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MACROFAUNA ASSOCIATED WITH BRANCHING FIRE CORAL *Millepora alcicornis* (CNIDARIA: HYDROZOA)

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Key words: calcified hydroids, fire-coral, associated macrofauna.

ABSTRACT

The genus *Millepora* occurs worldwide throughout tropical seas as a regular component of coral reefs. Millepores are found in depths of less than 1m to about 40m. By providing substratum for sedentary organisms and food or shelter for mobile ones, living corals create a rich series of habitats for a large number of species. The objective of this work was to identify and quantify all the macrofauna found in *Millepora alcicornis* colonies in the "Área de Proteção Estadual dos Recifes de Coral" RN, in Northeast Brasil. The samples were collected manually through SCUBA diving, in depths of less than 1 to 3m. The colonies were involved in plastic bags and then extracted from the substratum with the aid of hammer and chisel. Later, the samples were fixed in 4% formalin solution. In the laboratory, the colonies were analyzed to remove the epibiotic fauna and then, carefully broken up for the removal of the boring fauna. A total of 1,234 individuals and 95 species of not-colonials organisms and 86 colonies and 26 species of colonial organisms were registered, belonged to the taxa Cnidaria, Crustacea, Echinodermata, Mollusca, Nemertea, Polychaeta, Porifera, Sipuncula and Tunicata. The crustaceans presented the largest number of individuals and species, followed by Polychaeta and Mollusca. According to the coefficient of Spearman correlation, the number of individuals and species of the not-colonials organisms increase with the growth of the colony. In relation to the colonial fauna, the tunicates had the greatest number of colonies and the sponges the greatest number of species. The epifauna of the colonial and not-colonial groups were more numerous than the infauna. Comparisons between Scleractinia and Milleporidae can be traced because of a possible functional convergence of these taxa. It is possible to assume that the associations with corals do not depend exclusively on the species hostess, as distinct species inhabit the same species of corals in different regions. Probably the substratum had more important function, as its distinct forms promote the formation of habitats.

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INTRODUCTION

More than a half of the world species lives inside or on bodies of other organisms, where they find favorable conditions to support their growth (Townsend *et al*., 2006). The majority of hard substrata, including the coralline ones, are colonized by perforating and fouling organisms (Zuschin *et al*., 2001). The living corals create a rich series of habitats for a great number of species giving support for sedentary organisms and food or shelter for mobile ones (Reed & Mikkelsen, 1987; Díaz-Castañeda & Almeda-Jauregui, 1999).

In corals, it can be found obligatory symbiotics, that are normally restricted to the living corals (Mokady & Brickner, 2001), and facultative symbiotics, that only use corals as an alternative or temporary habitat (Castro, 1976). The endolitic fauna includes bivalves, sea worms, sipunculids and sponges (Cantera *et al*., 2003) that, through their perforations, produce a significant effect in the structural stability of the reef, participating of the bioerosion process (MacGeachy & Stearn, 1976). Many authors had studied some aspects of corals fauna association, such as Rees (1962), McCloskey (1970), Bruce (1972), Goreau *et al*. (1972), MacGeachy & Stearn (1976), Austin *et al*. (1980), Edwards & Emberton (1980), Reed *et al*. (1982), Young (1986), Tsuchiya *et al*. (1986), Reed & Mikkelsen (1987), Scott & Risk (1988), Cook *et al*. (1991), Lewis (1992; 1998), Peyrot-Clausade *et al*. (1992), Lewis & Crooks (1996), Amaral (1997), Moreno-Forero *et al*. (1998), Zubia & Peyrot-Clausade (2001), Cantera *et al*. (2003).

Many taxonomic groups are found associated with corals, being distinguished the not colonial organisms of Crustacea, Mollusca, Polychaeta and Sipuncula groups and the colonials of the Porifera group. Each colony forms a community with close relation between its members; however, to establish the limit among the diverse types of interactions is not always easy (Dajoz, 2005). The present study had as objectives to identify and to quantify the macrofauna found in live colonies of *Millepora alcicornis* in the "Área de Proteção Estadual dos Recifes de Coral (RN)" in Northeast Brazil.

MATERIALS AND METHODS

Study Area

The study area (Maracajaú Reef) is located 5 km from the beach (Figure 1). The reef extension is 9 km in length and 2 km in width, with depths that vary from 1 to 4 meters in the low tide (Feitosa *et al*., 2002). The area waters are warm (average 28ºC) and also limpid for the most part of year (MMA, 2003).

