

Radular ultrastructure of South American Ampullariidae (Gastropoda: Prosobranchia)

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Received September 20, 2005 – Accepted March 13, 2006 – Distributed November 30, 2007

(With 9 figures)

Abstract

The radula of five species of South American Ampullariidae was analysed by Scanning Electron Microscope (SEM) with the purpose of enlarging new studies on the systematic of this family. The studied species were *Pomacea canaliculata* (Lamarck, 1822), *Pomacea scalaris* (d'Orbigny, 1835), *Pomella (P.) megastoma* (Gray, 1847), *Asolene (A.) platae* (Maton, 1809) and *Felipponea neritiniiformis* (Dall, 1919). The central tooth shows different attributes which provide the means for generic determination; the analysis of the central tooth, the lateral and marginal ones by SEM adds further information for species differentiation.

Keywords: *Pomacea*, *Pomella*, *Asolene*, *Felipponea*, Ampullariidae South American, radula.

Ultra-estrutura radular dos Ampullariidae sul-americanos (Gastropoda: Prosobranchia)

Resumo

A rádula de cinco espécies sul-americanas de Ampullariidae é analisada ao microscópio eletrônico de varredura com objetivo de fornecer novos subsídios à sistemática desta família. As espécies estudadas são *Pomacea canaliculata* (Lamarck, 1822), *Pomacea scalaris* (d'Orbigny, 1835), *Pomella (P.) megastoma* (Gray, 1847), *Asolene (A.) platae* (Maton, 1809) e *Felipponea neritiniiformis* (Dall, 1919). O dente central apresenta novos subsídios à determinação genérica, o estudo ao microscópio eletrônico os dentes central, laterais e marginais acrescentam novos subsídios na determinação das espécies.

Palavras-chave: *Pomacea*, *Pomella*, *Asolene*, *Felipponea*, Ampullariidae sul-americanos, rádula.

1. Introduction

Ampullariidae are freshwater snails predominantly distributed in the Neotropical region (Castellanos and Fernandez, 1976; Cazzaniga, 2002) and in humid tropical and subtropical habitats in Africa, South and Central America and Asia. The following genera are recognized in South America: *Pomacea* Perry, 1810, *Asolene* d'Orbigny, 1838; *Felipponea* Dall, 1919, *Marisa* Gray, 1824 and *Pomella* Gray, 1847. In reviewing the Ampullariidae, Cowie and Thiengo (2003) carried out studies on its location and geographical distribution indicating the nomenclatural status (species, subspecies, synonymies, etc); the authors provide a list of fourteen genera and 307 species of the published American Ampullariidae.

In Argentina, the Ampullariidae contains twelve species and one subspecies which are included among five genera: *Pomacea*, *Asolene*, *Pomella*, *Felipponea*

and *Marisa*. The most frequent species in the lentic water bodies of the Mesopotamia Region, Del Plata basin (Cazzaniga, 1987) belong to these genera and present quite complete descriptions of their genital morphology (Hylton Scott, 1943, 1957; Martín, 1988; Cazzaniga, 1990a). The *Pomacea* species were studied by Lopes (1955, 1956a, 1956b), Thiengo (1987, 1989), Thiengo et al. (1993) and Faraco et al. (2002) in the Brazilian territory.

In the XX century, *Asolene* was considered as a subspecies of *Pomacea* (Dall, 1904; Hylton Scott, 1943) but at present, it represents nomenclaturally and taxonomically a genus with a subgenus: *Asolene* (d'Orbigny, 1837), while *Pomella* Gray, 1847, recognized as a subgenus of *Asolene*, has been replaced in the category of genus by Berthold (1991). Both genera have a short siphon, but they differ in their oviposition since *Asolene* deposits

its eggs under the waterline and *Pomella* lays its eggs above the waterline (Ghesquiere, 1998, 2003).

As for their ecological and biological behaviour, these species show predator and omnivorous activities (Cazzaniga, 1990b; Thiengo, 1995) and they are used as possible biocontrol agents of aquatic masses (Cazzaniga, 1981, 1983; Estebenet and Cazzaniga, 1990; Yusa and Wada, 1999) and as biological agents to control certain Planorbidae (schistosomiasis vectors) (Pointier et al. 1989). Results of studies carried out from 1972 to 1996 in Guadalupe island (Antilles) by the latter authors indicated that *Marisa cornuarietis* (Linnaeus, 1758), proved to be a useful biological agent to control *Biomphalaria glabrata* (Say, 1818) (intermediate host of schistosomiasis). The remaining Ampullariidae share the behaviour of this species, since they produce important modifications in the structure and functioning of freshwater ecosystems.

