ON THE STOCK STRUCTURE OF BIGEYE TUNA IN THE ATLANTIC OCEAN

by

S. Kume, Y. Morita

SUMMARY

By gathering available data on catch and effort statistics by area and biological information and by reviewing past studies, the stock structure of bigeye tuna in the Atlantic Ocean was examined. An explanatory description was given on the change in time and space for geographical distribution, size composition and sexual maturity. It is suggested that there would be a possible stock separation between the North and the South Atlantic, though there seems to exist an intermingling between the two groups. No information is available on the extent of the mixing. Further examination will be necessary on this point.

RESUME

La structure du stock de thon obèse dans l'Atlantique a été étudiée en réunissant les données disponibles sur les prises et l'effort par secteur, ainsi que sur l'information biologique, et en passant en revue les études antérieures. Une description explicative est fournie concernant les modifications spatio-temporelles de la répartition géographique, la structure démographique et la maturité sexuelle. Une séparation éventuelle du stock est suggérée entre nord et sud, bien qu'il semble se produire entre les deux groupes un mélange sur le degré duquel il n'existe pas d'information. Il est nécessaire d'étudier cette question plus avant.

RESUMEN

Examina la estructura del stock de patudo en el Atlántico, por medio de los datos disponibles sobre estadísticas de captura y esfuerzo por zona, información biológica, y por estudios realizados con anterioridad. Describe el cambio espacio/temporal de la distribución geográfica, composición por talla y madurez sexual. Se sugiere una posible separación de los stocks al Norte y Sur del Atlántico, con un cierto grado aparente de mezcla, cuya importancia no se conoce con exactitud. Será necesario continuar el estudio del tema.

Bigeye tuna in the Atlantic are distributed widely in the tropical and subtropical waters. This resource has been utilized historically and mainly by longline fishery, but the catch by surface fisheries has recently been on the increase. Distribution and biological information of the species have been reported by several studies: Shiohama et al (1965), Sakamoto (1967 and 1969), Sakagawa (1975) and so on. These researchers do not necessarily describe the clear explanation on the stock structure of the species in the Atlantic. Compiling again catch and effort statistics and biological data and reviewing past studies, geographical distribution, size composition and sexual maturity were examined in this report to acquire more positive characteristics of the stock structure.

Geographical distribution

In Fig. 1, is shown average monthly hook rate (catch in number per 100 hooks) of bigeye tuna by 5° square on the basis of 1965-1974 catch and effort statistics of Japanese longline fishery. Hook rate is an index of geographical relative abundance.

The distribution of bigeye tuna extends in the overall area between 45°N and 40°S in latitude. The occurrence of the distribution with high abundance will be summarized as follows:

1) In the high latitudes between 35°N and 45°N, from off New York to the central portion of the north Atlantic.
2) In the waters north of 20°N and centered by Las Palmas Islands.
3) In the region off Dakar between 5°N and 20°N extending offshore as far as 50°W between 5°N and 15°N.
4) In the tropical waters between 0° and 10°S from off the coastal area of west Africa to around 30°W.
5) In the waters off Angola between 10°S and 30°S.
6) In the waters off Argentine and seaward between 30°S and 40°S.

The seasonal change in relative abundance by area is also outlined as follows:

1) In the northern high latitudes, the appearance of the area of high density counts twice a year: the period centering around winter season and the one from May to July. There seems to occur higher abundance during the period from September to October in the high latitudes of south Atlantic.
2) In the middle latitudes, where dense distribution occur in the eastern half of the Atlantic, areal expansion of higher abundance is observed in the first semester of the year in northern hemisphere and in the second semester in southern hemisphere. This concentration seems to be related with the development of prevailing colder currents in each area: Canary and Angola Current respectively.
3) In the tropical waters, the seasonal change in abundance is not so clear as those of other areas. In the open sea of southern equatorial area, higher density is encountered in the first quarter-of-the-year.

The existence of the area of lower hook rate in the middle region of the equatorial waters, as pointed out by Sakamoto (1967), is also recognized in the present monthly distribution, being suggestive of north-south stock separation.

