








Mollusks associated with the *Avicennia schaueriana* (Magnoliophyta: Acanthaceae) roots of a hypersaline estuary in northeastern Brazil

Moluscos associados a raízes de *Avicennia schaueriana* (Magnoliophyta: Acanthaceae) em um estuário hipersalino no nordeste do Brasil

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Cite as: Muniz, A.P.A. et al. Mollusks associated with the *Avicennia schaueriana* (Magnoliophyta: Acanthaceae) roots of a hypersaline estuary in northeastern Brazil. *Acta Limnologica Brasiliensia*, 2019, vol. 31, e16.

Abstract: Aim: *Avicennia schaueriana* is one of the six species that composes the mangrove forests of Brazil and form mangrove fringes along waterways. The mangrove-roots of the *A. schaueriana* act as one of the microhabitats used by the invertebrate biodiversity of the estuarine ecosystem. The present note aimed to inventory the malacofauna associated with roots of *Avicennia schaueriana* of the hypersaline and inverse estuary, highlighting variations in abundance and diversity along a salinity gradient and different seasonal periods. **Methods:** Three sampling stations were delineated along the course of the estuary. At each station 3 transects of 10 meters were placed, and for each of them 3 sample points were selected, and at each point 3 samples of roots of *A. schaueriana* were obtained. A total of 108 samples were stored in plastic bags containing 4% formaldehyde and subsequently passed through a screening process, with identification of the associated specimens with the lowest possible taxonomic level. **Results:** A total of 171 specimens was recorded, belonging to 10 species, 7 families, and 9 genera of the Bivalvia and Gastropoda classes. The abundance of the specimens differed between the seasonal periods analyzed. **Conclusions:** The highest species richness and abundance of organisms in the rainy period allows inferences about the importance of the estuarine water cycle in regulating the biodiversity of these environments. Thus, the importance of the maintenance and protection of the mangrove forests composed of *A. schaueriana*, as well as the need for more in-depth studies becomes evident.

Keywords: mangrove forest; invertebrates; estuary; gastropods.

Resumo: Objetivo: *Avicennia schaueriana* é uma das seis espécies que compõem as florestas de mangue do Brasil e formam franjas de mangue ao longo dos cursos d'água, sendo diretamente influenciadas pela maré. As raízes do mangue *A. schaueriana* atuam como um dos microhabitats utilizados pela biodiversidade de invertebrados do ecossistema estuarino. Este estudo objetivou inventariar a malacofauna associada às raízes de *Avicennia schaueriana* em um estuário hipersalino e inverso, destacando variações na abundância e diversidade ao longo de um gradiente de salinidade e em períodos sazonais distintos. **Métodos:** Foram delimitadas três estações amostrais ao longo do curso



do estuário. Em cada estação foram posicionados 3 transectos de 10 metros paralelos a margem e para cada um deles foram sorteados previamente 3 pontos amostrais aleatórios e em cada ponto foram obtidas 3 amostras de raízes de *A. schaueriana*. Um total de 108 amostras foram acondicionadas em sacos plásticos contendo formol a 4% e posteriormente passaram por processo de triagem e identificação dos espécimes associados até o menor nível taxonômico possível. **Resultados:** Uma abundância total de 171 indivíduos foi registrada, distribuída entre 10 espécies, 7 famílias e 9 gêneros, das classes Bivalvia e Gastropoda. A abundância dos espécimes diferiu entre os períodos sazonais e entre as estações de amostragem ao longo do gradiente de salinidade. **Conclusões:** A maior riqueza de espécies e abundância de organismos no período chuvoso permite inferir sobre a importância do ciclo hidrológico estuarino na regulação da biodiversidade deste ambiente. O presente estudo evidencia a importância da manutenção e proteção das florestas de mangue compostas por *A. schaueriana*, bem como a necessidade da realização de estudos mais aprofundados.

Palavras-chave: florestas de mangue; invertebrados; estuário; gastrópodes.

