

SEXUALLY DIMORPHIC RADULAR MORPHOLOGY IN Columbella mercatoria (MOLLUSCA: GASTROPODA: COLUMBELLIDAE)

Dimorfismo sexual na rádula de *Columbella mercatoria*
(Mollusca: Gastropoda: Columbellidae)

Ênio Victor Paiva Bandeira^{1*}, Soraya Guimarães Rabay¹,
Helena Matthews-Cascon^{1,2}

ABSTRACT

Radular morphology in (Linnaeus, 1758) was investigated for the occurrence of sexual dimorphism. Thirty adult specimens of C. mercatoria (15 males and 15 females) were collected in the intertidal zone of the Farol do Trapiá Beach (2°51'S - 40°51'W) Camocim and Banco dos Cajuais Beach (4°40'S - 37°20'W) Icapuí, State of Ceará, Northeast Brazil, from May to June of 2012. The animals were fixed and had the shell length measured. The radula of six males and six females was separated and measured, and sixty lateral and rachidian teeth of both females and males had six and two dimensions measured, respectively. For males, the average length of radula ribbon was 7.24 ± 0.72 mm and that of females was in average 7.92 ± 1.02 mm. The difference was statistically significant ($p= 0.047$). The test revealed a positive significant correlation between shell length and the lengths of radula ribbon of males ($R^2 = 0.767$) and females ($R^2 = 0.508$).

Keywords: gastropod, *Columbella mercatoria*, radula morphology, intertidal zone.

RESUMO

Morfologia da radula de Columbella mercatoria (Linnaeus, 1758) foi estudada com o objetivo de se verificar a ocorrência de dimorfismo sexual. Trinta espécimes de C. mercatoria (15 fêmeas e 15 machos) foram coletados na zona intertidal no Faról do Trapiá (2°51'S - 40°51'W) e Banco dos Cajuais (4°40'S - 37°20'W) Icapuí, Ceará, Nordeste do Brasil, nos meses de maio a junho de 2012. Os animais foram fixados e tiveram o comprimento de suas conchas mensurado. As rádulas de seis machos e seis fêmeas foram separadas e medidas, e sessenta dentes laterais e raquidianos de ambos os sexos tiveram seis e duas dimensões medidas, respectivamente. Para os machos a média do tamanho da radula foi $7,24 \pm 0,72$ mm de comprimento, e para fêmeas a média do tamanho foi $7,92 \pm 1,02$ mm de comprimento. A diferença foi estatisticamente significativa ($p=0,047$). O teste revelou correlação significativa positiva entre o comprimento da concha e os tamanhos da rádula de machos ($R^2 = 0,767$) e fêmeas ($R^2 = 0,508$).

Palavras-chaves: gastrópode, *Columbella mercatoria*, morfologia da rádula, zona entre-marés.

¹ Departamento de Biologia, Universidade Federal do Ceará, Campus do Pici, Bloco 909, Fortaleza, CE 60455-760.

² Instituto de Ciências do Mar, Universidade Federal do Ceará, Av. Abolição, 3207, Fortaleza, CE 60165-081.

* Corresponding author. E-mail: _eniopaiva4@gmail.com

INTRODUCTION

Many studies on the Gastropoda radula showed that radular characters are generally considered constant within the species or that individual variation does not exceed the difference between species (Fretter & Graham, 1994). The radula morphology in Columbellidae is very conserved within species; however, intraspecific dimorphism in radular morphology could be interesting from a functional perspective (deMaitenon, 2004).

Sexual dimorphism in the radula is found in many gastropods. The radula ribbon in *Pisania pusio* is longer in the males than in the females, and the rachidian tooth is bigger in the males (Matthews-Cascon et al., 2005). In some Cypraeidae the radula of females is smaller (Schilder & Schilder, 1961). 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 family Columbellidae is very diverse and contains species that are either carnivorous or herbivorous. The digestive tract is different between them with the herbivorous having a shorter proboscis, a wider radula and a stronger subradular cartilage (Kantor & Medinskayer, 1991).

