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Primary Research Paper

Distribution and abundance of fauna on living tissues of two Brazilian hermatypic corals (*Mussismilia hispida* (Verril 1902) and *Siderastrea stellata* Verril, 1868)

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Abstract

This study describes the distribution and abundance patterns of the associate fauna on the living surface of the corals *Siderastrea stellata* Verril, 1868 and *Mussismilia hispida* (Verril 1902) using a non-destructive method, on the northern coast of Rio de Janeiro State. For each coral species, infestation density and proportions of infested colonies, colonies attached and unattached to the substrate were estimated. A total of 474 colonies of *S. stellata* and 452 colonies of *M. hispida* were examined. The barnacle *Ceratoconcha floridana* (Pilsbry, 1931) was the dominant coral associate found, followed by gall-crabs of the family Cryptochiridae Paulson, 1875 and the bivalve *Lithophaga bisulcata* (d'Orbigny, 1842). Both coral species presented similar patterns of infestation dominance. *S. stellata* colonies were more commonly infested and showed a greater mean infestation density of 0.62 ind/cm^2 at Armação dos Búzios, whereas *M. hispida* colonies had infestation densities of only 0.20 ind/cm^2. Infestation density does not appear to impact negatively on corals of Armação dos Búzios. A clear negative relationship between the number of associates in the coral colony and coral size was found. Evidently abundance and frequency of occurrence of associated fauna is highly related to coral community structure and composition and the results highlight the importance of local scale studies.

Introduction

There are many animal associates found with living corals (Patton, 1967, 1972, 1974, 1976, 1994; Kleemann, 1980; Young, 1986; Reed & Mikkelsen, 1987; Scott, 1987; Zann, 1987; Glynn, 1997; Goh et al., 1999; Scoffin & Bradshaw, 2000; Sin & Lee, 2000; Cantera et al., 2003). Living corals offer potential symbionts not only food, but also habitat, as shelter and hard substratum, thus allowing greater diversity of symbiotic modes of life than do many other types of host (Patton, 1976). The live and dead coral surface provides substrate for many organisms, mainly invertebrates such as copepods, sponges, data mussel, flatworms, crustaceans and certain species of fish (Patton, 1972; Kleemann, 1980; Scott, 1988a, b; Scoffin & Bradshaw, 2000; Cantera et al., 2003). According to Scoffin & Bradshaw (2000), macro-endoliths in coral skeletons can be separated into live and dead coral varieties, which have different origins and create different structures in host skeletons. They observed that living coral is attacked mainly by passive endoliths that embed themselves in the live tissue and allow the coral skeleton to grow up around them.

The great majority of endolithic borers attack dead skeletons, while few species are able to invade the coral rock directly through living tissues (Patton, 1976; Highsmith, 1980; Kleemann, 1980). Many barnacles as well as gall crabs are found on living substrates (Glynn, 1997; Ross & Newman, 2000) and for these animals, the host provides a suitable habitat for their growth and development (Rinkevich et al., 1991; Simon-Blecher et al., 1999; Carricart-Ganivet et al., 2004). The feeding of these commensals can bear little relation to the activities of the host (Patton, 1967) as often gall crabs only consume deposited material or algae on exposed coral skeleton (Carricart-Ganivet et al., 2004). Other crabs use the mucus produced by corals (e.g. Simon-Blecher et al., 1999). The ability to bore live coral is rare within the Bivalvia and Kleemann (1980) considered that with the exception of species of *Fungiacava*, all such borers, as far as is known, belong to the genus *Lithophaga*.

Most information on the distribution and abundance of symbiotic associates on their coral hosts comes from the Pacific and Caribbean regions (Scott, 1987) and there is virtually no information available for the Atlantic. Furthermore, in Brazil, little information is available about the ecology and biology of coral-associated fauna (Young, 1986; Nogueira, 2003). Our knowledge is restricted to taxonomic aspects of barnacles (Young & Christoffersen, 1984; Young, 1986, 1988, 1989), polychaetes (Nogueira & Rizzo, 2001; Nogueira et al., 2001; Nogueira & Amaral, 2000; Neves & Omena, 2003; Nogueira, 2003) hydroids (da Silveira & Migotto, 1984) and bioeroding sponges (Reis & Leão, 2000).

The cnidarian community is one of the most important groups observed on the subtidal rocky shores of the Armação dos Búzios (Oigman-Pszczol et al., 2004) and as Oigman & Creed (2004) recognized, this region as an important ecological site for coral growth. The present study was carried out to increase our knowledge of the coral associated fauna of Western Atlantic region. This study examines the abundance and distribution patterns of the associated fauna on the living surface of the corals *Siderastrea stellata* and *Mussismilia hispida* at 11 sites of the northern coast of Rio de Janeiro State.

