminishing return in these areas, but the data are not conclusive and studies in this direction have therefore been intensified.

3. The Offshore Fisheries Research Unit at Bombay paid special attention to the examination of trawl-fish landings, and compilation and analysis of trawling data for the years 1949–50 to 1954–55. The high catch rates obtained during the previous season have been maintained this season with the peak in December 1955. The trends of catch rates from different regions showed variations between 1235·5 and 2365·0 lb. per hour. Very high catches of pomfrets from the Bombay region in January 1956 were a notable feature of this year's offshore fishing.

Analysis of trawling data for the years 1949–50 to 1954–55 revealed that the principal trawling grounds were the Bombay region, Gulf of Cambay, Veraval region, Porbundar region and the Dwarka or Gulf of Cutch region. Of these, the Dwarka region proved to be the richest, which also yielded the best landings of prime fishes like *Dara* and *Koth*. In regard to distribution by depth, it has been observed that the bulk of the yield was from nearabout the 20-fathom line, with *Dara* and *Koth* showing relatively greater abundance on the landward side of this line, while *Ghol*, *Wam* and *Karkara* occurred in quantities a little to the seaward side of this line. It also appears possible that there are certain optimum temperatures limiting the abundance of different fishes even within the limited range found in our waters.

4. Fishery biological information of value has been obtained on the Malabar Sole and juvenile sardines. The occurrence of the larvæ of *Sardinella fimbriata*, the most common sardine of Indian waters, which was reported for the first time last year from the sea near Vizhingam (Travancore-Cochin State), has been confirmed and it is presumed that this area is an important breeding ground for the sardine. Post-larvæ of the mackerel and *Cybium* spp. have also been observed from this area. Work on the Indian mackerel has been expanded to include population studies from different zones.

Investigations carried out on prawn fisheries in this Institute during the past few years point to the possible existence of rich crops of prawns in deeper waters off the coasts of Travancore-Cochin and Malabar, but this could not be confirmed in the absence of an experimental fishing vessel. The F.A.O. and Norwegian fishery experts have been informed of these possibilities, and experimental fishing under Technical Assistance Projects of the F.A.O. has confirmed this view for the Malabar Coast, where the existence of a 140-mile long and 4-mile wide shrimp ground has been observed. The apparent association of prawn fisheries with mud banks as indicated at

Alleppey (Travancore-Cochin State) and probably at other places on the West Coast is proposed to be investigated as fully as facilities permit.

The Government of India have recently declared that the territorial waters of India will extend to a distance of six nautical miles measured from the appropriate baseline. It has been stipulated that large power boats should not operate in the territorial waters.

5. Studies on *Tilapia* are being revived following the decision to introduce this fish into some parts of India. Experiments have been carried out for evolving better methods of curing and preserving fish and for the preparation of quality fish-meals by cheap methods.

6. Cottage industry methods for utilization of marine algae have been developed. The seaweeds and seagrasses of the Indian coasts, at present unutilized, could be turned into a highly valuable marine resource. There are possibilities for the development of a number of by-products. The work carried out at this Institute had for its aim the production of seaweed products without the agency of any extensive machinery, these simple processes being ideally suited for small-scale cottage industries and promising a subsidiary income to the fishing villages. Agar, algin, food products, stockfeed and manure are seaweed products which could be successfully developed in India.

A training course in the utilization of seaweeds was conducted by the Research Station from the 15th November 1955 to the 15th December 1955. Six candidates (3 nominated by the Government of Bombay and one each by the Governments of Madras, Orissa and Andhra) attended the course. The trainees received instruction and practical training in the handling of the raw-material, in the processes of manufacture of agar, algin, stockfeed and compost, and in the value of agar and algin in various forms in industry and medicine. An exhibition of seaweed products and their application in food industries, etc., including a demonstration of their manufacture on a cottage industry scale, was held at the conclusion of the training. It is hoped that such training would enable popularization of the methods through the National Extension Service Blocks and the Community Development Projects.

In order to focus public attention on the utilization of seaweeds relevant material with illustrations for the printing of a folder on " Seaweeds " has been prepared and forwarded to the Government of India. Exhibits of seaweeds and seaweed products have been sent to a few educational institutions and other centres for exhibition purposes.

7. Models of fishing craft and gear from different parts of the country are being assembled and 80 have already been displayed in an extension of the museum where additional show-cases have been provided. Ninety items of fish products brought from Japan by Dr. N. K. Panikkar have also been labelled and displayed in the museum. Many additions have been made to the reference collections. Besides living organisms required for scientific study, live fish and animals of popular interest have been regularly maintained in the exhibition tanks of the aquarium. With these additions, the museum and the aquarium have proved to be major attractions to visitors, who numbered about three thousand during the year.

8. The year 1955–56 marked the close of the First Five-Year Plan period. Government had sanctioned a recurring grant of over Rs. 8 lakhs and a non-recurring grant of Rs. 2 lakhs under the First Five-Year Plan. Certain items of equipment required for research and extension work were also made available under the T.C.M. Programme. An additional provision of over Rs. 12 lakhs was allotted for the procurement of a Research Vessel and for construction of permanent staff quarters at Mandapam and a permanent building for accommodating the Research Substation at Kozhikode. Owing to non-availability of a suitable vessel, the grants allotted had to be surrendered to Government. Although expenditure sanction for the construction of buildings was received during 1955–56, work on the project could only be started early in 1956–57. The construction of a Cold Storage Plant and Workshop have been partly completed, but the Cold Storage Plant and Workshop equipment are still to be received and installed. Principal projects started under the First Five-Year Plan were (1) initiation of studies on Offshore Fisheries and charting of fishing grounds at Bombay, (2) construction of an experimental marine fish farm at Mandapam, and (3) intensified studies on the mackerel, sardines, shell fisheries and seaweeds.

A provisional allotment of Rs. 22·45 lakhs under recurring and Rs. 12 lakhs under non-recurring has been made by Government for this Research Station during the Second Five-Year Plan period (1956–61) for implementation of schemes of detailed investigations on (1) offshore fisheries, (2) correlation of oceanographic and fishing conditions, (3) populations of sardines and mackerel, (4) prawn fisheries both inshore and offshore, (5) fish cultural practices for coastal areas, and (6) for the establishment of a reliable system of sea fisheries statistics with emphasis on the forecasting of fisheries in relation to other biological and chemical factors.

10. Essential glassware, chemicals, scientific equipment and furniture required for day-to-day work were procured during the year. Among the major items of scientific equipment purchased could be mentioned a few microscopes, one Leitz Panphot photomicrographic equipment and one pH meter. A small portable fire-engine for the headquarters and a canoe for use at the Karwar Research Unit were also procured during the year. Under the T.C.M. Programme, a generating set to power the motion picture projector, a 16 mm. motion picture projector, and two jeeps have been received. The jeeps are proposed to be utilized for research and extension work, one at the Headquarters and the other at the Substation at Kozhikode.

11. Substantial additions have been made to the Library and subscriptions to serial publications of fisheries interest were increased during the year.

12. The following officers have been confirmed in permanent posts by the Government with effect from the 13th October 1953:—

Name of Officer	*Name of Post*
(1) Dr. N. K. Panikkar	Chief Research Officer
(2) ,, B. S. Bhimachar	Research Officer (Senior Scale)
(3) ,, R. Raghu Prasad	do. (Junior Scale)
(4) ,, H. L. Arora	do. do.
(5) Shri R. Velappan Nair	Assistant Research Officer
(6) ,, L. B. Pradhan	do.
(7) ,, K. Virabhadra Rao	do.
(8) ,, S. K. Banerji	do.
(9) ,, N. K. Velankar	do.
(10) ,, R. Jayaraman	do.
(11) Dr. (Mrs.) F. Thivy	do.
(12) Miss Mary Samuel	do.
(13) Dr. R. Subrahmanyan	do.
(14) ,, G. Seshappa	do.

Ten Fishery Survey Assistants who had put in a number of years' service were also confirmed with effect from the 13th October 1953.

13. The following posts were sanctioned during the year:—

(1) One Research Officer.

(2) Three Assistant Research Officers.

Shri L. B. Pradhan, Assistant Research Officer, who returned after special training in the U.K. in September 1955, was temporarily appointed to the new post of Research Officer and was posted at Waltair in charge of the Andhra Fisheries Research Unit. One new post of Assistant Research Officer was filled in May 1955, by the appointment of Miss Nora G. Sproston. In June 1955, Shri S. V. Suryanarayana Rao took over charge of the post of Assistant Research Officer (Fish Curing) from Dr. V. Krishna Pillai, who was subsequently posted in March 1956, to work as Assistant Research Officer (By-products Utilization). Shri M. S. Prabhu, a Permanent Research Assistant, was appointed to officiate as Assistant Research Officer (Sharks and Rays) in June 1955. A few Class III and IV posts were sanctioned by the Government during the year. In order to cope with the programme of work included in the First Five-Year Plan, pending sanction by Government of the required posts, a certain number of Class III and IV posts were also created by the Chief Research Officer during the year and filled in the usual manner. Shri R. Viswanathan, Assistant Research Officer, was granted study leave for two years to prosecute study in Oceanography at the Kiel University (West Germany).

14. Dr. N. K. Panikkar attended the United Nations Technical Conference on Conservation of the Living Resources of the Sea held at Rome in April-May, 1955, as Alternate Delegate for India. The question of fisheries conservation was examined in great detail at the Conference and certain general conclusions have been arrived at. These conclusions will be of considerable help in developing programmes of investigations on marine fisheries. Dr. Panikkar also participated as Observer at the Conference on Marine Biological Laboratories held at Rome at the same time.

