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Diversity and community composition of marine mollusks fauna on a mainland island of the coast of Paraná, southern Brazil

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Diversidade e composição da comunidade de moluscos marinhos de uma ilha continental do litoral do Paraná, sul do Brasil

Resumo: A Ilha do Farol é uma ilha continental, no estado do Paraná, sul do Brasil. Devido à sua posição em relação ao continente, três ambientes distintos são observados nela: área de costão rochoso exposto ao mar aberto (A); área estuarina (B); área de praia arenosa (C). Considerando que as ilhas continentais são excelentes modelos de estudo que reproduzem as condições ambientais da zona costeira em menor escala, o estudo teve como objetivo levantar e pesquisar a malacofauna marinha na Ilha do Farol e comparar sua diversidade e composição. O método de amostragem foi baseado em coletas mensais nos três ambientes da ilha durante dois anos (2011-2012). O levantamento encontrou 91 espécies: 47 Gastropoda, 41 Bivalvia e três Scaphopoda. A maior riqueza e abundância de espécies prevaleceu no ambiente A. A maior equidade foi observada em B e o maior domínio em C. Houve predominância de Gastropoda e Bivalvia em A, enquanto a frequência de Scaphopoda não variou entre os ambientes. A composição de espécies das três classes variou entre as três áreas. A variação da diversidade e composição das espécies nos três ambientes podem estar relacionados com as características naturais de cada ambiente da ilha, como salinidade e ação de ondas.

Palavras chave: Abundância, conservação, equitabililidade, levantamento, riqueza, Mollusca.

Abstract: Farol Island is a continental island in the state of Paraná, southern Brazil. Due to its position in relation to the continent, three distinct environmental areas are observed: rocky shore area with open exposure to the sea (A); estuarine area (B); sandy beach area (C). Considering that the continental islands are excellent study models that reproduce the environmental conditions of the coastal zone in a smaller scale, the study aimed at surveying and researching the marine malacofauna on the Farol Island and comparing the diversity and shellfish composition. The sampling method was based on a monthly collection in three locations for two years (2011-2012). The survey found 91 species: 47 Gastropoda, 41 Bivalvia and three Scaphopoda. The highest abundance and species richness prevailed in environmental area A. The greatest equitability was observed in B and the highest dominance in C. There was a predominance of Gastropoda and Bivalvia in A, while the frequency of Scaphopoda did not vary among environments. The species composition of the three classes varied among the three areas. The variation of diversity and species composition in the three environments may be related to the natural characteristics of each side of the island, as salinity and wave action.

Key words: Abundance, conservation, equitability, survey, richness, Mollusca.

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Introduction

The faunal survey is the initial step for the study of biological diversity, providing a database for analysis on taxonomy, biology and ecology, as well as revealing species with economic potential, while making their conservation possible (Amaral & Jablonski 2005; Cullen-Jr. *et al.* 2006).

Among the Metazoa, the mollusks are one of the most better known animals and have been closely associated with human society since pre-history, being used as ornaments, cutting tools, abrasion and food (Simone 2003; Gernet & Birckolz 2011). Mollusks are abundant in all marine environments, contributing to the maintenance of the ecosystems in which they live. Besides the environmental and anthropological aspects, they also have direct economic importance (food, crafts and pharmacology) as well as indirect importance as a food source for commercially important fish (Colley *et al.* 2012). Additionally, many of these species also play a fundamental role as intermediary transmitters of diseases to humans (Santos *et al.* 2007; Fernandez *et al.* 2011).

In Paraná State, southern Brazil, the first surveys of marine malacofauna began during the first half of the twentieth century, especially with the work performed by Frederico Lange de Morretes (Morretes 1940a, 1940b, 1943, 1949, 1953, 1954). Other important contributions include the zoogeography of the Paraná malacofauna (Gofferjé 1950); the survey of subfossil malacofauna (Bigarella 1946, 1949); and fossil malacofauna (Beurlen 1953, 1957); also the survey of living marine and estuarine malacofauna (Gofferjé 1950; Zanardini 1960, 1962). However, after this period there was a large gap in research due to lack of knowledge about the diversity of mollusks in this region and, consequently, the conservation of these populations was poor (Colley *et al.* 2012).

In order to investigate the malacofauna of Paraná and fill part of this knowledge gap, this study was conducted on a continental island as they provide excellent models to study and reproduce the environmental conditions of the coastal zone in a smaller scale (Poletto & Batista 2008). We hypothesise that the Farol Island presents variable mollusk composition among three recognised environments, which can have a significant influence on its diversity. Consequently, our study surveyed the marine malacofauna of Farol Island, on the coast of Paraná, Brazil, and compared its diversity and composition among different environmental zones.

