



Brachyuran and anomuran crabs associated with *Schizoporella unicornis* (Ectoprocta, Cheilostomata) from southeastern Brazil

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ABSTRACT

The main goals of this investigation were to describe the community structure of anomuran and brachyuran crabs inhabiting reefs constituted by colonies of *Schizoporella unicornis*, and to provide a species importance ranking for this community. Collections were carried out on *S. unicornis* reefs at two-month intervals from May 2003 to May 2004, in the rocky sublittoral of the southeastern Brazilian coast. Relative abundance and occurrence were used to rank these species in the hierarchy importance. A total of 2,018 individuals were obtained, in 11 families, 22 genera and 31 species. Porcellanidae and Pilumnidae were the most abundant families, comprising respectively almost 60% and 15% of individuals sampled. The species ranking indicated four main groups A, B, C and D, with group A subdivided. Subgroup A1 contained 9 species, including the species of greatest ecological importance for community regarding abundance and occurrence. The great abundance of crabs associated with *S. unicornis* seems to be the result of its recognized importance during the crab developmental cycle, and as shelter and food for some Decapod species. These observations reveal the importance of conserving the areas occupied by these reef colonies, which appear to be an important environment for maintaining local biodiversity.

Key words: biogenic substrata, bryozoan, community structure, decapods, symbiotic species.

INTRODUCTION

Sessile invertebrates including some corals, ectoprocts, polychaetes and mollusks are commonly recognized as biogenic substrata builders, which are exploited by a large epibiont fauna (Gore et al. 1978, Bradstock and Gordon 1983, Safrieli and Ben-Eliahu 1991, Thompson et al. 1996). On these biogenic

habitats, the associated fauna find shelter and food and thus a safe site for reproduction and development (Safrieli and Eliahu-Ben 1991, Porras et al. 1996).

Decapods occur in association with certain sessile invertebrates such as sponges (Porras et al. 1996, Caruso et al. 2005), corals and anemones (Humes 1991, Arvanitides and Koukouras 1994), worm tubes (Nalesso et al. 1995, Sepúlveda et al. 2003, Nascimento and Torres 2006), echinoderms

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(Wirtz et al. 2009) and bryozoans (Ferdegini et al. 2000, Morgado and Tanaka 2001). However, some decapod groups seem to be preferentially associated with certain biogenic substrata, where they can reach high abundances, which may mean a close relationship among these associated species (e.g., sponges with pilumnid crabs and alpheid shrimps; *Sargassum* beds with epialtid crabs; *Phragmatopoma* reefs with porcellanid crabs, among others) (Micheletti-Flores and Negreiros-Fransozo 1999, Széchy et al. 2001, Bosa and Masunari 2002, Ribeiro et al. 2003). Exact knowledge of which species are involved in these symbiotic relationships could provide biological and ecological information concerning these decapods, and also regarding the traits of the supposed dependence relationships between the decapods and their biogenic substrata.

Species of the genus *Schizoporella* Hincks, 1877 are bryozoan ectoprocts of the family Schizoporellidae, which build calcareous reefs on hard substrates, forming shelters for a variety of invertebrate fauna, including decapod crustaceans. Some investigators have reported on these associations involving decapods and *Schizoporella* reefs, mainly on United States and Brazilian coasts, such as Lindberg (1980), Lindberg and Frydenborg (1980), Lindberg and Stanton (1988, 1989), Mantelatto and Souza-Carey (1998a, b) and Morgado and Tanaka (2001).

Schizoporella unicornis (Johnston 1847) is a sessile cosmopolitan bryozoan, it is distributed along the Brazilian coast with records in Northeast, Southeast and South (Farrapeira 2011). The colonies of *S. unicornis* have an orange structure with a variety of branched shapes, occurring due to interactions with other organisms and the local hydrodynamic condition (Cocito et al. 2000, Ferdegini et al. 2000). These colonies grow in intertidal zones, on rocky substrates or on pier columns, and can reach up to 25 cm height (Ross and McCain 1976).

This contribution characterizes the community structure of the anomuran and brachyuran crabs living on reefs of *S. unicornis* in a small bay on the southeastern Brazilian coast. The following population parameters of decapods were also analyzed: abundance, occurrence, size and sex ratio. In order to evaluate the symbiotic species with *S. unicornis*, the level of importance to this community was evaluated by means of the occurrence and relative abundance of the species.

MATERIALS AND METHODS

Collections of *S. unicornis* reefs were carried out at two-month intervals from May 2003 to May 2004. The reefs studied were growing on pier columns at Itaguá Beach in Ubatuba, northeastern coast of São Paulo State (23°27'04"S-45°02'49"W) (Fig. 1). The reefs were collected by hand, by divers working during the daytime. The catch per unit effort consisted of one person scanning the bottom for reefs, for each two months.

The material (bryozoan colonies) collected was bagged during the dive to avoid the loss of specimens, and transferred to the Marine Biology Laboratory at the Universidade de Taubaté –

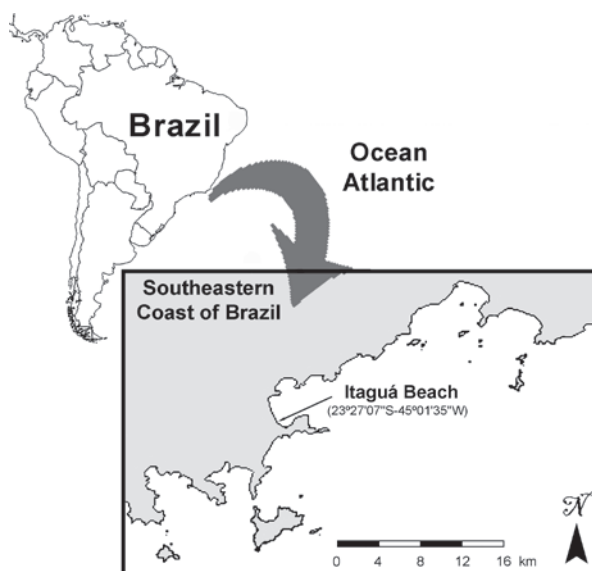


Fig. 1 - Map of the northeastern coast of São Paulo showing Itaguá Beach.

UNITAU, where the decapods were separated from the colonies. The crabs were identified according to Melo (1996, 1999), and their classification followed Ng et al. (2008).

