PRELIMINARY NOTES ON THE REPRODUCTIVE BIOLOGY OF THE LIZARDFISH, *SYNODUS SAURUS* (ACTYNOPTERYGII: SYNODONTIDAE) IN THE AZORES

by

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ABSTRACT. - Between March and November 2000, 307 specimens of the lizardfish *Synodus saurus* (Linnaeus,1758) were captured on several coastal areas of Terceira Island, Azores. This species is an important coastal epibenthic predator. Although common, its biology, namely its reproduction, is virtually unknown. During the study period, 206 females (155 mm to 460 mm TL) and 101 males (269 mm to 290 mm TL), were captured. Sex ratio was 2:1 with more males in June. Gonados-somatic Index (GSI) for females and males, attained its maximum values during Spring and Summer, showing that these are the most intensive reproduction periods. Hepato-somatic Index (HSI) suggests that this species may well recur on body reserves for energy metabolization in gonad development. Nevertheless, more studies are necessary in order to confirm this assumption. Ovarian histology, presenting different oocytarian phases, indicates that this species has an asynchronous posture. The male increment of June, associated to higher GSI values, suggests that this could represent a moment of intense competition for females, within the studied area.

RÉSUMÉ. - Notes préliminaires sur la reproduction du poisson lézard, *Synodus saurus* (Actinopterygii : Synodontidae) aux Açores.

Entre mars et novembre 2000, 307 poissons lézard, *Synodus saurus* (Linnaeus, 1758) ont été capturés à divers endroits de la côte de l'île Terceira, aux Açores. Cette espèce est un important prédateur épibenthique. Bien qu'elle soit une espèce assez commune, sa biologie, et surtout sa reproduction, est virtuellement inconnue. Pendant cette étude, 206 femelles (de 155 mm à 460 mm LT) et 101 mâles (de 269 à 290 mm LT) ont été capturés. Le sex ratio était de 2:1, avec plus de mâles en juin. L'indice gonado-somatique (GSI) pour les femelles et les mâles, a atteint ses valeurs les plus élevées au printemps et en été, ce qui montre que ces mois constituent la période de reproduction la plus intense. L'indice hépato-somatique (HSI), indique que les réserves corporelles sont susceptibles d'être utilisées pour le développement des gonades. Cependant, cette hypothèse doit être confirmée par d'autres études. L'histologie de l'ovaire, qui présente des phases ovocitaires différentes, indique que *S. saurus* a une ponte asynchrone. L'augmentation du nombre de mâles en juin, associée aux valeurs plus élevées de GSI, suggère l'existence, à cette période, d'une intense compétition pour les femelles.

Key words. - Synodontidae - *Synodus saurus* - ANE - Azores - Reproduction - sex ratio.

Teleost fishes achieved success in distinct environments for having a large array of reproductive tactics and strategies. The great adaptive capacity of teleost fishes allowed them to overcome both abiotic and biotic changes, with the possibility to reproduce successfully in changing and unstable environments (Vazzoler, 1996). Studies of fish reproduction are biologically and ecologically important (Lam, 1983; Garcia-Diaz *et al*., 1996) and constitute a valuable tool in assessing data for fisheries management purposes (Cadima, 1984).

Reproduction in fishes is a cyclical process (Munro, 1990), that is reflected in gonadic weight gain (Vlaming *et al*., 1992) due to maturation, increases in liver weight, where energy reserves are stored (Love, 1970; Podroschko *et al*., 1985) together with other parts, such as muscle, and directly from food (Vazzoler *et al*., 1989). Several methods were developed to study fish reproduction. Quantitative and qualitative methods were used. One of the most important quantitative methods is the Gonado-somatic Index (GSI), which allows identification of the breeding season (Erickson *et al*., 1984), together with histological observations to verify maturation of gonads (Hunter and Macewicz, 1985). The Hepato-somatic Index (HSI) (Patzner, 1980) allows to assess the role of the liver on reproduction.

Synodontidae are represented in the Azores by the following species: *Bathysaurus ferox* Günther, 1878, *Bathysaurus mollis* Günther, 1878, and *Synodus saurus* (Linnaeus, 1758) (Santos *et al*., 1997). The lizardfish, *S. saurus* has a cylindrical shaped body, and inhabits sandy bottoms in shallow waters (Saldanha, 1997). It is a carnivo-

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rous species that eats mainly small pelagic fish, such as *Sardina pilchardus* (Soares, 2001), and occasionally, crustaceans and molluscs, using both ambush and chase tactics (Golani, 1993). Only Golani (1983) described a reproductive period between February and August in the Mediterranean. Its reproductive biology is widely unknown.