Materials and methods

Study area

This study was carried out at Armação dos Búzios peninsula, on the north coast of the State of Rio de Janeiro (22° 44′ S–41° 52′ W, Fig. 1), a tropical region in south-eastern Brazil. Most of the substratum in this region is Precambrian gneiss (DRM & INPE, 1977). The coastal morphology of alternating sandy beaches in bays between headlands is repeated right around the peninsula. Water temperature ranges from 18 to 26 °C because of the Brazilian current influence (Yoneshigue & Valentin, 1992). The climate is defined by a dry season from May to August, and a wetter period ranging from December to February, although annual rainfall is very low (nearby Cabo Frio = 771 mm/year; WMO, 1996). The prevailing winds blow from the northeast from November to February and southwest from March to June. From August to September southeast winds prevail but northeast winds can also occur (DHN, 1995). This region is also influenced by the Una and São João rivers.

The sampling was carried out between September and December 2000. Eleven study sites were chosen on rocky shores along the northwest side of Armação dos Búzios (Fig. 1). All studied sites were very shallow attaining depths not greater than 4 m where rocky substrata ended in sand plains with occasional rock ledges. The nearshore biological communities are composed of assemblages of benthic algae, sponges, octocorals and stony corals (Oigman-Pszczol et al., 2004). All sites are likely to be influenced by similar meso-scale oceanographic events (e.g. cold fronts, currents, etc.). Cold upwelling with nutrient rich waters influence the eastern side of the peninsula although rarely reach the western side (Yoneshigue & Valentin, 1992). The sites varied in distance one from another by 0.5 to 4.35 km.

Field methods and analyses

SCUBA divers estimated the abundance of the main groups of organisms (barnacles, crabs and bivalves) inhabiting the two most abundant hermatypic coral species in the region, *M. hispida* and *S. stellata*, using a non-destructive method. The

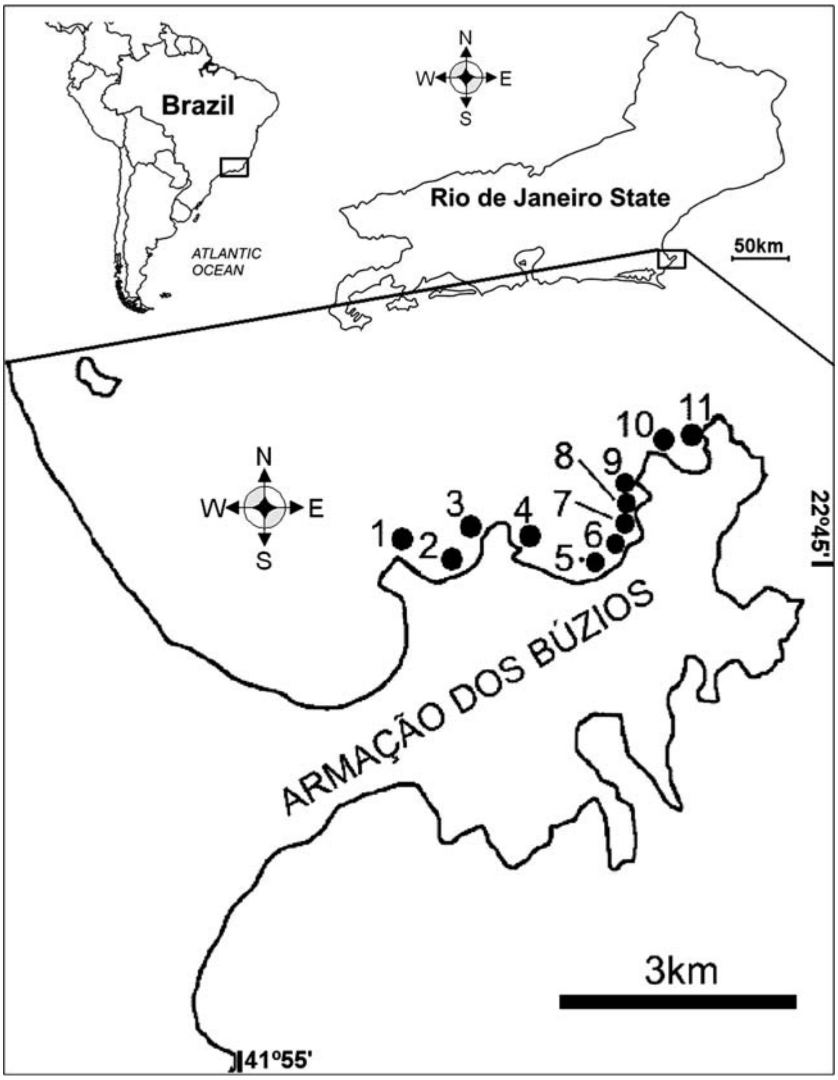

Figure 1. Map of Brazil, Rio de Janeiro State and the Armação dos Búzios region, with the location of the study sites. (1) Tartaruga L; (2) Tartaruga C; (3) Tartaruga R; (4) Canto; (5) Ilha do Caboclo; (6) Ossos L; (7) Ossos R; (8) Azeda; (9) Azedinha; (10) João Fernandes; (11) João Fernandinho.