Sex and developmental stage (juvenile or adult) of the brachyuran crabs were identified from the external morphology of the abdomen and appendages. The sex determination for anomurans was based on the gonopore position (females on the coxa of the third pereopod and males on the coxa of the fifth pereopod), and the individuals were identified as juvenile or adult considering the size of the smallest ovigerous females obtained in the samples. For those species, which no ovigerous females was recorded, the size of smallest ones obtained by Litulo (2005) and Miranda and Mantelatto (2009) was used. The sex ratio was estimated and tested by Chi-square ($p < 0.05$) (Zar 1999). The largest carapace width (CW) was measured for brachyuran and porcellanid crabs, and the shield length (SL) for hermit crabs.

The relative abundance (RAb) was calculated for each crab species as $RAb = n/N$, where n = total absolute abundance recorded for a given species, and N = total of the individuals recorded over the entire sampling program. The relative occurrence (RO) was represented as $RO = p/P$, where p = number of samples containing in the given species, and P = the total number of samples. In order to estimate the similarity of species present in the community, these species were grouped according to Bray-Curtis similarity index, followed by UPGMA cluster method (Zar 1999), where the indexes (RAb and RO) were employed as parameters to build the cluster. This similarity analysis recognizes set of species concerning their ecological importance for community.

Only the most important species (showed by grouping analyses) were included in the analyses of median size of individuals, sex ratio and frequency histograms.

RESULTS

During the field surveys, 2,018 individuals were collected, distributed in 11 families, 22 genera and 31 species of anomuran and brachyuran decapods. Identification at species level was not possible for 78 specimens, which were recognized only to family level (Table I). The porcellanid anomuran crabs *Megalobrachium roseum*, *Pachycheles monilifer* and *Pisidia brasiliensis* were the most abundant species, with 409, 297 and 179 individuals captured, respectively. The brachyuran crabs *Pelia rotunda*, *Microphrys antillensis*, *Hexapanopeus paulensis*, and the anomuran crab *Calcinus tibicen*, *Pachycheles riisei* and *Petrolisthes amoenus* were represented by only one specimen each (Table I).

The most abundant families were Porcellanidae and Pilumnidae, comprising respectively around 60% and 15% of the total decapods collected. These porcellanid crabs also showed the highest species richness, contributing 9 of the total species found in association with the reef colonies (Table I).

The species ranking indicated four groups (A, B, C, and D) composed of 15, 3, 5 and 8 species respectively. Group A was subdivided into subgroups A1 and A2 (Fig. 2). The species belonging to groups C and D showed the lowest relative abundance and occurrence, while group B species were recorded in intermediate abundance and occurrence, and species of group A were the most important in relative abundance and occurrence.

Subgroup A1 was composed of 9 species, *Megalobrachium roseum*, *Pachycheles monilifer*, *Petrolisthes galathinus*, *Pisidia brasiliensis*, *Menippe nodifrons*, *Mithraculus forceps*, *Pilumnus reticulatus*, *Pilumnus spinosissimus*, *Paguristes tortugae* (Fig. 2). This subgroup included 5 anomurans and 4 brachyurans. The species of this subgroup A1 were used in further analysis.

The size-class distribution frequency analysis showed that brachyuran and anomuran crab community was constituted mainly by small

TABLE I
Brachyuran and anomuran species associated with *Schizoporella unicornis* and their respective abbreviations (Cod);
absolute abundance (N); sex ratio (Male: Female); relative abundance (RAb); relative occurrence (RO).

Family/species	Cod	N	Size (mm)		M:F	RAb	RO
			Range	X±SD			
MENIPPIDAE							
<i>Menippe nodifrons</i> Stimpson, 1859	Mno	80	2.50-24.80	7.68±4.07	1:1.4	0.04	1.00
EPIALTIIDAE							
<i>Epialtus bituberculatus</i> H. Milne Edwards, 1834	Ebi	3	2.20-8.10	5.90±3.22	1:0.5	0.00	0.33
<i>Apiomithrax violaceus</i> (A. Milne Edwards, 1868)	Avi	12	2.50-16.20	6.13±4.21	1:1	0.01	0.83
<i>Pelia rotunda</i> A. Milne Edwards, 1875	Pro	1	6.50	-	-	0.00	0.17
INACHIDAE							
<i>Podochela gracilipes</i> Stimpson, 1871	Pgr	54	2.10-6.50	3.72±0.88	1:1.6	0.03	0.83
<i>Stenorhynchus seticornis</i> (Herbst, 1788)	Sse	5	2.10-12.10	6.98±4.57	1:4	0.00	0.50
MAJIDAE							
		3					
<i>Microphrys antillensis</i> Rathbun, 1901	Man	1	4.50	-	-	0.00	0.17
<i>Microphrys bicornutus</i> (Latreille, 1825)	Mbi	2	2.10-4.10	3.10±1.41	1:1	0.00	0.33
<i>Mithraculus forceps</i> (A. Milne Edwards, 1875)	Mfo	35	3.10-11.90	7.33±2.42	1:1.2	0.02	1.00
<i>Mithrax hispidus</i> (Herbst, 1790)	Mhi	6	7.60-12.20	9.42±1.82	1:1	0.00	0.67
PILUMNIDAE							
		48					
<i>Pilumnus diomedeeae</i> Rathbun, 1894	Pdi	2	3.60-4.40	4.00±0.57	1:1	0.00	0.33
<i>Pilumnus reticulatus</i> Stimpson, 1860	Pre	152	1.90-13.20	4.48±2.29	1:1.3	0.08	1.00
<i>Pilumnus spinosissimus</i> Rathbun, 1898	Psp	160	2.10-9.50	4.61±1.48	1:1.1	0.09	1.00
PORTUNIDAE							
		2					
<i>Cronius ruber</i> (Lamarck, 1818)	Cru	3	3.60-27.20	13.4±12.3	1:0.5	0.002	0.33
PANOPEIDAE							
		20					
<i>Acantholobulus bermudensis</i> Benedict & Rathbun, 1891	Abe	57	2.20-6.80	3.89±0.70	1:0.7	0.03	0.83
<i>Hexapanopeus paulensis</i> Rathbun, 1930	Hpa	1	6.50	-	-	0.00	0.17
<i>Panopeus americanus</i> Saussure, 1857	Pme	5	2.90-3.50	3.24±0.27	1:4	0.00	0.17
<i>Panopeus rugosus</i> A. Milne Edwards, 1880	Pru	2	3.40-6.50	4.95±2.19	1:1	0.00	0.33
GRAPSIDAE							
<i>Pachygrapsus transversus</i> (Gibbes, 1850)	Ptr	36	2.40-6.30	3.18±0.96	1:2.6	0.02	0.67
PAGURIDAE							
<i>Pagurus brevidactylus</i> (Stimpson, 1859)	Pbv	20	1.20-2.40	1.80±0.40	1:1.1	0.00	0.50
DIOGENIDAE							
<i>Calcinus tibicen</i> (Herbst, 1791)	Cti	1	2.20	-	-	0.00	0.17
<i>Paguristes tortugae</i> Schmitt, 1933	Pto	128	0.70-6.00	3.00±1.30	1:2.6	0.07	1.00
PORCELLANIDAE							
		5					
<i>Megalobrachium roseum</i> (Rathbun, 1900)	Mro	409	1.30-5.90	3.50±0.92	1:1.1	0.21	1.00
<i>Megalobrachium soriatum</i> (Say, 1818)	Mso	86	1.40-4.60	3.10±0.69	1:0.9	0.04	0.67
<i>Pachycheles laevidactylus</i> Ortmann, 1892	Pla	46	1.60-4.80	3.37±0.72	1:0.9	0.02	0.50
<i>Pachycheles monilifer</i> (Dana, 1852)	Pmo	297	1.50-9.20	4.31±1.57	1:0.8	0.16	1.00
<i>Pachycheles riisei</i> (Stimpson, 1858)	Pri	1	2.70	-	-	0.00	0.17
<i>Petrolisthes amoenus</i> (Guérin-Ménéville, 1855)	Pam	1	3.40	-	-	0.00	0.17
<i>Petrolisthes armatus</i> (Gibbes, 1850)	Par	2	3.70-4.30	4.00±0.42	2:0	0.00	0.17
<i>Petrolisthes galathinus</i> (Bosc, 1802)	Pga	83	1.40-8.50	4.65±1.8	1:0.7	0.04	1.00
<i>Pisidia brasiliensis</i> Haig in Rodrigues da Costa, 1968	Pbr	179	1.70-4.90	3.41±0.68	1:1.2	0.09	1.00

