



Gastropods associated to three reef macroalgae with different architectures

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ABSTRACT

An inventory of the gastropods associated with three species of reef macroalgae having different thallus structures are provided. We discuss how algal architecture influences diversity patterns, abundance and species richness. Fronds of the macroalgae *Gracilaria domingensis* (Kützinger) Sonder ex Dickie, 1874, *Padina pavonica* (Linnaeus) Thivy, 1960, and *Cryptonemia bengryi* W.R. Taylor, 1960 were collected in coastal reefs of Cabo Branco Beach, João Pessoa, State of Paraíba, Northeastern Brazil. Thalli were sorted in the laboratory to remove the associated mollusks. The macroalgae *Gracilaria domingensis* and *Cryptonemia bengryi* presented the most heterogeneous thallus architecture. The mollusk community comprised 18 species of gastropods, belonging to 14 genera. In total, 402 specimens were recorded, of which micromollusks predominated. The most frequent species were *Eulithidium affine* (C.B. Adams, 1850) (80% of occurrence), *Rissoina sagraiana* (d'Orbigny, 1842) (60%), *Astyris lunata* (Say, 1826) (40%), and *Phyllaplysia engeli* Marcus, 1955 (33.3%), the latter representing a new record for the coast of Paraíba state. The algae *C. bengryi* and *G. domingensis* presented highest values of richness and diversity for the associated malacofauna ($F_{1,6} = 10.14$; $p = 0.0001$). Differences in the associated mollusk communities among the three species, as well as differences in the ecological descriptors for each alga, suggest that the algal architecture influences the richness, diversity, and composition of microgastropods in the marine phytal.

Keywords: algal banks, community structure, microhabitat, micromollusks, phytal, reef habitat.

INTRODUCTION

Among the diverse marine ecosystems, it is possible to list a range of habitats as heterogeneous, such as coral reefs, banks of marine seagrass and algal banks, as well as consolidated substrates (TOKESHI & ARAKAKI 2012). Communities associated with macroalgae are known as the phytal. These environments serve as a habitat for several taxa of invertebrates, including mollusks. According to Kovalenko *et al.* (2012), macroalgae may be key components in aquatic ecosystems, due to their capacity for providing tridimensional environments. In these environments, macroalgae promote increase in space availability, and thus in diversity and coexistence among species.

Algal fronds attenuate hydrodynamism, promoting higher stability of the mollusk chemical parameters, mainly temperature and salinity. However, until now, few studies have dealt with the role of marine algae in structuring faunal communities (CHEMELLO & MILAZZO 2002). Edgar (1983) states that different algal shapes are important in determining patterns of abundance and size structure of associated animal species.

The phytal contains a range of associated organisms, such as epiphytic algae and sessile or vagile animals, including the meiofauna, macrofauna, and fish (CHRISTIE *et al.* 2009). Many of these organisms have their own life cycles correlated to the seasonal cycles of the algae (DEAN & CONNELL 1987). The macroalgae may even produce chemical substances capable of inducing the colonization of many invertebrates (BÉGIN *et al.* 2004).

Chemello & Milazzo (2002) found that the algae with most complex thalli had more abundant and diverse mollusks associated with them. Leite *et al.* (2009) established that the presence and distribution of gastropods depend on the structure and morphology of the algae and on the habitat conditions that they are able to furnish. These authors emphasize that the physical and biological condition of each beach, correlated with the morphology of the algae, the sediment retained by the rhizoids, and the overall hydrodynamism, may represent factors that control the composition, number of species, dominance, and density of gastropods. Thus, the distribution of individuals of a community into size classes may reflect the structural heterogeneity of the substrates with which they are associated.

Christie *et al.* (2009) points out that it is normal to expect more heterogeneous algae to have larger densities of organisms, mainly those with reduced bodies, due to the size of the available interstitial space. The choice of habitat may be simply a case of protection, as predation becomes significantly reduced in the most ramified algae, which limit access to individuals of larger size.

Chemello & Milazzo (2002) enumerate three aspects in which the algal architecture may influence the composition and distribution of associated mollusks: 1) by providing lower mortality rates due to low predation, because algae serve as a refuge; 2) by reducing hydrodynamism, due to the shelter offered; and 3) by functioning as a site of recruitment of young, serving as a nursery area.

The present study aims to inventory the gastropod community in three reef macroalgae with distinct architectures and to discuss how the algal structure influences the patterns of species diversity, abundance, and richness. This study also provides the first record of the opisthobranch gastropod *Phyllaplysia engeli* Marcus, 1955 for the coast of Paraíba state, Northeastern Brazil.

