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Spatial distribution of benthic macroorganisms on reef flats at Porto de Galinhas Beach (northeastern Brazil), with special focus on corals and calcified hydroids

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Resumo

Distribuição espacial dos macroorganismos bentônicos nos recifes da Praia de Porto de Galinhas (nordeste do Brasil) com atenção especial aos corais e hidróides calcários. Apesar da sua importância ecológica e socioeconômica, os recifes de coral estão sob constante ameaça e requerem práticas de gestão adequadas. Dados sobre a estrutura espacial destes ecossistemas são essenciais para projetos de conservação de boa qualidade nestas áreas. Este estudo objetivou analisar a distribuição espacial dos macroorganismos bentônicos do ambiente recifal da praia de Porto de Galinhas, com enfoque especial nos corais e hidróides calcários. Realizou-se um levantamento da plataforma recifal através de mergulho autônomo, utilizando-se transectos em linha de 10m de comprimento. Grandes regiões cobertas por algas foram verificadas, totalizando 53% das observações. Os zoantídeos compreendem o segundo grupo mais representativo (11%). Um total de 173 colônias de corais e hidróides calcários foi observado sendo que 40% destas colônias estavam total ou parcialmente branqueadas.

Unitermos: ambientes recifais, Brasil, corais, distribuição espacial, Praia de Porto de Galinhas

Abstract

Despite their ecological and social-economic importance, coral reefs are under constant threat and thus require proper management practices. Data on the spatial structure of these ecosystems are essential for good quality conservation projects in such areas. This study aimed to quantitatively analyze the spatial distribution of benthic macroorganisms from the reef environment of Porto de Galinhas Beach, with special focus on its

corals and calcified hydroids. Reef flats of the area were surveyed by scuba diving, using 10m line transects. A high cover of macroalgae was verified, averaging 53% of the observations. Zoanthids were the second most representative group (11%). A total of 173 colonies of corals and calcified hydroids were observed and 40% of these colonies were partially or totally bleached.

Key words: reef environments, Brazil, corals, spatial distribution, Porto de Galinhas Beach,

Introduction

Coral reefs only represent less than 0.25% of the oceans, yet they are habitats to over 25% of all species of marine fish and numerous other groups of organisms. Nevertheless, they are extremely fragile ecosystems that are suffering constant direct and indirect anthropogenic threats, such as pollution, sedimentation due to erosion, coastal urbanization, predatory fishing, unplanned tourism, etc. (e.g., Bryant et al., 1998).

In addition to ecological disturbances (such as alterations in food webs and coral bleaching) there are several consequences from reef destruction, including serious economic problems, such as decreasing tourist activity and the loss of subsistence economies (Bryant et al., 1998). Thus, good management practices are essential in areas with coral reefs.

According to Collinge (2001), research that focuses on spatially structured habitats is especially useful to biological conservation, as it can provide data with practical application for management and restoration projects. Additionally, this data can help define usage zones in marine reserves (Riegl and Riegl, 1996).

The studies of Loya and Slobodkin (1971) and Loya (1972), in addition to a later revision of transect methods (Loya, 1978) were a milestone in the quantitative study of coral community structure. Previous studies were almost exclusively qualitative and the few quantitative studies generally collected data inadequately (Loya, 1972).

General studies focusing on Brazilian reefs began with Hartt (1870) and Branner (1904), but the greatest contributions to the knowledge about these environments are those from Laborel's work during the 1960's and 1970's (Laborel, 1969; 1970; 1974). Later, revisions were carried out by Maida and Ferreira (1997), Castro and Pires (2001), Leão et al. (2003), and Prates (2003). However, extensive quantitative studies of Brazilian coral communities are still rare and have been carried out mainly in the Abrolhos region, Bahia state (Pitombo et al., 1988; Villaça and Pitombo, 1997; Ramos, 1998; Segal and Castro, 2000; 2001). Other areas that have been studied quantitatively are St. Peter and St. Paul Archipelago (Vasconcelos et al., 2004; Vasconcelos, 2005; Amaral et al., 2009), Manuel Luiz Parcel, Maranhão State (Amaral et al., 2007); Rocas Atoll (Gherardi and Bosence, 2001); Arraial do Cabo, Rio de Janeiro state (Castro et al., 1999); some beaches of the Costa dos Corais marine reserve, in the states of Alagoas and Pernambuco (Steiner, 2005); several areas off the coast of Pernambuco (Vasconcelos, 2005); and Todos os Santos Bay (Bahia) (Ramos et al., 2009).

