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Tuna and tuna-like fish resources in the South China Sea and adjacent waters

by
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Abstract

The distribution of tunas and billfishes in the South China Sea and the Southeast Asian waters was shown on the commercial longline data.

The seasonal changes in the hook-rate and the size composition of the yellowfin and bigeye tuna in the South China Sea were given and the previous suppositions on their stock structures in adjacent areas, the Indonesian waters and the Indian Ocean, were reviewed.

The estimated Japanese longline catches from the South China Sea attained their peak of about 6,800 tons in 1967 and since then they have fluctuated between 2,000 and 5,000 tons with somewhat downward trend. The yellowfin and bigeye tuna accounted for ninety percent of the Japanese catch more. The remainder was occupied by the billfish, mostly the blue marlin and black marlin. The total longline catch by the Japanese and Taiwanese fisheries from the South China Sea area were roughly estimated to be between 5,000 and 8,000 tons in a recent few years.

Among the small-sized tuna and tuna-like fishes, the skipjack, little tuna, longtail tuna, frigate mackerel and bonito seemed to be promising for their future exploitation. The biological information on some of them was briefly reviewed.

Recent activities in research on tuna fisheries in the Indo-Pacific areas (IPFC area) have been fully reviewed by Suda (1971). For the South China Sea area, however, little has been reported on the biology of large-sized tuna except a few studies (Nakamura, 1953), although this area has long supported the tuna longline fleets from Taiwan and Japan. The purposes of this paper are: (1) to show the distribution of tunas and billfishes caught by the Japanese commercial longline fishery in the South China Sea and its adjacent waters on the past data, (2) to show the recent trend in the longline catches from these areas and (3) to make a short review on the occurrence of small-sized tuna and tuna-like fishes in Southeast Asian waters.

1. AREAS CONSIDERED

The South China Sea area and the Southeast Asian waters are here arbitrarily defined as in Figure 1.

Since the South China Sea has the inflows of the North and South Equatorial Currents from the south of the Philippines, it is influenced by the Pacific waters rather than the Indian Ocean waters (Wyrtki, 1961, FAO, 1972). It is, on the other hand, under the influence of the wind system which dominates the northern half of the Indian Ocean. This monsoon climate with alternating seasonal winds makes the flows along the mainland coast

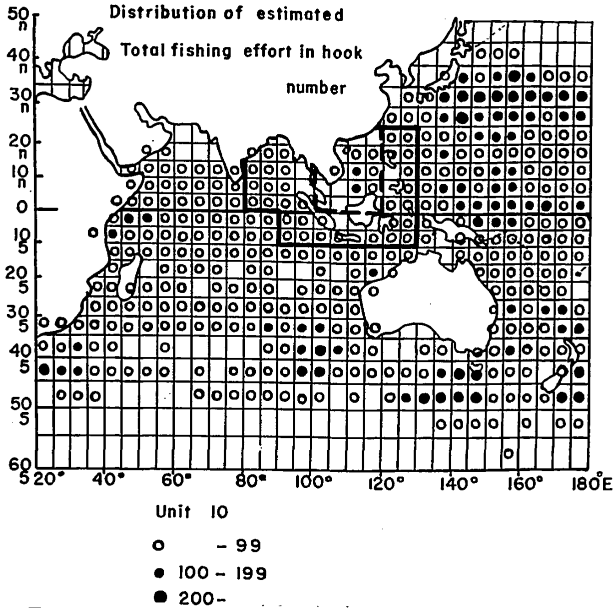

Fig. 1 Difinition of areas and distribution of estimated total fishing effort in number of hooks (1971).
Solid line, Southeast Asian waters.
Hashed line, South China Sea area.
From "Annual report of effort and catch statistics by area on Japanese longline fishery" (1973)

change their direction. The longline fishing grounds are formed from the central to the northeastern part of this area and never extend to the west along the southeast coast of Vietnam. This is related to the depth of the sea. In the South China Sea, the vast continental shelf waters with depths of less than 150 m stretch to the south and west while in the central and northeastern parts east of approximately 110° E. longitude, depths exceed 4,000 m. Such a topographic feature limits the westward expansion of the areas of the longline fishery which takes tuna at a depth of about 100 m or more.

2. FISH CAUGHT BY LONGINE FISHERY

Four species of the genus *Thunnus*, i.e. the yellowfin (*T. albacares*), bigeye (*T. obesus*), albacore (*T. alalunga*) and bluefin (*T. thynnus*) and five species of the Family Istiophoridae, i.e. the sailfish (*I. platypterus*), shortnose spearfish (*T. angustirostris*), striped marlin (*T. audax*), blue marlin (*M. mazara*) and black marlin (*M. indica*), are caught on the longline in the South China Sea. Sporadic catches of the broadbill (*X. gladius*) and the deep-swimming skipjack (*E. pelamis*) are also made. Sharks are sometimes an important item in the longline fishery in this area. All of these fishes, however, are not equally important in quantities; the yellowfin and bigeye and some billfishes have been supporting the South China Sea fishery.

2.1 Yellowfin tuna

2.1.1 Distribution and seasonal change in hook-rate. The yellowfin tuna are distributed most densely in the South China Sea and the Southeast Asian waters and are undoubtedly important among tunas in these areas.

Figure 2 indicates the distribution of the apparent relative abundance as expressed by the hook-rate in each 1-degree square. The figures have been prepared on the longline data from1952 to 1961 and are shown by picking up the highest value of the monthly averaged hook-rate for each square during the three-month period, for April-June and October-December, respectively. The areas of the high hook-rate occur in the central part of the South China Sea. Their eastern fringe does not reach the line through Taiwan and Luzon, which borders the western-most contour of the Pacific Ocean. These areas on the other hand, appear to be continuous to the Banda-Flores Seas or to the western equatorial Pacific from the south of Mindanao. Such a pattern of the apparent distribution may suggest the relationship of the fish in the South China Sea with those in the southern areas.

