

STUDIES OF FRIGATE TUNA AUXIS THAZARD (LACEPEDE) AGE AND GROWTH IN THE EASTERN PART OF THE EQUATORIAL ATLANTIC *

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SUMMARY

This paper deals with the problem of frigate tuna (Auxis thazard) (Lacepede) age determination. Based on the investigations carried out in 1982-1984, one of the possible ways for solving this problem is put forward. To study the age and growth rate, the use of cross-sections of the first dorsal fin ray is suggested. The marks showing the regularity of the fish growth amounting to a year's time are most distinct there. The obtained results were compared to the data calculated from the von Bertalanffy equation. They showed good agreement. The back-calculation data on growth indicate that frigate tuna achieve a length of 22.9 cm during their first year of life, 30.4 cm in the third year and 40.4 cm in the fourth year.

RESUME

Le document traite du problème de la détermination de l'âge de l'auxide Auxis thazard (Lacepede). Sur la base des recherches menées à bien durant la période 1982-1984, une des solutions éventuelles pour résoudre ce problème est donnée. Pour étudier le taux de l'âge et de la croissance, on recommande d'utiliser la coupe transversale du premier rayon de la nageoire dorsale. Les marques qui montrent la régularité de la croissance du poisson jusqu'à une période d'un an sont très distinctes à cet endroit. Les résultats obtenus ont été comparés avec les données calculées à partir de l'équation de Bertalanffy. Ils concordent assez bien. Les données de rétro calcul sur la croissance indiquent que l'auxide atteint une longueur de 22,9 cm au cours de sa première année de vie, 30,4 cm dans la troisième année et 40,4 cm dans la quatrième.

RESUMEN

Este documento trata sobre el problema de la determinación de la edad de la melva Auxis thazard (Lacepede). En base a investigaciones efectuadas en 1982-1984, se presenta una de las formas posibles para resolver este problema. Para estudiar la edad y tasa de crecimiento, se sugiere utilizar los cortes trasversales de la primera aleta dorsal, ya que es ahí donde son más nítidas las marcas que muestran la regularidad del crecimiento del pez hasta un año. Los resultados obtenidos se comparan con los datos calculados a partir de la ecuación de Bertalanffy, y mostraron buena coherencia. Los datos retrocalculados sobre crecimiento indican que la melva alcanza la talla de 22.9 c. durante su primer año de vida, 30.4 cm. en el tercer año y 40.4 cm. en el cuarto.

* Not to be cited without reference to the author

The tunas Auxis thazard (Lacepede, 1802) and Auxis rochi (Risso, 1810) are rather numerous among the Atlantic tunas, but the least studied. Large catches of the frigate tuna Auxis thazard are taken in the equatorial Atlantic waters with the purse-seines, together with the other tuna species (yellowfin, skipjack and little tunny). Very limited data exist on the biology and the age of this species in particular.

MATERIALS AND METHODS

The material was collected on board the commercial tuna purse-seiners in January through June period in 1982-1984 in the eastern part of the equatorial Atlantic. To determine the age of the frigate tuna the preparations were made according to the method suggested by Gaikov and Chur (1980). The cross-sections of the first dorsal fin ray, approximately 1 mm thick, were examined in passing light in a drop of the spirit-glycerine mixture under the microscope MBS-1, with magnification $\times 2$. A total of 322 cross-sections was examined. The distance between growth marks was measured with the ocular-micrometer, and the body length recorded was from the tip of the snout to the end of the middle caudal fin rays.

In fin ray cross-sections the following structural formations can be distinguished: feebly marked nucleus, porous center of a ray and alternating dark and light zones, which are considered to be growth zones. Porous center is absent or hardly visible in fin ray cross-sections of small individuals (25 cm or less).

Growth zones were easily readable in 20% cross-sections, not distinctly marked in 55%, and feebly marked in 25% due to availability of a great number of additional rings observed mainly in tunas of older age groups.

A total of 237 cross-sections was chosen for back calculation of growth rate. Back calculations were made using the method of empirical scales (Bryuzgin, 1969). The comparison of size composition of males and females taken for ray sampling did not reveal any significant difference between their length fre-

quences (fig. 1). This allows for using mixed materials in the analysis.

RESULTS

Formation of dark and light zones in fin ray cross-sections from the frigate tuna, as from the other tunas, is obviously the result of variation in growth rate caused by several reasons: change of hydrological conditions, feeding intensity or spawning. Slackened growth of tunas is marked in fin ray cross-sections by appearance of a light zone, and intensive growth by appearance of a broader dark zone. In this connection the analysis of dark and light growth zones edging the cross-section was made (table 1).

Most probably, the light zone is laid in June (probably in May-June) in the majority of individuals. This apparently can be related to unfavourable living conditions during that period, which has been confirmed by reducing fishery. Laying of light rings in the adult fish might be connected with spawning, because the tuna aggregations are mostly spawning in the considered period (fig. 2). Fishes 20 to 26 cm in length captured in June had the first light zone on the fin ray cross-section edge.

