Seasonal and areal distribution of the pelagic sharks taken by the tuna longline in the Indian Ocean

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Abstract

The results of analyses of data on the pelagic sharks taken by the Japanese longline fishery in the Indian Ocean during 1972-1975 are presented and discussed. Distribution of average monthly hook-rates indicates that areas of high concentration occur off the coast of southern and eastern Africa, western and eastern sectors of Arabian Sea and off western Australia. Seasonal pattern of abundance showed fluctuations. High hook-rates were recorded from the coast of southern Africa during November to July; from the tropical waters of east African coast from October to April; from the western sector of the Arabian Sea during January to July; from the eastern sector during January to July and from the west coast of Australia almost all the year round. Percentage composition of pelagic sharks, tunas, billfishes and skipjack taken by the longline in each 5°lat. ×5° long. area in the Indian Ocean during the same period are presented and discussed. Composition of sharks was generally high in the areas north of equator. It is also evident from this study that no significant annual variation in the percentage composition of sharks occurs in the oceanic area of the Indian Ocean. In view of the high incidence of pelagic sharks in the tuna longline fishery in the Indian Ocean, it is suggested that the economic utilization of sharks as profitably as tunas is a prime necessity.

Introduction

Tuna longline operations which are mainly aimed at catching tunas and billfishes, usually take a large number of other groups of fishes of which pelagic sharks constitute the major component. Information on these undersirable species is a prerequisite to understand their effect on the catches of tunas and billfishes, and to know about the community structure in the tuna fishing grounds. Sharks often cause considerable damage to the hooked tunas and reduce the fishing ability of the baited hooks by taking them. SIVASUBRAMANIAM (1964) discussed on the predation of the tuna longline catches by killer whales and sharks in the Indian Ocean, and according to him an annual average of 10% of the number of tunas and billfishes caught by the longline is damaged by sharks. MIMURA *et al.* (1963) reported on the predators of yellowfin tuna of the Indian Ocean, and according to them "the attacks by sharks are experienced evenly on each operation of the gear, while killer whale attacks are sporad-

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ic, severely damaging the tuna catch". Todate, no systematic attempt has been made to study the distribution and seasonal variation in the abundance of pelagic sharks taken by longline in the Indian Ocean. In view of the economic significance of these fishes in the tuna long-line fishery, it was felt desirable to analyze the areal and seasonal distribution of pelagic sharks in the tuna longline fishing grounds and to assess the percentage composition of sharks in relation to that of tunas and billfishes taken from the different areas in the Indian Ocean.

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Data sources and processing

The data used in the present study were collected from the Japanese commercial longline fisheries operations conducted in the Indian Ocean, during 1972–1975. Catch in number and number of hooks used represent the raw data collected from the log sheets. Detailed statistics such as shark catch by species are seldom maintained by the fishing vessels. In this study, the hook-rate of sharks (number per 100 hooks) has been taken as a parameter to analyze the variations in the density of their distribution. In order to study their spatial and temporal distribution, mean monthly hook-rates for each 10° lat. ×20° long. area in the Indian Ocean have been computed for the 4-year period, 1972–1975. In addition, the annual percentage composition of tunas, billfishes, pelagic sharks and skipjack in each 5° lat. ×5° long. area was calculated for the same period. These calculations were made using-HITAC -8450 in the Computing Center for Research in Agriculture, Forestry and Fishery.

Species composition

Information contained in the log sheets submitted by the Japanese longline fishing vessels to the Fisheries Agency, lacks in species-wise catch details. Inadequacy of such data is a major deterrent in the species-wise analyses of the seasonal and areal distribution of pelagic sharks in the Indian Ocean. However, based on the records maintained by the Japanese commercial, research and training vessels, SIVASUBRAMANIAM (1964) reported that the following species of sharks (Scientific name) appear commonly in the longline catches from the Indian Ocean:—

Scientific name (by SIVASUBRAMANIAM, 1964)	English and Japanese name	
1. *Carcharhinus longimanus* (POEY)	Oceanic whitetip shark,	Yogore
2. *C. brachyurus* (GÜNTHER)	Silky shark, Sickle shark,	Dotabuka
3. *C. albimarginatus* (RÜPPELL)	Silvertip shark,	Tsumajiro
4. *C. melanopterus* (QUOY et GAIMARD)	Blacktip reef shark,	Tsumaguro
5. *Glyphis glauca** (LINNAEUS)	Blue shark,	Yoshikirizame
6. *Isurus glaucus* (MÜLLER et HENLE)	Mako, Bonito shark,	Aozame
7. *Lamna ditropis* HUBBS et FOLLETT	Salmon shark,	Moukazame
8. *Galeocerdo* species	Tiger shark,	Itachizame
9. *Sphyrna* species	Hammerhead shark,	Shumokuzame
15. *Alopias pelagicus* NAKAMURA	Thresher shark,	Onagazame
11. *A. profundus* NAKAMURA	Bigeye thresher,	Hachiware

* *Prionace glauca*.

According to SIVASUBRAMANIAM (1964), the percentage composition of *Carcharhinus* species in the catch declined and that of *Glyphis* species increased with a latitudinal shift of the fishing ground from north to south as given in the following table:

Table 1. Latitudinal changes in the percentage composition* of pelagic shark species in the Indian Ocean.

Latitude	Longitude: 50°E.—120°E.				
	10°N.—0°	0°—10°S.	10°S.—20°S.	20°S.—30°S.	30°S.—40°S.
Glyphis glauca	10%	15%	37%	52%	92%
Carcharhinus sp.	65%	55%	38%	10%	3.5%
Other species	25%	30%	25%	38%	4.5%

* Data read from the graph of SIVASUBRAMANIAM (1964, p. 225, fig. 3)

Seasonal and areal distribution

The monthly average hook-rates of pelagic sharks for the 4-year period 1972–1975 are shown in Fig. 1. In order to distinguish the variations in the hook-rates, the indices were divided into five ranges, which are represented in the maps by symbols placed in the 10° lat. ×20° long. areas.

From the maps it is apparent that the general pattern of their distribution occupies the area 20°N. to 50°S. In general, relatively high catch rates of sharks were recorded along the western and eastern parts of the Arabian Sea in the northern sector, and off southern coast of Africa and off the west coast of Australia in the southern sector of the Indian Ocean (Fig. 1).

