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Morphology of the ovotestis of a hermaphroditic teleost, *Serranus auriga* (Osteichthyes: Serranidae)

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Abstract. Histological examinations of gonads of *Serranus auriga* confirmed that the species is always a functional simultaneous hermaphrodite with external fertilization. Sections of the gonads revealed that the dominant tissue was ovarian and each lobe was covered by smooth muscle and connective tissue, the tunica albuginea. The presence, in mature individuals, of hydrated oocytes and sperm within the ovotestis suggested the possibility of external self-fertilization. Descriptions based on microscopic examinations of ovarian and testicular tissues are given.

Keywords: *Serranus auriga*, simultaneous hermaphrodite, gonadal morphology

Resumo. **Morfologia do ovotéstis de um teleósteo hermafrodita, *Serranus auriga* (Osteichthyes: Serranidae).** Exames histológicos das gônadas de *Serranus auriga* confirmaram que a espécie é sempre um hermafrodita funcional simultâneo com fertilização externa. Seções das gônadas revelaram que o tecido ovariano foi dominante e cada lobo estava coberto por músculo liso e tecido conjuntivo, a túnica albugínea. A presença, em indivíduos adultos, de ovócitos hidratados e espermatozoides dentro do ovoteste sugeriu a possibilidade de auto-fertilização externa. Descrição baseada em exames microscópicos de tecidos ovariano e testicular são dadas.

Palavras chave: *Serranus auriga*, hermafrodita simultâneo, morfologia gonadal

Introduction

The Serranidae family contains many bottom-dwelling predators of high commercial interest (Froese & Pauly 2000). Genus *Serranus* is composed of 29 valid species (Froese & Pauly 2000), which are usually synchronous hermaphrodites, a reproductive pattern considered to be the most primitive within the Serranidae (Smith 1965). This sexual pattern, together with the possibility of self-fertilization (Atz 1965), has prompted several detailed descriptions of the gonad morphology in *Serranus* species (Abd-el-Aziz & Ramadan 1990; García-Díaz et al. 1997).

Serranus auriga (Cuvier 1829) is one of the eleven species of the Serranidae family inhabiting in the coastal waters of Argentina and Uruguay (Menni et al. 1984). It is a small fish, benthic and relatively common in demersal fisheries' captures. It feeds mainly on crustaceans Natantia, *Peisos* spp., brachyuran and amphipods. In terms of reproductive biology it has been characterized as a functional synchronous hermaphrodite, with male and female gametes distinguishable at the same time (Cussac & Molero 1987). The importance of this species lies in its potential role as food for larger fishes and its possible status as a competitor with other species. The existing information about the biology of S. auriga is limited to the description of Miranda-Ribeiro (1915) and Cussac & Molero (1987).

The objective of the present study was to describe the structure of the ovotestis of *Serranus auriga*, with the aim of expanding the knowledge on the reproductive biology of this species.

Materials and methods

Samples of *Serranus auriga* (Fig.1) were obtained from a coastal zone in the Northern Argentine Sea during a research trawl survey carried out in November 2008. A total of 32 total mature individuals (ranging for 9 to 15 cm in total length) were fixed in 10% neutral buffered formalin. For histological examinations the gonads were removed and weighed to the nearest 0.1 g. A portion of tissue was removed from the centre of each ovotestis, dehydrated in methanol, cleared in xylol and embedded in paraffin. Tissues were sectioned at 4 μm thick and stained with Harris' haematoxylin and eosin.

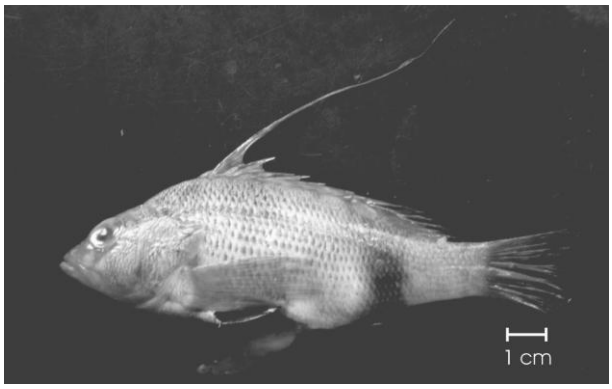

Figure 1. *Serranus auriga*

Results

The gonadal anatomy of the 32 individuals of *Serranus auriga* analyzed confirmed that always ovary and testis are present and mature at the same time (Fig. 2, Fig. 3). Ovarian tissue of mature individuals was yellowish while testicular tissue was white. The ovotestis was formed of two fairly cylindrical lobes; the left lobe is usually larger than the right, and they joined close to the anus. Testicular tissue was restricted to the posterior region and positioned ventrolaterally. Sections of the gonads revealed that the dominant tissue was ovarian and each lobe was covered by smooth muscle and connective tissue, the tunica albuginea (Fig. 3). It was also noted that in mature individuals, both the ovary and testis were developed simultaneously, concurrently, presenting hydrated oocytes and sperm at the same time.