Thus, in January, the majority of fish had a light zone on the fin ray cross-section edge, and in June a zone of slow growth was found. One dark and one light zones were taken as an annual growth mark in our calculations. The calculations revealed a close correlation between the body length of tunas and the central cross-section radius. A linear dependence was observed between the cross-section radius length and the body length. The correlation factor between these factors is 0.97 according to our data. There exists a linear dependence between the cross-section radius length and the body length (fig. 3). The calculated regression equation is as follows: $r = 0.731 - 4.98$, where r is the cross-section radius (points of ocular-micrometer). l - is the size of tuna, cm.

From the back calculation data on the frigate tuna growth a length-age key was constructed (table 2). A curve of the frigate tuna growth constructed from the back calculation data is depicted

ted in fig. 4. In the first year of life the frigate tuna reaches 22.9 cm in length, in the second - 30.4 cm, in the third 36.7 cm, and in the fourth - 40.4 cm. Rather close values were obtained by Konstantinjuk and Chur (1976).

According to the back calculation data the Bertalanfi equation parameters were calculated from:

$$L_t = L_{\infty} (1 - e^{-k(t-t_0)}),$$

where L_t is the length of the frigate tuna at a certain age;
 L_{∞} is the maximum length of the frigate tuna;
 k is the slackening growth rate;
 t_0 is the theoretical age, at which the fish length is zero;

The values of the Bertalanfi equation parameters are:
 $L_{\infty} = 51.47$ cm, $k = 0.32$, $t_0 = 0.83$. From the comparison of the frigate tuna length at a certain age calculated according to Bertalanfi equation with the actual data the comparable data were obtained (table 3).

SUMMARY

The study of possibilities of determination of the frigate tuna age from the cross-section of the dorsal fin rays has demonstrated the reliability of this method.

The alternating dark and light zones found in the ray cross-sections and showing the growth of the frigate tuna during the year make it possible to determine the age and to make back calculations of the growth rate in more than 70% of cases. It has been revealed that the light zone corresponds to the period of the slackened growth, and is laid in March-June. The dark zone corresponds to the period of intensive growth. One dark and one light zones are assumed to be an annual cycle for the frigate tuna. The growth back calculation data indicate that the frigate tuna length averages to 22.9 cm in the first year of life, to 30.4 cm in the second year, to 36.7 cm in the third year and to 40.4 cm in the fourth year of life. The comparison between the frigate tuna length

at a certain age calculated from the Bertalanfi equation, and the actual average data yielded the comparable data. The parameters of the Bertalanfi equation are as follows:

$$L_{\infty} = 51.47 \text{ cm}; \quad K = 0.32; \quad t_0 = -0.83.$$

REFERENCES

1. Bryuzgin V.L., 1969. The method of studying the fish growth from scales, bones and otoliths. Kiev, "Naukova dumka".
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Table 1

Distribution of dark and light zones of growth.

Month	Light		Dark		Total
	sp.	%	sp.	%	
January	3	4	67	96	70
February	22	37	38	63	60
March	14	33	29	67	43
April	8	26	26	74	34
June	23	88	3	12	26

Table 2
Length-age key for the frigate tuna

Length class, cm	Age (years), %				Total, sp.
	1	2	3	4	
15-16	100				1
17-18	100				3
19-20	100				20
21-22	100				23
23-24	100				32
25-26	75	25			28
27-28	23	77			43
29-30		100			48
31-32		93	7		40
33-34		56	44		48
35-36		14	86		73
37-38			88	14	48
39-40			57	43	56
41-42			29	71	21
43-44				100	5
45-46				100	1
Total, sp.	100	162	167	51	490
Mean size	22.9	30.4	36.7	40.4	
Sq. deviation	1.33	1.27	1.10	0.89	

Table 3
Theoretical and actual values
of the frigate tuna length

Age	1	2	3	4
Actual length, cm	22.86	30.41	36.66	40.36
Theoretical length, cm	22.85	30.69	36.38	40.51
Deviation	+0.01	-0.28	+0.28	-0.15

