

**BIOLOGY OF SILVER SCABBARD FISH, *LEPIDOPUS CAUDATUS*
(TRICHIURIDAE), FROM THE IONIAN SEA
(EASTERN-CENTRAL MEDITERRANEAN)**

by

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ABSTRACT. - *Lepidopus caudatus* was collected during trawling and long-line surveys carried out in 1996 and 1997 in the Ionian Sea (Eastern-Central Mediterranean). The smallest specimen measured 13.3 cm in total length, the greatest was 163.5 and 150 cm in females and males respectively. The population was almost exclusively sampled within the first 400 m with juveniles mostly distributed on the continental shelf. At depths greater than 400 m both small and large specimens were collected. Commercial trawls collected mostly small and immature specimens. Experimental trawls, with a higher vertical opening, caught a significantly higher proportion of adult specimens, although juveniles represented the most abundant fraction of the stock. The longline only sampled large individuals. The maximum age was 7+ in females and 5 in males. No significant differences were shown between the length-weight relationship of the two sexes. The von Bertalanffy growth parameters were: $L_{\infty} = 182.46 \pm 3.9$ cm, $k = 0.30 \pm 0.014$, $t_0 = -0.50 \pm 0.032$ in females and $L_{\infty} = 174.27 \pm 3.7$ cm, $k = 0.31 \pm 0.013$, $t_0 = -0.53 \pm 0.023$ in males. The smallest mature specimen measured 92 cm total length in females and 90 cm in males. Mature specimens of both sexes and young-of-the-year individuals were found both in spring and autumn.

RÉSUMÉ. - Biologie du sabre argenté, *Lepidopus caudatus* (Trichiuridae), dans la mer Ionienne (Méditerranée orientale et centrale).

Lepidopus caudatus a été capturé pendant des campagnes de chalutage et de pêche à la palangre effectuées en 1996 et 1997 en mer Ionienne (Méditerranée orientale et centrale). Le plus petit exemplaire capturé mesurait 13,3 cm (TL), les plus longs, 163,5 cm (femelle) et 150 cm (mâle). La population a été échantillonnée dans les 400 premiers mètres de profondeur, les juvéniles étant répartis surtout sur le plateau continental. Au-delà de 400 m, des individus jeunes ou adultes ont été capturés. La pêche commerciale capture surtout des individus jeunes et non matures. Une proportion plus grande d'adultes a été capturée avec un chalut à haute ouverture verticale, même si les juvéniles représentaient encore la fraction la plus abondante du stock. La palangre de fond a toujours capturé des individus adultes. L'âge le plus élevé a été 7+ ans parmi les femelles et 5 ans parmi les mâles. Aucune différence significative n'a été notée entre les relations longueur-poids des deux sexes. Les paramètres de croissance de von Bertalanffy étaient: $L_{\infty} = 182,46 \pm 3,9$ cm, $k = 0,30 \pm 0,014$, $t_0 = -0,50 \pm 0,032$ pour les femelles et $L_{\infty} = 174,27 \pm 3,7$ cm, $k = 0,31 \pm 0,013$, $t_0 = -0,53 \pm 0,023$ pour les mâles. Les plus petits exemplaires matures mesuraient 92 cm (LT) parmi les femelles et 90 cm parmi les mâles. Les exemplaires matures des deux sexes et les juvéniles 0+ ont tous été pêchés en automne et au printemps.

Key words. - Trichiuridae - *Lepidopus caudatus* - MED - Ionian Sea - Distribution - Population structure - Biology.

