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# ON THE BIOLOGICAL CHARACTER OF LONGFIN TUNA (Thunnus alalunga Gmelin) CONCENTRATIONS IN THE SOUTH-WEST, SOUTH-EAST, AND SOME OTHER AREAS OF THE ATLANTIC OCEAN.

THESES

to the Paper by V.L. Zharov

# On the Biological Character of Longfin Tuna (Thunnus alalunga Gmelin) Concentrations in the South-West, South-East, and Some Other Area of the Atlantic Ocean.

The paper presents the material on observations carried out by a number of soviet research expeditions to the Atlantic Ocean.

Information on concentration density, size-and-weight composition, distribution of fish by stages of maturity, indices of stomach filling, and occurrence of various food items in the stomachs is given for all five areas under investigations for the period of 1965-1970. Fishing of longfin tuna was made by the standard longline which in some instances had been sunk into the layers optimum for this species dwelling. The greatest density of concentration was observed the area of South-WEst Atlantic.

The data on different aspects of biology, distribution and fishing of longfin tuna are common in literature. Principal information is given as the synopses of the International Meeting on Tunas hold in 1962 (Idyll and Sylva, 1962; Jaeger, 1962; Postel, 1962; Talbot and Penrith, 1962; Mather, 1962; Squire, 1962 a,b) in La Jolla.

In our opinion, it is noteworthy among the recent papers the most important ones: Beardsley (1969); Le Guen, Baudin-Laurencin (1969); Jang, Nose, Higama (1969), Jang (1970).

Nevertheless, we believe many aspects of life cycle of this species, especially those knowledge on which is necessary for fisheries, to be at least rather poor studied. Additional data are required for more detailed description of these.

From this point of view it is interesting to bring out to many related workers the results of observations carried out by a number of soviet tuna-research expeditions. This paper is not aimed at comprehensive conclusions or at detailed discussion of different aspects of longfin tuna biology. It is principally dedicated to brief interpretation of the data collected which, in our opinion, can be used in the future investigations of generalized character.

Besides the author, the following scientists of AtlantNIRO participated in the collection and preliminary treatment of the data: K.Ya. Bataliantz, V.A. Lukin, A. Mena, N.F. Paliy, N.V. Titova, V.N. Chur.

## MATERIAL AND METHODS

Five areas of the Atlantic Ocean were studied altogether.

Area I — The open sea, to the north of Bahamas (May-July 1968; 15 specimens of tuna).

Area II — Northern Guinea Gulf (0°N-6°N, 4°W-10°W; April 1965, 15 specimens of tuna).

Area III — Southern Guinea Gulf (7°S-15°S, 8°E-14°E; August-September 1966; 32 specimens of tuna).

Area IV — South-East Atlantic (19°S-29°S, from African continental shelf edge to 9°E; 19 April - 9 May 1970; 99 specimens of longfin tuna).

Area V — South-West Atlantic (13°S-26°S, from South America continental shelf edge to 25°W; 30 November-19 December 1968; 136 specimens of tuna).

Pelagic longline of Japanese type (main line of kuralon, distance between hooks - about 50 m, number of hooks in the basket - 5) was used for tuna fishing in all 5 areas, the most favourable water layers (from the standpoint of knowledge available on the optimum parameters of depth and hydrological features) for longfin tuna dwelling being fished in the areas IV and V, and in the rest of the areas longline was used mainly in the surface water layers (yellowfin tuna concentrations were fished).

In each specimens caught the length to the nearest 1 cm (from the tip snout to the end of middle caudal rays), the weight to the nearest 1 kg, gonadal development, stomach filling degree, and food clot composition were measured.

Measuring board fixed on deck was used for the length measurements and when measuring specimens' size of integral number of centimeters and a part more than 0.5 cm were transferred to the next size - class (for example, 112.6 cm - 113 cm); those less than 0.5 and equaled to 0.5 cm were tranferred to smaller class (for example, 112.4 cm and 112.5 cm - 112 cm).