However, it seems that this does not support obvious separation of the stock, as can be seen the continuous distribution of rather high hook rate between northern and southern equatorial areas in the period from December to March.

Size composition

Considering the feature of the distribution, the division of the Atlantic was made to compile the size data (Fig. 2). This areal division is identical to that of the ICCAT area for bigeye tuna. All available size data obtained from Japanese longline fishery since 1965 were combined by quarter and by area as defined in Fig. 2 (Fig. 3). Modal progression of the size group between quarters reflecting possibly the growth of the fish is observed in some areas, which is marked by an arrow in Fig. 3.

The characteristics of the regional change of the size composition with its seasonal change will be described briefly as follows:

Area-1: Small- (less than 120 cm in length; 3 years old and less) and medium- (120-152 cm; 4 and 5 years old) sized fish are main constituents throughout the year.

Area-2: Small- and medium-sized fish are dominant in the first half of the year. On the other hand, medium- and large- (larger than 152 cm; 5 years old and greater) sized fish occupy the size composition in the second half of the year.

Area-4: All-sized fish are almost evenly included in the size composition in the first half of the year. In the later half of the year, the proportion of large-sized fish decreases.

Area-5: Major size groups are observed in every size category. The proportion of large-sized fish is larger in the first and fourth quarters.

Area-7: From small- to large-sized fish constitute the catch. In the later half of the year, small-sized fish become more dominant than other size groups.

Area-8: In the first quarter, large-sized fish are predominant, while small-sized fish become the major component of the catch in the third quarter.

The above is fundamentally not so different as Sakamoto (1969) described, but further detailed seasonal change is explained in this report because of the more accumulated data.

Taking into account of the seasonal change in abundance of the distribution together, it is noted that higher concentration of the fish in the middle and high latitudes is associated with the more appearance in abundance of smaller- and medium-sized fish. In the equatorial waters, higher abundance appears to be related with the increase of large-sized fish.

To compare the size composition by different fishing gear, all available size data are pooled by gear and indicated in Fig. 4. It is shown that 1) longline gear captures mainly 3 ages and older fish, 2) pole-and-line fishery does 1-3 ages fish, very young fish, and 3) purse seine gear does 1-5 ages with relatively more young fish.

Sexual maturity

Measurement of gonad weight of females has been conducted on board by Japanese experimental and exploratory longline fishing cruises. Gonad index [ovary weight (g)/ cube of fork length(cm) $\times 10^4$] is calculated for each measurement. To obtain information on maturity condition, the frequency of GI by such category as less than 1.5, 1.6-3.0 and greater than 3.1, is prepared (Table 1). Females with GI 3.1 and greater are considered to be highly advanced in sexual activity and belong to spawning group in view of the study on maturity of Pacific bigeye tuna by Kikawa (1966).

The results are outlined as follows:

Areas 1, 2, 7 and -8: These areas are of colder water temperature and almost all GI's are very low indicating sexually on inactive stage.

Area-5: The occurrence of about 10 % of individuals with GI 3.1 and greater is observed in the first quarter, when colder current, Angola Current, is the weakest. Majority of females, however, are relatively low in maturity condition throughout the year.

Areas 4 and -6: These areas locate in the warmer tropical waters. Remarkable appearance of females with GI 3.1 and greater is observed in both areas. In Area-4, northern equatorial waters, the peak season of maturity is in the third quarter. In Area-6, the peak spawning season appears to be during the first half of the year.

In summary, maturity condition is very low in the middle and high latitudes, whereas the spawning group occur in tropical waters. There seems to be the difference in the peak spawning season between northern and southern equatorial waters.

Richards (1969) reported that bigeye larvae occur in Guinea area from February to April when warmer water prevails and indicated the appearance of the larvae in the oceanic area along 10°N in August~October. This observation is fairly supportable with the present gonad observation.

