

Gills of the seawater fish
Oligoplites palometa (Carangidae):
morphology and functional activity of structures
described through scanning
electron microscopy

Brânquias do peixe
marinho *Oligoplites palometa* (Carangidae):
morfologia e atividade funcional de estruturas descritas
através de microscópio eletrônico
de varredura

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The seawater fish *Oligoplites palometa* (Cuvier, 1833) is found in the American continent, from Guatemala to the coastline of São Paulo, Brazil. Below this area, it does not occur frequently. (MENEZES & FIGUEIREDO, 1980).

Scientific literature on its biology is scarce. However, studies have shown that this species presents lepidophagous habits. Lepidophagy is characteristic to some fishes that must swallow scales of other fish. This habit is uncommon, but peculiar to other species of the Carangidae family (HALSTEAD *et al.*, 1972; MAJOR, 1973; SAZIMA & UIEDA, 1980).

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Study of the pharyngeal region of gill arches of fishes has provided information for better understanding the feeding habits of ichthyic species (MAGNUSON & HEITZ, 1971; HUGHES, 1984; OJHA *et al.*, 1987; EIRAS-STOFELLA, 1994; VANDENBERG *et al.*, 1994; EIRAS-STOFELLA & CHARVET-ALMEIDA, 1997, 1998, 2000; EIRAS-STOFELLA, 2001).

The main purpose of this work is to characterize the ultrastructures of the pharyngeal region of the gills of the *Oligoplites palometa*, with the aid of scanning electron microscopy. The relationship between the morphology of this region and the feeding habits of this species is also discussed. The branchial ultrastructure was investigated also at the region of the filaments and respiratory lamellae.

MATERIAL AND METHODS

Nine specimens of the *Oligoplites palometa* fish were captured at Pontal do Paraná beach (25° 35' S – 49° 22' W) in the state of Paraná (Brazil). After having been anesthetized (MS 222), the fish were measured (Lt), and the second pair of branchial arches (BaII) of each specimen was removed for study. After having been washed with NaCl (0.9%), the BaII were fixed and processed according to the technique described by EIRAS-STOFELLA & CHARVET-ALMEIDA (1997, 1998). The gills were observed and photographed in a Philips SEM-505 scanning electron microscope.

RESULTS

All *Oligoplites palometa* fish in this study were adult, and measured approximately 20 cm (± 1 cm) in total length. The upper region of the branchial arch (BaII) presents an extremely marked curvature (Fig. 1 and 2A) and the branchial filaments are longer in the middle region of the arch (Fig. 1). The space separating one branchial filament from the next is big, particularly near the pharyngeal region. (Fig. 2B and 2C). These filaments are not as wide near their distal region (Fig. 2C). The respiratory lamellae are well-developed and the space between them is small (Fig. 2C). The branchial arch is similar when both sides are compared, that is, the side facing the opercular opening, with the side facing the inside of

the fish (Fig. 1). There are no rakers in the pharyngeal region of the branchial arches of the *O. palometa* (Fig. 2A and 2B). Several taste buds are distributed among the spines found everywhere in this region (Fig. 2A, 2B, 3A and 3B). The epithelium covering the filaments (Fig. 3C) and the branchial pharyngeal region (Fig. 3A, 3B and 3D) present the same ultrastructures. Many caliciform cells are located among the pavement cells of the polygonal border, with salient concentric microridges (Fig. 3D). These folds in the membrane of the epithelial cells are not defined in the respiratory lamellae, where no mucous secretory cells were found.

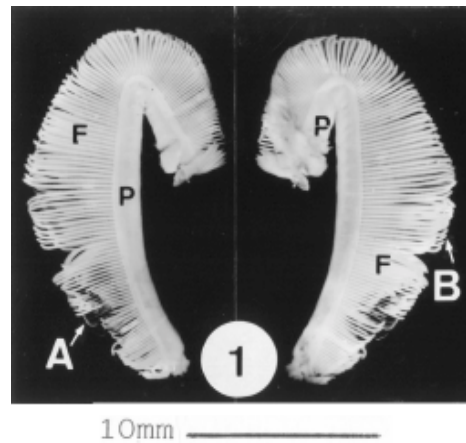


Fig. 1. Second branchial arch of the fish *Oligoplites palometa*: A, external side (portion of the arch turned toward to the opercular opening); B, internal side (lateral portion of the arch directed toward to the inner part of the fish). [F, branchial filaments (portion where the respiratory lamellae are transversally disposed); P, pharyngeal region (that includes all the structures of the arch except branchial filaments)]