Magni Drawich et al. (1989) could observe that *Asolene (Pomella) megastoma* (Sowerby, 1852) carries larvae and pupa of Simuliids insects on its shell (first record for the Neotropical region), representing a possible occasional phoretic. These dipterous have been found in the digestive system of *Asolene*, this is why it is suggested that snails could produce a biological control on these insects.

Although the available information on the internal morphology and mainly on the radular ultrastructure of species of this family is still incomplete, the aim of this work focuses on the comparison of the radulae of five species of the Ampullariidae family to verify the validity of this character as a classificatory tool in the study of the above family taxonomy.

2. Materials and Methods

The radulae of *Pomacea canaliculata* (Lamarck, 1822), *Pomacea scalaris* (d'Orbigny, 1835), *Pomella (P.) megastoma* (Gray, 1847), *Asolene (A.) platae* (Maton, 1809) and *Felipponea neritiniiformis* (Dall, 1919) were extracted from the radular sac and cleaned with sodium hypochlorite. Then, they were washed in distilled water with the aid of a paintbrush and finally taken through 50° and 70° ethyl alcohol (Lanzer, 1994) to study them with the Scanning Electron Microscope from the Museum of the National University of La Plata.

Descriptions of the radulae of the species here studied are based on the morphological studies carried out by Hylton Scott (1957); and for the particular case of *P. canaliculata* by Moretto and Nahabedian (1983).

2.1. Studied material

***P. canaliculata*:** Bajo de Velez (30° 42' S and 63° 30' W) San Luis; San Pedro (33° 39' S and 59° 41' W) Buenos Aires and Monte Caseros (30° 17' and 57° 38' W) Corrientes. Eleven radulae were examined.

***P. scalaris*:** Doña Flora stream (34° 49' S and 57° 59' W) Punta Lara, Ensenada, Buenos Aires. Five radulae from adult specimens (27.7-33.9 mm total length).

***P. (P.) megastoma*:** Monte Caseros 30° 17' S and 57° 38' W) Corrientes and Puerto Iguazú (25° 36' S and 54° 35' W) Iguazú, Misiones. Seven radulae of individuals whose sizes ranged from 25 to 50 mm length were analysed.

***A. (A.) platae*:** Lechiguanas Island (33° 39' S and 59° 41' W) San Pedro (Buenos Aires). Two radulae of adult specimens and of specimens (approximately 20, 5 mm. total length) from Dona Flora stream, Ensenada, Buenos Aires (34° 49' S and 57° 59' W) were studied.

***Felipponea neritiniiformis*:** Yabotí Mini stream (26° 55' S and 53° 25' W) Misiones. Two radulae of female specimens whose sizes ranged from 20 to 22.6 mm were analysed.

3. Results

The radular formula of the analysed specimens of the Ampullariidae species here studied is 2.1. c. 1.2 (Taenioglossate type) with straight rows of teeth. The base of the radula consists of a radular ribbon to which the teeth are attached. The seven teeth are disposed in the following way: the central tooth is flanked on each side by a lateral one and two marginal ones (inner and outer marginal teeth). The lamina basal settles on the radular ribbon. The posterior ends of the basal plate are sharp-pointed curving inwards. Gastropods replace their radular teeth throughout their entire life cycle (Runham, 1962; Runham and Thornton, 1967). The transmission electron microscope is the ideal means to observe, with high resolution, variations in the cusps of the central teeth and the level of tooth wear caused by rapping activity during feeding.

Radular teeth of freshwater snails feature the following characteristics:

Pomacea canaliculata (Lamarck, 1822)

The central tooth is elongated, broader than longer, with a main trapezoidal cusp. Three smaller cones ending in only one end are observed on each side of the central cone.

The lateral teeth located on each side of the central tooth are multicuspid, and one of these cusps is larger than the other two. One of these small cones is facing the central teeth.

The outer and inner marginal teeth are quite elongated and when the radula is at rest they lean among themselves and their tips end in two sharp cusps (Figure 1).