On the stock structure

It is not decisive yet on the number of stock(s) of bigeye tuna in the Atlatic Ocean. The present study may suggest the possible separation at around the equator between northern and southern groups or stocks of the resources. It is supposed that mixing of the fish between north and south groups would not be frequent and the rate of mixing would be low if it exists. In conclusion, from the stock managment point of view, it would be appropriate to give a consideration on the case of the existence of two stocks as well as the case of a single stock in the whole Atlantic Ocean.

References

Kikawa, S. 1966: The distribution of maturing bigeye and yellowfin and an evalution of their spawning potential in different areas in the tuna longline grounds in the Pacific. Nankai Reg. Fish. Res. Lab., Rept. 23; 131-208.

Richards, W. J. 1969: "Distribution and relative apparent abundance of larval tunas collected in the tropical Atlantic during Equalant I and II". Proceedings of the Symposium on the Oceanography and Fisheries Resources of the Tropical Atlantic, Review papers and Contributions, 289-315, UNESCO, Paris, 1969.

Sakagawa, G. T. 1976: Status of the bigeye tuna stocks of the Atlantic Ocean, 1957-73 from production model analisis. (SCR3/75/79) Coll. Vol. of Scent. Papers, Vol.V, (2); 176-184.

Sakamoto, H. 1967: Distribution of bigeye tuna in the Atlantic Ocean. Nankai Reg. Fish. Res. Lab., Rept. 25; 67-73.

Sakamoto, H. 1969: Preliminary review on the regional change in size composition, sex ratio and gonad index on the Atlantic bigeye caught by tuna longline fishery. Far Seas Fish. Res. Lab., Bull. 1; 49-56.

Shiohama, T. et al 1965: "The catch statistic data for the Japanese tuna longline fishery in the Atlantic Ocean and some simple considerations on it". Nankai Reg. Fish. Res. Lab., Rept. 21; 131p.

Addendum Data source for Fig. 4.

Longline: all Japanese data, 1965-74, were combined by north and south areas.

Pole-and-line:

Japan.....Data obtained from Tema-based fleet, partly recent unpublished data were included.

Spain.....From Data Record (ICCAT) Vol. 7.

Purse seine:

Japan.....All available data from Data Record series.

USA.....From Data Record Vol. 7.

Table 1. Frequency distribution of Gonad Index of Atlantic bigeye tuna, by quarter-of-the-year and by ICCAT area.

Area	Quarter	Total	G.I.			Area	Quarter	Total	G.I.		
			1.5≧	1.5-3.0	3.0≦				1.5≧	1.5-3.0	3.0≦
1	I	58	58	-	-	5	I	57	26	21	10
	II	91	89	1	1		II	67	64	2	1
	III	-	-	-	-		III	80	78	2	-
	IV	96	93	3	-		IV	41	35	3	3
2	I	62	61	1	-	6	I	203	44	18	141
	II	-	-	-	-		II	20	3	1	16
	III	101	85	15	1		III	-	-	-	-
	IV	75	75	-	-		IV	41	14	14	13
3	I	-	-	-	-	7	I	25	19	2	4
	II	1	1	-	-		II	174	122	52	-
	III	-	-	-	-		III	-	-	-	-
	IV	10	10	-	-		IV	27	22	2	3
4	I	221	49	68	104	8	I	16	16	-	-
	II	116	42	33	41		II	45	42	3	-
	III	239	43	22	174		III	309	296	12	1
	IV	240	160	38	42		IV	124	114	6	4