Mangrove environments are characterized by a structural complexity that provides stable conditions essential for the maintenance of estuarine ecological communities (Feller et al., 2010). The aerial mangrove-roots system, arranged in elevation to the substrate, significantly increases the architecture of mangrove forests, providing a habitat for colonization, feeding, and protection of several organisms (Nagelkerken et al., 2008). *Avicennia schaueriana* Stapf & Leechman is one of the six species that composes the mangrove forests of Brazil and form mangrove fringes along waterways, which are directly influenced by the tide (ICMBio, 2018).

The mangrove-roots of the *A. schaueriana* act as one of the microhabitats used by the invertebrate biodiversity of the estuarine ecosystem. The groups of organisms that compose this biodiversity are mainly macrobenthic organisms, polychaetes, mollusks, and crustaceans (Samidurai et al., 2012). These organisms actively participate in the mangrove food web, linking the food web to consumers at a higher trophic level (Macintosh, 1984; Smith III et al., 1991). Thus, some studies seek to inventory and understand the malacofauna composition associated with mangrove-roots (Jiang & Li, 1995; Márquez & Jiménez, 2002; Cedeño et al., 2010; Acosta Balbas et al., 2014), highlighting the importance of these as consolidated substrates for survival and maintenance of estuarine biodiversity. With this perspective, the present note characterized the malacofauna associated with roots of *Avicennia schaueriana* of the hypersaline and inverse estuary, highlighting variations in abundance and diversity along a salinity gradient and different seasonal periods.

This research was conducted during the low tide in the estuary of the Casqueira River (5°05'37" S × 36°32'21" O), located in Macau city (Rio Grande do Norte state, Northeast, Brazil)

(Figure 1). This environment is characterized by being hypersaline and inverse with a salinity that decreases as approaching the river mouth of the sea.

Sampling was performed per month in March and May (rainy period) and September and November (dry period) in 2012, totaling four campaigns of data collection. Three sampling stations were delineated along the course of the estuary. At each station 3 transects of 10 meters were placed parallel to the margin, and for each of them 3 sample points were randomly selected. At each point, one pneumatophore sample of *A. schaueriana* was obtained.

A total of 108 samples were stored in plastic bags containing 4% formaldehyde and subsequently passed through a screening process,

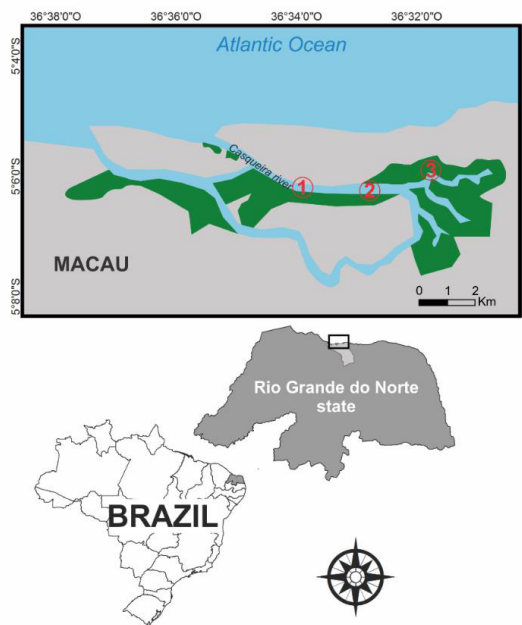


Figure 1. Geographical representation of the study area and sampling stations 1, 2 and 3.

with identification of the associated specimens with the lowest possible taxonomic level. To verify if there were differences between the community of mollusk mangrove-roots associated with the sampling stations and the seasonal periods, an ANOVA test was performed.

A total of 171 specimens was recorded, belonging to 10 species, 7 families, and 9 genera of the Bivalvia and Gastropoda classes (Table 1). Among the gastropods, the family Pyramidellidae was the most representative in the number of species (3 spp.), followed by the family Caecidae (2 spp.). Among the bivalves, the Mytilidae family was the most abundant with 82 specimens of the *Brachidontes exustus* (Linnaeus, 1758) (Table 1).

The abundance of the specimens differed between the seasonal periods analyzed ($F_{1,36} = 4.45$, $p = 0.01$), with the highest number of individuals recorded for the rainy season (91 individuals). Species richness was also higher for this period (10 spp.) (Table 1).