Ovary

In mature ovaries, oocytes in different development stages were present simultaneously within the ovarian lamellae. This type of ovary is classified as asynchronous according to Marza (1938). Five stages of oocytes were identified in late maturation phase (Fig. 4): (a) the primary growth oocytes, which represent the oocyte reserve for the next reproductive season (b) yolk vesicle formation - large irregular vacuoles and small oval vesicles may be observed in the cytoplasm. These vesicles are the 'cortical alveoli' according to Selman et al. (1988). At this stage yolk vesicles appeared in the ooplasm surrounding the nucleus. Later, the number and size of yolk vesicles increased and lipid inclusions began to accumulate in the cytoplasm. At this stage the zona radiata and follicular layer became visible; (c) vitellogenesis - yolk vesicles were larger in number and size; some had fused. Yolk granules, which appeared first in the periphery of the cytoplasm, increased in size and number, dispersing throughout the cytoplasm. The zona radiata increase in thickness and it can be observed an external thecal layer and internal granulosa layer (Fig. 4); (d) maturation - several oil droplets (o1, Fig.4) concentrated around the nucleus, then fuse together, forming a large droplet (o2, Fig.4) that migrated towards the animal pole together with the nucleus. The yolk granules progressively fuse forming a continuous mass as fluid yolk. (e) hydrated oocyte (Hunter & Macewicz 1985) - the nucleus was not always visible due to disintegration of the nuclear membrane and dispersion of its contents into the cytoplasm. The yolk granules finally fused in a mass of fluid yolk. Spawning begins with its formation (Hunter et al. 1986).

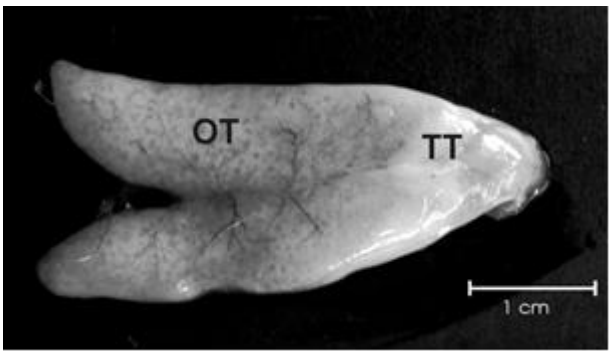

Figure 2. General view of the gonads of *S. auriga* showing ovarian (OT) and testicular tissue (TT).

Testis

The testis of *Serranus auriga* are organized into lobules. The lobules consist of many seminiferous tubules containing cysts. Each cyst is formed by spermatogenic cells in different stage of development and bounded by a thin layer of connective tissue. Following the terminology of Grier (1981), the cells that were observed in the cross section of the testis were (Fig. 5 and 6): (a) spermatogonia - globular cells positioned at the periphery of the seminiferous tubules, usually forming cysts; (b) spermatocytes – oval cells smaller

than spermatogonia; (c) spermatid cells with a large and rounded nucleus; (d) spermatozoa - spermatid cells rejected into the cyst cavity as spermatogenesis neared its end. Later, this cells continued to develop as spermatozoa.

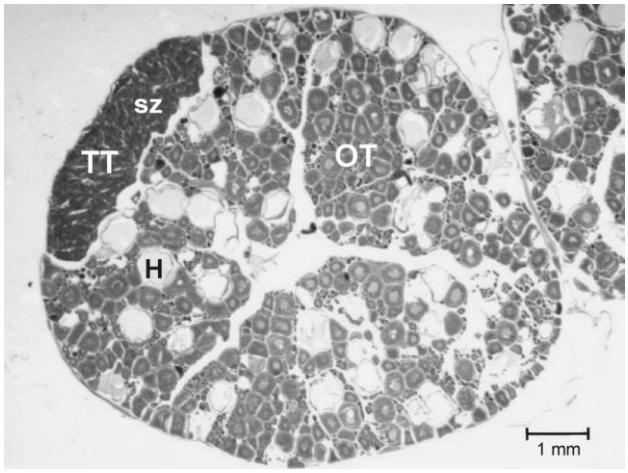

Figure 3. Transversal section of ovotestis: (OT) ovarian tissue; (TT) testicular tissue; (H) hydrated oocyte; (sz) spermatozoa.