Seasonal pattern of abundance showed variations. Off the coast of southern Africa, the hook-rates were low during August to October, and were relatively high during the rest of the year. In Madagascar waters, hook-rates were high during January through March and in

September. The hook-rates were moderately high along the tropical waters of the east African coast from October to April. Hook-rates perceptibly increase towards north from January, and high concentration along the western Arabian Sea was recorded during January to July. Low catches were recorded from the Arabian coast during February since when the hook-rate increased and during April highest concentration was observed off Gulf of Aden. Along the eastern sector of the Arabian Sea, particularly in the Lakshadweep Sea and its northern areas hook-rates were proportionately high during January to July and in October. In the Bay of Bengal, except for some localized concentration noted during the months of June and August in the southern area, the hook-rates were uniformly low. Off the west coast of Australia the concentration of sharks were relatively high throughout the year. There is little evidence of significant seasonal variation in the hook-rate of pelagic sharks in the oceanic area of the Indian Ocean.

Results of the analysis of data on the annual percentage composition of sharks in the different tuna longline grounds in the Indian Ocean in comparison to that of total tunas, billfishes and skipjack during the period 1972–1975 are presented in Fig. 2. On the whole, tunas constitute the major component of the longline catches in most of the areas. It is also evident that no significant annual variation in the percentage composition of pelagic sharks occurring in the oceanic waters of the Indian Ocean. However, high concentration of sharks was noted in certain areas where their percentage composition during the 4-year period showed fluctuations as follows:—

(i) Area off South Africa (30°—40°S., 20°—35°E.): 0.9–21.8%

(ii) Area 5°N.-10°S., 35°-55°E. in the tropical coast of the east Africa: 1.1–13.5%

(iii) Area 10°-20°N., 50°-65°E. in the western Arabian Sea: 2.2–25.1%

(iv) Area 5°-15°N., 65°-75°E. in the south-eastern sector of the Arabian Sea: 1.9–55.6%

(v) Area 10°-20°N., 80°-90°E. in the western sector of the Bay of Bengal: 0.6–22.1%

(vi) Central tropical waters of the Indian Ocean (5°S.-5°N., 55°-95°E.): 0.3–11.7%

(vii) Area 20°-35°S., 100°-115°E. in the west coast of the Australia: 0.6–39.8%

Based on the limited information at hand, no decisive conclusion could be made to explain the causative factors for such localized concentration.

Discussion

From the pattern of distribution presented herein, as interpreted by the longline catches, no definite conclusion could be derived on the migratory pattern of pelagic sharks in the Indian Ocean. It seems that the regions with high hook-rates are due to their concentration in favourable areas and time, and may depend on the abundance of tunas during those seasons and areas.

SIVASUBRAMANIAM (1964) opined that the extent of damage to tuna is relatively high when *Carcharhinus brachyurus* and *C. longimanus* are abundant. According to him, in the tuna fishing grounds of the Indian Ocean north of equator, the hook-rates of sharks are very high and that the relative denseness appears to decline latitudinally southwards. He estimated an average of 11% and a maximum of 45% of tuna catches may be damaged by the sharks in the Indian Ocean. MIMURA *et al.* (1963) presented the seasonal records of attack on tunas by killer whales and sharks in the Indian Ocean. According to them, the rate of attack on tunas is high in the area north of 10°S., especially west of 80°E. and around the Banda and Flores Seas as detailed below:—

Table 2. Record of attacks by sharks and killer whales on tunas caught by longline in the Indian Ocean, April, 1958–March, 1960.

Area	Months	Rate of attacks*	Hook-rate** of sharks
N. of 10°S.,	April–June	0.09	0.60
W. of 80°E.	July–Sept.	0.18	0.46
	Oct.–Dec.	0.17	0.71
	Jan.–March	0.15	0.73
N. of 10°S.,	April–June	0.07	0.48
E. of 80°E.	July–Sept.	0.09	0.38
	Jan.–March	0.07	0.65
Banda and	April–June	0.14	0.58
Flores Seas	Jan.–March	0.16	0.59
S. of 10°S.,	Oct.–Dec.	0.04	0.28
W. of 80°E.	Jan.–March	0.06	0.41
S. of 10°S.,	Oct.–Dec.	0.04	0.50
E. of 80°E.	Jan.–March	0.06	0.26

(Source of data: MIMURA *et al.*, 1963, p. 335, Table IV)
* Rate of attack: No. of tunas attacked divided by No. of tunas hooked.
** Hook-rate of sharks: No. of sharks caught per 100 hooks.

Further, the results of experimental tuna longline fishing conducted in the south-east Arabian Sea (Area: 4°–13°N., 72°–79°E.) show that sharks form more than 60% of the catch in this area (EAPEN, 1964, JOSEPH, 1972). Recently, VARGHESE (1974) reported on the shark resources of the Lakshadweep Sea and stated that the longline fishing showed a high potential with regard to sharks in that area. The average hooking rate has been very high at 8.4% with an average weight of 57.0 kg. It is evident from the present analysis that although the hook-rates of pelagic sharks are relatively high in the tropical western Indian Ocean, proportionately high concentrations occur off the coast of south-east Africa and west coast of Australia in the southern hemisphere as well.

The high hook-rate of pelagic sharks in the Indian Ocean by the longline shows that they sometimes form a major constituent of the fishes taken by this gear, especially from certain areas and this necessitates suitable programmes to utilize the shark catches economically (FAO, 1976). Shark skin of relatively large fishes could be made into attractive leather by chemical process. Further, shark liver oil which is rich in vitamins 'A' and 'D' is of medicinal value. TANIKAWA (1971) reported on the utilization of sharks in Japan as raw material for fish sausage and ham. Owing to the strong elasticity of the meat, they have been utilized also as raw material for Japanese fish paste (Kamaboko). He also stated that especially as to the shark meat, the older the meat becomes, the stronger is the elasticity of Kamaboko processed therefrom. According to him, *Lamna ditropis* (Japanese: Moukazame) is eaten as daily dish and *Isurus glaucus* (Japanese: Aozame) and *Sphyrna* species (Japanese: Shumokuzame) are mainly utilized in the fish sausage and ham industry. Another product from the shark in Japan is the dried sharks fin (Japanese: Fuka-bire) which is used for shark fin soup.

The high incidence of pelagic sharks in the longline catches result in the decrease in both the tuna catches and profitable fishing. This will adversely affect the performance of the crew in the longline vessels because of the low hook-rate of tunas. In view of these, the economic utilization of pelagic sharks taken by the longline fishery as profitable as tunas is an urgent necessity.

References

EAPEN, P. K. 1964: Tuna longline operations in the west coast of India. *Indian Seafoods*, **2** (1), 5 pp.

