



## SEXUAL DIMORPHISM IN THE RADULA OF *PISANIA PUSIO* (LINNAEUS, 1758) (MOLLUSCA, GASTROPODA, BUCCINIDAE)

H. MATTHEWS-CASCON<sup>(1)</sup>, H. A. PEREIRA ALENCAR<sup>(2)</sup>, S. GUIMARÃES RABAY<sup>(2)</sup> & R.M.S. MOTA<sup>(3)</sup>

**Keywords:** Mollusca, prosobranch, radula, sexual dimorphism.

### ABSTRACT

*Pisania pusio* (Linnaeus, 1758) is an inhabitant of the intertidal zone, being generally found under the rocks during the low tide. It presents spindle, smooth and glossy shell measuring 34 mm of length, with purplish brown color with narrow, revolving, dark brown bands, sometimes in the shape of arrowheads and rachiglossate radula type. The objective of this study was to investigate the occurrence of sexual dimorphism in the size of the radula and in the shape of the teeth among adults of *Pisania pusio*. Forty-two adult specimens of *P. pusio* were collected in the Pacheco Beach, Caucaia, State of Ceará, Northeast Brazil. Twenty specimens were males and twenty-two were females. The radula was removed, and then measured with a millimetric slide under compound microscope. Sixty lateral and rachidian teeth of both

females and males had five dimensions measured. For comparison of the radula size between sexes, the "t" test of Student was used. For the males the average size of the radula was of 10.25±2.4 mm of length, for the females, the average size of the radula was of 8.87±1.2 mm of length. The length of radular ribbon of showed a statistically significant difference between male and female ( $p=0.002$ ). The size of the lateral teeth of the males and females showed statistically significant difference in five dimensions measured and the size of the rachidian teeth of males and females showed statistically significant difference in four dimensions measured.

### INTRODUCTION

Prosobranch mollusks may present sexual differences in the shell, radula and in some parts of the body. The differences in the shell are generally related to size and format, with the females usually larger than the males as in the species *Voluta ebraea* (Matthews, 1969), *Pugilina morio* (Matthews-Cascon, Matthews & Belucio, 1990) and *Lacuna pallidula* (Bandel, 1976; Fretter, 1984; Fretter & Graham, 1994). Dimorphism only affecting the weight of the animals was registered in some species of *Polinices*, where the males are generally heavier than the females (Bernard, 1968; Fretter, 1984). Sexual dimorphism in shell color is

(1)Departamento de Biologia, Centro de Ciências, Instituto de Ciências do Mar. Universidade Federal do Ceará (UFC), Campus do Pici, Bloco 906, Fortaleza - Ceará - Brasil, 60.455-970. e-mail: hmc@ufc.br

(2)Departamento de Biologia, Centro de Ciências, Universidade Federal do Ceará

(3)Departamento de Estatística e Matemática Aplicada, Centro de Ciências, Universidade Federal do Ceará

found in *Cypraea gracilis*, where the females are red and the males brown (Griffiths, 1961). In *Ficus subintermedia*, the propodium in the males is sharp while in the females is dull (Fretter, 1984). Sexual dimorphism in radula size is found in *Nassa francoliana* (Maes, 1966; Fretter, 1984) where the rachidian tooth is larger in the males. In some Cypraeidae the radula of females is smaller and the shape of the rachidian tooth presents sexual dimorphism (Schilder & Schilder, 1961). The radula of some species of *Drupella* presents sexual differences in the lateral teeth (Arakawa, 1958a). Another species that presents sexual dimorphism in the radula is *Tricolia variabilis*, where the males have less marginal teeth than the females (Robertson, 1971).

The Buccinidae *Pisania pusio* is a slow moving gastropod found in the intertidal zone under the rocks associate with tunicates, sponges and calcareous algae. *Pisania pusio* presents spindle smooth and glossy shell measuring in average 34 mm of length, with purplish brown color with narrow, revolving, dark brown bands, sometimes in the shape of arrowheads and rachiglossate type radula. The objective of this study was to investigate the occurrence of sexual dimorphism in the size of the radula and in the shape of the radular teeth among adults of *Pisania pusio* (Linnaeus, 1758).

## MATERIAL AND METHODS

Forty-two adult specimens of *P. pusio* (20 males and 22 females) were collected in the intertidal zone in the Pacheco Beach (38°38'48"W, 03°41'24"S) Caucaia, State of Ceará, Northeast Brazil, in October of 2001. The animals had the shell length measured and were anesthetized in 30% magnesium chloride and later fixed in 70% alcohol. After the initial examination for determination of the sex, the proboscis was removed and boiled in solution of saturated potassium hydroxide (KOH), until the soft parts dissolved and remained just the radula.