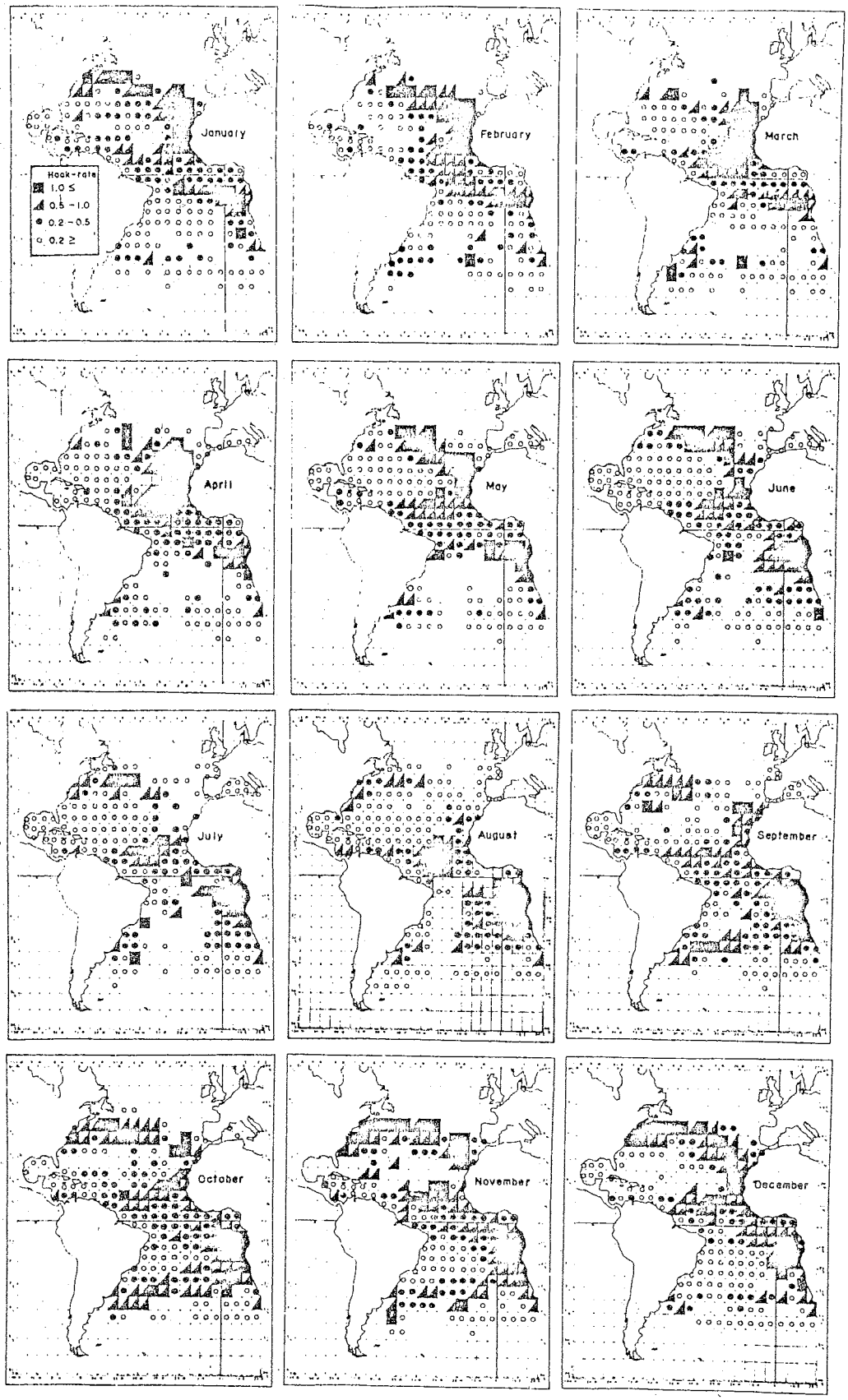

Fig. 1. Monthly distribution of avarage hook rate (1965-1974) of bigeye tuna caught by Japanese Atlantic longline fishery.

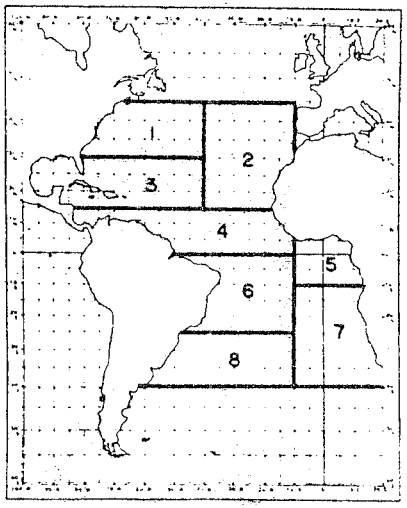

Fig. 2. Division of area (ICCAT area).