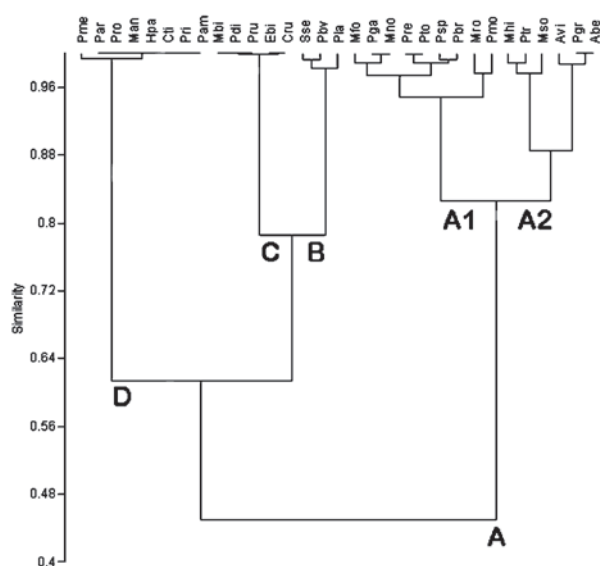


Fig. 2 - Cluster analysis (UPGMA - Bray-Curtis), similarity between the relative occurrence and abundance of species obtained in association with *Schizoporella unicornis* in Ubatuba, southeastern Brazil. The species codes are found in Table I.

specimens (Table I). In the subgroup A1, anomurans were mainly distributed from the first to third size class, except for *Pachycheles monilifer* e *Petrolisthes galathinus* that were recorded for larger size classes, (Fig. 3A-E). Among brachyuran crabs the maximum size reached was included into the 12.1-14.0 mmCW size class, with exception to *Menippe nodifrons* that was the largest decapod recorded during the present study (Fig. 3F-I).

Of these species, only *Menippe nodifrons* was not recorded in all demographic categories, being represented mainly by juveniles (Fig. 4A, B). Meaningful deviations from the Mendelian sex ratio were found only for *Paguristes tortugae*, biased toward females ($1:2.61$, $\chi^2 = 22.32$; $p < 0.001$).

Some small individuals of *Menippe nodifrons*, *Pilumnus reticulatus*, *Pilumnus spinosissimus* and *Paguristes tortugae* could not be sexed, and were included in the analyses as “sex undetermined” (Figure 4A, B).

DISCUSSION

The richness recorded for Brachyura and Anomura (19 and 12 species, respectively) associated with

Schizoporella unicornis is larger than in previous reports. According to Lindberg and Stanton (1988) *Schizoporella pungens* that occurs only from the north-eastern Gulf of Mexico and Yucatan Peninsula, found 11 species of brachyurans and 5 species of anomurans. Mantelatto and Souza-Carey (1998a, b) found 20 brachyuran species and 9 anomuran species in their study on *S. unicornis* realized at Itaguá Beach in Ubatuba, southeastern Brazil (Table II). This number of species is larger than those found by investigations of other biogenic substrata along the Brazilian coast (Bosa and Masunari 2002, Ribeiro et al. 2003, Chintiroglou et al. 2004). Structural complexity and abundance might explain differences among studies and remain to be studied in the future (Witman 1985, Thiel and Baeza 2001).

The anomuran and brachyuran crabs recorded in this investigation were characterized by their small adult body size (e.g., *P. gracilipes*, *P. tortugae*, *M. roseum*), or presence of juveniles of species reaching large body sizes (e.g., *M. nodifrons*, *C. ruber*, *M. hispidus*) and therefore exploit the reefs only in their initial development stages. Taking into account that portunids are considered predators (Warner 1977, Nevis et al. 2009), *Cronius ruber*, which has recorded the largest mean size, can use *S. unicornis* colonies as feeding site, where it can get its prey.