MATERIALS AND METHODS

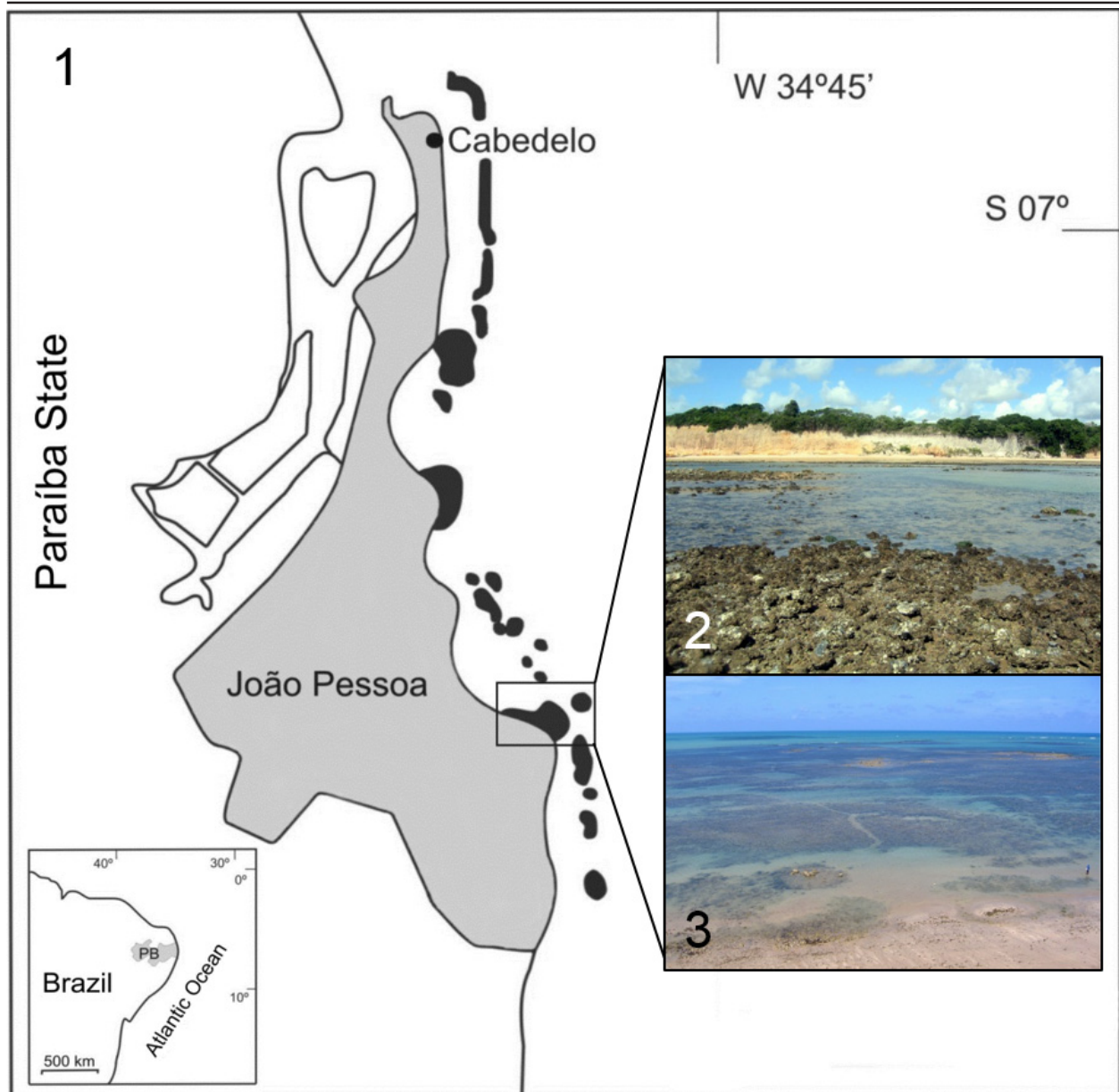
Study site

The present study was conducted at the southern end of Cabo Branco Beach (07°08'41.37''S 34°47'45.60''W), located in the metropolitan area of the city of João Pessoa, Paraíba state, Brazil (Figs. 1-3). This represents the easternmost coastal area in South America.

The beach ends in an extensively eroded cliff, which has produced an accumulation of arenitic-ferruginous rocks that extend for 1.16 km along the coast and for several hundreds of meters into the sea. These form part of the sandstone reefs that occur parallel to the coastline and produce several microhabitats for the fixation of many marine species (GAMA *et al.* 2006; GONDIM *et al.* 2008; DIAS 2009). The reefs harbor extensive algal banks in depths of 0–4 m.

Characterization of the studied macroalgae

The studied macroalgae were defined randomly based on the visual difference in the structure of the thallus. The species are widely distributed along the Brazilian coastline, being common in reef environments: (a) *Padina pavonica* (Linnaeus) Thivy in W.R. Taylor, 1960 (Fig. 4) is a brown algae of the Phylum Heterokonta, belonging to the Family Dictyotaceae. It has a foliaceous, complanate,

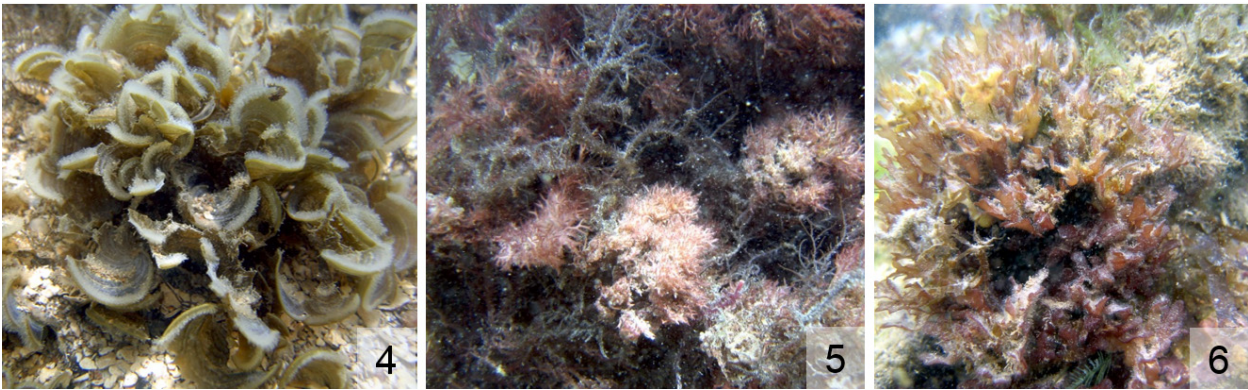


Figures 1–3: Map of the study site. Photos by Thelma L. P. Dias. **1:** Location of the Cabo Branco reefs on the coast of Paraíba state. **2:** Partial view of the reefs and the cliff in the background. **3:** Aerial view of the reefs.

fan-shaped, thallus, being thin and brown-yellow in color. Its size varies from 10 to 20 cm in height. Samples of this alga were collected in shallow waters (0.3 m). (b) *Gracilaria domingensis* (Kützing) Sonder ex Dickie, 1874 (Fig. 5) is a red alga of the Phylum Rhodophyta, belonging to the Family Gracilariaceae. It has a filamentous structure, with thallus red-orange in color, structured into cylindrical branches. Its size may vary from 15 to 25 cm in height. Samples were collected in shallow water (0.2 m). (c) *Cryptonemia bengryi* W.R. Taylor, 1960 (Fig. 6) is also a red alga of the Phylum Rhodophyta, belonging to the Family Halymeniaceae. Its morphological structure is also characterized for being filamentous, but having less filaments than *G. domingensis* and with a carnose thallus. Its color may vary from pink-red to orange-red. Sizes vary from 5 to 10 cm in height. Samples were collected in shallow waters (0.3 m).

