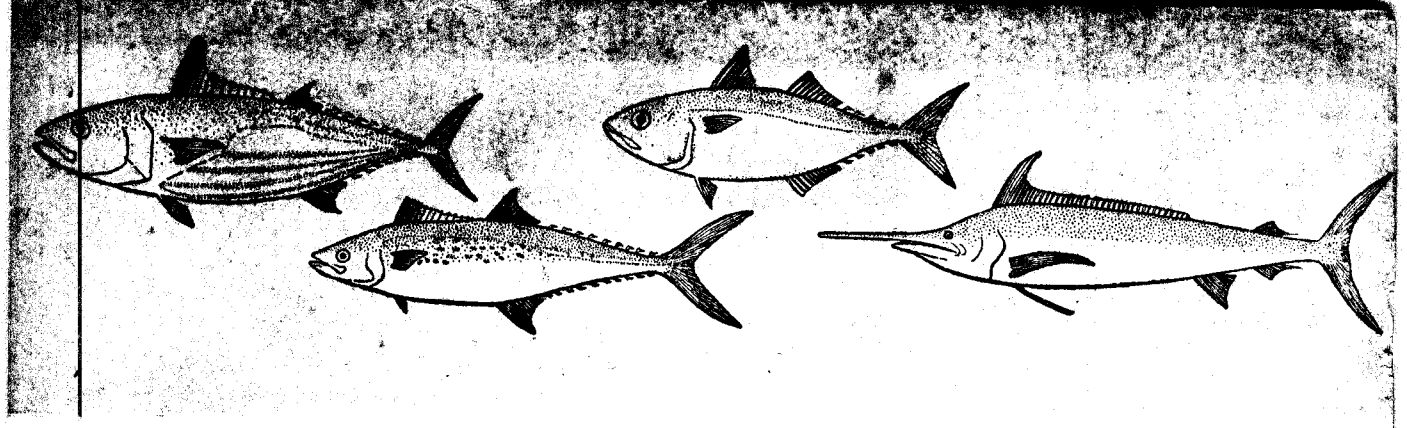
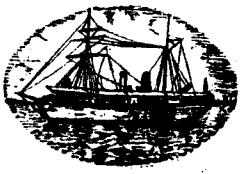


SYMPOSIUM ON

SCOMBROID FISHES

PART III



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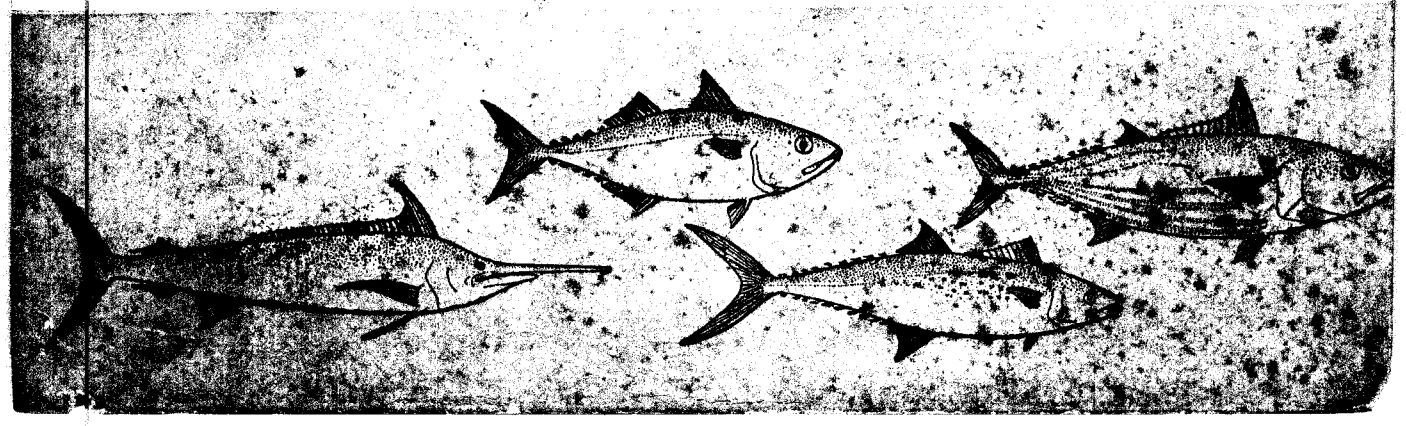
S. INDIA

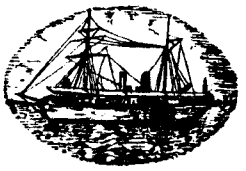


PROCEEDINGS OF THE

SYMPOSIUM
ON
SCOMBROID FISHES

HELD AT MANDAPAM CAMP FROM JAN. 12-15, 1962

PART III



SYMPOSIUM SERIES I

MARINE BIOLOGICAL ASSOCIATION OF INDIA

MANDAPAM CAMP

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TUNA FISHERY OF THE TINNEVELLY COAST, GULF OF MANNAR*

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INTRODUCTION

DURING the last few years, the world-wide demand for fresh sources of protein has increased considerably and this has been a stimulus for the rapid development of the fishery for some of the pelagic fishes in the tropical and subtropical oceans. The scombroid fishes (mackerels, seerfishes, tunas and billfishes) constitute an important element of pelagic fishes, the annual world production of which has more than doubled, from about 0.93 million metric tons in 1948 to about 2.11 million metric tons in 1961. This quantum of increased production has naturally added to the volume of selected, preserved and processed fishery commodities of tunas and related fishes sold in the world markets during the last few years. In figures, from 301,000 metric tons in 1955, it has risen to about 420,000 metric tons (net product weight) in 1961 (FAO, 1960-61). A bulk of the increase in fresh catches as well as in processed goods mentioned above is constituted by tunas, the fishery of which has rapidly expanded during this period, and is being most actively pursued by Japan and the United States. The fact that in the Indian Seas, the tuna resource is a potentially important one is quite evident from the success of the Japanese fishing efforts in this area. However, in spite of the fact that the success of our oceanic fisheries will eventually depend to a great extent on the development of this latent resource, to date, even exploratory fishing has not been attempted by us.

The data on landings, of tuna contained in Fisheries Departmental Reports suffer from the great drawback that species-wise information is almost always wanting. The data given below (Table 1) will give an idea of the total marine fish landings in relation to the three major groups of scombroid fishes (data after FAO, 1960-61).

TABLE 1

Marine fish landings in India (Figures in thousand metric tons)

Year	1955	1956	1957	1958	1959	1960	1961
Total marine fish landings excluding crustaceans and molluscs.	489.1	561.1	738.0	688.2	516.4	807.1	618.7
Indian mackerel ..	22.8	16.4	89.0	123.3	62.2	133.7	34.5
Seerfishes	6.0	12.4	8.9	7.9	6.6	8.6	11.5
Tunas	3.4	3.7	3.0	3.2	2.9	5.6	7.8

In the island of Minicoy in the Laccadive Archipelago there exists a regular pole and line, live-bait fishery for tunas, especially for the skipjack *Katsuwonus pelamis* (Linnaeus), and the yellowfin tuna *Thunnus (Neothunnus) albacares macropterus* (Temminck and Schlegel) (Ayyengar,

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1922 ; Jones and Kumaran, 1959). During an exceptionally good season, as in 1960-61, about 1200 metric tons of tuna were landed at Minicoy (Thomas, P. T. in litt.). Along the Indian Coast a few species of tunas, such as, the little tunny *Euthynnus affinis affinis* (Cantor), the frigate mackerels *Auxis thazard* (Lacépède) and *A. thynnoides* Bleeker ; the northern bluefin tuna *Thunnus* (*Kishinoella*) *tonggol* (Bleeker) ; and the oriental bonito *Sarda orientalis* (Temminck and Schlegel) occur during certain seasons in the coastal waters. However, up to now there has been no organised fishery for tunas except along the Tinnevelly coast, Gulf of Mannar where for well over fifty years there has been in vogue a regular seasonal fishery for these fishes, mainly using multiple trolling. The present paper is the result of observations conducted on this fishery off Tuticorin from about June 1960 to December 1961. In view of the paucity of information on the biology of these fishes from Indian Seas, the little information given here may be of added interest.

History of Tuna Fishery off the Tinnevelly Coast

As far back as 1915, Sir F. A. Nicholson, then Director of Fisheries of the Government of Madras, while discussing the utility of larger boats for fishing in deeper waters than the catamarans and small canoes in use than, remarked that at Tuticorin the Ceylon boats, usually outriggers and splendid sailers, regularly came over in the cold weather for seer, ' but so far have found no imitators.' The whole picture seems to have changed almost abruptly after 1912, as could be made out from the observations of Hornell (1917). He remarks that ' Until 1912 this fishery was in the hands of the Sinhalese fishermen who came across annually from Ceylon with their outrigger canoes or kūllams, at the beginning of the north east monsoon and who returned home in March. The year named was characterised by an exceptionally severe outbreak of cholera in Tuticorin ; this combined with the restrictive quarantine measures adopted by the Ceylon authorities against passengers coming from Tuticorin had such a deterent effect that no Sinhalese fishermen came that season and, once broken, the custom has not been resumed.'

' As trolling provides the bulk of the fish (seer) most esteemed by Europeans and as the market price in consequence is better than for any other fish, there was distinct inducement for the local fishermen to supply the want caused by the defection of the Sinhalese men. For the first year little progress was made and the catch for the year October 1912 to September 1913 fell by 50 per cent compared with the preceding year's catch (11,835 lbs. as against 24,438 lbs.). But a year's experience revealed to the local men, that, contrary to their own belief, no special virtue in inherent to the Sinhalese outrigger as against their own boats ; the latter sail quite fast enough with a good wind to make trolling for seer a success. The success of the pioneer boats was so obvious that the number engaged in this branch of fishing rapidly increased and if Sinhalese fishermen ever came again to Tuticorin, they will find themselves supplanted and with strong competition to face.'

There is hardly any evidence that Sinhalese fishermen ever came to Tuticorin after 1912 to engage in this fishery. Since 1917, no attempt has been made to review this fishery, the only information being landing figures of ' seerfishes ' and ' tunnys ' (not species-wise) for Tuticorin contained in a few recent annual reports emanating from the Department of Fisheries of the Government of Madras. Suffice it to say, that by trial and error and by experimentation, the fishermen of Tinnevelly Coast (at Tuticorin) have evolved a system of multiple trolling for scombroid fishes, which today they find most suited for conditions obtaining in these waters.

Fishing Grounds

The fishing ground where multiple trolling is carried out is indicated in the accompanying figure (Fig. 1). I have been informed by the older fishermen at Tuticorin that even 15 to 20 years back, multiple trolling for scombroid fishes used to be carried out within sight of land. From the north fish landing centre at Tuticorin, one could see the boats in operation off Hare Island.

The subsequent increase in the number of fishing boats operating from Tuticorin, fishing boats and catamarans from the coastal fishing villages to the south of Tuticorin for regular fishing in the inshore waters, and the consequent numerical increase in the gear, mainly bottomset gill nets

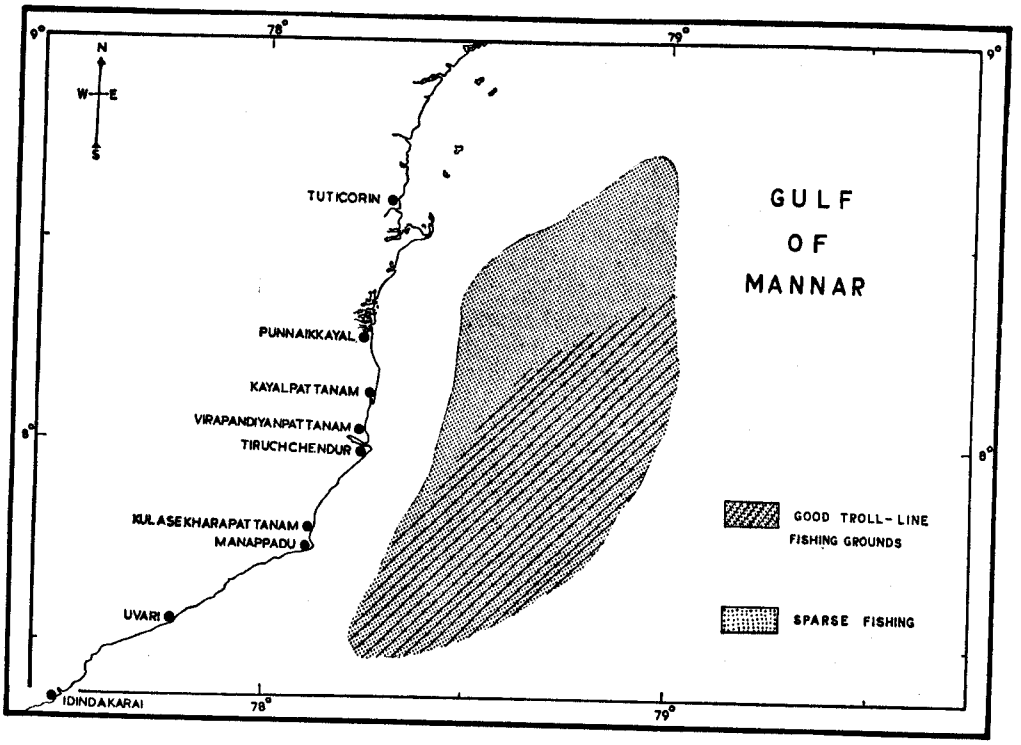


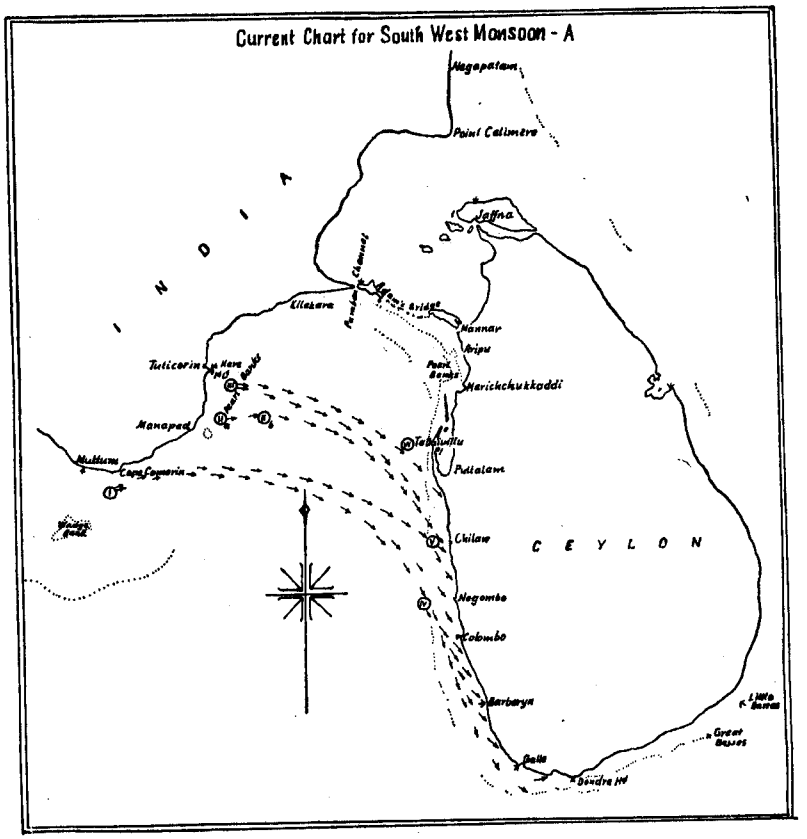
FIG. 1. Map of Tuticorin coast and part of Gulf of Mannar showing the area in which multiple trolling carried out at present.

and boat seines, perforce shifted the trolling grounds further south and offshore. The use of nylon fibre for nets has increased the efficiency of the nets used in the regular fishery in the inshore waters where fishing is carried out throughout the year. This increased activity has no doubt resulted in the more efficient capture of the smaller species, such as *Sardinella* spp., consequent to which larger predatory species, such as the larger seerfishes, and tunas are deflected or kept away from the inshore waters. At present, hardly any trolling is carried out 3 to 4 miles off Tuticorin although boats returning from handline fishing and trolling with one or two lines may take an occasional seer (*Scomberomorus commerson*), sailfish or little tunny.