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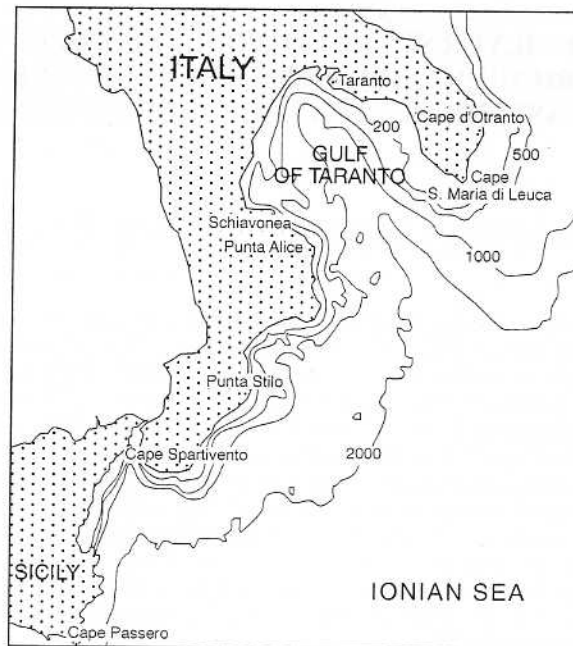


Fig. 1. - Map of the study area in the Ionian Sea (eastern-central Mediterranean).

The silver scabbard fish, *Lepidopus caudatus* (Euphrasen, 1788), is a teleost distributed in the temperate waters of all oceans and throughout the Mediterranean Sea. It has benthopelagic habits throughout the continental shelf and slope (Nakamura and Parin, 1993).

The knowledge on the biology of this fish in the Mediterranean Sea comes mainly from studies carried out in the north-western basin (e.g., Macpherson, 1979; Orsi Relini *et al.*, 1989; Moli *et al.*, 1990; Palandri and Orsi Relini, 1992; Demestre *et al.*, 1993). In the eastern-central Mediterranean Sea, despite several investigations on eggs and larvae distribution being conducted over many years (Raffaele, 1888; Lo Bianco, 1909; Padoa, 1956; Sparta, 1959; Karlovac and Karlovac, 1976), the scientific information on *L. caudatus* is generally limited to its presence and distribution in the various basins (e.g., Pastore, 1976; Parenzan, 1983; Papaconstantinou 1986; Bello and Rizzi, 1988; Matarrese *et al.*, 1996).

Particularly, concerning the Ionian Sea along the south-eastern Italian coast, although the silver scabbard fish ranks among the most abundant fish species collected during experimental trawling (Matarrese *et al.*, 1996), no data on its biology have been published until now. In this area, only the large specimens have commercial value while the small ones are generally discarded. The former can be selectively caught by longline while the latter are mostly fished during trawling, as observed in the western Mediterranean (e.g., Palandri and Orsi Relini, 1992; Demestre *et al.*, 1993).

During recent years data on the silver scabbard fish from the Ionian Sea have been collected as part of study projects on the demersal resources using mainly trawl gears and to a lesser extent the longline. The aim of this paper is to provide the first contribution to the knowledge of its distribution, size structure and biology from this eastern-central Mediterranean basin.

MATERIALS AND METHODS

The data were collected during trawling and long-line surveys carried out in 1996 and 1997 in the Ionian Sea, between Cape Otranto and Cape Passero (Fig. 1).

An experimental trawl net was used during June 1996 and June 1997 in the context of an international bottom trawl survey funded by EC-DGXIV (MEDITS project). The experimental trawl net was a nylon otter trawl GOC73 type (Bertrand, 1994), with stretched mesh of 20 mm in the codend. The horizontal and vertical net opening, measured by means of the SCANMAR sonar system and depending on various factors (depth, warp length, towing speed, etc.), were approximately 17 m and between 2.0 and 3.0 m respectively (Fiorentini, 1994).

A commercial trawl net was used during November-December 1996 and September-October 1997 as part of the study on demersal resources financed by Italian government. The commercial net was an Italian type nylon otter trawl net, with stretched mesh of 40 mm in the codend. The horizontal and vertical net opening, ranged respectively from 21.71 to 25.09 m and from 0.80 to 0.73 m (Fiorentini *et al.*, 1994).