For weight measuring lever balance with maximum load up to 150 kgs, and to the nearest 0.1 kg was used. Fishes with weight of integral number of kilograms and more than 0.5 kg were transferred to greater size-class (for example, 15.6 kgs. - 16 kgs.); those less than 0.5 kg and equaled to 0.5 kg were transferred to smaller one (for example, 15.4 kgs. and 15.5 kgs. - 15.0 kgs.).

When determing the state of development of sexual products there was used six-grade scale accepted in the soviet fisheries investigations which is interpreted by the following:

I - immature fish, the sex of which impossible to define by naked eye; II - mature fish which either have never spawned, or their gonads have been in rest. It is possible to determine the sex by naked eye, but there are no sighs of sexual products development; III - gonads are in the beginning of their maturation, the testis starts increasing by size, but does not occupy yet the whole free space in the body cavity, the ovocytes are in the initial phase of trophoplasmatic growth in the ovaries; IV - the end of maturation, but there are no signs of spawning, the testis occupies the whole free space in the body cavity and is filled with viscous sperm, the ovocytes are in the final phase of trophoplasmatic growth in the ovaries, but there are no indices of hydrotization and ovulation, V - sexual products

are running in the gonads, the spawning takes place; VI - the gonads have the traces of recent spawning of the next portion of eggs (in this case the next portion may be in the stages III or IV), or that of all the portions of sexual products (in this instance the gonad turns into the stage II).

Feeding intensity of fish was determined by five-degree scale where 0 - the food is absent from the stomach, I - traces of food in the stomach, 2 - the stomach is filled less than by half of its volume, the stomach is filled with food more than a half, but not to an extent of full volume, 4 - the stomach is filled with food to a maximum extent, its walls are extended, sometimes the part of the food is in the pharynx, gullet or even in the buccal cavity.

The mean index of stomach filling was calculated by the formula : $A = \frac{P_1 \cdot n1 + P_2 \cdot n_2 + P_3 n + P_4 n_4}{N}$ ,

where A - mean index;

$P_1$ , $P_2$ , $P_3$ , $P_4$ - index value (1,2,3,4);

$n_1$ , $n_2$ , $n_3$ , $n_4$ , - number of fish having stomach with a certain index of filling;

N - total stomachs examined.

## RESULTS OF OBSERVATIONS

Information (in tabular form) on fish concentration density (catch as specimens per 100 hooks of a longline), size-weight composition, distribution of fish by stages of maturity and indices of stomach filling, and on the occurrence

of different food items in the stomachs is presented for each area.

Area I. The open sea to the north of Bahamas. Period of work - from May till July 1968. Concentration density is from 0.04 to 0.11 sp. per 100 hooks of a longline.

Size of fish (table I and 2) varied between 90 and 122 cm (mean - 101.00 cm), and weight varied between 15.5 and 38.5 kgs. (mean value - 23.4 kgs) which confirms the fact that in this area adult specimens constituting the main body of spawning stock, as well as young maturing fish were fished.

Extent of gonadal maturity (Table 3) confirms this suggestion and testifies to the second one consisting in the fact that the beginning of longfin tuna spawning is observed in the area in the above mentioned period. Sex ratio is 11: 2 .

Feeding intensity (Table 4) of tunas was low in the area (most specimens had empty stomachs; mean index of filling was 0.64). This was the evidence of unfourable conditions for feeding in the area.

Area II Northern Guinea Gulf (0°N-6°N, 4°W-10°W). Working period - April 1965. Density of concentration - 0.8 specimens per 100 hooks of a longline.

Size of fish (Tables 5 and 6) varied between 36 and 112 cm (average - 93.3 cm). Weight varied between 2.6 and 26 kgs. (average - 17.7 kgs.), that is mainly young and growing fish were present in the area, and adult specimens were not abundant.

Gonadal distribution by stages of maturity (Table 7) suggests the spawning in this area or in the vicinity. Sex ratio is 7:8.

Ratio of empty and filled stomachs was 1:2 (normal feeding intensity), and the main items of food clot were cephalopods (mainly squids) and fishes of Myctophidae and Alepisauridae families.

Area III. Southern Guinea Gulf (7°S-15°S, 8°E-14°E). Working period - from August to September 1966. Density of concentrations is 0.7 fish per 100 hooks of a longline.