At the commencement of the fishing season in June, multiple trolling is carried out beyond the 10 fathom line directly off Tuticorin. However, as the season progresses, and if there is evidence of good bite from the fish, the activity is shifted southwards. It is recognised by fishermen using this mode of fishing that the area lying beyond the 10 fathom line off Punnaikkayal and Manapad is good for trolling. This area lies within Long. 78° 15′ to 78° 25′ E. and Lat. 8° 15′ to 8° 40′ N. A part of the Tuticorin Pearl Banks lies within these limits and a few dead or partly alive coral reefs are also present in this area and its vicinity to the south and north. The continental shelf slopes more rapidly beyond the 10 fathom line. There can be hardly any doubt that mechanization of the craft and improvements in the gear would go a long way in extending the trolling grounds to well over 60 miles off this coast. Occasionally during the trolling season, boats which venture 25 miles off Virapandianpattanam and Manapad invariably bring very good catches of tunnies. However, this is a risky operation for the sailboats used, on account of the unpredictable weather . The distance to the fishing grounds from Tuticorin, the wind force and

the direction of wind play an important role in restricting the trolling grounds to its present size. Although the ' Tuticorin-type ' boats are excellent sail boats, the sailing time from Tuticorin to the fishing grounds is very great. Often, 6 to 8 hours are taken to reach the grounds and as usually late in the afternoon the winds are favourable the return journey is done in 3 to 4 hours. This allows for about 4 to 6 hours of fishing time. In order to study the conditions first hand, on 26-8-61 night at 23.00 hours, I left Tuticorin by one of the larger boats ' St. Antho ', with George, an experienced ' chammati ' and a crew of seven inclusive of three boys. On 27th morning we reached the fishing grounds at about 6.30 hours. Sudden change in the weather resulting in strong winds and choppy sea conditions hampered multiple trolling and only one little tunny and one northern bluefin tuna were caught on two of the lines. Deteriorating weather forced all 45 boats which had gone to the grounds that day to return to Tuticorin, some having caught no fish. The return journey hardly took 3 hours, all boats getting back by 11.30 hours. Due to persistent bad weather for several days after this, multiple trolling was discontinued.

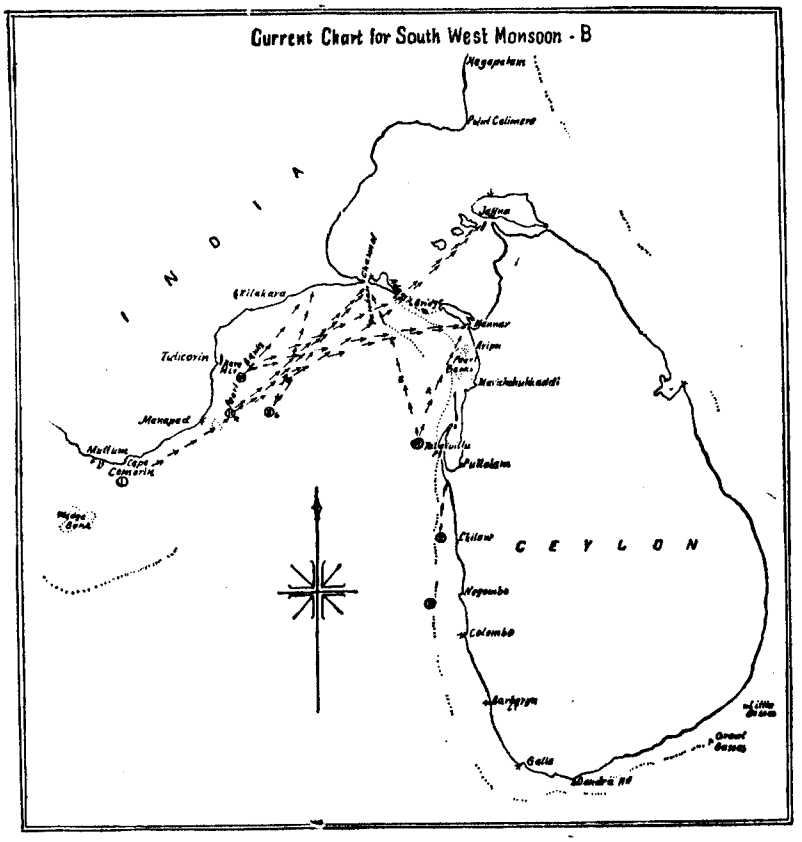
It is mainly on account of the distance from Tuticorin that the base of operation is shifted during any good fishing season to Virapandianpattanam 25 miles to the south. Boats leaving from here around 04.00 hours reach the grounds by 07.00 hours and can fish for about 8 hours before returning to land the catches at Virapandianpattanam.



TEXT FIG. 2. Current chart showing the easterly set when the South West Monsoon was strong from 9 to 25 July and again from 15 to 25 August 1910 (After Southwell and Kerkham, 1912).

HYDROGRAPHY

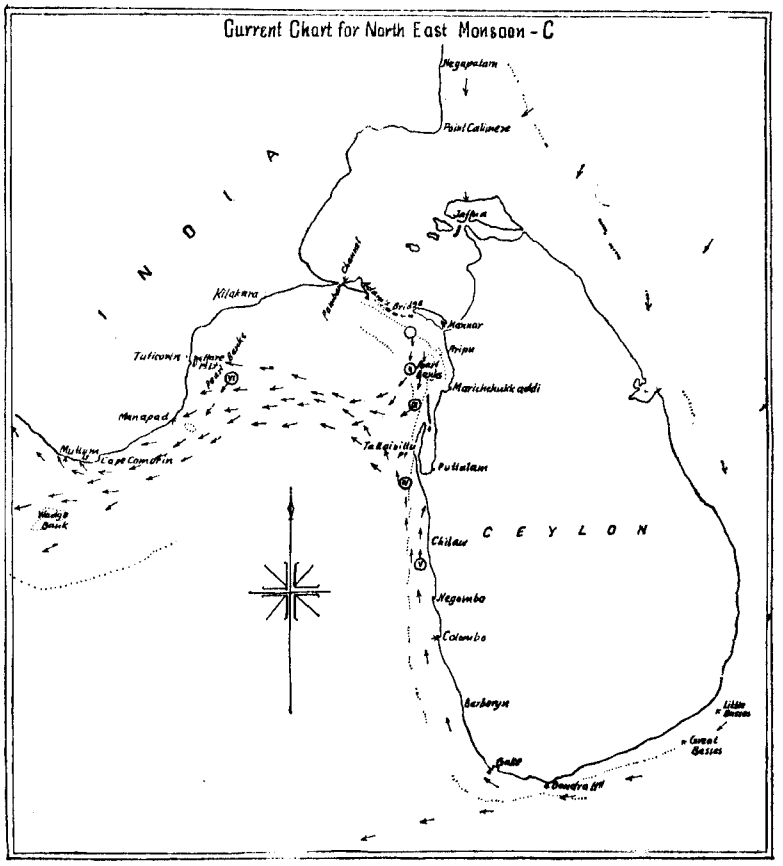
No hydrographic observations are available for the trolling grounds indicated in Fig. 1. The scanty information on the surface currents in the Gulf and the fluctuations in temperature and salinity in the inshore waters off Tuticorin may throw some light on the conditions obtaining in the vicinity.



TEXT FIG. 3. Current chart showing a north westerly current during a lull in the monsoon from 28 July to 5 August and again from when the monsoon commenced to subside from 1 September 1910 after which the current ran steadily to the north during the month (after Southwell and Kerkham, 1912).

Southwell and Kerkham (1912) have given surface current charts for the Gulf of Mannar for the North East and South West Monsoon seasons based on the recovery of drift bottles released at different times at Cape Comorin and off Colombo. The work was undertaken mainly to understand the surface current patterns that may help in the transport and settling of oyster spat in the pearl banks off Ceylon. The three current charts given by them are reproduced here (Figs. 2-4) for reference. They recognise two phases in the surface currents during the south west monsoon. The first, when the currents run northerly towards the Pamban Pass, during which time the monsoon is light or moderate. The second is a phase of strong monsoon, when the oceanic current penetrates the Gulf ' and the water at the head of the Gulf consequently becomes piled up as a cushion. The Oceanic current aided by the westerly wind which prevails over Southern India, takes an easterly course, and eventually reaches the Ceylon coast about Tallaivillu Point. It is here joined by an overflow of water from the head of the gulf and then runs south on to the Ceylon coast ' (Fig. 2). In Fig. 3, a transition between these two phases of the south west monsoon is

shown. During the north east monsoon there is a reversal in the surface drift as shown in Fig. 4. Some of the bottles liberated off Tallaivillu Point on the west coast of Ceylon have been recovered from as far north as Calicut, and one from the Maldive Islands.



TEXT FIG. 4. Current chart showing the westerly set when the North East Monsoon was strong (after Southwell and Kerkham, 1912).

The fishermen at Tuticorin, Virapandianpattanam, and Manapad are also aware of the existence of definite surface drift or current systems, off the Tinnevelly coast in the gulf. The Vāni vadu Nēerottam which commences in the Tamil month of Aāni may extend even up to Thai corresponding to the period June to December. Good fishing is expected in the coastal waters once this Nēerottam is established. Concurrent with this, from ten to fifteen miles off the coast opposite Virapandianpattanam and Manapad, the colour of the water is also said to change from a deep blue to ' murky ' and when such a condition occurs very good fishing by multiple trolling is predicted.

For information on the average monthly surface temperatures of the inshore waters of Tuticorin, reference may be made to Chacko (1956). He has tabulated six years data from 1949 to 1954 inclusive. The Madras Government Department of Fisheries Year Book (1960) contains some information on the average monthly surface and bottom temperature and salinity for the period April 1958 to March 1959 for waters off Tuticorin for depths up to 19 metres.

General Climatological Conditions

Since multiple trolling is carried out from sail boats and upto now no mechanised boats have been used for this purpose, weather conditions play an important role in this fishery. The North East Monsoon from about November to March, and the South West Monsoon more intense from June to September along the east coast of India and the Bay of Bengal are dominant features during which period the direction and strength of winds differ from place to place. Much of the ensuing information of climatological conditions is taken from ' Weather in the Indian Ocean ', Volume 2, part 6A (1940). In the Gulf of Mannar, the North East Monsoon blows until about the end of January and the wind direction is NNE to NE. During the month of April, both land and sea breeze prevail, and from February to May, the sea breezes gradually become of longer duration and increase in force. By the end of April, the winds at night become light and variable and in May the wind begins to blow continuously from SW. The South West Monsoon gains strength from June. In July the weather is cloudy and hazy with generally a fresh breeze. The wind moderates in the northern part in the morning and blows strong again in the afternoon. Fresh South-Westerly to West-South-Westerly winds continue in August and September, but the weather is generally fine ; the afternoon breezes are strengthened and are accompanied by occasional squall or rain. In November, the winds are light and variable between NE. and WNW. and by about the middle of the month the North East Monsoon winds commence blowing.

Throughout the year the visibility is good, except in September when the atmosphere is often hazy. It is estimated that the average difference in temperature between the hottest and coolest months of the shores of the Gulf of Mannar is about 7.5°F. The day to day temperature may vary and may range from as low as 65°F. in the coolest month (January) to about 95°F. in the hottest months (April-May).

As regards sea temperature, the 80°F. line is situated in the extreme north east corner of the Bay of Bengal off Sundarbans in the month of March, but by July, August and September it is in the south-west, off the west coast of Ceylon, and the Gulf of Mannar. The arrival of the South West Monsoon brings about a slight drop in the sea surface temperature and in the Gulf it falls slightly below 80°F.

The humidity is highest in the Gulf of Mannar during December and lowest in June or July.

As regards sea swell, in the Gulf of Mannar a swell from westward occurs during the latter part of April.

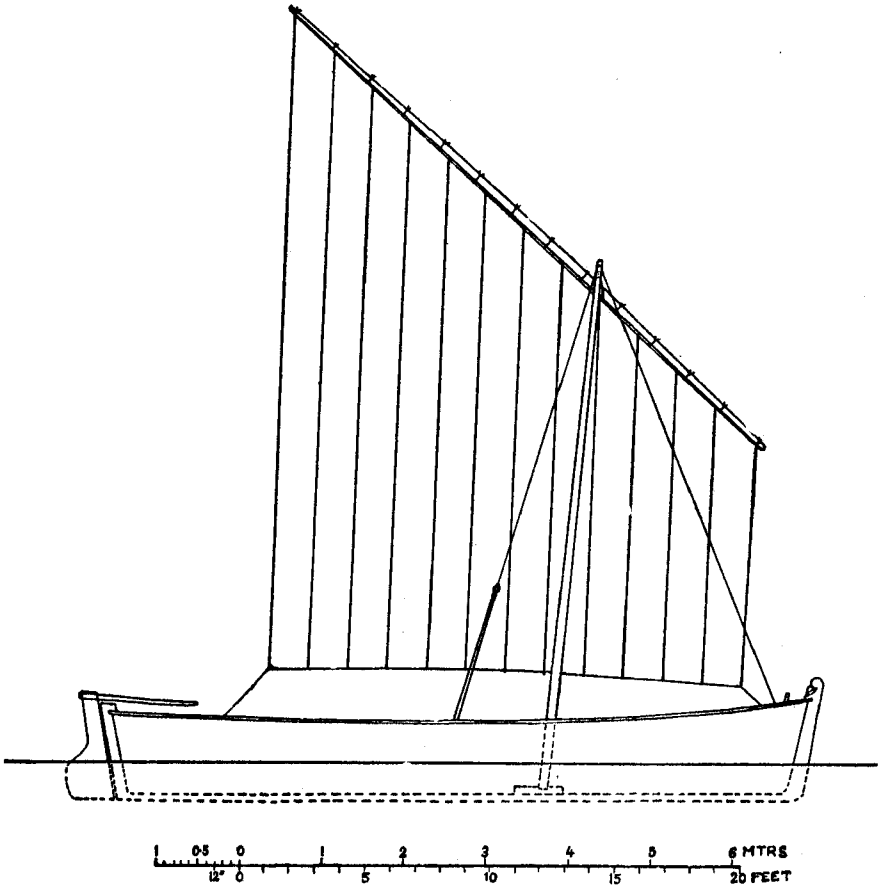
Fishing Craft and Gear used in Multiple Trolling

About 400 to 450 fishing boats commonly known as the ' Tuticorin-type ' boats (Zeiner and Rasmussen, 1958) operate from two fish landing centres at Tuticorin. Of these, generally 150 to 200 boats or even more, depending on the season are engaged in bottomset gillnet, driftnet and boat seine fishing. About 50 to 100 boats are used for handline fishing and invariably the boats while returning troll one or two lines, each about 30 fathoms in length.

If the winds are favourable and trolling is expected to yield good catches, more boats are engaged exclusively in multiple trolling. To suit the convenience of the fishermen who are subsidised with food articles, money, and other sundries by the auctioners, and to take advantage of the shorter distance to the fishing grounds, a great majority of the boats engaged in multiple trolling, often 150 or more, station and operate for the season from Virapandianpattanam. Normally only catamarans are used for regular fishing from this centre.