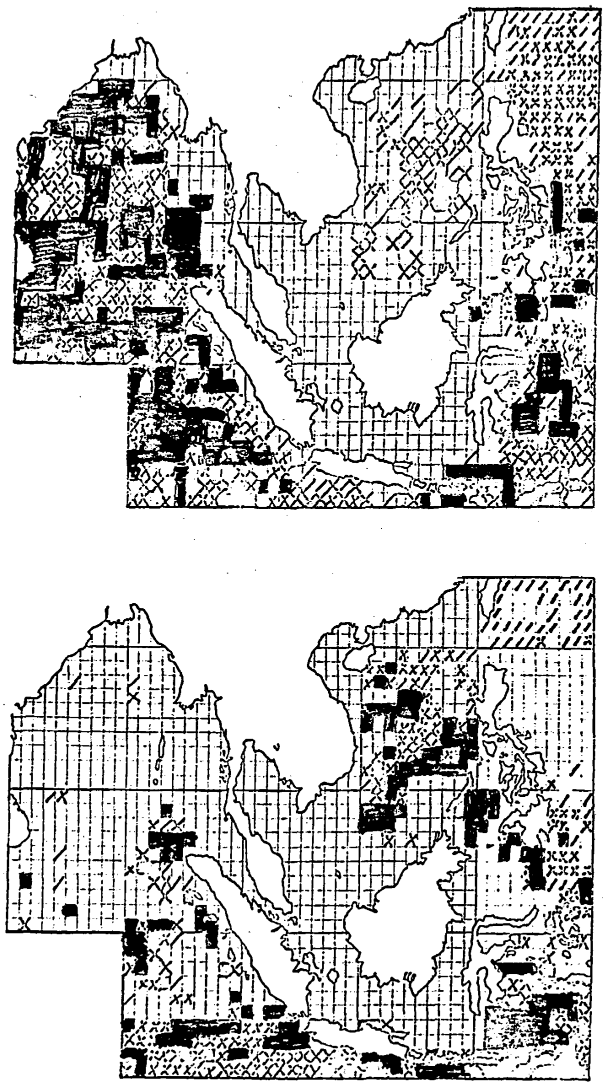

Fig. 2 Distribution of yellowfin tuna, as seen from the hook-rate of the Japanese tuna longline fishery.
Upper, April–June.
Lower, October–December.
Black, cross and oblique lines indicate areas with hook-rate of 3.1 and greater, 2.1–3.0 and 2.0 and smaller, respectively. Figures are shown with combined hook-rate for three-month period. Data mostly from 1952 to 1961.

Figure 3 shows the seasonal change in the hook-rate for the South China Sea. It indicates the average catch conditions for the period from 1930 to 1956, excluding the war time. As is observed clearly, the hook-rate changes with the season; it is relatively high from October to May and low during the rest of the year. The months of the lowest hook-rate are July and August, which correspond to the southwest monsoon season. In the Indonesian waters such as the Banda-Flores Seas, the seasonal changae in the hookrate appears to be more complicate, according to the previous study (Mimura and Nakamura, 1959).

2.1.2 Size composition

The size of the fish caught on the longline in the South China Sea, according to the information from the monthly report of Taiwan Fisheries Research Institute, ranged from 100 to 170 cm in length, but most of them were between 120 and 150 cm (Kikawa and Anraku, 1959). The monthly size composition based on these data, as shown in Figure 4, appear to suggest the alternation of the fish during the months between about July and October. The period of such an alternation of the fish nearly coincides with that assumed from the monthly change in the hook-rate. To make this point clearer, detailed analyses should be done with more information.

2.1.3 Suppositions on stock structure in adjacent seas.

A number of studies on tuna fisheries and their population structures have recently been made on an ocean-wide basis. The Indonesian waters such as the Banda-Flores Seas have been considered as a boundary area between the Pacific and the Indian Oceans concerning the distribution of the yellowfin tuna in the Indo-Pacific areas. And the distribution of the fish in this boundary area has so far been discussed in relation to those distributed in the eastern Indian Ocean (Nakamura, 1953; Mimura and Nakamura, 1959; Morita and Koto, 1971).

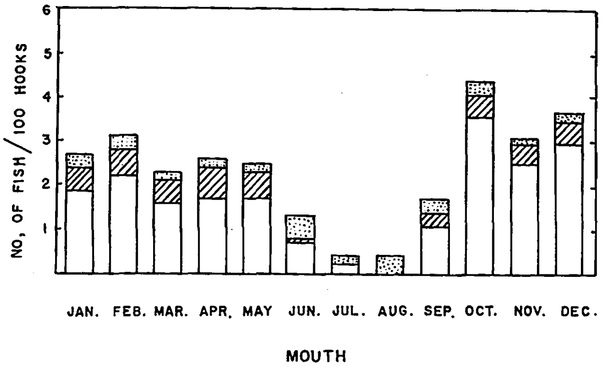

Fig. 3 Seasonal change in the hook-rate in the South China Sea area (Average for the period 1930 – 1956, excluding the years 1942 – 1950) ... (Kikawa, 1959)

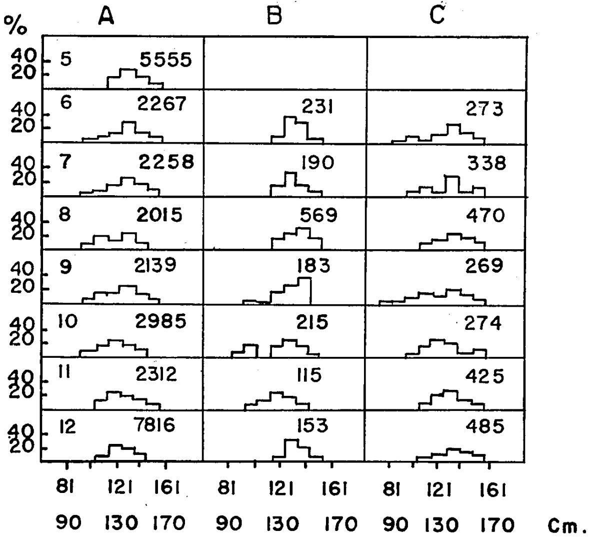

Fig. 4 Body length compositions of yellowfin tuna by month (Data from the monthly report of Taiwan Fisheries Research Institute-1954). (Kikawa and Anraku, 1959)
A. South China Sea area (North of 10° N)
B. 〃 (South of 10° N)
C. Sulu Sea

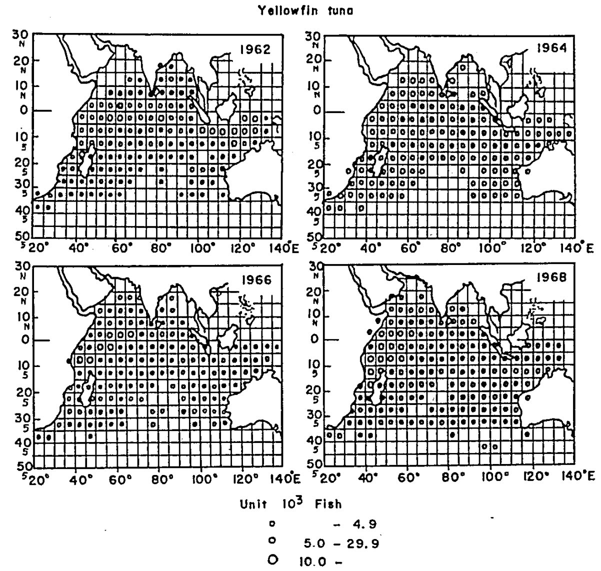

Fig. 5 Distribution of yellowfin tuna catch by Japanese longline fishery in the Indian Ocean, 1962, 1964, 1966 and 1968 (Honma and Suzuki, 1972).