Field work

In April 2011, five fronds of each of the three algae were collected by snorkeling (15 algal fronds). Macroalgae were randomly collected in the environment. Fronds were removed by their basis of



Figures 4–6: Reef macroalgae sampled. **4:** *Padina pavonica* (Linnaeus) Thivy in W.R. Taylor, 1960. **5:** *Gracilaria domingensis* (Kützinger) Sonder ex Dickie, 1874. **6:** *Cryptonemia bengryi* W.R.Taylor, 1960.

fixation to the substratum, being carefully surrounded in plastic bags containing water from the environment in order to avoid organisms from escaping. The plastic bags were closed and transported to the lab for sorting. Collections were made during low tide, in salinity of 37 and water temperature of 27°C.

Laboratory procedures

During sorting of specimens, the fauna associated with each alga was removed under a stereomicroscope with the help of tweezers. The mollusks found were anesthetized with crystals of menthol, except the opisthobranchs, which were anesthetized by freezing. They were then fixed and conserved in 70% ethanol. Identification was done under a stereomicroscope to the lowest taxonomic level possible, using the specialized literature (*e.g.*, OLIVER 2004; RIOS 2009; TUNNELL *et al.* 2010). Scientific names were confirmed with Rosenberg (2009). The specimens were deposited in the Reference Collection of Mollusca in the State University of Paraíba (UEPB-Mol.). Morphological attributes considered in the definition of the algal architecture followed Chemello & Milazzo (2002). To measure algal samples we used rulers divided into millimeters and calipers with a precision of 0.01 mm. Table 1 shows a summary of the analyzed attributes.

Table 1: Definition of algal attributes evaluated for three species of reef macroalgae studied at Cabo Branco reefs.

Attribute	Description
Algal height	Measurement of macroalga from base to tip.
Algal width	Measurement of thallus from side to side of the frond.
Degree of ramification	Count of the number of branches from the basal branch (base) to the last ramification; first divisions are of first order, second divisions of second order, and so on.
Width of thallus	Measurement that considers the thickness of the main axis of the alga at three levels: inferior, intermediary, and superior.
Number of branches	Count of the number of emergent branches, at three levels (inferior, intermediary, and superior) beginning with the basal axis.

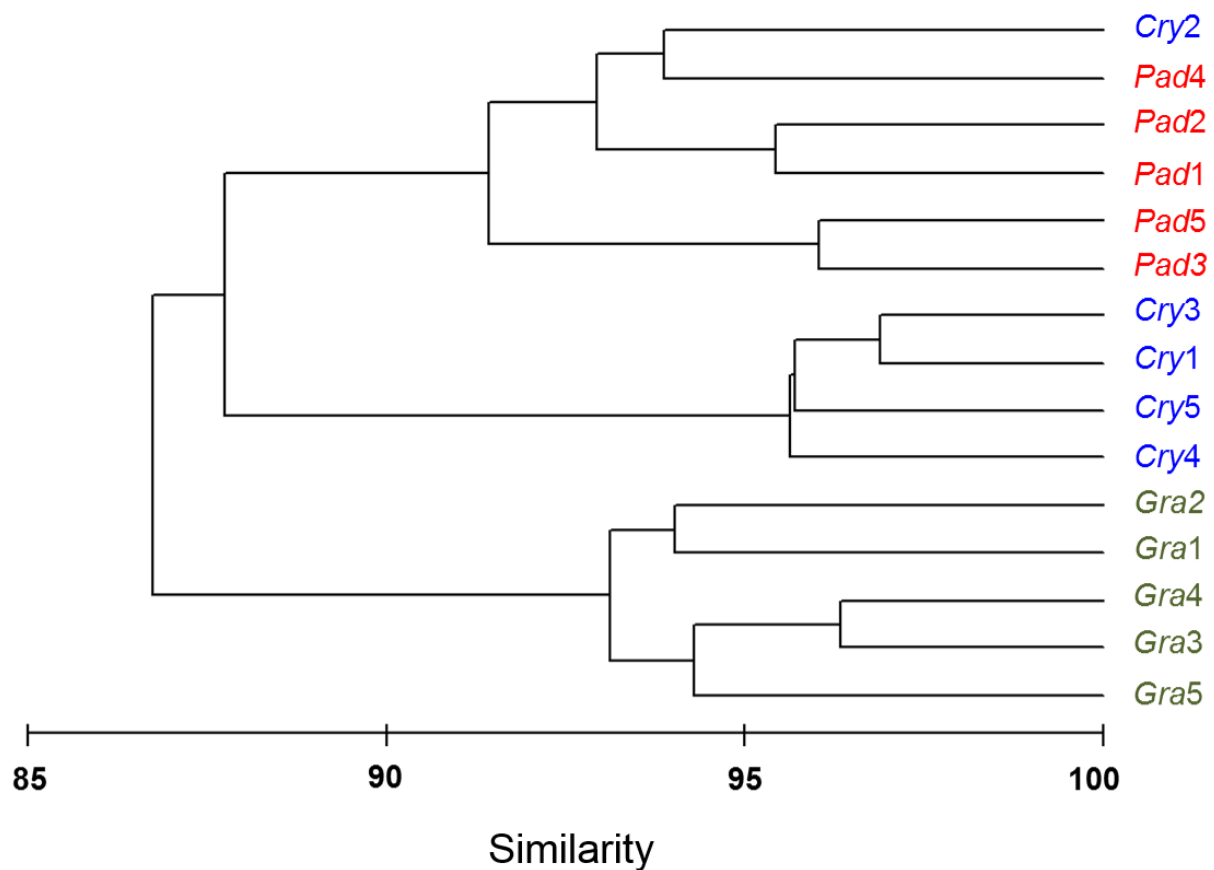


Figure 7: Euclidian distance cluster analysis on algal attributes between different types of macroalgae. Abbreviations: *Cry* = *Cryptonemia bengryi*; *Pad* = *Padina pavonica*; *Gra* = *Gracilaria domingensis*.