The species occurs in the Eastern Atlantic (Azores, Madeira, Cabo Verde and Canary islands), Mediterranean and Morocco Atlantic shelf waters. In the western Atlantic it is known from the Bermudas, Bahamas and Leeward islands (Sulak, 1989).

Here we give preliminary results on the reproductive biology from a sample of *S. saurus* caught in Terceira Island, Azores (NE Atlantic).

MATERIAL AND METHODS

Specimens were collected by spearfishing between March and November 2000 in Terceira island, Azores (Fig. 1). This method makes selection easy (Derbal and Kara, 1996) and was used in previous works (e.g., Barreiros and Santos, 1998)

Specimens were measured to the nearest millimeter (Total length - TL and Standard length - SL) and weighed with a precision of 0.01g. Sex determination was only possible after gonad removal. Gonads were preserved in Bouin solution for 24 to 48 h, and transferred to ethanol 70% (Vazzoler, 1996). Sections were taken from the medial part of the left gonad and embedded in parafin. Gonads were histologically prepared and Gonado-somatic (GSI) and Hepato-somatic (HSI) indexes were determined both for females and males. Sectioned at 2 μm, and stained with "Harris" hematoxylin and eosin, each sample was examined microscopically to determine the reproductive state. Classification of gonads followed an adaptation based on the maturity criteria of Budnichenko and Dimitrova (1981), Vazzoler (1996) and Lourinho (1998). Ovarian and testis maturation scales are presented in table I.

Gonado-somatic index (GSI), was calculated as (Vazzoler, 1996):

$$GSI = (GW/(TW-GW)) \times 100,$$

where GW is the gonad weight (g) and TW is the total fish weight (g).

Hepato-somatic index (HSI) was calculated as (Patzner, 1980):

$$HSI = (LW/TW-LW) \times 100,$$

where LW is the liver weight (g) and TW is the total fish weight (g).

Average indexes were plotted to show seasonal reproductive pattern. Sea surface temperature was measured in all sampling dates with a thermometer.

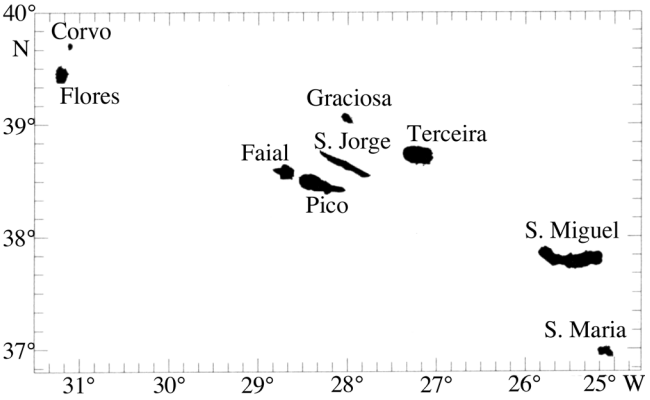

Figure 1. - The Azores Islands (NE Atlantic) - © *Imag*DOP.

RESULTS

Two hundred and six females were captured ranging in size from 155 mm to 460 mm TL. The commonest size range was between 307 mm and 338 mm TL (SE = 3.6). Similarly, 101 males where captured during the study period. Their commonest size ranged between 269 mm and 290 mm TL (SE = 4.7), with a minimum at 185 mm to a maximal at 395 mm TL. The sex ratio observed was 2:1. In June the number of males increased turning the sex ratio from 2:1 to 1:1.

Water surface temperature gave average values somehow atypical, reaching a maximum value in October (20.7°C) (Fig. 2).

For females, GSI results showed a pronounced growth reaching a maximal peak in July (8.26). From July to August, GSI has an evident decrease, reaching a minimal value in October (0.75). HSI has an increase until May (2.06), followed by a maximal peak in July (2.26), with a

Females		Males	
Stage A	Immature	Stage A	Immature
Stage B	In Maturation	Stage B	In Maturation
Stage C	Mature	Stage C	Mature
Stage D	In recovery post-spawning	Stage D	In recovery
Stage Bp	Ovaries in maturation	Stage Bp	In maturation after ripe
Stage Cp	Mature Ovaries		

Table I. - Gonad maturation scale used for *S. saurus*. Adapted from Lourinho (1998).

minimum in August (1.65) (Fig. 3). For males, GSI has a maximal peak in June (3.96) and a minimal value in October (0.71). The HSI has several peaks during the study period. Two, less intense peaks occurred in April (1.76) and in July (1.89), and were followed by a maximal peak in September (2.52). In November, it reaches the maximal value of 2.90 (Fig. 4).