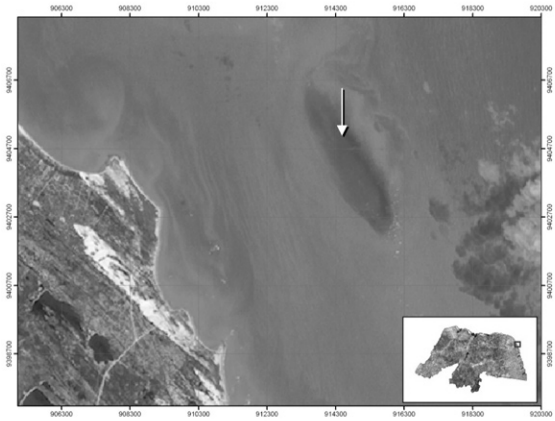

Figure 1:
Maracajaú Reef (RN, Brazil) (see arrow), belongs to the Área de Proteção Ambiental Estadual dos Recifes de Coral (RN). In detail, the location of the study area in the Rio Grande do Norte State map. Source: Landsad7ETM + colored composition RGB-543, scene 21464, dates 04/08/2001.

Metodology

The samples were collected in July and November of 2004 and February of 2005. The reefs, where *Millepora alcicornis* colonies had been located were marked with buoys using snorkeling. Later, using SCUBA, one colony of each reef was chosen randomicaly and collected. During the study 26 colonies had been demarcated.

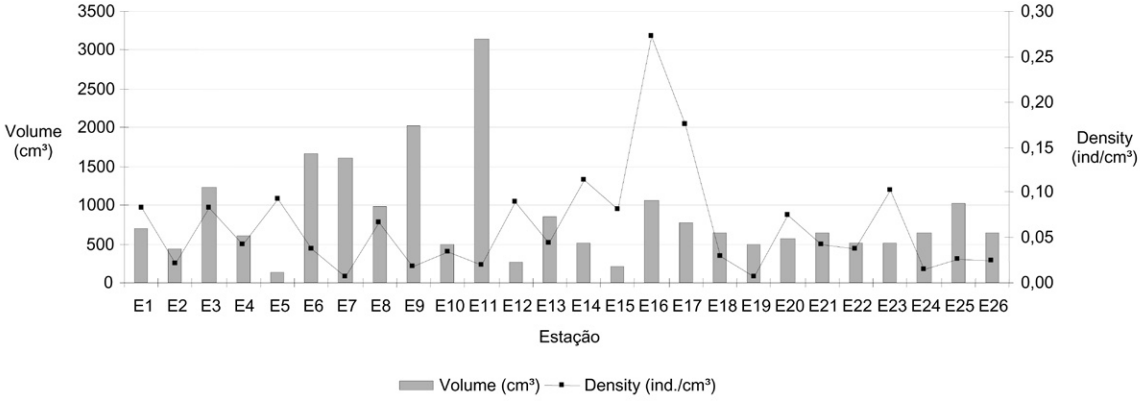

Figure 2: *Volume (cm³) and Density (ind./cm³) of the colonies of "Millepora alcicornis" sampled in Maracajaú reefs (RN), Northeast, Brazil*

The colonies were involved in plastic bags, to prevent the loss of the vagile fauna, and, after that, extracted from the substratum with the aid of hammer and chisel. Later, the samples were fixed in 4% formalin solution for 24 hours.

In the laboratory, each colony was examined for removal of the vagile epifauna. For attainment of colony volume, a container with known volume of water was used. The water dislocated volume when the colony was inserted in the container corresponded to the coral volume. The colonies were carefully broken up, with hammer and slitter, and the animals were removed with clamps and spatulas preventing to damage its structures. The organisms found were conserved in alcohol 70% for posterior sorting and identification to the lesser possible taxonomic level.

Data analysis

For diversity study of the macrofauna it was used the indices of Shannon-Weaner diversity (H'), Pielou equitability (J´), that varies from 0 to 1, and the species richness (Margalef), using the program Primer 5 (Windows 5.2.4.). The density (ind./cm³), individuals number (n) and species number (s) were correlated to the size of the colonies and epifauna correlated to infauna, through of Spearman correlation coefficient (r), using the Statistical program (Windows 5.0.).

In relation to abundance, the species that had more than 100 specimens had been considered abundant, between 30 and 100, common species, between 10 and 30, rare species, and with less than 10, very rare species (Young, 1986).