Thus, this study aimed to quantitatively analyze the spatial distribution of benthic organisms from the reef environment of Porto de Galinhas Beach (one of the country's most popular tourist destinations), with special focus on its corals and calcified hydroids.

Material and Methods

Porto de Galinhas beach is located on the southern coast of the state of Pernambuco (northeastern Brazil), 64km south of the state capital, Recife. It has a humid tropical climate with rainy and dry seasons and a mean air temperature of 24ºC (CPRH, 2001). Reef formations 900 meters long can be found next to the shore. The entire beach is approximately 6.3km long and is visited by approximately 60 thousand tourists during high season (MMA/SECTMA/CPRH, 2003).

Four stations were randomly selected along the reef formation using a GPS (Global Positioning System): two of them (2: 8º30'34"S, 34º59'94"W and 3: 8º30'41"S, 34º59'91"W) in easy to access areas frequently visited by tourists and two of them in more distant areas, with little tourist visitation (1: 8º30'73"S, 35º00'43"W and 4: 8º30'16"S, 34º59'92" W) (Figure 1).

The reef flat's benthic organisms were surveyed during November 2004 at low tide, using line transects as described by Loya (1978) and adapted by Segal and Castro (2001). The observations were carried out by scuba diving, using a 10m measurement tape stretched taught along the reef. Depth varied from 2.5 to 4m. The line transects ran parallel to the shore in all stations. Three transects were carried out for each station, with a standard distance of 1m between them (thus totaling 12 transects for the entire study area). The benthic organisms were recorded every 5cm, totaling 201 sites per transect, 603 sites per station and 2412 sites for the entire area studied. Cover was calculated by simple percentage of the transect area.

Water samples were collected in October/2004, for salinity and pH analyses. The pH value was recorded using a Hanna potentiometer. Salinity was measured using the method described by Strickland and Parsons (1972), and data for water transparency and temperature were measured *in situ* using a secchi disk and a thermometer.

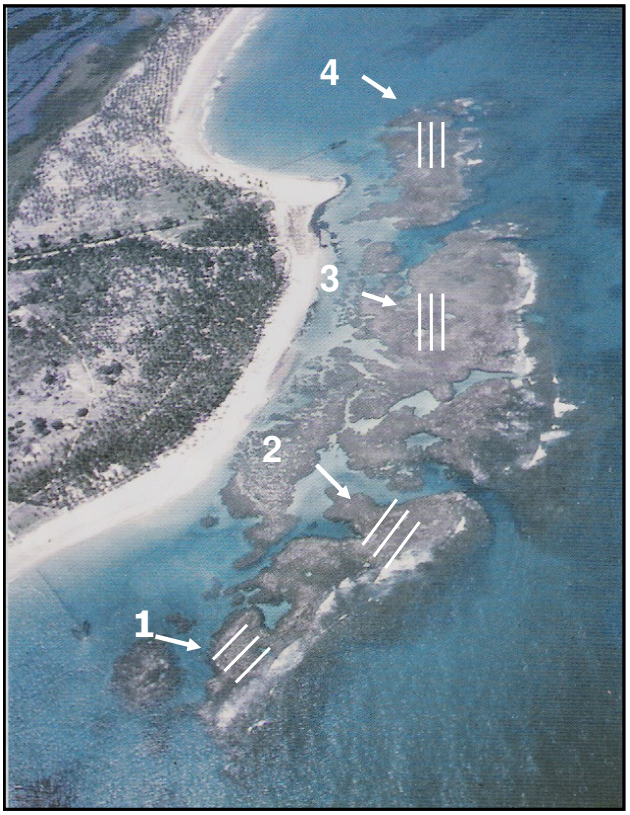

FIGURE 1: Four stations selected along the reef formation of Porto de Galinhas beach (White lines represent the three transects that were carried out for each station) (Picture: Laborel 1963/Projeto Recife Costeiros).