coral fauna was recorded at each site by 4 × 1 m belt transects which were run along haphazardly located areas where at least one of the coral species occurred. As the corals species varied in size, two different quadrats were used as sub samples to estimate the macrofaunal density of the colonies, 4 × 4 and 2 × 2 cm. The quadrats were laid flush along colonies length and all macrofaunal associates on living portions of the colonies surfaces were counted. Quadrats used on each colony had fixed equal spacing so that the number of quadrats used increased with colony diameter and height. In this way it was possible to sample over the whole colonies and regulate sample effort to potential spatial variability in fauna across the colony. Boreholes were easily recognized and distinguished from coral skeletal chambers by their characteristic form and generally larger size. These surveys are considered quantitative only for crustaceans and bivalves due to the sampling methods employed. Although previous studies (P.S. Young, personal communication) indicated the presence of the gall crab *Troglocarcinus corallicola* Verrill, 1908 in corals at Búzios, we maintained records at the family level (Cryptochiridae) because the identification to species level would have necessitated breaking open of all the coral colonies, which was not compatible with the methods employed.

For each colony, the mean infestation density of *M. hispida* and *S. stellata* in the quadrats ($n = 1$–38) was determined and subsequently an overall mean infestation density was calculated for each site from $n = 6 - 68$ colonies per species per site. The corals sizes were estimated at all sites using the index developed by Oigman-Pszczol & Creed (2004) based on measurements made with a flexible measuring tape laid flush along each colony's arc, length, and width (in cm). The cover percentage of corals were estimated with 1 m^2 quadrats laid out at 1 m intervals along 4 – 6 transects at each site (Oigman-Pszczol & Creed, 2004).

For each colony, whether attached or not to the substratum, the presence of infesting organisms and infestation density (cm^{-2}) were estimated at each site. Data analyses were performed using SPSS software for Windows. Data were tested for homogeneity of variances by Levene's test. To test the null hypothesis of no differences in the infestation density between both sites and coral host species, a two-way analysis of variance (ANOVA) was conducted on the square root transformed data ($\sqrt{x+1}$) (Underwood, 1997). Student *t*-test was used for differences in infestation density between attached and unattached coral colonies on both hosts. All data were tested for assumption violations of these procedures. The Pearson's Correlation Coefficient (Zar, 1999) was used to determine the relationship between degree of infestation and co-occurrence of infestation on both coral species, density coral and colony size. Where necessary, non-parametric analyses (Mann–Whitney *U*-test) were performed (Zar, 1999).

Results

The total sample observed included 474 colonies of *S. stellata* and 452 colonies of *M. hispida* from 11 sites in the Armação dos Búzios. The most common coral associates were attributed to Crustacea (barnacle and gall-crabs) and Mollusca (bivalve).

Class Maxillopoda Dahl, 1956
Infraclass Cirripedia Burmeister, 1834
Order Sessilia Lamarck, 1818
Suborder Balanomorpha Pilsbry, 1916
Family Pyrgomatidae Gray, 1825
Subfamily Ceratoconchinae Newman & Ross, 1976
Genus *Ceratoconcha* Kramberger-Gorjanovic, 1889
Species *Ceratoconcha floridana* (Pilsbry, 1931)

Class Malacostraca Latreille, 1802
Order Decapoda Latreille, 1803
Infraorder Brachyura Latreille, 1802
Family Cryptochiridae Paulson, 1875

Class Bivalvia Linnaeus, 1758
Order Mytiloida Ferussac, 1822
Family Mytilidae Rafinesque, 1815
Genus *Lithophaga* Roding, 1798
Species *Lithophaga bisulcata* (dOrbigny, 1842)

Mussismilia hispida presented a slightly higher mean overall proportion of infested colonies (91%) than *S. stellata* colonies (88%). The barnacle *C. floridana* was the dominant coral associate found, followed by the gall-crabs and the bivalve *L. bisulcata*. Both coral species presented similar infestation dominance patterns (Table 1).

Siderastrea stellata colonies showed greater mean infestation density (0.62 ind/cm^2) at Armação dos Búzios, whereas *M. hispida* colonies had infestation densities of only 0.20 ind/cm^2. Mean infestation densities on *S. stellata* colonies ranged from 0.13 ind/cm^2 at Tartaruga-R site to 1.16 ind/cm^2 at Azeda site (Fig. 2). In contrast infestation densities on *M. hispida* varied from

Table 1. Number and mean proportion of infested colonies of *M. hispida* and *S. stellata* containing the three coral associates at Armação dos Búzios, south-eastern Brazil

Coral/ Associates	*Ceratoconcha floridana*		Cryptochiridae		*Lithophaga bisulcata*	
	n	(%)	*n*	(%)	*n*	(%)
Mussismilia hispida	393	94.2	92	21.1	25	3.8
Siderastrea stellata	396	94.4	73	17.1	37	7.2