Dr. N. K. Panikkar represented the Government of India at the sixth meeting of the Indo-Pacific Fisheries Council held at Tokyo (Japan) from the 30th September to 14th October 1955, and was unanimously elected as Chairman of the Council till the end of the next session to be held at Bandung (Indonesia) in 1957. He also participated in the meetings convened by the UNESCO at Tokyo on marine sciences. He served as Vice-Chairman of the regional meeting of Representatives of Marine Science Institutes and as Observer on behalf of the I.P.F.C. at the meeting of the Interim Advisory Committee on Marine Sciences.

Dr. Panikkar participated in the first meeting of the Standing Sub-Committee on Oceanography held in Calcutta in January 1956, which also considered and recommended proposals sent up by this Research Station for extension of the scheme for collection of oceanographic data. As decided

at this meeting a symposium on oceanography was held at Waltair (Andhra State) in May 1956, in which Dr. Panikkar, Dr. R. Subrahmanyan and Shri A. A. Rama Sastry participated.

The *Hilsa* Sub-Committee meeting of the I.P.F.C. which was held at Calcutta from the 30th June 1955 to 4th July 1955 with representatives from India, Pakistan, Burma and the I.P.F.C. Secretariat was opened by Dr. Panikkar; he also served on the Committee for standardization of names of fishes constituted by the Government of India.

15. Dr. R. Raghu Prasad, Research Officer, held charge of the current duties of the Chief Research Officer during the absence of Dr. Panikkar from Headquarters.

16. During the year Shri V. Krishna Pillai, M.Sc., was awarded the Ph.D. Degree of the Travancore University for work carried out by him at this Institute as a Research Scholar, the results of which were submitted to the University in the form of a thesis entitled " Physiological and Biochemical Investigations on Marine Algae". For studies carried out at the Research Station on the egg-masses and larval development of some gastropods from the Palk Bay and the Gulf of Mannar, Shri A. V. Natarajan, B.Sc. (Hons.), was awarded the M.Sc. Degree of the Annamalai University. Two other research scholars, Sarvashri K. Ramalingam, M.Sc., and M. Vasudev Pai, M.Sc., also made substantial progress with their work for the Ph.D. Degrees of the Madras and Bombay Universities respectively. Sarvashri K. C. George, K. Krishna Kartha and D. V. Pahwa were admitted in the Institute as honorary research workers during the year.

17. The visit of Shri Ajit Prasad Jain to this Institute on the 22nd August 1955, was the first visit of the Union Minister for Food and Agriculture to the Headquarters of this Research Station. The Minister visited the various Sections of the Station and the activities were explained by the Chief Research Officer and staff. The Minister also addressed a staff meeting. Later, on the 28th December 1955, Shri P. N. Thapar, I.C.S., Secretary to the Government of India, Ministry of Food and Agriculture, also visited the Research Station. Shri M. Bhaktavatsalam, Minister for Agriculture and Fisheries, and Shri B. Parameswaran, Minister for Religious Endowments and Transport, Madras State, also visited the Research Station in June 1955. Sir M. Bhavani Sankar Niyogi (former Vice-Chancellor, Nagpur University and Chairman, Madhya Pradesh Public Service Commission and Chief Justice, Nagpur High Court) was another distinguished visitor to the Institute in June 1955.

Among distinguished foreign visitors to the Research Station could be mentioned Dr. Anton F. Bruun, the noted Danish Zoologist and

Oceanographer, who led the " Galathea " expedition, and Prof. La Fond of the United States National Electronics Laboratory, California and Visiting Professor of Oceanography at the Andhra University, who visited the Research Station in November 1955 and February 1956 respectively. U Ba Kyaw, Fisheries Executive Officer, Burma, Dr. Altevogt, a German scientist, and four Philippine scientists deputed for training in India under the T.C.M. Aid Programme also spent short periods at the Institute discussing scientific and fisheries problems. Several parties of University students, research workers and trainees from various other educational institutes also visited the Station during the year.

Among the visitors to the subordinate establishments of the Institute could be mentioned Mr. R. N. Fiedler, Chief of the Technical Assistance Programme, F.A.O., Rome, Mr. Allen T. Sherman, President of the International Fisheries Corporation, New York, Mr. T. M. Nilsen, Chief Fisheries Adviser and Mr. A. A. Solbakk, Secretary of the Indo-Norwegian Project, all of whom visited the Prawn Research Unit at Ernakulam.

18. The Research Station actively participated in the All-India Fisheries Exhibition held at Cuttack from the 20th to the 26th February 1956, by the Government of India in collaboration with the Orissa Government. The Exhibition was intended to educate the general public with fishery activities in India, both in the public and private sectors, especially with the activities of the Central fisheries institutes and the fisheries departments of various States. A certificate of merit was awarded to this Research Station by the Chairman of the Exhibition Committee. The Chief Research Officer contributed an article on marine fisheries research to the Souvenir volume published on the occasion. Another exhibition on somewhat similar lines was held by the Andhra State Government at Kakinada from the 18th to 21st March 1956, in which also the Research Station participated.

19. An interest-free loan of Rs. 1,500 was sanctioned by the Government for the departmental Canteen and Store and this amount is being utilized for stabilizing and expanding the activities of the Canteen and Store. A film club has been organized and periodical shows of educational films have been arranged. To meet a long-felt need for the education of the children of the staff of the Institute, a privately organized nursery school was started in June 1955, and is being continued. Government support in the form of grant-in-aid for the school is awaited.

20. A list of research papers published by the staff of the Research Station in 1955–56 is given at the end of this Report.

Fishery Survey

21. The analysis of the data collected in 1955 was completed during the year under review. The total weight of marine fish landed in India in 1955 is estimated at 586,315 tons (596,696 metric tons) distributed along the zones as shown below. These figures are exclusive of the production in Cutch (see note below):—

Table I

Zonal statistics of total marine fish landings

Zones	Fish landings in tons (1 ton = 2,240 lb.) 1954	1955
(1) West Bengal and Orissa	9,356	5,874
(2) North Andhra Coast (South of Gopalpur to North of Visakhapatnam)	5,447	10,586
(3) Central Andhra Coast (South of Visakhapatnam to Masulipatnam)	19,840	50,488
(4) South Andhra Coast (South of Musalipatnam to Pulicut Lake)	6,330	2,028*
(5) North Coromandel Coast (Pulicut Lake to Cuddalore)	24,245	12,328
(6) South Coromandel Coast (South of Cuddalore to Devipatnam)	23,589	15,021
(7) South of Palk Bay and Gulf of Mannar (South of Devipatnam to Cape Comorin)	9,298	9,074
(8) Travancore-Cochin (Cape Comorin to Ponnani River)	78,786	118,108
(9) Malabar and South Kanara (North of Ponnani River to Mangalore)..	79,304	42,700
(10) Konkan and Kanara Coast (North of Mangalore to South of Ratnagiri)	28,858	33,960
(11) Bombay and Gujarat Coast (Ratnagiri to Broach) ..	275,820	267,806
(12) Saurashtra and Gujarat Coast	17,121	18,010
(13) Mechanised Vessels	972	332†
TOTAL ..	578,966	586,315

Note.— (i) * No data were collected in South Andhra coast. The figure given here is the average of last five years.

(ii) † The figures for mechanised vessels for 1955 relate only to the landings of Government of India cutters and Reekie boats operating in Bombay. The data of catches obtained by powered vessels operating elsewhere have not yet been received from the State Governments. The landings for indigenous boats fitted with motors and operating in Bombay waters have been included in the figures of landings in Bombay Zone.

(iii) The landings along Cutch coast is believed to be of the order of 4,000–4,500 tons, of which 1,500–2,000 tons appear to be prawns. Arrangements are being made to include Cutch in the survey programme.

The decline in fish landings along the West Bengal and Orissa coast was due to a partial failure of the sardine fishery. The rise in fish landings in North Andhra coast was, however, due to an improvement in the sardine as well as the other clupeoid fisheries. Along Central Andhra coast also there was some improvement in the sardine, *Anchoviella* and *Thrissocles* fisheries. But the substantial increase in the catch in this region resulted from successful fisheries of *Sciæna*, *Caranx*, *Leiognathus* and *Lactarius*. The ribbon-fish fishery also showed some improvement in this zone.

The decline in the zonal landings in North Coromandel coast was due mainly to failure of *Anchoviella* and *Thrissocles* fisheries as also to some decline in the sardine, silver-belly and seer-fish fisheries in this zone. Similarly a failure of the catfish fishery, along with poor landings of *Sciæna*, elasmobranchs and polynemids, accounted for a decline in the zonal landings of South Coromandel coast.

Along the South Palk Bay and Gulf of Mannar the total landings, in spite of a complete failure of *Anchoviella* fishery, did not suffer, because there was a successful ribbon-fish fishery.

There was a considerable increase in the total landings in Travancore-Cochin in 1955. This was mainly due to heavy landings of *Balistes* spp., the fishery of which was not so successful in 1954. Some improvement in the landings of oil-sardines and other sardines also accounted for the rise in the total catch of this zone in 1955.

The sharp decline in the total catch in Malabar zone was mainly due to a substantial decrease in the oil-sardine and mackerel catches and also a partial failure of pomfret, *Anchoviella*, *Leiognathus* and catfish fisheries. There was, besides, a reduced yield of carangids in this zone, though ribbon-fish fishery fared better than that of last year.

On the Kanara coast, the total landings were higher than in 1954. Some improvement in sardine fishery was responsible for this, more so since the mackerel fishery was not so good as that of last year.