Data analysis

The molluscan community was described by the number of species (S), abundance of individuals (N), Margalef's richness (d), Shannon-Wiener diversity (H'), frequency of occurrence (FO%) and relative abundance (RA%). For the analysis of algal architecture, the attributes described in Table 1 were considered, for which mean values followed by standard deviations were obtained. Similarity among algal replicates was analyzed by Euclidian distance cluster analysis. Algal architecture and associated molluscan samples were compared using ANOVA test, cluster analysis and non-parametric multi-dimensional scaling (nMDS) based on Bray-Curtis similarity. Data on mollusk abundance were transformed on $\text{Log}(X+1)$. Statistical analyses were performed using the software Primer 6 & Permanova+ and Biostat.

RESULTS

The studied algae differ in the morphological attributes of their fronds ($F_{1,3} = 7.12$ $p = 0.004$). Samples of *Gracilaria domingensis* have a higher thallus (mean = 19 cm), followed by *Padina pavonica* (mean = 14.1 cm) and *Cryptonemia bengryi* (mean = 6 cm) (Table 2). *Gracilaria domingensis* had the largest width of the thallus (mean = 15.3 cm), followed by *P. pavonica* (mean = 14.1 cm), and *C. bengryi* (mean = 10.6 cm). *G. domingensis* also had the largest degree of ramification (mean = 6.6). Among the three algal species, *P. pavonica* was least ramified, but had the largest width of the thallus on the three levels analyzed (Table 2). *Gracilaria domingensis* and *C. bengryi* were the most heterogeneous in architecture, while *P. pavonica* was the most homogeneous. The Distance Euclidian

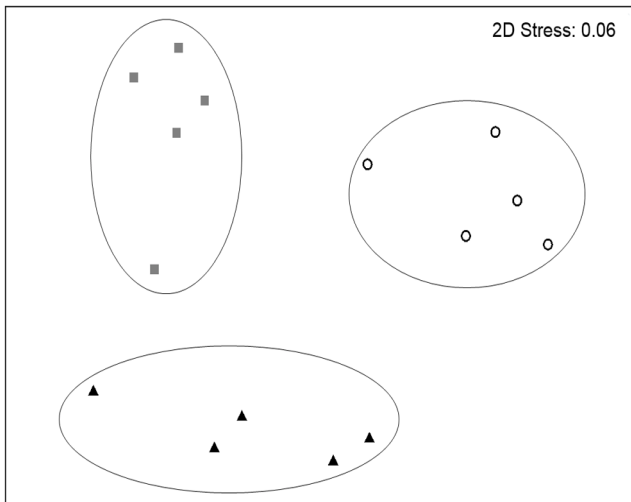


Figure 8: Multidimensional scaling ordination model of morphological attributes of different macroalgal species studied. Symbols: ▲ = *Padina pavonica*; ○ = *Gracilaria domingensis*; ■ = *Cryptonemia bengryi*.

associated species (55.5% of all species). *Cryptonemia bengryi* and *G. domingensis* also presented the highest values of richness and diversity (respectively, $d = 2.020$; $H' = 1.707$; $d = 1.926$; $H' = 1.081$) (Figs. 9–12).

The dendrogram and the resultant model of multidimensional ordering obtained by the similarity index of Bray-Curtis indicated a strong similarity of gastropod community among the studied algae. However, communities were most similar between the algae *P. pavonica* and *G. domingensis* (Fig. 13–14).

Eulithidium affine (C.B. Adams, 1850) (80% of occurrence) (Fig. 15), *Rissoina sagraiana* (d'Orbigny, 1842) (60%), *Astyris lunata* (Say, 1826) (40%), and *Phyllaplysia engeli* Marcus, 1955 (33.3%) (Fig. 16) were the most frequent molluscan species on the three macroalgae (Table 3). In this study, *P. engeli* has been recorded for the first time for the coast of Paraíba state, being associated exclusively to the macroalga *P. pavonica*. *Eulithidium affine* was also the most abundant species (69.9% of associated specimens), followed by *A. lunata* (6.9%), *P. engeli* (5.22%), *Caecum ryssotitum* Folin, 1867 (4.7%) (Fig. 17). *R. sagraiana* (3.9%). *Mitrella dichroa* (Sowerby, 1844), *Costoanachis sertulariarum* (d'Orbigny, 1839), and *Olivella minuta* (Link, 1807) (Fig. 18) were among the least frequent and least abundant species (Table 3).

In the alga *P. pavonica*, the species *Eulithidium affine* and *Phyllaplysia engeli* showed 100% of occurrences, with *E. affine* being more abundant than *P. engeli*. Both these species are more than 90% of associated species (Table 3). *Rissoina sagraiana* and *E. affine* were the most frequent species (100% of occurrences), the latter being also most abundant in the replicates of *G. domingensis* (N = 80 specimens). *Cerithium atratum* (Born, 1778) (Fig. 19), *Columbella mercatoria* (Linnaeus, 1758) (Fig. 20), *Diodora listeri* (d'Orbigny, 1847), *Neritina virginea* (Linnaeus, 1758) (Fig. 21) and *Turbonilla toyatani* Henderson & Bartsch, 1914 occurred exclusively on *G. domingensis*. *Diodora dysoni* (Reeve, 1850) and *E. affine* were the most frequent species in *C. bengryi* (both with 60% of frequency of occurrence). The most abundant species were *Astyris lunata* (27.9%) and *E. affine* (25.5%). The specimens that occurred only in *C. bengryi* were *Rissoina sagraiana*, *D. dysoni*, *Eulithidium bellum* (M. Smith, 1937), *Mitrella dichroa*, and *Olivella minuta*. The latter three species were less frequent and less abundant.

model of similarity indicated a smaller dissimilarity between samples of *P. pavonica* and *C. bengryi* (Fig. 7–8).

The molluscan community was composed by 18 species of gastropods, belonging to 14 genera (Table 3). A total of 402 specimens, representing mostly micromollusks (Table 3), composed the associated fauna with the fronds of the three studied macroalgae. Considering the number of species per thallus, *P. pavonica* housed the smallest richness and diversity of species ($d = 0.935$; $H' = 0.548$), having only six of the 18 listed species (33.3% of total number of associated species) (Figs. 9–12). However, *P. pavonica* had the largest abundance of individuals, housing 209 of the 402 specimens (51.9% of all associated individuals) (Figs. 9–12). Both *G. domingensis* and *C. bengryi* had 10

Table 2: Mean values (\pm SD) of the algal attributes of the three algal species sampled at Cabo Branco reefs.