FAO 1976: A selected bibliography on shark utilization. *FAO Fish. Circ.*, (347), 1–17.

FOURMANOIR, P. and A. CROSNIER 1964: Rapport sur la campagne, de pêche au thon á la palangre dérivante, faite par le "MARAN ATHA" dans les environs de Majunga (Côte Nord-Ouest) du 21 September au October 1961. Proc. Sympos. Scombroid fish, Pt. 1, 379–388, Mar. biol. Ass. India, Mandapam Camp.

JOSEPH, K. M. 1972: Some observations on the exploitation of the Indian Ocean tuna resources. *Seafood exp. Jour.*, 4 (8), 11–18.

MIMURA, K. and Staff of NRFRL 1963: Synopsis of biological data on yellowfin tuna, *Neothunnus macropterus* Temminck and Schlegel, 1842. Species synopsis No. 10, *FAO Fish. Rep.*, (6), Vol. 2, 319–349, Proceedings of the world scientific meeting on the biology of tunas and related species, La Jolla, California, USA, 2–14 July, 1962.

SIVASUBRAMANIAM, K. 1964: Predation of tuna longline catches in the Indian Ocean by killer whales and sharks. *Bull. Fish. Res. Stn., Ceylon*, **17** (2), 221–236.

TANIKAWA, E. 1971: Marine products in Japan. *Fac. Fish. Univ. Hokkaido, Spl. publ.*, 1–401.

VARGHESE, G. 1974: Shark resources of the Laccadive waters. *Seafood exp. Jour.*, **6** (1), 65–68.

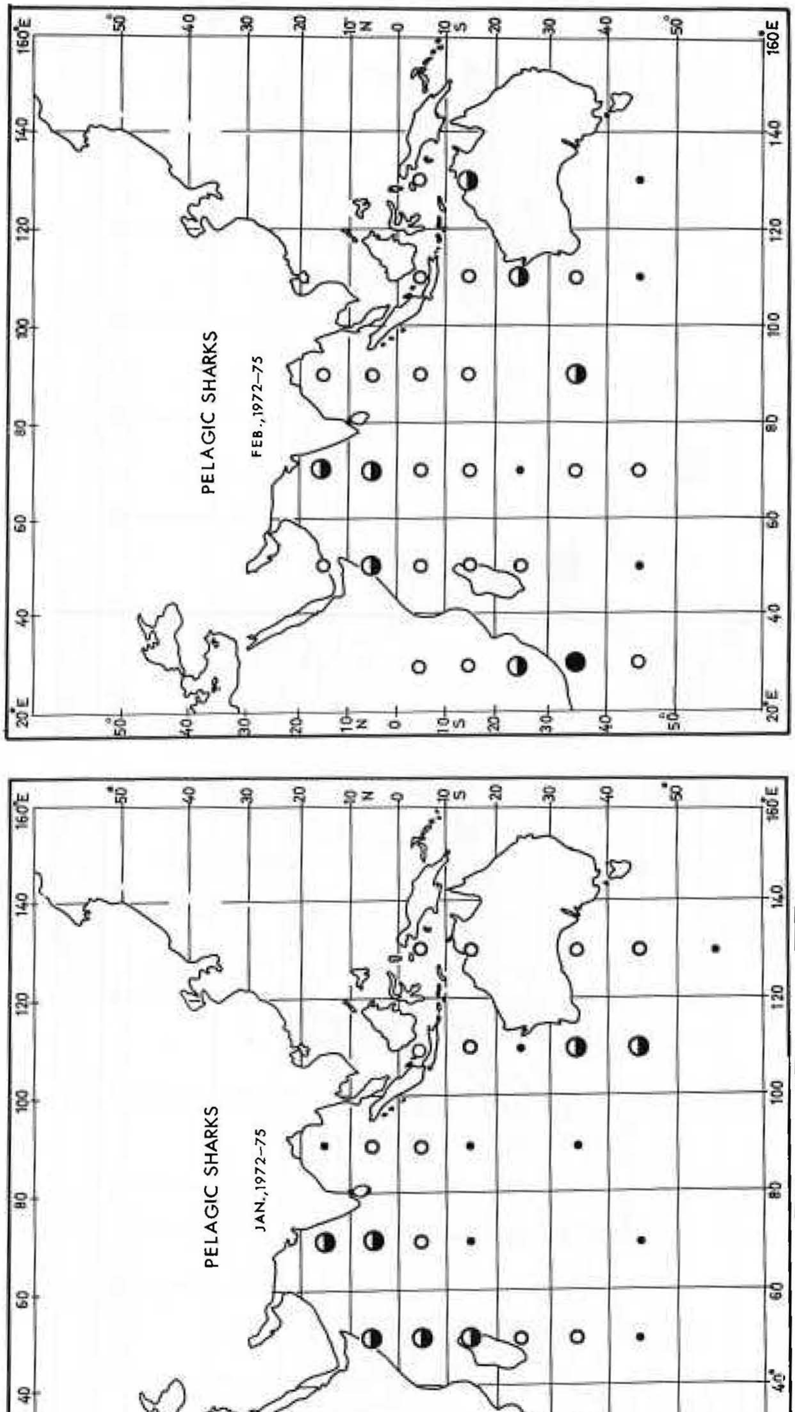


Fig. 1. Average monthly distribution of hook-rates (number per 100 hooks) of pelagic sharks taken by the Japanese longline fishery in the Indian Ocean, 1972–1975, January and February.

