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in

Bridges C.R. (ed.), García A. (ed.), Gordin H. (ed.).
Domestication of the bluefin tuna *Thunnus thynnus thynnus*

Zaragoza : CIHEAM
Cahiers Options Méditerranéennes; n. 60

2003
pages 123-125

Article available on line / Article disponible en ligne à l'adresse :

<http://om.ciheam.org/article.php?IDPDF=3600108>

To cite this article / Pour citer cet article

Megalofonou P., Platis K., De Metrio G., Santamaria N. **Age estimation of juvenile bluefin tuna, *Thunnus thynnus*, from the Mediterranean sea.** In : Bridges C.R. (ed.), García A. (ed.), Gordin H. (ed.). *Domestication of the bluefin tuna *Thunnus thynnus thynnus**. Zaragoza : CIHEAM, 2003. p. 123-125 (Cahiers Options Méditerranéennes; n. 60)



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Age estimation of juvenile bluefin tuna, *Thunnus thynnus*, from the Mediterranean Sea

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SUMMARY – The sagittae of juvenile bluefin tuna captured in the Mediterranean Sea were prepared using sectioning and immersion in Methylbenzoate reinst. Counts of presumed daily growth increments were performed. Estimated ages ranged from 15 to 162 days of fish ranging in size from 8.5 to 55.5 cm fork length. A growth rate of 4.5 cm/day for the range of size of the fish was estimated. Most of the back calculated spawning days were found in June, July and August.

Key words: Age, growth, otoliths, bluefin tuna, Mediterranean.

RESUME – "Estimation de l'âge de thons rouges juvéniles, *Thunnus thynnus*, provenant de la mer Méditerranée". Les sagittae de thons rouges juvéniles capturés dans la mer Méditerranée ont été préparés par sectionnement et immersion dans du benzoate de méthyle. On a évalué les augmentations présumées de la croissance journalière. Les estimations allaient de 15 à 162 jours d'âge pour des poissons dont la taille variait de 8,5 à 55,5 cm de longueur à la fourche. On a estimé un taux de croissance de 4,5 cm/jour pour la classe de taille de ces poissons. La plupart des jours de ponte calculés remontaient à juin, juillet et août.

Mots-clés : Age, croissance, otolithes, thon rouge, Méditerranée.

Introduction

Skeletal hard parts such as fin spines, otoliths and vertebrae have been used to study age and growth of Atlantic bluefin tuna (Compeán-Jimenez and Bard, 1983; Lee *et al.*, 1983; Cort, 1991), however, information on age estimates of the early growth stages of this fish is limited (Brothers *et al.*, 1983; Radtke and Morales-Nin, 1989; Megalofonou and De Metrio, 2000). In this study, we used the otoliths to estimate the age and growth of juvenile bluefin tuna sampled from the Mediterranean Sea and test if estimated spawning dates are consistent with the observed times of gonad maturation and occurrence of bluefin tuna larvae in the plankton.

Materials and methods

Juveniles of bluefin tuna were collected from purse seine boats fishing small pelagic fishes in the Aegean, Adriatic, Ionian and Tyrrhenian Seas. Fork length (FL) measurements were taken to the nearest millimeter and weight (RW) to the nearest gram. Place and date of capture were also recorded. Sagittae were removed from a total of 106 specimens, weighed to the nearest μg and measured for length and width to the nearest μm . Then, they were prepared for age reading following two methods: (i) observation after sectioning and (ii) observation after immersion in Methylbenzoate reinst ($\text{C}_8\text{H}_8\text{O}_2$, Merck) for three days. Counts of presumed daily growth increments performed at 250 to 630 magnifications were used to estimate age and growth. Otolith ages were corrected by adding 4 days to total counts (Brothers *et al.*, 1983). This correction implies that the first counted increment was formed 4 days after spawning or fertilization. The birthday of each individual was back-calculated from the date of capture and the estimated age.

Results and discussion

Bluefin tuna ranged from 8.5 to 55.5 cm in fork length and weighed from 7.5 to 3000 g. Their sagittae were small, quite complex calcified structures with elongated form. Summary statistics of sagittae weight, length and width are shown in Table 1.