Concerning the intermingling of the yellowfin tuna between the Pacific and the Indian Oceans, Mimura and Nakamura (1959) assumed that some intermingling of the fish between the western equatorial Pacific and the eastern Indian Ocean might take place through the Banda-Flores Seas but such an intermingling would be of too small a scale to change the abundance of the stocks in these adjoining oceans. In this context, Mimura (1957) reported a notable phenomenon observed in the Japanese Indian Ocean fishery in its earlier stage; it was an immediate and a remarkable decrease in the hook-rate and the size of the fish which occurred in many of the newly exploited fishing grounds. This sudden decrease was considered to be the direct effect of the fishery exploitation on the virgin stock. Analysing the annual fluctuations in the hook-rate and the size of the fish, Mimura and Nakamura (1959) noted that such an effect occurred so that the fish among different fishing grounds appeared to be independent of each other. On the other hand, however, the detailed analyses on the distribution and the fish size indicated a large-scale east-west movement of the fish in the equatorial waters of the Indian Ocean and a large north-south migration in the Bay of Bengal. This absence of agreement in phenomena led them to a conclusion that two or more independent groups of the fish were hardly recognizable in the Indian Ocean but the intermingling was much more active among the fish in adjoining areas and the rate of mixing was less among those in distant localities. The same idea is set forth for the yellowfin tuna in the equatorial Pacific Ocean (Royce, 1965).

The morphometric comparisons also suggested the existance of some semi-independent subpopulations within the Indian Ocean (Kurogane and Hiyama, 1958; Kurogane, 1960). In this analysis, it was noted that the fish

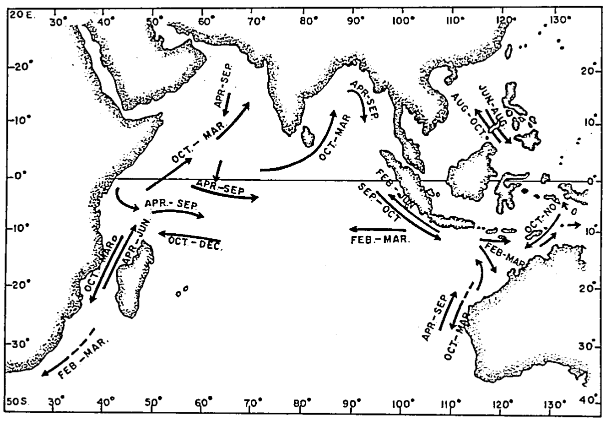

Fig. 6 Supposed movements of yellowfin tuna in the Indian Ocean and adjacent areas, as speculated on the changes in the hook-rate and the size of the fish (Honma, unpublished)

in the areas from the eastern Indian Ocean to the south of Java appeared to be separable from those in the central and western equatorial areas of the Indian Ocean, although some intermingling of the fish was assumed.

More recent analysis on the seasonal and regional changes in the yellowfin tuna concentrations suggest the occurrence of two separable migratory groups, one in the western Indian Ocean and the other in the Banda-Flores Seas. The apparent boundary between the areas of these two fish concentrations occurs at approximately 100° E. longitude (Morita and Koto, 1971). Such a pattern of the fish concentrations is suggested in Figure 5.

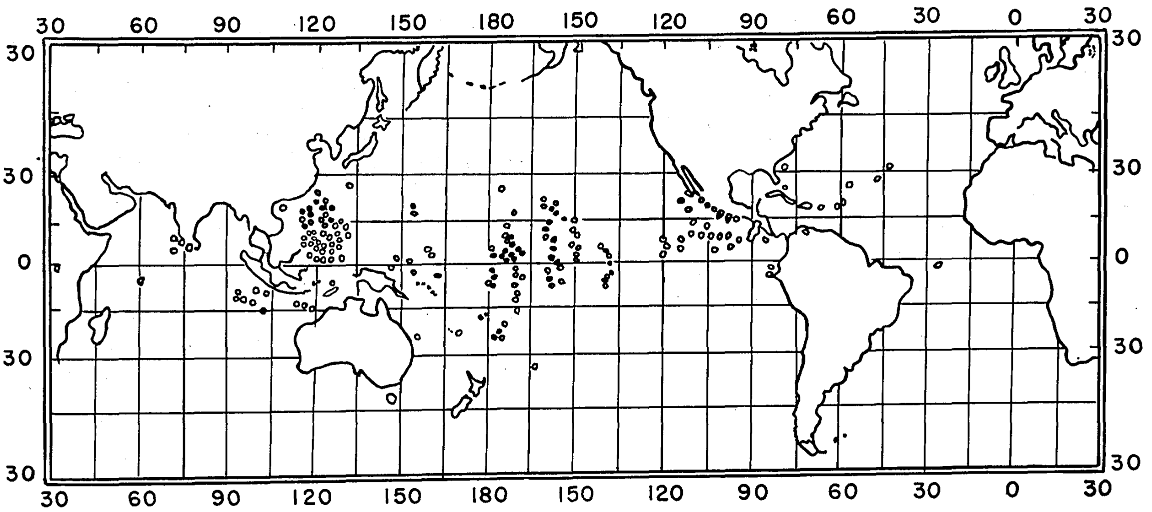

Fig. 7 Localities of capture of larval yellowfin tuna (Yabe et al., 1963).

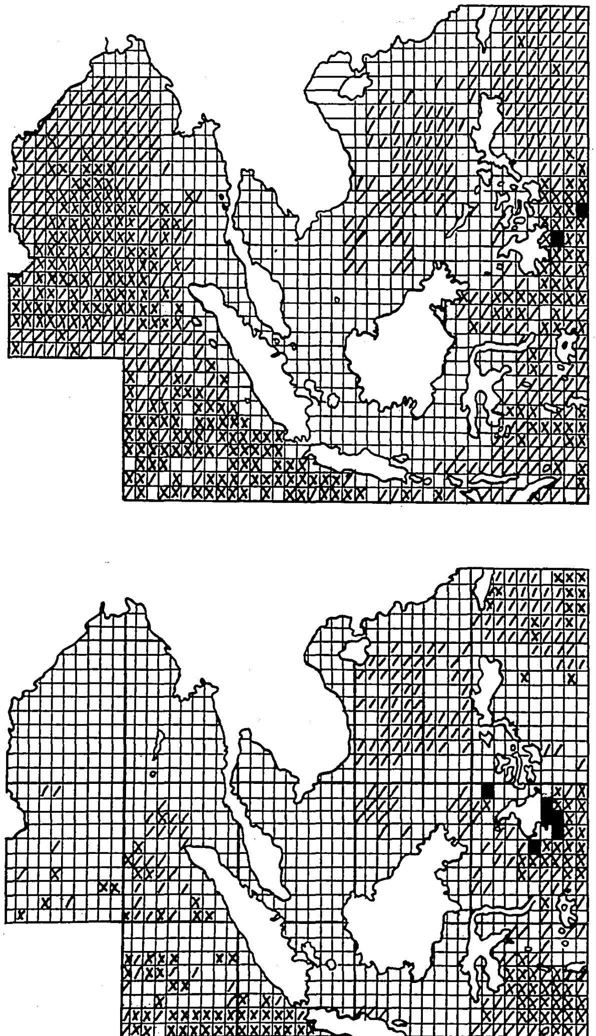

Fig. 8 Distribution of bigeye tuna.
Upper, April–June.
Lower, October–December.

Figure 6 shows the supposed movements of the yellowfin tuna in the Indian Ocean and adjacent seas, which were assumed in the light of these suppositions (Honma, unpublished). In this figure, it is suggested that the yellowfin tuna in the South China Sea have a higher relationship with the fish in the Sulu, Celebes, Banda and Flores Seas or in the western equatorial Pacific than with those in the northern areas to the east of Balintang Channel.