Attributes	<i>Padina pavonica</i>	<i>Gracilaria domingensis</i>	<i>Cryptonemia bengryi</i>
Algal height	14.1 \pm 2.6	19 \pm 3.5	6.0 \pm 1.3
Algal width	14.1 \pm 2.6	15.3 \pm 3.1	10.6 \pm 1.1
Degree of ramification	3.2 \pm 0.4	6.6 \pm 1.1	4.8 \pm 0.8
Width of thallus (level 1)	0.45 \pm 0.2	0.5 \pm 0.3	0.28 \pm 0.03
Width of thallus (level 2)	0.33 \pm 0.1	0.15 \pm 0.03	0.23 \pm 0.04
Width of thallus (level 3)	0.21 \pm 0.1	0.10 \pm 0.02	0.14 \pm 0.03
Number of branches (level 1)	2.8 \pm 0.4	6.8 \pm 1.3	4.8 \pm 1.3
Number of branches (level 2)	2.6 \pm 0.5	6.8 \pm 1.3	4.2 \pm 0.8
Number of branches (level 3)	9.8 \pm 4.0	12 \pm 2.1	7.2 \pm 0.8
Number of "ramuli" (level 1)	-	17.2 \pm 4.3	-
Number of "ramuli" (level 2)	-	19.8 \pm 4.4	-
Number of "ramuli" (level 3)	-	29.8 \pm 7.6	-

*Significance test ANOVA: ($F_{1,3}=7,12$; $p = 0.004$)

DISCUSSION

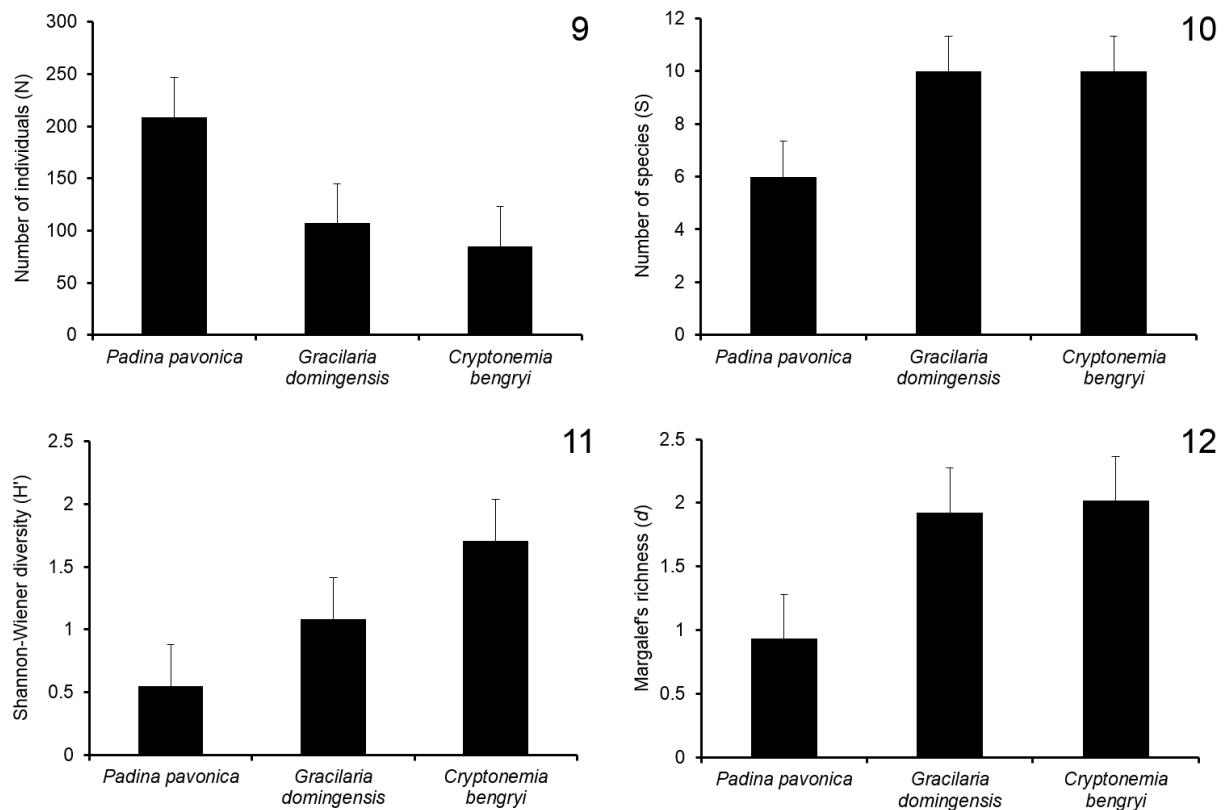
Our study indicates that the three macroalgae have different architectures, which provide distinct microhabitats for the associated organisms. Edgar (1983) also observed this difference in algal architecture for 23 analyzed species. Chemello & Milazzo (2002), who studied six species of algae from Italy, found the same. The analysis of the morphological attributes of algae represent an important tool for the detection of algal microhabitats.

Studies that evaluate the influence of algal architecture on the composition and diversity of the associated fauna demonstrate that the morphology of the algae influences the structure of the associated community (*e.g.*, CHEMELLO & MILAZZO 2002). Our study emphasizes *Gracilaria domingensis* as the species with the most heterogeneous structure. However, this higher thallus heterogeneity apparently did not influence the diversity of species and abundance of the associated individuals. This may be related to several factors, for example to available food, structure of the thallus, hydrodynamism in the sampling localities, among others. *Cryptonemia bengryi*, although presenting a structurally simpler frond architecture, harbored the largest diversity ($d = 2.02$) and abundance ($H' = 1.707$) of associated gastropods. Its fleshy thallus may have favored its colonization by a larger variety of species, even though in less abundance.