The radulae of all individuals were measured on a millimetric slide, and those of six males and of six females were clarified with xylol, stained with Congo red diluted in absolute alcohol and had their teeth removed under compound microscope. The teeth were placed in a microscopic slide with glycerin and

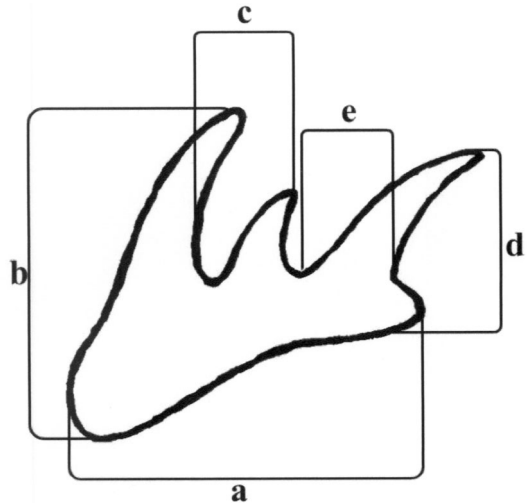


Figure 1.  
Five dimensions measured in the lateral tooth of *Pisania pusio*: a- Lateral tooth width; b- Lateral tooth outer cusp length; c- Lateral tooth width between outer and middle cusps; d- Length of inner cusp; e- Width of inner cusp

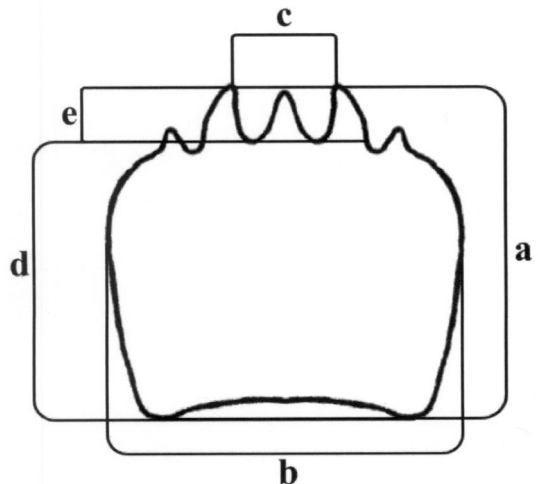


Figure 2.  
Five dimensions measured in the rachidian tooth of *Pisania pusio*: a- Rachidian tooth length; b- Rachidian tooth width; c- Rachidian tooth width between middle cusps; d- Rachidian tooth length without the cusps; e- Rachidian tooth length of all middle cusps.

measured under an optic microscope with a graduated ocular lens. Sixty lateral and rachidian teeth of both females and males had five dimensions measured (Figs.1, 2).

Four radulae (two of each sex) were observed and photographed under scanning electron microscope (SEM) model XI 30, covered with carbon filament (Metalizer the Sputer Coater SCD 0,50). All the statistical analysis were developed with the program GraphPad Instat® Version 3.06, 32bit for Windows. The normality of the distribution of the collected data was verified with the test KS, while the veracity of difference in the samples was verified with Mann-Whitney test.

All shell measurements were made with a vernier caliper to 0.1mm. The shell length of *Pisania pusio* was the distance from the apex to the tip of siphonal canal.

## RESULTS

The radula ribbon of *P. pusio* males presented in average a length of  $10,25 \pm 2,38$  mm and that of females was in average  $8,87 \pm 1,2$  mm. The difference was statistically significant ( $p=0.02$ ). The difference

among sexes in the variance was also statistically significant ( $p<0.01$ ), with the measures of the females being less variant.

The rachidian tooth of *P. pusio* males presented higher values than that of females in four of the five dimensions measured, with the differences being statistically significant (Table 1).

The lateral teeth of *P. pusio* showed statistically significant difference among the sexes in all five dimensions measured, when the males presenting higher values (Table 2).

Besides the differences in the size, *P. pusio* presented sexual dimorphism in the shape of the radular teeth. The rachidian tooth is subquadrate with three big cusps in the middle, but in the females the base of the rachidian is concavewhile in the males is straight. The lateral teeth has three cusps inclined toward the central part of radular row (Figs. 3,4), but in the males the inner cusp is longer and slim than the females.

The shell length in adults of *Pisania pusio* did not showed a statistically significant difference between males and females ( $p=0.3385$ ).

Table 1.