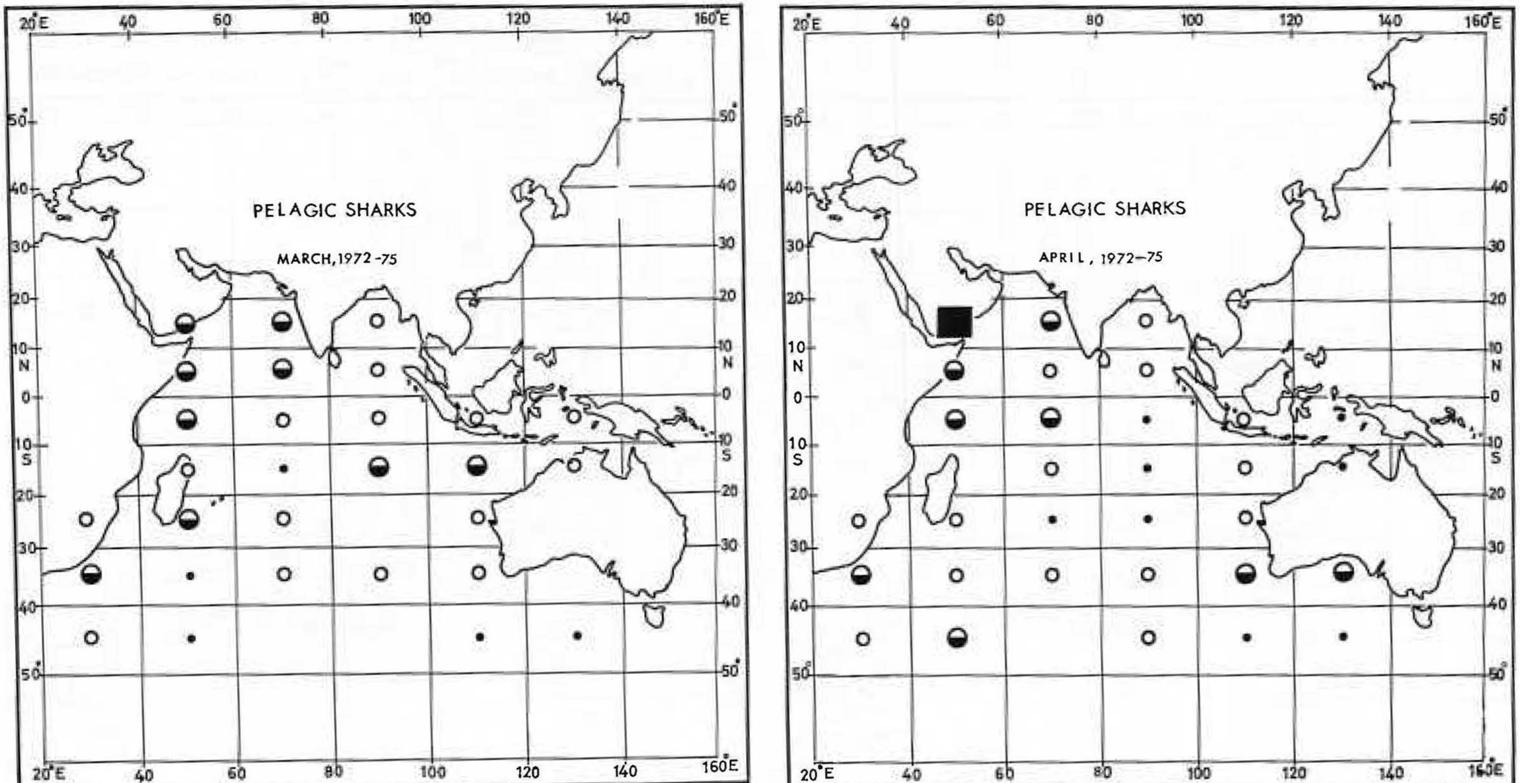
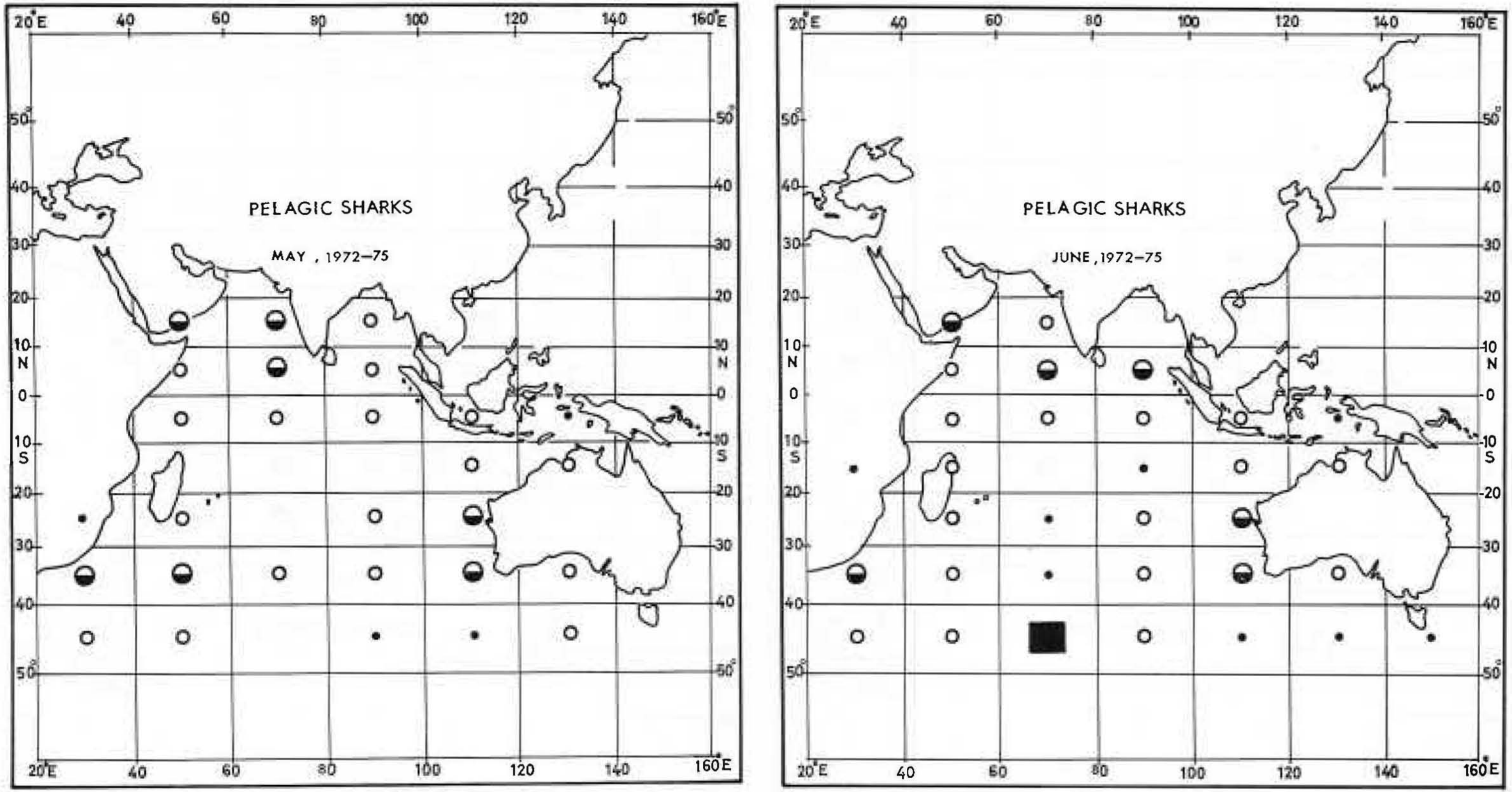


Fig. 1. Continued, March and April.