Columbella mercatoria (Linnaeus, 1758) (Figure 1) is an herbivorous gastropod found in the intertidal zone (deMaitenon, 1999), that presents squat and heavy shell measuring in average 16 mm of length, with 12 spiral ridges on body whorl. The shell color is very variable, usually white and brown with broken dark spiral bars and it has a rachiglossate-type radula, but with an acuspate center plate rather than a typical rachidian.

The Columbellidae radula is characterized by having secondary cusps laterally placed on a single

lateral tooth and by the presence of medial plate (Guralnick & deMaitenon, 1997). In the radula morphology many modifications are probably associated with herbivory (deMaitenon, 1999). However, many studies have demonstrated that the radular characters are modified by many factors as seasonal changes, sexual differences, and age (Maes, 1966, Fujioka, 1984, 1985a/b/c).

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 radula teeth among adults of *Columbella mercatoria*.

MATERIAL AND METHODS

Thirty adult specimens of *Columbella mercatoria* (15 males and 15 females) were collected in the intertidal zone of the Farol do Trapiá Beach (2°51'S - 40°51'W) Camocim and Banco dos Cajuais Beach (4°40'S e 37°20'W) Icapuí, State of Ceará, Northeast Brazil, from May to June of 2012.

The animals had the shell length measured and were anesthetized with 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.

All specimens of *C. mercatoria* were incorporated into the "Prof. Henry Ramos Matthews-series B" Malacologica Collection of the Universidade Federal do Ceará (CMPHRM-B/UFC - CMPHRM3891-B, CMPHRM3892-B).

The radulae of all individuals were measured on a milimetric slide, and those of six males and of six females had their teeth removed under compound microscope. The teeth were placed in a microscopic slide with glycerin and measured under an optic microscope with a graduated ocular lens. Sixty lateral and rachidian teeth of both females and males had six dimensions measured (Figures 2 and 3).

All the statistical analysis was developed with the program BioEstat Version 5.3. 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 the Mann-Whitney test. All shell measurements were made with a vernier caliper to 0.1mm. The shell length of *Columbella mercatoria* was the distance from the apex to the tip of siphonal canal.

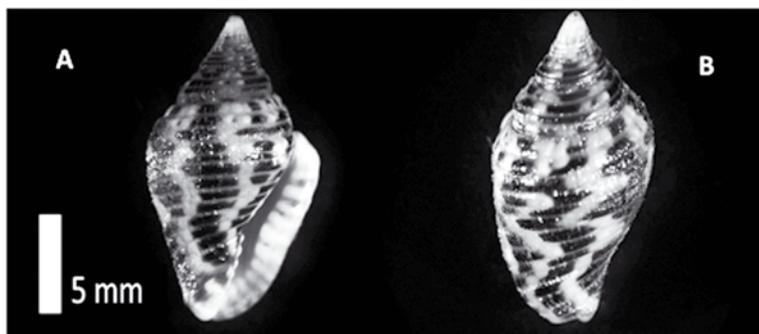


Figure 1 - *Columbella mercatoria* ventral view (A), dorsal view (B).