The percentage of the maturing stage for females after histological observation is presented in figure 5. Stages C and Cp represent the maximal ovarian development, and show that the percentage of mature individuals, increases until 100% in July. In October it reaches a minimum (9.5%), and increases again in November (to 38%). Testis histological observation produced the following results for each maturation stage (Fig. 6). The percentage of individuals on maturation stage C, shows that 50% of mature males occur in March, decreasing to a minimal in May with only 10%. In August, 86% of males are mature and in October the maximal value is reached (93%).

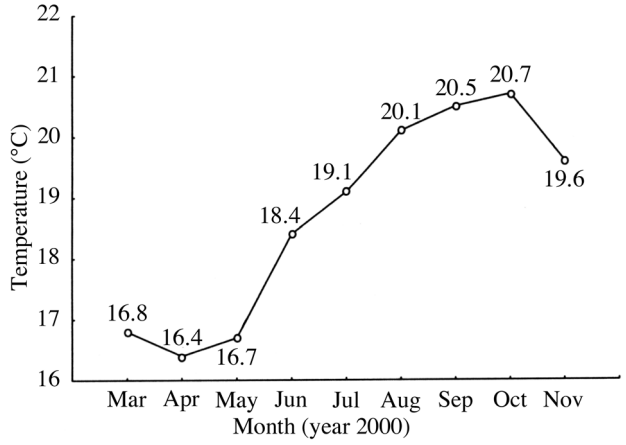

Figure 2. - Average temperatures of sea water during sampling period.

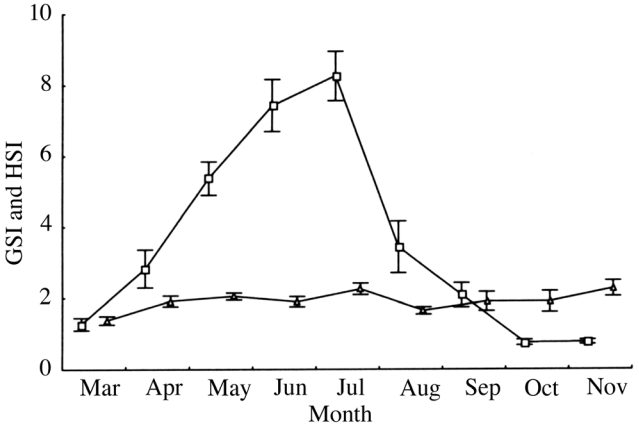

Figure 3. - GSI (□) and HSI (Δ) variation for females of *S. saurus* (mean values).

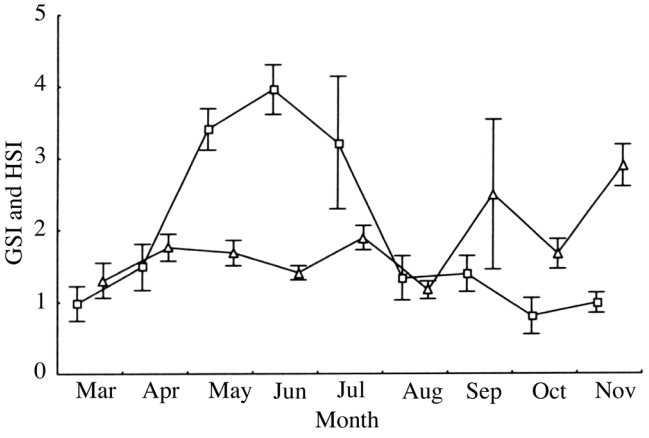

Figure 4. - GSI (□) and HSI (Δ) variation for males of *S. saurus* (mean values).

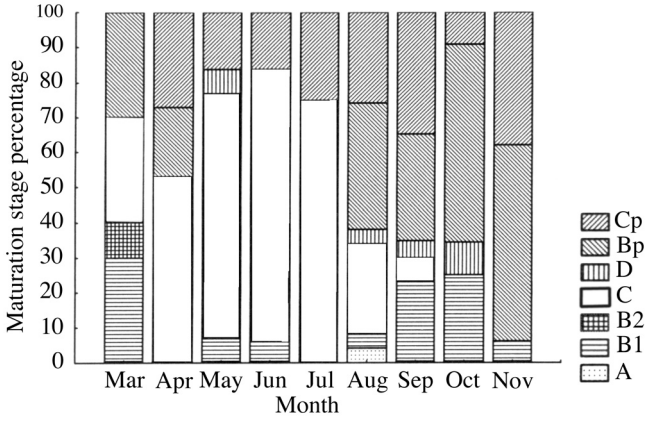

Figure 5. - Distribution of the maturation stages (%) for females of *S. saurus* during the collection period. A - Immature, B1 - Beginning of maturation, B2 - End of maturation, C - Mature, D - In recovery post-spawning, Bp - Ovaries in maturation, Cp - Mature ovaries.