The boats engaged in multiple trolling may be broadly classed under two categories, namely small boats measuring between 27 and 29 feet in length and larger boats between 30 and 34 feet

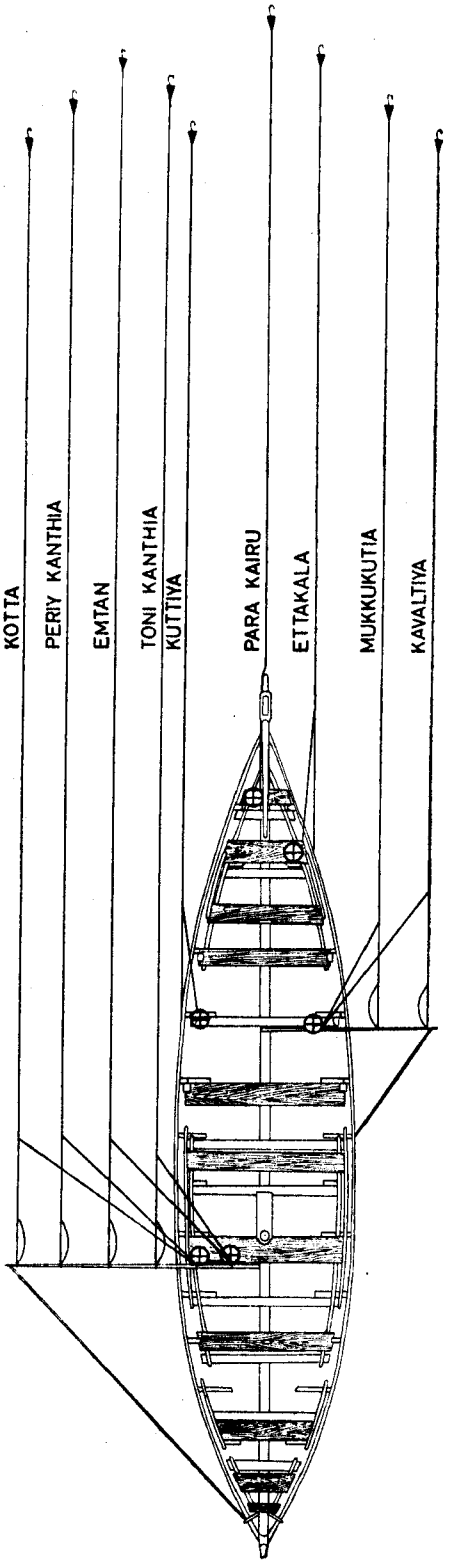
in length. The former generally carry a crew of six or seven persons and generally seven lines are used for multiple trolling. Seven to nine men go out in the larger boats and generally nine lines are used for trolling.



TEXT FIG. 5. Schematic drawing of the typical ' Tuticorin-type ' boat (after Zeiner and Rasmussen, 1958).

But for the difference in size, there is hardly any other difference in the design of these boats which are locally constructed. The timber commonly used in the construction is benteak (*Lagerstroemia lanceolata*) and poovarasu or portia (*Thespesia* sp.). Zeiner and Rasmussen (1958) describe the typical ' Tuticorin-type ' fishing boats as being long and relatively narrow, with vertical stems and sterns. The sheerline is almost straight and both ends of the boat are sharp. The curved wood of portia, locally available at low cost is used for the hull. The frames are cut away at the sheer plank and not carried to the gunwale. The uppermost plank which is very broad is framed with a very short piece not fastened to the main frame, and generally at some distance from it. Only one mast is carried and the sail which is a lugger is peculiar and indigenous. The main dimensions of a typical boat (Fig. 5) are given as : length o.a. 29′ ; breadth 6′ 3″ ; depth 2′ 11″ ; registered tonnage 2.9 and sail area 330 sq. ft. The cost of such a boat in 1958 including rig and sail was estimated to be about Rs. 2,000. In 1961, a boat of these dimensions was estimated to cost around Rs. 3,000.

The arrangement of the trolling lines in a larger boat is shown in Fig. 6. One interesting



TEXT FIG. 6. Schematic drawing showing the arrangement and the vernacular (Tamil) names of troll lines used from the 'Tuticorin-type' fishing boats for multiple trolling. The circle with a + indicate the position taken by fishermen handling the lines.

feature is that each line is denoted by a name starting from the outermost on the starboard side as follows :

1. Kotta
2. Periy Kanthia
3. Emtan
4. Toni Kanthia
5. Kuttiya
6. Para kairu
7. Ettakala
8. Mukkukuntia
9. Kavaltiya

Six of these lines are attached to two booms of varying size. The boom on the starboard side which is longer carries four lines (Nos. 1-4). This boom is about 14 to 16 feet long and about 3.5" in diameter at the tip and 4.5" to 5" at the butt end. The second boom is shorter, 10 to 12 feet long and carries two lines (Nos. 8 and 9). No butt blocks are used and the butt end of the booms rest on the side planks and the basal portions are rigged by ropes to keep them in position, resting also on the gunwale at an angle of about 40° to 45° to the horizontal. Usually, casuarina poles or some other local wood is used as trolling booms.

The length of the lines, vary depending on the location to which it is fixed to the boat, speed of the boat, as well as individual preferences of the fishermen. Those tied to the booms (Nos. 1-4 and 8 and 9) are from 18 to 25 fathoms long, while the other lines (Nos. 5-7) may be 15 to 20 fathoms long. However, I have measured lines of about 50 fathoms length which are coiled and taken, but all this length will not be paid out while trolling. The line used was found to be 3-ply cotton line about 4.2 mm. in diameter. Hooks of two different sizes (between 7 and 8 cm. long) were used with fish bait or with artificial lures. The latter was used only rarely, and made by tying the bleached fibres of *Agave* and pieces of red and white rag-cloth. The fish bait used was almost exclusively *Sardinella* spp. (*S. albela, S. gibbosa, S. sirm*). This was purchased from the previous mornings boat seine and gillnet catches and packed in brine in tin containers and taken along to the fishing grounds. A sum of Rs. 3 to Rs. 6 is spent per boat for the purchase of fish bait which if unexpended is brought back and reauctioned (Plate 3, Fig. A). This would fetch hardly one-fourth its original price and was generally purchased by fisherwomen for local sales.

Natural and other Factors Affecting Multiple Trolling off Tinnevelly Coast

The natural causes mainly responsible for restricting multiple trolling off Tinnevelly coast is inclement weather conditions or lack of proper wind to facilitate operation of the sail boats. The land-to-sea breeze known locally as ' vada kathu ' which blows from the earlier part of the night to the morning hours during the months June to August help in the boats reaching the fishing grounds. The ' sani kathu ' which blows from south to north and from sea towards land from noon or early afternoon to late in the evening aid the speedy return of the boats after fishing. When these favourable winds are not present, multiple trolling is not generally undertaken.

Even during the fishing season, some of the fishermen are attracted to other works which give them a steady remuneration. It is interesting that the passage of time has not brought about any marked change in the nature of the inducements that keep the fishermen away from this mode of fishing during a slack season. A good deal of what Hornell (1917) reported in this connection has remained unchanged. He remarks that the number of fishermen working when the respective fisheries are in vigorous prosecution considerably fluctuates from time to time and some take up alternate employment ' . . . either when the fishery is poor, or the counter attraction is great. For example when the port is busy with exports and imports and the demand for lighterage is great a certain proportion of the fisher class find it more profitable to act as lighter crews.

Or again they may quarry coral on the reefs, or enlist as chank divers. A pearl fishery in Ceylon causes a great exodus of fishermen and lighter men.'

While at present there is no migration of fishermen to Ceylon during the pearl fishery season there, pearl fishery operations from the banks off Tuticorin in recent years have seen considerable reduction in fishing activities including multiple trolling at Tuticorin, as most of the fishermen are expert divers.

Another very important inducement for fishermen who engage in multiple trolling is quarrying coral, which industry has in recent years grown by leaps and bounds in view of the establishment of at least three cement and chemical factories in the Tinnevelly and Ramnad Districts. At the time that these investigations were carried out in 1961, the fishermen were paid a fixed rate per boat load of quarried coral as follows : The larger boats with a complement of 7 to 9 crew (average 8) after a day's quarrying will be able to bring about 2 to 2½ square yards of coral which is stacked 3 feet high and the contractors purchase rate per square yard obtaining in September 1961 was Rs. 12. Most of the fishermen engaged in this work get themselves heavily indebted to the contractors by receiving money in advance. This is additional inducement given by the contractors who eventually pay the fishermen only Rs. 11 per stacked square yard of coral blocks. The larger boats have a capacity for carrying upto 5 square yards of quarried coral. A minimum of Rs. 30 is thus earned per day which means that a man gets an average income of at least Rs. 3.50 per day. This is considerably higher than what they could expect from multiple trolling if the fishery is not exceptionally good.

Added to these, the set back in the dry fish trade with Ceylon of which already mention has been made had forced many fishermen to seek other employment.

Fishing off Virapandianpattanam

During the fishing season which starts from about the middle of June, in addition to the 100 to 150 sail boats of the ' Tuticorin-type ' which congregate at Virapandianpattanam for multiple trolling, the local catamarans numbering about 50 also participate in the fishing. The catamarans fish upto about 10 miles off the coast, while the sail boats fish from even 25 miles off the coast. The catamarans using sail and usually two or three troll lines catch seer, northern bluefin tuna, and the little tunny, while the boats land in addition, yellowfin tuna, bigeye tuna, sailfish, and marlins.

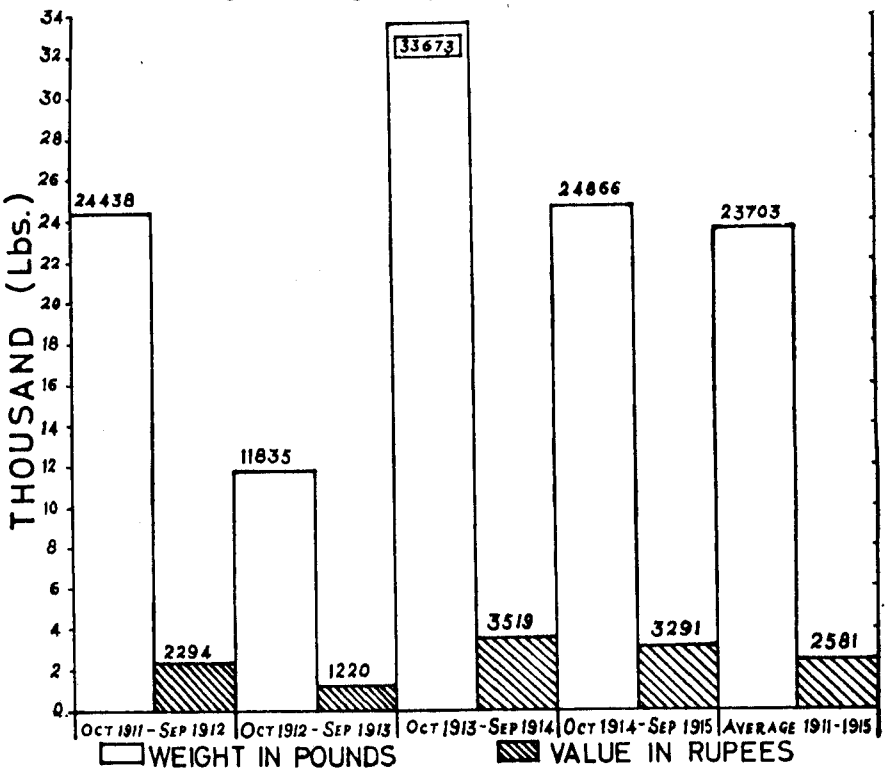
All fish landed by multiple trolling at Virapandianpattanam goes in for salt curing to be eventually exported to Ceylon. The fish when landed is auctioned as at Tuticorin with one difference. The entire catch is handled by only four merchants with mutual understandings to keep out outside competition. The auctioner's share is one anna (= 6 P.) per rupee plus one fish per boat.

During the 1961 season for slightly over a fortnight in July-August about 20 ' Tuticorin-type ' boats were operating from Virapandianpattanam. Fishing was poor and the daily catch instead of being auctioned, was weighed and taken by the merchants at the following rates : *Surai* (little tunny, northern bluefin, and yellowfin) 2½ annas (=15 P.) per lb. ; *Parai, Katta,* etc. (*Caranx* spp., *Chorinemus* spp., etc.) 3½ annas (=22 P.) per lb. ; and *Cheela* (*Scomberonorus commerson*) 5 to 5½ annas (31 to 34 P.) per lb. These prices amount to hardly one-fourth the rates obtaining prior to the curb on the export of dry fish to Ceylon in 1960.

Review of Earlier Work on Fishery for Tunas and Related Scombroids at Tuticorin

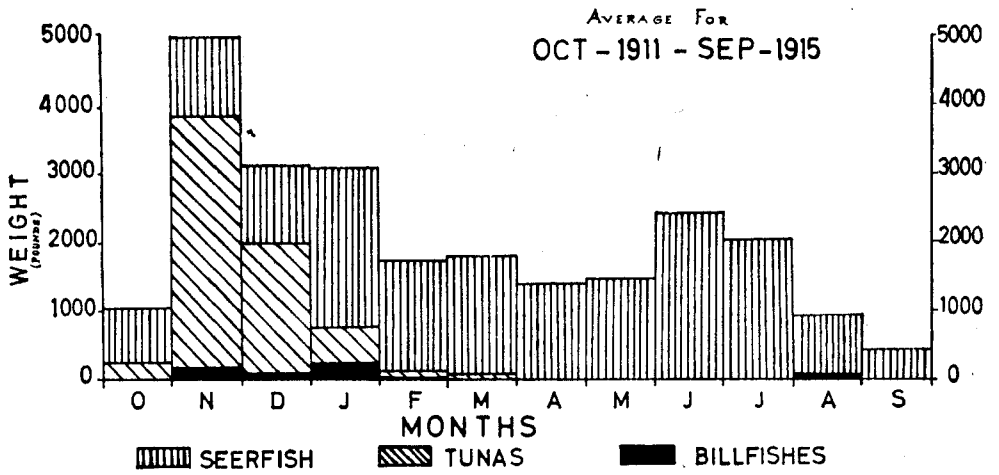
The earliest account is that given by Hornell (1917) wherein he has tabulated the average yearly weight and value of 36 most important species of fish landed at Tuticorin. It is presumed

that ' seerfish ' will include all three species of *Scomberomorus* landed with all gear at Tuticorin ; ' bonito ' more than one species of tuna ; and ' swordfish ' both the sailfish and the marlins. Based on this data, the average annual quantity and value of scombroid fishes landed chiefly by

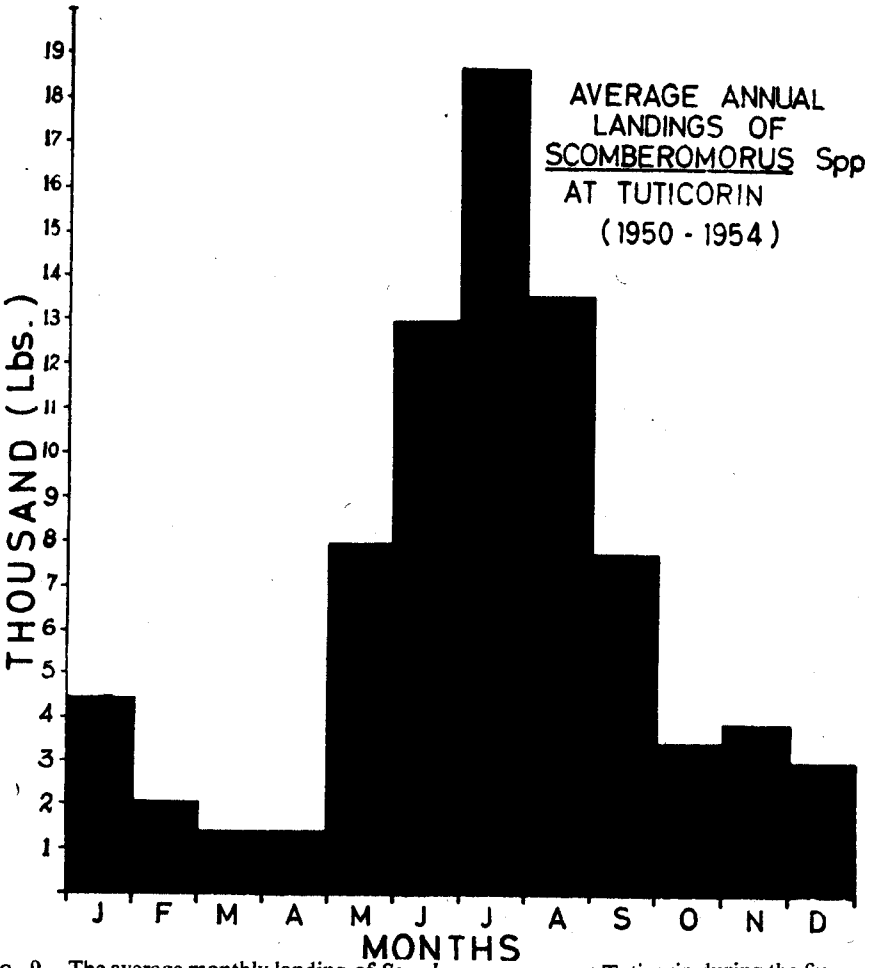


TEXT FIG. 7. The average annual quantity and value of scombroid fishes landed by muliple trolling at Tuticorin during the four year period October 1911 to September 1915.

