

Spermatozoa ultrastructure in Sciaenidae and Polynemidae (Teleostei:Perciformes) with some consideration on Percoidei spermatozoa ultrastructure

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Abstract

Spermatozoa ultrastructure was studied in five marines (*Paralonchurus brasiliensis*, *Larimus breviceps*, *Cynoscion striatus*, *Micropogonias furnieri*, *Menticirrhus americanus*, *Umbrina coroides*, *Stellifer rastrifer*), and one freshwater (*Plagioscion squamosissimus*) species of Sciaenidae and one species of Polynemidae (*Polydactylus virginicus*). The investigation revealed that, in all species, spermatozoa display a round head, a nucleus containing highly condensed, filamentous chromatin clusters, no acrosome, a short midpiece with a short cytoplasmic channel, and a flagellum showing the classic axoneme structure (9 + 2) and short irregular lateral fins. In Sciaenidae, the spermatozoa are type II, the flagellar axis is parallel to the nucleus, the lateral nuclear fossa is double arched, the centriolar complex is outside the nuclear fossa, the proximal centriole is anterior and perpendicular to the distal centriole, and no more than ten spherical (marine species) or elongate (freshwater species) mitochondria are observed. Polynemidae spermatozoa are of the intermediate type with the flagellar axis eccentric to the hemi-arc-shaped nucleus, and exhibit no nuclear fossa, the centriolar complex close to the upper nuclear end, the proximal centriole lateral and oblique to the distal centriole, and one large ring-shaped mitochondrion. The data available show that no characteristic is exclusively found in the spermatozoa of members of the Sciaenidae family when compared to other Percoidei with type II spermatozoa. However, three characteristics were exclusively found in Polynemidae: (1) the hemi-arched nucleus; the positioning of the centrioles; and (2) the ring-shaped mitochondrion. The interrelationships between Sciaenidae and Polynemidae as well as between these two families and other Percoidei are herein discussed.

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1. Introduction

Perciformes is the most diverse of all fish orders with 20 suborders, 150 families, and at least 6900 species (Greenwood et al., 1966; Gosline, 1968; Nelson, 1994). It was not cladistically defined, and is almost certainly a gradual and unnatural assemblage, clearly polyphyletic (Lauder and Liem, 1983). In a phylogenetical review of Perciformes, Perciformes has been described as probably paraphyletic (Johnson and Patterson, 1993). The hypotheses about limits

and/or interrelationships among Perciformes proposed since Greenwood et al. (1966) have led to classificatory changes in two or three of the suborders of Perciformes and in about two-thirds of the 70 families of Percoidei (Johnson, 1993).

Percoidei, the largest and most diverse of the perciform suborder (Lauder and Liem, 1983) is divided into three superfamilies that contain 71 families (Greenwood et al., 1966). The superfamily Percoidea congregates a paraphyletic group formed by 65 families, which are mostly very similar and poorly separated from one another (Lauder and Liem, 1983; Nelson, 1994).

Sciaenidae, one of the largest Percoidei families, includes about 78 genera and 287 described species (Nelson, 1994). It

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is considered one of the most important families in the suborder Percoidei because of the number of its species that have been described, as well as wide geographic distribution and importance in fishery. The fish of this family inhabit marine coastal, estuarine and freshwaters in tropical and temperate regions of the world. Six genera are restricted to freshwater, four of them endemic and widely distributed across South America (Nelson, 1994; Casatti, 2003). A study conducted by Sasaki (1989), demonstrated the monophyly of the Sciaenidae family on the basis of 21 synapomorphies and the absence of relationships between this family and the other Percoidei families. However, Johnson (1993) demonstrated that many of the synapomorphies identified by Sasaki (1989) were not unique among percoids or sciaenids—in fact, five of them were shared with the polynemids. Though recognizing that further investigations were desirable, Johnson (1993) suggested that Sciaenidae and Polynemidae were sister-groups, and recommended the inclusion of both families in a superfamily, Polymenoidea.

The Polynemidae family comprises seven genera and 33 species that dwell marine and brackish waters in all tropical and subtropical seas (Nelson, 1994). According to Johnson (1993), Polynemidae, Mugilidae and Sprhyaenidae have frequently been placed together in a single suborder even though Greenwood et al. (1966) assigned them to separate suborders. Johnson added that Rosen (1964) discounted a close relationship between these three families and atheriniforms, but did not resolve the question of their relationship. Nelson (1994) included the polynemids in the Percoidei suborder.