DISCUSSION

The morphology of the gills of the *Oligoplites palometa* is within the standards found in other teleost fishes (HUGHES, 1984; EIRAS-STOFELLA, 1994). The variation in length found in the branchial filaments and the presence and dorsal location of the marked curvature angle of the arch are aspects not found in some species (HOSSLER *et al.*, 1979; EIRAS-STOFELLA, 1994; EIRAS-STOFELLA *et al.*, in press), but are common in others (HUGHES, 1984; EIRAS-STOFELLA & CHARVET-ALMEIDA, 1997, 1998, and 2000). The distance variation

found between the branchial filaments must be related to the size and spacing between the respiratory lamellae. Although this variation has been recorded in some fish species, there are no studies determining their function (OJHA *et al.*, 1987; EIRAS-STOFELLA, 1994). These different configurations may influence the respiratory needs of the species and the type of food contained in the water that flows through this region.

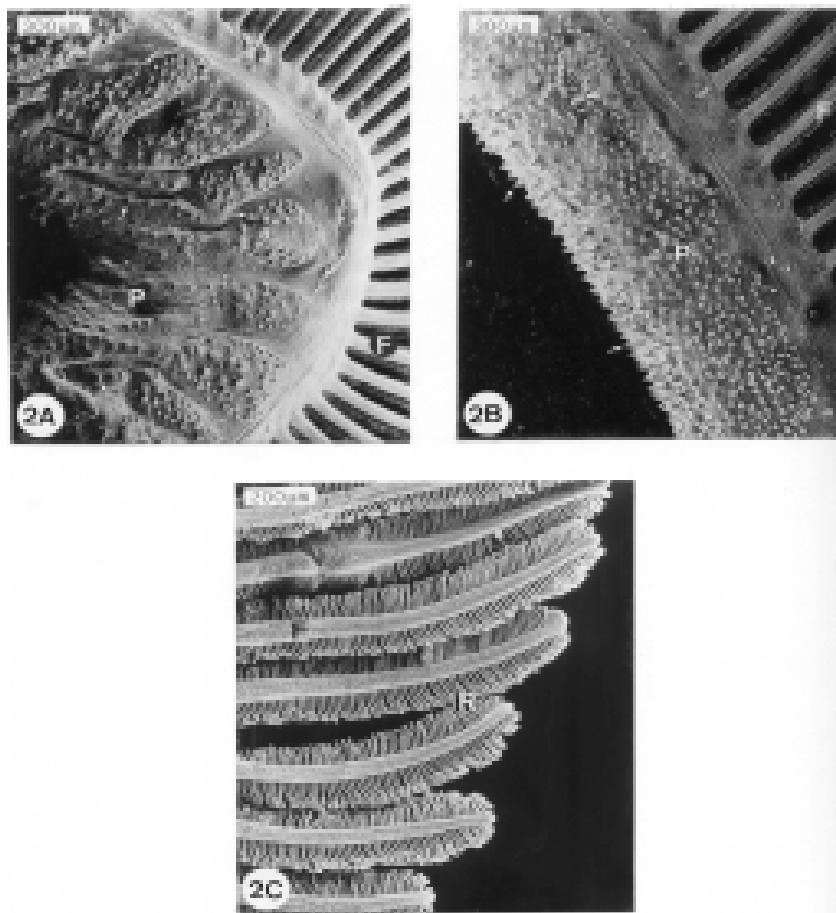


Fig. 2. General aspects of the branchial arch of the fish *Oligoplites palometa*: A, Strong curvature angle on the dorsal portion of the arch; B, Straight portion of the arch; C, Apical view of the branchial filaments. [P, pharyngeal region; F, filaments; R, respiratory lamellae; →, taste buds and spines]