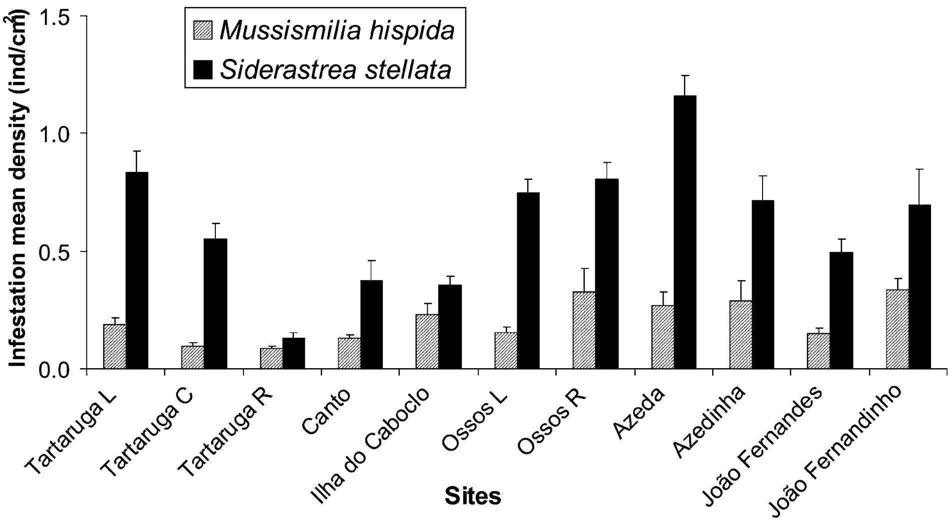

Figure 2. Mean infestation density of associate fauna on the corals *S. stellata* and *M. hispida* from 11 sites at Armação dos Búzios south-eastern Atlantic.

0.08 ind/cm^2 at Tartaruga R site to 0.34 ind/cm^2 at João Fernandinho site (Fig. 2). Differences in infestation density between sites and coral species were significant, as well as the interaction, indicating specific patterns of infestation density among different coral species and location dependence (Two-way ANOVA $F = 9.19$ $p \leq 0.001$ $n = 828$). For example, while at most sites infestation densities were different between coral species, at Tartaruga R site no difference in infestation between the two coral species was detected. The infestation density on *S. stellata* colonies varied significantly between sites such as Tartaruga R, Azeda and João Fernandinho (one-way ANOVA $F = 73.59$ $p < 0.001$ $n = 122$) although significant differences were not found between sites like Tartaruga C, Canto and João Fernandes. For *M. hispida* colonies the infestation densities varied significantly between sites like Tartaruga R, Azeda and João Fernandinho (one-way ANOVA $F = 9.34$, $p < 0.001$, $n = 125$) although it did not differ significantly between sites like Tartaruga C, Ossos L and João Fernandes.

The degree of infestation on *M. hispida* colonies did not show any correlation with infestation on *S. stellata* ($r = 0.062$, $p = 0.074$, $n = 415$). The infestation mean density was statistically negatively correlated with mean coral colony size ($r = -0.78$, $p < 0.01$, $n = 22$) (Fig. 3) however it was not statistically correlated with mean coral abundance ($r = 0.14$, $p > 0.05$, $n = 22$) (Table 2). Both host species had more colonies attached than unattached to the substrate. Overall, *S. stellata* presented 87% (32.6 ± 3.54) of its colonies attached to the substrate and 13% of unattached colonies (5.09 ± 1.25) while *M. hispida* showed 83% (30.3 ± 3.73) of colonies attached to the substrate and 17% of unattached colonies (7.55 ± 2.18). No significant differences in infestation densities was found between attached and unattached colonies of *M. hispida* (Student *t*-test = 0.619, $n = 100$, df = 98, $p = 0.538$), nor between attached and unattached colonies of *S. stellata* (Mann–Whitney *U*-test = −1657, $n = 100$, $df = 98$, $p = 0.098$).

By location, percent infestation on both coral species ranged from 75 to 100% of *M. hispida* colonies and from 65 to 100% of *S. stellata* colonies (Fig. 4). *S. stellata* presented 100% of colonies infested by barnacle at Ossos R, Azeda and Azedinha sites. The lowest proportion of barnacle infestation was observed on *S. stellata* colonies at João Fernandinho site (78%). This site showed the highest barnacle infestation of *M. hispida* colonies together with Canto, Ossos R and Ilha do Caboclo (100%). *M. hispida* presented the lowest proportion of colonies infested with the barnacle at Azedinha site (75%) (Fig. 4b). The greatest proportion of colonies of *S. stellata* infested with crabs was observed at Tartaruga R site (35%) but