Figure 7 shows the distribution of the larvae of the yellowfin tuna around the Philippines. Such a larval distribution appears to support a view of the strong mixing of the fish in Philippine waters.

From the foregoing, if the intermingling exists for the yellowfin tuna in the South China Sea, it would possibly cause the significant change in abundance of the stock in this area.

2.2 Bigeye tuna

2.2.1 Distribution and seasonal change in hook-rate.

Bigeye tuna rank next to yellowfin tuna in abundance in the South China Sea and adjacent waters.

The distribution of areas of the apparent relative abundance is shown as Figure 8. The average hook-rate of bigeye tuna was about one third or one fourth of yellowfin tuna on the past data from 1952 to 1961. The catches of this fish have increased gradually in recent years.

The hook-rate is also subject to a large seasonal change (Figure 3). The months of the lowest hook-rated are July and August, the southwest monsoon season, as with yellowfin tuna.

2.2.2 Size composition

The size of the fish caught in the South China Sea, according to a small number of data obtained from the longline fishery in 1953–1955, ranged from 100 to 170 cm in length, but was mostly between 120 and 150 cm. Figure 9 shows the size composition in the Banda-Flores Seas. The size of the fish nearly resembles that in the South China Sea but in this Indonesian area smaller fish were relatively abundant in the early half of the year (Mimura and Nakamura, 1959).

2.2.3 Suppositions on stock structure in adjacent seas.

From the morphometric comparisons of some body characters, it was found that the differences between the fish in the south of Java and the central and western equatorial Indian Ocean were larger than the differences among those distributed throughout this equatorial belt of waters (Hiyama and Kurogane, 1961). Analyzing the distribution of the bigeye tuna in the Indian Ocean, Kume and others (1971) assume that the fish in this ocean are composed of groups of fish which are highly related with each other throughout their life history. Concerning the intermingling of fish between the western Pacific and the eastern Indian Ocean, some possible intermingling through the Banda-Flores Seas is also assumed (Kume et al., 1971).

2.3 **Albacore and bluefin tuna**

Unlike the tropical tuna, the albacore are sparsely distributed in the South China Sea, as indicated in Figure 10. The fish occurring in this area are probably related to the North Pacific albacore, not to the fish in the eastern Indian Ocean. Their economic value as a fishery resource is low in this area.

Bluefin tuna rarely occur in Japanese longline catches but they are important for small vessels based on Kiohsiung, Taiwan. The fish are known to be distributed in the South China Sea north of approximately 16° N. latitude. Formerly, the fishing grounds were restricted to the region west of the Bashi Channel but they gradually expanded to the area off the east coast of Luzon (Nakamura, 1953). The season of the best fishng is April and May. For bluefin tuna in the western North Pacific, it is known that spawning takes place from near Taiwan to the south of southern Japan in May and June and the hatched larvae are collected in the same area. The juvenile fish, 15 cm long or more, are caught by coastal trolling off southern Japan after July. The fish after spawning also migrate to the north. The results of tagging experiments and analyses on size data strongly suggest that the bluefin tuna in the western Pacific and those in the Californian waters belong to the same population. Therefore, the South China Sea area is the westernmost fraction of the area of the distribution for the North Pacific bluefin tuna.

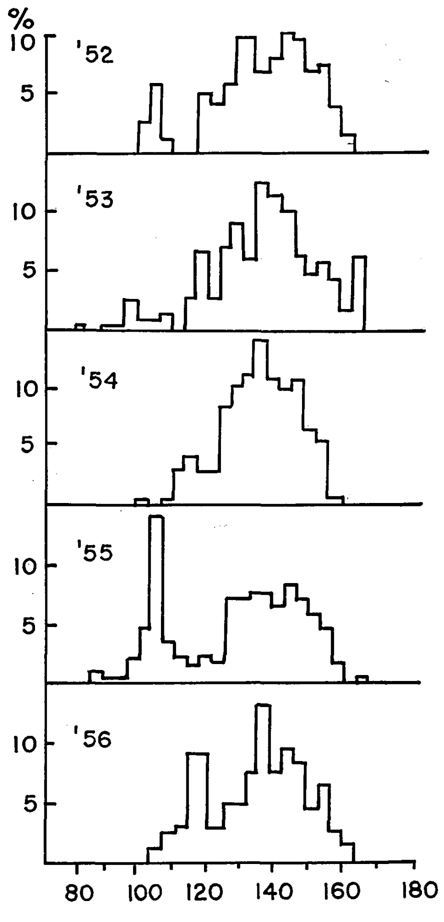

Fig. 9 Length frequency distributions of bigeye tuna taken by the longline fishery in the Banda-Flores Seas (Minura and Nakamura, 1959).

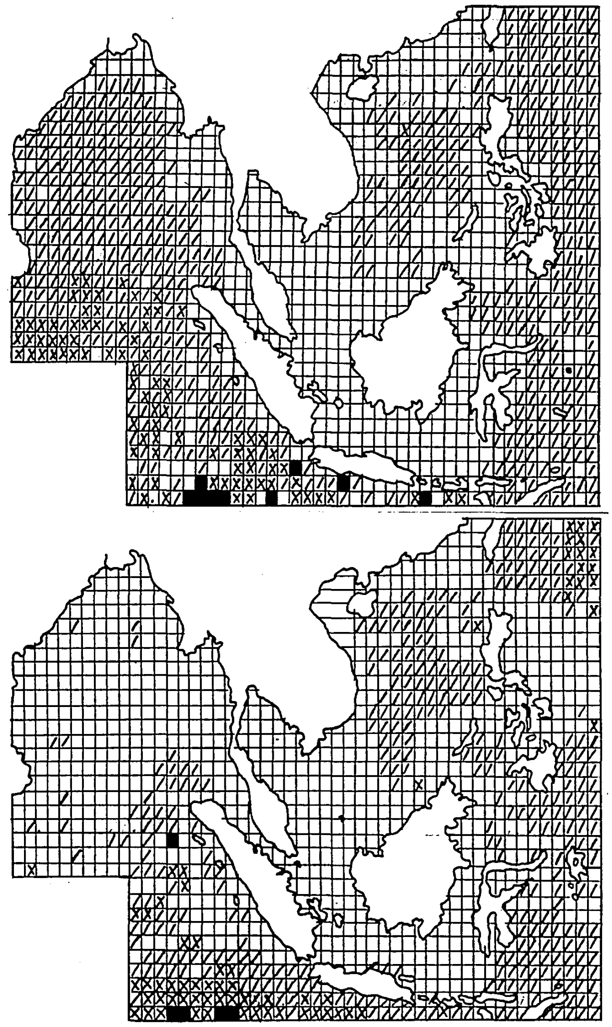

Fig. 10 Distribution of albacore.
Upper, April–June.
Lower, October–December.