Material and Methods

Study area

Farol Island (Ilha do Farol) (25º51'07" S, 48º32'09" W) is located on the municipality of Matinhos, state of Paraná coast, Brazil. The island corresponds to the rocky outcrop of the crystalline basement formed by igneous-metamorphic rocks (granite-gneiss) and is connected to the mainland by an isthmus partially exposed during low tide (Bigarella 2009). The onshore portion of the island has about 33.350 m^2, with typical vegetation of lowland Atlantic Forest and areas of rocky shore (**Figure 1**). The climate, according to Koppen, is "Cfa" (Humid Subtropical Climate) and has a warmest monthly average exceeding 22°C (71.6°F) and the coldest below 18°C (64.4°F) with a hot, rainy summer, but presenting no defined dry season (Peel *et al.* 2007; IAPAR 2015).

Due to its position relative to the mainland, three distinct environmental areas are observed: **(A)** rocky shore area with open exposure to the sea - under the direct influence of wave action; **(B)** estuarine area - facing the estuary formed by the Guaratuba Bay, having typical mangrove vegetation; **(C)** sandy area - facing the continental portion formed by sandy beach (**Figure 1**).

Sampling method

The fieldwork was conducted monthly for five hours/month, between 2011–2012, during all 24 months (once a month), totaling 40 hours sampling in each of the three environments (**A**, **B**, **C**). In each one of them, were made manual collection and scraping the substrate, when necessary, in intertidal zone at low tide.

The collection involved both live specimens and empty shells. Live mollusks were put in 70% alcohol and placed in plastic containers with lids. Empty shells were stored in plastic zip-lock bags. In the laboratory, specimens were analyzed under stereoscopic microscope and identified based on comparisons with material deposited in malacological collections of reference and specialized literature (Rios 1994, 2009; Domaneschi & Martins 2002; Absalão & Pimenta 2005; Malaquias & Reid 2008; Rosenberg 2009; Claremont *et al.* 2011; Abbate & Simone 2015). Malacological material obtained during the collection was deposited in the collections of the Museu de História Natural Capão da Imbuia (MHNCI 5208-5297), Curitiba, Brazil, and Museu de Zoologia da Universidade de São Paulo (MZUSP 121844-121845), São Paulo, Brazil.

