# A HYPOTHESIS ON POPULATION STRUCTURE OF YELLOWFIN TUNA IN THE ATLANTIC OCEAN, MAINLY BASED ON LONGLINE DATA

by

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## SUMMARY

Examination of previous studies reveals the following features in the structure of the population of yellowfin tuna in the Atlantic Ocean:

(1) there are two concentrations in the eastern and western equatorial waters, separated in the northern winter and continued in the summer,

(2) presence of heterogeneity within the eastern concentration, and,

(3) seasonal migration of fish from the Indian Ocean to the southwestern waters of Africa.

Morphometric and genetical surveys should begin with materials taken in the northern winter. Tagging experiments in eastern Atlantic surface fisheries will provide a clue to relate the apparent concentrations.

The stock assessment should be based on the three alternative assumptions on population structure:

(1) A single group in the whole Atlantic Ocean except southeastern waters,

(2) An overwhelmingly dominating local group in the equatorial waters,

(3) Two local groups in the equatorial waters separated by a line - Long. 30º W.

It may be necessary to divide the eastern Atlantic into more than one subarea for assessing the surface stocks.

## RESUME

L'examen des études antérieures permet d'observer les aspects suivants de la population d'albacore dans l'Atlantique:

(1) la présence de deux concentrations dans les eaux équatoriales orientales et occidentales, séparées pendant l'hiver (hémisphère nord) et réunies pendant l'été,

(2) le fait que la concentration orientale présente une certaine hétérogénéité, et

(3) la migration saisonnière du poisson de l'Océan Indien à l'extrémité sud de l'Afrique.

Des études morphométriques et génétiques se baseront sur des données relevées pendant l'hiver (hémisphère nord). Des expériences de marquage dans les pêcheries de surface de l'Atlantique Oriental fourniront les renseignements permettant de déterminer les relations qui existent entre les concentrations observées.

L'évaluation des stocks devrait se baser sur trois suppositions concernant la structure des populations:

(1) l'existence d'un groupe unique dans l'Atlantique entier, à l'exception des eaux sud-orientales,

(2) la prédominance d'un groupe local très important dans les eaux équatoriales,

(3) l'existence dans les eaux équatoriales de deux groupes locaux délimités par 30º O de longitude.

Il sera peut-être nécessaire de diviser l'Atlantique Oriental en plus d'un secteur pour évaluer les stocks de surface.


RESUMEN

El examen de estudios anteriores revela las siguientes características en la estructura de la población de rabil en el Oceano Atlántico:

(1) que existen dos concentraciones en aguas del este y del oeste ecuatorial, separadas durante el invierno (hemisferio Norte) y mezcladas durante el verano.

(2) una heterogeneidad en la concentración oriental, y

(3) la migración estacional de los peces del Oceano Indico al extremo sureste de Africa.

Deberán realizarse estudios morfométricos y genéticos con datos obtenidos durante el invierno (hemisferio Norte). Los experimentos de marcado llevados a cabo en las pesquerías de superficie del Atlántico oriental sin duda proporcionarán algún indicio para relacionar las aparentes concentraciones.

La evaluación de los stocks deberá estar basada en los tres posibles supuestos de la estructura de la población:

(1) Un grupo homogéneo en todo el Oceano Atlántico excepto en aguas del Sudeste.

(2) Un grupo local muy predominante en aguas ecuatoriales.

(3) Dos grupos locales en aguas ecuatoriales separados por una línea Long. 30º W.

Puede resultar necesario dividir el Atlántico oriental en más de una subzona para evaluar los stocks de superficie.

