

AN ESTIMATION OF PARAMETERS OF Y/R MODEL ON ALBACORE STOCK
OF LONGLINE FISHERY IN THE ATLANTIC OCEAN

by

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SUMMARY

The length frequency data collected from the Japanese longline fishery since 1957 were compiled by year and by area, and then converted into the age composition by the age-length key method utilizing the growth equation estimated by Bard (1974). Annual age compositions of catch by stock were obtained by weighting the sample composition of each area with catch in number.

Based on the compositions, mean age of the catch (\bar{t}) and mean age at recruitment (t_c) were estimated on each of the Japanese and whole longline harvests. \bar{t} and t_c gradually decreased in periods II and III. It is noticeable that the recent \bar{t} 's in the Japanese fishery have become smaller than those in the whole fishery, though t_c have been so different from each other.

In addition, instantaneous rate of natural mortality was estimated rather roughly using the data on 7-10 ages in the N-1 area during 1961-1968. Fitting each set of Z and f, calculated from annual cpue and effort, to $Z=zf+M$, M was estimated to be 0.4 as approximate average value.

RESUME

Les données de fréquence de taille rassemblées sur la pêche palangrière japonaise depuis 1957 ont été compilées par année et par secteur, puis converties en composition par âge au moyen de la clef âge-longueur qui utilise l'équation de croissance estimée par Bard (1974). La composition annuelle par âge de la prise par stock a été obtenue en pondérant la composition de l'échantillon de chaque secteur avec la prise en nombre de spécimens.

Ces compositions ont permis d'estimer l'âge moyen de la prise (\bar{t}) et l'âge moyen au recrutement (t_c) pour les palangriers japonais et la pêche à la palangre dans son ensemble. \bar{t} et t_c diminuent graduellement pour les périodes II et III. Il convient d'observer que récemment \bar{t} est devenu moindre dans la pêcherie japonaise que dans la pêcherie dans son ensemble, bien que t_c n'ait pas présenté de telles différences.

En outre, le taux instantané de mortalité naturelle a été estimé de façon assez grossière à partir de données sur les âges 7 à 10 dans le secteur N-1 de 1961 à 1968. En ajustant à $Z = zf + M$ tous les jeux de Z et de f calculés à partir du CPUE et de l'effort annuel, une valeur moyenne approximative de 0,4 a été estimée pour M.

RESUMEN

Los datos sobre la frecuencia de tallas, recogidos de la pesca japonesa de palangre desde 1957, fueron recopilados por año y por área, y convertidos en composición por edades, por medio del método clave edad-talla, empleando la ecuación de crecimiento calculada por Bard (1974). Las composiciones anuales de la captura por stocks, se obtuvieron comparando la composición de la muestra de cada área, con la captura en número.

Basándose en las composiciones, se calculó la media de edad de la captura (\bar{t}) y la media de edad al reclutamiento (t_c) por cada uno de los palangreros japoneses, y por el conjunto de la pesca de palangre. \bar{t} y t_c decrecieron gradualmente en los periodos II y III. Es notable que los recientes índices de \bar{t} en la pesca japonesa son inferiores a los de toda la pesca en conjunto, mientras que los índices de t_c no han sido tan diferentes.

Por otra parte, la tasa instantánea de mortalidad natural se evaluó bastante por encima con los datos sobre las edades 7-10 en el área N-1 durante 1961-68. Ajustando cada juego de Z y f, calculado sobre el CPUE y esfuerzo anual, a la fórmula $Z = qf+M$, se dió a M un valor medio aproximativo de 0,4.

Table 2 reproduced in Data Record Vol. 7.

Tableaux 2 reproduit dans le Vol. 7. du Recueil de Donnees.

Cuadro 2 reproducido en Vol. 7 de Coleccion de Datos Estadisticas.

1. Age composition

Biological measurements of Atlantic tunas sampled from Japanese longline fleet including some research boats have been carried out since 1956. However, the measurement program has not been of systematic nature, so that accumulated data do not necessarily cover space and time very well. Length data of albacore caught by Japanese longline fishery for the period 1970-73 were already compiled by Shiohama (1973, 1974 and ms), in which substitution of data was made for the stratum without any data available.