Length of fish (Table 8) varied between 76 and 95 cm (average - 85.19 cm), average weight was 13.0 kgs. This is evidence of presence of mainly young and moreover growing individuals in the area. This suggestion is confirmed by the data on the extent of gonadal maturity (in August 66% of fish had gonads in stage II, and the rest of fish had gonads in stage III; in September 100% of fish had gonads in stage III). These fishes were the representatives of growing year-class which was ready to recruit the spawning stock.

Information on feeding intensity and food composition of fish from this area is lacked.

Area IV. South -East Atlantic (19°S-29°S, from the edge of African continental shelf to 9°E). Working period - from 19 April till 9 May 1970. Number of longline settings - 12. Density of concentration (average) is 1.42 fish per 100 hooks.

In our opinion, the longline was sunked into the optimum layers for longfin tuna dwelling.

Size of fish (Tables 9 and 10) varied between 49 and 106 cm (average size was 85.4 cm). Weight of fish varied between 2.3 and 26.5 kgs. (average value - 13.5 kgs.), the main body of concentrations being fish of growing year-class.

Among all the fish immature individuals constituted 11.9%, individuals with gonads in stage II - 69.1%, and specimens with gonads in stage III - 19.0 %. Sex ratio was 39:36. Feeding intensity of fish was high in the area (Table 11), average index of stomach filling being 1.35. The main food items were different crustacean, squids and fishes of Trichiuridae family. Fishes of Sternoptichidae, Bramidae and Myctophidae families were the secondary food objects.

Area V. South-West Atlantic (13°S-26°S, from the edge of South America shelf to 25°W). Working period - from 30 november till 19 December 1968. Density of concentrations was between 1.5 and 4.0 individuals per 100 hooks of a longline. The longline hooks were sinked into the water layers optimum for longfin tuna dwelling.

Size of fish varied (Tables 12 and 13) between 95 and 120 cm (average - 27.28 kgs.), that is the main body of concentration consisted of adult fish of spawning stock. It is interesting to note that average length and weight of fish in longline catches increased from the coast towards the open sea.

Basing on the gonadal maturity (Table 14) we may consider longfin tuna spawning to be over in this area.

Feeding intensity of fish was high (average index of filling - 1.30), and the main body of their food was composed of squids, various crustacean and fish of Brotulidae and Berycidae families.

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Table 1.

SIZE COMPOSITION OF FISH FROM THE AREAI

| Length variants (cm) | 81-90 | 91-100 | 101-110 | 111-120 | 121-130 | N |
|---|---|---|---|---|---|---|
| Number of specimens | I | 7 | 6 | - | I | 15 |
| (%) | 6.7 | 46.6 | 40.0 | - | 6.7 | 100 |

Table 2.

Weight Composition of Fish from the Area I

| Weight variants (kgd) | 16-20 | 21-25 | 26-30 | 31-35 | 36-40 | N |
|---|---|---|---|---|---|---|
| Number of specimens | 6 | 6 | 2 | - | 1 | 15 |
| (%) | 40.0 | 40.0 | 13.3 | - | 6.7 | 100 |

Table 3

Extent of Gonadal Maturity of Fish from the Area I

| Stage of maturity | I | II | III | IV | V | VI | N |
|---|---|---|---|---|---|---|---|
| No.of specimens | 6 | I | 4 | - | - | 2 | 13 |
| (%) | 46.1 | 7.7 | 30.8 | - | - | 15.4 | 100 |

Table 4

Stomach Filling of Fish from the Area I

| Index of filling | 0 | I | 2 | 3 | 4 | N |
|---|---|---|---|---|---|---|
| No. of specim. | 7 | 2 | I | I | - | 11 |
| (%) | 64.0 | 18.0 | 9.0 | 9.0 | - | 100 |

Table 5

Size composition of fish from the area II

| Length variants (cm) | 31-40 | 41-80 | 81-90 | 91-100 | 101-110 | 111-120 | 121-130 | N |
|---|---|---|---|---|---|---|---|---|
| No. of specimens | I | - | 2 | 8 | 3 | 1 | - | 15 |
| (%) | 6.7 | - | 13.3 | 53.3 | 20.0 | 6.7 | - | 100 |