Padina pavonica, although having a more homogeneous thallus of foliaceous appearance, housed the highest abundance of gastropods, with 51.9% of the total number of individuals. Possibly the foliaceous thallus offers a larger substrate for the fixation and displacement of individuals, as well as favoring the presence of other organisms that may be used as food by its hosts. According to Gunnill (1982), macroalgae with a more heterogeneous thallus tend to house a more abundant and diversified fauna of invertebrates. Nevertheless, Chemello & Milazzo (2002) stress that other factors, such as food availability and predation rates, may also strongly influence these indexes. In the case of *P. pavonica*, the larger abundance of individuals was due to the dominance of a single species, the microgastropod *Eulithidium affine*, that represented 44.52% of the total number of recorded specimens. This alga also housed a significant population of the opisthobranch *Phyllaplysia engeli* ($N = 21$), a species usually found in low abundance. Though usually associated with macroalgae, *P. engeli* is not easy to observe in these microhabitats due to its small size and high camouflage in algal habitat, which also provides protection against predators. The occurrence of this species

Table 3: Abundance (N) and frequency of occurrence (FO%) of the molluscan species collected in association with the three reef algal species (replicates 1–5). Checklist arranged in accordance with Bouchet *et al.* (2005).

Species	<i>Padina pavonica</i> (P)					<i>Gracilaria domingensis</i> (G)					<i>Cryptonemia bengyii</i> (C)					N	RA%	FO%	Vouchers
	P1	P2	P3	P4	P5	G1	G2	G3	G4	G5	C1	C2	C3	C4	C5				
<i>Astypis lunata</i>	-	-	1	1	-	-	1	-	-	1	12	12	-	-	-	28	6.72	40	1313
<i>Caecum ruscovittum</i>	-	-	-	-	-	3	-	-	-	-	1	15	-	-	-	19	4.56	20	1314
<i>Cerithium atratum</i>	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	2	0.48	13.3	1315
<i>Columbelta mercatoria</i>	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.24	6.67	1316
<i>Costoanachis sertulariarum</i>	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.24	6.67	1317
<i>Costoanachis sparsa</i>	-	-	-	-	1	-	-	-	3	-	-	-	-	-	4	0.96	13.3	1318	
<i>Diodora dysoni</i>	-	-	-	-	-	-	-	-	-	-	1	-	1	-	3	0.72	20	1319	
<i>Diodora listeri</i>	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2	0.48	6.67	1320	
<i>Eulithidium bellum</i>	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.24	6.67	1321	
<i>Eulithidium affine</i>	42	20	26	28	63	10	17	14	18	21	13	8	-	1	281	67.44	80	1322	
<i>Mitrella dichroa</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	0.24	6.67	1323
<i>Neritina virginea</i>	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2	0.48	6.67	1324	
<i>Olivella minuta</i>	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	0.24	6.67	1325	
<i>Physalphysia engeli</i>	4	6	5	1	5	-	-	-	-	-	-	-	-	-	21	5.04	33.3	1326	
<i>Rissoina indiscreta</i>	-	-	-	-	-	-	-	-	-	-	5	11	-	-	16	3.84	13.3	1327	
<i>Rissoina saepeana</i>	-	1	-	2	2	3	1	1	1	1	-	1	-	-	13	3.12	60	1328	
<i>Turbonilla toyotani</i>	-	-	-	-	-	2	-	-	1	2	-	-	-	-	5	1.2	20	1329	

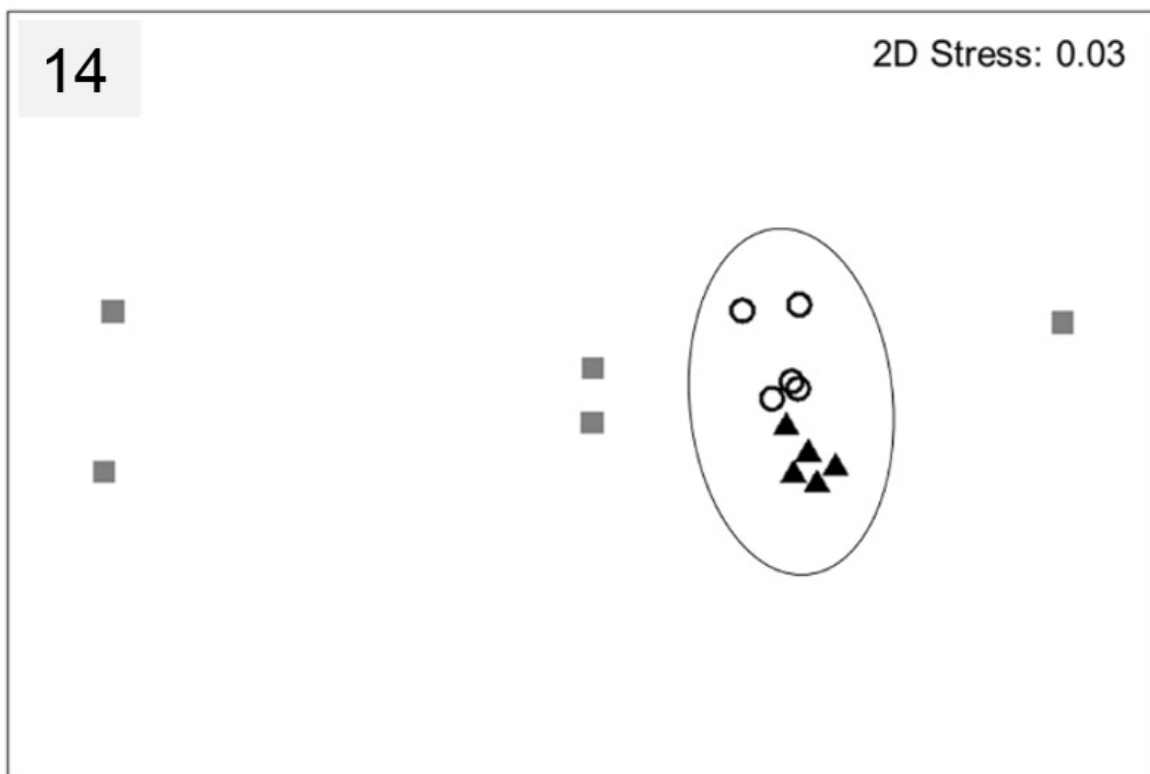
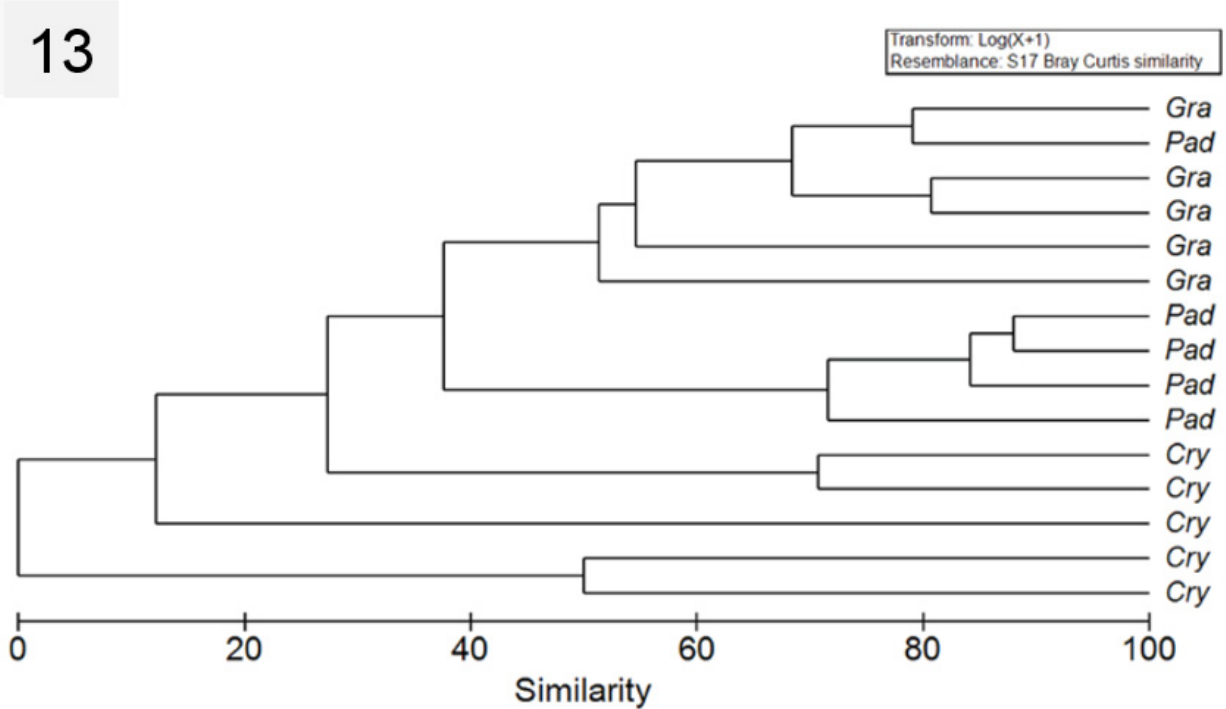