An experimental longline was used during June-July 1996 and May-June 1997 as part of a study project on the hake spawners unavailable to trawling funded by the E.C. The experimental longline was a bottom type approximately 4000-5000 m long, with 450-750 hooks at distances of 6-9 m. The baits used consisted of herrings, *Sardina pilchardus* and *Sardinella aurita*. Each longline survey lasted 4 days in the northern area of the investigated basin. Fishing duration of the longline was around 4-8 hours each day.

A professional motor-powered vessel was hired for each project. The depth range investigated was between 10 and 800 m during trawl and between 200 and 800 m during longline surveys.

The sampling design adopted during trawl surveys was random-stratified. The number of hauls was proportional to the surface area of each depth stratum. These were: 10-50 m; 50-100 m; 100-200 m; 200-500 m; 500-800 m. Sampling stations during longline surveys were allocated on transects according to depth.

Total length (cm, TL), weight (g) and sex were recorded for each specimen. Length-frequency distributions were performed for the whole population sampled during each study period, grouping lengths into 1 cm intervals. The depth distribution pattern was analysed for the trawl survey data of both 1996 and 1997, due to the high number of individuals sampled. Sex ratio by depth was computed after pooling the trawl surveys of spring and autumn of the two years. Sex ratio by size was calculated for all the pooled trawl data. Statistical differences between the number of females and males by survey and depth were determined using the G-test (Sokal and Rohlf, 1969).

The length-weight relationship was computed for the two seasons according to the power curve function transformed into a straight line equation using natural logarithms: $\ln \text{Weight} = \ln a + b \ln \text{TL}$. The linear regression equations for the two sexes were compared statistically using the Chow-test (Koutsoyiannis, 1977). This test verifies whether there is a significant difference between both the slope (b) and the intercept (a) of two regression lines estimated from two different samples.

Both sagittae were removed from 450 specimens whose sizes were between 18.6 to 163.5 cm TL. The smallest sagittae were read as whole, while the sagittae belonging to the specimens greater than 110 cm total length were ground with sandpaper to obtain the best reading. Otoliths were placed in a black dish with glycerin (30%) and alcohol (70%) to improve reading. The opaque and translucent zone deposition pattern was con-