In this study, all available size data on Atlantic albacore caught by longline fishery since 1957 were summarized by calendar year and by four areas, N-1, N-2, S-1 and S-2, designated by Shiohama (1974). To convert size data to age, the age-length key was utilized by adopting the growth equation of Bard (1974). This equation was chosen because it is the latest estimate on Atlantic albacore and also fairly consistent with the growth of Pacific albacore (Yabuta and Yukinawa, 1963). In summarizing the age composition, substitution of data was made for the case being no data available: the age composition without any data was filled up by either one of corresponding average compositions of four divided periods as shown in Table 1. Using these age compositions, catch in number by age was estimated for north and south stocks by weighting with the number of catch by area which is obtained by the same process explained by Shiohama (1974) based on ICCAT Stat. Bull. Vol.4 up to 1972 and Vol.5 for 1973 data. The results are tabulated in Table 2 for Japanese catch and whole longline catch, in which substitution is marked by asterisks.

2. Mean age of the catch (\bar{t}) and mean age at first capture (t_c).

Utilizing the age composition obtained above, annual \bar{t} and t_c were estimated. t_c was calculated rather simply using modal and younger ages, each age of which was added 0.5 and then weighted by corresponding percentage. The resultant \bar{t} and t_c for Japanese and whole longline fisheries separately (Table 3 and Fig. 4) indicated almost similar figures except \bar{t} of 1970 and onward in the south stock. There has been a gradual decreasing trend in \bar{t} and t_c , which was due to the shift of albacore catch of longline fleets from lower latitudes to higher latitudes as shown in Fig. 2. It is noted that recent \bar{t} 's of Japanese catch for the south stock has become younger than those of whole longline catch though both t_c 's were almost the same. This is reflected by the remarkable decrease of Japanese catch in S-1 area where larger fish are abundant (Fig. 2).

3. An estimation of natural mortality coefficient (M).

To estimate M, though rather tentatively, data of area N-1 during the years from ¹⁹⁶¹ to 1968 were taken, since albacore longline fishery was operated mainly by Japanese fleet in the area and effort varied fairly markedly during this period. In N-1 area, adult albacore are distributed (Shiohama, 1973). A series of total mortality coefficients (Z) were calculated by following equation:

$$Z = \ln \left(\frac{\sum_{n=7}^9 \frac{C_{n,i}}{e_i}}{\sum_{n=8}^{10} \frac{C_{n,i+1}}{e_{i+1}}} \right)$$

where,

$C_{n,i}$: Japanese catch in number of n-age in i-th year.
 e_i : Japanese effective effort in i-th year.

Using set of Z and the index of fishing intensity (f) (Table 4), the latter of which an average effective effort of i-th and i+1-th years for whole longline fleet, a regression analysis was made with the equation, $Z = qf + M$ (Paloheimo, 1961), where

q is a catchability coefficient. Calculated M and q were 0.40 and 0.000014 (per 1000 hooks) respectively, with $r=0.52$ (Fig.5). Beardsley (1971) estimated overall M for Atlantic albacore to be 0.23. It is suggested by Suda (1966) that M for older fish would become higher for the north Pacific albacore. The present M, 0.4, estimated above, though the coefficient of correlation (r) is rather low, is assumed to be applicable to older ages, since the data from N-1 area are mainly of adult fish.

It seems, however, that the above estimated M should be re-examined in the future.

Some of critical problems are pointed out as follows:

- 1) The effect of substitution of data with average age composition for the stratum in which no data available.
- 2) Revision of unit stratum for compiling age data in space and time. This is related with the seasonal change in the distributional pattern of adult and young fish. For example, it is observed that there are seasonal movement of adult fish in N-1 area into N-2 area and that of young fish in N-2 area into N-1 area.
- 3) The possible effect of sexual dimorphism in growth. Neppen (1970) suggested a sexual difference in growth and Suda (1959) noted the male predominance in older ages.