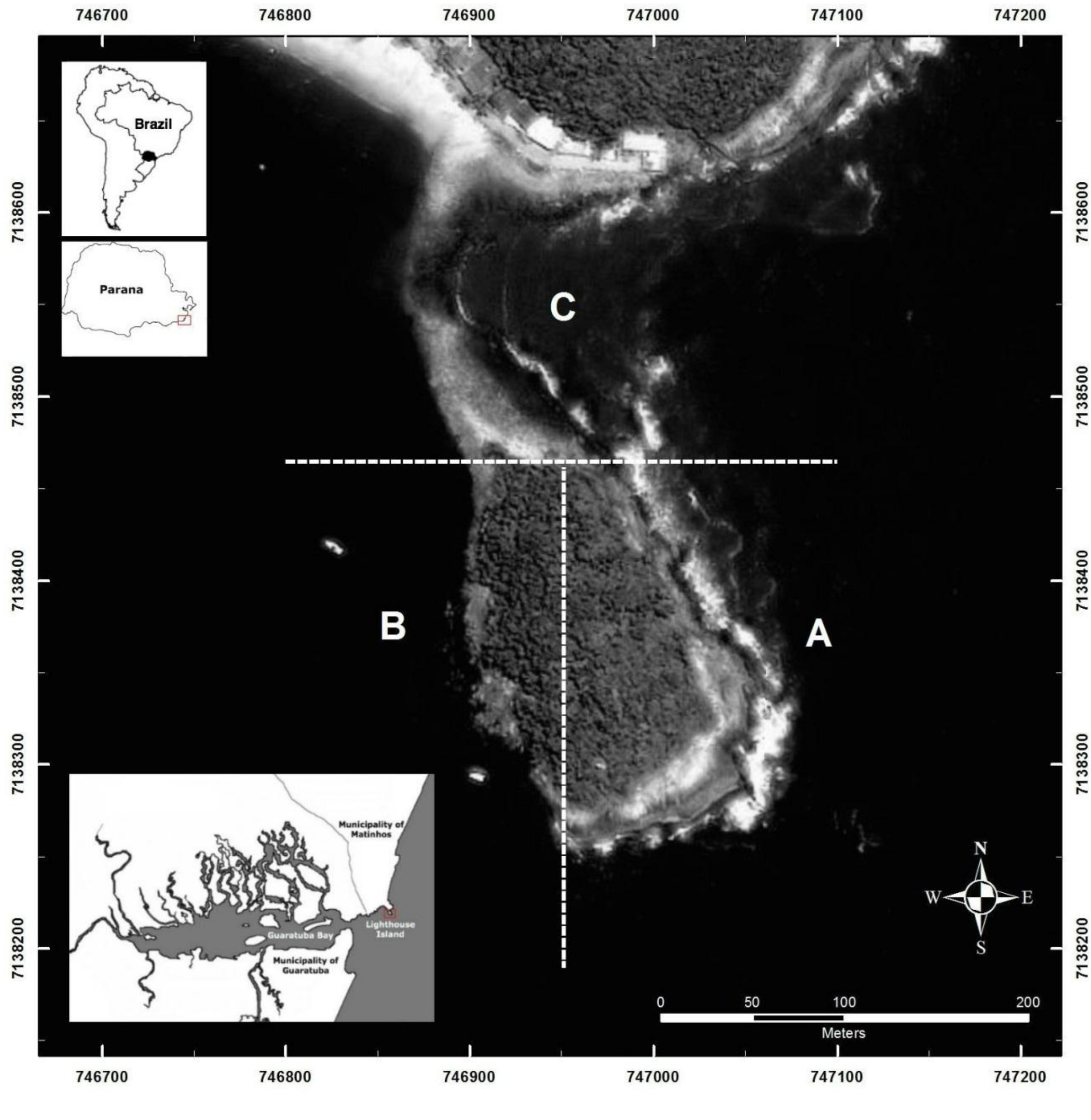


Figure 1. Farol Island (25º51'07" S, 48º32'09" W). Letters (A, B and C) indicate the three distinct environmental zones where the samples were taken: **A**. Area with open exposure to the sea; **B**. Estuarine area; **C**. Sandy area. In front of environment **C** the rocky isthmus that connects the island to the mainland is observed at low tide.

Data analysis

The diversity in the three studied environments was evaluated by Diversity Profiles in Past program 2.17 (Hammer *et al.* 2001). This analysis uses the exponential function of Rényi index, where: $\alpha = 0$ (total number of species); $\alpha = 1$ (assigns greater weight to the richness according to the Shannon index); $\alpha \geq 2$ (gives greater weight to equitability according to the Simpson index). Thus, eliminating the problem of an arbitrary choice of one or another diversity index and the dilemma of interpretation (Peet 1974).

The frequency of species observed and expected for the three environments (**A**, **B** and **C**) and the frequency of species per class (Bivalvia, Gastropoda and Scaphopoda) were measured by the Chi-Square test compound by Yates correction, considering the significance of $p \leq 0.001$ (Yates 1934).

The Cluster analysis was used to visualize the similarities among the environments (**A**, **B** and **C**) and to present such similarities in discrete groups, considering the species within each class (Bivalvia, Gastropoda and Scaphopoda) as a variable. For this analysis the Euclidean similarity coefficient was used.

Results

The survey of mollusks in the three environments (**A**, **B** and **C**) detected 91 species; 47 Gastropoda (27 families), 41 Bivalvia (25 families) and three Scaphopoda (one family) (**Table 1**). The difference of the total number of species between Bivalvia and Gastropoda was not significant ($\chi2(1) = 0.409$; $p = 0.522$).

The most abundant species of Bivalvia were represented by *Anomalocardia brasiliana* (Gmelin, 1791); *Brachidontes solisianus* (d'Orbigny, 1846); *B. rodriguezii* (d'Orbigny, 1846); *Crassostrea brasiliana* (Lamarck, 1819); *Isognomon bicolor* (C.B. Adams, 1845); *Perna perna* (Linnaeus, 1758) and *Thracia distorta* (Montagu, 1803) (**Table 1**).

The most abundant species of Gastropoda were represented by *Bostrycapulus odites* Collin, 2005; *Lottia subrugosa* (d'Orbigny, 1846); *Diodora patagonica* (d'Orbigny, 1839); *Echinolittorina lineolata* (d'Orbigny, 1840); *Fissurella rosea* (Gmelin, 1791); *F. clenchi* Farfante 1943; *Hastula cinerea* (Born, 1778); *Littoraria flava* (King & Broderip, 1832); *Olivancillaria vesica* (Lamarck, 1810); *Olivella mutica* (Say, 1822); *Stramonita brasiliensis* Claremont & Reid, 2011 and *Tegula viridula* (Gmelin, 1791) (**Table 1**).

