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FIRST RESULTS ON THE AGING OF JUVENILE SWORDFISH, *XIPHIAS GLADIUS* L., FROM THE MEDITERRANEAN SEA, USING OTOLITHS

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ABSTRACT

Age estimates were made on juvenile swordfish, *Xiphias gladius* L., from the Mediterranean Sea using otoliths. Increments were observed in a transverse plane of sectioned sagittae with light and scanning electron microscopy. Counts of these increments were made for age estimation. Estimated ages ranged from 87 to 147 days for fish ranging in size from 51 to 74 cm. A growth rate of 2.3 mm/d within the size interval analyzed was calculated.

INTRODUCTION

The swordfish, *Xiphias gladius* L., occurs widely in the Mediterranean Sea and supports important commercial fisheries. However, a lack of biological data, particularly on age and growth rates, does not permit a definitive assessment of the status of the resource.

Attempts at age estimation of swordfish from the Mediterranean have been made using size frequency analysis (De Metrio and Megalofonou, 1987) and anal fin spine sections (Megalofonou and De Metrio, 1989), but age determination of swordfish is still in its developmental stages.

The objective of this study was to estimate the age and the growth of young swordfish from information contained in otoliths.

MATERIALS AND METHODS

A total of 26 small swordfish were collected during commercial albacore operations in the Gulf of Taranto in the autumm of 1987. Eviscerated weight in Kg, lower jaw fork length (LJFL) in cm and date of capture were recorded for each fish.

Otoliths were removed, cleaned, dried and embedded in epoxy resin (Spurr, 1969). The embedded sagittae were ground in a transverse plane through the core region on 220, 400 and 600 grit wet-dry emery paper and polished against a piece of Microcloth containing 0.3 micron alumina polishing compound.

Sections were examined at 600 to 1500x with an Olympus BH2 compound microscope adapted for video viewing. Continuous increment counts from the core to the margin of the antirostrum were made from the video monitor. Otolith readings were performed by two independent readers and the precision of the counts was assessed (Beamish and Fournier, 1981). Four sections were also examined with scanning electron microscopy for which they were decalcified with 5% EDTA, (pH 7.6) and coated with gold.

Counts of presumed growth increments were used to estimate the age and growth. An average percent error of 2.1% was calculated for the two repetitive series of determinations and with that information, the average age was calculated for each fish. Artificial fertilization and hatching of the Mediterranean swordfish (Yasuda <u>et al</u>., 1978) showed that the eggs hatched from 60 to 70 hours after fertilization at water temperatures ranging from 22.5 to 23.6 C. This information was used to estimate the age after fertilization and the increment counts were adjusted by adding a factor of 3 days to the increment count.

RESULTS

Swordfish length (LJFL) ranged from 51 to 74 cm while weight was from 0.51 to 2.78 kg.

The presumed daily growth increments were clearly and easily distinguished along a counting path from the core to the edge of the antirostrum and variability in their width was clearly observable (Figure 1). There was a zone of about 10 increments which began outside the core with an average width of 4.8 micron. That zone was followed by another area af about fifty wider increments with an average thickness of 5.6 micron. Beyond this point increment widths averaged 4.6 micron and continued to the tip of the antirostrum. This indicates differential otolith growth during presumed different developmental periods.

Estimated ages ranged from 87 to 147 days. The average growth rates for all the period of life of each individual, calculated from length at estimated age, ranged between 4.6 and 6.7 mm per day with an average value of 5.7 mm per day.

The regression analysis of age against LJFL (r=0.71, a=35.8, b=0.23) and weight (r=0.80, a=2.0, b=0.03) gave the best correlation coefficients for the linear model. The slope of 0.23 indicates a growth rate of 2.3 mm/d within the size interval analyzed (Figure 2).

Estimated spawning dates were from June 27 to August 25. Most of the specimens (85.7%) were spawned in July and especially during the first fifteen days of the month (Figure 3).