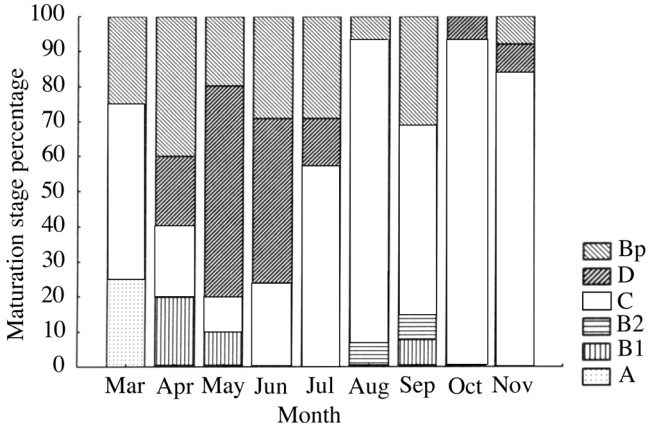

Figure 6. - Distribution of the maturation stages (%) for males of *S. saurus* during the collection period. Abbreviations as in figure 5. Bp - Mature testicles.

DISCUSSION

GSI results for females, suggest that *Synodus saurus* in the Azores have a more intensive reproduction period during Spring and Summer, with a peak in July. This fact is confirmed by histological observation. The maximal average value obtained for females was 8, which, according to Tyler and Sumper (1996), indicates asynchronous spawning cycles. GSI for males suggest that, like females, the most intense reproduction period is during Spring and Summer. However, the histological observation did not confirm this fact and the percentage of males in stage C in this period is smaller than the values found during Autumn months. The cause of this can be due to a smaller number of specimens sampled during Spring and Summer which made the histological results inconsistent with the analytic results.

It is known that energy stored in the liver, both in males and in females, is channelled to muscular activity and for reproduction effort, being more evident in females, where the lipidic reserves are later transferred to oocytes for initial embryo development (Love, 1970). HSI results for females, during the more intensive reproduction period (July), have a peak, suggesting that the liver reserves may not be used in the final maturation stages. Nevertheless, care must be taken on this observation, because accumulation and storage of fat within the liver, in the course of ovary maturation, is known in many fish species (Bailey, 1952; Smith, 1957).

For males, the minimal value obtained in June, when GSI is highest, suggest that the liver has a weight loss, which may indicate the mobilization of hepatic reserves for testis maturation. However, this mobilization could also be derived to body condition. Once again this must be viewed with care. Other methods would be needed in order to test this hypothesis such as hepatic histological analysis.

The maturation type found in females shows similar macroscopic and microscopic characteristics to those observed by Budnichenko and Dimitrova (1981) in the confamilial species *Saurida tumbil* and *S. undosquamis*. The resemblance is in the type of development until it gets to a mature stage. In this are included all stages of oocyte development until spawning and the type of gonad coloration during that process. Budnichenko and Dimitrova (1981) described maturation stages after spawning, where it was possible to find oocytes in early and late vitellogenesis, referring to *Saurida tumbil* and *S. undosquamis* as having intermittent spawning periods. The continuous maturation of several generations of oocytes during the spawning season provides evidence of an unbroken type of maturation (Oven, 1976).

It appears that males have continuous sperm production cycles, where they ripe, and simultaneously start a new cycle of sperm production. This fact was already described in other teleost fish, such as *Ophidion* sp. (Mattei *et al*., 1993). The percentage of mature males during Spring and Summer was too low and inconsistent with GSI results. This can be connected with the fact that the number of males collected during Spring and Summer was not enough to achieve consonance between histological observations and GSI results. The high percentage of mature males in October and November and mature females in October and September, may be explained by the higher temperatures verified in those months, probably causing an unusual maturation period, that could only be detected by histological analysis.

The role of liver reserves during the reproduction effort did not become clear.

Our results indicate that the increment of males during June, one month before the maximal GSI of males, can be due to some kind of competition strategy between males resulting in the selection of the more fit for reproduction.

This work leads to new research possibilities that are important to complement the information exposed above. It is necessary to collect more specimens for longer periods in order to test our results and detect eventual seasonal and/or inter-annual variations. The small size of our sample did not allow an efficient analysis of data from different size classes. It is also important to produce age-determination studies for this species.

The results presented in this paper should be considered as preliminary.

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