The internal spaces in the reef colonies can also be used by the motile fauna from adjacent substrata, which exploit these colonies as a refuge or/and food resource. Some authors such as Jones et al. (1994) and Chintiroglou et al. (2004) have categorized the sessile fauna as “engineer species” that are able to increase the heterogeneity and tridimensionality of the habitat.

The reef colonies of *S. unicornis* provide refuge sites at the milimetric scale, which seems to be important for the first settlement of certain crabs, that will grow to larger sizes, as seen in Table III. The colonies of *S. unicornis* function as a nursery

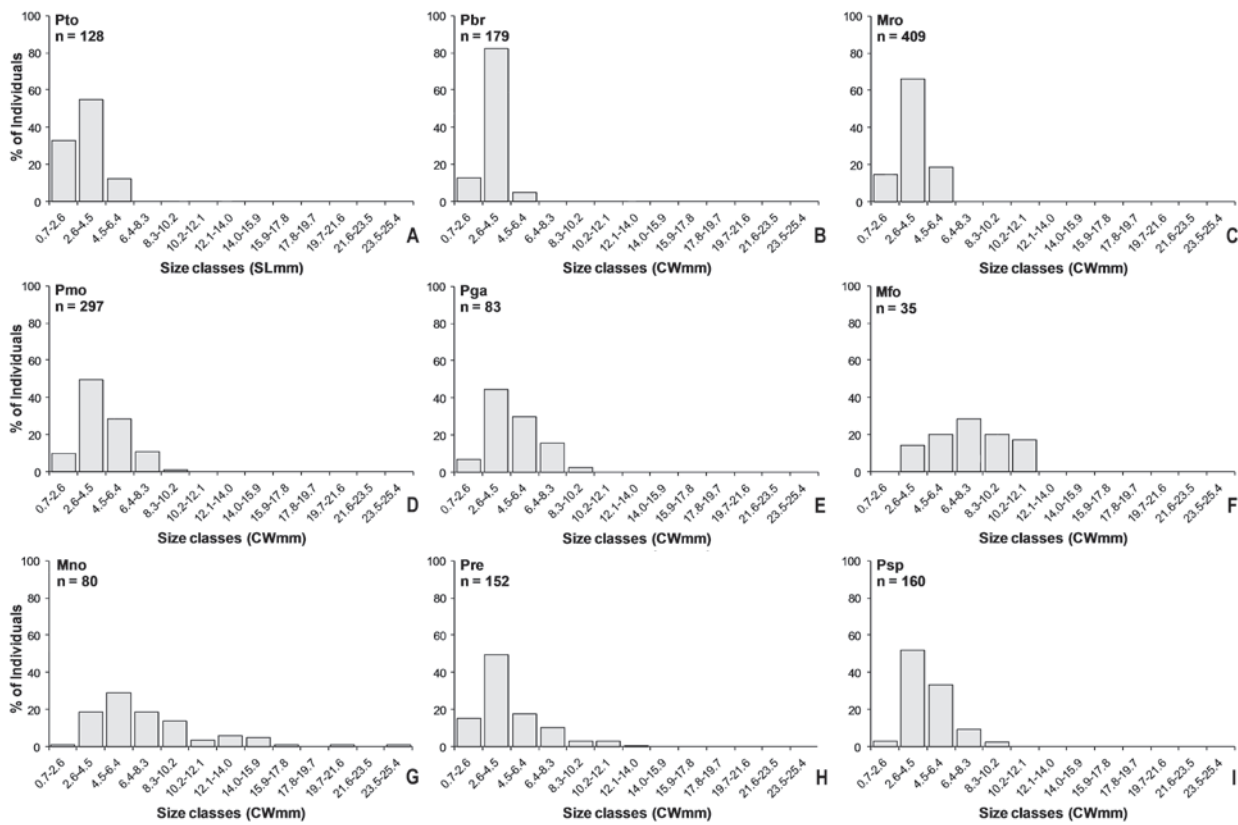


Fig. 3 - Size-frequency distribution of specimens of anomurans (A-E) and brachyurans (F-I). The species codes are found in Table I.

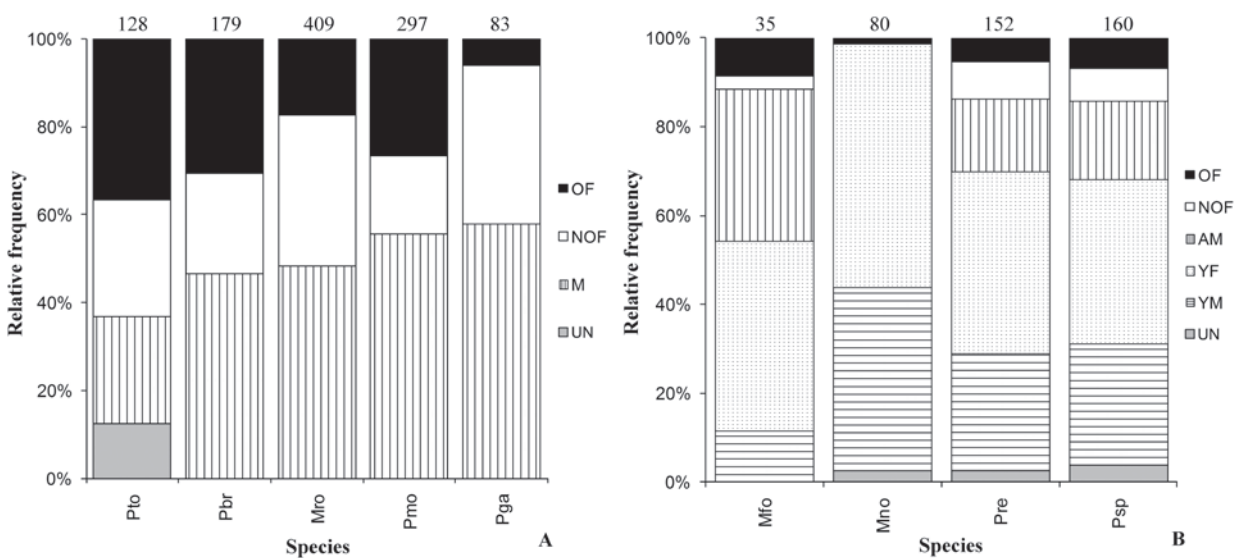


Fig. 4 - Relative frequency of specimens by group of anomuran (A) and brachyuran (B) species associated with *Schizoporella unicornis*. M= males; UN= undetermined; OF= ovigerous females; NOF= non-ovigerous adult females; YF= young females; AM= adult males; YM= young males. The number above the bars represents the absolute abundance of the species. The species codes are found in Table I.