Results

During the survey period the Secchi depth (Z_D) was 1.75m on average. The mean water temperature and salinity were 27.7°C and 36, respectively, and pH values oscillated between 8.2 and 8.4.

A considerable variety of macroalgae was observed, among which the most abundant genera were *Sargassum*, *Padina*, *Caulerpa*, *Dictyota*, and *Dictyopteris*, as well as calcareous algae from the order Corallinales and genera *Halimeda.* From phylum Porifera, it was possible to identify *Cinachyrella alloclada* (Uliczka, 1929), *Tedania ignis* (Duchassaing and Michelotti, 1864), and *Haliclona* sp. A single representative of phylum Echinodermata was observed, the sea urchin *Echinometra lucunter* (Linnaeus, 1758). Animals belonging to class Ascidiacea and phylum Bryozoa were not identified, and were listed as ascidians and bryozoans. Due to the variety of species, only the cnidarians were identified to species level, while other organisms were just identified as macroalgae, calcareous algae, and sponges.

The cnidarians observed were the calcified hydroid *Millepora alcicornis* Linnaeus, 1758; the zoanthids *Palythoa caribaeorum* (Duchassaing and Michelotti, 1860) and *Zoanthus sociatus* (Ellis, 1767); and the scleractinian corals *Siderastrea stellata* Verrill, 1868, *Favia gravida* Verrill, 1868, *Mussismilia hispida* (Verrill, 1902), *Montastraea cavernosa* (Linnaeus, 1767), and *Porites astreoides* Lamarck, 1816.

A high coverage of macroalgae was verified, averaging 53% of the total cover. The second most representative group was that of the zoanthids – which averaged 10.7% cover – followed by calcareous algae (6.8%), scleractinian corals and calcified hydroids (7.2%), sponges (4.9%), sea urchin (1.6%), bryozoans and ascidians (1% each). Areas covered by rocks and sand added up to 13.7% of the percentage cover (Figure 2).

A total of 173 colonies of corals and calcified hydroids was observed along the line transects in the four study stations; *S. stellata* was the most frequent species at stations 1, 2 and 3 and *M. hispida* was the most abundant at station 4 (Table 1).

The analysis of variance (ANOVA) showed significant difference in the number of corals and

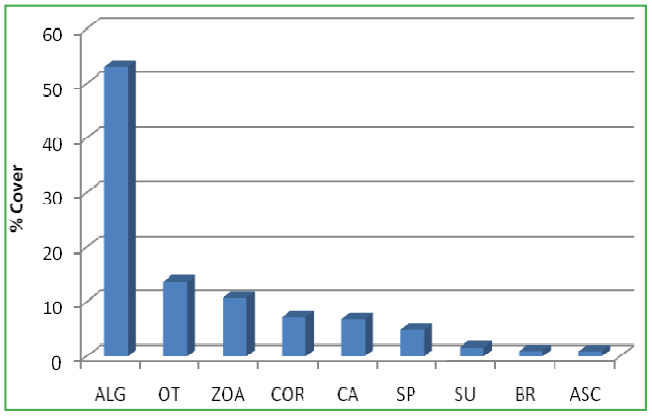

FIGURE 2: Percentage cover of benthic macroorganisms at the reef environment of Porto de Galinhas Beach (Pernambuco, Brazil) in the four study stations, in November 2004. (ALG = algae; OT = rocks and sand; ZOA = zoanthids; COR = corals and calcified hydroids; CA = calcareous algae; SP= sponges; SU = sea urchins); BR = bryozoans; ASC = ascidians).

calcified hydroids at the four study stations (F= 5.49; df = 3.8; $p<0.05$). An average of 18 colonies were found at stations 1 and 4, while at stations 2 and 3 the mean was 9 and 12 colonies, respectively.

TABLE 1: Number of colonies of corals and calcified hydroids observed along the line transects in Porto de Galinhas Beach in the four study stations.