The diversity index showed greater richness in environment A (N = 65) when compared to C (N = 48) and B (N = 39). The highest abundance was found in A (N = 1.451), followed by B (N = 1.185), and finally C (N = 911). The greatest equitability was observed in B (E = 0.914), when compared to environment A (E = 0.8998) and C (E = 0.8771). The factor dominance of species was bigger in C (D = 0.04474), than in B (D = 0.04071) and in A (D = 0.02933) (**Figure 2**). The most abundant species (over 60 specimens per environment), occurred in at least two environments above 60% of dominance.

The overall frequency of species in the three environments varied significantly above the expected in A, while in the other areas there was no change between the values observed ($\chi2(2) = 123.32$; $p < 0.001$). Regarding classes, Bivalvia varied significantly above the expected in A ($\chi2(2) = 32.07$; $p < 0.001$); Gastropoda varied significantly above the expected in A and significantly below the expected in C ($\chi2(2) = 126.44$; $p < 0.001$); and Scaphopoda showed no variation among the three environments ($\chi2(2) = 3.77$; $p = 152$). When comparing classes of mollusks among the three environments, Bivalvia and Gastropoda were significantly above the average and Scaphopoda was below ($\chi2(2) = 1490.77$; $p < 0.001$). The exclusive comparison between Gastropoda and Bivalvia showed that the Gastropoda frequency was significantly higher than the Bivalvia ($\chi2(1) = 31.34$; $p < 0.001$) (**Figure 3**).

Cluster analysis revealed that Bivalvia showed the lowest similarity of species composition among the three environments. The Gastropoda had greater similarity between environments A–B than in C. As for Scaphopoda, it showed greater similarity between B–C areas than A (**Figure 4**).

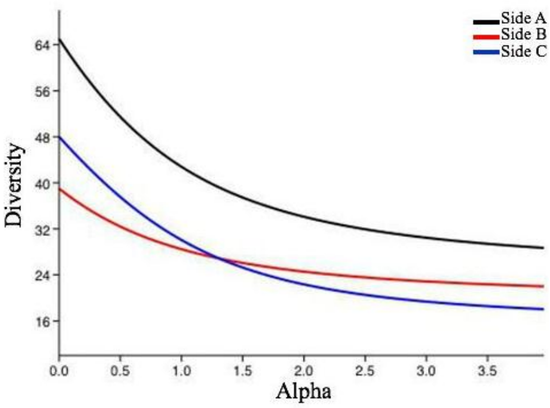
Table 1. Number of individuals of the species collected in each environmental (A, B and C) on Farol Island, Paraná State, Brazil (*indicates the most abundant species).