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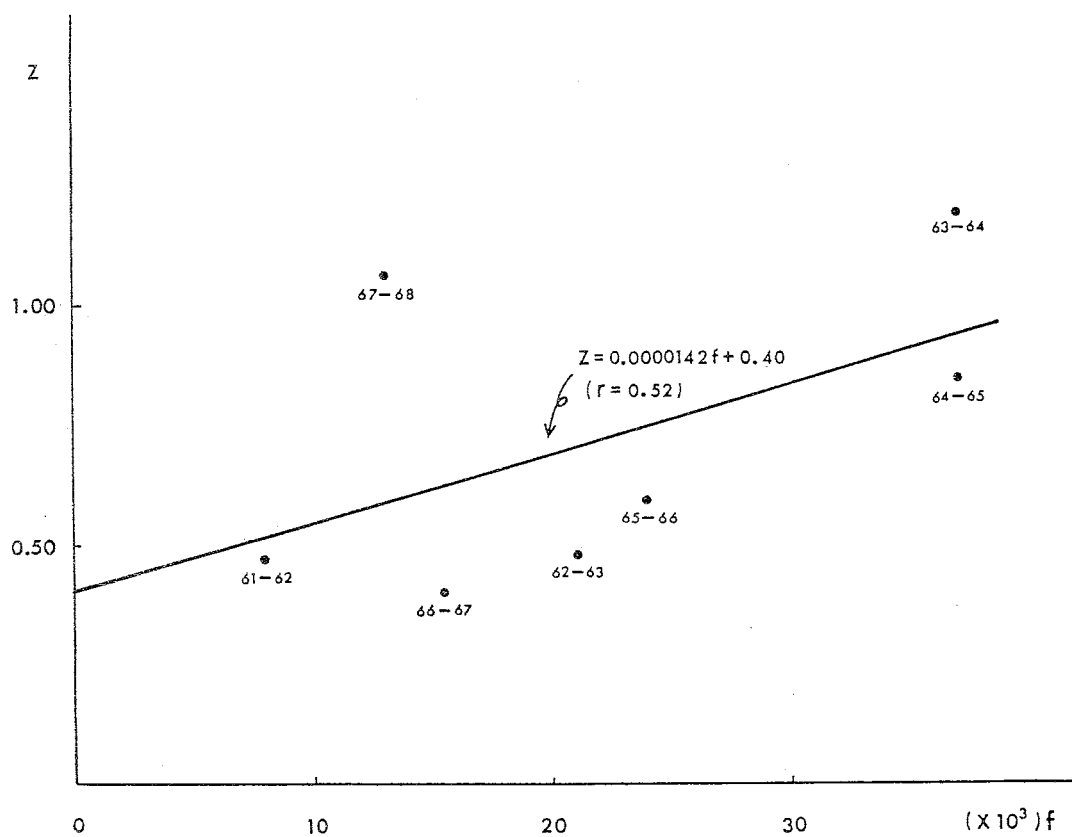


Fig. 5 Regression line estimated from the data in Table 4.