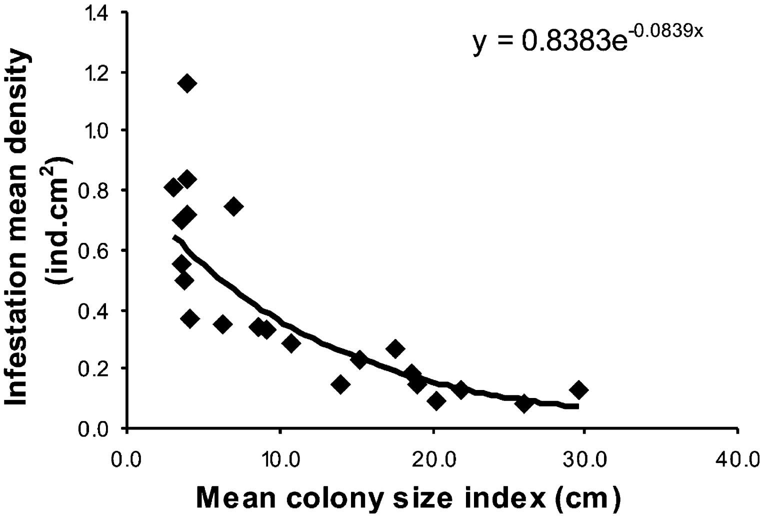

Figure 3. Relationship between mean coral colony size and mean density of infesting fauna at Armação dos Búzios, south-eastern Atlantic.

no crab infestation was found at two sites, Tartaruga L and Azedinha (Fig. 4c). In *M. hispida* the highest proportion of colonies infested with the crab was at Ossos L (43%) and the least at João Fernandinho site (2%) (Fig. 4c). The João Fernandinho and Canto sites did not show any bivalve infestation on *S. stellata* colonies. The highest bivalve infestation on *S. stellata* colonies was observed at Ossos L site (18%). *M. hispida* colonies did not show any bivalve infestation at Ossos L, Ossos R or the Azedinha site. Infested *M. hispida* colonies had the greatest proportion of the bivalve at the Tartaruga C site (24%) (Fig. 4d).

Table 2. Mean abundance of the corals *M. hispida* and *S. stellata* at 11 sites at Armação dos Búzios, south-eastern Atlantic

Sites/Abundance	Mean% (SE)	
	Siderastrea stellata	*Mussismilia hispida*
Tartaruga L	2.60 (0.46)	1.49 (0.42)
Tartaruga C	3.73 (0.82)	6.57 (1.27)
Tartaruga R	45.78 (3.84)	0.37 (0.17)
Canto	0.74 (0.21)	0.22 (0.13)
Ilha do Caboclo	19.76 (2.49)	1.48 (0.42)
Ossos L	9.12 (1.05)	1.09 (0.44)
Ossos R	3.21 (1.28)	0.16 (0.17)
Azeda	3.51 (0.90)	0.94 (0.34)
Azedinha	0.41(0.16)	0.02 (0.02)
João Fernandes	2.83 (0.77)	2.14 (0.66)
João Fernandinho	1.77 (1.05)	1.02 (0.40)

Infestation frequency distributions by colony size classes for *S. stellata* and *M. hispida* are shown in Figure 5. For *S. stellata*, the smallest size class (0.1–15.0 cm) had the highest relative frequency of infested colonies for all coral associates. For *M. hispida* colonies, colonies infested by barnacles presented the same patterns whereas for other coral associates (bivalves and crabs) the second class had the highest relative frequency of colonies infested. Even so, as the corals grow the proportion of colonies infested decreases.

Discussion

The living and dead surfaces of corals can provide habitat for numerous fauna assemblages. However, few organisms are able to install themselves on the living surfaces of the corals (Patton, 1976; Highsmith, 1980; Kleemann, 1980). In this study, no associate species was restricted to a single coral species, as both scleractinian species presented the same composition and proportion of associate species on their living tissues: one barnacle (*C. floridana*), gall crabs of the family Cryptochiridae and one bivalve species (*L. bisulcata*). Mostly, these findings are consistent with previously studies in Brazil, which have mentioned living coral habitants (Young, 1986; Nogueira, 2003). These studies have shown that few species are found in close