## Introduction

The Standing Committee on Research and Statistics, SCRS, of the International Commission for the Conservation of Atlantic Tunas, ICCAT, at its second meeting held just before the Second Commission Meeting in autumn 1971, decided to formulate, by June 1972, working hypotheses on structure of yellowfin tuna population in the Atlantic Ocean in order to expedite studies for rational utilization of this important living resources. Population structure of the yellowfin tuna is, among others, difficult to identify. Going through the literatures so far available, it is noted that disagreement in conclusion is apparently caused by the difference in the techniquesof investigation, source of data, and concept of population structure. Therefore, it is necessary to summarize what kinds of data were analyzed and what concepts were applied to the analysis of population structure. The present note reviews such information mainly on longline fishery. Another note by Dr. J. C. Le Guen will present comparable information chiefly from surface fishery.

## Summary of information so far obtained

Previous studies were based on (1) distribution of catch and its seasonal change, (2) year-to-year fluctuation in the amount of catch, or (3) geographical variations in morphometric characters. More direct studies based on population genetic techniques or tagging experiments have started recently but are still at very beginning stages.

Materials were taken by longline and surface fisheries, except larvae collected by plankton nets. The longline fishery operates in wide extent of the ocean, aiming at adult fish scattering in sub-surface layers, while the surface fishery develops in the eastern equatorial waters where the fish, mostly young and immature, are liable to aggregate near the sea surface.

The results seem to coincide with each other in the following findings:

(1) two concentrations in the eastern and western equatorial waters,
(2) presence of heterogeneity within the eastern concentration, and,
(3) seasonal migration of the fish from the Indian Ocean to the southern tip of Africa.

However, no evidence was obtained to conclude whether these heterogeneities represent genetical segregation among the population of this species.

(Table 1, Fig. 1).

## Concepts of population structure

Good many data did not provide clear information on population structure of the species in the Pacific Ocean compared to that of albacore or bluefin tuna which are based on same or less amount of information. According to Honma and Hisada (1971), the difficulty in the study of yellowfin tuna is caused by indistinct segregation by developmental and maturation stages. They consider that the wide and long spawning activity results rahter complicated st structure such as complex of "semi-independent groups" suggested by Kamimura and Honma (1963). Further knowledge on life history will contribute to make this concept more concrete.

Joseph et al. (1964) examined two problems in their study on the Pacific yellowfin: one is segregation between the eastern tropical waters and the western waters, and the other is segregation within the eastern tropical waters. Their study suggests that there must be some segregation not only between the eastern and western Pacific but also within these regions. Examination of concepts may solve apparent confusion among biologists having analyzed different kinds of data on different concepts. The most remarkable example is found in literatures on the southern bluefin tuna. According to Shingu (1967, 1970), Australian scientists defines three separate "stocks" among youngs taken by surface fishery in the neritic waters, while information from longline fishery shows that fish of this species spawn only off northwestern Australia, stay their first few years of life around the continent, and then disperse throughout the higher latitude during immature stage and also feeding phase of adult stage. He explains the apparent disagreement by introducing two concepts of population structures. The species population consists of only a single local group that is defined as an aggregation of individuals segregated from the others throughout the life span. This may account to Marr's(1957) subpopulation, if genetical separation is identified. On the other hands, the long-lasting spawning may result two or more space-time groups that are aggregations of individuals separated from the others only at early stage of life history, probably corresponding to elementary groups by Levedev (1958). These concepts in yellowfin population will be more clearly defined according to the progress of study on life history.

## Proposed survey programs

The ICCAT and the member countries have planned several surveys including tagging, serology and biochemistry, parasites, morphometries and general life history(ICCAT 1971). The SCRS's Sub-Committee on Stock Identification stressed continuation and expansion of tagging and the other surveys on the surface fishery in the eastern equatorial Atlantic. As to the hypothetical two local groups suggested by concentrations of the longline fishery, Honma

two local groups suggested by concentraions of the longline fishery, Honma and Hisada (1971) described three possible phenomena from morphometric and population genetic characters and tagging experiment over the whole equatorial waters.

(1) Some morphometric characters of samples taken in northern winter, when the two concentraions are separated, may reveal geographical difference. The difference detected in the winter may appear as a cline along the equator during northern summer.

(2) Blood type and other genetical characters may also show the geographic and seasonal variations ~~observed from~~ expected for the morphometric surveys.