The catch in Bombay zone was slightly lower and the fishery was characterized this year by a general fall in the catch of shrimps, sciænids, ribbon-fish and *Bregmaceros*. This was, however, compensated by a bumper yield of Bombay-duck, together with a very high yield of polynemids.

In Saurashtra, the landings showed a slight improvement.

The composition of the total catch for the whole of India is shown in Table II.

Composition of fish landings

Name of fish	Quantity landed in tons				Percentage of total catch			
	1954		1955		1954		1955	
1. (*a*) Prawns			43,898				7·49	
(*b*) Shrimps..			60,444				10·31	
(*c*) Other Crustacea			600				0·10	
		151,789		104,942		26·22		17·90
2. Mackerel		27,812		22,436		4·80		3·83
3. Seer fish		6,156		5,950		1·06		1·01
4. (*a*) Oil-sardine	33,416		29,966		5·77		5·11	
(*b*) Other sardines	24,621		41,031		4·25		7·00	
(*c*) *Hilsa*	2,013		2,284		0·35		0·39	
(*d*) Other clupeoids ..	20,403		19,159		3·53		3·27	
		80,453		92,440		13·90		15·77
5. Anchovies and whitebaits ..		31,309		25,257		5·41		4·31
6. Bombay-duck		35,482		102,473		6·13		17·48
7. Jewfish (Sciænids)		72,055		42,598		12·45		7·27
8. Ribbon-fish		29,089		32,155		5·02		5·48
9. Catfish		21,354		18,383		3·69		3·14
10. Carangids		16,150		18,070		2·79		3·08
11. (*a*) Sharks			14,685				2·50	
(*b*) Rays			4,305				0·73	
(*c*) Skates			1,138				0·19	
		15,767		20,128		2·72		3·42
12. Pomfret		18,320		13,466		3·16		2·30
13. Eels		..		12,156		..		2·07
14. Polynemids		2,248		11,575		0·39		1·97
15. Perches		4,713		6,963		0·81		1·19
16. Silverbellies		14,713		6,856		2·54		1·17
17. *Lactarius*		5,609		5,563		0·97		0·95
18. Soles		1,657		5,507		0·29		0·94
19. Dorab		5,294		4,315		0·91		0·74
20. Tunnies		2,284		3,318		0·39		0·56
21. Flying-fish		1,935		3,207		0·33		0·55
22. *Bregmaceros*		9,599		3,140		1·66		0·54
23. Red mullet		1,513		1,110		0·26		0·19
24. *Mugil*		40		205		0·01		0·03
25. *Sphyræna*		3,988		387		0·69		0·07
26. *Hemirhamphus* and *Belone* ..		..		434		..		0·07
27. Miscellaneous		19,637		23,281		3·40		3·97
Total ..		578,966		586,315				

Comparing this with the figures for 1954, we find that the salient features of 1955 fisheries were as follows.

(*a*) An enormous increase in Bombay-duck landings was noticed during the year, along with appreciable improvement in the catches of polynemids, other sardines and eels and also a slight increase in the yield of sole.

(*b*) Heavy fall in the landings of prawns and shrimps and jewfishes occurred, and a perceptible fall in the catches of silver-bellies, *Sphyræna* and *Bregmaceros*. Catches of mackerel, oil-sardine, anchovies, whitebaits and pomfrets also showed a decline.

The enormous increase in Bombay-duck landings was due to improved catch of this fish in Bombay zone. Similarly improved catches of polynemids and eels in Bombay zone accounted for the rise in the total landings of these fishes.

The increase in the total catch of other sardines was mainly due to a good crop of *Sardinella fimbriata* in Travancore-Cochin. Similarly the increased landings of soles was due to improvement in the sole fishery in Malabar and Travancore-Cochin.

Heavy fall in the total catch of prawns and shrimps and jewfishes was mainly due to reduced catches of these in the Bombay zone. The fall in the catch of *Bregmaceros* was also due to the same reason. Failure of *Leiognathus* fishery in Madras and Malabar, resulted in the diminished total for this fish in 1955. The poor catches of mackerel in Malabar and Kanara coast and of oil-sardine in Malabar coast was responsible for the decline in the yield of these fishes. Though the overall catch of mackerel was less than that of last year, the local catches showed improvement at certain places.

The failure of the pomfret fishery in Malabar resulted in the fall in the total pomfret catch in India. The fall in the *Anchoviella* catch was due to a partial failure of this fish along the North Coromandel coast, and to a reduced catch in Travancore-Cochin. Similarly the partial failure of *Thrissocles* fishery in Madras coast was responsible for lowering the total catch of the fish in 1955.

Nearly 43% of the catch was landed during the last quarter of 1955. The third quarter, as usual, was the poorest with 14% of the total catch.

Notes on the Important Fisheries

22. Comparison of the figures of catch per unit of effort and zonal catch figures in 1955 with those of 1954 show that:—

(*a*) In West Bengal, Orissa, Malabar and Bombay zones, both the zonal landings and the figures of catch per unit effort for the zones show a decline

in 1955. Data are insufficient to indicate any overfishing but positive decline in fisheries is evident.

(*b*) On the Andhra coast, both zonal landings and the catch per unit of effort increased in 1955, indicating thereby that the availability was more in this region in 1955.

(*c*) On the Coromandel coast, the zonal catch diminished, but the catch per unit of effort remained more or less the same. The situation merely indicates that lesser effort was put in, in 1955.

(*d*) On the Travancore-Cochin and Kanara coasts, the zonal landings increased, but figures of catch per unit of effort decreased. This indicates that the higher catches in 1955 were due to higher effort and as the effort increased, the catch per unit of effort fell according to the law of diminishing return.

(*e*) On the Gulf of Mannar coast and in the Saurashtra coast, zonal landings remained more or less the same as in 1954, but the catch per unit of effort increased; in other words, the same amount of catch was obtained with less effort. This may mean greater availability of fish in 1955 in these zones; this also indicates that a fuller exploitation was not made in these zones in 1955.

Fishery Biology

(1) *At Mandapam*

23. Owing to a cyclone, followed by very heavy rains during December 1956, the fishing season was interrupted for about a month in the area around Mandapam. The places affected included many areas adjoining the Palk Bay and, on the east coast, around Adirampatnam.

24. *Observations on the* choodai *fishery.*—The *choodai* fishery began in April and lasted up to about the middle of November. Both in total yield and catch per unit of effort, there were two peaks—one in May and the other in October. The total catch in 1955 was about 1,470 tons, while in 1954 season it amounted to about 2,100 tons.

From April to August the catches were supported mainly by *Sardinella albella*; but from September onwards, *S. gibbosa* was the dominant species. Hand-nets (used along with torches) took only the smaller length-groups of the 1955-year-class of *Sardinella* spp. Shore-seine catches were dependent mainly on the 1955-year-class, but at Dhanushkodi a small percentage of the landings included the 1954-year-class as well. The gill-nets operated on the 1954-year-class from April to June and on the 1955-year-class from September onwards.

A partial correlation was observed, between weekly fluctuations in *choodai* catches on the one hand, and of copepods and diatoms in plankton samples collected from the fishing grounds on the other. During the periods of swarming of *Noctiluca*, catches were generally low. Critical examination of the data on the *choodai* fisheries during the past few years is in progress.

TABLE III

Choodai *Statistics*

	Seasons							
	1952		1953		1954		1955	
	(*a*)	(*b*)	(*a*)	(*b*)	(*a*)	(*b*)	(*a*)	(*b*)
Total catches for the season..	26·7 tons	330 tons	1 ton	94·0 tons	39·3 tons	690 tons	12·0 tons	422·3 tons
Average catch per man-hour for the season	7·8 lb.	11·0 lb.	1·5 lb.	9·5 lb.	8·3 lb.	28·9 lb.	6·2 lb.	26·0 lb.

(*a*) Torch and hand-net boats at Munakkad.

(*b*) Shore-seines at Thedai and Pullamadam.

25. *The mackerel fishery.*—The mackerel fishery of Mandapam during the 1955–56 season was the best out of the past five years. Total landings at Pudumadam and Muthupet amounted to about 125 tons. Night catches were far more productive than daylight operations.

Observations were also made on the mackerel fishery at Malpe during the last quarter of 1955 where the fishery started in October. Very good catches were recorded during that month. The yield declined in November, but in December the catches improved considerably.

26. *Raciation studies on Indian mackerel.*—Since discrete populations if such exist, most probably migrate over considerable distances and enter the commercial fisheries at more than one centre as the season progresses, it is insufficient to study fish from a few isolated centres alone, however prolific the supply may be, *e.g.*, Kozhikode and Karwar. Therefore, it was decided to conduct investigations from the headquarters where samples were sent from as many stations as possible and at frequent intervals throughout the year. Thus, simultaneous samples could be examined from widely separated places by the same workers. At least 50 criteria for each fish seemed worthy

of preliminary record—some of these are qualitative but most are quantitative. Even though some of these are not intended for immediate use in statistical analysis, they have been included for the sake of collaborative comparisons with series of similar data taken by workers in other countries. One outstanding feature of this work is that all data, including gill-raker and vertebral counts, have been taken from *numbered* (and sexed) fishes—and the fully labelled axial skeletons have been preserved. In all the published work we know, several categories of data have been recorded from bulked samples, so that correlation with sex, fin-count discrepancies, etc., were impossible. It is evident that in possibly mixed samples this individual correlation is essential.