Pomacea scalaris (d'Orbigny, 1835)

The central tooth is sharp and the cusp or main cone is narrow and elongated, two or three shorter cusps are observed on each side; they show different levels of fusion and they occasionally develop bifid points, a wide variation is observed along the subsequent rows (Figure 2). This central tooth or rachidian tooth features some microsculptures or small ornamentations at its base which are only present below the lateral cusps.

These dental pieces are broader than longer. The lateral teeth are almost planate and flattened with four cusps of distinct sizes. The marginal outer and inner teeth are quite elongated and thin and they are not multicuspoid (Figure 3).

***Pomella (P.) megastoma* (Gray, 1847)**

The central tooth has seven cusps, the largest of which is trapezoidal and the most important, in adult specimens, it becomes rounded and affects the smaller cusps. The most distal of these three cusps is very small, bluntly pointed and is always orientated inwards. As for the breadth-length relationships, they are always broader than longer. The lateral teeth have three cusps, the central of which is the largest, and the other two lateral cusps are weakly developed. The marginal inner and outer teeth are quite elongated, the inner one shows two cusps at its end, that is, it features a bifid end. The outer marginal teeth tend to lie over the inner one becoming sharply pointed, with a little lat-

eral point orientated towards the inner marginal teeth (Figures 4 and 5).

***Asolene (Asolene) platae* (Maton, 1809)**

The main cusp of the central tooth is the most developed and conspicuous, almost lanceolate; the lateral cusps show a progressive decrease in size, but keeping their own forms (Figure 6). The central teeth breadth always doubles its length. The lateral teeth are rather short and with bifid rounded ends. The marginal teeth are quite slender and they overlap the lateral ones ending in curve and sharply-pointed ends, with two small points (Figures 7 and 8).

***Felipponea neritiniiformis* (Dall, 1919)**

The central tooth has a large triangular cusp ending in a sharp point and three other small blunt points are observed on each side. Up to five cones have been observed on the right or left side of some of these teeth. Also, some knot-shaped cones are observed at the base

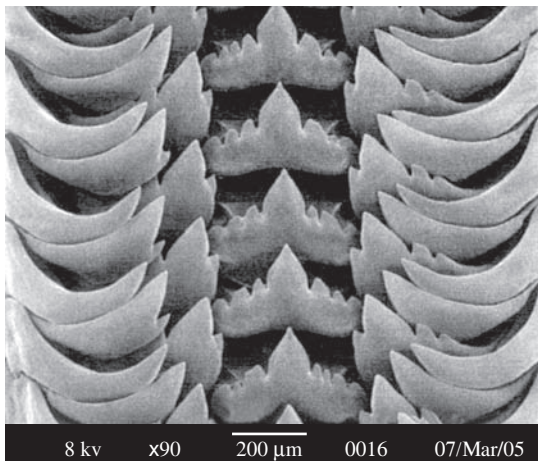


Figure 1. Radula of *Pomacea canaliculata*.

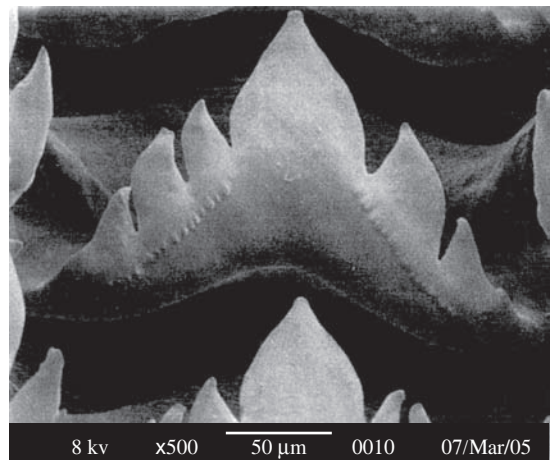


Figure 3. Detail of central teeth of radula *Pomacea scalaris*.