Class/Family	Species	Areas		
		A	B	C
Bivalvia				
Veneridae	*Amiantis purpuratus* (Lamarck, 1818)	0	0	23
	Anomalocardia brasiliana (Gmelin, 1791)*	0	0	60
	Chione paphia (Linnaeus, 1767)	08	0	0
	Protothaca antiqua (King & Broderip, 1835)	0	0	07
	Pitar palmeri Fischer-Piette & Testud, 1967	04	0	0
	Pitar rostratus (Philippi, 1844)	0	02	05
Petricolidae	*Petricolaria stellae* (Narchi, 1975)	0	14	0
Semelidae	*Semele casali* Doello-Jurado, 1949	04	0	03
	Semele proficua (Pulteney, 1799)	16	0	0
Tellinidae	*Strigilla carnaria* (Linnaeus, 1758)	37	0	15
Cardiidae	*Trachycardium muricatum* (Linnaeus, 1758)	0	19	05
Lucinidae	*Codakia costata* (d'Orbigny, 1842)	21	0	13
	Divaricella quadrisulcata (d'Orbigny, 1842)	27	0	0
Mactridae	*Mulinia cleryana* (d'Orbigny, 1846)	14	0	0
	Mactra petiti d'Orbigny, 1846	08	0	0
Ungulinidae	*Felaniella vilardeboana* (d'Orbigny, 1842)	07	0	04
Chamidade	*Chama congregata* Conrad, 1833	06	0	0
Donacidae	*Iphigenia brasiliensis* (Lamarck, 1818)	0	31	15
Crassatellidae	*Crassinella lunulata* (Conrad, 1834)	03	0	0
Arcidae	*Arca imbricata* Bruguière, 1789	14	0	0
	Arcopsis adamsi (Dall, 1886)	03	0	0
	Barbatia candida (Helbling, 1771)	11	0	16
Glycymerididae	*Glycymeris longior* (Sowerby I, 1833)	17	0	09
Noetiidae	*Noetia bisulcata* (Lamarck, 1819)	0	31	0
Mytilidae	*Brachidontes solisianus* (d'Orbigny, 1842)*	60	0	60
	Brachidontes rodriguezii (d'Orbigny, 1842)*	60	60	12
	Perna perna (Linnaeus, 1758)*	60	60	60
	Gregariella coralliophila (Gmelin, 1791)	14	27	08
	Modiolus carvalhoi Klappenbach, 1966	30	19	0
Isognomonidae	*Isognomon bicolor* (C.B. Adams, 1845)*	60	60	0
Pteriidae	*Pteria hirundo* (Linnaeus, 1758)	07	03	0
Plicatulidae	*Plicatula gibbosa* Lamarck, 1801	25	0	13
Pectinidae	*Aequipecten tehuelchus* (d'Orbigny, 1842)	10	0	0
Nuculanidae	*Adrana electa* (A. Adams, 1856)	02	0	06
Ostreidae	*Crassostrea brasiliana* (Lamarck, 1819)*	0	60	60
	Ostrea puelchana d'Orbigny, 1842	34	27	0
Thraciidae	*Thracia distorta* (Montagu, 1803)*	60	0	60
Corbulidae	*Corbula patagonica* d'Orbigny, 1845	0	04	11
Pholadidae	*Cyrtopleura costata* Linnaeus, 1758	0	16	0
	Pholas campechiensis Gmelin, 1791	0	11	09
Solenidae	*Solen tehuelchus* Hanley, 1842	0	12	0
Gastropoda				
Cerithiidae	*Cerithium atratum* (Born, 1778)	0	24	0
Epitoniidae	*Epitonium candeanum* (d'Orbigny, 1842)	16	0	09
	Epitonium angulatum (Say, 1831)	07	0	03
	Epitonium albidum (d'Orbigny, 1842)	20	0	06
Eulimidae	*Eulima mulata* Rios & Absalão, 1990	07	0	09
Janthinidae	*Janthina janthina* (Linnaeus, 1758)	0	07	05
Bullidae	*Bulla occidentalis* A. Adams, 1850	0	09	12
Olividae	*Agaronia travassosi* Morretes, 1938	09	0	0
	Olivancillaria vesica (Gmelin, 1791)*	0	0	60
	Olivancillaria urceus (Röding, 1798)	0	0	22
	Olivella mutica (Say, 1822)*	0	60	60
	Olivella nivea (Gmelin, 1791)	0	0	13
	Oliva circinata Marrat, 1871	17	0	06
Columbellidae	*Anachis lyrata* (Sowerby I, 1832)	05	0	03
	Costoanachis catenata (Sowerby I, 1844)	17	0	21
Melongenidae	*Pugilina tupiniquim* Abbate & Simone, 2015	0	08	15

Table 1. Number of individuals of the species collected in each environmental (A, B and C) on Farol Island, Paraná State, Brazil (*indicates the most abundant species) [continued].