Preliminary work showed that variations are abundant, but that in our inshore waters (*i.e.*, excluding island fisheries) only one species of mackerel occurs, as has been indicated in previous reports. Since no detailed investigations on Indian mackerel have been recorded we have no clue to the characters which may be significant in labelling populations, namely, which characters are influenced by sex or maturity, or which show regression with growth. Another (physiological) character, studied at the same time on each fish, is the phase of maturity which, it is presumed, may be correlated with structural variation when populations happen to be mixed. In this connection it is found misleading to rely on the conventional relative-volume-of-gonad method. Hence the ovaries are all examined microscopically and diameter ranges of ova noted.

Over one thousand fishes have been examined in this way. The work is proceeding. Recent statistical checks showed that gill-raker counts are non-significant. The arrays in the different sex and length categories for each locality are as yet insufficient to attempt other eliminations for non-significant characters.

27. *Dorab fishery.*—Results of dorab investigations carried out during the previous years have been compiled with a view to their publication.

28. *Light fishing.*—Preliminary experiments have been carried out on fishing with lights. An artificial platform was erected for this purpose on the Gulf of Mannar side of the Central Marine Fisheries Research Station. Clupeoids, *Hemirhamphus* and squids formed the principal catches in the nets operated with lights. Interesting data and field experience in this method of fishing—probably tried for the first time in India—have been gathered and it is hoped to continue these experimental operations during the next fishing season.

29. *Fishery investigations on Rameswaram Island.*—The total amount of fish landed on the Rameswaram Island during the period was 1,021·36 tons, of which the gill-nets, the shore-seines and the boat-seines contributed 431·98, 53·47 and 535·91 tons of fish respectively. The trend of the fishery and the seasonal fluctuations in the total catches during the period showed a similarity with the data for the early years of 1953 and 1954. During December, however, due to a cyclone, there was a temporary setback in fishing operations resulting in heavy fall in fish landings. The catch composition is given below:—

1.	*Leiognathus splendens*	42·406%
2.	*Chirocentrus dorab*	21·302%
3.	*Scomberomorus guttatus*	13·453%
4.	*Scoliodon* sp.	6·755%
5.	*Lactarius lactarius*	5·090%
6.	*Sardinella gibbosa*	4·458%
7.	*Dussumieria hasselti*	1·750%
8.	*Gerres filamentosus*	1·197%
9.	*Chorinemus* sp.	0·874%
10.	*Caranx* sp.	0·869%
11.	*Sillago sihama*	0·571%
12.	*Hemirhamphus georgii*	0·259%
13.	*Pellona* sp.	0·212%
14.	*Rastrelliger canagurta*	0·202%
15.	*Sciæna indica*	0·175%
16.	*Arius* sp.	0·119%
17.	*Therapon quadrilineatus*	0·076%
18.	*Cypsilurus oligolepis*	0·073%
19.	*Upeneus indicus*	0·064%
20.	*Anchoviella indica*	0·028%
21.	*Formio niger*	0·025%
22.	*Trichiurus savala*	0·018%
23.	*Mugil* sp.	0·014%
	TOTAL ..	100·000%

Only the first 10 contributed to a major share of the fisheries of the Island. The rest of the species altogether contributed only 10% of the total. While *L. splendens* reached the peak of season only once in the year, during the month of July, *C. dorab* was abundant in March and again in September and *S. guttatus*, like *L. splendens*, had a single peak, which was in March.

(2) *At Calicut*

30. *General fishery conditions.*—The coastal fisheries in general indicated fair returns, the mackerel landings being on the whole better than those of sardines. In the first quarter both mackerel and sardine were scarce, the fishery being of a miscellaneous nature, of soles, sciænids and prawns. There was improvement during the second quarter especially in prawn fisheries and in *Caranx* fishery. Juvenile oil-sardines (7–14 cm.) were available from the middle of August to middle of September, which were replaced by adults in October. The catches of whitebait and silver-bellies were poor through the monsoon months. The fishery for Malabar sole, from the middle of August to the middle of October, yielded good catches, though intermittently. The third quarter of the year showed marked general improvement, when fair quantities of sardines of length 17–20 cm. and of mackerel of length 19–25 cm. were obtained all along the coast. The sardine fishery came to a close by the end of January, while stray catches of large-sized mackerel continued to occur in February and March.

31. *The sole fishery.*—The fishery for *Cynoglossus semifasciatus* commenced all over Malabar coast by the third week of August and a few weeks later in Travancore-Cochin and Kanara centres. The total catches for the year were better than last year's. The active fishery came to a close by early November. The dominant size-group in the catches was the 110–120 mm. group with gonads nearing maturity, though soles of smaller size, 80–100 mm., were obtained in smaller numbers by the boat-seines in the hot months. Field studies on the nature of the inshore sea bottom at the various centres and on the gut contents of samples from these places were made, to assess the relationship between the actual food of soles and available food elements in the different areas. Experiments in artificial fertilization of sole eggs for elucidation of early life-history were tried but were not successful.

32. *Ecological studies.*—The bottom fauna was poor at Calicut and Quilandy inshore areas during the monsoon months and successful re-colonization was observed during October-December period. The bottom fauna settled more quickly in Quilandy Bay than in the Calicut area.

33. *Investigations on the oil-sardine.*—The oil sardine fishery was less successful than that of last year. The noteworthy features of this year's fishery were the restricted occurrence of the juveniles, which usually form the mainstay of the fishery, and the dominance of the two to three-year-old adults during the peak period of the fishery. During the first quarter, in April and May, the fishery was poor and unsteady, comprising mainly two-year old sardines of modal size 15 to 16 cm. Their landings dwindled in June due to

the advent of the south-west monsoon. Again after occasional landings in July, there was a distinct improvement in August and early September when large quantities of juvenile sardines of size 7 to 14·5 cm. were landed at Calicut and many other centres along the Malabar Coast. The modal size of the juveniles caught at Calicut varied from 9·5 to 13 cm. By October the shoals had disappeared from the fishing grounds. The fishery improved considerably in the third quarter, with fair catches of adults (17 to 18·5 cm.), mostly of the second-year class. While the fishery was good at Malpe during this period, it was a complete failure at Karwar. A decline in the catches was noticed in January and the fishery practically came to a close by the end of the month, which was in contrast to that of the last season when the sardines continued to occur till the end of the season. But occasional catches of oil sardines were reported from some fishing centres in Travancore-Cochin during February and March.

The estimated total catch of oil-sardines at Calicut this season is 463 tons which is less than that of the previous season, when for 8 months, *i.e.*, from November to June, the total landings were 623 tons.

The period of juvenile sardine fishery at Calicut was found to coincide with the blooming of *Fragilaria oceanica* in the plankton. The subsequent decline in the juvenile sardine fishery occurred with the scarcity of this diatom in the plankton.

Spawners were rare in the sardines caught during the year and the examination of gonads showed that in most of the specimens they correspond to stages up to IV. But a few spent sardines were obtained in the month of November, during which period oil-sardine eggs were also observed in some of the plankton collections.

34. *Mackerel investigations.*—The fishery at Calicut, though it started by the second week of July and was showing signs of improvement in August, declined by September. November proved to be the peak month and there were only two months of intensive fishing, November and December. More than 83% of the total (345·14 tons) was landed during these two months.

Fifty per cent. of the commercial samples was composed of the 21 cm. size-groups, while the 20 cm. and 22 cm. size-groups constituted another 48%. The range of size varied from 19 to 25 cm.

Sexes were almost equally distributed in the fishery and the stages of sexual maturity of the commercial samples were I and II.

Forty-four per cent. of the spawners belonged to the 23 cm. size-group, while another 27% was composed of the 24 cm. group.

An important finding during the year is that very young mackerel have been found off Vizhingam in South Travancore during late summer months, thereby indicating that spawning of mackerel (as also of some sardines) takes place near the southern parts of the west coast. Vizhingam has, therefore, been included as an observation centre for mackerel.

(3) *At Bombay*

35. *Offshore fisheries.*—The Government of India cutters *Ashok* and *Pratap* were the only trawlers that operated during the year. During April-May (1955) the boats stayed out for 21 days, putting in 59·3 fishing hours (54·8 hours in April alone, and 30 hours in Porbunder region) and bringing in a total landing of 66,080 lb. in April and a tenth of that in May. From December 1955 to February 1956, the trawlers fished for 331·3 hours in 70 days. The fishery was concentrated in the Dwarka region in December, and in Bombay-Cambay region in February.

December recorded the highest landings in this season, 217,280 lb., and February the lowest, 108,689 lb. In December and January *Dara* were most abundant, being 30·6% and 24·3% of the landings respectively. While *Karkara* occupied the second place in December (16·3%), in January *Wam* and pomfrets shared the second place (14·9% and 14·5% respectively). *Ghol* was third in order of abundance in these two months. The highest landings of *Koth* were in January being 18,425 lb. which formed nearly 50% of the total *Koth* landings in the three months. The landings of *Dara* were less in February although *Dara* still formed the highest percentage among the good fishes.

The trends of catch rates from the different regions show that variations are between 1,235·5 and 2,563·0 lb. per hour, maintaining the high catch rates obtained during the last season. In the Dwarka region the catch rates for "all fish" fluctuated between 1,317·1 lb. and 1,810·6 lb. while the values for *Dara* remained high in all the three months, being more than 600 lb. per hour. The *Koth* fishery has not been so good as in the previous years, the average yield being 124 to 270 lb. per hour. In the case of *Ghol* the catches were of the usual order, while *Karkara* has shown the highest yield (320 lb. per hour) in the month of December.

36. The principal conclusions formed as a result of detailed study of the trawling operations so far conducted between Bombay and Saurashtra are given below:—

(*a*) Five main trawling grounds are recognized, *viz.*,

(i) Bombay region;
(ii) Gulf of Cambay region;
(iii) Veraval region;
(iv) Porbundar region; and
(v) Dwarka region or Gulf of Cutch region.