TABLE II
Studies reporting the association of decapods (Brachyura and Anomura) with *Schizoporella* colonies, noting the richness of species and the most abundant species found in each study.

Author/year	Location	Species of <i>Schizoporella</i>	Richness Brachyura	Most Abundant Species	Richness Anomura	Most Abundant Species
Lindberg and Stanton 1988	Florida, USA	<i>Schizoporella pungens</i> Canu & Bassler, 1928	11	<i>Pilumnus sayi</i> Rathbun, 1923	5	<i>Porcellana sayana</i> (Leach, 1820), <i>Pagurus brevidactylus</i> , <i>Petrolisthes armatus</i>
Mantelatto and Souza-Carey 1998a	Ubatuba, Southeastern Brazil	<i>S. unicornis</i>	-	-	9	<i>Pachycheles monilifer</i>
Mantelatto and Souza-Carey 1998b	Ubatuba, Southeastern Brazil	<i>S. unicornis</i>	20	<i>Pachygrapsus transversus</i>	-	-
Morgado and Tanaka 2001	Ubatuba, Southeastern Brazil	<i>Schizoporella errata</i> (Walters, 1878)	10	<i>Acantholobulus schmitti</i> (Rathbun, 1930)	4	<i>Pachycheles rugimanus</i> Milne-Edwards, 1880
	São Sebastião, Southeastern Brazil		4	<i>Pilumnus dasypodus</i> Kingsley, 1879	4	<i>Pachycheles rugimanus</i>
Present study	Southeastern Brasil	<i>S. unicornis</i>	19	<i>Pilumnus spinosissimus</i>	12	<i>Megalobrachium roseum</i>

TABLE III
Comparison of maximum sizes (mm) of the brachyuran and anomuran species recorded in this study and in the literature. Note: only species with 5 or more specimens were included in this analysis.

Species	Present study	Literature	Reference
<i>Menippe nodifrons</i>	24.8	129.0	Williams 1984
<i>Apiomithrax violaceus</i>	16.2	21.0	Melo 1998
<i>Podocheila gracilipes</i>	6.5	10.9	Melo 1998
<i>Stenorhynchus seticornis</i>	12.1	24.0	Williams 1984
<i>Mithraculus forceps</i>	11.9	38.0	Williams 1984
<i>Mithrax hispidus</i>	12.2	146.0	Williams 1984
<i>Pilumnus reticulatus</i>	13.2	13.3	Melo 1998
<i>Pilumnus spinosissimus</i>	9.5	11.0	Melo 1998
<i>Acantholobulus bermudensis</i>	6.8	9.6	Melo 1998
<i>Panopeus americanus</i>	3.5	24.3	Melo 1998
<i>Pachygrapsus transversus</i>	6.3	26.4	Williams 1984
<i>Pagurus brevidactylus</i>	2.2	6.7	Melo 1999
<i>Paguristes tortugae</i>	5.0	19.3	Melo 1999
<i>Megalobrachium roseum</i>	5.9	4.3	Melo 1999
<i>Megalobrachium soriatum</i>	4.6	5.5	Williams 1984
<i>Pachycheles laevidactylus</i>	4.8	8.5	Melo 1999
<i>Pachycheles monilifer</i>	9.2	11.0	Melo 1999
<i>Petrolisthes galathinus</i>	8.5	9.2	Melo 1999
<i>Pisidia brasiliensis</i>	4.9	5.3	Melo 1999

ground for several of the species recorded in this study, as it provides the largest number of refuges for crabs ranging from 2.7 to 5.1 mm CW.

The identification of substrate features such as texture can be a determining factor for decapod crustacean larval establishment and the stimuli for metamorphoses that take the individuals to the juvenile life stage (Anger 2006). The large number of individuals that could not be identified to species level because of their small sizes suggests the importance of these bryozoan colonies for the establishment and juvenile development of at least some species.

The overall ranking of species importance in the community for the data obtained during entire the sampling period showed that 9 (29%) species of subgroup A1 are temporary or permanent residents on the *S. unicornis* reefs. All the species of this group were recorded in all samples, which were found in all demographic categories and in similar sizes to those mentioned in the literature; except for *M. nodifrons* (see Table III).

The data for *M. nodifrons* and *P. reticulatus* suggest that *S. unicornis* does not provide appropriate conditions for their entire life cycle, because after the modal class their frequencies declined. *M. nodifrons* may reach 130 mm CW (Williams 1984) (see Table III), and is a common inhabitant of intertidal rocky shores along the entire Brazilian coast (Melo 1996). Juveniles of *M. nodifrons* were reported occupying *S. unicornis* reefs by Mantelatto and Souza-Carey (1998b) and Morgado and Tanaka (2001). During its development, this crab can exploit different biogenic substrata on intertidal rocky shores, especially for food and refuge (see Fransozo et al. 2000, Oshiro 1999). The results of this investigation agree with this pattern, since the specimens captured were no larger than 25 mm CW, suggesting that colonies of *S. unicornis* provide favorable sites only for immature *M. nodifrons*.

Subgroup A1 was composed of a filter-feeding component including porcellanid crabs (4 species)

(Trager et al. 1992, Achituv and Pedrotti 1999); an omnivorous component with one hermit-crab species (Reese 1969) and 2 brachyuran species; and an herbivorous component with 2 brachyuran species, represented by 2 majoid crabs (Stachowicz and Hay 1996). In addition, the size-class frequency distribution in size classes of individuals for these 9 species indicated a trend to a normal and unimodal distribution, suggesting that these species may spend their entire post-embryonic life history associated with *S. unicornis* reefs.

The juveniles of *P. tortugae* were difficult to sex, and therefore individuals in this stage were classified as “sex undetermined”. External sex identification is based on the presence of a gonopore, but these apertures are only conspicuous after sexual maturity. The same difficulty was reported by Negreiros-Fransozo and Fransozo (1992) and Mantelatto and Dominciano (2002).