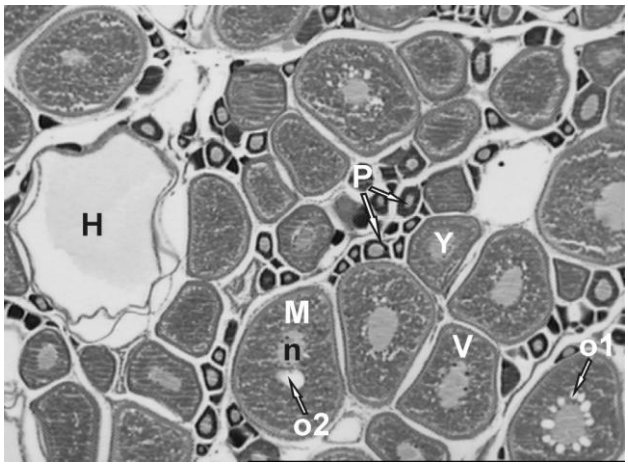

Figure 4. Section of ovary (4X): (P) primary growth oocyte stage; (Y) yolk-vesicle stage; (V) vitellognesis stage; (M) maturation stage; (H) hydrated oocyte; (n) nucleus; (o1) small oil droplets; (o2) large droplet.

Discussion

The gonadal morphology of *Serranus auriga* and the clearly presence of two areas described as ovarian and testicular tissue confirmed that it is a functional simultaneous hermaphrodite as reported by Cussac & Molero (1987). This sexuality pattern is common in all *Serranus* species (Smith 1965; Fischer & Petersen 1987; García-Díaz et al. 1997; 2002; Tuset et al. 2005). Within *Serranus* species, serial monogamy is the most frequent style of reproduction, in which individuals are solitary during the day before pairing up and spawning in the late afternoon (Fischer 1986). During spawning one fish in each pair functions as a male and the other as a female and cross-fertilization occurs. In some *Serranus* species (*S. subligarius*, *S. cabrilla*, *S. hepatus, S. scriba* and *S. atricauda*) self-fertilization was suggested or experimentally demonstrated (D'Ancona 1949; Hastings & Bortone 1980; Abd-el-Aziz & Ramadan 1990; García-Díaz et al. 2002, Zorica et al. 2005). In *Serranus auriga* the simultaneous presence of hydrated oocytes and sperm also suggest the possibility of self-fertilization. However, in this species the presence of sperm duct and oviduct separated (Cussac & molero, 1987) suggest that internal self-fertilization does not occur, but the possibility of external self-fertilization is not to be discarded.

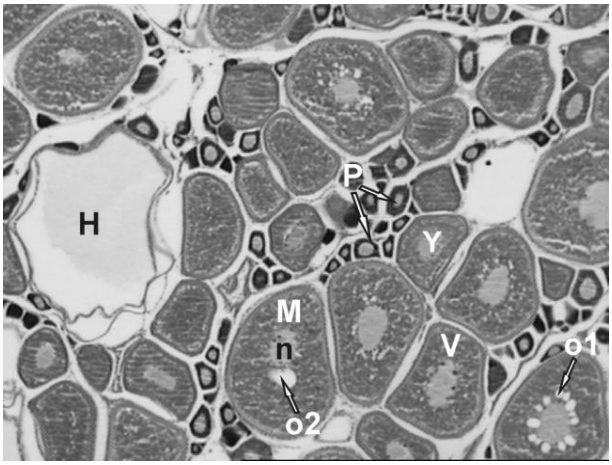

Figure 5. Section of ovotestis (20X): *Ovary:* (M) maturation stage; (Y) yolk-vesicle stage; (a) cortical alveoli; (z) zona radiate; (t) theca layer (g) granulosa layer; (yv) yolk-vesicle. *Testis:* (sg) spermatogonia; (sc) spermatocytes; (st) spermatids; (sz) spermatozoa.

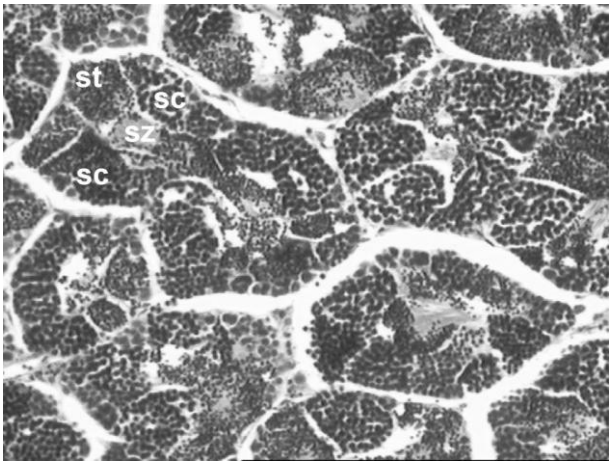

Figure 6. Spermatogenic cyst (20X). (sc) spermatocytes; (st) spermatids; (sz) spermatozoa.

The cytological characteristics of the ovotestis of *Serranus auriga* were agree with those of other *Serranus* species (García-Díaz et al. 1999; 2002) and other teleosts (Macchi & Christiansen 1992; Militelli & Macchi 2001; Rodrigues et al. 2008).

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