LUNAR CYCLES OF OTOLITH GROWTH IN THE JUVENILE SILVER SCABBARDFISH (*LEPIDOPUS CAUDATUS*)

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Abstract
Otolith analysis was performed on the silver scabbardfish (*Lepidopus caudatus*) in the northern Aegean Sea in order to examine whether the growth zones that appeared between the nuclear area and the otolith edge in fish aged less than a year old, are related to the lunar cycle. The number of these zones ranged between 1 and 13 and was highly correlated with fish length. The periodicity of the zone formation was attributed to the lunar cycle. This hypothesis was validated by comparing the assigned birth of each fish to the spawning of adult population.
Keywords : Aegean Sea, Teleostei, Growth, Deep Waters, Fish Behaviour.

Introduction
The silver scabbardfish, *Lepidopus caudatus*, is a benthopelagic species living along the continental shelf and upper slope. It is a schooling species that lives close to the bottom during the day and migrates into midwater at night [1]. Growth analysis on the northern Aegean population of the species using otolith reading revealed that, in fish up to one year old, a series of opaque and translucent zones appear between the nuclear area and the otolith edge (Torre *et al.*, unpublished data) (Figure 1). The aim of the present work is to examine whether these zones are related to the lunar cycle.

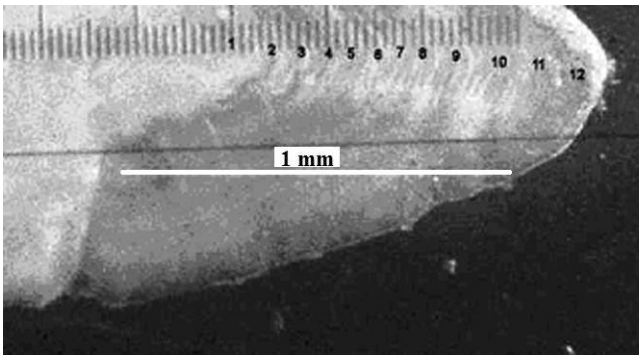

Fig. 1. Translucent zones checked in 0+ specimen of the silver scabbardfish (*Lepidopus caudatus*) in the northern Aegean Sea.

Materials and methods.
A total of 370 otolith of fish up to 1 yr old (TL range: 85-700 mm; mean TL= 487.5±12.54 mm) were seasonally sampled (summer 2003-summer 2005) with bottom trawling. Otoliths were observed under a light microscope. The number of translucent zones, their distances from the otolith nucleus, and otolith radius were recorded.

Results and discussion
The number of growth zones checked, varied between 1 and 13 and a highly significant linear correlation between the number of translucent zones (N) and otolith radius (OR) was observed (N = 7.94 OR - 0.94; R^2=0.97, n=370, p<0.01). The fact that in 1 yr old fish the number of growth zones was 13 suggested that growth zones followed a lunar periodicity (13 cycle x 28 days = 364 days ≈ one year). Thus, for each specimen, a date of birth was assigned. The peaks of birth (summer and autumn-winter) coincided with the reproductive peaks of the species in the area (Torre *et al.*, unpublished data) and hence indirectly validated the ageing method.
Accordingly, the number of translucent zones recorded, was age transformed (month) to formulate an age-length key. Total length at age data were statistically analyzed using non-linear regression analysis. The data were best fitted by the logistic model (R^2 = 0.87, Figure 2): $TL = La(1/(1+\exp(-r(t-a))))$ where *TL* is the total length (mm), *La* the asymptotic length (in mm), *t* the age (in months), *r* the growth coefficient (in months^{-1}) and *a* is a parameter (in months) equivalent to the age at 1/2 *La*. The parameters computed were: *La* = 702.19±43.28 mm (p<0.01), *a*=7.33±0.41 months (p<0.01), *r*=0.34±0.04 months^{-1} (p<0.01).
The growth of the otolith daily increments is slower during the full moon in deep water species following the same daily migratory behavior [2, 3]. This is probably caused by the possible dispersion of zooplankton during full moon [2]. Euphausiid crustaceans are the main prey of the silver scabbard fish [4] and their diel vertical migration may be influenced by moonlight [5]. Assuming that the silver scabbardfish may also be a nocturnal feeder, changes in prey availability related to the lunar cycle, may influence its feeding activity and consequently its growth rate. Hence, the lunar cycle may influence the growth patterns of the silver scabbardfish otolith.
Further studies on the daily feeding and migratory behavior of the silver scabbardfish coupled with otolith microstructure analysis may clarify this hypothesis. Moreover, the possibility of detecting lunar phases by otolith reading instead of using the time consuming daily increment analysis may be an useful tool in ageing of fish.

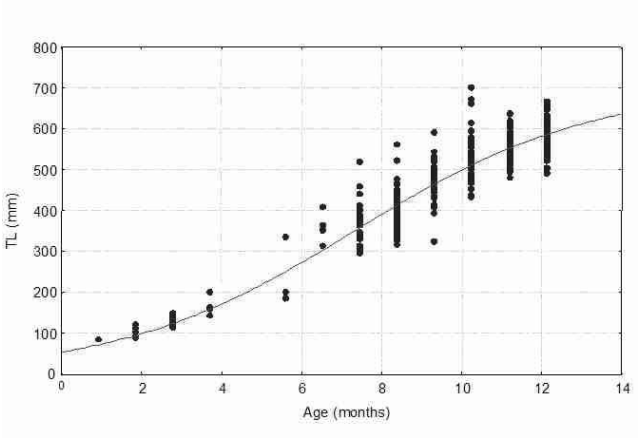

Fig. 2. Logistic model applied to total length (TL, mm) at age (months) data for silver scabbardfish (*Lepidopus caudatus*) in the northern Aegean Sea.

References

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