The species of subgroup A1 might be characterized as symbiotic with *S. unicornis* on the southeastern Brazilian coast. Of these, *M. nodifrons* has only a temporary relationship, exploiting these reefs during its juvenile development.

Subgroup A1 included both anomurans and brachyurans, specially Pilumnidae and Porcellanidae species, in agreement to Lindberg and Stanton (1988), whereby *Pilumnus sayi* and *Porcellana sayana* were the most abundant decapods in Florida, USA, and Morgado and Tanaka (2001) that founded *Pilumnus dasypodus* and *Pachycheles rugimanus* as the most abundant species for southeastern Brazil. Mantelatto and Souza-Carey (1998a) also reporting *Pachycheles monilifer* as the most abundant Anomuran associated with *S. unicornis* in the southeastern Brazilian coast (see Table II). On the other hand, unlike the finds of the present study, *Pachygrapsus transversus* was recognized by Mantelatto and Souza-Carey (1998b) as the most abundant Brachyuran in the *S. unicornis* colonies, as shown in Table II.

Those findings indicate that *Schizoporella* sp colonies would be an opportunistic shelter for

decapods. The dominance of porcellanids was likely constrained by their suspension- or detritus-feeding habit (Trager et al. 1992, Achituv and Pedrotti 1999). On the other hand, Kyomo (1999) reported *Pilumnus vespertilio* (Fabricius 1793) as omnivorous, tending to herbivory, and a common feeding habit among brachyurans (see Hill 1976, Barros et al. 2008). Although pilumnids and porcellanids shared the same habitat and were both abundant, they avoid competition by exploiting different food sources.

The subgroup A2 species may be visitors or residents that show some degree of seasonality, and were separated from group A1 by the relative occurrence of these groups. The remaining species, belonging to groups B, C and D, were less abundant or accidental. This situation of minimal frequency may have different biological meanings, such as cryptic behavior, migration and dispersal, or even the influence of the adjacent habitats, which might reduce the frequency of individuals and also the catch efficiency (Witman 1985, Bertness 1999) in addition to the natural self-regulation that drives the community structure and determines the size of the populations in the community. However, these statements must be viewed as speculations that still require empirical confirmation.

Additionally, it is possible that the species *M. roseum*, *P. monilifer* and *Pisidia brasiliensis* are characteristic of the *S. unicornis* habitat, mainly as a consequence of their filter-feeding habit and because of the wide range of food resources available in the area. Bryozoans are also filter-feeders, and therefore, the sites where they settle are obviously suitable for other filter-feeding animals (Cocito et al. 2000).

Seasonal alterations in the population density of key species belonging to subgroup A1 can modify the dominance patterns of the community and cause oscillations in competition for refuges and/or food. Nevertheless, the period of highest diversity is the same as observed in other studies of decapod

communities on the southeastern Brazilian coast (e.g. Mantelatto and Fransozo 2000, Mantelatto et al. 2004). This period may be associated with the larger amounts of organic matter made available by the incursion of the South Atlantic Central Waters (SACW) in these coastal regions (Arasaki 2004, Santos and Pires-Vanin 2004).

The rich decapod fauna found associated with *S. unicornis* indicates the contribution of these reef colonies to the ontogenetic development of these crabs. These findings reveal the importance of conservation of the areas occupied by these reefs, which appear to be an important environment for local biodiversity stocks.

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RESUMO

Os principais objetivos deste estudo foram descrever a estrutura da comunidade de caranguejos anomuros e braquiúros que habitam recifes constituídos por colônias de *Schizoporella unicornis*, e fornecer uma ordenação das espécies mais importantes para esta comunidade. As coletas foram realizadas bimestralmente desde maio de 2003 até maio de 2004, no infralitoral rochoso da costa sudeste brasileira. A abundância e ocorrência relativas foram usadas para ordenar estas espécies em hierarquia de importância. Obteve-se um total de 2.018 indivíduos, distribuídos em 11 famílias, 22 gêneros e 31 espécies. Porcellanidae e Pilumnidae foram as famílias mais abundantes,

compreendendo, respectivamente, cerca de 60% e 15% dos indivíduos amostrados. A ordenação das espécies indicou quatro grupos principais A, B, C e D, sendo o grupo A subdividido em dois. O subgrupo A1 contém 9 espécies, incluindo as espécies de maior importância ecológica para a comunidade, com relação à abundância e ocorrência. A grande abundância de caranguejos encontrados associados com *S. unicornis* é resultado de sua importância reconhecida durante o ciclo de desenvolvimento, e como abrigo e alimento para algumas espécies de decápodos. Estas observações revelam a importância de conservar as áreas ocupadas por essas colônias de briozoários, que parece ser um ambiente importante para a manutenção da biodiversidade local.

Palavras-chave: substrato biogênico, briozoário, estrutura da comunidade, decápodos, espécies simbióticas.