(3) The most practical area for tagging experiment is the Gulf of Guinea where live-bait boats chatch youngs belonging to the eastern concentration. Tagged fish must be recaptured in the coastal waters during the year of release. Next year, the immatures may be found in wider part of the surface fishing grounds and probably also in longline fishing grounds. There is possibility that adults would be recaptured by longline fishery as west as northern Brasil.

~~According~~ According to the experience in the eastern Pacific, however, it is not sure that the longline gear catches effectively the tagged fish as the surface gear does (see Bi-monthly Reports of IATTC, 1971).

## Tentative division of the Atlantic Ocean for assessment of yellowfin tuna stocks

It is then proposed from the review mentioned above that further assessment of the stocks of this species in the Atlantic Ocean should be made on the assumptions of three possible population structures as listed below:

(1) A single local group in the whole Atlantic Ocean except south-eastern waters.

(2) A single local group in the equatorial waters.

(3) Two local groups in the equatorial waters separated by Long. 30°W, $E_E$ and $E_W$ in Fig. 2.

It may be necessary to divide the eastern Atlantic into more minor areas for assessing the surface stocks.

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Table 1. Summary of previous works on population structure of yellowfin tuna in the Atlantic Ocean

| Author(s) | Techniques and data sources | Major findings |
|---|---|---|
| Le Guen et al. (1965) | (1) Catch distribution and its seasonal change in surface fishery.<br>(2) Geographical and seasonal change of size composition of surface catch. | The same fish may appear in the waters between São Thomé and Pointe-Noire during July through November |
| Le Guen and Poinsard (1966) | Catch distribution and its seasonal change in surface fishery. | Yellowfin tuna is distributed throughout the year in the Gulf of Guinea. |
| Wise and Le Guen(1966) | (1) Catch distribution and its seasonal change in longline fishery.<br>(2) Geographical difference of yearly amount of longline catch. | Two stocks present in the eastern and western Atlantic Ocean. |
| Zharov(1967) | Catch distribution and its seasonal change in longline and surface fisheries. | Small sized fish along Africa show seasonal migration between Cape Verde and Gulf of Guinea.<br>Four groups in longline fishery are suggested but they may intermingle with each other. Their habitats are; west Africa, southern waters off South America, Caribbean Sea to northeast of South America, and Gulf of Mexico. In addition, fish originated in the Indian Ocean appears southern coast of South America. |
| Baudin Laurencin and Marchal(1968) | Morphometric characters of surface catch in the Gulf of Guinbaumetric characters of | Lengths of fins and body parts show discontinuity in relative growth curve on body length at the length of 80 cm corresponding to maturation. |
| Le Guen et al. (1968) | (1) Catch distribution and its seasonal change in surface fishery.<br>(2) Geographical change of size composition of surface catch in Gulf of Guinea. | Both live-bait boats and purse seiners aim the same stocks of fish, even though the major fishing seasons differ depending on fishing gear. |
| Richards(1969) | Catch distribution and its seasonal change in longline and surface fisheries, and in larval collection by plankton net. | Adults enter into Gulf of Guinea and spawn there in warm season of a year. Larvae and youngs stay there for a year, and then move down as south as Angola in northern winter and returen to Gulf of Guinea in summer. Fish older than two-age move to central Atlantic. |

| | | |
|---|---|---|
| Yang et al. (1969) | Morphometric characters of longline catch in equatorial waters. | Geographical differnce is distinct. The difference is larger along south-north direction than along east-west direction. |
| Baudin Lauroncin (1971) | Parasite infestation in surface catch in Gulf of Guinea. | Infestation rate and species of parasites indicate three ecological stocks in Gulf of Guinea. |
| Honma and Hisada(1971) | (1) Catch distribution and its seasonal change in longline and surface fisheries.<br><br>(2) Body length and gonad weight of longline and surface catch.<br><br>(3) Distribution of larvae. | (1) Catches of immatures and adults in the longline fishery segregates into eastern and western parts in northern winter, but continue in summer.<br><br>(2) Youngs and immatures appear throughoutta year in the Gulf of Guinea.<br><br>(3) Larvae occur continuously in the South Equatorial Current, Brasil Current, Gulf Stream and adjacent waters.<br><br>(4) Two groups are suggested in longline fishery. But it is not concluded that they are definitly separated in the propagation. |