While in the earlier years there was a concentration of trawling in the first two regions, from 1951–52 onwards the intensity of fishing was shifted to the Dwarka region.

(*b*) Of the fishing regions, the Dwarka region has proved to be the richest and has provided, in general, the best landings as well as total catch rates. This region has also been the best for *Dara* and *Koth* fisheries.

(*c*) *Wam* fishery has been the best in Cambay and Veraval regions. *Ghol* occurred in considerable but varying quantities in all the regions but *Karkara* occurred mainly in the Porbundar and Dwarka regions.

(*d*) In regard to distribution by depth it is seen that the bulk of the yields is near about the 20-fathom line with *Dara* and *Koth* showing relatively greater abundance on the landward side of this line, while *Ghol*, *Wam* and *Karkara* occur in quantities a little to the seaward side of this line.

(*e*) A study of day-night and spring-neap variations has shown that the yields of daytime trawling are better than those from night trawling and also the catches tend to be better during neap tide than during spring tide.

(*f*) A comparison of the catch data with the variations in the bottom temperature of the fishing grounds shows that there are different, though graded, patterns of temperature distributions among the different regions and correlated with these are the differences in the trends of fisheries also. It appears possible that there are certain definite optimum temperatures limiting the abundance of the different fishes even within the limited range found in our waters.

(*g*) The *Dara* and *Koth* fisheries of the Dwarka region are essentially juvenile fisheries.

(*h*) Catfishes, sharks and rays form a good proportion of the catches of the Bombay and Cambay regions.

(*i*) The introduction of a more efficient gear than before in the form of Vignoran-Dahl trawl and the bull-trawl and also more sustained efforts than at any time previously, are responsible for the remarkable success of

the recent trawling operations. While the Vignoran-Dahl trawl has been known to yield very good catches as compared to the otter-trawl, the cutters, while doing bull-trawling, were able to catch, on an average, 2 to 2½ times as much as the *Taiyo Maru* using Vignoran-Dahl trawl and fishing in the same grounds and the same season.

(*j*) A comparison of the catch rates for the Dwarka region with those of some of the other parts of the world shows that this region compares favourably with some of the richest grounds elsewhere.

37. *The sciænid fishery.*—The *Ghol* fishery was fairly successful this year, the fish generally forming 9·2 to 20·5% of the trawler landings, except in region V, where values were low throughout the season. The *Koth* fishery on the other hand was particularly poor as compared to previous years.

Examination of the size category data has shown that during this year also, the *Koth* fishery was essentially a juvenile fishery, while *Ghol* fishery included only a small percentage of "smalls" in it. The percentage of "small" *Koth* in the total *Koth* catches varied from 45% in April 1955 to 99·5% in February 1956. In January which was the month of peak *Koth* catches for the year, the percentage of juveniles (smalls) was 88·7.

38. *Studies on eels.*—Investigations on the biology and fishery of the common marine eel of Bombay (*Muræsox talabonoides*) were wound up during the year. From the study made so far, it is seen that *M. talabonoides* accounts for more than 10% of the trawler landings in Bombay. The best yield of the species, *viz.*, 686·4 lb. per trawling hour was realised from Veraval region in August 1952. With the exception of Dwarka region all the regions gave fairly good catches of eels in all the years. The seasonal trend noticed from the catches suggests that the eel fishery starts from the northern regions in May-June and progresses southward gradually.

Examination of stomach contents revealed that more than 90% of the volume of food consumed by adults was fishes, and that crustaceans and cephalopods were scarce. Also, juveniles fed mainly on crustaceans.

From the study of ova diameter measurements it is presumed that the eels spawn once a year, from February to May. The average size of the fish at first maturity is estimated to be 122 cm. in females and 117 cm. in males. Males predominated in the catches landed in the breeding season.

(4) *At Karwar*

39. *General fishery conditions.*—A total of 13,58,335 lb. of fish is estimated to have been landed at Karwar this year as a result of the operations

of 752 *yendi*, 54 cast nets, 89 *Rampan* nets and 33 *patta bale*. *Sardinella longiceps* dominated the landings in April, though the next two months' catches were, in general, poor. Fishing activity was more or less steady during monsoon months, the *yendi* doing most of the fishing, especially in July. The mackerel fishery commenced during the last week of October, but good catches were recorded only for the first two months. Both mackerel and sardine fisheries were complete failures this year.

40. *The sardines*.—The approximate landings of oil-sardines at Karwar for the months of April, May and June were 30,715 lb., 8,310 lb. and 2,826 lb. respectively. During the monsoon months, *i.e.*, July onwards, oil-sardines completely disappeared from the Karwar Bay, though small-sized oil-sardines were landed in small quantities in September. A noteworthy feature observed was the occurrence of small-sized ones with the size range of 5·5 cm. to 7·2 cm. in total length. The 13·0 cm. dominant size-group, which constituted the fishery during the pre-monsoon months, disappeared from the fishing grounds, and a new stock composed of small juveniles was observed in the catches. Mature sardines were obtained in November.

From length-frequency studies it was seen that the dominant size-group, which was seen for the month of April, remained constant during the succeeding months (May and June) at 13·0 cm. For November two modes were seen, one at 16 cm. and the other at 18 cm. Probably the first mode may be the continuation of the mode observed from April to June. For September, a new stock, with a mode at 6·0 cm., was noticed.

41. *The mackerel*.—The fishery as a whole was a total failure, probably the worst season at Karwar for the last eight years. The total landings of mackerel at Karwar during the present season has been estimated as 508·3 tons.

During the post-mackerel season (April-May) mackerel were landed thrice at Karwar by *yendi*. The larger of the specimens belonged to the IV and V maturity stages. Rough weather, during the rainy months of June-September, prevented active fishing; in a few neighbouring villages, however, fairly good numbers of mackerel (18–22 cm.) were landed by *patta bale*. The male specimens, in July, were in oozing condition and the females were in Stage V and VI. During the mackerel season (October-March) a total 508·3 tons were landed at Karwar. With frequent breaks in fishing activity (after a fair start in October) and the erratic appearance of shoals in the Karwar Bay, the season this year was far from successful and a slightly improved fishery was had only from January onwards.

There was wide fluctuation in the values for catch per unit effort of fishing. From 389 mackerel per piece of *Rampan* in October it fell considerably in December and January and reached the lowest of 6 per piece in February. A slightly improved value of 33 per piece was recorded for March.

Scarcity of catches occasioned a steep rise in prices. At the commencement of the season mackerel was sold to the fish-curers at Rs. 10 per thousand, and Rs. 20 per thousand to the fish carrier launches. During the end of the season, mackerel was quoted at Rs. 80 per thousand.

(5) *At Ratnagiri*

42. *General fishery conditions.*—After a steady decline for the past 17 years, the fishery at Ratnagiri this year showed some improvement in quantity of fish landed, as compared with last year, though prolonged monsoon and cyclonic weather affected fishing operations for over a month. Approximately over four million pounds of fish were landed up to end of March 1956.

The season started well in September 1955, reached the peak period during October-November and declined towards end of January 1956. There has been some improvement in the trend from February 1956, which is expected to reach the second peak during April-May 1956, after which sea fishing ceases altogether on account of the monsoon.

Of the fishes of commercial importance cat-fishes, tuna, *Cybium*, Dorab, sharks and rays and *Chorinemus* formed the bulk of the fish cured at the fish-curing yards. Tuna and seer were especially abundant from September-November and cat-fishes and sharks from October-December. Shore-seine operations, which are limited to a stretch of 2 miles, brought in considerable quantities of smaller fish during October-November, most of which was converted to manure for lack of quick transport, marketing and refrigeration facilities. *Otolithus* sp., *Leiognathus* sp., *Synagris* sp., *Dussumieria* sp., *Caranx* sp. and *S. fimbriata* formed the bulk of these landings. *S. fimbriata* were available in good quantities from September 1955 to March 1956 with fluctuation between two peak periods.

43. *Mackerel fishery.*—Mackerel were available only in stray quantities intermittently from end of September 1955 to last week of March 1956, with regular catches between October and December 1955.

44. *Sardine fishery.*—Oil-sardines reported to have appeared in good quantities last year, failed to appear during the year under review.

(6) *At Ernakulam*

45. *General fishery conditions.*—

(*a*) *Marine prawn fishery.*—Though appreciable quantities of prawns were captured at first, the catches were comparatively poor in the first quarter of the year, except in June. It was not better in the next quarter and practically came to a close early in October. As in the previous year, fishing with boat-seine started in February 1956 and prawns also were caught though the catches were rather poor. Based on the catch statistics from March-September the following figures have been calculated for prawn landings at Narakkal: April—7,920 lb.; May—2,494 lb.; June—38,715 lb.; July—1,589 lb.; August—1,139 lb.; and September—69 lb. *Parapenæopsis stylifera* was the dominant species on most days in the first quarter and *Metapenæus dobsoni*, *M. affinis* and *Penæus indicus* occurred in gradually decreasing numbers. In the second quarter *M. dobsoni* was the most abundant species, forming practically the entire catch on a few days. As in the previous quarter the percentage value of *P. indicus* was rather low except on rare occasions.

(*b*) *Backwater fishery.*—The backwater prawn fishery, as in previous years, continued throughout the year without much interruption. The catches were noticeably less in the third quarter. Detailed study of the catches has not been attempted for some time; samples of *P. indicus*, however, have been examined with a view to gather biological data relating to the species.