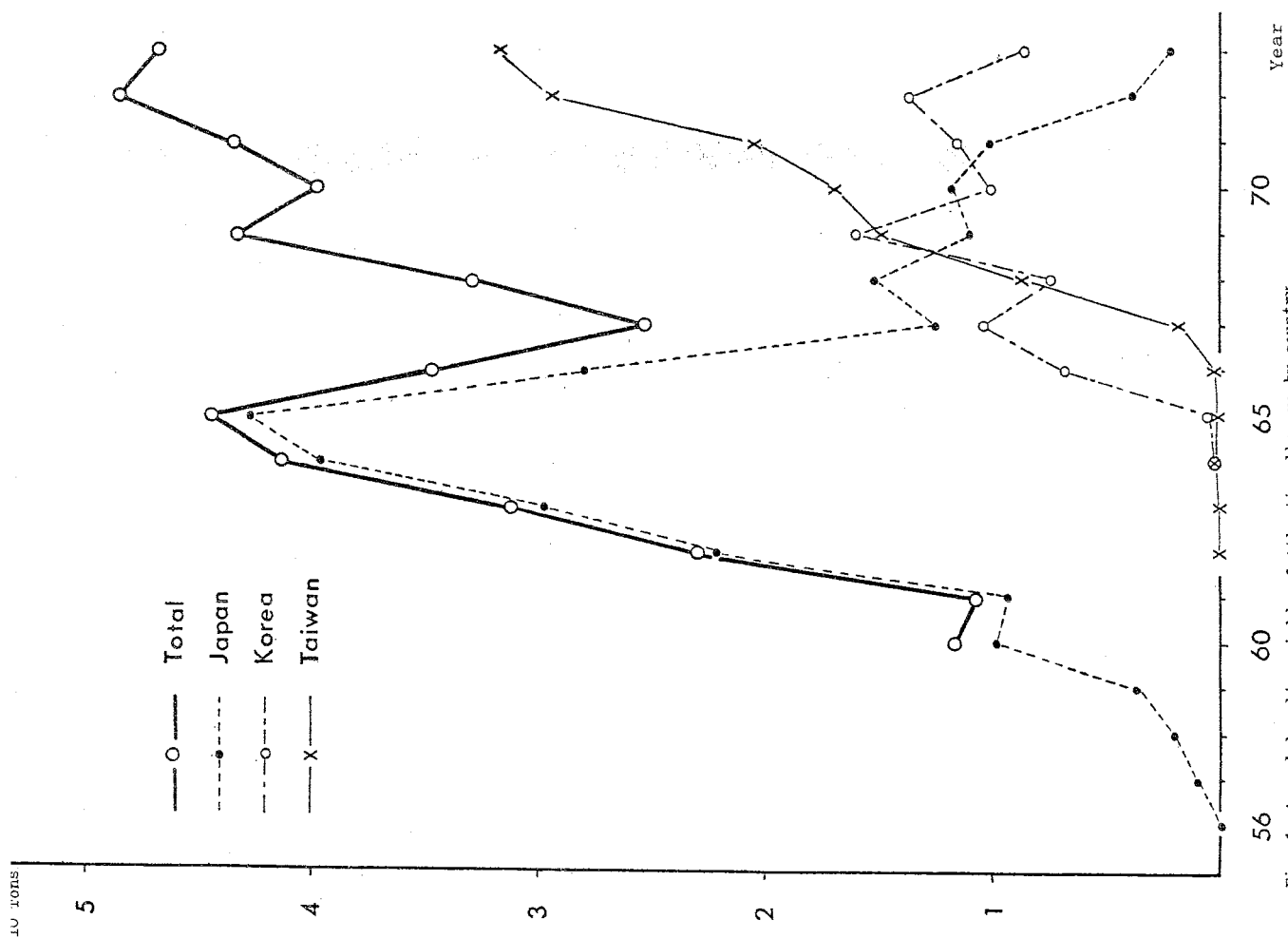


Fig. 1 Annual longline yields of Atlantic albacore by country.