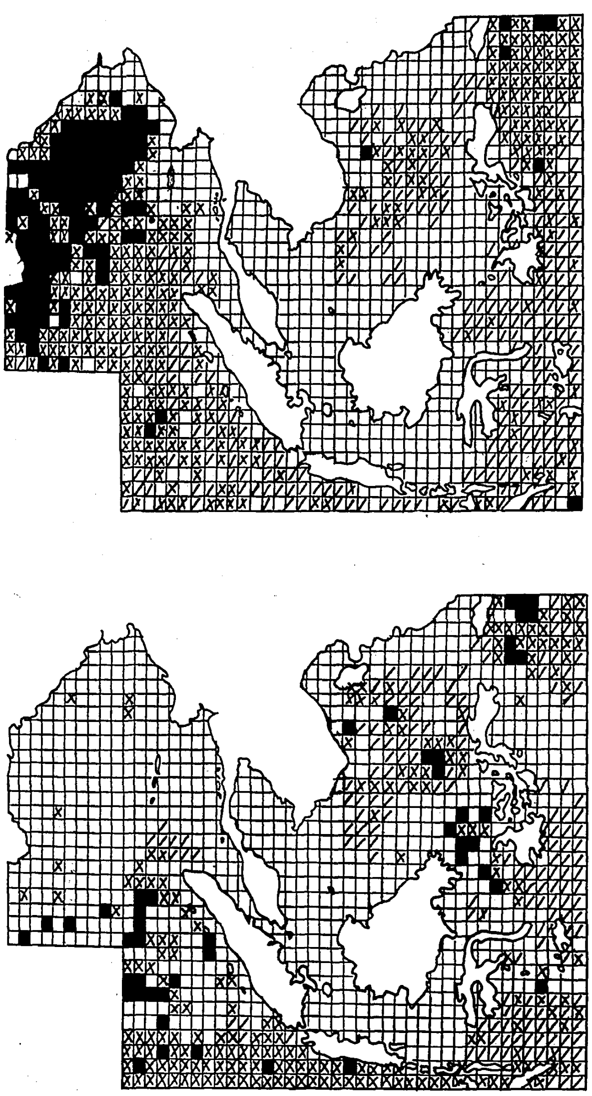

Fig. 11 **Distribution of striped marlin.**
Upper, April–June.
Lower, October–December.
Black, cross and oblique line indicate areas with hook-rate of 0.5 and greater, 0.1–0.4 and 0.0, respectively.

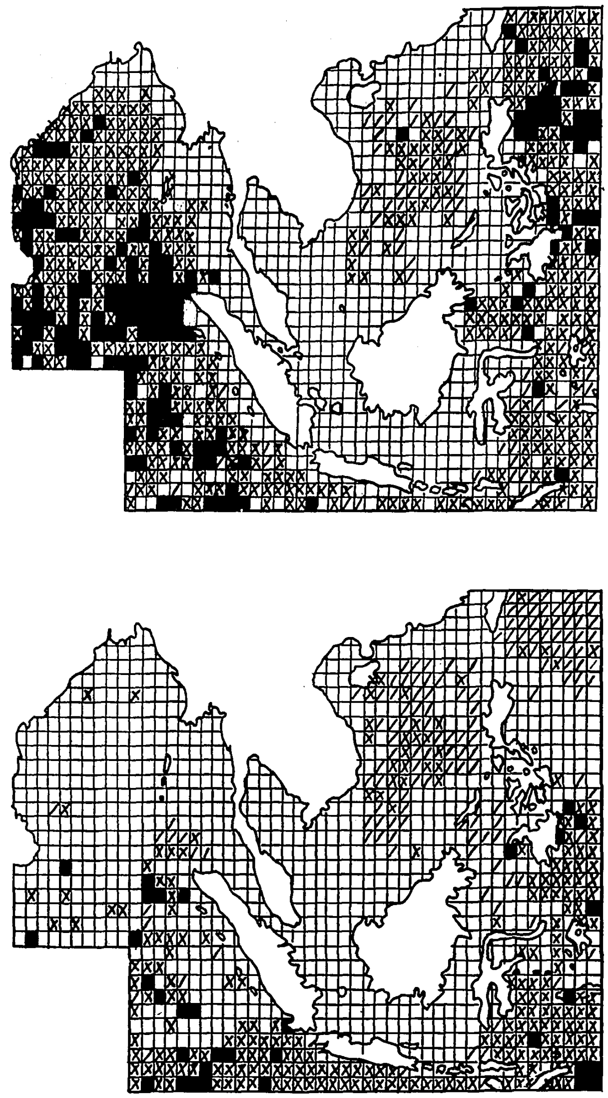

Fig. 12 **Distribution of blue marlin.**
Upper, April–June.
Lower, October–December.

2.4 Billfishes

Generally, the billfishes are more sparsely distributed than the tropical tuna in the South China Sea.

Figure 11 has been prepared for the striped marlin and shows markedly less value of the hook-rate than in the case of tunas. The areas of relatively high hook-rate occur in the western half of the Bay of Bengal in April – June. In the South China Sea, only a small number of such areas are found in the central part and also in the Sulu and Celebes Seas and the eastern seas of Taiwan in October–December.

For blue marlin, as shown in Figure 12, the area of relatively high fish concentrations also occur outside the South China Sea, that is, in the western equatorial area of the Indian Ocean from the Bay of Bengal region to the south of Java and the eastern seas of the Philippines. However, the blue marlin was the most important item in the South China Sea fishery based on Kaohsiung (Nakamura, 1953) and even today occurs most frequently in the Japanese longline catches among billfish.

Black marlin are fish of the continental shelf waters and possibly important in this area. In Japanese catches, they are comparable with blue marling in quantity.

Sailfish rarely occur in Japanese catches in this area but they are the most important in quantity among billfish for the Taiwanese fleets. This difference may probably be dependent on the difference in the construction of the longline gear.

3. RECENT TREND IN LONGLINE CATCHES

Table 1 shows the estimated catches by species made by the Japanese longline fishery in the South China Sea area from 1960 to 1971. The Japanese catches from this area as specified in Figure 1 have ranged from 200 tons to 6,800 tons during the past 12 years. The largest catches were attained in 1967 and since then the longline catches have fluctuated between 2,000 and 5,000 tons with a somewhat downward trend. Taiwanese data for the same estimation are not available for this period. According to the 1966 statistics, the total landings by the Taiwanese

Table 1. Estimated catches (M/T) by species made by Japanese longline fishery in the South China Sea area (1960 – 1971).

Year	YF	BE	AL	SM	BM	BKM	SF·SS	SJ	Total
1960	160	38	0	1	8	4	0	0	211
1961	1,325	270	0	10	32	29	1	0	1,668
1962	1,257	444	6	11	46	45	12	0	1,821
1963	1,429	369	6	17	51	45	7	0	1,925
1964	682	165	4	6	30	26	2	0	916
1965	1,796	495	7	11	82	55	5	2	2,452
1966	1,360	542	0	5	54	41	7	1	2,012
1967	4,661	1,817	8	35	206	103	18	1	6,848
1968	2,586	985	1	18	109	78	8	0	3,786
1969	3,100	1,434	4	16	73	79	9	1	4,728
1970	1,454	745	1	6	43	53	3	0	2,304
1971	2,038	1,000	0	11	56	60	4	0	3,169

Data are based on the "Annual report of effort and catch statistics by area on Japanese tuna longline fishery, 1962 – 1971" (Research Division, Fisheries Agency of Japan) and unpublished data, 1960 and 1961.
Catch by species was estimated by multiplying the average weight of fish in this area by the total estimated number of the fish.
YF, Yellowfin; BE, Bigeye; AL, Albacore; SM, Striped marlin; BM, Blue marlin; BKM, Black marlin; SF·SS, Sailfish and Shortbill spearfish combined; SJ, Skipjack.

fleets from the South China Sea area are roughly estimated to be 2,500 tons. So, the estimated total catches by the Japanese and Taiwanese fisheries in recent years may be between about 5,000 and 8,000 tons annually. The largest catches are of yellowfin tuna. The proportion of bigeye tuna has increased recently to about a half of that of yellowfin tuna. Ninety percent of the total catches or more is held by these two species in the case of the Japanese longline fishery. For the Taiwanese catches, 30 per cent or more may be occupied by billfish, mostly sailfish. Figure 13 shows the trend of yellowfin and bigeye tuna catches in the South China Sea.