Table 1. Summary statistics of sagittae measurements

	N	Mean	S.D.	Min	Max
Left otolith					
Length (mm)	49	6.11	1.74	1.74	8.08
Width (mm)	51	2.05	0.36	1.11	2.56
Weight (mg)	50	6.96	3.44	0.10	13.50
Right otolith					
Length (mm)	49	6.42	1.47	1.86	8.08
Width (mm)	52	2.02	0.28	1.09	2.34
Weight (mg)	54	8.56	10.15	0.10	78.00
All					
Length (mm)	98	6.27	1.61	1.74	8.08
Width (mm)	103	2.03	0.32	1.09	2.56
Weight (mg)	104	7.79	7.70	1.10	78.00

Preliminary examination under the light microscope revealed the optically dense core near the sulcus, surrounded by fine, apparently daily, increments. Immersion in methyl benzoate or sectioning enhanced the light microscopy images of sagittae. The age of individual fish was determined by counting the increments and assuming that each corresponded to a day. The estimated ages were from 19 to 164 days. The average growth rate for each individual, calculated from length at estimated age was 4.8 ± 1.1 mm per day and the average growth rate, calculated from weight at estimated age was 17.3 ± 8.4 g per day.

The relationship between estimated ages and length of fish was studied. A sigmoid regression model of age versus fork length (Fig. 1A) yielded the best fit ($FL = \exp(4.3 - 46.3/\text{age})$, $r^2 = 0.86$). The estimated spawning dates indicated that most of the specimens were born during June, July and August (Fig. 1B). These dates coincide with increased gonadal activity in adult bluefin tuna (EU project 97/029) and the appearance of bluefin larvae in the Mediterranean Sea (Piccinetti and Piccinetti Manfrin, 1993).

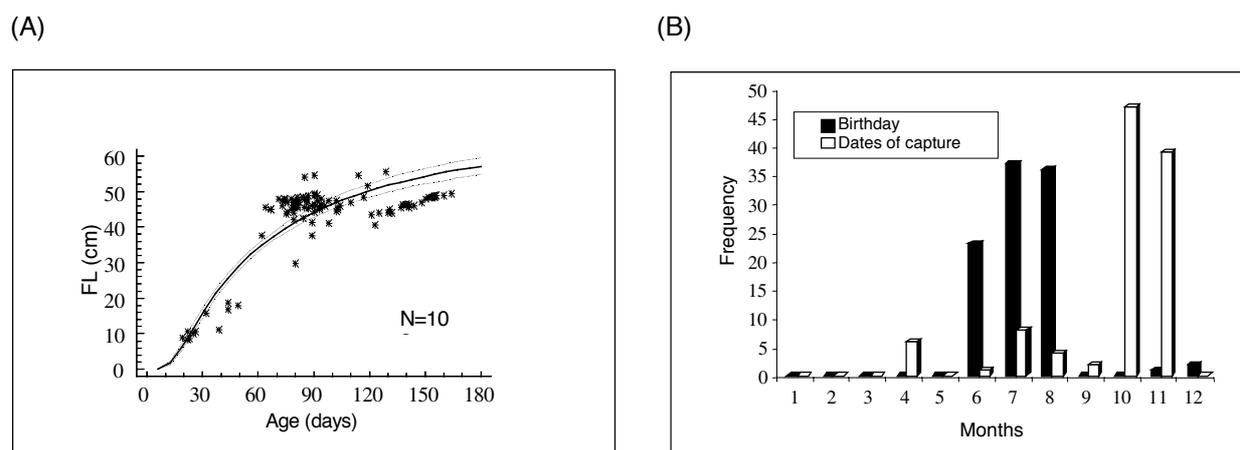


Fig. 1. (A) Relationship between estimated ages (days) and fork length (FL) of bluefin tuna. (B) Dates of capture and back calculated spawning dates.

Acknowledgements

This study was made possible by the financial aid from the European Community. Project 96/93 DG XIV/C1.

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