Comparative measurements of the rachidian tooth of males and females in *Pisania pusio* from Pacheco Beach, Caucaia, State of Ceará, Northeast Brazil, collected in October of 2001. N=60.

|         |        | Rachidian<br>tooth length<br>(mm) | Rachidian<br>tooth width<br>(mm) | Rachidian<br>tooth width<br>between<br>middle cusps<br>(mm) | Rachidian<br>tooth length<br>without the<br>cusps (mm) | Rachidian<br>tooth length<br>of all middle<br>cusps (mm) |
|---------|--------|-----------------------------------|----------------------------------|---|--|--|
| Males   | Mean±S | 0.14±0.02                         | 0.16±0.02                        | 0.08±0.00   | 0.10±0.02  | 0.04±0.00  |
|         | D      |                                   |                                  | 9   |  | 7  |
|         | Range  | 0.10-0.18                         | 0.12-0.19                        | 0.05-0.09   | 0.08-0.14  | 0.02-0.05  |
| Females | Mean±S | 0.10±0.00                         | 0.13±0.01                        | 0.08±0.01   | 0.09±0.006   | 0.02±0.05  |
|         | D      | 08                                | 2                                |   |  |  |
|         | Range  | 0.10-0.13                         | 0.10-0.15                        | 0.05-0.09   | 0.08-0.10  | 0.008-0.03   |
|         | p      | <0.0001                           | <0.0001                          | =0.25   | <0.0001  | <0.0001  |

Table 2.

Comparative measurements of the size of the lateral teeth of males and females in *Pisania pusio* from Pacheco Beach, Caucaia, State of Ceará, Northeast Brazil, collected in October of 2001. N=60.

|         |        | Lateral tooth width (mm) | Lateral tooth outer cusp length (mm) | Lateral tooth width between outer and middle cusps (mm) | Lateral tooth length of inner cusp (mm) | Lateral tooth width of the inner cusp (mm) |
|---------|--------|--------------------------|--------------------------------------|---|---|--|
| Males   | Mean±S | 0.21±0.04                | 0.19±0.04                            | 0.10±0.02   | 0.13±0.03                               | 0.05±0.00                                  |
|         | D      |                          |                                      |   |   | 9  |
|         | Range  | 0.16-0.28                | 0.13-0.28                            | 0.07-0.13   | 0.06-0.19                               | 0.04-0.07                                  |
| Females | Mean±S | 0.16±0.01                | 0.14±0.01                            | 0.08±0.007  | 0.09±0.009                              | 0.05±0.00                                  |
|         | D      |                          |                                      |   |   | 8  |
|         | Range  | 0.15-0.12                | 0.12-0.18                            | 0.07-0.10   | 0.08-0.12                               | 0.03-0.07                                  |
|         | p      | <0.0001                  | <0.0001                              | <0.0001   | <0.0001                                 | <0.0001                                    |

## DISCUSSION

There have been many studies on the gastropod radula, where the radular characters are generally considered constant within the species or that individual variation does not exceed the difference between species (Fretter & Graham, 1994). However, many studies have demonstrated that the radular characters are modified by many factors as seasonal changes, sexual differences, age (Maes, 1966, Fujioka, 1984, 1985a, 1985b, 1985c).

Sexual dimorphism in the radula of Muricidae have been reported in four species of *Drupella* (Arakawa, 1958a; Fujioka, 1982) in two species of *Nassa* (Maes, 1966), in four species of *Mancinella* (Arakawa, 1958b; Fujioka, 1985a), and in *Morula musiva* and *Cronia margariticola* (Fujioka, 1984). Nevertheless, in Buccinidae the only case reported was for *Pisania luctuosa* (Cernohorsky, 1971), where as found in the present study for *Pisania pusio*, the radula ribbon was longer in the males than in the females.

Larger teeth in the radula of adults males than in females and sexual dimorphism in the shape of the rachidian tooth, found in this study for *Pisania pusio* was also reported for some species of *Mancinella*, a muricid gastropod (Fujioka, 1985b).

Sexual dimorphism in the size the radular ribbon is largely dependent on the growth of individual teeth, because the length of radular ribbon is determined by the tooth size or the thickness of the tooth bases along the longitudinal axis by the number of rows (Fujioka, 1985a).

According to Fujioka, (1985b) sexual dimorphism in the radula of Muricidae was predominantly observed in the genera with simplified tricuspidate rachidians such as *Mancinella* and *Cronia*. *Pisania pusio* rachidian tooth is also simplified with three big cusps in the middle.

Robertson (1971) believed that sexual dimorphism of the radula found in species of the genus *Hilota* may be selectively advantageous for their different food requirements. The biological significance of this dimorphism in *Pisania pusio* if any, is yet unknown. It is not possible at present to determine whether this radular dimorphism is functional.

## ACKNOWLEDGEMENTS

We are very grateful to Dr. Paulo Cascon who provided useful insights and for revising English language. For assistance with electron microscopy we thank Daercio da Costa Magalhães.