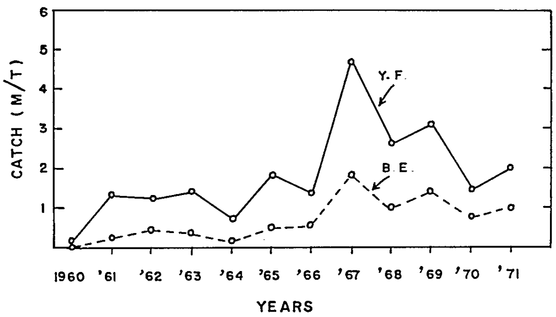

Fig. 13 Catches of yellowfin and bigeye tuna by the Japanese longline fishery in the South China Sea area.

Table 2. Estimated catches (M/T) by species made by Japanese longline fishery in the Southeast Asian waters (1960 – 1971)

Year	YF	BE	AL	SM	BM	BKM	SF·SS	SJ	Total
1960	7,791	3,463	239	276	1,030	606	244	4	13,653
1961	5,856	3,638	487	565	632	377	169	1	11,725
1962	15,564	6,743	372	364	1,148	1,295	631	9	26,124
1963	7,359	4,145	580	389	623	620	961	5	14,632
1964	6,522	4,480	524	137	912	1,010	230	3	13,818
1965	9,147	5,604	581	634	1,226	771	290	23	18,277
1966	7,361	4,041	475	163	608	688	167	19	13,523
1967	9,748	6,044	317	496	955	825	304	14	18,702
1968	7,547	4,471	391	101	618	1,103	279	15	14,525
1969	7,863	4,402	226	183	648	468	147	16	13,953
1970	5,198	3,262	187	167	360	334	73	27	9,607
1971	4,352	2,377	68	126	325	399	118	10	7,774

Data are based on the "Annual report of effort and catch statistics by area on Japanese tuna longline fishery, 1962 – 1971" (Research Division, Fisheries Agency of Japan) and unpublished data, 1960 and 1961.
Catch by species was estimated by multiplying the average weight of fish in this area by the total estimated number of the fish.
YF, Yellowfin; BE, Bigeye; AL, Albacore; SM, Striped marlin; BM, Blue marlin; BKM, Black marlin; SF·SS, Sailfish and Shortbill spearfish combined; SJ, Skipjack.

Table 2 shows Japanese longline catches in the Southeast Asian waters as defined in Figure 1. Total estimated catches for the past 12 years have varied between 7,000 and 27,000 tons with a remarkable drop in the last two years.

Such trends as mentioned above are shown in Figure 14. For Southeast Asian waters, yellowfin and bigeye tuna are the major products of the longline fishery but it should be remembered that this area only represents a part of the ocean where the stocks of these tunas are maintained. As seen in the figure, the recent decrease in number of fishing vessels. It probably reflects the growing interest of the fishermen in southern bluefin tuna which, in turn, has resulted in the removal of some proportion of fishing effort out of the eastern equatorial Indian Ocean. Such a removal of fishing effort from the Southeast Asian waters seems to be indicated in Figures 15 and 16.

4. SMALL-SIZED TUNA AND TUNA-LIKE FISH

The stocks of the large-sized tuna have been heavily fished in every ocean but the world demand for tuna is still growing. In this situation, a great deal of interest has recently been directed to small-sized tuna and tuna-like fish. Most of these fish are coastal in habitat or dwellers in continental shelf waters from the tropical to the temperate zones.

According to RAO fisheries statistics, catches of various tuna-like fishes in the Southeast Asian countries were 100,000 – 150,000 tons in recent years. Of these, 40,000 – 60,000 tons were taken by the Philippines and Malaysia in the South China Sea.

The catches appearing on the statistics probably comprise many different species. These various fishes may include the skipjack (*Euthynnus pelamis*), little tuna (*E. affinis*) longtail tuna (*Thunnus tonggol*), frigate mackerel (*Auxis thazard* and *A. rochei*), bonito (*Sarda orientalis*), spanish mackerel (*Scomberomorus spp.*) and sometime even the young form of the yellowfin tuna. These small-sized tuna and tuna-like fish are caught by various local fisheries in countries surroundng the South China Sea but they, as a whole, seem to be quite under-exploited.

Figure 17 shows the distribution of skipjack as seen from commercial longline data. Like large-sized tuna, skipjack are distributed widely in the world oceans between about 40° N. and S. latitudes and, among small-sized tuna, they are the only fish supportng the large-scale commercial fisheries. In the Pacific Ocean, they are mostly caught by the Japanese live-bait fishery in the western part and by the American purse-seine fleets in the eastern equatorial areas.

This size composition of the fish based on data from different sources are shown in Figures 18 – 20.

In the South China Sea, skipjack are caught by trolling or other coastal fisheries in the Philippines. The fish taken by trolling are mainly from 40 to 60 cm in length. The size range is almost identical with the size of fish caught by the Japanese live-bait fishery. According to Ronquillo (1963), skipjack are knwon to breed during the greater part of the year in Philippine waters.

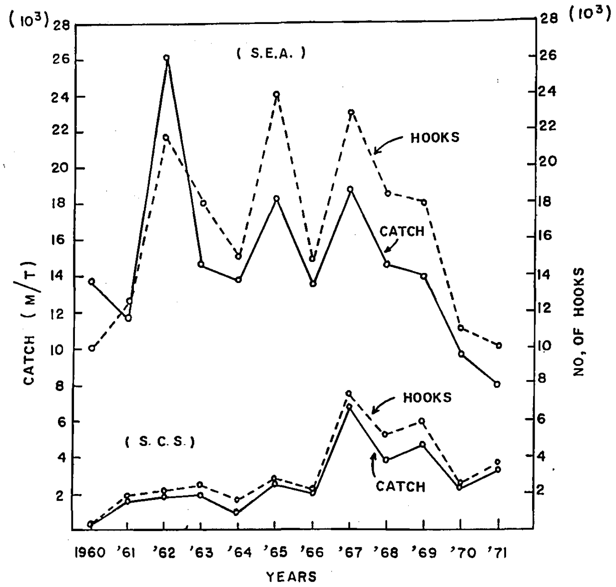

Fig. 14 Total catches and effort by the Japanese longline fishery in the South China Sea area and the Southeast Asian waters.