multiple trolling at Tuticorin is shown in Fig. 7. The weight and value of fish obtained by multiple trolling at Tuticorin for the four year period October 1911 to September 1915, based on Hornell (1917) is given in Fig. 8. This includes the period of take over of this mode of fishing by the Tuticorin fishermen from the Sinhalese migrant fishermen in 1912-1913. From Fig. 8 it will be seen that seerfishes constituted the main catch, and the best landings were during the months November, December and January. Tunas were also caught in the months October, December, and January and in very negligible quantities in February and March. Billfish landings were mainly during November-January and very few were also caught in February and in August. The data relating to the sale of *Scomberomorus* and tunnys caught along the west coast of Ceylon and sold in the various markets of Colombo as given by Pearson (1930) for the years 1928 and 1929 also indicate that the maximum landings of these fishes were during the months November to January coinciding with the North East Monsoon period. As for the waters off Tuticorin, Hornell (1917) adduces the reasons for this seasonal abundance of scombroid fishes coinciding with the period of the North East Monsoon due to the sea being clear '. . . . and the wind just strong enough to give the boats sufficient speed through the water and yet carry full sail. In the south-west monsoon poor fishing results partly from the frequent turbidity of the water and partly (more) from the fact that the wind and sea are then usually too high to permit the local boats to carry full sail. It is at these times that the outrigger canoes of Ceylon and Palk Bay come to the front by reason of their greater power to stand up to heavy weather.' Conditions have greatly changed since then and as shall be discussed presently, the best period for multiple



TEXT FIG. 8. The average monthly catches of tunas, seerfish and billfishes landed by trolling at Tuticorin during the four year period—October 1911 to September 1915, indicating the seasons of good fishing.



TEXT FIG. 9. The average monthly landing of *Scomberomorus* spp. at Tuticorin during the five year period 1950 to 1954, indicating May to September to be the best months of fishing.

trolling is considered to be from June to August or September. Not a single outrigger canoe operates from Tuticorin to influence the change in the main fishing season. On the other hand, the skill of the fisherman has had a lot to do with this. Boats which went out for multiple trolling or handline fishing had a balance board of sufficient length on the weather side to allow for two or three of the crew to stand as counter weight. The fishermen have also become adept at this method of fishing, and more than anything else, venture far off the coast. The average annual landings of *Scomberomorus* and ' tunny ' at Tuticorin in recent years bears this out. The data for 1950 to 1954 (Figs. 9 and 10) shows that more fishing is now carried out during the South West Monsoon period than the North East Monsoon period.

While tunas and related scombroid fishes may be present in the Gulf of Mannar off Tinnevelly coast at all times, from experience, the fishermen feel that during the months June to August there is an influx of these fishes towards coastal waters. Favourable winds for trolling do occur during this season. However, temporary breaks in the fishing operations take place when the weather conditions are really adverse, and this may last for a few days at a time.

Some Observations on the Habits and Behaviour of Scombroid Fishes Caught in Trolling off Tuticorin

During my visits to Tuticorin and other centres along the Tinnevelly coast to conduct the present survey it was possible to obtain some information about the behaviour of some of the species of scombroid fishes usually caught by trolling, from fishermen engaged in this mode of fishing for a long time. Since these may be of some interest, opportunity is taken here to record these.

Adult *S. commerson* do not shoal at the surface as tunas. However, on occasions, especially in the later part of the afternoon and towards dusk this fish is seen to leap out of water. Several may be seen within the range of vision and on such occasions trolling will be very successful. On 19th, 21st and 22nd August 1961 in the trolling grounds off Tuticorin hundreds of *S.commerson* were seen to leap clearly out of the water. Some, close to the boats which were trolling were estimated to have lept about 10 feet clear off the water. The size range of the specimens caught from the same area on 24th and 25th August 1961 was 628 mm. to 1280 mm., weighing from 3.5 to 30.5 pounds. The males had oozing milt and the large females were partly spent. The reason for the fish leaping out of water in such large numbers is not clear.

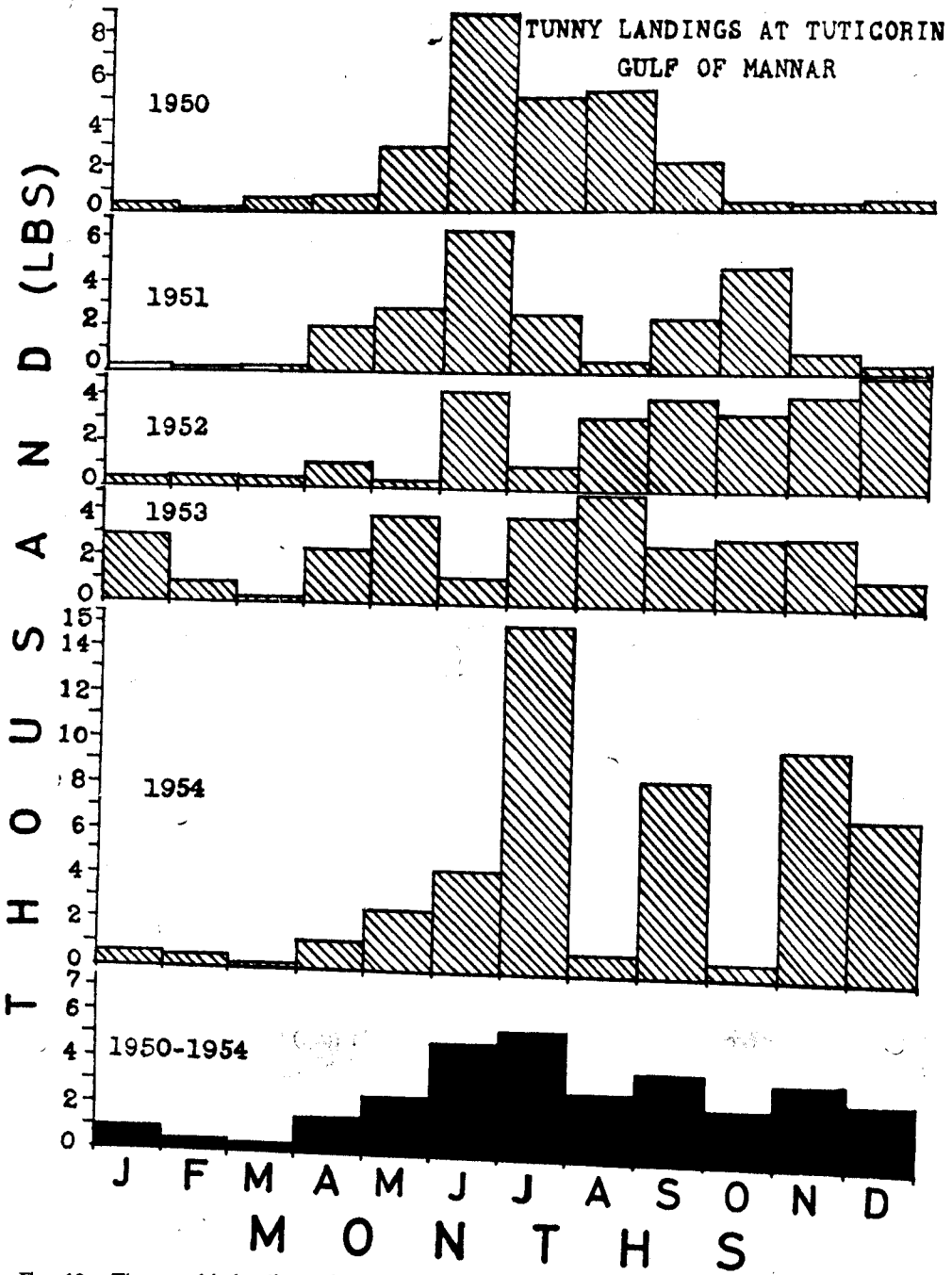
Unlike the little tunny and the northern bluefin tuna, the yellowfin tuna is not sighted by the fishermen as surface schools. Since some of the troll lines are manipulated by hand, the fishermen are adept at distinguishing a yellowfin bite from that of other tunas, as it gives only a small tug on the line and instead of leaping, the fish invariably sounds. The line has to be very slowly hauled in at a steady pace if the fish is to be successfully landed. Even so, when the keel of the boat is within its visual field, the fish again sounds and 15 to 20 fathoms of line is let out and the hauling repeated. The second time the fish is drawn closer to the boat, with a single movement it is gaffed and hauled in. Several yellowfin are lost at this stage by improper gaffing.

On rare occasions, large schools of skipjack (*K.pelamis*) are sighted, and when a school is approached, it usually sounds and only very few fish are caught in troll lines.

Bird flocks are not seen accompanying tuna shoals.

The black marlin and the striped marlin are sometimes sighted at the surface and the fish is also known to leap out of water. When attracted by trolling bait, they usually dash to the bait and the moment the bite is effected, the fish leaps out of water. At this stage, the strain on the line is usually great and often the fish gets away, due to improper hooking, or due to the straight-

ening of the hook or the snapping of the line. When a hooked marlin is drawn alongside the boat, the moment the fish is within reach, the first thing that is done is to tightly grip the bills



TEXT FIG. 10. The monthly landings of tunas at Tuticorin during the five year period—1950 to 1954, and also the average for the five year period. (June-July as the best months of fishing for tunas may be noted).

of the fish, which action I am told immobilises the fish enabling gaffing and hauling in. Strangely enough, no fisherman I had spoken to could ever remember of having seen or heard of damage caused to boats by marlins in the fishing grounds or while the fish is being hauled into the boat.

At Tuticorin it was interesting to find that the liver and stomach of tunas are eaten and these are collected from the place where the fish is filleted for curing. However, the visceral organs of marlins and sailfish are avoided. I was told that in 1959 two families (altogether 11 members) were hospitalised on account of eating the stomach (not gonad) of the black marlin.

Tunas and Related Pelagic Fishes Caught off Tuticorin

Hornell's (1915, 1917) reports indicate that the following scombroid fishes were generally caught at Tuticorin (Table 2).

Table 2

Scientific name (Hornell, 1915)	Vernacular name (Tamil)	Upto date nomenclature
Thynnus thunnia	Suraimin	*Euthynnus affinis affinis* (Cantor)
Cybium commerson	Mavulasi	*Scomberomorus commerson* Lacépède
Cybium interruptum	Vanjaram	*Scomberomorus guttatus guttatus* (Bloch and Schneider)
Cybium guttatum	Velramin	
Cybium guttatus	Mayilmin	*Istiophorus gladius* (Broussonnet)
Histiophorus gladius	Emankōlā	*Makaira indica* (Cuvier)
Histiophorus immaculatus		
Histiophorus brevirostris		

From the above list, only one species of *Scomberomorus*, namely *S.commerson* was taken in multiple trolling during the period of observation. More species of tunas and other pelagic fishes which occurred regularly or sporadically in the multiple troll fishery during 1960-1961 are given in Table 3.

Table 3

Scientific name	Vernacular name (English name)	Remarks
Auxis thazard Lacépède	(short corseletted frigate mackerel)	Rare
Euthynnus affinis affinis (Cantor)	Suraimin (little tunny or mackerel tuna)	Common
Katsuwonus pelamis (Linnaeus)	(skijpack tuna)	Rare
Thunnus (Neothunnus) albacares macropterus (Temminck and Schlegel)	Kelavalai (yellowfin tuna)	Common
T.(Kishinoella) tonggol (Bleeker)	Ettalai (Northern bluefin tuna)	Common
Istiophorus gladius (Broussonnet)	Thalapathu (sailfish)	Common
Makaira indica (Cuvier)	Kopprai Kulla (black marlin)	Rare
Makaira nigricans Lacépède	Kola (blue marlin)	Rare
Tetrapturus audax Philippi	Kola (striped marlin)	Rare
Tetrapturus sp.	Kola	Rare
Scomberomorus commerson (Lacépède)	Chela (Seer)	Common
Scomberomorus lineolatus (Cuvier)	Nonachela (Seer)	Rare
Acanthocybium solandri (Cuvier)	Sawara (Wahoo)	Rare

The oriental bonito *Sarda orientalis* (Temminck and Schlegel) which constitutes a minor fishery in certain parts along the south west coast of India was not encountered off Tuticorin in 1960-1961. During this entire period only one specimen of *Scomberomorus lineolatus* was caught by multiple trolling, while not a single specimen of *S.g.guttatus* was caught by this gear. This is interesting as both these species along with *S.commerson* in the size range 180 to about 700 mm. are caught regularly in bottomset gill nets operated off Tuticorin. *Auxis thynnoides* Bleeker, another species reported from the south west coast of India was not encountered in the catches. One other notable absence in the multiple troll catches off Tuticorin is the bigeye tuna *T(P.) obesus mebachi* Kishinouye, which has a distribution in the tropical waters more or less co-extensive with that of the yellowfin tuna.

In addition to these scombroid fishes, other pelagic fishes such as *Coryphaena hippurus* Linnaeus, *Sphyraena* spp., *Caranx* spp., *Chorinemus* spp., and *Elagatis bipinnulatus* (Quoy and Gaimard) are occasionally taken by trolling.

In a separate contribution presented at this Symposium, Silas and Rajagopalan (1962) have made some observations on billfishes (sailfish and marlins) caught off Tuticorin. For an aid to the identification of tunas and related scombroid fishes caught off Tuticorin, Gulf of Mannar, reference is invited to ' A Systematic review of the scombroid fishes of India ' by Jones and Silas (1962) presented at this Symposium.

Composition of Scombroid Fish in Catch

During 1961 from the time that multiple trolling was commenced in June up to the end of December (total 214 days) day to day observations were carried out at Tuticorin in order to find out the quantity and the species-wise composition of scombroid fishes landed by this gear. It was not possible for me to be in the field on all these days, but I was ably assisted in this by Shri M. S. Rajagopalan. The catch landings showed that on 41 days tunas and other scombroid fishes were caught off Tuticorin using troll lines, but the fishery by multiple trolling was confined to 28 days as follows : 3 in June, 4 in July, 16 in August, and 5 in September. On the other 13 days scombroid fish landings were the result of catches made from boats returning from handline fishing for perches, and using one or two troll lines. In the details of the catch listed date-wise below, it was not possible to estimate the actual number of fish of a particular species on a few days, especially on account of other fishing data which had to be collected. On such occasions, a visual estimate was made of the numbers as follows : 5 or less ; 10 or less meaning 5 to 10 ; 20 or less meaning 10 to 20 ; and ' several ' meaning more than 20 but less than 50. In the following list, the common English names for the species as given by Jones and Silas (1962) is followed, but abbreviated as : FM=short corseletted frigate mackerel ; LT=little tunny ; M=Marlins ; NB=northern bluefin tuna ; SE=seerfish (*S. commerson*) ; SF=sailfish ; WA=wahoo ; and YF=yellowfin tuna.