46. *Biology of prawns.*—Studies on the biology of *P. indicus* and *M. affinis* were continued, and the data on *M. monoceros* were re-examined. The apparent association of prawn fisheries with mud banks, as indicated at Alleppey and probably at other places on the west coast, is proposed to be investigated as fully as facilities permit and a start has been made in the closing month of the year to collect simultaneously statistical data on prawn landings and hydrological data of the sea-water at the site of fishing from one station, *viz.*, Alleppey. When better facilities are available it is proposed to extend this study to one or two other centres also and to include analysis of samples of mud from the banks.

47. *Prawn farming.*—The experiment in prawn farming started in November 1954 has proved that, by adopting the method of trapping as many fry as possible and retaining them, the percentage value of the species (*P. indicus*) could be raised substantially.

Another experiment, of keeping a large number of prawns through the monsoon months, has indicated the possibility that both species (parti-

cularly *P. indicus*) survive in water of very low salinities and also grow to some extent. The sudden appearance of prawns of fairly large size (130-140 mm.) in the backwaters in the post-monsoon period after a few days of sunshine may therefore be due, in part at least, to the emergence of such prawns from the deeper portions of the backwaters where they may have remained during the rainy months. But the possibility of such prawns re-entering the backwaters from the sea has to be recognized in order to explain their similar appearance in later months.

(7) *At Madras*

48. *General fishery conditions.—Anchoviella commersonii*, carangids and *Trichiurus haumela* comprised the bulk of the catches. The ribbon-fish and the whitebait fisheries have shown decided improvement this year, the catches of the former being twice as much and of the latter half as much again as in the previous year. Next, in the order of abundance were (i) crustaceans (mostly *Metapenæus monoceros*), (ii) sardines, (iii) perches (*Synagris*, *Pristipoma*, *Therapon*, *Lethrinus*, etc.), (iv) sciænids (*Sciæna*, *Otolithus* and *Johnius*) and (v) mackerel, which formed fair catches. Silver-bellies (Leiognathids), seer-fish, other clupeoid fishes, elasmobranchs and pomfrets were also landed in moderate quantities. The abundant occurrence of juvenile black pomfrets in the months of July and August is worthy of note. The flying-fish fishery was generally a failure this year.

49. *Studies on oysters.*—Consequent or the unusual opening of the bar on 21st May 1955 by heavy rains, a good set of spat was obtained on 1st June 1955, with a minimum size of 1·9 mm., a maximum size of 5·0 mm. and a mean size of 3·02 mm. Fresh clean culch was put in waters on the 1st of June and examined on 13th June when the spat set thereon measured 1·0 mm. minimum and 4·0 mm. of maximum size. The observations are in confirmation of the former conclusions reported that (1) spat-setting takes place only during the period when the bar is open and (2) besides the main breeding season in November-December, there is an occasional supplementary spawning of the oysters in about April or May in our east coast backwaters and estuaries.

Studies on the seasonal gonadal changes in *Meretrix* are being continued along with routine studies in growth-rate.

General studies on juvenile fishes, available along the Madras coast, have been started. The periods of occurrence, size-frequencies and food habits of some 77 species, belonging to 33 families, have been noted and the work is progressing.

MARINE BIOLOGY

(1) *At Mandapam*

50. *Plankton studies.*—The striking characteristics of the plankton during the year were: (1) the species constituting the summer maxima of phytoplankton in the Gulf of Mannar and the Palk Bay were different—*Chætoceros* spp., *Rhizosolenia* spp., *Bacteriastrum* spp., and *Thalassiothrix frauenfeldii* in the Palk Bay and *Hemidiscus hardmannianus* and *Biddulphia sinensis* in the Gulf of Mannar, (2) the summer bloom of *Trichodesmium* was restricted to the Gulf of Mannar and the swarming of *Noctiluca* in the second half of June was confined to the Palk Bay, (3) an unusual bloom of *T. frauenfeldii* in the Gulf of Mannar was noticed during the last week of July, which extended up to the first week of August. The same species bloomed again in December. In February 1956 two spcies of diatoms, *Thalassionema nitzschioides* and *Thalassiothrix frauenfeldii*, were in bloom in the same area, (4) soon after the blooms of *T. frauenfeldii* in July-August and in December there was a swarming of *Noctiluca*, and (5) an unusually large population of *Trichodesmium* was found in November in the Palk Bay.

A comparative study of the plankton of the fishing ground and that of an inshore station (about 2 miles from shore) off Thangachimadam revealed a relatively higher standing crop of plankton in the fishing ground. Both phytoplankton and zooplankton seemed to be richer in the fishing ground and this difference is more striking in the case of phytoplankton.

51. *Hydrological studies.*—Routine studies on the salinity, dissolved oxygen, silicates, phosphates, and nitrates were continued. Analysis of sea-water samples from the fishing grounds off Thangachimadam indicated significant differences in organic and total phosphorus content from corresponding inshore samples.

52. *Studies on fish eggs and larvæ.*—Comparative studies on the availability of fish eggs in the Gulf of Mannar and Palk Bay were continued. Spawning in flat fishes and carangids seems to be most intense from January-April, though carangid eggs occurred in small numbers all through the year.

(2) *At Calicut*

53. *Plankton studies.*—The seasonal cycle of the plankton was more or less of the same pattern as in the previous years with the main peak in July and a second one in January, February or March following, according to the stations. The poorest month, however, was June, unlike as in the

previous years, which is, pending confirmation, attributed to the absence of mud banks during the south-west monsoon this year and the consequent non-availability of certain nutrients from the mud essential for production locally. Assessment of the standing crop has shown that the west coast of India is highly productive, comparable with the other very fertile waters in the tropical, temperate and arctic regions of the world. While the south-west monsoon is the predominant phytoplankton period, during the north-east monsoon zooplankton dominates. However, in terms of dry weight, the values for standing crop during these seasons are not very variable, thus indicating that, irrespective of the nature of the plankton, whether plant or animal, the water can support only a certain quantity of life and there tends to be an equilibrium in the same manner as the chemical constituents tend to balance one another.

54. *Hydrological studies.*—The nutrient content of water samples was found to be of a low order during the year compared with the values for the earlier years. This appeared unusual. This is attributed to the insufficient release of nutrients from the bottom mud into the water, which apparently was taking place in all the former years during the mud bank formation, when there is mixing up of the water and mud.

(3) *At Bombay*

55. *Hydrological studies.*—Routine studies on salinity and temperature distribution of surface waters of off-shore fishing grounds and on the variations of total phosphorus were continued.

(4) *At Karwar*

56. *Studies on plankton and hydrology.*—Observations on the hydro-planktological conditions of Ankola and Kumpta were begun for a correlative study, besides the routine studies on plankton and analysis of water samples from Karwar Bay, Binge Bay and Chendie Bay. The maximum and minimum range of hydrological conditions were similar to those of earlier years, except that minimum salinity was 10·93‰, this year, instead of the earlier 23·99‰, presumably due to heavy monsoon.

From plankton studies it was found that the bulk of the plankton was good following the setting in of monsoon. *Fragilaria* blooms were observed in Karwar Bay in July-August, the peak period for diatoms. *Noctiluca* swarms, noticed last year, were not seen. The prominent occurrence this year was the Red Water phenomenon due to flagellates, on many occasions in November-December. In the Binge Bay there were swarms of *Noctiluca* in July, and in Chendie Bay it occurred in July-August.

57. *Studies on fish eggs.*—From preliminary investigations on the occurrence of fish eggs at five centres along the coast, nine different types of fish eggs have been obtained of which six belong to Clupeids. There did not seem to be any correlation between the salinity and the occurrence of eggs.

(5) *At Ratnagiri*

58. *Plankton and sea-water analysis.*—A preliminary study indicated that the plankton was rich from September-November after which there was a decline from December-January, followed by a gradual improvement from February. The fluctuation of plankton coincided with the trend of fisheries in the area.

Surface-water temperature showed a range of 25–27° C. in September-October and 24–25° C. during November-January, since when there was a steady rise to over 25° C. in March 1956. Similarly, salinity was lower during September-October and from middle of November onwards fairly constant higher salinity has been recorded.

(6) *At Ernakulam*

59. *Plankton studies.*—Regular collection of inshore plankton samples was started by the end of December. The plankton was quite rich and zooplankton was found to predominate during January-March, copepods, larval decapods and other crustaceans like *Lucifer*, mysids and cladocerans, being well represented.

60. *Physical oceanography.*—Work has been started during the first quarter of 1956 at the Naval Physical Laboratory in Willingdon Island on the dynamical computation of ocean currents and on analysis of the collected B.T. data.

Physiology and Fish Farming

61. Physiological studies on the milk fish have been continued during the year. Results on food and reproductive habits obtained so far have been summarised for publication.

New investigations have been started on the rate of metabolism of the milk fish under different conditions of temperature and salinity. Since these observations are likely to be of practical value in problems of fish fry transport, data are being gathered in a systematic manner for critical analysis. Similar test observations are also being made on the marine catfish *Plotosus arab.*

62. *Chanos* fingerlings of 30–55 mm. length were collected from the tidal creeks earlier than usual (by beginning of April) which might indicate

a comparatively early breeding of the fish this year in this area. Plankton collections from the Gulf of Mannar taken just before the appearance of the fry, however, failed to show any *Chanos* eggs.

From preliminary trials in artificial manuring of saline fish ponds it was found that cheap organic fertilisers such as seaweeds, cow dung and groundnut oilcake gave satisfactory results.