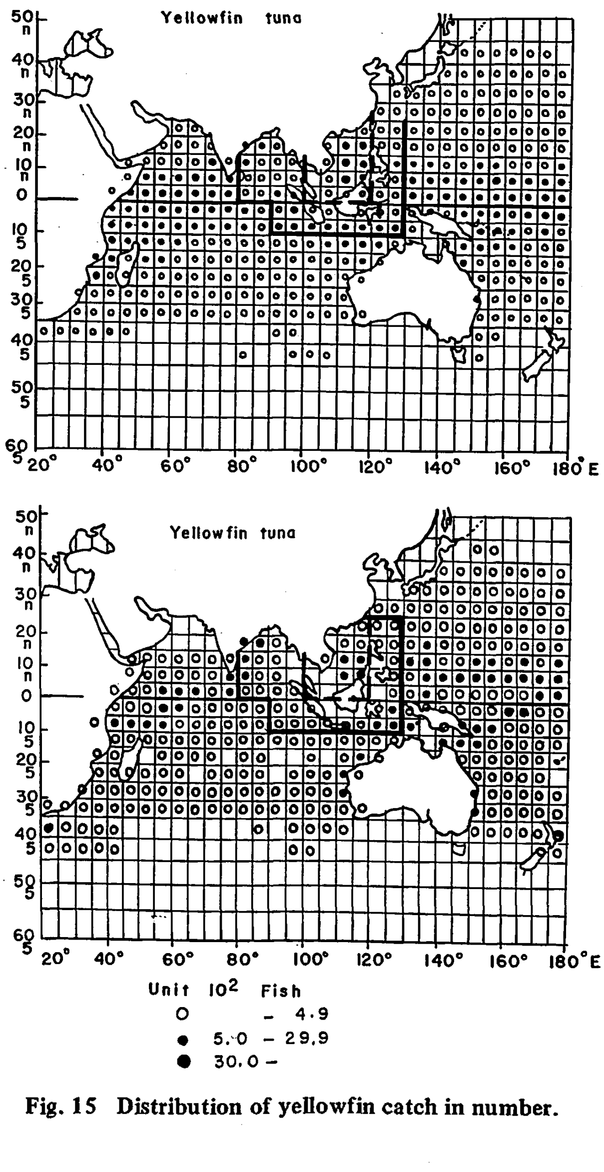

Fig. 15 Distribution of yellowfin catch in number.

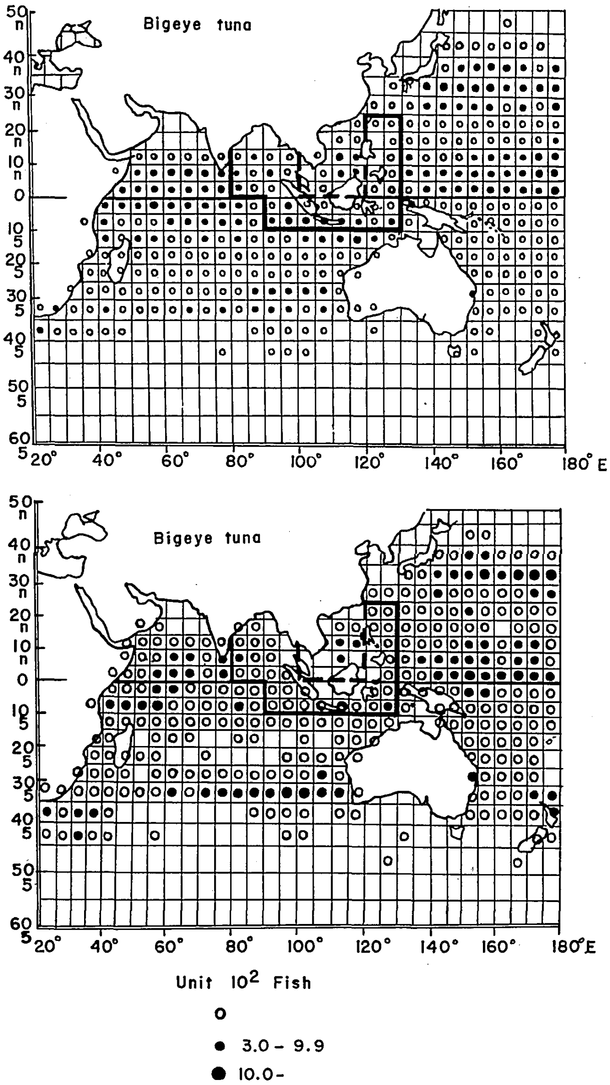

Fig. 16 Distribution of bigeye catch in number.

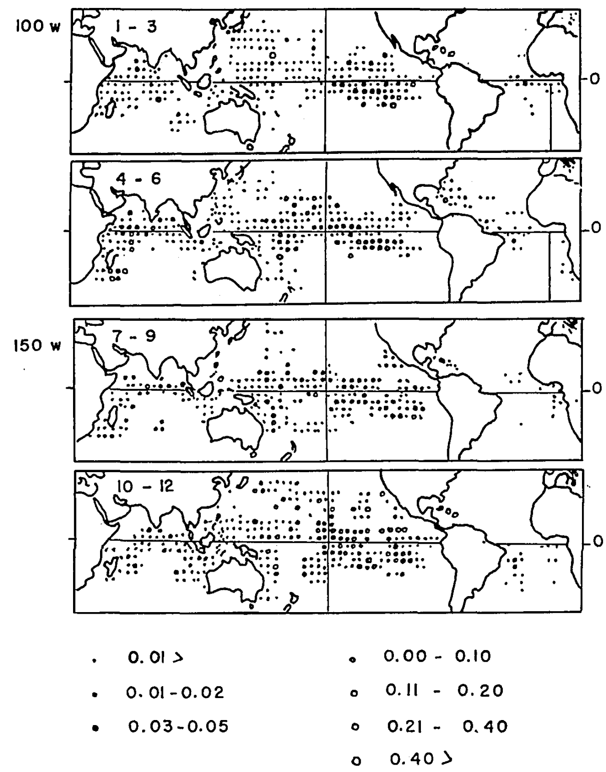

Fig. 17 Geographical distribution of skipjack tuna based on the hooking-rate of Japanese long-line catch in 1965 (Kasahara, 1968).

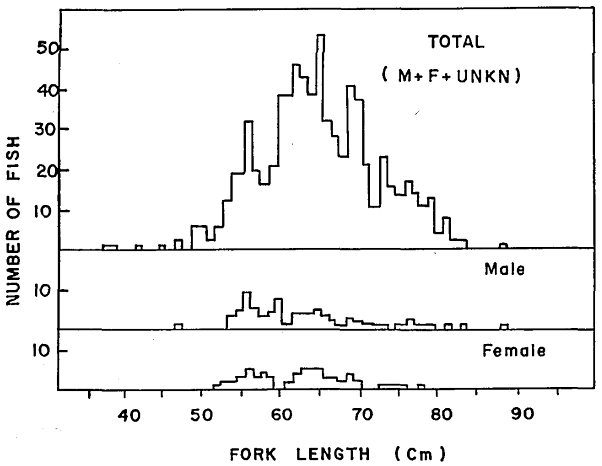

Fig. 18 Size composition of skipjack caught by long-line for all areas, seasons and year combined (Miyake, 1968).