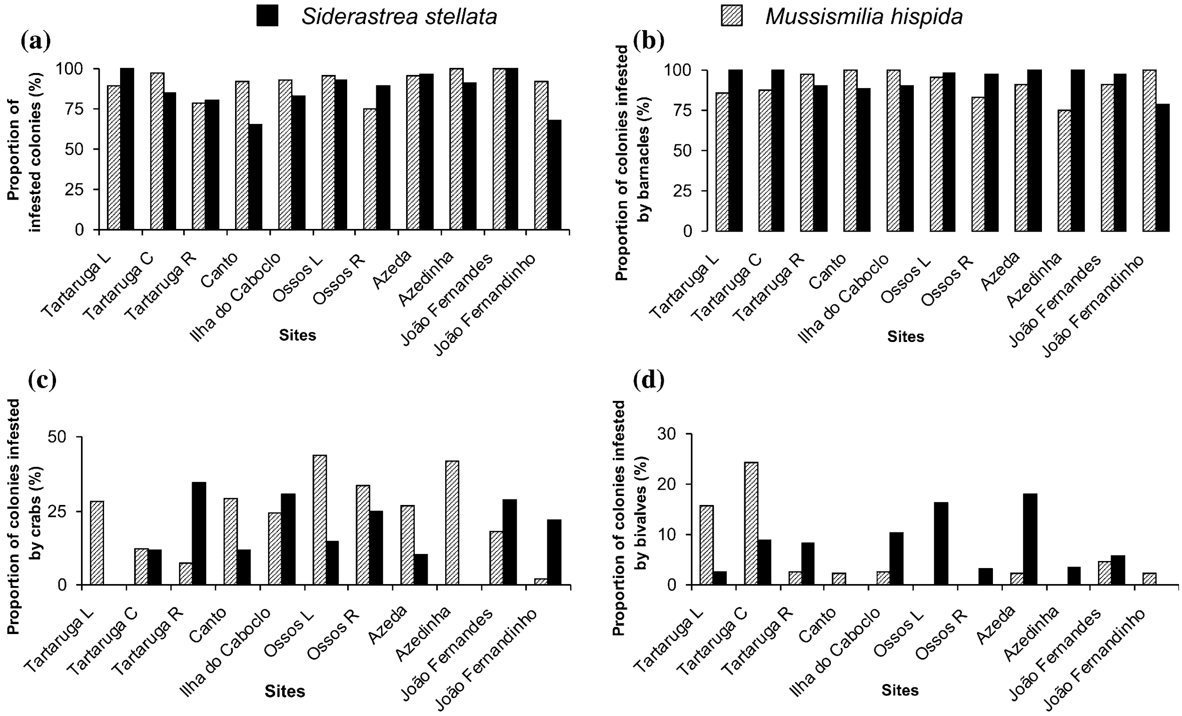

Figure 4. Proportion of colonies of the corals *S. stellata* and *M. hispida* infested by associate fauna at 11 sites at Armação dos Búzios, south-eastern Atlantic. (a) All organisms; (b) barnacles; (c) crabs and (d) bivalves.

contact with the living tissue like those of for example, *M. hispida* in south-eastern Brazil islands (Nogueira, 2003) and *M. hispida* and *S. stellata* on reefs of João Pessoa, Northeast Brazil (Young, 1986).

The barnacle, *C. floridana*, can be considered an important coral associate in Búzios, since it is the most frequent and abundant. The barnacle density corresponded of 88% of the total mean infestation density in *M. hispida* and 81% in *S. stellata*, attaining 93 and 94% of the total associate densities in some sites. The family Pyrgomatidae contains many species of obligatory coral associates (symbionts or parasites). The genus *Ceratoconcha* Kramberger-Gorjanovié, 1859, is restricted to hermatypic corals, and only four living obligatory symbiont species are known in the western Atlantic (Ross & Newman, 2000). It seems that obligate symbionts have become markedly specialized in both morphological and growth characteristics in order to live within a continuously growing substratum, such as a living coral colony (Ross & Newman, 1973; Young & Christoffersen, 1984). According to Young (1986), these species can install on the living coral surface and mould their tunnels little by little to accompany the coral vertical growth. The occurrence of these pyrgomatid species on the living surface of corals also implies adaptive growth in order to avoid coral overgrown. Young & Christoffersen (1984) attributed some of the barnacle's morphological differences to be the result of adaptation to live on the host, since these species inhabit corals with vertical growth and thus need greater calcareous deposition at their bases. As indicated by Young (1988) the distribution of *C. floridana* probably coincides with the distribution of its hosts. In Brazil, this species only lives in corals of the suborder Faviina, except for its occurrence on the genus *Siderastrea* (Young & Christoffersen, 1984), so it appears to have partial host specificity.

In our study *M. hispida* presented a higher proportion of its colonies infested by crabs than *S. stellata*. This can be explained by the fact that this crab species can hide itself both in the cup depression and in the intercostal space of the coral where there is relatively greater protection from predators. In contrast, *S. stellata* colonies make