Month	*Date*	*Species composition*
June	19-6-61	Several SE
	21-6-61	16 NB, 50 LT, 2 YF
	22-6-61	3 FM
July	17-7-61	1 M, 70 NB, 20 LT, 5 FM
	18-7-61	1 SF, 9 NB
	19-7-61	35 NB, 1 YF, 7 LT, 10 SE
	28-7-61	1 SF
	31-7-61	5 or less LT, and NB

Month	*Date*	*Species composition*
August	4-8-61	20 or less LT, and NB, 1 SF
	7-8-61	10 or less LT, and NB
	8-8-61	5 NB, 10 or less LT
	9-8-61	1 NB, 10 or less LT
	10-8-61	5 or less LT
	11-8-61	30 NB, 50 LT, 5 YF
	14-8-61	Several LT, 10 or less NB, 2 YF
	16-8-61	25 LT, 4 NB
	17-8-61	2 NB, 1 SF
	18-8-61	1 M
	19-8-61	Over 300 SF landed after dusk
	21-8-61	Over 200 SF, 10 or less NB, 1 YF
	22-8-61	Several SF, 10 or less NB, 1 YF
	23-8-61	1 WA, 1 M, Several NB
	24-8-61	76 SF, Several YF, 27 NB
	25-8-61	1 SF, 1 M, Several YF, Several NB, 20 or less LT
	30-8-61	1 WA
September	2-9-61	1 SF
	9-9-61	1 SF
	12-9-61	4 NB
	13-9-61	11 NB, 1 YF, 6 LT
	14-9-61	4 NB, 1 YF, 2 LT
	25-9-61	8 LT, 9 NB
	28-9-61	6 NB
	29-9-61	1 NB
	30-9-61	1 LT
October	6-10-61	5 LT
November	14-11-61	1 M
	21-11-61	1 SF
	23-11-61	1 SF
	27-11-61	4 NB
	29-11-61	1 M
December	11-12-61	1 SF

From the above it will be seen that among tunas, the northern bluefin tuna predominated in the catch followed by the little tunny and the yellowfin tuna.

Percentage Composition of Species by Weight in the Catch

It should be mentioned that boats engaged in multiple trolling return at about the same time and the anxiety of the fishermen to have the catch auctioned as early as possible makes it sometimes difficult to weigh and measure all the fish from each boat. At Tuticorin about a dozen auctioners are present at the time when the boats return after fishing, generally between 15.00 and 18.30 hours. The auction is brisk and once the fish is purchased by the retail traders it is difficult to handle the fish for taking data for length, weight, etc. The co-operation of the auctioners was sought and by delaying the auctioning of each lot by a few minutes it was possible to collect a good deal of data. There was no problem when the fish was purchased by merchants for salt curing. It is also customary for fishermen bringing a good catch not to display the entire

TABLE 4

Percentage Composition of Species (Weight)

Name of Species	19-7-61			24-8-61			25-8-61			2-9-61		
	Av. of 5 boats out of 25			Av. of 10 boats out of 35			Av. of 18 boats out of 47			Av. of 2 boats out of 8		
	No. of specimens (Av.)	Actual weight in lbs. (Av.)	% of weight	No. of specimens (Av.)	Actual weight in lbs. (Av.)	% of weight	No. of specimens (Av.)	Actual weight in lbs. (Av.)	% of weight	No. of specimens (Av.)	Actual weight in lbs. (Av.)	% of weight
S. commerson	10 (2)	55 (11)	23.80	13 (1.3)	127 (12.7)	23.3	11	87.25 (4.8)	11.4	1 (0.5)	11.5 (5.7)	46
S.lineolatus	..	..	..	..	..	..	..	10.5 (0.48)	1.4	..	..	..
T.(K.) tonggol	35 (7)	109 (21.8)	47.1	110 (11)	354 (35.4)	64.9	33	126.5 (7.0)	16.6	..	..	..
E.a.affinis	7 (1.4)	24 (4.8)	10.4	19 (1.9)	64 (6.4)	11.74	3	10 (0.5)	1.3	2 (1)	13.5 (6.7	54
T.(N.) albacares macropterus	1 (0.2)	13 (2.6)	5.6	..	..	..	23	377 (20.9)	49.3	..	..	..
A. thazard	1 (0.2)	8 (1.6)	3.5	..	..	..	..	..	..	..	..	..
Elagatis bipinnulatus ..	5 (1)	22 (4.4)	9.5	..	..	..	..	..	..	..	..	..
Sphyraena sp. ..	..	..	..	..	..	..	1	5 (0.27)	0.1	..	..	..
I.gladius	..	..	..	..	..	..	1	36 (2)	4.7	..	..	..
Tetrapturus audax ..	..	..	..	..	..	..	1	112 (6.2)	14.7	..	..	..

catch at one auction, but to do this in lots, and this fact was also taken into account when catch data, auction rates, etc., was studied. In Table 4, the details of the percentage composition of species (weight) and numbers are given for four fishing days for 35 boats sampled at random out of a total of 115 boats. This again would indicate that the northern bluefin tuna was the most common tuna in the catch.

Weight of Fish Caught by Multiple Trolling in Relation to Auction Rates and Earnings of Fishermen

The fish sold at the landing place at Tuticorin to the merchants is not by actual weighing, but by ' eye measure.' Both auctioners as well as wholesale merchants were found to have excellent judgement in estimating weights by ' eye measure ' and this was on several occasions corroborated by actual weighing carried out for the present studies. From Hornell's account (Hornell, 1917) it is seen that this method of appraisement was prevalent even at that time. The prices fluctuated from day to day and this depended not only on the size of the catch, but on the species composition as well. The rates for tunas were the lowest, and during 1961 this was more so on account of the adverse set back in the dry fish trade with Ceylon. The average wholesale price rates per pound avoirdupois reported by Hornell (1917) for these fishes are compared below with the current rates (Table 5). In the same Table, I have also included the rates obtaining during 1959 when the export market for dryfish was very favourable. This information was obtained from the wholesale merchants who purchased the bulk of the catch from multiple trolling for salt curing.

Table 5

Prices per pound avoirdupois of tuna, seerfish, and billfishes at Tuticorin

Name	Rates per pound		
	Hornell (1917)	1959	1961
Seerfish	2½ - 3 annas** (= 15 - 19 P.)	12 - 14 annas** (= 75 - 87 P.)	8 - 10 annas** (= 50 - 62 P.)
Little tunny & Northern bluefin tuna	1½ - 2 annas (= 9 - 12 P.)	8 - 9 annas (= 50 - 56 P.)	4½ - 5 annas (= 28 - 31 P.)
Yellowfin tuna ..	1½ - 2 annas (= 9 - 12 P.)	-Do-	5 - 5½ annas (= 31 - 34 P.)
Marlins and sailfish ..	1 anna (= 6 P.)	-Do-	4½ - 5½ annas (= 28 - 34 P.)

** 16 annas = 100 paise = 1 rupee.

The retail price for fresh seerfish, tunas and marlins at Tuticorin during 1961 was as follows: Seerfish=Rs. 1.25 to 1.50 ; and Tunas, marlins and sailfish from 75 P. to Re. 1 per pound.

In Table 6, information regarding weight of fish caught, actual auction price rates, estimated income per head per fishing trip for multiple trolling, etc. are given. The wide fluctuations in the catch, both species-wise as well as in quantity, and the low income per head for the hours of work are noticeable.

TABLE 6

Details of Weight of Fish landed by Multiple Trolling in relation to auction rates and earnings of Fishermen per head per day' fishing

Details	Dates 19-7-61	24-8-61	25-8-61	2-9-61	Average of 4 days
Actual No. of boats fishing	25	35	47	8	28.72
No. of boats sampled	5	10	18	2	8.72
Actual weight of fish landed in boats sampled (Lbs.)	231	545	764.25	25	391.31
Average weight of fish landed per boat (Lbs.)	46.2	54.0	42.45	12.5	37.78
Estimated total wt. of fish landed by all boats (Lbs.)	1155	1890	2202.2	100	1336.75
Actual price fetched at auction for catch sampled (Rs. P.)	78.00	203.00	213.25	6.00	125.06
Value of fish landed (Average) per boat	15.60	20.30	11.84	3.00	12.68
Estimated total value of fish landed by all boats	488.00	710.50	556.48	24.00	434.49
Average number of men per boat** ..	8	8	8	8	8
No. of hours at sea (Sailing time + actual fishing-approximate)	16	16	16	16	16
Income per head per fishing trip (Rs. P.)..	1.95	2.53	1.48	0.37	1.58

** The smaller boats using 7 troll lines had generally 7 or 8 crew and the larger boats operating 9 troll lines had 8 or 9 crew. Of these, usually 2 or 3 were boys.

OBSERVATIONS ON THE SPECIES OF TUNAS AND RELATED FISHES

1. **Thunnus (Kishinoella) tonggol** Bleeker

(Northern bluefin tuna or the Indian longtailed tunny)

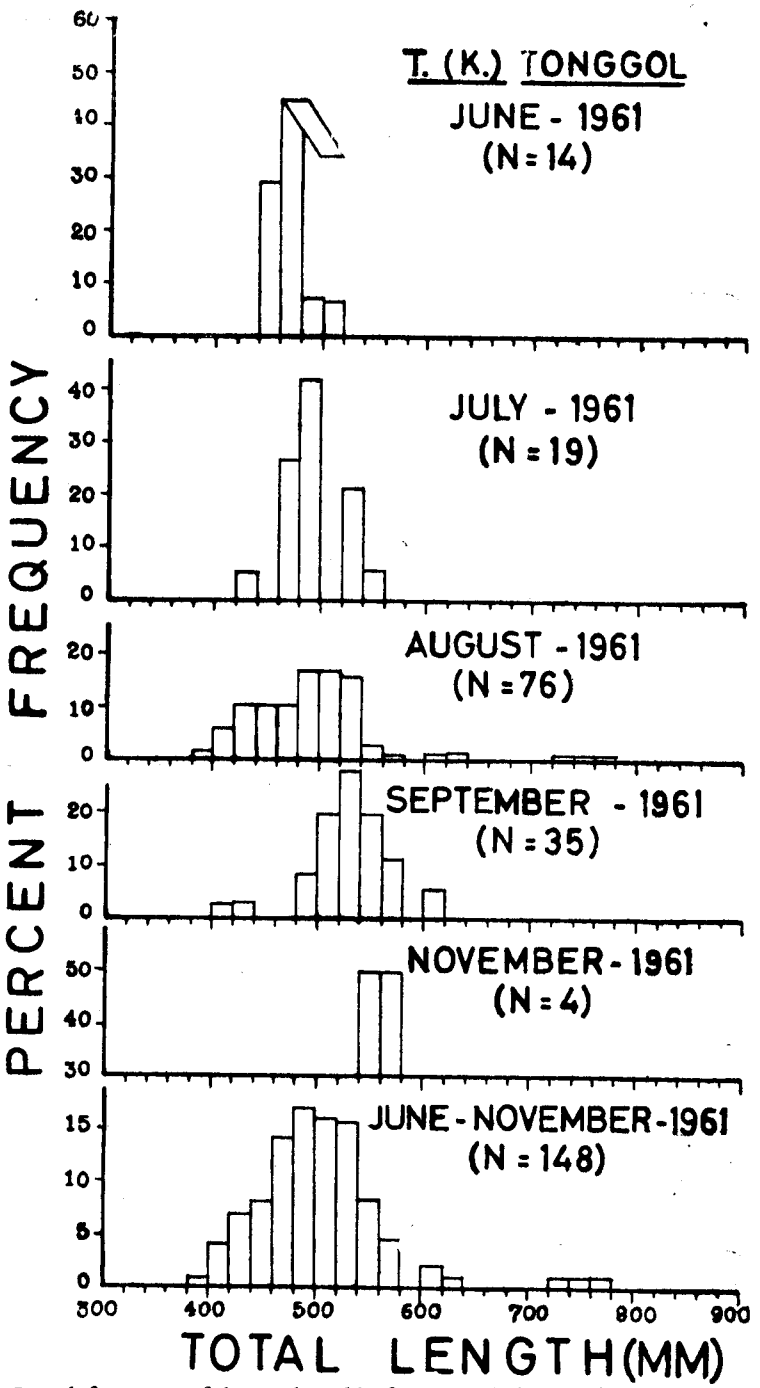
MATERIAL : During the 1960 and 1961 seasons over 250 specimens in the size range 395 to 775 mm. weighing from 2 to 15 pounds were examined. The catch in 1960 was sporadic. The length frequency of 148 specimens in the above size range landed in 1961 (June to November) is shown in Fig. 11. The total length in tunas refer to length from tip of snout to end of hypural.

DESCRIPTION :

Meristic counts :

D1. XII-XIII ; D2+ finlets 14+8-9 ; P1. 31 ; A+finlets 14+8 ; Gill rakers 6-8+16-19.

Published records show hardly any difference in the finray counts for *T.* (*K.*) *tonggol* from various parts of the Indo-Pacific. However, there appears to be regional differences in the modal formulae for the number of gill rakers, and as such this character is dealt with at some length here. The frequency of gill raker counts for the material examined from off Tinnevelly Coast is given in Tables 7 and 8.



TEXT FIG. 11. Length frequency of the northern bluefin tuna *T.(K.) tonggol* (Bleeker) caught by multiple trolling off the Tinnevelly Coast for the months June to November, 1961.

TABLE 7

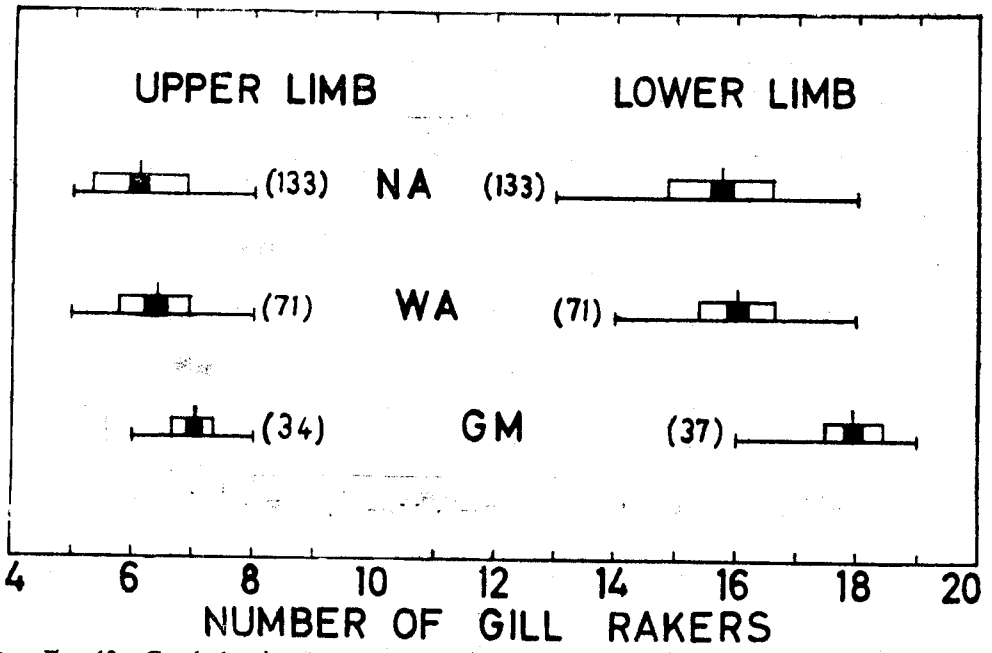
Frequency of gill raker counts

Counts	Upper Limb			No. of specimens	Lower limb				No. of specimens	Combined frequency						No. of specimens
	6	7	8		16	17	18	19		22	23	24	25	26	27	
No. of specimens	5	23	6	34	2	6	21	8	37	1	3	7	16	9	1	37

TABLE 8

Frequency of combination of gill rakers on upper and lower limbs of outer gill arch

Lower limb \ Upper limb	No.	6	7	8
	16	1	1	..
	17	2	5	..
	18	4	12	5
	19	..	6	1



TEXT FIG. 12. Graph showing the variation in the total number of gill rakers on the upper and lower limbs of the outer gill arch of *T.(K.) tonggol* from Northern Australia (NA), Western Australia (WA) ; and the Gulf of Mannar (GM). (The horizontal line represents the total range ; the short vertical line the mean ; the solid rectangle two standard errors on each side of the mean and the hollow rectangle one standard deviation on either side of the mean). The number of specimens are indicated in parenthesis.