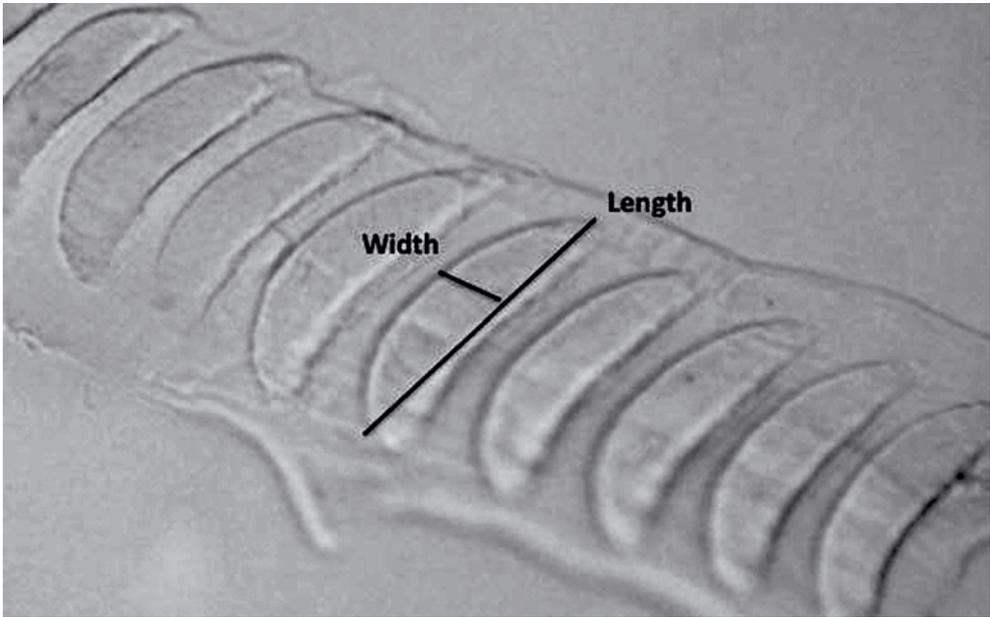


Figure 2 - Rachidian tooth of a male *Columbella mercatoria*.

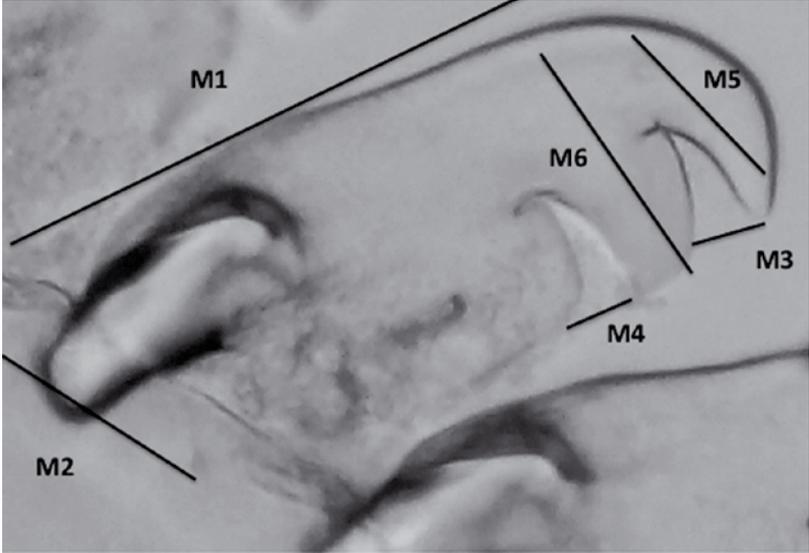


Figure 3 - Six dimensions measured in the lateral tooth of *Columbella mercatoria*: M1- Lateral tooth length; M2 - Lateral tooth width; M3 - Lateral tooth outer cusp length; M4 - Lateral tooth middle cusp length; M5 - Lateral tooth outer cusp width; M6 - Lateral tooth middle cusp width.

RESULTS

The radula ribbon of *Columbella mercatoria* males presented in average a length of 7.24 ± 0.72 mm and that of females was in average 7.92 ± 1.02 mm. The difference was statistically significant ($p = 0 > 0.47$).

The width of the rachidian tooth of males presented higher values than that of females with the difference being statistically significant ($p < 0.05$) (Table I). The lateral teeth of *C. mercatoria* showed statistically significant difference among the sexes in

four of the six dimensions measured, when the females presenting higher values (Table II).

Table I - Comparative measurements of the rachidian tooth of males and females in *Columbella mercatoria* (N=30).

| Attributes | | Rachidian tooth length (mm) | Rachidian tooth width (mm) |
|-------------|------|-----------------------------|----------------------------|
| Male | Mean | 0.10 ± 0.01 | 0.03 ± 0.005 |
| Female | Mean | 0.10 ± 0.004 | 0.02 ± 0.005 |
| Probability | | > 0.05 | < 0.05 |

Table II - Comparative measurements of the size of the lateral teeth of males and females in *Columbella mercatoria* (N=30).