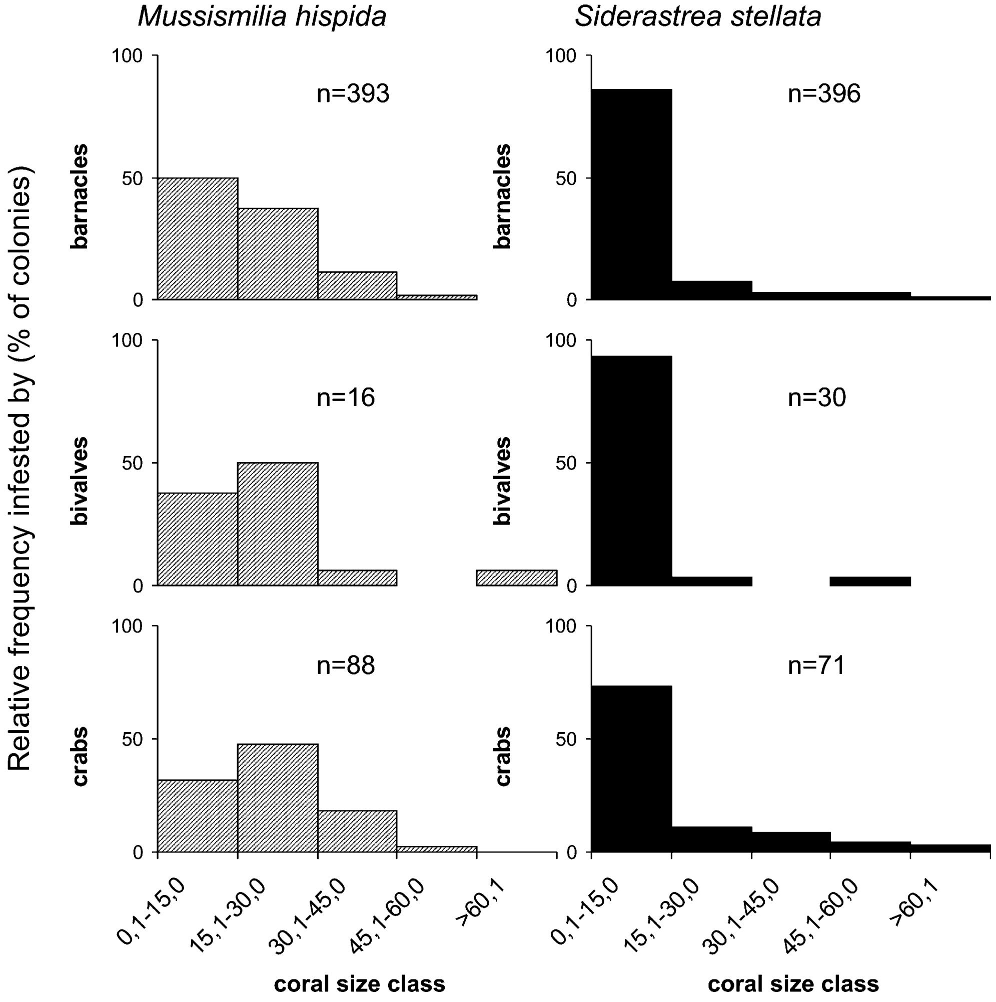

Figure 5. Relative frequency of infesting barnacles, bivalves and crabs in different sizes of colonies of *S. stellata* and *M. hispida* at Armação dos Búzios, south-eastern Atlantic. The linear coral size index was based in three measurements of colony's arc, length, and width (in cm).

the installation of this organism more difficult because it has smaller cups and intercostal spaces are absence (Young, 1986). These small crabs are likely to occur abundantly at a wide range of depths and in a large number of hosts, among them members of the coral families Mussidae, Faviidae, Caryophillidae and Siderastreidae (Kropp & Manning, 1987).

Most boring bivalves inhabit dead substrata, including dead parts of coral, but some, especially members of the Lithophaginae, have the ability to penetrate living coral tissue (Scott, 1988b) and are restricted to this habitat (Kleemann, 1980). *Lithophaga bisulcata* is the most common Caribbean and Atlantic Lithophaginae and is the only species of the genus known to occur frequently in both living and dead coral. Its abundance in living corals is non-random and variable. For example, it has been reported to occur in 7 of 44 Caribbean coral species and is not evenly distributed between sites (Scott, 1987). In the present study a low proportion of colonies of *S. stellata* and *M. hispida* were found to be infested by *L. bisulcata*. In the same study area, J.H.N. Leal, P.S. Young, C.B. Castro and A.C.S. Fernandes (personal communication) recorded *L. bisulcata* in colonies of *S. stellata* and *M. hispida* as the most abundant bivalve species observed. However, they did not discriminate in what part of the coral (live or dead) these organisms were found.

Young (1986) observed that *L. bisulcata* is able to bore the living surface of corals, but does so only when no dead areas are available. He suggested therefore that this species usually prefers to colonize dead coral surface. The same preference pattern of *L. bisulcata* was found by Nogueira (2003) who also pointed out that it is very difficult to determine whether these individuals bored living colonies or dead areas, which were later overgrown by the host colony. Meanwhile Scott (1988a) showed that *L. bisulcata* was more abundant in living colonies of *S. siderea* (Ellis & Solander, 1786) than in dead corals. The beneficial nature of symbiosis for *L. bisulcata* on a living coral substrate has also been demonstrated as Scott (1988b) observed that the bivalve profits by an enhanced longevity and reduced mortality rates when the mussel is surrounded by living coral tissue. It would be interesting to compare our data to the density of *L. bisulcata* on dead coral surfaces in order to better understand the substrate preferences and distribution patterns of this species since the same species can be found in both substrata.