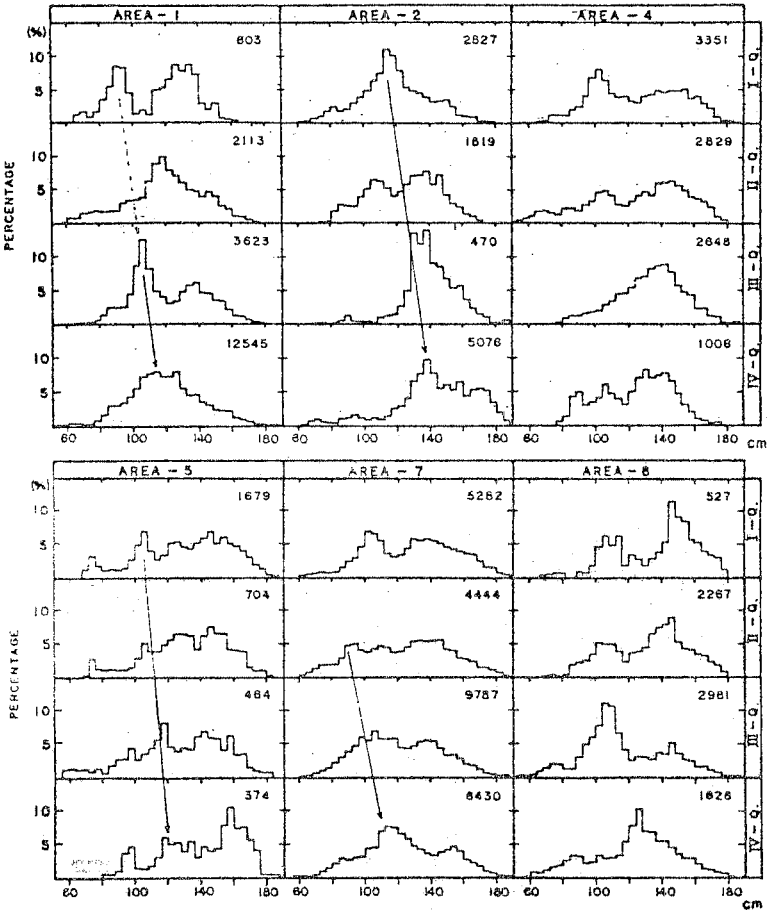

Fig. 3. Average size composition of bigeye tuna caught by Japanese Atlantic longline fishery, by quarter of the year and by ICCAT area. A figure in each panel indicates number of sample.

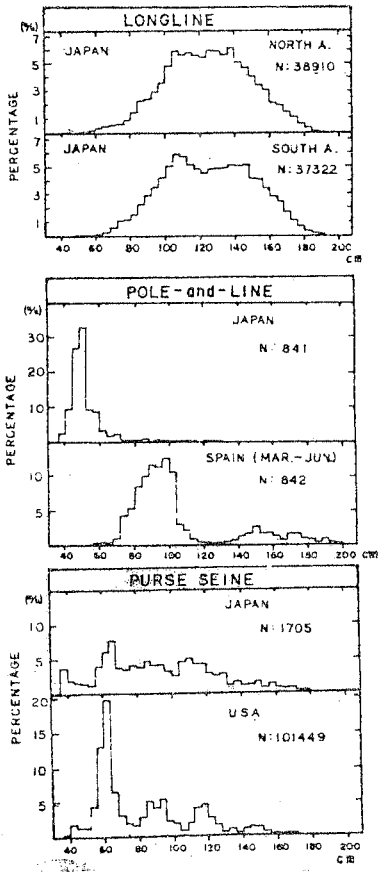

Fig. 4. Average size composition of bigeye tuna caught by different type of gears in the Atlantic Ocean.