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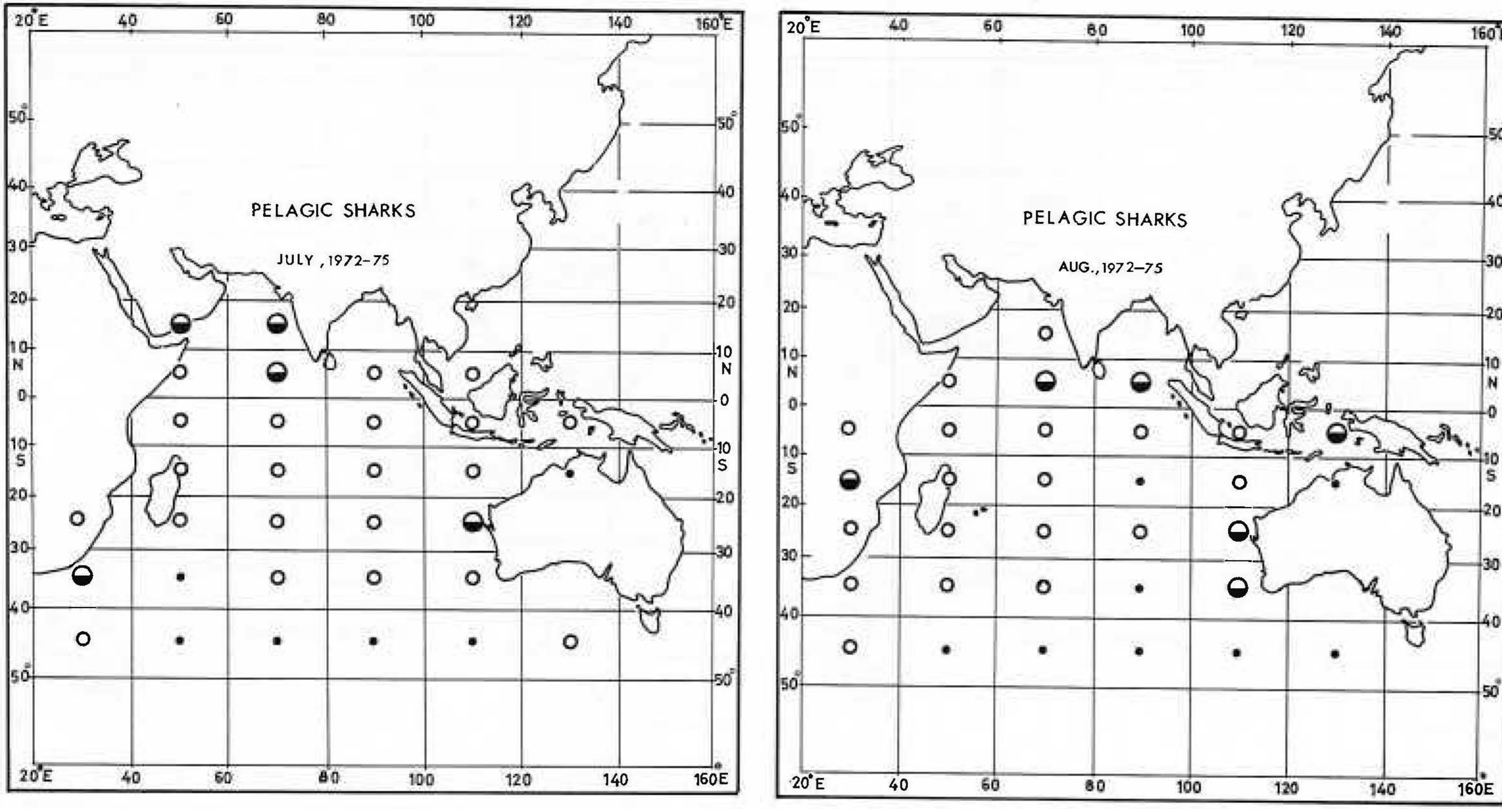

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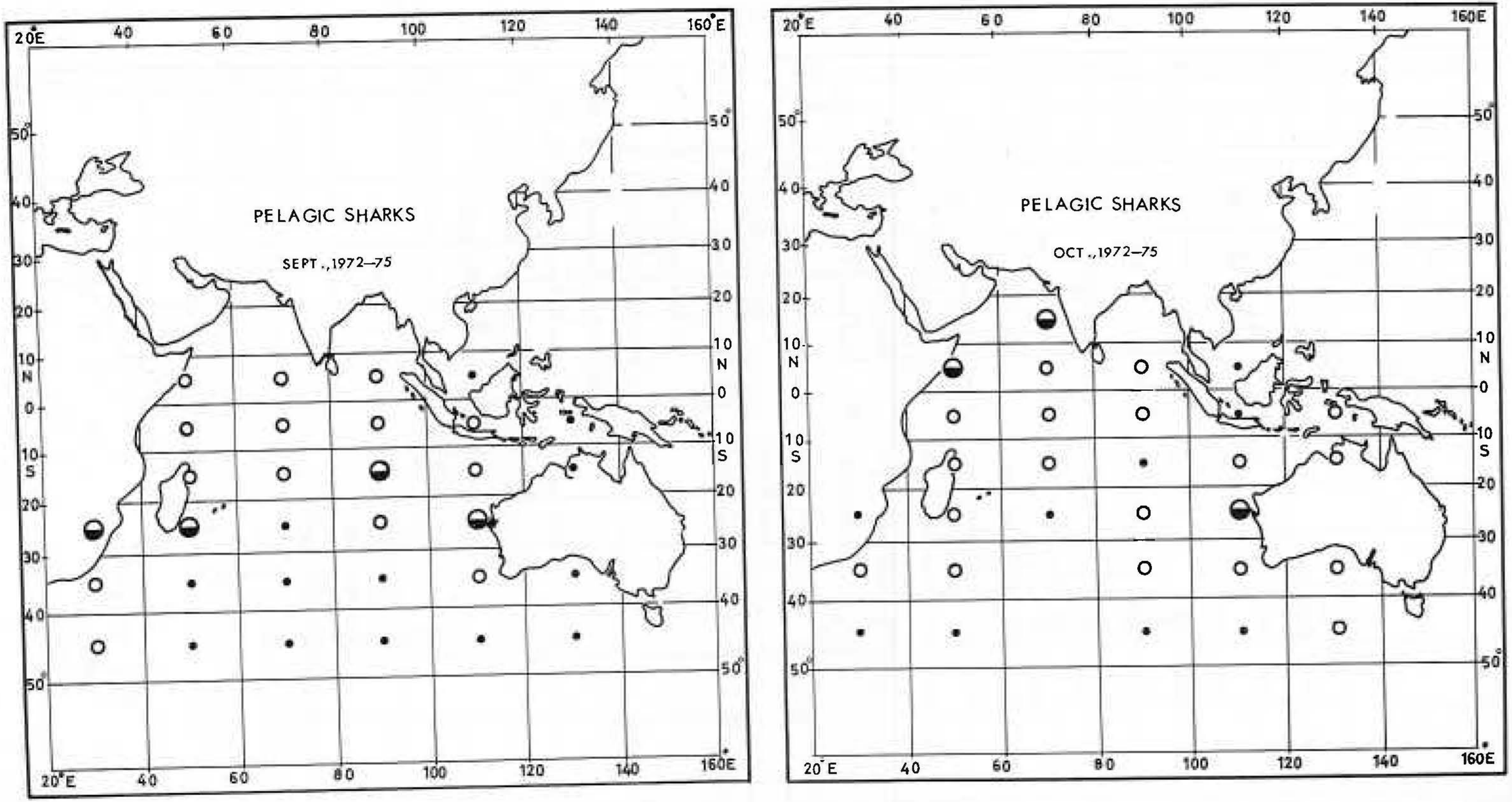