Species	Study Stations				
	1	2	3	4	Total
Favia gravida	0	4	8	2	**14**
Millepora alcicornis	7	0	0	5	**12**
Montastraea cavernosa	11	0	7	11	**29**
Mussismilia hispida	15	3	0	17	**35**
Porites astreoides	3	1	6	3	**13**
Siderastrea stellata	18	20	16	16	**70**
Total	**54**	**28**	**37**	**54**	**173**

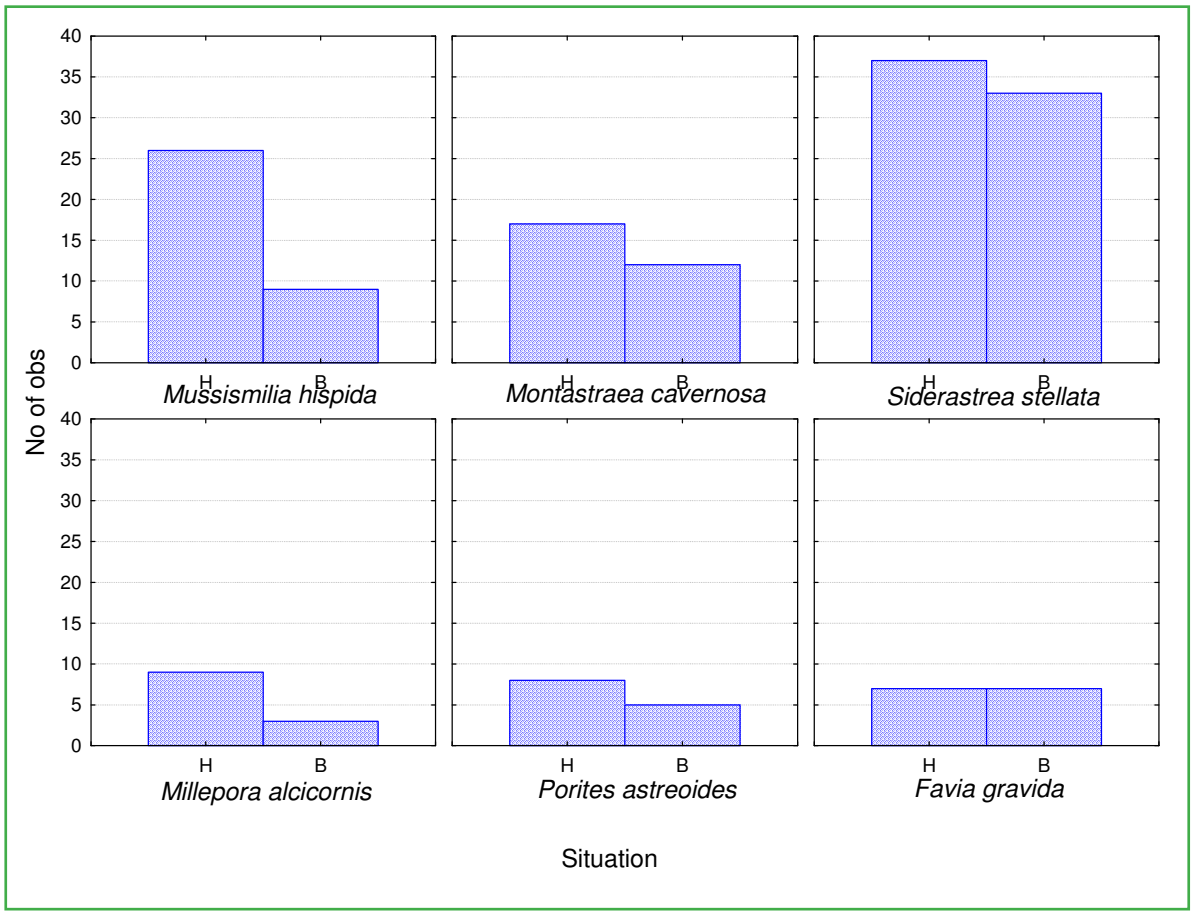

FIGURE 3: Health and Bleached colonies along the line transects at the reef environment of Porto de Galinhas Beach (Pernambuco, Brazil), in November 2004 (H= health; B= bleached).

Forty percent of the colonies observed were partially or totally bleached; proportionally, *Favia gravida* was the most affected by the phenomenon (50%), followed by *S. stellata* (47%), *M. cavernosa* (41%), *P. astreoides* (38%) and *M. hispida* (25%). There were no dead colonies along the line transects (Figure 3).