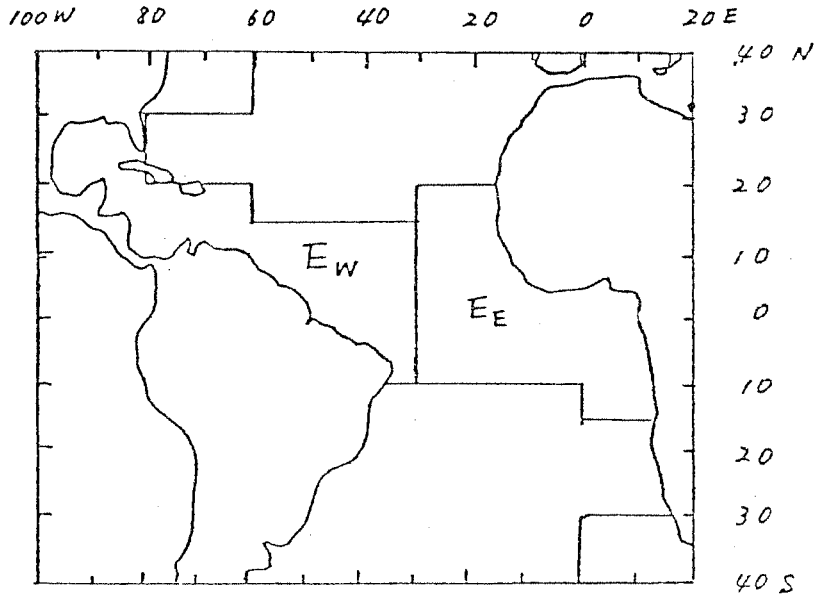


Fig. 2. Possible division of the Atlantic Ocean for stock assessment of yellowfin tuna.

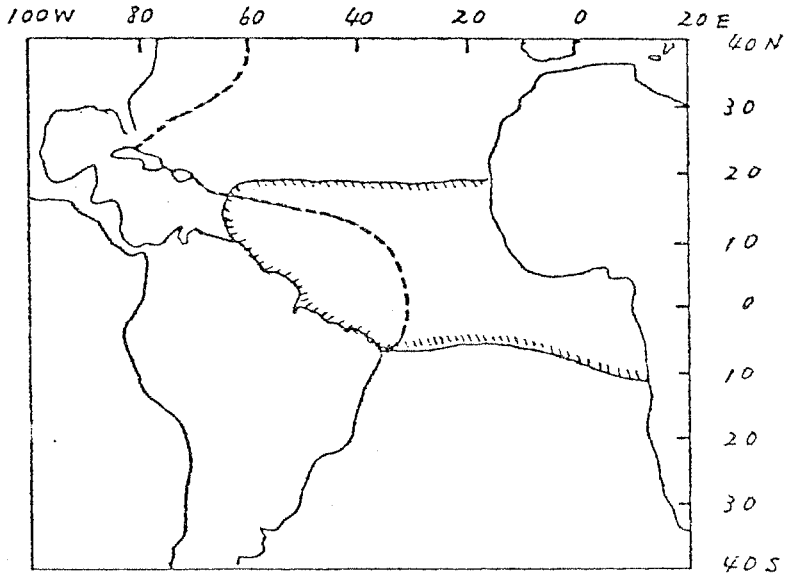


Fig. 1. Schematic representation of two concentrations of yellowfin tuna in longline fishery in the Atlantic Ocean.

Distribution range of eastern concentration

Distribution range of western concentration