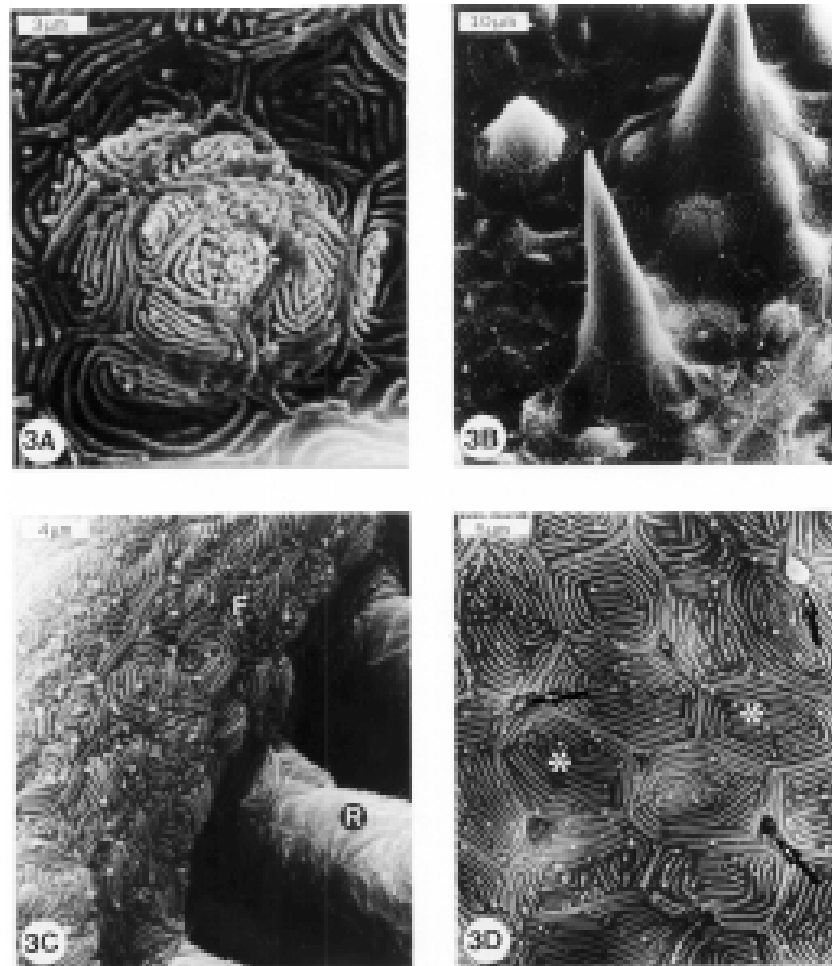


Fig. 3. Structural details of the branchial arch of *Oligoplites palometa*. A, taste bud; B, spines; C, epithelial surface of the branchial filaments; D, external epithelium of the pharyngeal region. [F, branchial filament; R, respiratory lamella; *, pavement cells with microridges; → hole of mucous cell].

The configuration, quantity, and the ways in which the different structures found in the pharyngeal region of the fish gills are distributed revealed the relationship between the morphology and feeding habits of the species (NIKOLSKI, 1963; MAGNUSON & HEITZ, 1971; EIRAS-STOFELLA, 1994; VANDENBERG *et al.* 1994; EIRAS-STOFELLA & CHARVET-ALMEIDA, 1997, 1998, 2000; EIRAS-STOFELLA, in press). According to CRAIG (1986), the *Oligoplites palometa* feeds

mainly on fish, followed by crustaceans ectoparasites, and presents lepidophagous behavior. Studies carried out by SAZIMA & UIEDA (1980) show that the feeding habits of the *O. palometa* consist namely of scales, and that it is possible that this species is necrophagous. Several morphological and behavioral adaptations favoring this type of food have been recorded and listed for this type of fish (WHITFIELD & BLABER, 1978; SAZIMA & UIEDA, 1980). The abundance of taste buds in the branchial pharyngeal region of the *O. palometa* shows the strategy used by the fish to select food before swallowing. The action of chemical receptors probably is the first protective measure taken by the species against possible damage to their respiratory structures. Because the *O. palometa* is a predator, with lepidophagous habits, it is difficult to prevent food from causing lesions to the branchial structures, particularly the respiratory lamellae.