| Attributes | | Lateral tooth length (mm) | Lateral tooth width (mm) | Lateral tooth outer cusp width (mm) | Lateral tooth middle cusp width (mm) | Lateral tooth outer cusp length (mm) | Lateral tooth middle cusp length (mm) |
|-------------|------|---------------------------|--------------------------|-------------------------------------|--------------------------------------|--------------------------------------|---------------------------------------|
| Male | Mean | 0.15±0.009 | 0.06±0.005 | 0.03±0.004 | 0.01±0.001 | 0.04±0.005 | 0.05±0.004 |
| Female | Mean | 0.16±0.005 | 0.07±0.004 | 0.03±0.005 | 0.01±0.00 | 0.05±0.006 | 0.06±0.006 |
| Probability | | <0.05 | <0.05 | >0.05 | >0.05 | <0.05 | <0.05 |

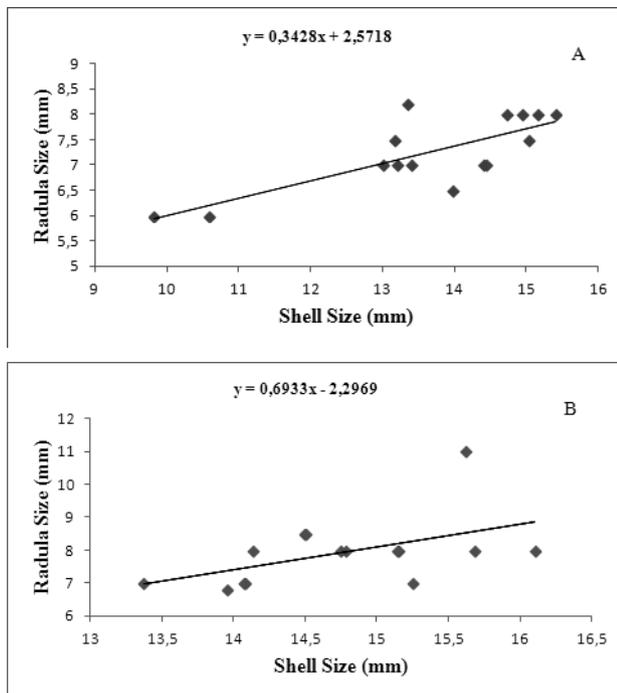


Figure 4 - Scatter plot showing significant positive correlation between (A) length of the shell and size of radula, in males ($R^2 = 0.767$) and (B) between length of the shell and size of radula, in females ($R^2 = 0.508$) of *Columbella mercatoria*.

The tests revealed a significant positive correlation between the length of the shell and the size of radula in both males ($R^2 = 0.767$) and females ($R^2 = 0.508$) (Figure 4).

DISCUSSION

The pattern of mollusks' radula is generally unique for each species or genus, but reported intraspecific variations in its morphology seem to imply an adaptive meaning that is still unclear.

Sexual dimorphism in the radula was reported for the Vetigastropoda *Tricolia variabilis* (Robertson, 1971) but it seems to be more frequent in Caenogastropoda where it was reported, among

other taxa, for the Buccinidae *Pisania pusio* (Matthews-Cascon *et al.*, 2005) and in the Muricidae. In the latter, sexual dimorphism in the radula has been reported in four species of *Drupella* (Arakawa, 1958; Fujioka, 1982), two species of *Nassa* (Maes, 1966) and in four species of *Mancinella* (Fujioka, 1985 b). On the other hand, the Columbellids *Euplica varians* and *E. versicolor* presented an unusual case of sexual dimorphism in the radula, with adult males having a larger number of teeth per row than females (DeMaintenon, 2004).

In the present study, *Columbella mercatoria* females presented larger radula ribbons than the males. Sexual dimorphism in the size of radula ribbon is largely dependent on the growth of individual teeth, because the former is determined by the tooth size or the thickness of the tooth bases along the longitudinal axis by number of rows (Fujioka, 1985).

The occurrence of larger rachidian teeth in the radula of adult males than in females, found in this study for *Columbella mercatoria*, was also reported for *Pisania pusio*, a buccinid gastropod (Matthews-Cascon *et al.*, 2005).

The functional meaning of radula dimorphism in *Columbella mercatoria* is yet unknown and, according to Robertson (1971), it may be related to dietary differences.

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