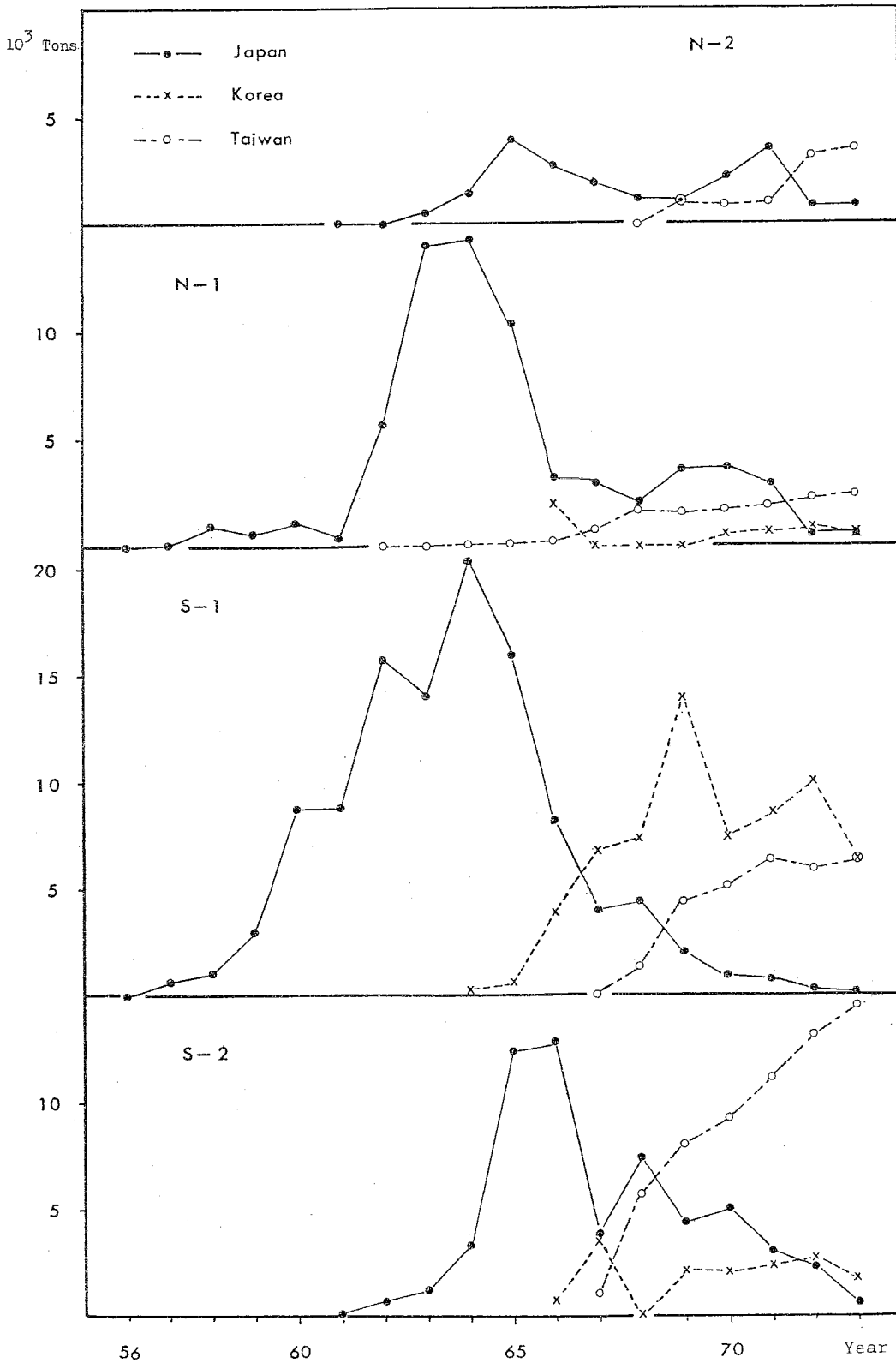


Fig. 2 Annual longline yields of Atlantic albacore by area and by country.