The modal formula of 7+18 (=25) differs markedly from that given for a good series of specimens from Western Australia by Serventy (1956). A statistical comparison of the gill raker counts he has given for the northern bluefin from Northern and Western Australia shows no significant difference, but this is not the case when we compare the counts for the Australian specimens with those from the Gulf of Mannar. In table 9, the *t* values were calculated using the formula :

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

where $\bar{x}_1$ and $\bar{x}_2$ are the means, s_1^2 and s_2^2 the standard deviations, and n_1 and n_2 the number of specimens. For the Western Australian and Gulf of Mannar samples the *t* value was calculated to be 10.92 and 3.82 for the gill rakers of the lower and upper limbs respectively, both showing highly significant difference as *P* at 5% level is 1.96. When *t* was calculated for the two samples collected at Western and Northern Australia, it was much lower at the 5% level for the gill rakers of the upper (1.7692) and lower (2.5274) limbs indicating the likelihood of the samples belonging to the same population, though slightly significant difference is noticeable in the number of gill rakers on the lower limb (Table 9). A graphical presentation of the data is given in Fig. 12.

The scope of the present work, besides drawing attention to this significant difference, does not permit further elaboration, especially as there is hardly any data for the intervening area (Indonesian waters). As the species was originally described from the 'Sea of Batavia', data from this area is vital for delimiting the distributional ranges of the subpopulations in this region. Ranade (1961) has detected some difference in the gill raker counts in the specimens of *T. (K.) tonggol* collected off Ratnagiri coast, south of Bombay, but has not presented data to enable detailed comparisons.

28 specimens of *T. (K.) tonggol* collected between 21-6-61 and 14-9-61 were examined for sex and maturity. Of these 14 were females of 430 to 728 mm. in length and 10 males measuring 445 to 743 mm. and 4 sex indeterminable. But for one female 728 mm. (10.5 pounds) and one male 743 mm. (13 lbs.), all specimens were immature, the maturity of gonads corresponding to stages I, II, and III (as defined by Marr and Schaefer, 1948 : *U.S. Fish Wildlife Service Fisher. Bull.*, 47 : 241-44). The large female mentioned above had spent and flacid ovaries weighing 29 gms.

TABLE 9

Comparison of Gill Raker counts between samples of *T.(K.) tonggol* from Gulf of Mannar and Australian Waters[1]

A

Characters	*Northern Australia*					*Western Australia*					Difference between means	t	P
	No.	Range	Mean	σ	σM_1	No.	Range	Mean	σ	σM_2			
Upper limb	133	5-8	6.11	7.6505	0.6634	71	5-8	6.39	5.9161	0.7021	0.28	2.5274	P at 5% level is 1.96
Lower limb	133	13-18	15.74	8.4445	0.7322	71	14-18	16.04	6.2370	0.7402	0.30	1.7692	

B

Characters	*Gulf of Mannar*					*Western Australia*					Difference between means	t	P
	No.	Range	Mean	σ	σ_{M_1}	No.	Range	Mean	σ	σ_{M_2}			
Upper limb	34	6-8	7.03	3.3166	0.5688	71	5-8	6.39	5.916	0.7021	0.64	3.82	P at 5% level is 1.96
Lower limb	37	16-19	17.95	4.6797	0.7693	71	14-18	16.04	6.2370	0.7402	1.94	10.92	

[1] For Australian waters data is based on information given in Serventy (1956).

FOOD OF *T.(K.) tonggol* :

Altogether 40 specimens were examined as under : on 21-6-61 (10) ; 19-7-61 (6) ; 4-8-61 (4) ; 17-8-61 (2) ; 21-8-61 (1) ; 24-8-61 (13) ; 25-8-61 (2) ; and 14-9-61 (2).

The visual grading of the fullness of the stomach for the 40 specimens was as follows :

Grading	*Per cent*
Empty	27.5
Trace	32.5
$\frac{1}{4}$+ or −	37.5
$\frac{1}{2}$+ or −	—
$\frac{3}{4}$+ or −	—
Full (gorged)	2.5

From Table 10, it will be seen that both from the number of occurrences as well as the actual volume, squids constituted the most important item among the food organisms of *T.(K.) tonggol* caught by multiple trolling. Since most of the balistid fish (*Sufflamen capistratus*) were almost fresh in the stomachs, it has been possible to compare the sizes of these fishes in the stomach contents of the northern bluefin and the yellowfin tunas (Fig. 14 and Table 14).

TABLE 10

Food of *Thunnus (Kishinoella) tonggol* Bleeker

Constituents	Occurrence No.	Occurrence %	Actual volume (c.c.)	Actual numbers of food organisms
Crustacea				
Stomatopod larvae	3	7.5	0.1	6
Mysids	2	5.0	Trace	2
Megalopa	4	10.0	5.0	180
Other crustacean remains	3	7.5	0.5	..
Mollusca				
Pteropods (*Clavolina* sp.)	1	2.5	0.3	6
Squids (Ommastrephidae)	11	27.5	187.2	22
Fishes				
Anchoviella spp.	3	7.5	14.5	10
Sardinella spp.	2	5.0	7.0	2
Other clupeoids	5	12.5	10.6	..
Syngnathidae	1	2.5	0.2	1
Cypsilurus sp.	1	2.5	11.0	1
Trichiurus lepturus	1	2.5	15.0	1
Juvenile scombroid fish	1	2.5	Trace	2
Lutjanus sp.	1	2.5	0.5	1
Sufflamen capistratus	8	20.0	48.9	18
Skeletal remains of fish	6	15.0	14.9	..

2. **Thunnus (Neothunnus) albacares macropterus** (Temminck & Schlegel) (Yellowfin tuna)

MATERIAL :

During the 1960 and 1961 seasons this species was caught only during very restricted periods, but mostly with good catches of *T.(K.) tonggol*. The length frequencies of the specimens landed for the months June to September 1961 are shown in fig. 13. The specimens caught measure from 553 to 860 mm. in total length and weigh from 7.5 to 26 pounds.

DESCRIPTION :

Meristic counts :

D1. XIII-XV ; D2+finlets - +8 - 9 ; A+finlets - +8 - 9 ; gill rakers 8 - 10+19 - 22.

For the frequency of gill raker counts (of outer gill arch of right side) see tables 11 and 12.

TABLE 11

Frequency of gill raker counts

Counts	Upper limb			No. of specimens	Lower limb				No. of specimens	Combined frequency				No. of specimens
	8	9	10		19	20	21	22		28	29	30	31	
No. of specimens	9	7	4	20	2	4	10	7	23	2	7	7	4	20
%	45	35	20		8.7	17.4	43.4	30.4		10	35	35	20	

TABLE 12

Frequency of combination of gill rakers on upper and lower limbs of outer gill arch

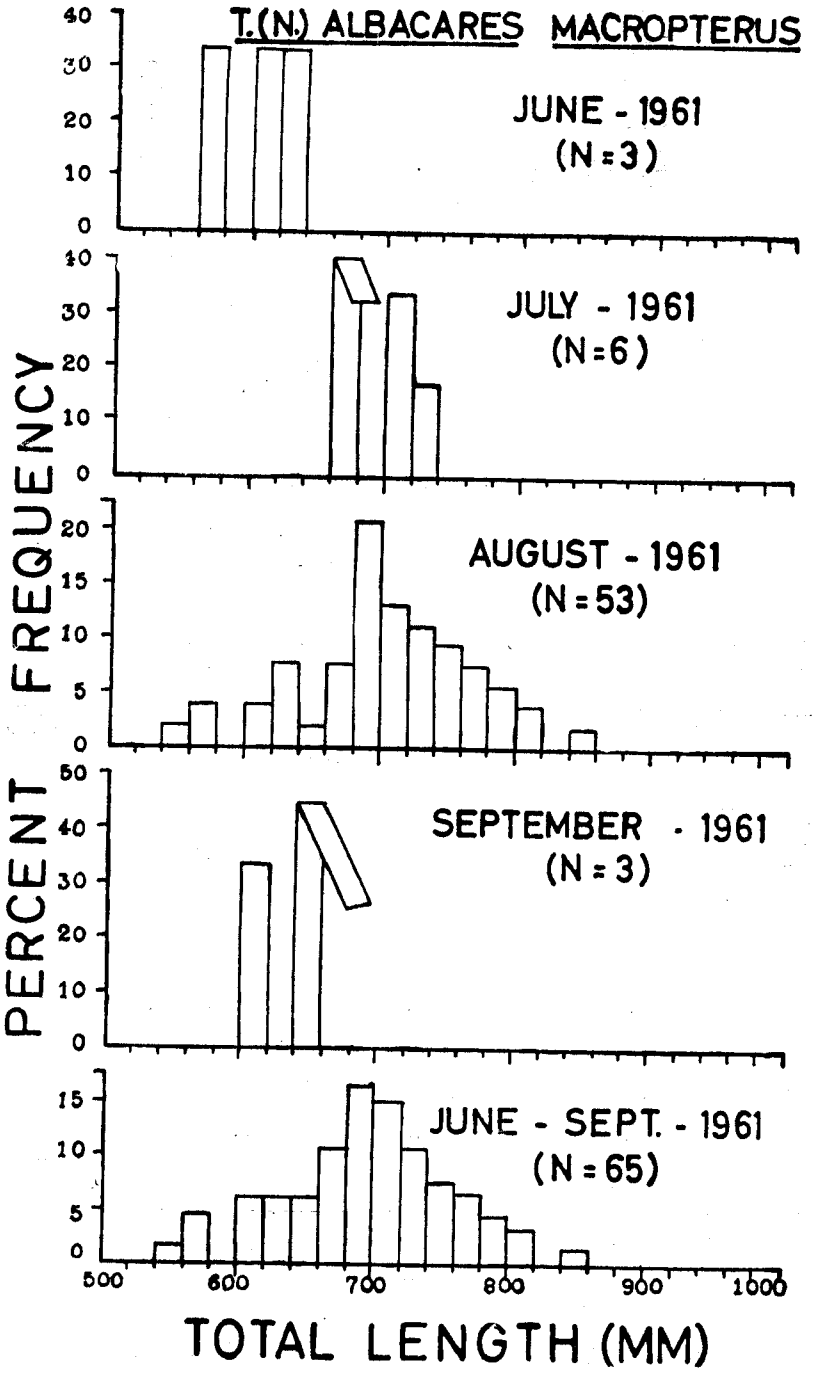
		Upper limb		
	No.	8	9	10
Lower limb	19	..	1	1
	20	1	1	1
	21	4	3	2
	22	4	2	..

The most frequent counts are 8 - 9+21 - 22 (=29 - 30).

Of the 22 specimens sexed, 7 were males and 15 females ; the males measuring from 562 to 744 mm. (mean 644.4 mm.) and the females from 580 to 816 mm. (mean 685.25 mm.). The larger females caught in August 1961 measuring upto 700 mm. were found to be in stages I to III of maturity, the weights of the ovaries varying from 7.5 to 35 gms. Two specimens, 740 and 782 mm. had spent recovering ovaries.

FOOD OF *T.(N.) albacares macropterus* :

Altogether 49 specimens were examined as follows : 27-7-60 (4) ; 20-6-61 (2) ; 10-7-61 (1) ; 19-7-61 (1) ; 11-8-61 (5) ; 23-8-61 (7) ; 24-8-61 (4) ; 25-8-61 (24) ; and 13-9-61 (1).



TEXT FIG. 13. The length frequency of the yellowfin tuna caught by multiple trolling off the Tinnevelly Coast during the Months June to September, 1961.

The visual grading of the fulness of the stomach for the 49 specimens was as follows :

Grading	*Per cent*
Empty	20.4
Trace	18.4
¼ + or −	53.1
½ + or −	4.1
¾ + or −	2.0
Full (gorged)	2.0

From the following Table (Table 13) it will be seen that from the number of occurrences as well as actual volume of the food balistid fishes constituted the most important food item followed by squids. As in the case of the northern bluefin, a great majority of the balistid fishes were undigested indicating that the fish had been feeding just before it was caught. It was interesting to find that the specimens of *Sufflamen capistratus* from the stomach of the yellowfin were relatively larger than those found in the stomachs of the northern bluefin (Fig. 14, and table 14).

TABLE 13

Food of yellowfin tuna

Constituents	Occurrence No.	Occurrence %	Actual vol. (c.c.)	Actual No. of food organisms
Crustacea ..				
Stomatopod larvae	4	8.163	6.00	27
Penaeidae	1	2.040	0.50	1
Mollusca				
Squids (Ommastrephidae)	14	28.571	249.50	24 + 7 pairs of Mandibles (beaks)
Salps	2	4.081	0.40	2
Fishes				
Anchoviella spp.	3	6.122	7.00	4
Sardinella spp.	9	18.367	48.00	10 (not bait)
Caesio sp.	1	2.040	0.50	1
Sufflamen capistratus	24	48.979	362.10	74 of which 41 were fresh
Balistis sp.	1	2.040	10.00	2
Carangids	3	6.122	41.90	3
Fish remains (unidentifiable)	4	8.162	18.20	4

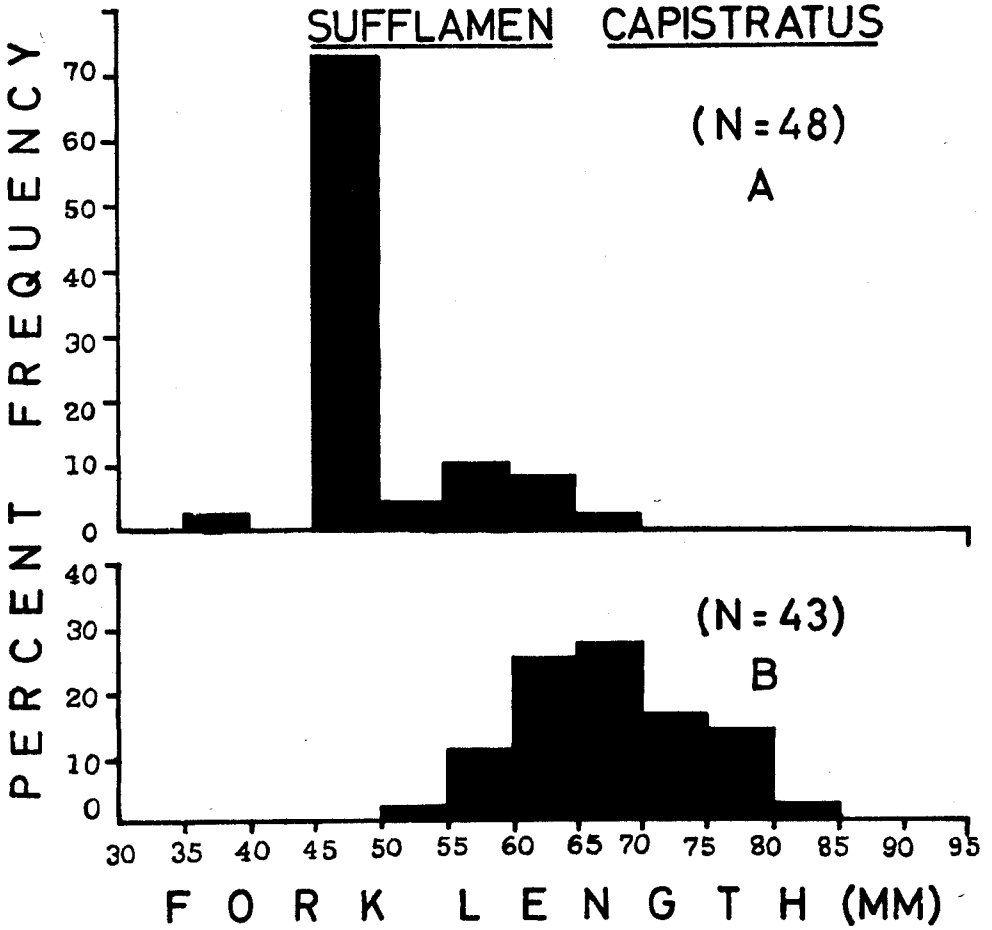
TABLE 14

Size ranges of yellowfin and northern bluefin tuna and the balistid fish *Sufflamen capistratus* found in their stomachs

	Predator-species			Prey-species (*Sufflamen capistratus*)		
Species	No.	Range* (mm.)	Mean (mm.)	No.	Range (mm.)	Mean (mm.)
Northern bluefin tuna	8	460-650	530	18	35-66	56.92
Yellowfin tuna	24	558-816	676	74	54-83	66.16

* The length of tunas refer to only those species in which *S.capistratus* was occurring as a food item in the stomach.