REFERENCES

- ACHITUV Y AND PEDROTTI ML. 1999. Costs and gains of porcelain crab suspension feeding in different flow conditions. *Mar Ecol Prog Ser* 184: 161-169.
- ANGER K. 2006. Contributions of larval biology to crustacean research: a review. *Invertebr Reprod Dev* 49(3): 175-205.
- ARASAKI E, MUNIZ P AND PIRES-VANIN AM. 2004. A Functional analysis of the benthic macrofauna of the São Sebastião Channel (Southeastern Brazil). *Mar Ecol* 25(4): 249-263.
- ARVANITIDES C AND KOUKOURAS A. 1994. Polychaete fauna associated with the coral *Cladocora caespitosa* (L.) in the eastern Mediterranean. *Mem Mus Nat Hist Nat Ser A* 162: 347-353.
- BARROS SP, COBO VJ AND FRANZOZO A. 2008. Feeding habits of the spider crab *Libinia spinosa* H. Milne Edwards, 1834 (Decapoda, Brachyura) in Ubatuba Bay, São Paulo, Brazil. *Braz Arch Biol Techn* 51(2): 413-417.
- BERTNESS MD. 1999. *The Ecology of Atlantic Shorelines*. Sinauer: Sunderland, 417 p.
- BOSA CR AND MASUNARI S. 2002. Crustáceos decápodos associados aos bancos de *Phragmatopoma caudata* (Kröyer) (Polychaeta, Sabellariidae) na Praia de Caiobá, Matinhos, Paraná. *Rev Bras Zool* 19(Supl. 1): 117-133.
- BRADSTOCK M AND GORDON DP. 1983. Coral-like bryozoan growths in Tasman Bay, and their protection to conserve commercial fish stocks. *N Z J Mar Freshw Res* 17: 159-163.
- CARUSO T, FALCIAI L AND ZUPO V. 2005. Do hermit crabs like living in sponges? *Paguristes eremita* and *Suberites domuncula*: biometric data from the southern Mediterranean Sea. *J Mar Biol Ass U K* 85: 1353-1357.
- CHINTIROGLOU CC, DAMIANIDIS P, ANTONIADOU C, LANTZOUNI M AND VAFIDIS D. 2004. Macrofauna biodiversity of mussel bed assemblages in Thermaikos Gulf (northern Aegean Sea). *Helgoland Mar Res* 58: 62-70.
- COCITO S, FERDEGHINI F, MORRI C AND BIANCHI CN. 2000. Patterns of bioconstruction in the cheilostome bryozoan *Schizoporella errata*: the influence of hydrodynamics and associated biota. *Mar Ecol Prog Ser* 192: 153-161.
- FARRAPEIRA CMR. 2011. Macrobenthic invertebrates found in Brazilian coast transported on abiogenic solid floating debris. *J Integr Coastal Rec* 11(1): 85-96.
- FERDEGHINI F, COCITO S, MORRI C AND BIANCHI CN. 2000. Living bryozoan buildups: *Schizoporella errata* (Waters, 1848) (Cheilostomatida, Ascophorina) in the northwestern Mediterranean (preliminary observations). In: Herrera CA and Jackson JBC (Eds), *Proceedings of the 11th International Bryozoology Association Conference: Panama*, p. 238-244.
- FRANZOZO A, BERTINI G AND CORRÊA MOD. 2000. Population biology and habitat utilization of the stone crab *Menippe nodifrons* Stimpson, 1859 (Decapoda, Xanthidae) in Ubatuba region, Brazil. In: Vaupel-Klein JC and Schram FR (Eds), *The Biodiversity Crisis and Crustacea*. A.A. Balkema/Rotterdam: Crustacean Issues, p. 275-281.
- GORE RH, SCOTTO LE AND BECKER LJ. 1978. Community composition, stability, and trophic partitioning in decapod crustaceans inhabiting some tropical sabellariid worm reefs. *Bull Mar Sci* 28(2): 221-248.
- HILL BJ. 1976. Natural food, foregut clearance rate and activity of the crab *Scylla serrata*. *Mar Biol* 34: 109-116.
- HUMES AG. 1991. Copepoda associated with the scleractinian coral genus *Montipora* in the Indo-Pacific. *Proc Biol Soc Wash* 104(1): 101-137.
- JONES CG, LAWTON JH AND SHACHAK M. 1994. Organisms as ecosystem engineers. *Oikos* 69: 373-386.
- KYOMO J. 1999. Feeding patterns, habits and food storage in *Pilumnus vespertilio* (Brachyura: Xanthidae). *Bull Mar Sci* 65(2): 381-389.
- LINDBERG WJ. 1980. Patterns of resource use within a population of xanthid crabs occupying bryozoan colonies. *Oecologia* 46: 338-342.
- LINDBERG WJ AND FRYDENBORG RB. 1980. Resource centered agonism of *Pilumnus sayi* (Brachyura, Xanthidae), an associate of the bryozoan *Schizoporella pungens*. *Behaviour* 75: 235-250.
- LINDBERG WJ AND STANTON GR. 1988. Bryozoan-associated decapod crustaceans: community patterns and a case of cleaning symbiosis between a shrimp and crab. *Bull Mar Sci* 42(3): 411-423.
- LINDBERG WJ AND STANTON GR. 1989. Resource quality, dispersion and mating prospects for crabs occupying bryozoan colonies. *J Exp Mar Biol Ecol* 128: 257-282.
- LITULO C. 2005. Population biology and fecundity of the Indo-Pacific hermit crab *Clibanarius longitarsus* (Anomura: Diogenidae). *J Mar Biol Ass U K* 85: 121-125.