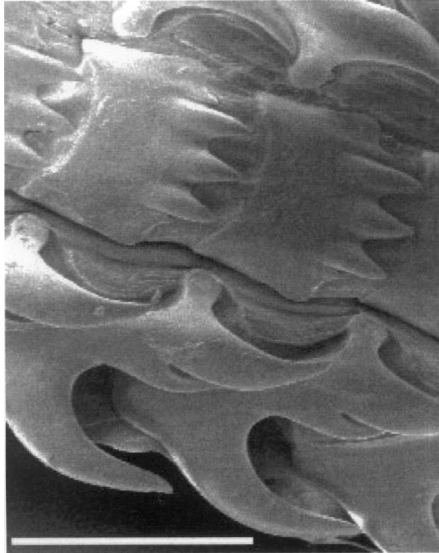


Figure 3.  
Female radula of *Pisania pusio* (S.E.M.). Measure bar=100µm.

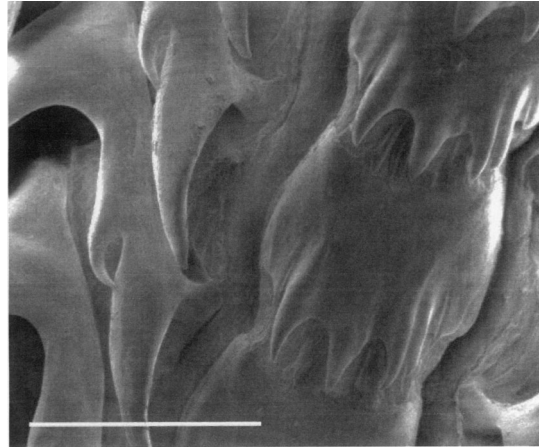


Figure 4.  
Male radula of *Pisania pusio* (S.E.M.). Measure bar=100µm.

## REFERENCES

- Arakawa, K.Y. 1958 a. On the remarkable sexual dimorphism of the radula of *Drupella*. *Venus* 19 : 206-214.
- Arakawa, K.Y. 1958 b. Some notes on the radula of *Purpura echinata* Lamarck. *Venus*, 20: 69 - 75.
- Bandel, K. 1976. Spawning, development and ecology of some higher Neogastropoda from the Caribbean Sea of Columbia (South America). *Veliger* 19 (2) : 176-193.
- Bernard, F.R. 1968. Sexual dimorphism in *Polinices lewisi* (Naticidae). *Nautilus* 82: 1-3.
- Cernohorsky, W.O. 1971. Indo-Pacific Pisaniinae (Mollusca: Gastropoda) and related buccinid genera. *Rec. Auckland Inst. Mus.*, 8: 137 - 167.
- Fretter, V. 1984. Prosobranchs. In: K.M.Wilbur (Ed.), *The Mollusca. Reproduction* vol. (1 - 45pp.). New York: Academic Press, Inc.
- Fretter, V. & Graham, A. 1994. *British prosobranch molluscs*. London: The Ray Society. 820 pp.
- Fujioka, Y. 1982. On the secondary sexual characters found in the dimorphic radula of *Drupella* (Gastropoda: Muricidae) with reference to its taxonomic revision. *Venus*, 40: 203 - 223.
- Fujioka, Y. 1984. Sexually dimorphic radulae in *Cronia margariticola* and *Morula musiva* (Gastropoda: Muricidae). *Venus*, 43: 315 - 330.
- Fujioka, Y. 1985 a. Systematic evaluation of radular characters in Thaidinae (Gastropoda: Muricidae). *J. Sci. Hiroshima Univ., Ser. B, Div.1*, 31: 235 - 287.
- Fujioka, Y. 1985 b. Sexually dimorphic radulae in four species of *Mancinella* (Gastropoda: Muricidae). *Mukaishima Mar. Biol. Station*, 238: 73 - 81.
- Fujioka, Y. 1985 c. Seasonal aberrant radular formation in *Thais bronni* (Dunker) and *T. clavigera* (Kuster) (Gastropoda: Muricidae). *J. Exp. Mar. Biol. Ecol.*, 90: 43 - 54.
- Griffiths, R.J. 1961. Sexual dimorphism in Cypraeidae. *Proc. Malacol. Soc. London*, 34: 203-206.
- Maes, V.O. 1966. Sexual dimorphism in the radula of the muricid genus *Nassa*. *Nautilus*, 79: 73-80.
- Matthews, H. 1969. Notas sobre a familia Volutidae no Nordeste brasileiro (Mollusca : Gastropoda). *Arq. Ciên. Mar*, 9: 71-75.
- Matthews-Cascon, H.; Matthews, H. & Belucio, L. 1990. Notas sobre a anatomia, sistemática e biologia de *Pugilina morio* Linnaeus, 1758 (Mollusca: Gastropoda). *Arq. Ciên. Mar*, 28: 3-8.
- Robertson, R. 1971. Sexually dimorphic archaeogastropods and radulae. *Annu. Rep. Am. Malacol. Union.*, 75-78 pp.
- Schilder, F.A. & Schilder, M. 1961. Sexual differences in cowries. *Proc. Malacol. Soc.*, 74: 207-209.

(Received: January, xx 200x. Accepted: July, xx, 200x)