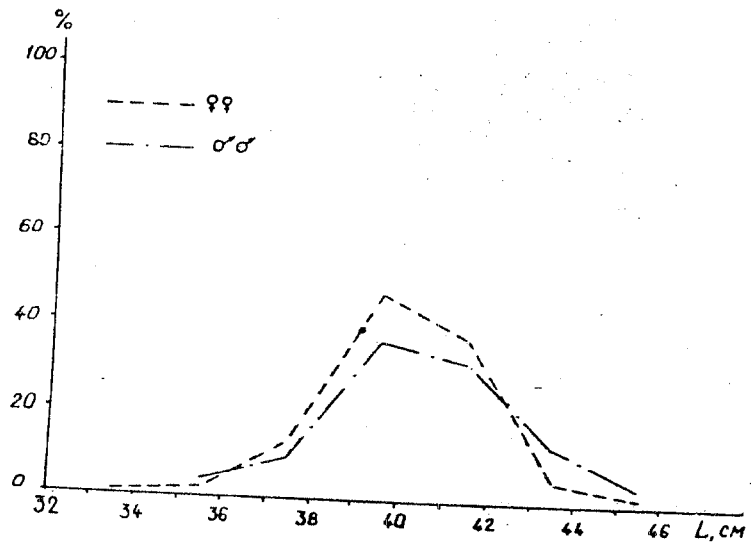


Fig. 1. Size composition of the frigate tuna males and females.

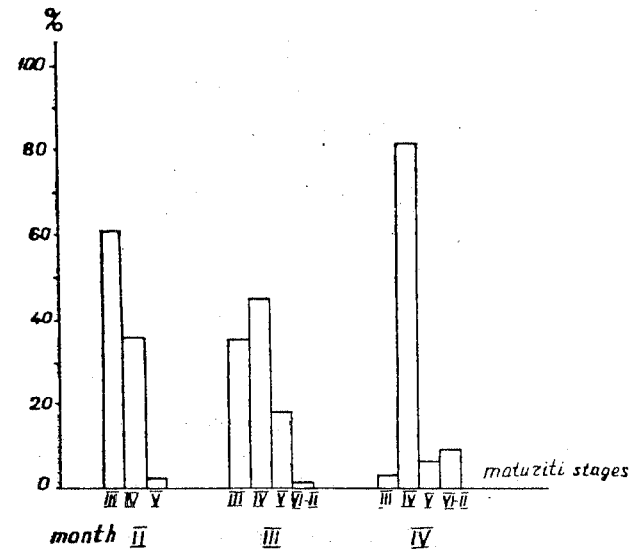


Fig. 2. Maturity stages of the frigate tuna females.

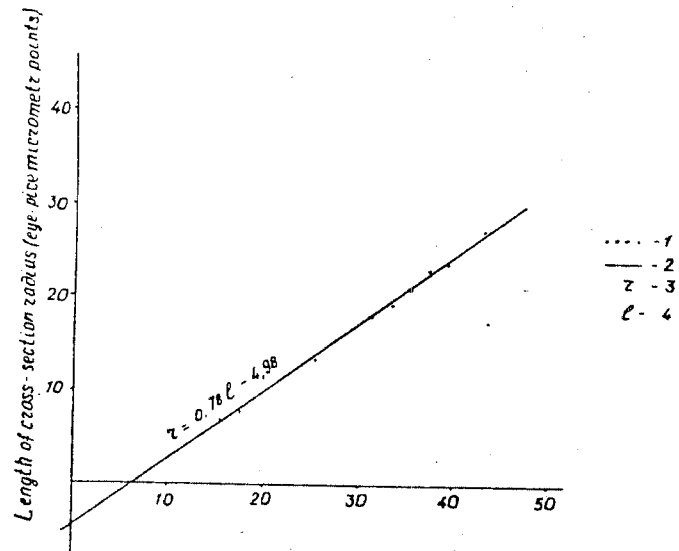


Fig. 3. A ratio of the body length to the central radius of the frigate tuna ray cross-section;

- 1 - empiric value,
- 2 - theoretical regression line.

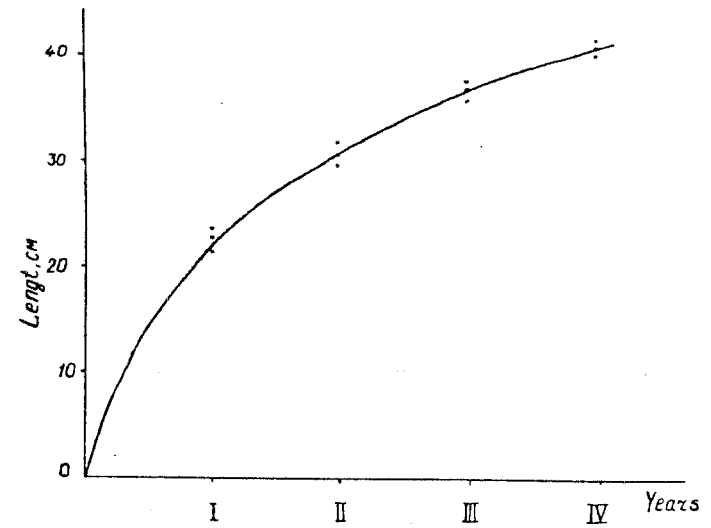


Fig. 4. A curve of the frigate tuna growth from the growth back calculation data. Vertical segments show mean square deviation (\pm).