Table 6

Weigth composition of fish from the area II

| Weight variants (kgs) | 1 - 10 | 11-20 | 21-30 | N |
|---|---|---|---|---|
| No. of specimens | 1 | 9 | 5 | 15 |
| (%) | 6.7 | 60.0 | 33.3 | 100 |

Table 7

Gonadal maturity of fish from the area II

| Stage of gonadal maturity | I | II | III | IV & V | VI | N |
|---|---|---|---|---|---|---|
| No. of specimens | 1 | 2 | 7 | - | 5 | 15 |
| (%) | 6.7 | 13.3 | 46.7 | - | 33.3 | 100 |

Table 8

Size composition of fish from the area III

| Length variants (cm) | 76-80 | 81-85 | 86-90 | 91-95 | N |
|---|---|---|---|---|---|
| No. of specimens | 2 | 16 | 12 | 2 | 32 |
| (%) | 6.3 | 49.4 | 38.0 | 6.3 | 100 |

Table 9

Size composition of fish from the area IV

| Length variants (cm) | 46-50 | 51-70 | 71-75 | 76-80 | 81-85 | 86-90 | 91-95 | 96-100 | 101-105 | 106-110 | N |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of specimens | I | - | 3 | 7 | 40 | 30 | 11 | 3 | 3 | 1 | 99 |
| (%) | 1.0 | - | 3.0 | 7.1 | 40.5 | 30.3 | 11.1 | 3.0 | 3.0 | 1.0 | 100 |

Table 10

Weight composition of fish from the area IV

| Weight variants (kgs) | 2-3 | 3-4 | 5-6 | 7-8 | 9-10 | 11-12 | 13-14 | 15-16 | 17-18 | 19-20 | 21-22 | 23-24 | 25-26 | 27-28 | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of specimens | 1 | - | - | 2 | 7 | 24 | 21 | 15 | 7 | 5 | 3 | - | 1 | 1 | 87 |
| (%) | 1.1 | - | - | 2.3 | 8.0 | 27.8 | 24.3 | 17.2 | 8.0 | 5.7 | 3.4 | - | 1.1 | 1.1 | 100 |

Table 11

Stomach filling of fish from the area IV

| Index of filling | 0 | 1 | 2 | 3 | 4 | N |
|---|---|---|---|---|---|---|
| No. of specimens | 18 | 28 | 31 | 7 | 1 | 85 |
| (%) | 21.3 | 33.0 | 36.3 | 8.2 | 1.2 | 100 |

Table 12

Size composition of fish from the area V

| Length variants (cm) | 91-95 | 96-100 | 101-110 | 111-115 | 116-120 | 106-110N | N |
|---|---|---|---|---|---|---|---|
| No. of specimens | 1 | 13 | 54 | 28 | 7 | 33 | 136 |
| (%) | 0.7 | 9.6 | 39.6 | 20.6 | 5.2 | 24.3 | 100 |

Table 13

Weight composition of fish from the area V

| Weight variants (kgs) | 21-22 | 23-24 | 25-26 | 27-28 | 29-30 | 31-32 | 33-34 | 35-36 | 37-38 | N |
|---|---|---|---|---|---|---|---|---|---|---|
| No. of specimens | 6 | 26 | 27 | 25 | 18 | 13 | 13 | 7 | 1 | 130 |
| (%) | 4.4 | 19.1 | 19.9 | 18.9 | 13.2 | 9.6 | 9.6 | 5.1 | 0.7 | 100 |

Table 14

Gonadal stage of maturity in fish from the area V

| Stage of maturity | I | II | III | IV | V | VI | N |
|---|---|---|---|---|---|---|---|
| No. of specimens | - | - | 9 | 13 | - | 114 | 136 |
| (%) | - | - | 6.6 | 9.6 | - | 83.8 | 100 |

Table 15

Stomach filling in fish from the area V

| Index of filling | 0 | 1 | 2 | 3 | 4 | N |
|---|---|---|---|---|---|---|
| No. of specimens | 11 | 60 | 37 | 4 | - | 112 |
| % | 9.8 | 53.6 | 33.0 | 3.6 | - | 100 |