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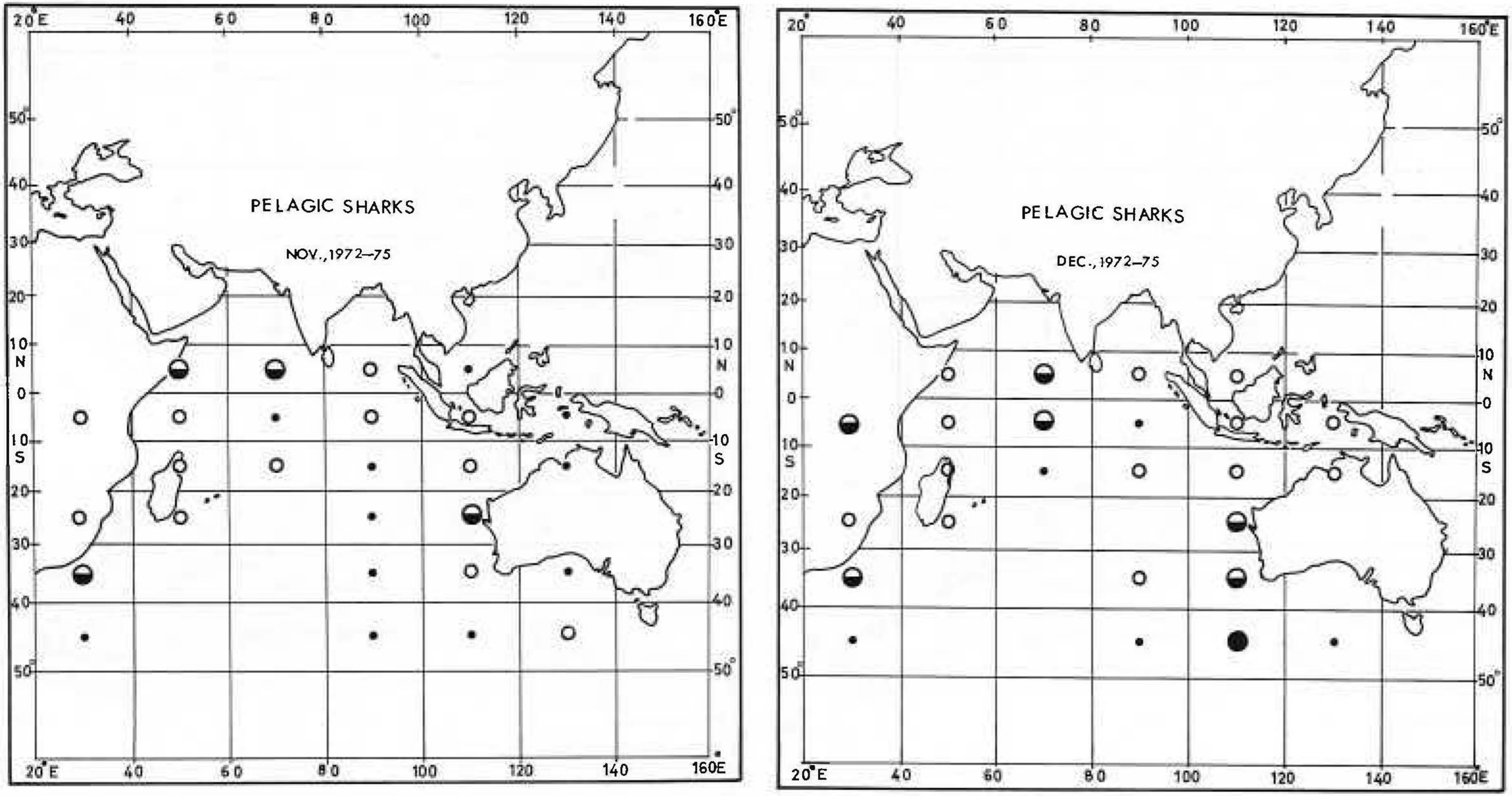