Figures 9–12: Values of ecological descriptors. **9:** Total number of individuals (N). **10.** Number of species (S). **11:** Shannon-Wiener diversity (H'). **12:** Margalef's richness (d) among different algal species.

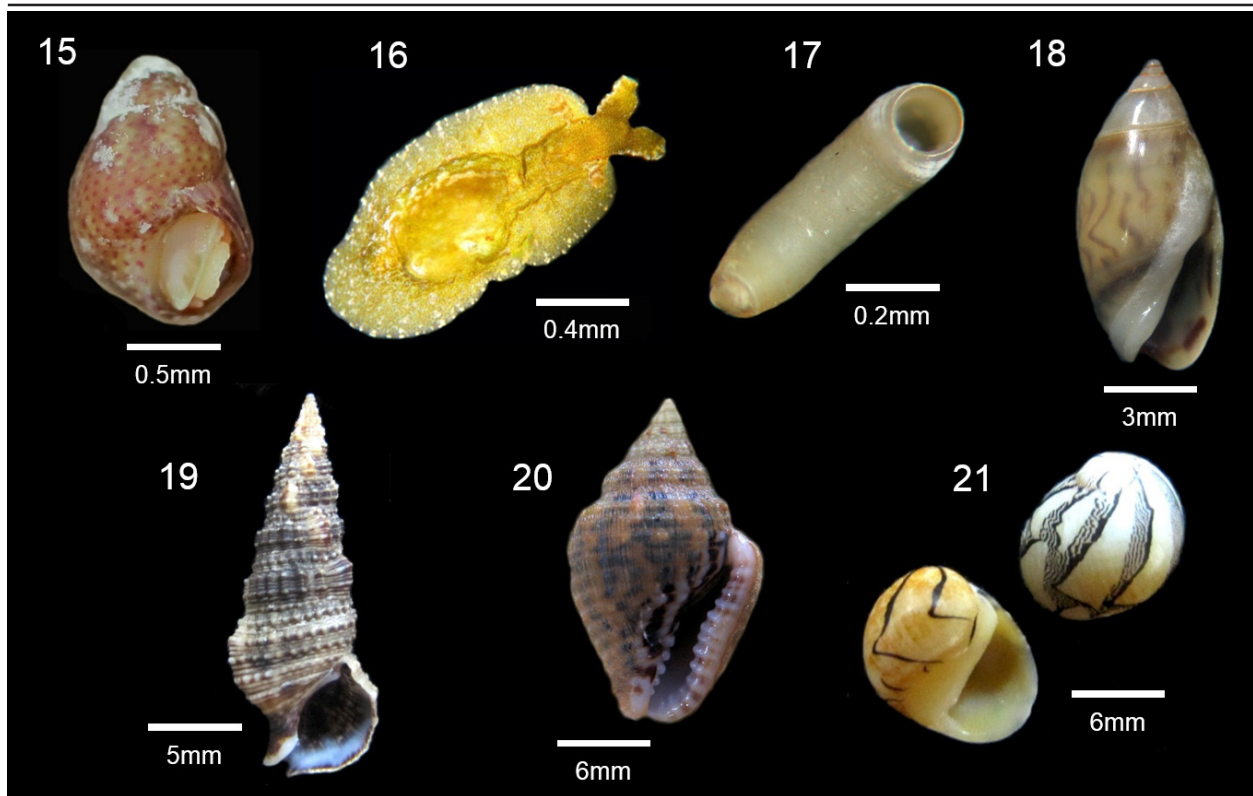
specifically in the alga *P. pavonica* can be related to its foliose structure, which probably facilitates the mobility of this flattened gastropod along the frond.