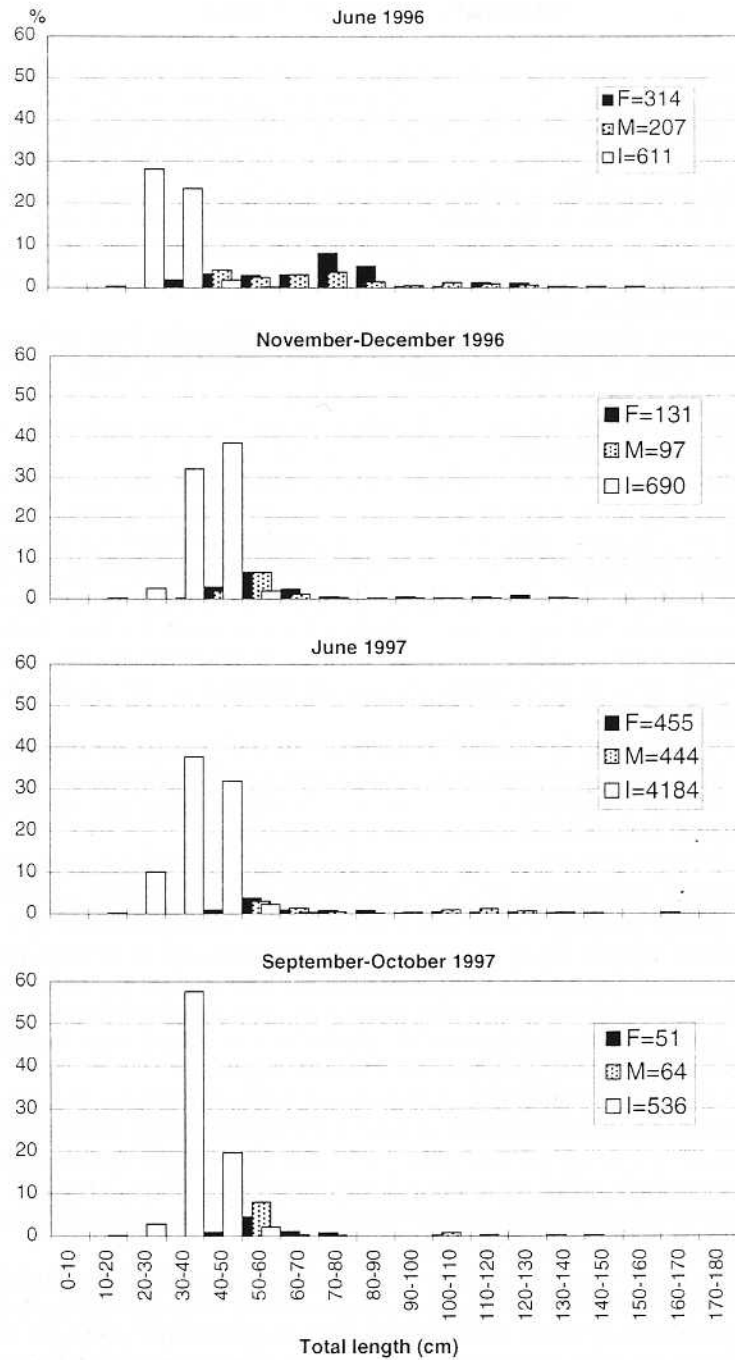


Fig. 2. - Length-frequency distribution of *Lepidopus caudatus* (F: females; M: males; I: undetermined individuals) caught by experimental trawl (June 1996 and 1997) and commercial trawl (November-December 1996 and September-October 1997) in the Ionian Sea.

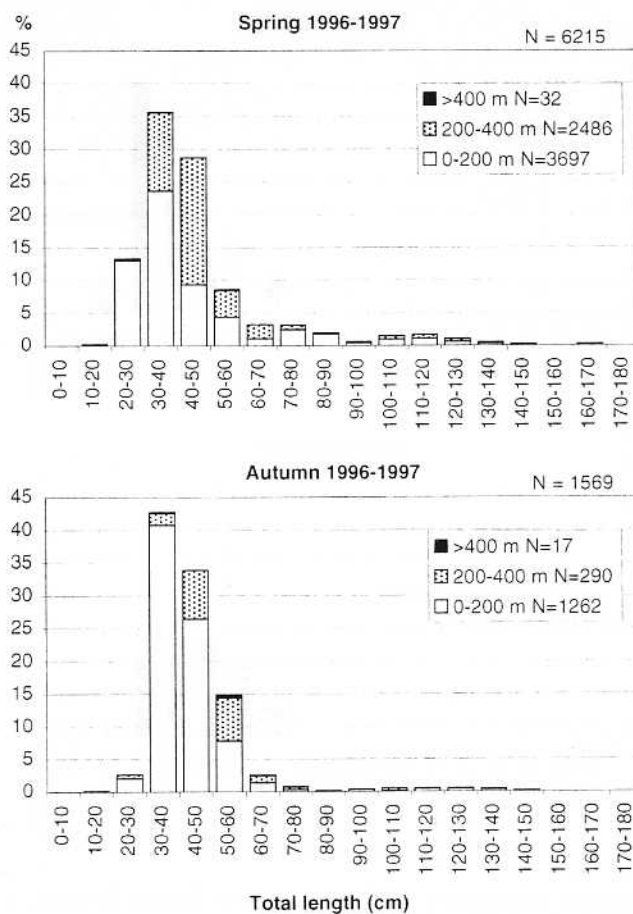


Fig. 3. - Length-frequency distribution by depth of *Lepidopus caudatus* caught by experimental trawl (Spring 1996-1997) and commercial trawl (Autumn 1996-1997) in the Ionian Sea.

sidered as an annual event (Moli *et al.*, 1990). Otoliths were read at least twice independently by two observers under a stereoscope using reflected light. If agreement was not reached, the otoliths in question were excluded from the growth estimate. Only 382 sagittae were used to obtain the age-length key for each sex (187 for females and 195 for males).