So, extra care is required against possible friction. The situation seems to become more serious due to the absence of rakers. So, it is possible that the large quantity of spines found everywhere in the pharyngeal region of the gills may have a protective function, as well as of retaining and accumulating scales to be swallowed. At the same time, the large concentration of caliciform cells among the spines secretes a large amount of mucus. This secretion may involve and accumulate scales, thus reducing friction and the consequent lesions to the gills and adjacent regions in the digestive tract. Besides protection, it also renders the feeding process easier.

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SUMMARY

Gills of the seawater fish *Oligoplites palometa* were characterized ultrastructurally, with the aid of scanning electronic microscopy. The branchial filaments vary in length according to their location in the arch. The respiratory lamellae are well-developed. The epithelium that covers the surface of the filaments and the pharyngeal region of the branchial arches is formed by polygonal pavement cells with salient microridges. These folds in the membrane are not defined in the epithelium of the

respiratory lamellae. Caliciform cells are abundant, but were not found in the respiratory lamellae. There are no rakers in the pharyngeal region of the arches. The food ingestion process must begin by selection, based on information obtained from the various chemical receptors (taste buds) found. Besides protection, the large amount of spines found in the region must retain and accumulate the scales to be swallowed. The abundant mucous secretion probably involves the scales retained by the spines, making them easier to swallow. This also prevents food from damaging the gills and adjacent regions in the digestive tract.

Key words — fish-gill, morphology-and-functionality, *Oligoplites-palometa*.

RESUMO

Brânquias do peixe marinho *Oligoplites palometa* foram caracterizadas em nível ultra-estrutural, com auxílio de microscópio eletrônico de varredura. Os filamentos branquiais variam em comprimento conforme sua localização no arco. As lamelas respiratórias são desenvolvidas. O epitélio que reveste a superfície dos filamentos e da região faríngea dos arcos branquiais é formado por células pavimentosas poligonais com micropregas salientes. Essas dobras na membrana não são definidas no epitélio das lamelas respiratórias. Células caliciformes são abundantes e só não foram encontradas nas lamelas respiratórias. Não há rastro na região faríngea dos arcos. O processo de ingestão de alimentos deve começar pela triagem realizada a partir das informações vindas dos muitos quimiorreceptores (botões gustativos) encontrados. Além de proteger, a grande quantidade de espinhos que há na região deve reter e acumular as escamas a serem ingeridas. A abundante secreção de muco provavelmente envolve as escamas retidas entre os espinhos tornando mais fácil sua deglutição. Dessa forma é evitado, também, que o alimento provoque danos aos próprios arcos branquiais e às suas regiões vizinhas, no trato digestivo.

PALAVRAS CHAVE — brânquias-de-peixe, morfologia-e-função, *Oligoplites-palometa*.

RÉSUMÉ

Les branchies du poisson de mer *Oligoplites palometa* ont été décrites au niveau ultrastructural, à l'aide d'un microscope électronique à balayage. Les filaments branchiaux varient en longueur selon leur localisation dans l'arc. Les lamelles respiratoires sont développées. L'épithélium qui revêt

la surface des filaments et la région pharyngienne des arcs branchiaux est formé de cellules pavimenteuses polygonales avec des micro-plis saillants. Ces plis de la membrane ne sont pas définis *sur* l'épithélium des lamelles respiratoires. Les cellules caliciformes sont abondantes, sauf dans les lamelles respiratoires où elles n'ont pas été retrouvées. Il n'y a pas de branchiospines dans la région pharyngienne des arcs. Le processus d'ingestion des aliments doit commencer par le triage réalisé à partir des informations venues des plusieurs chimiorécepteurs (bourgeons gustatives) retrouvés. Outre la protection, la grande quantité d'arêtes qu'il y a dans la région doit retenir et accumuler des écailles à être ingérées. L'abondante sécrétion du mucus probablement enveloppe les écailles retenues améliorant ainsi leur déglutition. Ainsi, cette sécrétion évite aussi que les aliments provoquent des effets nuisibles aux arcs branchiaux et dans les régions avoisinantes du tube digestif.

MOTS CLÉS — Branchie-de-poisson, morphologie-et-fonction, *Oligoplites-palometa*.

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