DISCUSSION

In recent years, otolith microstructure examination has found an increasing number of applications in a wide range of species (Campana and Neilsen, 1985). Otolith microstructure studies, mainly of the larval and juvenile stages, have confirmed that daily increments can be used to successfully estimate age and growth rates of fishes (Rice <u>et al</u>., 1985; Secor <u>et al</u>., 1989).

In our observations of the sagitta sections, both under the light microscope and with the SEM, we clearly recognized fine increments like those Wilson and Dean (1983) described on Atlantic swordfish otoliths. They were similar to daily increments described for other species (Tanaka <u>et al</u>., 1981; Dean <u>et al</u>., 1983; Campana and Neilsen, 1985) and we hypothesize that swordfish post-larvae and juvenile otoliths have all the microstructural characteristics that correspond to daily increment growth features. Therefore, we used the increment counts to estimate the age and the growth rates for the individual fish.

We do not have direct validation of the growth increments for this study, so we attempted to verify them with indirect methods. Two lines of evidence are used to compare our results with other available data on the early life history of swordfish.

Estimated spawning dates from our analysis occurred during the months of June, July and August. Most of the estimated spawning dates were in July and were concentrated in the first 15 days of the month (Figure 3). These results are in complete agreement with examinations of the maturity stages of swordfish gonads collected from commercial fishery during the year (Megalofonou et al., 1987) and the seasonal appearance of swordfish larvae in the Mediterranean. Spawning generally takes place from June through August with the peak in early July (Sella, 1911; Sanzo, 1922; Cavaliere, 1963; De Metrio et al., 1988).

Another method we used to verify the estimated juvenile ages was to compare this data with those estimated by length frequency analysis from the same population. Modal analysis suggested that the swordfish between 55 and 65 cm captured in the Gulf of Taranto during autumm are less than one year old (60-90 days) (De Metrio and Megalofonou, 1987). Our results indicate that the juvenile swordfish captured during the autumm (October and a few in December) in the Gulf of Taranto, ranging in size from 51 to 74 cm, are juvenile individuals of a few months with estimated ages of from 87 to 147 days.

Average growth rates estimated indicate that swordfish have a rapid growth during their early life history. However, the whole pattern of growth in larval and juvenile stages is not clear. The regression analysis for swordfish within the size interval 51-74 cm showed that growth in this range was linear with a slope of 0.23 corresponding to a growth rate of 2.3 mm per day. We have not yet examined samples of smaller or larger swordfish from the Mediterranean. The information available on swordfish growth rates during their larval, post larval and juvenile stages is very limited. De Metrio and Megalofonou (1987) indicated that the average size of one year old swordfish is about 97.5 cm with an average growth rate of 2.7 mm/d.

The results of this study indicate that growth increments can be used to estimate the age of young swordfish and help clarify some aspects of juvenile swordfish growth. It is not yet possible to draw definitive conclusions about the whole pattern of growth in larval and juvenile stages. However, we believe that further studies on otoliths, from both smaller and larger individuals, can provide the information necessary to form a better understanding of the growth of larval and juvenile swordfish.

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LITERATURE CITED

BEAMISH, R.J. and D.A. FOURNIER; (1981). A method for comparing the precision of a set of age determinations. Can. J. Fish. Aquat. Sci. Vol. 38, pp. 982-983.

CAMPANA, S.E., and J.D. NEILSEN; (1985). Microstructure of fish otoliths. Can. J. Fish. and Aquat. Sci. Vol 44, pp. 1922-29.

CAVALIERE, A.; (1963). Studi sulla biologia e pesca di Xiphias gladius L. Nota II. Boll. Pesca Piscic. Idrobiol. Vol. 18, pp. 143-170.

DEAN, J.M., C.A. WILSON, P.W. HAAKE, and D.W. BECKMAN; (1983). Microstructure features of teleost otoliths. pp.353-359. in P. Westbrock and E.W. deJong (ed). Biomineralization and biological metal accumulation. D.Reidel pub.CO., 1)Ordrecht, The Netherlands.

DE METRIO, G. and P. MEGALOFONOU; (1987). Catch,size distribution, growth and sex ratio of sworfish (Xiphias gladius L.) in the Gulf of Taranto. FAO Fisheries Report No. 394. pp. 91-102.