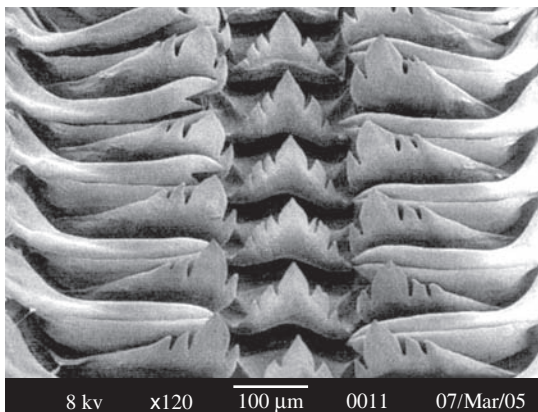


Figure 2. Radula of *Pomacea scalaris*.

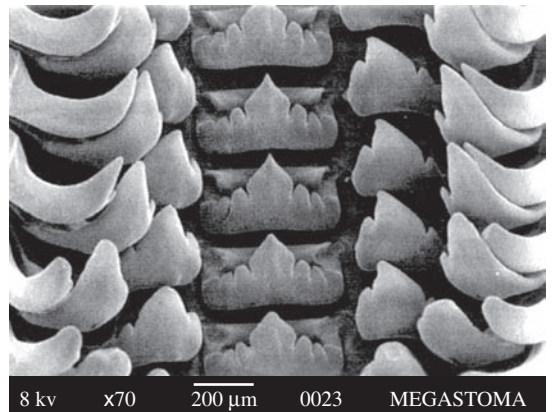


Figure 4. Radula of *Pomella (Pomella) megastoma*.

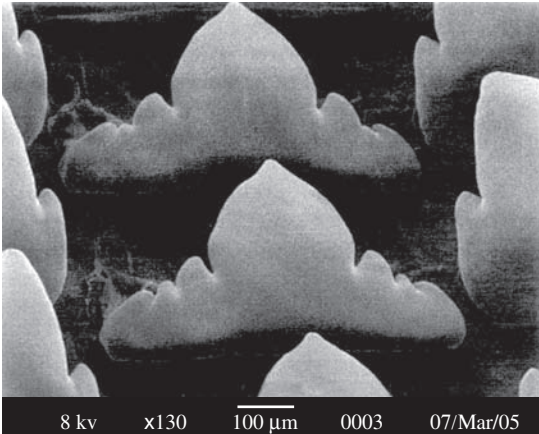


Figure 5. Detail of central teeth of radula *Pomella* (*Pomella*) *megastoma*.

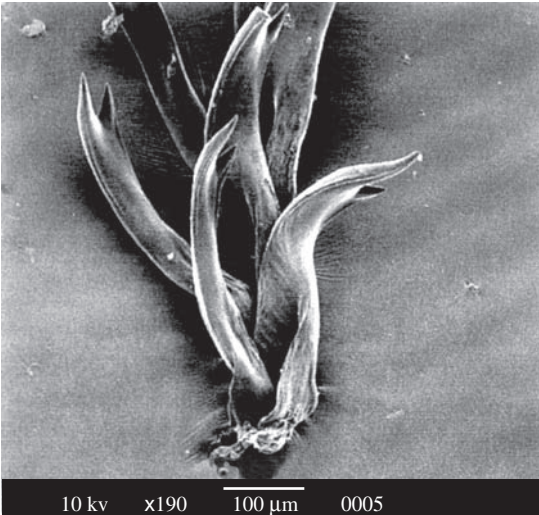


Figure 6. Detail of lateral teeth of radula *Asolene* (*A*) *platae*.

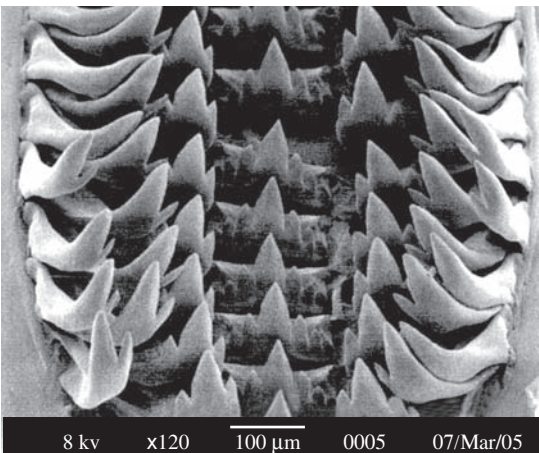


Figure 7. Radula of *Asolene* (*A*) *platae*.

of these teeth. The lateral tooth has a main cusp as well and on each side, one or two shorter cones are observed. The inner and outer marginal teeth are quite elongated and they fold one over the other (Figure 9).