Class/Family	Species	Specimens		
		A	B	C
Muricidae	*Coralliophila aberrans* (C. B. Adams, 1850)	05	0	0
	Stramonita brasiliensis Claremont & Reid, 2011*	60	60	0
	Siratus senegalensis (Gmelin, 1791)	02	0	06
	Morula nodulosa (C.B. Adams, 1845)	09	02	05
Nassaridae	*Nassarius albus* (Say, 1826)	16	0	0
Conidae	*Conus clerii* Reeve, 1844	12	0	02
Terebridae	*Hastula cinerea* (Born, 1778)*	0	0	60
	Hastula hastata (Gmelin, 1791)	11	0	0
	Duplicaria gemmulata (Kiener, 1839)	03	0	0
Ranellidae	*Cymatium parthenopeum* (Salis Marschlins, 1793)	05	0	0
Calyptraeidae	*Bostrycapulus odites* Collin, 2005*	60	60	0
	Crepidula protea (d'Orbigny, 1841)	07	11	0
Littorinidae	*Echinolittorina lineolata* (d'Orbigny, 1840)*	60	60	0
	Littoraria flava (King & Broderip, 1832)*	60	60	60
Naticidae	*Naticarius canrena* (Linnaeus, 1758)	03	0	07
	Polinices hepaticus (Röding, 1798)	12	0	08
	Sinum perspectivum (Say, 1831)	06	0	0
	Sinum maculatum (Say, 1831)	02	0	0
Ovulidae	*Cyphoma intermedium* (Sowerby I, 1828)	03	0	0
Triviidae	*Hespererato maugeriae* (Gray, 1832)	06	0	0
Architectonicidae	*Architectonica nobilis* Röding, 1798	03	0	06
Acteonidae	*Acteon pelecais* Marcus, 1972	11	0	0
Lottiidae	*Lottia subrugosa* (d'Orbigny, 1846)*	60	60	0
Fissurellidae	*Diodora patagonica* (d'Orbigny, 1839)*	60	60	0
	Fissurella rosea (Gmelin, 1791)*	60	60	0
	Fissurella clenchi Farfante, 1943*	60	60	0
Calliostomatidae	*Calliostoma adspersum* (Philippi, 1851)	27	0	04
Tegulidae	*Tegula viridula* (Gmelin, 1791)*	60	60	0
Neritidae	*Neritina virginea* (Linnaeus, 1758)	0	24	0
Pleurobranchaeidae	*Pleurobranchaea inconspicua* Bergh, 1897	0	06	0
Ellobiidae	*Melampus coffea* (Linnaeus, 1758)	0	06	0
Scaphopoda				
Dentaliidae	*Antalis ceratum* (Dall, 1881)	19	10	03
	Dentalium laqueatum Verrill, 1885	0	15	19
	Fissidentalium amphialum (Watson, 1879)	29	07	13

A



B

	Side A	Side B	Side C
Taxa	65	39	48
Individuals	1451	1185	911
Dominance	0.02933	0.04071	0.04474
Simpson	0.9707	0.9593	0.9553
Shannon	3.756	3.349	3.403
Evenness	0.6582	0.7297	0.6262
Brillouin	3.659	3.273	3.294
Menhinick	1.706	1.133	1.59
Margalef	8.791	5.369	6.897
Equitability	0.8998	0.914	0.8791
Fisher	13.97	7.742	10.79
Berger-Parker	0.04135	0.05063	0.06586
Chao - 1	65	39	48

Figure 2. Diversity Profile of the three environments: **A**. A, B and C. calculation based on the exponential function of Rényi index, where: α = 0 (total number of species); α = 1 (richness according to Shannon); α ≥ 2 (equitability according to Simpson); **B**. Table with the calculated values.

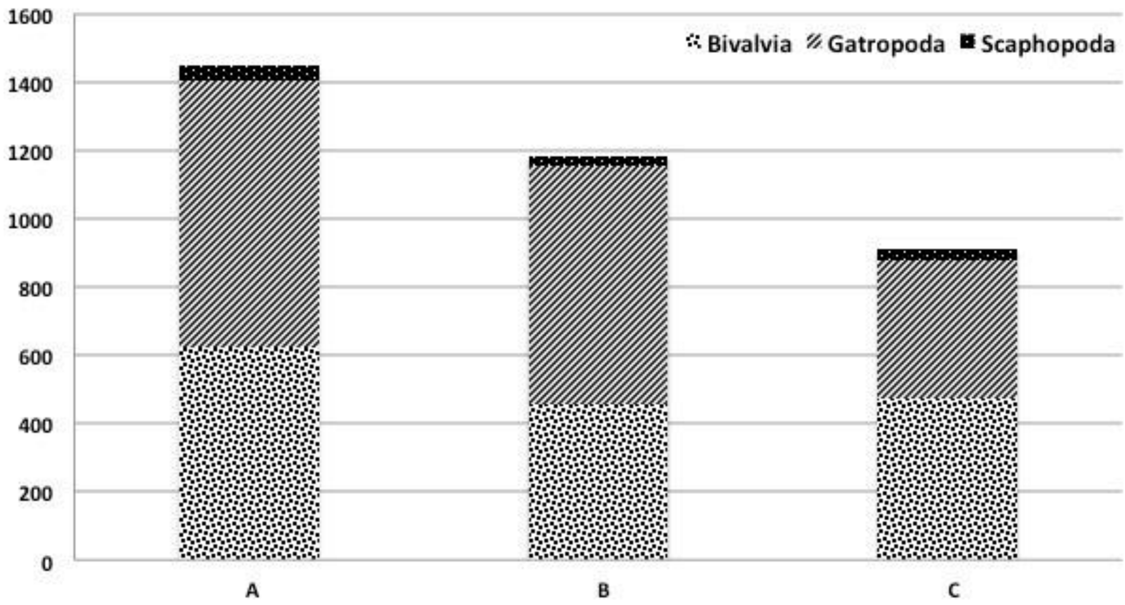
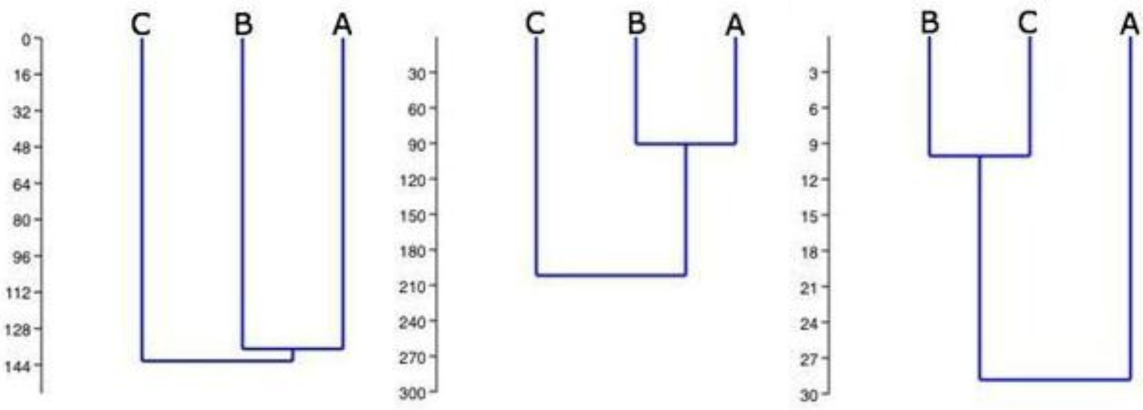