The chi-square test showed an association between the study station and the situation (i.e., bleached or healthy) of the corals and calcified hydroids (X^2= 8.95; df = 3; $p<0.05$): there were more healthy colonies at stations 1 (30%) and 4 (38%), while at stations 2 and 3 this proportion fell to less than 20%.

Discussion

The alkaline pH values are characteristic of water with reduced influences of suspended organic matter and the seawater carbonate system. The water temperature showed little variation during the survey period and its homogeneity is associated with the shallow depth and warm climate, characteristic of the tropical coastal environment, as related by Perkins (1974).

The cnidarians reported in Porto de Galinhas are very common in Brazilian reef environments and are well distributed along the coast. The present study found five species of zooxanthellate corals, one of calcified hydroid, and two of zoanthids. In fact, zoanthids were the second most representative group, agreeing with Rohlfs de Macedo and Belém (1994) who state that zoanthids occur frequently in Brazilian intertidal zones. According to these authors, *Zoanthus* and *Palythoa* are the most common genera along the Brazilian coast, as confirmed by this study. In a spatial study of headlands off the coast of Espírito Santo state, Longo (1997) also observed a high occurrence of zoanthids among the species found in her research.

Additionally, zoanthids are at an advantage to occupy the substrate of regions such as Porto de Galinhas since these organisms have few predators and adapt easily to shallow areas with a lot of sedimentation (Segal-Ramos, 2003).

The high coverage of macroalgae and low cover of corals and calcified hydroids observed in this study have already been found in other reef environments near urban areas in different parts of the world (see, for example, Brainard et al., 2002; Linton et al., 2002; Salvat, 2002). Other authors have also observed such predominance along the Brazilian coast, such as Coutinho et al. (1993) and Costa Jr et al. (2000) off the coast of Bahia; Villaça and Pitombo (1997) for the region of Abrolhos (Bahia); Vasconcelos et al. (2004) and Vasconcelos (2005) on reefs off the state of Pernambuco; and Steiner (2005) for a marine reserve shared by the states of Pernambuco and Alagoas.

Linton et al. (2002) observed the predominance of macroalgae in the Bahamas starting in 1994, when coral cover was 9.6% at a depth of 10m; in 2001, coral cover decreased to 4%, while the cover of macroalgae was 41%. In Jamaica, coral cover was 60-80% in the 1970's, but recent studies show that these animals presently represent less than 10% of total cover with predominance of macroalgae (Hallock, 2002). This author states that changes in diversity and/or biomass among algae communities can be observed among impacted environments, as well as several species that indicate pollution.

The low cover of corals and calcified hydroids found in this study might be the result of competition for space against the macroalgae and zoanthids. According to Tanner (1995), algae have the potential to be corals' main competitors. Competition, however, is not only for space; it could also be due to the constant abrasion by algae parts on corals, which could result in frequent polyp retraction and reduced feeding ability (Coyer et al., 1993).

Another factor to be considered when analyzing the composition of the benthic cover in Porto de Galinhas is the great number of visitors the beach receives every year. Areas covered by rocks and sand, for instance, were most frequent at the points of high tourist visitation. Nevertheless, unplanned, disorganized tourism and its related activities have been growing fast over the last fifteen years in Porto de Galinhas (MMA/SECTMA/CPRH, 2003). This has generated several environmental problems, similar to what was found by Steiner et al. (2006) for an adjacent marine reserve (Costa dos Corais) who list several negative impacts of tourism on the reef organisms of that area.

The predominance of macroalgae and zoanthids and low cover of corals and calcified hydroids characterize the reef environment of Porto de Galinhas Beach. Such spatial display might be influenced by competition for space between the different organisms and direct and indirect damage caused by intense tourist visitation. This is backed by the fact that the highest percentage of coral and calcified hydroid cover occurred in the two least visited stations, which were also statistically distinct from the rest. Additionally, the areas with the highest tourist visitation also had the greatest percentage of bleached colonies and the largest extensions of areas with no organism cover whatsoever. However, more studies are needed to reveal the details of the causal links between competition, the occurrence of the different organisms, and the impact of tourism on the spatial distribution of benthic organisms on northeastern Brazilian beaches.

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