The von Bertalanffy (1938) function was adopted to model the growth pattern. The least square method was applied to the age-length relationship implemented in the LFSA program (Sparre, 1987). The program uses a non-linear least squares procedure which estimates the growth parameters in such a way that the sum of the squares of the deviations between the model and the observations is minimized. Since the von Bertalanffy growth parameters L_{∞} and k are inversely correlated, the growth performance index (ϕ') (Munro and Pauly, 1983) was computed in order to compare growth rates in the two sexes.

Since mature fish are assumed to grow less than the juveniles in relation to the fact that more energy is directed to reproduction than growth (Wotton, 1998), the maturity

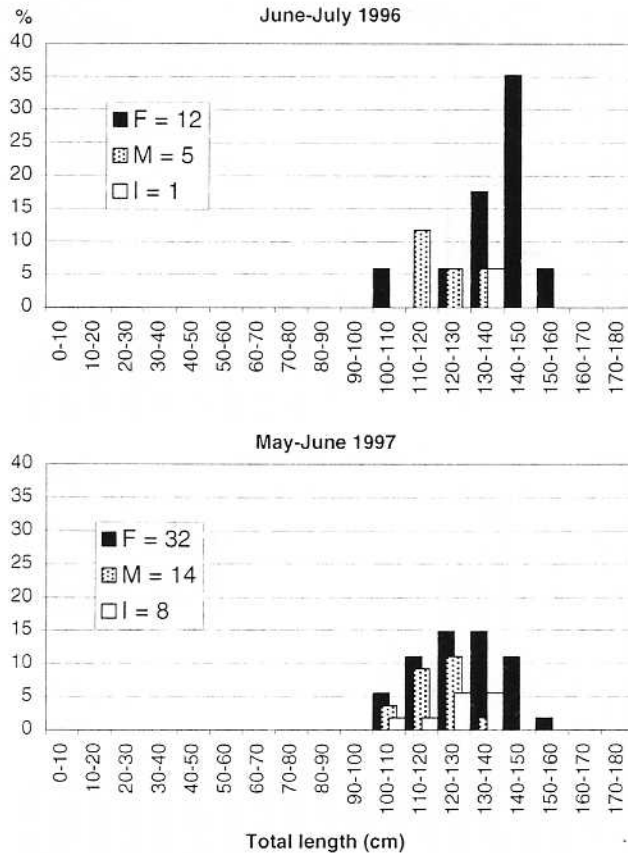


Fig. 4. - Length-frequency distribution of *Lepidopus caudatus* (F: females; M: males; I: undetermined individuals) caught by experimental longline in the Ionian Sea.

stage of the gonads by survey and size was studied in both sexes. Maturity was recorded macroscopically according to Nikolsky (1963), considering the following stages: II) resting (immature); III) maturing; IV) mature; V) running ripe; VI) spent. The sex of the virgin gonad (stage I) was indistinguishable in the very small specimens. The size-frequency distribution by maturity stage was performed for all the sexed specimens collected by both trawl gears and longline.

RESULTS

Structure of the sampled population

Although a wide range of sizes was shown in the sampled population by trawling, most of the specimens were smaller than 60 cm TL. These specimens made up the first modal component in each survey and were mostly indeterminate (unsexed) due to their virgin gonads (Fig. 2). The smallest specimen measured 13.3 cm in total length, the greatest was 163.5 and 150 cm in females and males respectively. Size composition by