Figure 3. Total frequency of occurrence of classes Bivalvia, Gastropoda and Scaphopoda in the three environments A, B and C.



A B C

Figure 4. Clustering dendrogram among the environments A, B and C considering the three Mollusca classes as variable: **A**. Bivalvia 0.5047 (cophenetic correlation); **B**. Gastropoda 0.9997 (cophenetic correlation); and **C**. Scaphopoda 0.9978 (cophenetic correlation).

Discussion

The Gastropoda followed by Bivalvia represent the most diverse and abundant classes of Mollusca in the marine environment, accounting for around 90% of living species (Abbott & Dance 2000). Following the same tendency in the present study, a similar pattern was found for both richness (52% Gastropoda, Bivalvia 45% and Scaphopoda 3%), and abundance (Gastropoda 53%, Bivalvia 44% and Scaphopoda 3%).

The diversity in the three evaluated environments varied in richness, abundance, equitability and dominance. Environment A showed greater richness, according to both the Shannon index (α = 1, greater weight to species richness), and the Simpson index (α = 2, greater weight to equitability) (Magurran 2004). In the other environments, C showed greater richness than B according to the Shannon index, but B had greater richness than C according to the Simpson index. In this case, in the absence of an objective criterion of decision, Tóthmérész (1995) suggests that the malacofauna representing the two environments are not comparable, or according to Liu *et al.* (2007), non-separable. Therefore, other criteria were used to infer the difference of diversity (Hill 1973). Environment B has a greater equitability than A and C, while the dominant species were the most noticeable in C.

In this scenario, a set of hypotheses were considered to explain the observed pattern. The greatest richness of environment A was related to greater heterogeneity and complexity of the local substrate (Kaiser *et al.* 2011), which is composed of boulders, gravel and sand, also presenting a wide vertical range in the limit of intertidal zone, providing shelter to a vast number of species. The exposure to the open seawater makes environment A more stable when it comes to salinity, oxygen, temperature and nutrient composition, allowing the recruitment of a wide range of generalist and specialist species, increasing local diversity. This hypothesis is based on previous studies that compared the diversity of malacofauna in different beaches based on its distinct environmental characteristics (Denadai *et al.* 2000; Caetano *et al.* 2008; Leite *et al.* 2009).

For the other environments, in which there was no change in richness, other diversity criteria were considered for comparison. Environment B showed higher equitability than C, while environment C showed higher dominance of species than B. A parsimonious hypothesis to explain this pattern is correlated to a feature of estuarine transition from seawater to mangrove, observed in environment B. According to Masunari & Dubiaski-Silva (1998), this side of Farol Island is colonized by typical mangrove trees, such as *Laguncularia racemosa* Gaertn and *Avicennia schaueriana* Stapf & Leechmann. The salinity values for environment B confirm the estuarine influence of Guaratuba Bay (see **Figure 1**) on this portion of the island (Bosa & Masunari 2002). It is a known fact that reducing the salinity of the open sea to the estuarine environment is directly related to the formation of a osmoregulation barrier that prevents the living of species previously non-adapted (McLusky & Elliott 1981; Ysebaert *et al.* 1998). However, according McLusky & Elliott (1981), the principal limiting environmental feature for mollusks in estuaries is the sediment accumulation in the form of mud. This type of substrate makes mollusk locomotion difficult and is the main factor in maintaining conditions of turbid water due to suspended sediment, making it also difficult for water filtration for gas exchange and filter-feeding. Thus, even though fewer species were recorded in environment B, they showed similar representation, evidenced by the high value of equitability.