DE METRIO, G., P. MEGALOFONOU, S. TSELAS and N. TSIMENIDES; (1988) Fishery and Biology of the Swordfish, Xiphias gladius, L., 1758 in Greek waters. FAO Fisheries Report No. 412. pp. 135-145.

MEGALOFONOU, P., G. DE METRIO and M.C. LENTI; (1987). Eta' e dimensioni di prima maturita' sessuale del pesce spada Xiphias gladius L. Atti della S.I.S. VET. Vol. XLI - Parte I. pp. 234-237.

MEGALOFONOU, P. and G. DE METRIO; (1989). Stima dell'eta' e dell'accrescimento di Xiphias gladius L. del mar Egeo mediante lo studio dei raggi spiniformi della pinna anale. XXI Congresso Societa' Italiana di Biologia Marina. Riasunti. Comunicazioni comitato necton e pesca. Fano 11-16 Settembre 1989. pp.40.

RICE, J.A., L.B. CROWDER, and F.P. BINKOWSKI; (1985). Evaluating otolith analysis for bloater, Coregonus hoyi: do otoliths ring true? Trans. Am. Fish Soc. Vol. 114, pp. 532-539.

SANZO, L.; (1922). Uova e larve di Xiphias gladius. Mem. R. Comit. Talassogr. Ital., Vol. 7, pp. 97-97.

SELLA, M.; (1911). Contributo alla conoscenza della riproduzione e dello sviluppo del pesce spada (Xiphias gladius L.). Mem. R. Comit. Talassogr. Ital., Vol 2, pp. 1-16.

SPURR, A.R.; (1969). A low-viscosity epoxy resin embedding medium for electron microscopy. J.Ultrastructure Res. Vol. 26, pp. 31-43.

TANAKA, K., Y. MUGIYA and J. YAMADA; (1981). Effects of photoperiod and feeding on daily growth patterns in otoliths of juvenile Tilapia nilotica. Fish. Bull. Vol. 70, pp. 459-466.

WILSON, C.A. and J.M. DEAN; (1983). The potential use of sagittae for estimating age of Atlantic swordfish, Xiphias gladius. U.S. Dept. Commer., NOAA Tech. Rep. NMFS.Vol. 8, pp. 151-156.

YASUDA, A., H. KOHNO, A. YATSU, H. IDA, P. ARENA, F. Li GRECI and Y. TAKI; (1978). Embryonic and early larval stages of the swordfish, Xiphias gladius, from the Mediterranean. Journ. Tokyo Univ. of Fisheries, Vol. 65 (1) , pp. 91-97.