- MANTELATTO FLM, BIAGI R, FARIA FCR, MEIRELES AL AND MELO GAS. 2004. Checklist on brachyuran fauna (Decapoda) from infralittoral rocky/sandy bottom of Anchieta Island, São Paulo State, Brazil. *Nauplius* 12(2): 135-142.
- MANTELATTO FLM AND DOMINCIANO LCC. 2002. Pattern of shell utilization by the hermit crab *Paguristes tortugae* (Diogenidae) from Anchieta Island, southern Brazil. *Sci Mar* 66(3): 265-272.
- MANTELATTO FLM AND FRANZOZO A. 2000. Brachyuran community in Ubatuba Bay, northern coast of São Paulo State, Brazil. *J Shellfish Res* 19(2): 701-709.
- MANTELATTO FLM AND SOUZA-CAREY MM. 1998a. Caranguejos anomuros (Crustacea, Decapoda) associados à *Schizoporella unicornis* (Bryozoa, Gymnolaemata) em Ubatuba (SP), Brasil. *Anais do IV Simpósio de Ecossistemas Brasileiros ACIESP* 2(104): 200-206.
- MANTELATTO FLM AND SOUZA-CAREY MM. 1998b. Brachyura (Crustacea, Decapoda) associated to *Schizoporella unicornis* (Bryozoa, Gymnolaemata) in Ubatuba Bay (SP), Brazil. *Braz Arch Biol Techn* 41(2): 212-217.
- MELO GAS. 1996. Manual de Identificação dos Crustacea Decapoda do Litoral Brasileiro. São Paulo: Plêiade/FAPESP, 640 p.
- MELO GAS. 1999. Manual de Identificação dos Crustacea Decapoda do Litoral Brasileiro: Anomura; Thalassinidea; Palinuridea e Astacidea. São Paulo: Plêiade/FAPESP, 551 p.
- MICHELETTI-FLORES CV AND NEGREIROS-FRANZOZO ML. 1999. Porcellanid crabs (Crustacea, Decapoda) inhabiting sand reefs built by *Phragmatopoma lapidosa* (Polychaeta, Sabellariidae) at Paranapuã Beach, São Vicente, SP, Brazil. *Rev Bras Biol* 59(1): 63-73.
- MIRANDA I AND MANTELATTO FL. 2009. Estimating population features of the anomuran crab *Petrolisthes armatus* (Porcellanidae) in a remaining and impacted mangrove area of the western Atlantic. *J Nat Hist* 43(33-34): 2027-2039.
- MORGADO EH AND TANAKA MO. 2001. The macrofauna associated with the bryozoan *Schizoporella errata* (Walters) in southeastern Brazil. *Sci Mar* 65(3): 173-181.
- NALESSO RC, DUARTE LFL, PIEROZZI JRI AND ENUMO EF. 1995. Tube epifauna of the polychaete *Phyllochaetopterus socialis* Claparède. *Est Coast Shelf Sci* 41: 91-100.
- NASCIMENTO EE AND TORRES MFA. 2006. Macroinvertebrados associados a agregados de tubos de *Nicolea uspiana* Nogueira, 2003 (Polychaeta, Terebellidae) nos recifes da Praia de Boa Viagem, Recife – Pernambuco. *Bol Tec Cient CEPENE* 14(2): 9-15.
- NEGREIROS-FRANZOZO ML AND FRANZOZO A. 1992. Estrutura populacional e relação com a concha em *Paguristes tortugae* Schmitt, 1933 (Decapoda, Diogenidae), no litoral norte do Estado de São Paulo, Brasil. *Naturalia* 17: 31-42.
- NEVIS AB, MARTINELLI JM, CARVALHO ASS AND NAHUM VJI. 2009. Abundance and spatial-temporal distribution of the family Portunidae (Crustacea, Decapoda) in the Curuçá estuary on the northern coast of Brazil. *Braz J Aquat Sci Technol* 13(1): 71-79.
- NG PKL, GUINOT D AND DAVIE PJF. 2008. Systema brachyurorum: Part I. An annotated checklist of extant brachyuran crabs of the world. *Raffles Bull Zool* 17: 1-208.
- OSHIRO LMY. 1999. Aspectos reprodutivos do caranguejo guaiá, *Menippe nodifrons* Stimpson (Crustacea, Decapoda, Xanthidae) da Baía de Sepetiba, Rio de Janeiro, Brasil. *Rev Bras Zool* 16(3): 827-834.
- PORRAS R, BATALER JV, MURGH E AND TORREGROSA MT. 1996. Trophic-structure and community composition of polychaetes inhabiting some *Sabellaria alveolata* (L.) reefs along the Valencia Gulf Coast, Western Mediterranean. *Mar Ecol* 17: 583-602.
- REESE ES. 1969. Behavioral adaptations of intertidal hermit crabs. *Am Zool* 9: 343-355.
- RIBEIRO SM, OMENA EP AND MURICY G. 2003. Macrofauna associated to *Mycale microsigmatosa* (Porifera, Demospongiae) in Rio de Janeiro State, SE Brazil. *Est Coast Shelf Sci* 57: 951-959.
- ROSS JRP AND MCCAIN KW. 1976. *Schizoporella unicornis* (Ectoprocta) in Coastal Waters of Northwestern United States and Canada. *Northwest Sci* 50(3): 160-171.
- SAFRIEL UN AND BEN-ELIAHU MN. 1991. The influence of habitat structure and environmental stability on the species diversity of polychaetes in vermetid reefs. In: Bell SS, McCoy ED and Mushinsky HR (Eds), *Habitat Structure - The Physical Arrangement of Objects in Space*. London: Chapman and Hall, p. 349-369.
- SANTOS MFL AND PIRES-VANIN AMS. 2004. Structure and dynamics of the macrobenthic communities of Ubatuba bay, southeastern Brazilian coast. *Braz J Oceanogr* 52(1): 59-73.
- SEPÚLVEDA RD, MORENO RA AND CARRASCO FD. 2003. Diversidad de macroinvertebrados asociados a arrecifes de *Phragmatopoma moerchi* Kinberg, 1867 (Polychaeta: Sabellariidae) en el intermareal rocoso de Cocholgué, Chile. *Gayana* 67(1): 45-54.
- STACHOWICZ JJ AND HAY ME. 1996. Facultative mutualism between an herbivorous crab and a coralline alga: advantages of eating noxious seaweeds. *Oecologia* 105(3): 377-387.
- SZÉCHY MTM, VELOSO VG AND PAULA EJ. 2001. Brachyura (Decapoda, Crustacea) of phytobenthic communities of the sublittoral region of rocky shores of Rio de Janeiro and São Paulo, Brazil. *Trop Ecol* 42(2): 231-242.
- THIEL M AND BAEZA JA. 2001. Factors affecting the social behaviour of crustaceans living symbiotically with other marine invertebrates: a modelling approach. *Symbiosis* 30: 163-190.
- THOMPSON RC, WILSON BJ, TOBIN ML, HILL AS AND HAWKINS SJ. 1996. Biologically generated habitat provisioning and diversity of rocky shore organisms at a hierarchy of spatial scales. *J Exp Mar Biol Ecol* 202: 73-84.
- TRAGER GC, COUGHLIN D, GENIN A, ACHITUV Y AND GANGOPADHYAY A. 1992. Foraging to the rhythm of ocean waves: porcelain crabs and barnacles synchronize feeding motions with flow oscillations. *J Exp Mar Biol Ecol* 164: 73-86.

- WARNER GF. 1977. The biology of crabs. Elek Science London: New York, 202 p.
- WILLIAMS AB. 1984. Shrimps, Lobsters, and Crabs of the Atlantic Coast of the Eastern United States, Maine to Florida. Washington: Smithsonian Institution Press, 550 p.
- WIRTZ P, MELO G AND GRAVE S. 2009. Symbioses of decapod crustaceans along the coast of Espírito Santo, Brazil. *Mar Biodivers Rec* 2: 1-9.
- WITMAN JD. 1985. Refuges, biological disturbance, and rocky subtidal community structure in New England. *Ecol Monogr* 55(4): 421-445.
- ZAR JH. 1999. *Biostatistical Analysis*. 4th edition. Upper Saddle River, New Jersey. Prentice-Hall, 662 p.