One of the yellowfin caught on 25-8-61, measuring 553 mm. weighed 7 pounds. The fish looked slightly different from several others caught on the same day. When it was filleted for



TEXT FIG. 14. The length frequency and numbers of the balistid fish *Sufflamen capistratus* found in the stomachs of (A) northern bluefin tuna and (B) yellowfin tuna caught by multiple trolling off the Tinnevelly coast.

salt curing, the entire flesh was found to be profusely studded with whitish spore-like rounded bodies. Although the fish was fresh, the flesh was 'jelly-like' and very pale in colour, unlike the usual red. Such infestation was not encountered in other yellowfin or in any of the other tunas landed at Tuticorin during 1960 and 1961.

3. **Euthynnus affinis affinis** (Cantor)

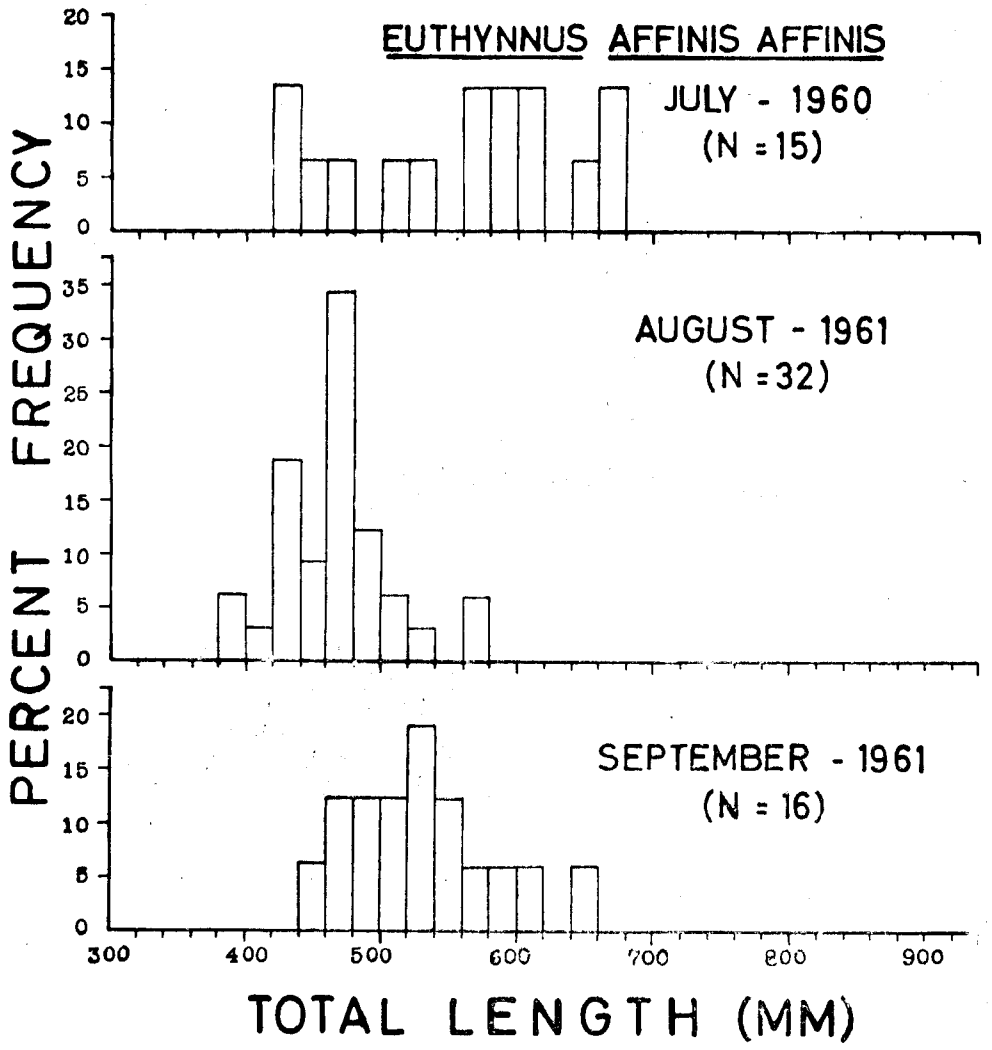
(Little tunny or mackerel tuna)

MATERIAL :

Next to *T.(K.) tonggol*, this was the most common species of tuna landed at Tuticorin by multiple trolling. Detailed data could not be collected for this species, but the length frequency of specimens caught in July 1960 and in August-September 1961 is shown in Fig. 15. The fish caught during the 1961 season were from 396 to 678 mm. in total length, weighing 1.75 to 12 lbs.

DESCRIPTION :

For specimens in the size range 423 to 678 mm., the frequency of gill raker counts are given in tables 15 and 16.



TEXT FIG. 15. The length frequency of the little tunny caught by multiple trolling off the Tinnevelly coast during July 1960 and August-September 1961.

TABLE 15

Gill rakers on outer arch of right side																					
Upper limb				No.	Lower limb						No.	Combined frequency					No.
6	7	8	9		20	21	22	23	24	25		28	29	30	31	32	
1	8	7	3	19	1	1	4	6	5	1	18	1	3	3	7	4	18

TABLE 16

Frequency of combination of gill rakers on upper and lower limbs

Lower limb \ Upper limb	6	7	8	9
20	..	..	1	..
21	..	..	1	..
22	..	1	1	2
23	1	2	2	1
24		3	2	..
25	..	1	..	..

25 specimens examined for sex and maturity in July 1960 showed that 5 were females measuring 534 to 637 mm. (mean 585 mm.) and the rest males measuring 437 to 636 mm. (mean 547 mm). Some of the large males had loose milt, while all females had spent recovering ovaries.

No detailed observations were made of the stomach contents of this species. However, field observations made at the time that the fishes were cut for salt curing showed that roughly 10% of the stomachs were empty. A great majority of those with food were found to be $\frac{1}{2}+$ or $-$, to Full (gorged) with reddish shrimps (euphausiids and penaeids). A few stomachs had remains of squids, cuttlefish and stomatopod larvae. Partly digested fish remains mainly of clupeoids were present in a few stomachs, but unlike the yellowfin and the northern bluefin tunas, no Balistidae were seen in the stomachs examined.

4. **Auxis thazard** (Lacépède)

(Short corseletted frigate mackerel)

On 22-6-61 three specimens measuring 384,395, and 400 mm., weighing 2.25, 2.5, and 2.75 lbs. respectively were caught. The gill raker counts for these specimens are as follows : 10+29 for 2 specimens and 8+29 for one.

On 17-7-61, five specimens of this species were landed, but could not be examined in detail. Daily observations made during the 1960 and 1961 seasons showed that the species was very rare in the multiple troll catches. One reason may be that the size of the hook and lures used in trolling are too large for this species.

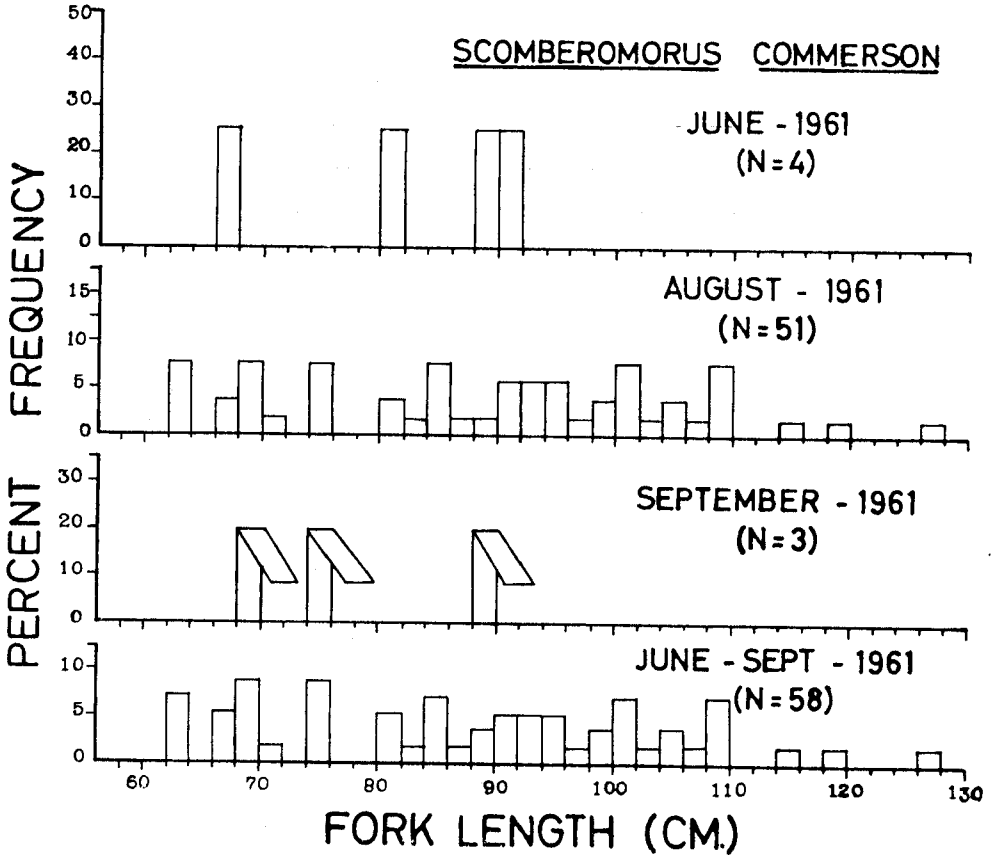
5. **Scomberomorus commerson** (Lacépède)

(Seerfish)

During the 1960 and 1961 multiple troll fishery seasons, there were fairly good landings of seerfish, especially between 19-8-61 and 25-8-61. The length frequency of specimens caught in June, August and September 1961 is given in fig. 16.

6. **Scomberomorus lineolatus** (Cuvier)

Only one specimen (Pl. II fig. C) was caught by multiple trolling on 25-8-61, measuring 845 mm. and weighing 10.5 lbs.



TEXT FIG. 16. The length frequency of 58 specimens of seerfish caught by multiple trolling off the Tinnevelly coast.

Small specimens of this species upto a length of 500 mm. along with similar sized specimens of both *S.commerson* and *S.g.guttatus* are regularly caught during the multiple troll fishery seasons in gill nets operated 5 to 12 miles off Tuticorin in depths upto about 10 fathoms.

7. **Acanthocybium solandri** (Cuvier)

(Wahoo)

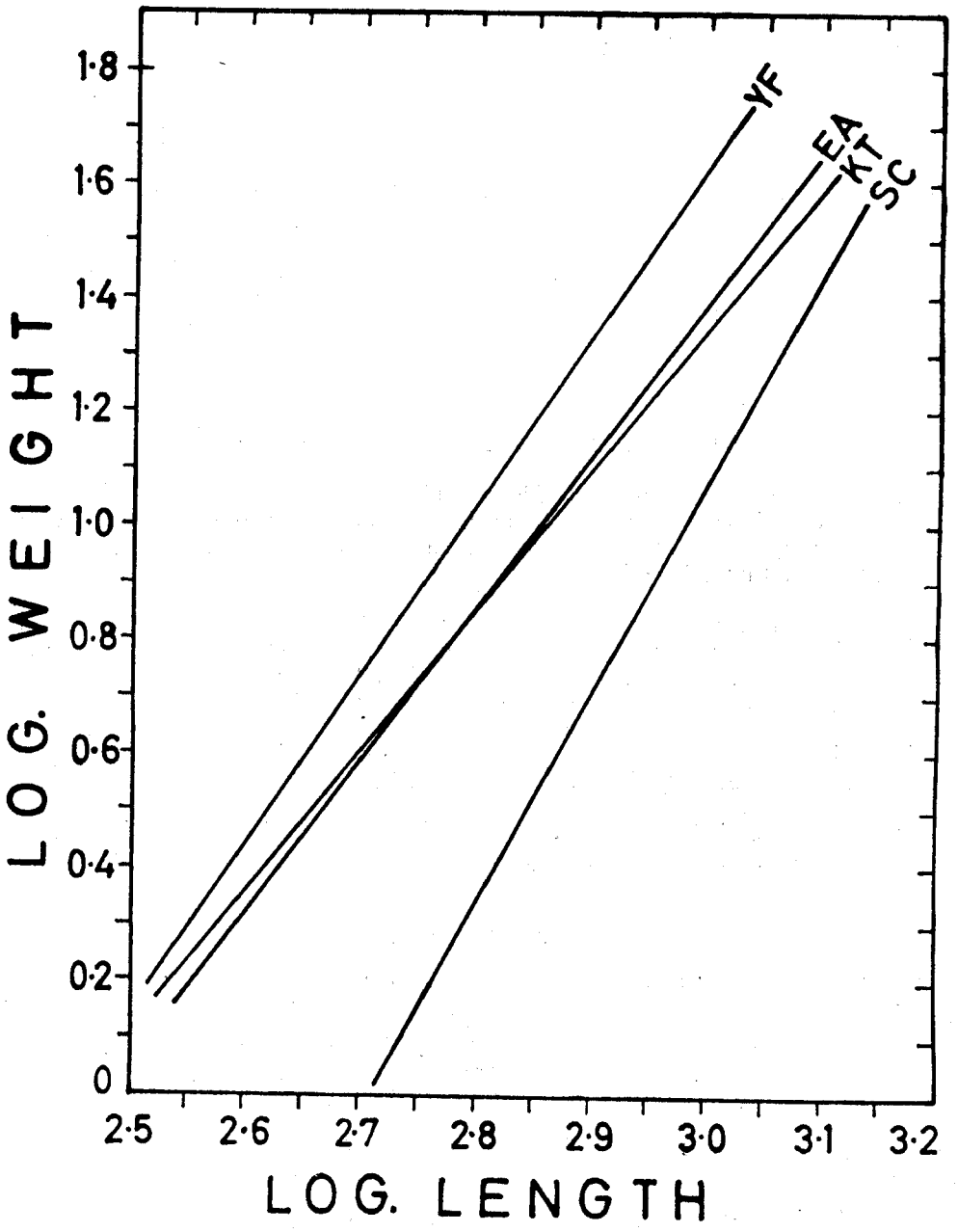
Three specimens were caught during the 1960 and 1961 seasons as follows :

21-7-60 : Length 844 mm. Weight 12.5 lbs.
23-8-61 : Length 1540 mm. Weight 36 lbs. Sex female.
30-8-61 : Length ab. 1600 mm. Weight ab. 38 lbs.

The stomachs of the first two specimens mentioned above contained semidigested remains of fish. The larger of these two fetched Rs. 11.50 at auction. In this specimen, the ovaries were

distended, turgid, with translucent eggs showing through the ovarian wall, but no loose eggs were seen in the lumen of the lobes.

I was told that during certain years a large number of *A.solandri* are caught in multiple trolling off Tuticorin. Even so, when compared to *S.commerson*, the species is rare.



TEXT FIG. 17. The logarithmic relation of length and weight in three species of tunas and the seerfish landed by multiple trolling at Tuticorin. YF=yellowfin tuna, *T. (N.) albacares macropterus*; EA=little tunny, *E. affinis affinis*; KT=Northern bluefin tuna, *T. (K.) tonggol*; and SC=Seerfish, *S. commerson*.