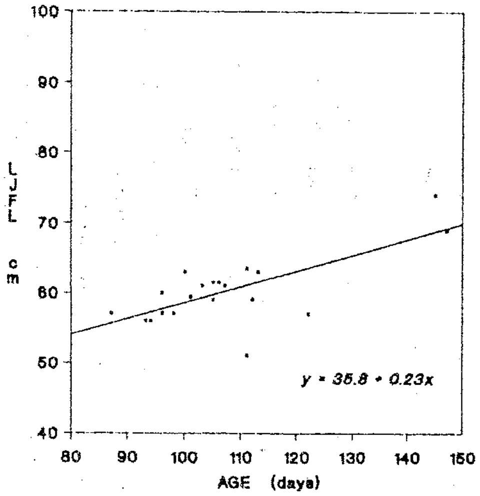

Fig 2 Age-length relationship

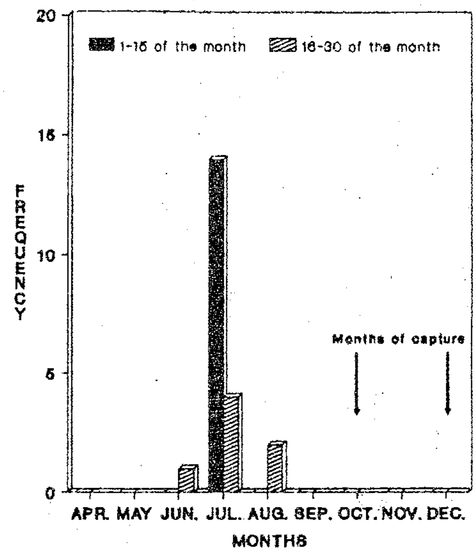

Fig.3 Estimated spawning dates

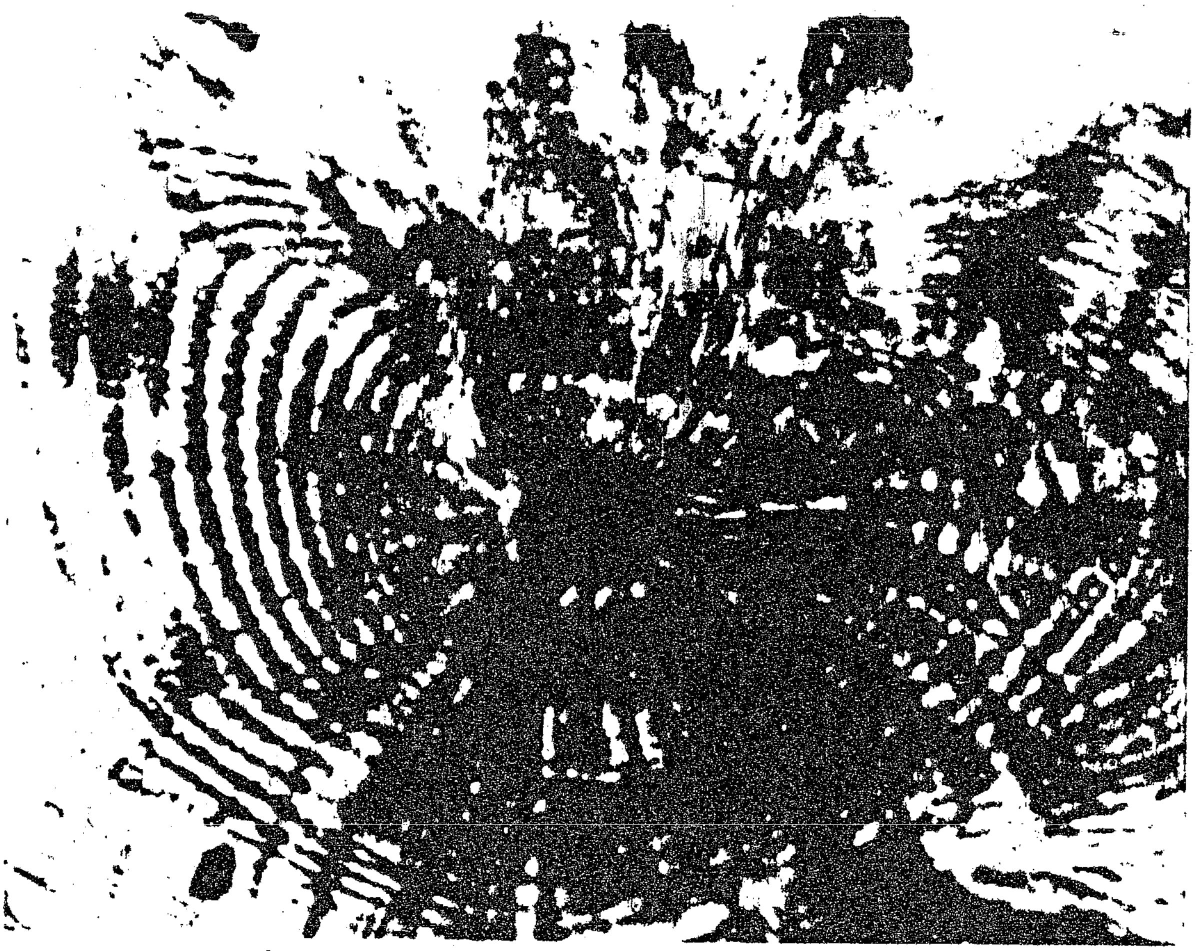

Fig. 1. Growth increments near to the core observed with light microscopy (1000x).