For the determination of species dominance, the Index of Biological Value (IBV) for each species was used. This index is calculated attributing decreasing values for successively more common dominant species of each collection and adding the values of each species in the diverse samples (McCloskey, 1970; Young, 1986). In this study, it was attributed values from 10 to 1 for the ten more common species of each sample.

RESULTS

Not colonial organisms

Ninety five (95) not colonial species and 1,234 organisms had been found in association with *Millepora alcicornis*, whose collected colonies presented a volume that varied from 130 to 3146 cm³ (863 ± 647 cm³) and a density that varied from 0.01 to 0,27 ind./cm³ (0,07 ± 0,06 ind./cm³) (Figure 2). The individuals (n) and species (s) numbers had been correlated significantly only with the colony volume ($p<0,01$) (R= 0,56 and 0,52, respectively) with the correlation being considered moderate.

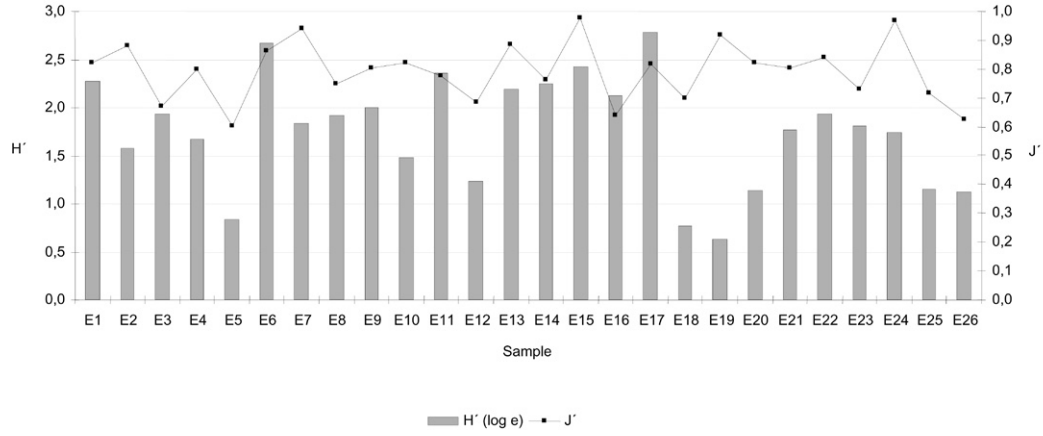

Figure 3:
Shannon-Weaner diversity index (H´) and equitability (J´) of not colonial organisms' associates to "Millepora alcicornis" in Maracajaú reefs (Brazil, RN).

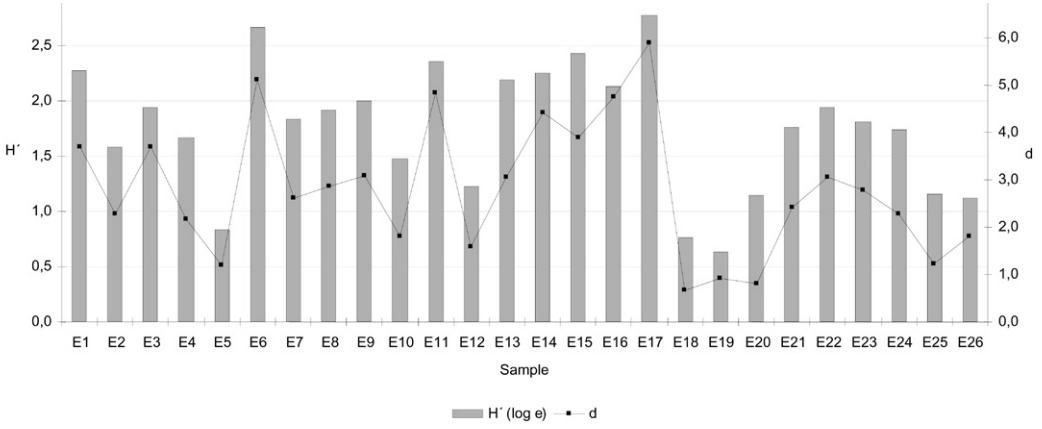

Figure 4:
Shannon-Weaner diversity index (H´) and Margalef richness (d) of not colonial organism's associates to "Millepora alcicornis", in Maracajaú reefs (Brazil, RN).