Length-Weight Relationship of Tunas and Seerfish Caught by Multiple Trolling

The weight and length were related by using the equation of the form :

$$\log W = a + b \log L$$

where *a* and *b* are constants. The equation was found to be linear and the regression coefficient was tested for the linearity. The regression equations obtained were as follows :

1. Yellowfin tuna : $\log W = -7.3781 + 3.0056 \log L$
2. Northern bluefin tuna : $\log W = -6.1708 + 2.5128 \log L$
3. Little tunny : $\log W = -7.5442 + 3.0287 \log L$
4. Seerfish : $\log W = -7.0771 + 2.7536 \log L$

The increment in weight per unit length is higher in the yellowfin tuna (YF) than in the little tunny (EA) and the northern bluefin tuna (KT). In the case of the latter, two species, after a length of about 630 mm. (log L=2.8) and weight of 7.25 lbs. (log. W=0.86) (see Fig. 17) the increment in weight per unit length is slightly greater in the little tunny than in the northern bluefin tuna. In the case of the seerfish, the rate of increment in weight per unit length is higher than in the three species of tunas.

Other Fishes Caught by Multiple Trolling

Only two other species, *Coryphaena hippurus* Linnaeus and *Elagatis bipinnulatus* (Quoy and Gaimard) were occasionally caught by multiple trolling during the 1960 and 1961 seasons. Species of *Caranx*, *Sphyraena* and *Chorinemus*, though known to be caught by trolling, were not landed by this gear during this period.

C. hippurus fetches a very low price at auction at Tuticorin. The flesh of the species rapidly deteriorates and is considered inferior for salt curing. Surprisingly, this species was rare in the multiple troll catches, although boats returning from handline fishing frequently caught a few by using one or two troll lines. On 14-9-61, two specimens of *C.hippurus* caught measured 710 and 740 mm. weighing 7.5 and 8 lbs. respectively. The stomach of the smaller specimen contained a partly digested squid, while the larger specimen had semidigested remains of stomatopod larvae, other crustaceans, parts of a squid, and a few pupils of fish eyes.

A few specimens of *E.bipinnulatus* were caught during the 1961 season, and the examination of the stomachs showed the presence of large numbers of the pelagic mollusc *Clavolina* sp.

Concluding Remarks

It should be mentioned here that the collection of data of fish landed by multiple trolling is rather difficult since the fishermen as well as the merchants do not look upon favourably the handling of fish by others. The auction is brisk and the retail merchants purchasing the fish for local markets or to be sent to the interior markets do not generally permit handling of the fish even for taking length and weight data. Hence, most of the data had to be collected at the time the fish were spread out for auctioning through the good will of the auctioneers who delayed the proceedings a few minutes each time, and with the help of the wholesale merchants when they purchased the fish for salt curing.

The considerable fluctuations in this fishery from year to year is not chiefly on account of the non-availability of the fish in the fishing grounds, but due to natural and other causes which play an important part in the actual fishing effort. It is felt that the fishing grounds could be considerably extended to over deeper waters if multiple trolling could be carried out from

mechanised boats or sail boats fitted with suitable motors for plying to and from the fishing grounds. Exploratory longlining for tunas in the area 40 to 80 miles off the Tinnevelly coast (opposite Virapandianpattanam and Manapad) during the fishing season, especially from June to August should give favourable results.

The present investigations show that there has been little change in the fishery from the time it was completely taken over by the Tuticorin fishermen nearly fifty years ago. A shift in the main fishing season from November-January to June-August is seen at present, and this reflects partly on the skill of the fishermen to brave the unpredictable weather in the Gulf during the South West Monsoon. While the quantity of tunas and related fishes landed by multiple trolling at present is not great, it is hoped that this account will help in drawing attention to an area where improvements in the methods of fishing could be effected for the development and utilization of the available resources.

ACKNOWLEDGEMENT

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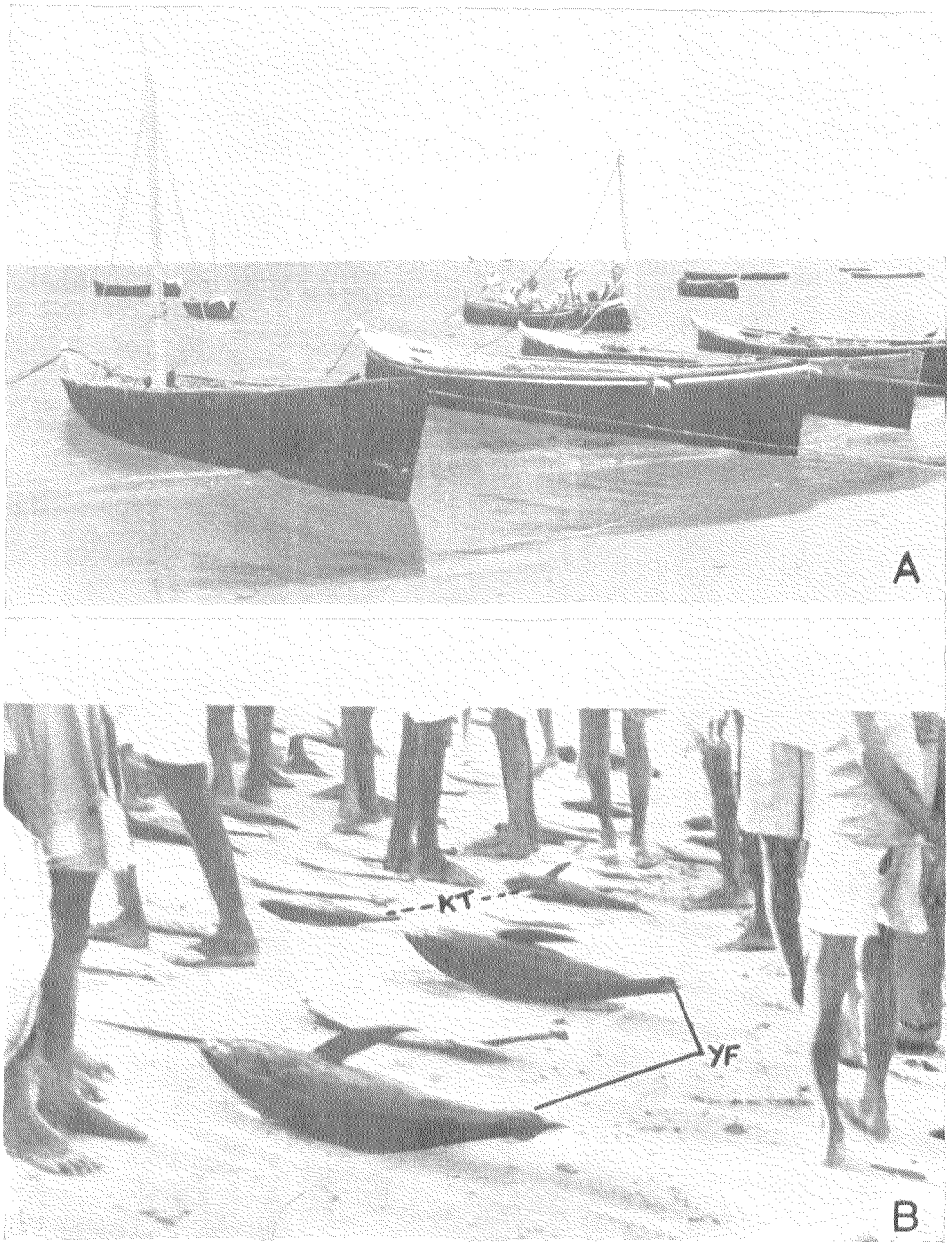

PLATE I. A. 'Tuticorin-type' fishing boats used also for multiple trolling; B. Yellowfin tuna (YF), northern bluefin tuna (KT), and a few carangids spread out on the beach at Tuticorin prior to auctioning. All tunas were caught by multiple trolling, and the carangids by handline fishing (Photos : E. G. Silas).

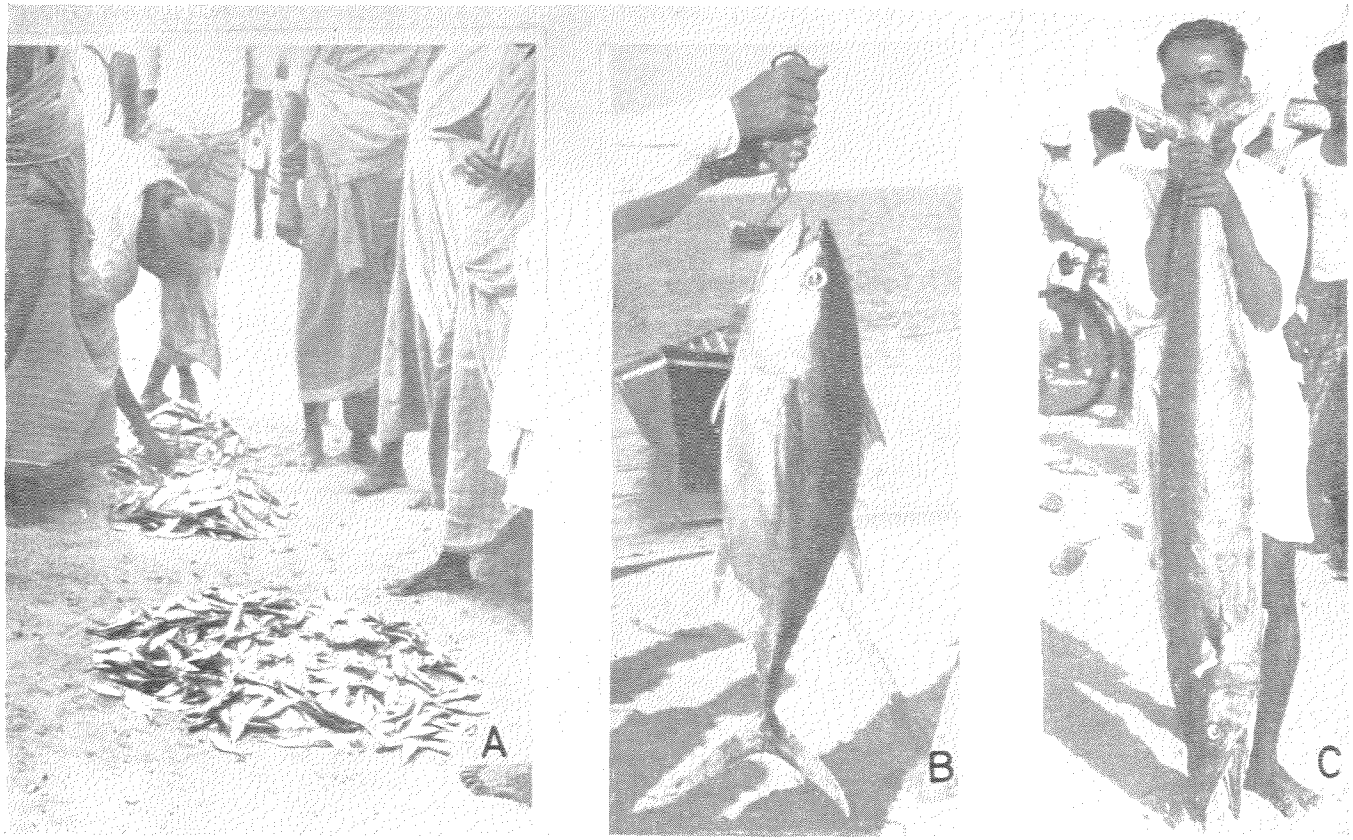

PLATE II. A. Balance of bait (*Sardinella* spp.) being re-auctioned after the day's multiple trolling. The photo shows three such lots from three boats on a bad day's fishing ; B. Yellowfin tuna (640 mm.) ; C. *Acanthocybium solandri* weighing 36 lbs. caught by multiple trolling (Photos : E. G. Silas).

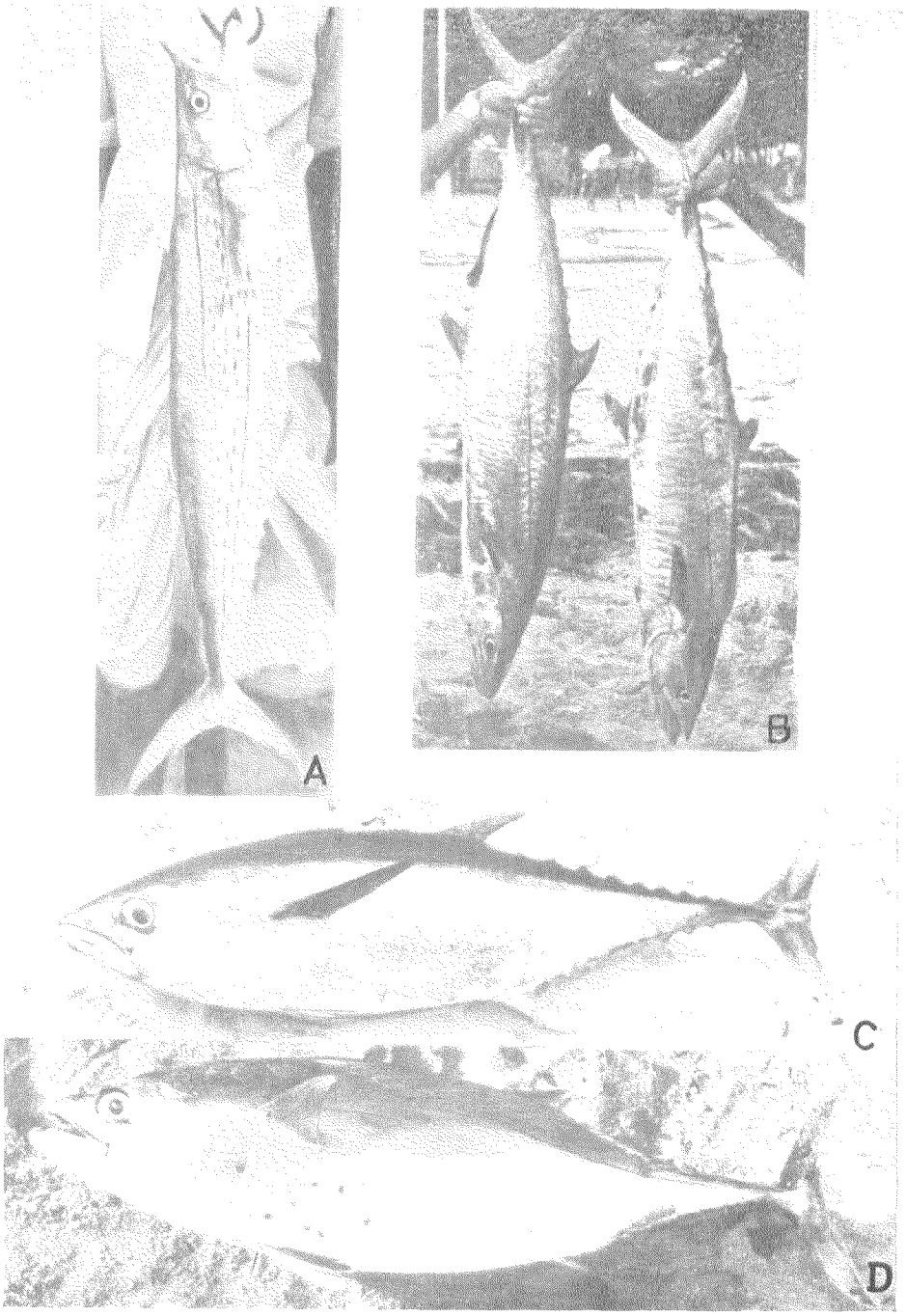

PLATE III. A. *Scomberomorus lineolatus*, 845 mm. in length ; B. Two *S. commerson*, the right—a male (775 mm.) and the left—a female (945 mm.) ; C. *Thunnus* (*Kishinoella*) *tonggol*, 650 mm. ; and D. *Euthynnus a. affinis*, 600 mm. All fish were caught by multiple trolling. (Photos : E. G. Silas).