The abundance of mollusks also differed among the sampling stations ($F_{1,36} = 4.479$, $p = 0.02$). With a posteriori Tukey test, it was observed that stations

1 and 3 were significantly different since they were the most distant and dissimilar with respect to the salinity gradient.

This is the first study that analyzes the mollusk composition associated with roots of *Avicennia schaueriana*. Surveys have already been conducted with congener *A. marina* (Schrijvers et al., 1996; Morrisey et al., 2003) in mangrove areas of Kenya and New Zealand. The number of species found in the roots of *A. schaueriana* was much lower than that reported in other studies with mangrove roots of the *Rizhophora* genus (e.g. Márquez & Jiménez, 2002; Acosta Balbas et al., 2014) which together with *A. schaueriana* forms the mangrove forests of the Brazilian Northeast. This fact may be largely related to the smaller size of this root when compared to other species, but still the significant presence of mollusks in this microhabitat is observed, which demonstrates the great potential of these roots in offering shelter and protection for these individuals. Bivalves, following a pattern observed in studies conducted in this type of environment, were more abundant than the gastropods (Acosta Balbas et al., 2014; Cedeño et al., 2010). The dominance exerted

Table 1. Abundance of individuals per species in sampling stations and seasonal periods.

Clade	Sampling station			Period	
	I	II	III	Rainy	Dry
Class Gastropoda					
Litorinomorfa					
CAECIDAE					
<i>Caecum ryssotitum</i> Folin, 1867	7	4	-	8	3
<i>Caecum johnsoni</i> Winkley, 1908	-	1	-	1	-
Neogastropoda					
COLUMBELLIDAE					
<i>Parvanachis obesa</i> (C. B. Adams, 1845)	18	2	4	8	16
Heterobranchia					
PYRAMIDELLIDAE					
<i>Turbonilla fasciata</i> (d'Orbigny, 1840)	10	4	1	15	-
<i>Folinella robertsoni</i> (Altena, 1975)	-	5	4	8	1
<i>Odostomia</i> sp.	-	1	-	1	-
Class Bilvalvia					
Pteriomorphia					
MYIDAE					
<i>Sphenia fragilis</i> (H. & A. Adams, 1854)	6	2	1	7	2
MYTILIDAE					
<i>Brachidontes exustus</i> (Linnaeus, 1758)	33	18	31	34	48
OSTREIDAE					
<i>Crassostrea rhizophorae</i> (Guilding, 1828)	2	1	1	3	1
Heterodonta					
VENERIDAE					
<i>Anomalocardia flexuosa</i> (Linnaeus, 1767)	10	4	1	6	9
Total Abundance	86	42	43	91	80
Relative abundance (%)	50.3	24.6	25.1	53.2	46.8
Richness	7	10	7	10	7

by the bivalve can be explained by the strong bonding mechanism to the root by cementing or by the byssus thread, conferring greater resistance to these organisms in function of the high dynamics of the estuarine environment.

The highest species richness and abundance of organisms in the rainy period allows inferences about the importance of the estuarine water cycle in regulating the biodiversity of these environments. The increased nutrient input as a result of rainfall should contribute to the increasing diversity of mollusks associated with the roots of *Avicennia schaueriana*.

The malacological fauna supported by the roots of *A. schaueriana* constitute a range of organisms peculiar to this microhabitat, since some of the species found in this study were not sampled in other studies developed in estuarine regions of the Brazilian Northeast (e.g. Barroso et al., 2013; Lima et al., 2017), highlighting the particularity and importance of *A. schaueriana* roots in harboring such species.

In general, the species *A. schaueriana* demonstrates an essential support capacity of benthic macrofauna, especially of mollusks, sustaining not only the taxonomic diversity but also the functionality of estuarine species. Thus, the importance of the maintenance and protection of the mangrove forests composed of *A. schaueriana*, as well as the need for more in-depth studies becomes evident.

Acknowledgements

We thank PIBIC/CNPq/UEPB (2013/2014) Program for the Scientific Initiation scholarship granted to Jessica Lima. To Luis Carlos Damasceno for their assistance in the field.

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Received: 02 July 2018
Accepted: 18 June 2019