The Shannon-Weaner index (H´) showed a great variation between colonies, with higher diversity in E17 and E6 and lower, in E5, E18 and E19 (Figure 3). The equitability has constant and high values, whereas the values of the richness had presented great variation (Figure 3; 4).

In relation to specimens' abundance, the very rare species represented 79% of the total of individuals, followed for rare species (14%), common species (4%), and abundant species (3%). In relation to the life habit, the organisms had been classified as epifauna and infauna. The animals from epifauna were more abundant in individuals number as well as in species number, representing 74% and 72% of the total, respectively. The relation between the number of individuals of the epifauna and of the infauna was not statistically significant (P> 0,05).

The animals found in this study belongs to six taxa (Crustacea, Echinodermata, Mollusca, Nemertea, Polychaeta and Sipuncula), where the crustaceans had

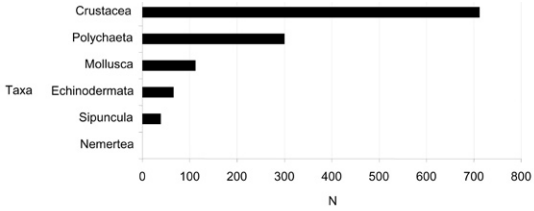

Figure 5:
Taxa and respective individuals number (N) of not colonial organisms' associates to "Millepora alcicornis", in Maracajaú reefs (Brazil, RN).

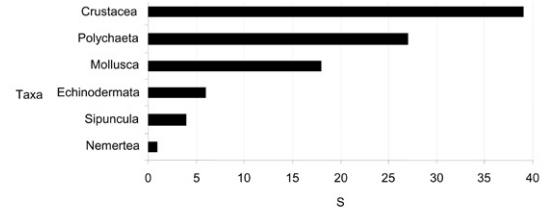

Figure 6:
Taxa and respective species number (S) of not colonial organism's associates to "Millepora alcicornis", in Maracajaú reefs (Brazil, RN).

presented greater number of individuals and species, followed by polychaetes and mollusks (Figure 5; 6). These three groups had been found in at least 69% of the samples studied.

Through the biological value index (BVI), the 10 more dominant species were: Cirripedia sp1 (Crustacea), *Eunice cariboea* (Polychaeta), *Synalpheus fritzmuelleri* (Crustacea), *Domecia acanthophora* (Crustacea), *Quadrimaera* sp (Crustacea), *Ophiactis savignyi* (Echinodermata), *Hipponix subrufus* (Mollusca), *Elasmopus rapax* (Crustacea), *Aspidosiphon elegans* (Sipuncula) and *Dodecaceria* cf. *pulchra* (Polychaeta), whose indices had varied from 50 to 132. Amongst these species, 50% were crustaceans (Caridea, Brachyura and Amphipoda) and the others were echinoderms, mollusks, polychaetes and sipunculids (Figure 7).

In the studied area, the taxonomic groups of not colonial organisms found, associated to *Millepora alcicornis* were Crustacea, occurring in 93% of the samples, followed by Polychaeta (76%), Mollusca (69%), Sipuncula (42%), Echinodermata (38%) and Nemertea (7%) (Figure 8).

COLONIAL ORGANISMS

In association with *Millepora alcicornis* 86 colonies beloging to 26 species were found. These species belong to 3 taxa (Cnidaria, Porifera and Tunicata).

Tunicata presented the higest number of colonies, followed by Porifera and Cnidaria, whereas Porifera presented the higest number of species, followed by Cnidaria and Tunicata (Figure 9; 10). In relation to the life habit the epifauna represented 98.8%.

In the studied samples, the colonial organisms had not been found in samples 4, 5, 8, 10, 12, 21 and 24. The Porifera had occurred in 57% of the studied area, followed by Cnidaria and Tunicata, with 30% each one (Figure 11).

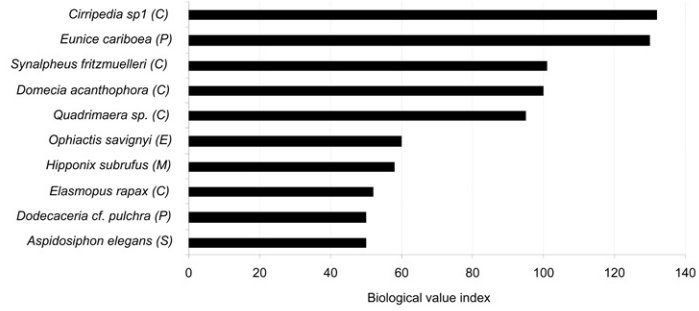

Figure 7:
Dom inant species of not colonial organisms associates to "Millepora alcicornis", in Maracajaú reefs (Brazil, RN), determined through the biological value index. Crustacea (C), Echinodermata (E), Mollusca (M), Polychaeta (P) and Sipuncula (S).