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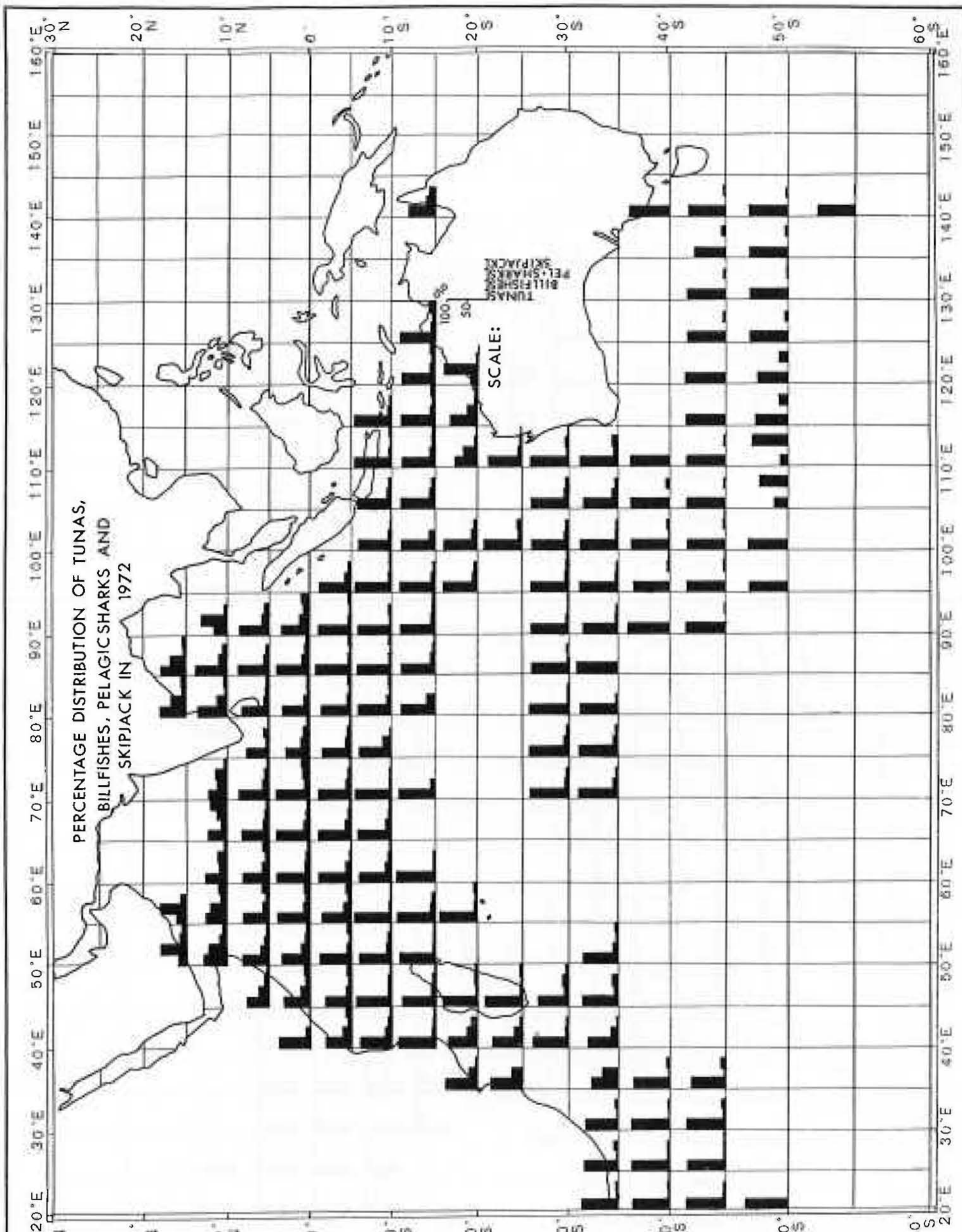
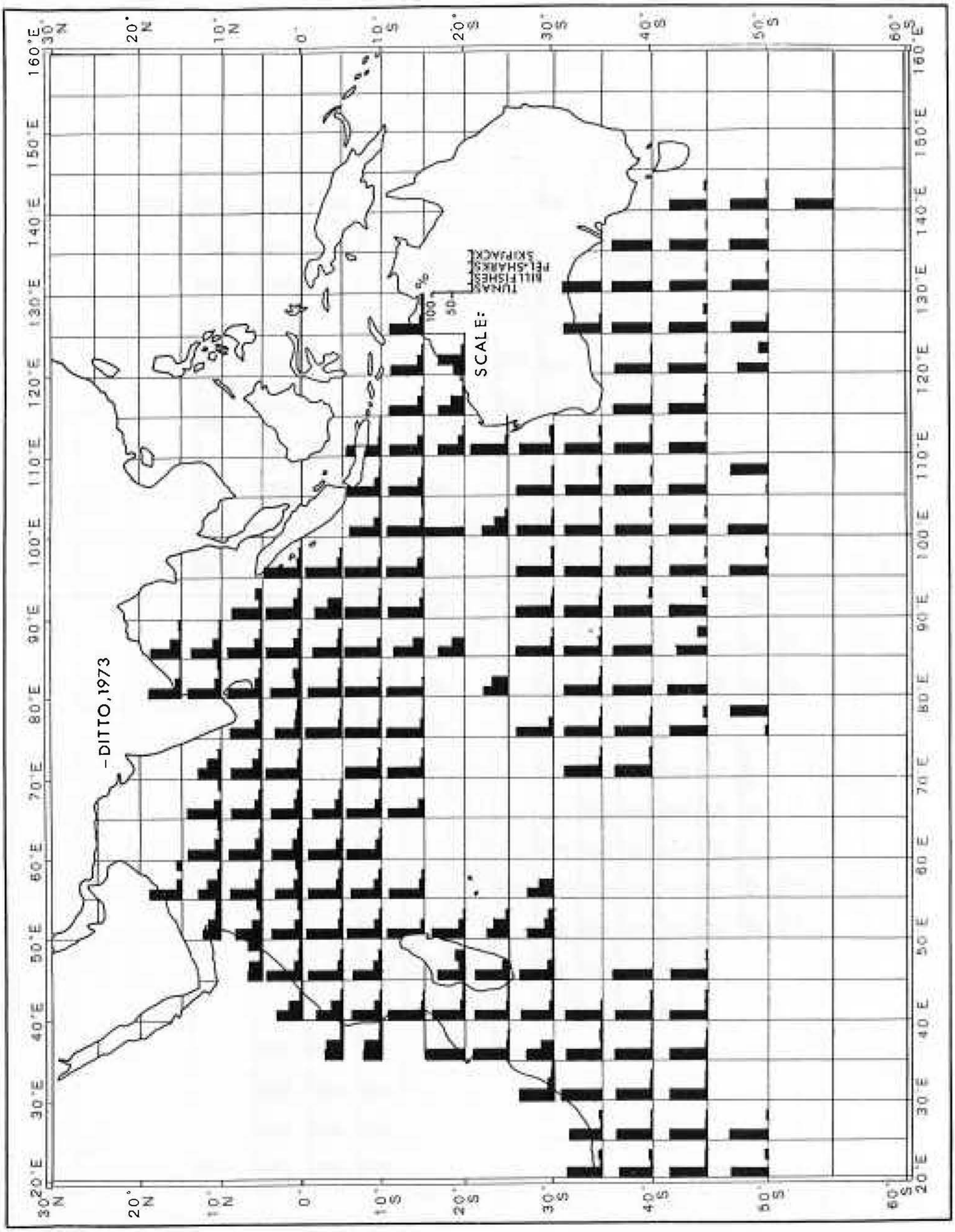


Fig. 2. Annual distribution of percentage composition of tunas, billfishes, pelagic sharks and skipjack in the Japanese tuna longline fishery, in the Indian Ocean, 1972.