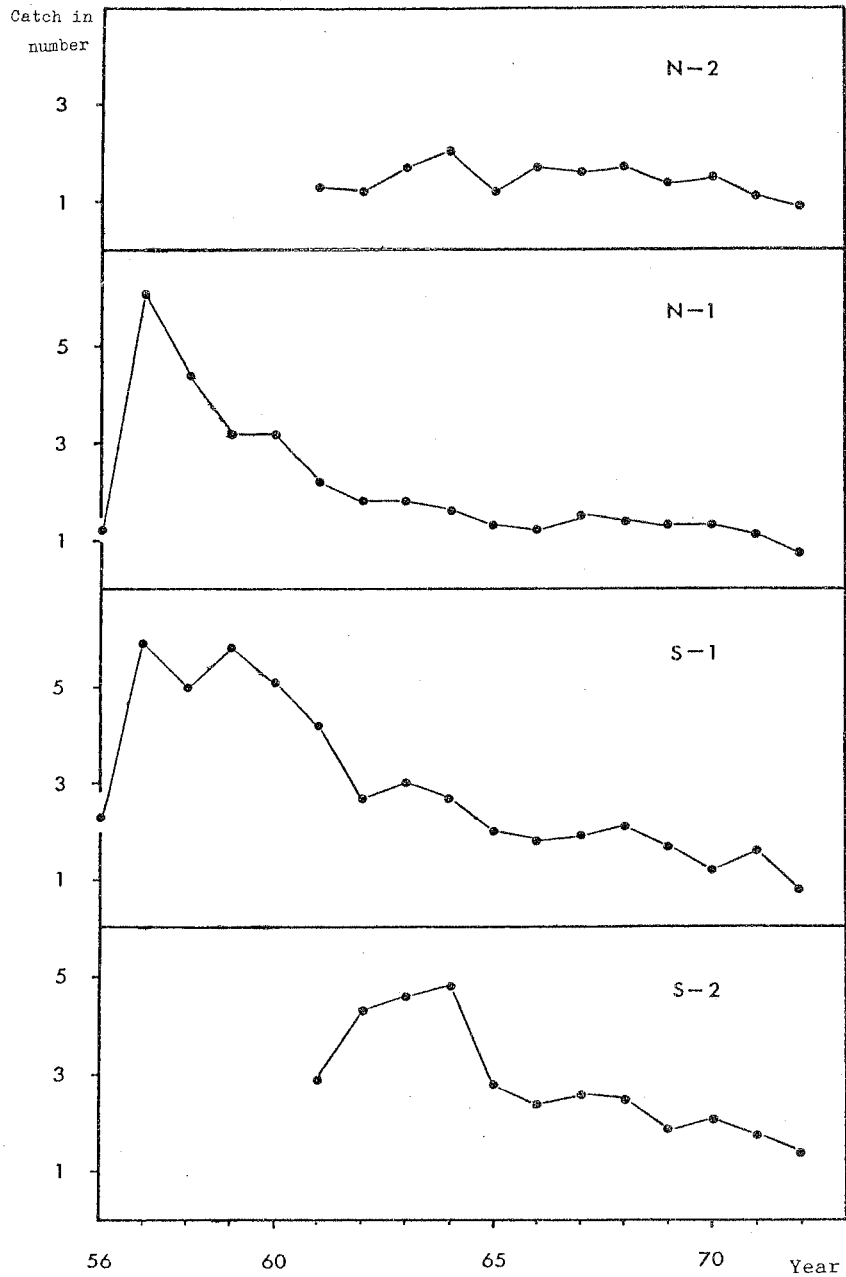


Fig. 3 Annual change of catch in number per unit effective effort (100 hooks) of Japanese fleet by area.

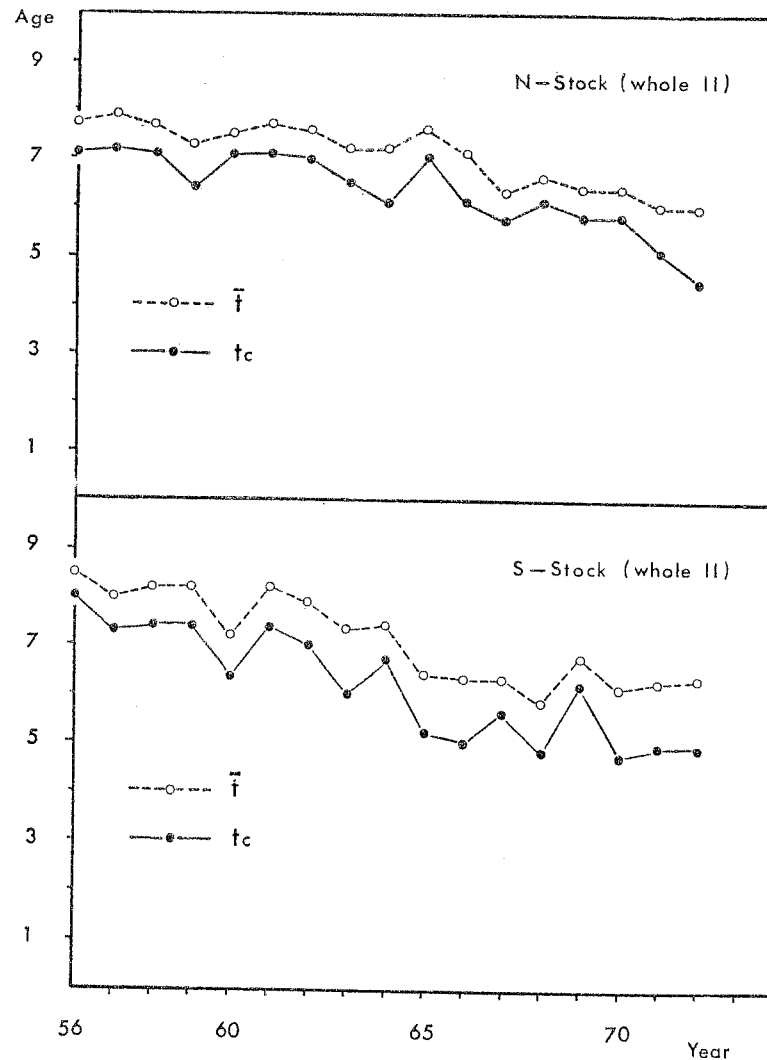


Fig. 4 Annual change of the mean age of catch (\bar{t}) and the mean ages at first capture (t_c) of the Atlantic aibacore stocks, N and S, for whole longline fisheries.