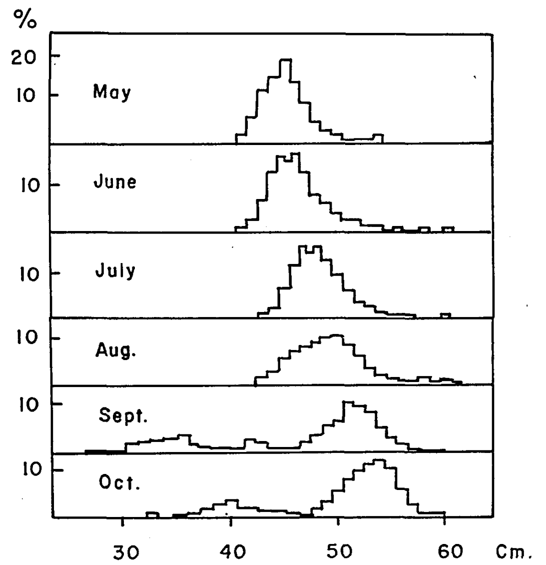

Fig. 19 Average monthly frequency distribution of skipjack tuna caught by the Japanese live-bait fishery in the northeastern offshore area of Japan, 1951–1955 (Kawasaki, 1964).

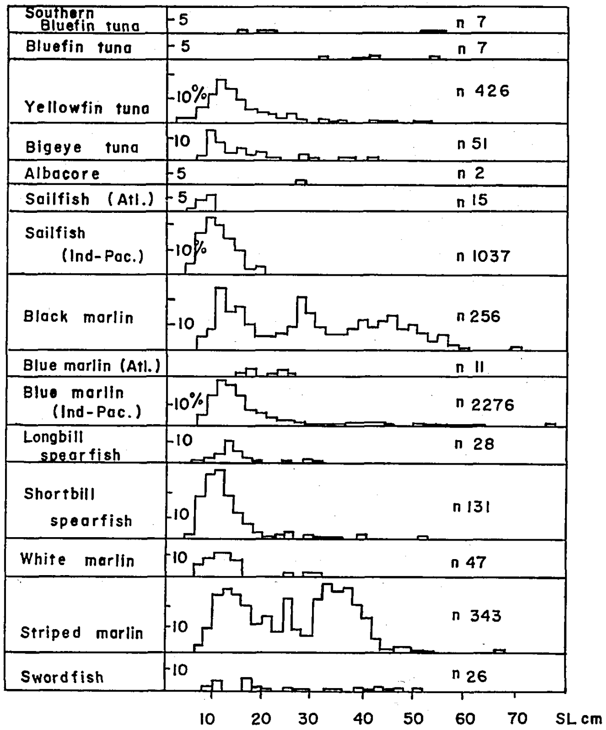

Fig. 20 Length frequency distribution of skipjack found in the stomachs of predatory species. All areas, seasons and years combined. (Mori, 1972).

The little tuna are very widely distributed in the continental shelf waters and around the islands in the Southeast Asian waters, as suggested in Figure 21. The fish are also known to spawn nearly throughout the year in Philippine waters (Ronquillo, 1963). In this area, the fish taken by trolling range in length from 30 to 70 cm, mostly between 40 and 60 cm. In the Hong Kong area, little tuna are caught in the modified purse-seine set close to the gulch. Catches are mostly made during June to August. Fish from 30 to 70 cm in length occur in catches but during the fishing season, June-August, larger fish above 50 cm predominate (Williamson, 1970).

Frigate mackerel also occur in catches in the Hong Kong area (Williamson, 1970). In the Indian Ocean, they are the seasonal visitors to the coastal waters and usually caught in shore seine, drift nets and by trolling (Jones and Silas, 1963).

For longtail tuna, exact information on their occurrence in the South China Sea is not available. However, since their distribution ranges from the east coast of Africa to the Southeast Asian waters (Jones and Silas, 1963), it is likely that they are distributed widely in the continental shelf waters around the South China Sea.

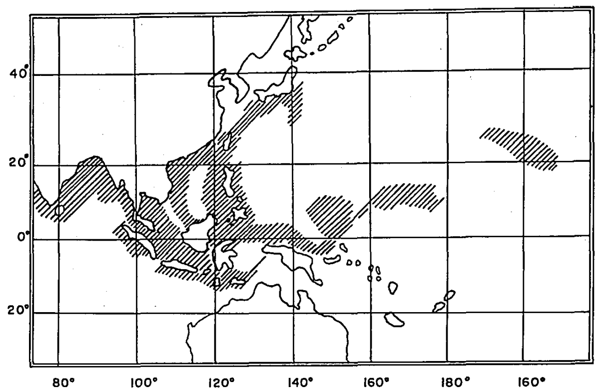

Fig. 21 Distribution of little tuna, Euthynnus affinis (Williamson, 1970).

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Some Considerations of Research and Study on Pelagic Fishery Resources

by

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Abstract

The approach to the stock assessment and fishery management is briefly described on the Indo-Pacific mackerel resource in the Gulf of Thailand and the yellowtail resource around the Pacific coast of Japan.

Recently, the fishery forecast has become one of the great concerns of Japanese researchers working on the pelagic fisheries. In addition to information concering the stock assessment, knowledge on fish movements and aggregations connected with environmental conditions is accumulated to secure a correct forecast of fishery.

In spite of strenuous efforts of researchers, pelagic fishery such as natural fluctuation in fish abundance and catch, widely ranging movement and distribution and diversity of fishing gear etc., bring about many difficulties and problems on the block assessment, fishery management and forecast. At present, the results of studies are not always so reliable to satisfy the fishermen. Researchers, however, are endeavouring step by step to ensure correct and timely judgements on the above objects of fishery science with more intensive communication wih fishermen.

1. INTRODUCTION

The landings of some commercially important pelagic fish in Japan, such as sardine, anchovy, herring, saury pike, common mackerel and horse mackerel, have fluctuated considerably in past years as shown in Fig. 1. Details of these fluctuations were described for each resource by Uda at 15th Session of IPFC. Such fluctuation characters in catches of pelagic stocks have been recognized not only by fishermen but also by many researchers working on fishery resources.

These landings are affected by many factors, such as the strength of fishing efforts, the availability of fish stock in the fishing grounds, the stock abundance and so on. However, it may be said that fluctuation patterns in landings of these pelagic fish for a long period are almost similar to the ones in stock abundances.

In fishery science, one of the important works is to carry out the stock assessment, using the catch statistics, biological information and so on. According to a result of stock assessment, some stocks may be more heavily exploited and others may have to be managed by fisheries regulations in order to secure the full and optimum utilization of the resources.

For some pelagic stocks, researchers' efforts are centered to get the information on the abundance of offspring and recruitment, migratory and distributional patterns of fish by developmental stage, local movement and aggregation of fish schools in the fishing grounds connected with oceanographic conditions. Based on above information and stock assessment, works of forecasting on the fish catch, size, time and area of formation of fishing grounds for the comming season, have been conducted recently.