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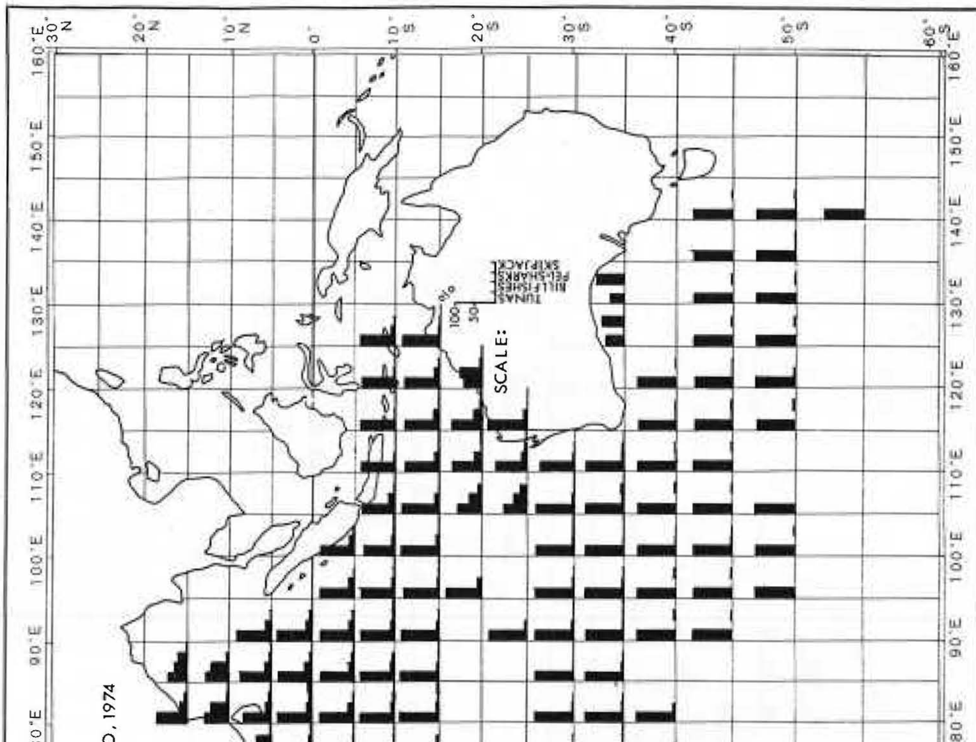

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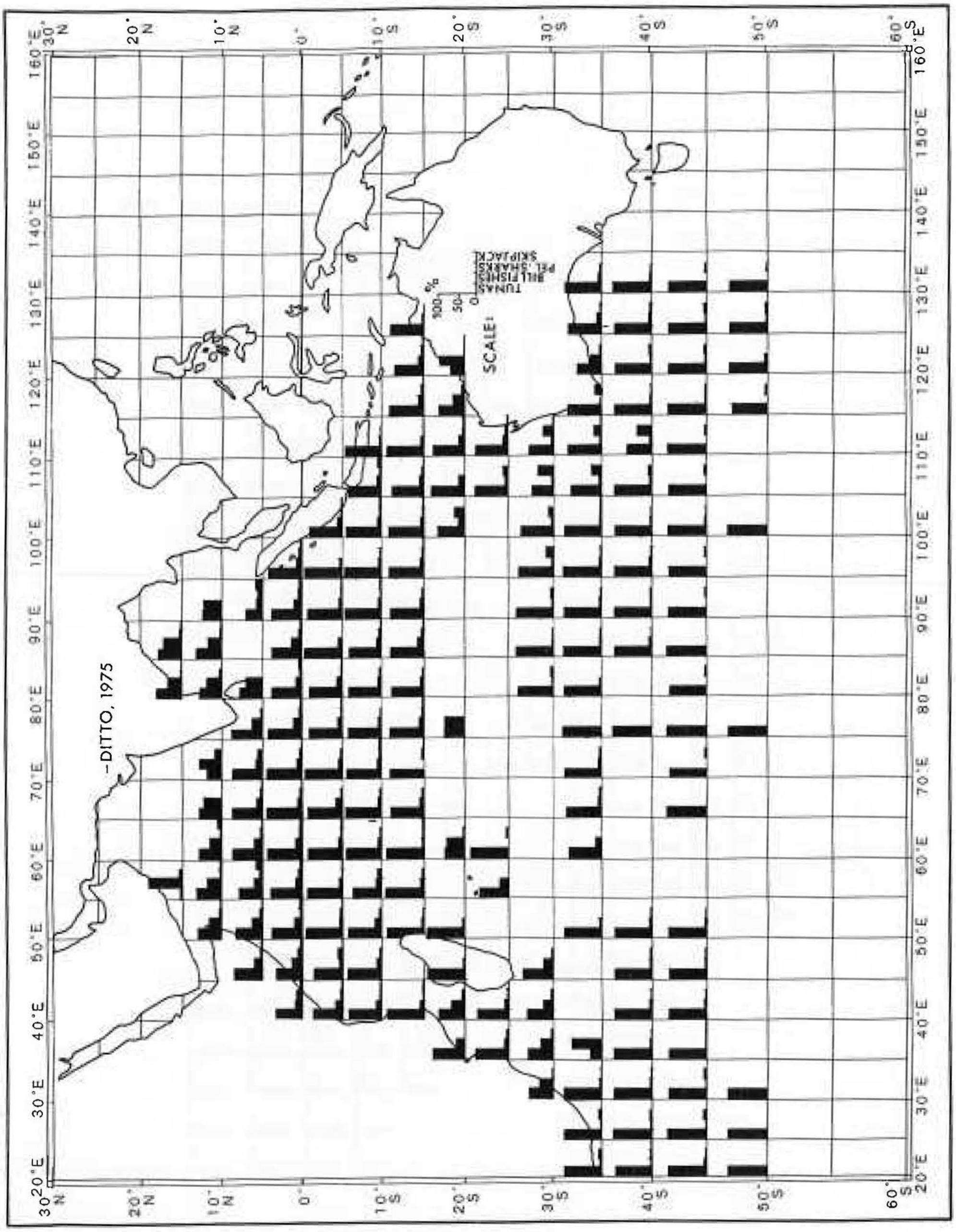

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