The presence of infestation can be related either to coral host characteristics and/or to physical factors affecting dead coral and borers. Our results show different degrees of infestation in each coral host. *S. stellata* colonies were more infested than *M. hispida*. Young & Christoffersen (1984) characterized the recent species of *Ceratoconcha* and recorded their distribution along the northeast coast of Brazil. They showed that *Ceratoconcha floridana* infestations clearly prevail on *S. stellata* colonies, occurring in decreasing densities on *M. hispida*. This fact may be related to coral host characteristics, like vertical growth and defence mechanisms against stinging nematocysts. *M. hispida* colonies have porous skeletons (Laborel, 1969) which in turn would suggest that they grow faster than *S. stellata*. Furthermore, Thomason & Brown (1986) compared the relative aggressive proficiencies of Indo-Pacific and Caribbean scleractinian corals and proposed that Mussidae is one of the most aggressive in the Caribbean. Scott (1987) noted that live-coral associates are found more frequently on less aggressive corals with smaller polyps. As *S. stellata* seems to have less aggressive nematocysts and higher infestation densities than *M. hispida*, our results would corroborate the observations of Scott (1987) in the Caribbean. More data are needed to understand the relative aggressive proficiencies of the Brazilian Scleractinia and further experiments on larval behaviour and physiology during settlement and metamorphosis may indicate which criteria are most important for the installation and survival of associates in these Southwest Atlantic corals.

At Armação dos Búzios, *S. stellata* is the most common coral species, comprising 86% of overall stony coral cover (Oigman-Pszczol & Creed, 2004). In the same region J.H.N. Leal, P.S. Young, C.B. Castro and A.C.S. Fernandes (personal communication) observed that *S. stellata* was more infested by *L. bisulcata* than *M. hispida*. Generally, associates tend to live in the most locally abundant coral within their potential host assemblage (Scott, 1987; Sin & Lee, 2000). This may be a result of simple statistical probability of finding a given species during the settlement period (Scott, 1987). Siderastreidae has previously been described as one of the families most commonly inhabited by associates in the Caribbean region, while less than 20% of the Mussidae were found to be inhabited (Scott, 1987). However the present study did not show any relationship between associates fauna and coral abundances.

Infestation density does not appear to impact negatively on corals of Armação dos Búzios. Results from studies in the Caribbean Sea and Indian Ocean indicate that boring barnacles cause relatively little erosion compared with other internal borers (Glynn, 1997). Moreover, Scoffin & Bradshaw (2000) analysed the macro-endoliths in dead vs. live coral skeletons and concluded that paraendoliths (e.g. pyrgomatid barnacles and cryptochirid crabs) which are passively embedded in living coral surfaces develop in association with the growing coral and create simple holes that parallel the growth structure of the coral. As both species have a massive growth form, and are susceptible to bioerosion at the base, unattached colonies of the two species may have been intrinsically more susceptible to infestation. However, we did not find any relationship between infestation density and whether coral colonies were attached or unattached to the substrate, so it seems that either higher infestation levels, were not responsible for weakening corals or growing attached or unattached did not affect coral associates densities.

Despite the fact that infestation density varied significantly between sites and hosts, no positive relationship between hosts and commensal density were found. In contrast other studies have concluded that abundance of associated coral fauna increases with a high coral abundance (Scott, 1987; Cantera et al., 2003). Since commensal and host have an intimate association, in this case what benefits the coral will ultimately benefit the coral associates. The local environmental conditions which favour the coral distribution and composition are the same which will also benefit larval filter feeding coral associates, and this could explain why no relationship was found in this study.

Another important characteristic that can determine infestation density is coral size. Indeed, our data showed a clear negative relationship between the number of associates present in the coral colony and the coral size. As the coral grows older, the number of associates increases, due to greater space availability and also because the endolith forms create galleries opening space for the settlement of new larvae (Kiene & Hutchings, 1992). Conversely, other studies have not found any relationship between coral colony size and their associated fauna (Young, 1986; Scott, 1987; Nogueira, 2003). Different from branched corals, where arborescent morphology and rapid growth can provide many niches for associates (Patton, 1994; Goh et al., 1999), size and growth of massive coral species does not necessarily imply directly an increase of habitat for new species and specimens. Questions concerning larval settlement and survival of cirripeds and its relationship coral size are yet to be solved.

Summarizing our findings, *C. floridana* represents the most common associate of Armação dos Búzios' corals, with higher infestation on living tissue of *S. stellata* colonies. As this symbiont does not obtain its energy source from living host tissues, there will be a long-term relationship, such that the intimate association will not interfere with the hosts' activities. Although this barnacle occurs on quite unrelated hosts, its predilection for a certain host (*S. stellata*) in Armação dos Búzios is clear. Such a pattern is an interesting subject for future experimental research. Is this substrate preference related to an evolutionary pattern of associate-coral symbioses? Further research on living coral associates' distribution will yield important information on the ecology and history of coral-associate interactions.

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