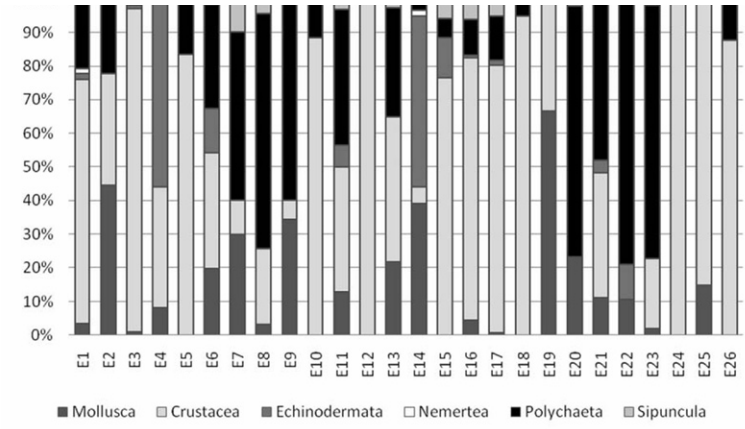

Figure 8:
Percentage of individuals' occurrence of not colonial organisms' associates to "Millepora alcicornis", in Maracajaú reefs (Brazil, RN).

SPATIAL DISTRIBUTION OF THE MACROFAUNA ASSOCIATED WITH *MILLEPORA ALCICORNIS*

The spatial distribution of the macrofauna in the *Millepora alcicornis* showed three distinct regions: base, body and extremities (Table 1).

The basal region, next to the substratum, presented the majority of the individuals found in association with *M. alcicornis*. Some individuals of the vagile fauna, as shrimps and ophiuroids, had been found in small cervices and cracks. In the extremities of the colonies, only barnacles had been observed.

Table 1: The region where is locate the organisms not colonial associates to *Millepora alcicornis*, in Maracajaú reefs (Brazil, RN).

DISCUSSION

The ecological interactions observed between corals and associated organisms are difficult to be established, due, mainly, to the absence of studies and the difficulty to perform observations of the livings organisms. However, it was possible to observe that some organisms can use *Millepora alcicornis* as shelter, as it was registered in the present study, for ovigerous females of Caridea and Isopoda and young individuals of Polyplacophora.

The greatest part of the fauna found in association with *Millepora alcicornis* were located in the coral base, being related to the substratum. Ayal & Safriel (1982) had considered the hypothesis that the great diversity of species found in coral reefs is related to predation, as the presence in a protected

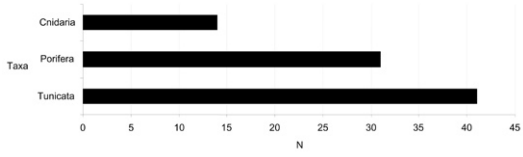

Figure 9:
Taxa and respective colonies numbers (N) of colonial organisms associates to "Millepora alcicornis", in Maracajaú reefs (Brazil, RN).

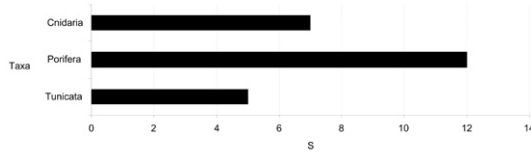

Figure 10:
Taxa and respective species number (S) of colonial organisms associates to "Millepora alcicornis", in Maracajaú reefs (Brazil, RN).

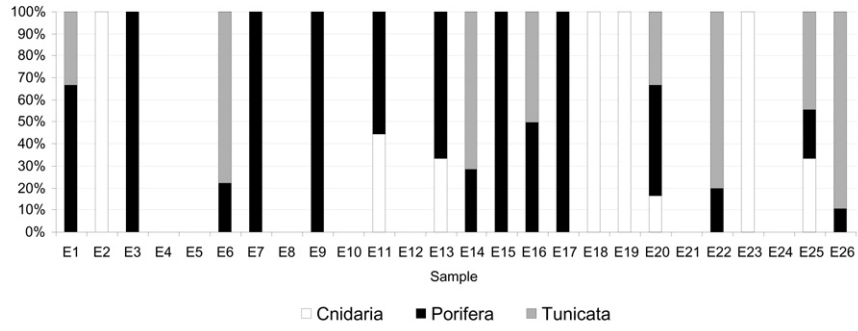

Figure 11:
Percentage of occurrence of colonial organisms associates to "Millepora alcicornis", in Maracajaú reefs (Brazil, RN).

environment, as the basal coral region, would allow the development of young forms, that, later, will colonize others regions of the reef and will serve as food for other animals.