Table 1. Division of the progress of albacore longline fishery in the Atlantic Ocean, based on Shiohama (1971) and Figs. 1-3.

Period	Years	Characteristic
I	1956-1961	Annual fishing effort of longline fishery was increasing gradually. Albacore were caught mainly in S-1 area. The interest of longline fleet on albacore was fairly low.
II	1962-1966*	Japanese fleet expanded its fishing ground from lower latitudes to higher latitudes with a rapid increase of albacore catch. The fishing interest on albacore was relatively on higher level.
III	1966*-1971	Remarkably decreasing Japanese albacore catch was being replaced with the rapid increase of the catch by Taiwanese and Korean fleet, especially that by the former. The main albacore fishing ground of Japanese fleet was in S-2 area. The Korean and Taiwanese fleets were operating mainly in the southern hemisphere.
IV	1972 onward	Further decline of Japanese fishing effort, catch and cpue of albacore was marked in overall areas. The concern of Japanese fleet on albacore was on the lowest. Taiwanese and Korean fleets invested more effort on the south stock than on the north stock.

Table 3 Annual mean ages of catch (\bar{t}) and mean ages at first capture (t_c) of the Atlantic albacore stocks by each of the Japanese and whole longline fishery.

year	N - stock						S - stock					
	\bar{t}		t_c		modal age		\bar{t}		t_c		modal age	
	Japan	Whole	Japan	Whole	Japan	Whole	Japan	Whole	Japan	Whole	Japan	Whole
1956	7.65		7.07		7		8.52		8.04		8	
1957	7.93		7.21		7		8.02		7.34		7	
1958	7.65		7.07		7		8.20		7.35		7	
1959	7.25		6.42		6		8.20		7.35		7	
1960	7.50		7.07		7		7.20		6.39		6	
1961	7.65		7.07		7		8.20		7.35		7	
1962	7.56	7.56	6.95	6.95	7	7	7.86	7.87	6.98	6.98	7	7
1963	7.18	7.18	6.45	6.45	6	6	7.20	7.34	5.98	5.99	6	6
1964	7.19	7.19	6.05	6.05	6	6	7.43	7.43	6.75	6.73	7	7
1965	7.57	7.57	6.95	6.95	7	7	6.28	6.35	5.10	5.15	5	5
1966	6.93	7.08	6.07	6.13	6	6	6.04	6.26	5.00	5.04	5	5
1967	6.31	6.32	5.73	5.73	6	6	6.18	6.29	5.32	5.60	6	6
1968	6.47	6.57	5.98	6.07	6	6	5.57	5.75	4.92	4.83	5	5
1969	6.47	6.44	5.81	5.81	6	6	6.30	6.71	5.54	6.23	6	7
1970	6.40	6.43	5.79	5.79	6	6	5.43	6.05	4.71	4.67	5	5
1971	5.99	6.00	5.13	5.13	5	5	5.70	6.23	4.98	4.93	5	5
1972	5.66	6.00	4.68	4.52	5	5	4.43	6.25	4.99	4.93	5	5
1973												
I (56 - 61)	7.49		7.02		7		7.84		7.04		7	
II (62 - 66)	7.27	7.46	6.77	6.78	7		6.87	6.91	6.21	6.25	7	
III (66 - 71)	6.42	6.46	5.79	5.81	6		5.87	5.41	4.92	4.86	5	

Table 4 Total mortality coefficient (Z) and an average effective effort of successive years (f) in N-1 area, 1961-1968.

year	f $\times 10^3$	Z
1961 - 62	8,075	0.47
1962 - 63	21,829	0.48
1963 - 64	37,159	1.18
1964 - 65	37,143	0.84
1965 - 66	24,140	0.59
1966 - 67	15,537	0.40
1967 - 68	13,023	1.06