The algae *Gracilaria domingensis* and *Cryptonemia bengryi*, with somewhat similar thalli, as shown by the grouping analysis of Euclidian distance (Figs. 7–8), housed the same number of species (10 species each). Notwithstanding, only four of these are shared by the two species of algae. Of the 18 species found in *Padina pavonica*, only three were shared by the three species of algae (*Astyris lunata*, *Rissoina sagraiana*, and *Eulithidium affine*). This suggests that, among other factors not considered in this study, algal structure may influence the composition of these species. Comparing, for example, *G. domingensis* and *C. bengryi*, which housed a similar number of species, it can be observed that the composition of these species is very different, even though most gastropods are small species. Some are apparently occasional, presenting a single individual. These data suggest that some species of mollusks of the phytal may be related to specific algal structures. This may be the case of the opisthobranch *Phyllaplysia engeli*, which crawls with its large foot, and requires a flat surface for displacement. This species occurred only on *Padina pavonica*, whose foliaceous thallus possibly favored the colonization of this particular alga. According to Christie *et al.* (2009), faunistic composition depends mainly on the architecture of the habitat at a certain micro scale, while abundance depends on the size of the habitat.

Concerning species composition of mollusks in the studied algae, it may be stated that the gastropod fauna is composed mainly by minute species, or by young individuals of larger species, such as *Cerithium atratum*, *Neritina virginea*, and *Columbella mercatoria*. Of these, only *C. atratum* may attain 35 mm, while the other cited species do not exceeds 15 mm. This observation corroborates studies from several regions in the world (*e.g.*, EDGAR 1983 – Tasmania; AZEVEDO 1992 – Portugal; CHEMELLO & MILAZZO 2002 – Italy; RUEDA & SALAS 2003 – Spain; LEITE *et al.* 2009 – Brazil), thus



Figures 13–14: Bray-Curtis cluster analysis on molluscan assemblages of different reef macroalgal samples from Cabo Branco reefs. **13:** Similarity dendrogram. **14:** Multidimensional scaling ordination model showing the similarity between the malacofauna found in *Padina pavonica* and *Gracilaria domingensis*. Symbols: ▲ = *Padina pavonica*; ○ = *Gracilaria domingensis*; ■ = *Crytonemia bengryi*.



Figures 15–21: Some mollusk species found associated with the three reef macroalgae studied. Photos by Thelma L. P. Dias. **15:** *Eulithidium affine* (C.B. Adams, 1850). **16:** *Phyllaplysia engeli* Marcus, 1955. **17:** *Caecum ryssotitum* Folin, 1867. **18:** *Olivella minuta* (Link, 1807). **19:** *Cerithium atratum* (Born, 1778). **20:** *Columbella mercatoria* (Linnaeus, 1758). **21:** *Neritina virginea* (Linnaeus, 1758).

indicating the importance of macroalgal fronds of different species and architectures for providing microhabitats for different taxa, such as polychaetes, crustaceans, mollusks, and echinoderms. In Brazil, studies of the phytal are still scarce. It is nevertheless already possible to perceive the important role that marine macroalgae have in providing habitats for young specimens and species of small size.

All recorded mollusks belong to the Gastropoda, similarly to the findings of Chemello & Milazzo (2002), Rueda & Salas (2003) and Leite *et al.* (2009). Bivalves are adapted to excavating, living mostly in non-consolidated substrates, such as sand and mud, or alternatively attaching to more rigid substrates, such as shells and rocks, to which they become fixed by the byssus, or by cementation of one of the valves (DAME 1996).

Some gastropod genera recorded in this study, such as *Caecum* Fleming, 1813, *Turbonilla* Risso, 1826, *Mitrella* Risso, 1826, *Eulithidium* Pilsbry, 1898, and *Costoanachis* Sacco, 1890 are very widespread in phytal communities in several countries and in other regions of Brazil. These genera were also registered in phytal communities by Azevedo (1992) in Portugal, by Kelaher *et al.* (2007) in Argentina, and by Lacerda *et al.* (2009) and Leite *et al.* (2009) in Brazil. They are represented by minute species, commonly known as microgastropods, which are usually found in association with specific habitats, such as the phytal ecosystem.

Considering the sampled N of 15 thalli in a punctual collecting site, the abundance of 402 individuals recorded herein may be considered low (about 26.8 individuals per thallus), when compared to similar studies. Leite *et al.* (2009) recorded 4.401 specimens collected in 24 samples of *Caulerpa racemosa* during the period of one year, which gives a mean of 183 individuals per thallus.

Of the 18 species recorded, *Eulithidium affine* (Fig. 15) (previously *Tricolia affinis*; see Pereira *et al.*, 2010) stand out in abundance and in frequency of occurrence. Of the total number of individuals,

this species represented 69.9%, occurred in 80% of the samples (13 of 15 samples), and was found in the three algae studied herein. *Eulithidium affine* is a minute species that occurs from Florida to Texas, and through the Caribbean to Brazil (TUNNELL *et al.* 2010), where it is recorded down to Santa Catarina state and oceanic islands (RIOS 2009). Although this species is associated with other substrates, such as rocks, coral reefs and marine seagrass, it is particularly common in macroalgae of many species and with different architectures, as recorded by Pereira *et al.* (2010). These authors suggest that the occurrence and abundance of *E. affine* in different algae and localities may be related to the algal structure, biomass of the algal substrate, and availability of food in these algae. The present study showed a fauna of mollusks typically composed of microgastropods associated with reef macroalgae from shallow coastal reefs. The gastropod diversity associated with macroalgae is still underestimated in faunistic inventories. It is necessary to include these macroalgal microhabitats in conservation and monitoring programs, mainly by the fact that this habitat is considered a key component in structuring marine ecosystems. It provides several ecological services for the whole environment; furthermore, it supports a specific fauna, distinct of the molluscan community found in others marine microhabitats.

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