BACTERIOLOGY

63. Investigations concerning the storage of fish at low temperatures and the bacterial flora associated with spoilage were continued. A considerable volume of data on the qualitative and quantitative bacteriological changes and the trimethylamine and total volatile nitrogen levels occurring in fish muscle during storage was obtained. The duration of storage in ice till the bacterial count and/or the T.M.A. or T.V.N. become significant varied from less than a week to over two weeks. This work has indicated the limitations of some of these factors as criteria of freshness of fish. The bacterial flora isolated from fish muscle during storage in ice included *Achromobacter*, *Pseudomonas*, *Bacillus*, *Flavobacterium* and *Micrococcus*; pink yeasts also were frequently observed.

Further investigations in this direction will be in association with commercial cold storage and freezing operations in order to evaluate the technological implications of the observations.

64. Studies on the use of ice containing recently developed antibiotics and other chemicals in fish preservation, mainly from the aspect of their effect on the bacterial flora, were commenced during this year. pH determinations were made on the muscle of fresh and iced fish. In the case of perches (*Lethrinus*) the pH values ranged from 6·2–6·6 for fish in very fresh condition and from 6·6–6·9 after a week's storage in ice.

65. Early this year a survey of the quality of fish in the boat landings at Dhanushkodi and other places on the Rameswaram Island was undertaken. Bacteriological and chemical examination of a number of samples showed considerable variation in the quality. This survey is being extended to other fishing centres. These studies are expected to yield scientific information of value in the marketing of fish.

ALGOLOGY

66. The first All-India Training Course in Seaweed Utilization was conducted by the Algology Section at Mandapam Camp. The utilization of the agarophytes of the Indian coast in the manufacture, on cottage industry basis, of agar, jelly, seaweed porridge meal, seaweed compost, etc. and the popularization of these methods were the main aims of the course. Work

has also been directed to further improvements in the technique of handling seaweeds for cottage industries. The possibility of using brown seaweeds for the manufacture of alginic acid and alginates is being explored.

A general survey of the vegetation of Palk Bay and Gulf of Mannar with special reference to agarophytes was undertaken. A preliminary check list of Indian marine algæ is also under preparation.

Fish Curing and Fishery Products

67. Studies on the curing of Rainbow sardine with salt and ordinary tamarind on the lines of the Colombo cure showed that the product could be improved by the addition of sodium nitrate. It was found that good quality spiced and pickled fish could be prepared from Rainbow sardine. Sodium benzoate was found to be helpful in improving the keeping quality of salted and dried fish.

A modified iodine absorbtion index was perfected to serve as a chemical test for detection of spoilage along with the well-known Total Volatile base estimation.

Studies on curing of *choodai* showed that, application of pressure, during salting, hastened the dehydration of fish while enhancing the penetration of salt uniformly, without any extra loss of fat or proteins. This procedure also reduced the time necessary for curing almost by half. Results of surveys of fish curing methods on the west coast of India have been compiled for publication.

68. Chromatographic studies conducted on the muscle tissues of a number of samples of sardines revealed that interspecific differences (both qualitative and quantitative) exist between the ninhydrin-positive patterns obtained from the two species of sardines, *viz.*, *S. albella* and *S. gibbosa*. This study was extended to preserved samples also. It was found that ether-treated muscles gave normal patterns without any distortion. Under controlled conditions the muscle tissues from the same species of fish gave the same pattern irrespective of the size-groups examined (80–130 mm.). The subject being of considerable scientific interest, further work is proposed.

69. Different methods are being tried out for the preparation of odourless fish-meal from sardines. This and related investigations are being handled by the section on utilization of by-products which was started towards the end of the year.

Central Marine Fisheries
Research Station,
Mandapam Camp P.O., S. India,
August 27, 1956.

N. K. Panikkar,
Chief Research Officer.

The following scientific papers based on the work at the Research Station have been published during 1955–56:—

106. N. K. VELANKAR. 1955. Bacteria in the inshore environment at Mandapam. *Indian J. Fish.*, **2** (1), 96–112.

107. K. V. SEKHARAN. 1955. Observations on the "Choodai" fishery of Mandapam area. *Ibid.*, **2** (1), 113–32.

108. M. KRISHNA MENON. 1955. Notes on the bionomics and fishery of the prawn *Metapenæus dobsoni* Miers on the south-west coast of India. *Ibid.*, **2** (1), 41–56.

109. G. SESHAPPA AND B. S. BHIMACHAR. 1955. Studies on the fishery and biology of the Malabar Sole, *Cynoglossus semifasciatus* Day. *Ibid.*, **2** (1), 180–230.

110. K. H. MOHAMED. 1955. Preliminary observations on the biology and fisheries of the thread-fin, *Polydactylus indicus* Shaw in the Bombay and Saurashtra waters. *Ibid.*, **2** (1), 164–79.

111. M. S. PRABHU. 1955. Some aspects of the biology of the ribbon-fish *Trichiurus haumela* (Forskål). *Ibid.*, **2** (1), 132–63.

112. S. V. BAPAT. 1955. A preliminary study of the pelagic fish eggs and larvæ of the Gulf of Mannar and the Palk Bay. *Ibid.*, **2** (1), 231–55.

113. V. KRISHNA PILLAI. 1955. Some factors controlling algal production in salt-water lagoons. *Symposium on Marine and Freshwater Plankton in the Indo-Pacific*, Bangkok, 1954. *Proc. Indo-Pac. Fish. Coun.*

114. R. R. PRASAD. 1955. Observations of the distribution and fluctuations of Planktonic larvæ off Mandapam. *Ibid.*, 1954.

115. V. KRISHNA PILLAI. 1955. Observation on the ionic composition of blue-green algæ growing in saline lagoons. *Proc. Nat. Inst. Sci. Ind.*, **21 B** (2), 90–102.

116. V. KRISHNA PILLAI. 1955. Water-soluble constituents of *Gracilaria lichenoides*. *J. Sci. Industr. Res.*, **14 B** (9), 473–77.

117. K. RAMALINGAM. 1955. A remarkable organism, *Telegamatrix pellona* gen. et sp. nov. (Monogenea: Diplect—Aninæ) parasitic in an Indian herring. *Proc. Indian Acad. Sci.*, **42 B** (5), 209–18.

118. K. NAGAPPAN NAIR. 1955. Studies on the growth of the wedge clam, *Donax* (*Latona*) *cuneatus* Linnæus. *Indian J. Fish.*, **2** (2), 325–48.

119. N. K. VELANKAR AND P. V. KAMASASTRI. 1955. Shark spoilage bacteria. *Curr. Sci.*, **24**, 272–73.

120. N. K. PANIKKAR. 1956. Marine Fisheries Research in India. *Progress of Fisheries Development in India*, Cuttack, 1956, 20–28.

PUBLICATIONS SUBSEQUENT TO MARCH 1956

R. RAGHU PRASAD. Further studies on the plankton of the inshore waters off Mandapam. *Indian J. Fish.*, **3** (1), 1–42.

V. KRISHNA PILLAI, A. P. VALSAN AND M. RAJENDRANATHAN NAYAR. Studies on the chemical quality of cured fish products from the west coast of India. *Ibid.*, 43–58.

M. S. PRABHU. Maturation of intra-ovarian eggs and spawning periodicities in some fishes. *Ibid.*, 59–90.

L. B. PRADHAN. Mackerel fishery of Karwar. *Ibid.*, 141–85.

S. JONES. Some deaths due to fish poisoning (Ichthysarcotoxism) in India. *Indian J. Med. Res.*, **44** (2), 353–60.

V. KRISHNA PILLAI. Chemical studies on Indian seaweeds. I. Mineral constituents. *Proc. Indian Acad. Sci.*, **44 B**, (1) 3–29.

G. SESHAPPA AND R. JAYARAMAN. Observations on the composition of bottom muds in relation to the phosphate cycle in the inshore waters of the Malabar coast. *Ibid.*, **43 B** (6), 288–301.

G. SESHAPPA. Occurrence of *Johnius hololepidotus* (Lacepede) in Indian waters. *Curr. Sci.*, **25**, 121–22.

R. VISWANATHAN AND V. KRISHNA PILLAI. Paper chromatography in fish taxonomy. *Proc. Indian Acad. Sci.*, **43 B** (6), 334–39.

N. K. VELANKAR. Bacterial flora, trimethylamine and total volatile nitrogen of fish muscle at 3° C. *Indian J. Fish.*, **3** (2), 261–68.

N. K. VELANKAR AND P. V. KAMASASTRI. Bacterial flora, trimethylamine and total volatile nitrogen of fish muscle at 0° C. (In ice). *Ibid.*, **3** (2), 269–89.

G. VENKATARAMAN. Studies on some aspects of the biology of the common anchovy, *Thrissocles mystax* (Bloch and Schneider). *Ibid.*, **3** (2), 311–33.

K. VIRABHADRA RAO AND K. NAGAPPAN NAIR. Rate of growth in spat and yearlings of the Indian backwater oyster *Ostrea madrasensis* Preston. *Ibid.*, **3** (2), 231–60.

APPENDIX I

Zonal catch of Marine Fish and its composition in 1955

(Figures in tons) (1 ton = 2240 lb.)