Ultrastructural studies of the spermatozoa of many fish species have shown that the organization of the spermatid organelles is very conservative in the members of a same family or subfamily (Baccetti et al., 1984; Mattei, 1991; Jamieson, 1991; Burns et al., 1998; Abascal et al., 2002; Quagio-Grassiotto et al., 2003). Sperm characteristics are likely to be very useful in the identification of the relationship patterns among families (Jamieson, 1991). Furthermore the ultrastructural characters of spermatozoa seem to be the kind of data that can be well combined with usual morphologic characters, in phylogenetic analyses.

The study of Mattei (1991), that includes 24 new descriptions, analyzes the ultrastructure of spermatozoa in 36 species pertaining to 25 families of the suborder Percoidei. The families analyzed by this author were Acropomatidae, Apogonidae, Carangidae, Centrarchidae, Centrarchidae, Centropomidae, Cepolidae, Chaetodontidae, Echeinidae, Emmelichthyidae, Ehippididae, Gerreidae, Haemulidae, Kuhlidae, Lutjanidae, Malacanthidae, Monodactylidae, Mullidae, Percichthyidae, Percidae, Pomatomidae, Priacanthidae, Sciaenidae, Serranidae, and Sparidae. The study of Jamieson (1991), with one new description, adds six other species to this total.

Recent studies of the suborder Percoidei have led to new hypotheses about the relationship among some families, which resulted in the reallocation of some genera (Johnson,

1993). Therefore, an update of the classification of the families analyzed by Mattei (1991) and Jamieson (1991) becomes necessary. Thus, the species *Nannoperca oxleyana*, described by Marshall (1989—*apud* Jamieson, 1991) as pertaining to the Kuhlidae family, is now allocated in the family Percichthyidae (Johnson, 1984; Nelson, 1994); the species *Parakuhlia boulangeri* (= *Parakuhlia macrophthalmus*), described by Mattei (1991) as also pertaining to the Kuhlidae family, is today in the family Haemulidae; *Synagrops microlepis*, described by Mattei (1991) as pertaining to the family Percichthyidae, is now in the family Acropomatidae; *Morone punctata*, described by Mattei (1991) as pertaining to the family Percichthyidae, is now placed in the family Moronidae; and *Drepane africana*, described by Mattei (1991) as pertaining to the family Ehippididae, is now in the family Drepaneidae (Johnson, 1993; Nelson, 1994). Consequently spermatozoa believed to belong to the families Kuhlidae and Ehippididae actually pertain to the families Moronidae and Drepaneidae. The representative species of the family Polynemidae whose spermatozoa were described by Mattei (1970, 1991), as pertaining to the suborder Polymenoidea is now included in the suborder Percoidei (Nelson, 1994).

Descriptions of the sperm structure in several Percoidei species have shown that the structure of spermatozoa varies within some families (Jamieson, 1991; Mattei, 1991). The recent descriptions of the structure of spermatozoa in Apogonidae (Lahnsteiner, 2003); Carangidae (Lahnsteiner and Patzner, 1998; Maricchiolo et al., 2002); Moronidae (Saperas et al., 1993); Mullidae (Saperas et al., 1993; Lahnsteiner and Patzner, 1995, 1998; Gwo et al., 2004b); Sciaenidae (Gusmão et al., 1999; Gwo and Arnold, 1992), Sparidae (Gwo et al., 1993, 2004a; Gwo, 1995; Lahnsteiner and Patzner, 1995, 1998), and Serranidae (Gwo et al., 1994; García-Díaz et al., 1999) have added new information and confirmed the heterogeneity of the spermatozoa of this suborder. However, most part of this documentation is available only in the form of schematic drawings. In spite of the vast number of families of Percoidei in which spermatozoa are documented, the use of the sperm characters in phylogenetic analyses is not yet feasible because the schematic drawings available do not provide ultrastructural details of most cell organelles. In the same way the lack of detailed documentation about spermatozoa structure for many Percoidei species prevents a fine comparison of the structures presents in different species.

Considering the proposal of monophyly in the family Sciaenidae (Sasaki, 1989), and the possibility that Sciaenidae and Polynemidae may belong to a natural group (Johnson, 1993), spermatozoa of seven species pertaining to seven different Sciaenidae marine genera, one species of a freshwater Sciaenidae, and one species of Polynemidae were analyzed and the resulting data was compared with all the data available on the suborder Percoidei. The analyses were conducted with the purpose of identifying ultrastructural spermatozoon characters that could be use-

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