The contact of boring organisms with the coralline substratum occurs, probably, through the larvae (McCloskey, 1970), that must possess the capacity to penetrate in the coral (Hutchings, 1986). However, Cantera *et al*. (2003) had considered that species of ramified corals exert a control on the distribution and abundance of the endolitic fauna, where the living corals function as a barrier to the larval settling (MacGeachy & Stearn, 1976). The settling of these larvae can be facilitated by the presence of injuries provoked in the coral by predation (Witman, 1988; Zubia & Peyrot-Clausade, 2001).

In *Millepora alcicornis*, the sting cells in the epidermis can form the barrier against the larval settling. Young (1986) observed that practically all the colonies of *Millepora* spp. from reefs of Picãozinho (PB, Brazil)) had suffered an intense scraping from fish; these injuries provoked by the predation can promote the entrance of the larvae in the coral skeleton. However, in the present study, it was not registered vestiges of predation by fish.

MacGeachy & Stearn (1976) comment that the infauna control can also be carried through by the epifauna, where the growth of the fouling organisms can block the openings of infauna and avoid the larval settling. However, in this study, there was no significant correlation between the infauna and epifauna values. There was, on the other hand, a significant correlation (although moderate) between fauna and the colony volume, indicating that the number of individuals and species of the associated organisms increase with the growth of the colony.

McCloskey (1970), with *Oculina arbuscula*, MacGeachy & Stearn (1976), with *Montastrea annularis*, and Tsuchiya *et al*., (1986), with *Favona frondifera*, had registered that the oldest corals possess

Table 1:
The region where is locate the organisms not colonial associates to "Millepora alcicornis", in Maracajaú reefs (Brazil, RN).

Taxa	Location in *Millepora alcicornis*
Crustacea	base or body/extremities
Echinodermata	body/extremities
Mollusca	base boring / base
Polychaeta	base boring
Sipuncula	base boring

proportionally larger number of perforations for sponges, clams, sea worms and sipunculids. However, Austin *et al*. (1980), in *Pocillopora damicornis*, had shown that the individuals density for coral diminishes with the increase of size of the colony.

It is possible to assume that the barrier against the larval settling is more efficient in *Millepora alcicornis* that in Scleractinia corals. McCloskey (1970) studied eight colonies of *Oculina arbuscula* and found 309 species and 56,616 individuals associated, numbers significantly higher than the ones we found in the present study. Maybe, this difference is related to the localization of the sting cells, therefore in *Millepora alcicornis* (Hydrozoa) this sting cells are in the epidermis, whereas in Scleractinia corals (Anthozoa) they are in the gastrovascular cavity (Brusca & Brusca, 1990).

The rare species represented a great percentage (79%) of the fauna associated to *Millepora* in the present study. Amongst the fauna found for Austin *et al*. (1980), a great ratio of species also was considered rare. Amaral (1997) analyzed *Millepora alcicornis*, *M. braziliensis* and *M. nitida*; the author found species that also had occurred, in the present study, in association to *Millepora alcicornis* colonies, however Amaral (1997) did not analyze the macrofauna quantification.

Although milepores (Hydrozoa) and escleractinians corals (Anthozoa) are classified in distinct taxonomic groups of Cnidaria, some parallels can be traced in order to establish a possible functional convergence of these taxa (Lewis, 1989). Both Capitata and Scleractinia share common corporal plans (Brusca & Brusca, 1990) and their members possess simbiont dinoflagelates (Edmunds, 1999). These facts, despite the scarcity of studies, justify the comparisons carried through between escleractinians and milepores corals.

Finally, considering the different studies of fauna associated with corals, it is possible to consider that the nature of the associations do not depend exclusively of the species hostess, as distinct species inhabit the same coral species in different regions. Probably, the substratum (skeleton) exerts more important role, as its different forms (ramified, massive) supply conditions for the formation of distinct habitats.

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