Environment C presented the highest number of dominant species. This side of the island faces the continent and has low water depth, due to association with the isthmus of rock and sand. Many shells of different species that predominate in other environments of the island or in other distant ecosystems, end up being brought by sea currents and are released in this area by wave action. An example is the pelagic gastropod *Janthina janthina* (Linnaeus, 1758), featuring environment C as depositional area of the Farol Island. Although empty shells of different species found around the perimeter of the island may have appeared in the sample brought by the currents, or associated action of other animals, such as pagurid crabs. It is considered that such taxa are part of the local ecosystem (Bouchet *et al.* 2002), because they provide shelter and substrate for other species and participate in the nutrient cycle as a source of calcium when they decompose. In addition, the empty shells are useful as important bio-indicator tools, unlike other species of various animal groups, which leave no traces after death, and therefore are extremely difficult to measure.

It is known that biotic and abiotic variables are the primary factors of zonation of marine fauna (e.g.: bauplan, competition for space and food, drying gradient, air and water temperature, salinity content, pH and oxygenation of the water, type substrate, topography, vegetation composition, seasonality, wave action and currents, among many other environmental and also anthropogenic variables) (Kaiser *et al.* 2011). Considering these variables, few works address the issue of species richness in spatial scale in a significant way to the conservation and management of local species (Bouchet *et al.* 2002), even in areas considered well sampled (Gosliner & Draheim 1996). Bouchet *et al.* (2002) suggest three main factors that contribute separately or together to underestimate the real richness of marine mollusks in other studies: (1) improper or inadequate spatial coverage in relation to local environmental heterogeneity; (2)

inadequate sampling of organisms that live only in a restricted range of habitats; (3) exaggerated emphasis on macromollusks. In the present study, it was regarded that the long sampling period on a monthly basis and the five sampling methods employed, allowed not only an answer to the hypothesis about the diversity and composition of local malacofauna, but also granted the elimination of the effect of one or more variables on sample result. Considering this, and also the fact that water quality in the study site was deemed approved by the environmental agency during the study period (IAP 2015), it can be said that the variation of diversity and species composition in the three sides are directly related to the natural environmental characteristics of each face of the island and does not suffer any influence of anthropogenic variables.

The richness of mollusks revealed in this survey highlighted the environmental importance of Farol Island, reinforcing the need for preservation and conservation of the local ecosystem. Each of the evaluated areas revealed a distinct diversity of mollusks, adapted to specific environmental characteristics of recruitment and deposition. These species also work as a bio-indicator of environmental quality (Oehlmann & Schulte-Oehlmann 2003). Despite the importance attributed to these mollusks, and although the island is protected by law (Matinhos 1989), in reality, nothing has been done to prevent or control public access to it and the indiscriminate use of its natural resources.

On a local scale, the survey of the Farol Island malacofauna should help in the understanding the dynamics of the coastal environment of Paraná State. On a broader scale, it will help us understand the environmental dynamics of subtropical coast of Brazil, which belongs in the biogeographical region of São Paulo Province (Palacio 1982) and is considered a transitional area for temperate fauna (Floeter *et al.* 2009).

Taking into account that the coastal region of the states of São Paulo (to the north of Paraná State) and Santa Catarina (to the south of Paraná State) are well sampled and that the study of the biodiversity of Brazilian oceanic islands is in progress (Simone 1999; Luiz R. L. Simone - personal communication, March 2018), there is a need to raise and study the biodiversity on islands adjacent to the mainland. Such study should work as a control group, being helpful in the understanding of the colonisation process on other continental islands in Paraná, including the recently created National Marine Park of Currais Islands (Ilhas dos Currais) (Law 12.829/2013).

Therefore the information provided in this study into account, it is expected that the results of the present study may clarify the dynamics of the coastal environments of Paraná and provide support for the development of management and conservation plans of protected areas and their biodiversity, aiming at a balanced resource management of both environmental and economic interest.

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