Name of Fish	Zones*												Mech. Vessels	Total
	1	2	3	4	5	6	7	8	9	10	11	12		
Sharks	241·82	415·87	1483·80	40·05	916·78	603·56	225·33	3778·12	2846·72	2684·23	1116·49	305·90	26·32	14684·99
Skates	23·05	..	8·08	18·90	24·72	369·27	14·14	442·00	70·60	90·96	1·13	76·66	..	1137·51
Rays	41·71	..	..	29·48	61·53	1992·18	65·68	392·67	100·30	522·55	1064·36	27·57	6·73	4304·76
Eels	..	..	..	..	..	..	0·04	1·24	1·37	77·32	12063·76	..	12·64	12156·37
Arius spp.	93·19	809·23	789·79	..	164·84	199·73	482·78	6102·30	1017·09	4721·84	3810·77	167·14	24·24	18382·94
Chirocentrus dorab	374·03	76·69	1621·33	27·87	194·89	629·11	166·40	547·21	28·36	136·42	366·22	145·96	..	4314·49
(*a*) *Sardinella longiceps*	..	..	..	..	..	..	..	10721·82	15648·53	3595·91	..	..	..	29966·26
(*b*) *Sardinella fimbriata*	1892·79	2702·84	1658·20	..	29·51	104·19	791·13	13923·05	1578·98	2392·67	..	..	..	25073·36
(*c*) *Sardinella leiogaster*	..	..	..	..	62·87	..	484·64	..	..	..	..	..	..	547·51
(*d*) *Sardinella gibbosa*	..	..	..	..	..	..	166·73	..	..	..	..	..	..	166·73
(*e*) *S. brachysoma*	..	..	..	..	..	..	..	..	11·90	..	..	..	..	11·90
(*f*) Other *Sardinella* spp.	..	..	..	..	..	..	31·91	..	..	..	..	..	..	31·91
(*g*) *Dussumieria* spp.	132·71	250·75	182·09	88·11	233·74	854·39	100·24	4901·84	907·69	0·42	..	..	..	7651·98
(*h*) *Kowala* spp.	..	..	6390·41	..	..	..	..	398·38	759·06	..	..	..	..	7547·85
(*i*) *Hilsa* spp.	323·99	84·70	516·62	8·97	19·81	20·33	0·02	..	198·70	..	46·48	1064·65	..	2284·27
(*j*) *Hilsa* spp.	26·30	198·80	2512·48	60·55	536·09	663·95	156·62	203·05	284·63	0·46	913·30	96·43	..	5652·66
(*k*) *Anodontostoma chacunda*	..	..	943·99	..	14·69	201·57	..	65·63	443·97	0·03	..	3·52	..	1673·40
(*l*) *Opisthopterus tardoore*	..	..	97·60	..	7·35	..	..	920·71	155·69	155·87	..	..	..	1337·22
(*m*) *Anchoviella* spp.	423·16	165·67	2556·14	119·49	377·89	..	7·24	14144·50	181·22	138·44	..	32·95	..	18146·70
(*n*) *Thrissocles* spp.	51·91	1156·18	3174·70	105·40	379·67	545·81	176·90	469·69	279·22	331·50	439·78	..	..	7110·76
(*o*) *Coilia* spp.	30·38	..	28·50	..	0·90	32·66	..	..	..	..	10248·29	144·39	..	10475·12
(*p*) Other clupeoids	..	..	..	2·24	..	..	0·67	16·22	..	..	..	..	1·44	20·57
(*a*) *Harpodon nehereus*	..	75·49	117·36	45·17	..	4·95	..	..	..	..	89820·79	12214·48	0·11	102278·35
(*b*) *Saurida* spp.	..	66·25	4·49	11·21	98·69	..	1·07	4·55	..	8·67	..	..	..	194·93
(*a*) *Belone* spp.	..	1·86	..	..	..	..	11·35	..	0·22	7·14	..	..	..	20·57
(*b*) *Hemirhamphus* spp.	..	1·57	..	..	50·41	1·94	358·78	..	..	0·36	..	..	..	413·06
(*c*) *Cypsilurus* spp.	..	29·54	..	..	1048·37	2129·01	0·46	..	..	..	..	..	..	3207·38
(*a*) *Serranus* spp.	..	14·58	..	..	54·45	5·00	198·28	61·92	6·32	2·61	..	..	..	338·16
(*b*) *Lutjanus* spp.	42·30	106·92	1605·73	..	53·61	..	127·47	377·76	..	7·49	310·58	27·90	8·88	2668·64
(*c*) *Lates calcarifer*	3·52	..	..	..	..	8·46	..	..	..	0·05	2·26	..	..	14·29
(*d*) *Ambassis* spp.	..	..	..	..	..	..	..	167·69	10·23	..	..	..	..	177·92
(*e*) *Therapon* spp.	..	..	..	4·49	49·74	25·78	14·75	..	40·29	2·57	..	..	..	137·62
(*f*) *Pristipoma* spp.	2·02	8·98	54·75	1·28	193·30	..	0·02	35·76	0·30	..	22·62	..	38·59	357·62
(*g*) *Synagris* spp.	..	36·02	0·84	..	242·81	..	..	1397·46	74·09	58·52	..	..	..	1809·74
(*h*) *Aprion* spp.	..	..	..	..	..	..	67·59	..	..	..	..	..	..	67·59
(*i*) *Sparus* spp.	..	..	..	..	..	..	..	..	..	..	..	29·43	..	29·43
(*j*) *Lethrinus* spp.	..	..	..	..	30·73	..	211·39	166·41	..	9·39	..	..	..	417·92
(*k*) *Scolopsis* spp.	..	..	..	..	47·99	..	..	..	..	..	..	..	..	47·99
(*l*) *Teuthis* spp.	..	..	..	..	0·26	..	8·54	..	..	11·37	..	..	..	20·17
m) *Diagramma* spp.	..	..	..	..	..	..	16·20	..	..	..	..	..	..	16·20
(*n*) *Sillago* spp.	62·33	9·75	247·33	..	22·74	440·24	4·02	30·23	..	3·99	..	14·45	..	835·08
(*o*) Other Perches	..	..	..	..	9·84	..	13·07	..	..	1·32	..	..	0·35	24·58
Red Mullets	..	3·60	826·59	10·89	119·71	44·60	22·99	81·41	..	..	..	..	..	1109·79
Polynemus spp.	119·09	74·81	61·39	..	101·80	30·34	0·54	180·53	0·27	26·05	10498·58	414·95	66·51	11574·86
(*a*) *Sciena* spp.	55·42	416·81	5207·85	201·52	763·73	1335·13	288·01	2394·83	574·76	230·28	26027·43	109·65	46·24	37651·66
(*b*) *Scianoides* spp.	..	..	..	..	3·60	..	..	256·85	..	114·57	280·08	18·61	..	673·71
(*c*) *Pseudosciaena* spp.	..	..	..	..	..	..	..	..	408·15	20·46	..	..	..	428·61
(*d*) *Otolithus* spp.	115·09	2·81	829·72	..	187·16	1197·29	60·62	454·16	169·04	828·49	..	..	..	3844·38
Trichiurus spp.	220·31	519·92	1742·36	302·45	4026·96	424·43	3038·69	17141·02	933·67	154·19	6880·67	70·61	..	32155·28
(*a*) *Caranx* spp.	5·45	81·46	5655·03	41·01	1593·49	628·88	208·60	5001·19	2102·54	285·55	165·17	..	..	15761·37
(*b*) *Chorinemus* spp.	0·51	120·54	40·98	..	332·49	32·73	28·69	1022·36	308·16	102·37	1·08	4·52	..	1994·43
(*c*) *Elacate niger*	..	6·90	..	..	26·39	..	1·03	51·68	89·85	9·31	..	..	..	185·16
(*d*) *Coryphaena hippurus*	..	..	..	..	126·20	..	1·97	..	0·96	..	..	..	..	129·13
(*a*) *Leiognathus* spp.	62·45	243·76	1121·43	51·57	798·03	1425·59	175·16	1524·09	1106·17	154·35	..	..	..	6662·60
(*b*) *Gerres* spp.	..	..	..	..	..	191·34	0·94	..	..	0·61	..	..	..	192·89
(*c*) *Gaza* spp.	..	..	..	..	0·68	..	..	..	..	..	..	..	..	0·68
Lactarius lactarius	9·29	146·78	1674·30	1·28	117·77	187·49	864·72	2457·37	90·76	13·50	..	..	..	5563·26
Stromateus spp.	129·70	170·38	845·82	131·03	244·87	467·13	52·21	1050·95	36·96	99·58	7950·72	2284·40	1·81	13465·56
(*a*) *Rastrelliger canagurta*	1·52	23·19	657·25	10·89	238·72	..	0·04	1766·69	4740·16	14996·97	..	..	..	22435·43
(*b*) *Cybium* spp.	387·04	1109·43	1111·08	16·66	510·83	175·22	226·60	1247·00	165·29	528·13	277·96	194·48	..	5949·72
(*c*) Tunnies	32·26	6·37	30·60	..	1·06	..	124·58	2634·52	51·69	437·06	..	..	..	3318·16
Sphyraena spp.	..	2·59	..	..	76·85	..	29·45	214·23	33·23	30·41	..	..	..	386·76
Mugil spp.	10·79	..	..	..	..	..	1·05	2·69	0·79	11·91	..	178·15	..	205·38
Stegnaceros macclellandi	..	..	..	..	..	..	..	..	..	..	3139·54	..	..	3139·54
Cynoglossus spp.	..	2·26	..	..	7·57	3·02	0·20	1644·88	3525·21	88·95	235·11	..	..	5507·20
(*a*) Prawns (penæid)	368·06	1010·46	1771·42	652·32	622·75	305·69	21·98	5985·02	3466·61	551·49	29143·24	0·58	0·16	43897·78
(*b*) Prawns (non-penæid)	..	10·82	..	..	228·79	..	..	..	..	..	60204·35	..	..	60443·96
(*c*) Crabs	4·31	16·02	..	..	84·71	28·52	..	22·63	2·23	260·08	181·90	..	..	600·40
Miscellaneous	599·29	407·33	4916·04	45·17	185·92	11·68	29·27	13703·30	252·46	53·82	3595·77	383·63	93·02	32210·53