4. Conclusions

The radulae of the species of the Ampullariidae family studied under SEM have a common pattern (taenioglossate: 2.1. c. 1.2) characterized by a central radular tooth or rachidian tooth, a lateral and two marginal ones (inner and outer marginal teeth) on each side. The number of rows varies depending on the species; they possess some wing-like extensions and a ribbon to which rows of teeth are attached.

The central teeth, one per row, are subsequently displayed, being perpendicular to the sagittal plan of the odontophore.

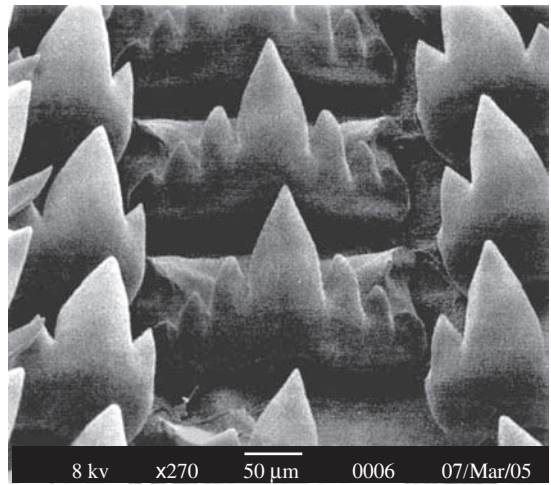


Figure 8. Detail of central teeth of radula *Asolene* (*A*) *platae*.

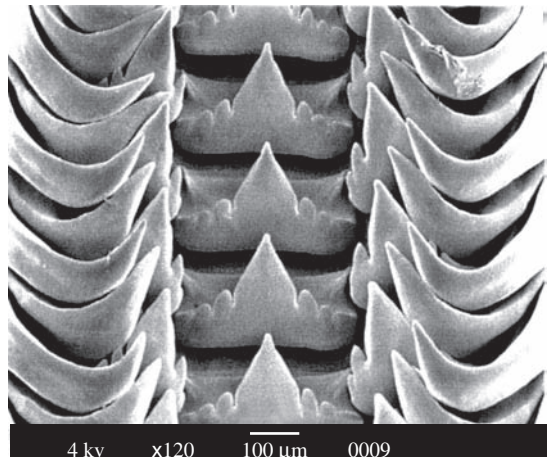


Figure 9. Radula of *Felipponea neritiniformis*.

The lateral teeth form parallel rows among themselves and with respect to the central teeth, they form an angle orientated towards the posterior region of the radula.

There are two marginal teeth per horizontal row; they are located one next to the other.

Results of comparisons among radulae of the species of the Ampullariidae family carried out using SEM indicate that the characters of the central tooth together with those of the, lateral and marginal teeth can be used to differentiate the species among themselves from *Pomacea* and in turn differentiate them from the other genera studied in this present work.

In all cases, when the odontophore is at rest the outer marginal tooth accommodates over the inner marginal one and the latter shows a concavity where the lateral rests projecting towards the central or rachidian tooth. The region that arises from these teeth is much thinner and it always ends in two points, on the other hand, the base is broader and is lobe or cone-shaped, this structure could be used as an anchorage in the radular ribbon allowing the coordinated movement of the remaining teeth of the same row and allowing the mechanism of cutting and collecting food by the snail.

The central tooth is a useful morphological character to identify *Pomacea*, *Asolene*, *Pomella* and *Felipponea*. *Pomacea scalaris* central tooth has some microsculptures and is more fragile than that of the other species here studied. Also, the main cusp is quite elongated and is not trapezoidal.

All specimens of *P. canaliculata*, *P. scalaris* and *Asolene platae* are adults, while individuals of *Pomella (Pomella) megastoma* were juveniles; yet no remarkable differences were observed in the forms of the cusps in the dental series, except for the wear of the central teeth that can be caused by the way the molluscs graze vegetation growing on the rocky bed.

On the other hand, the comparison of the radulae of South American species with those of *Afropomus balanoideus* (Gould, 1850) indicated that the basal tip of the marginal inner tooth bears a basal lobe, a character that could be observed in the studied species which is not so conspicuous as in this African species and in *P. canaliculata* (Berthold, 1988).

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