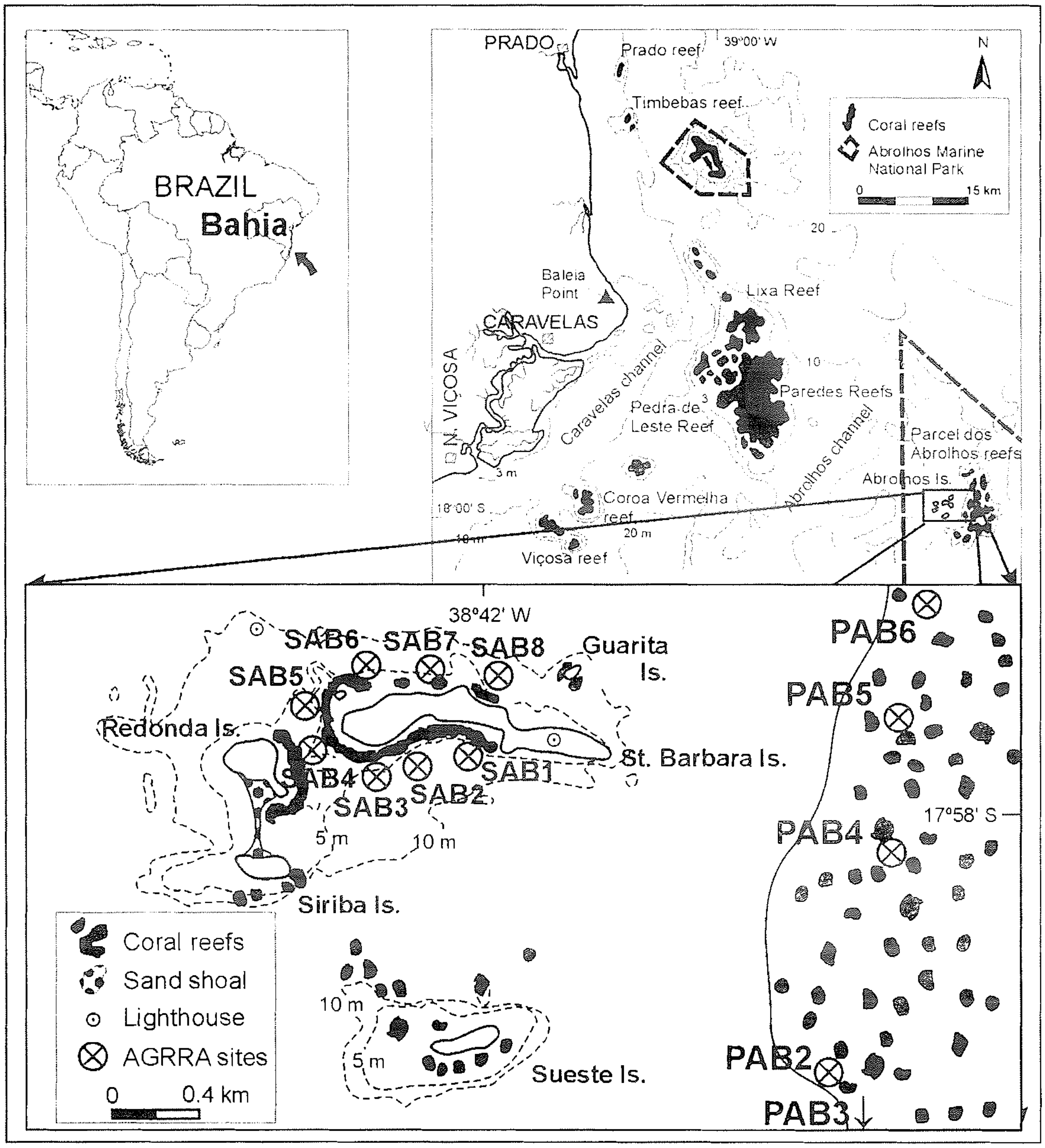

Figure 1. AGRRA survey sites off Santa Bárbara Island (SAB) and in the Parcel dos Abrolhos chapeirões (PAB) in the Abrolhos, Brazil. See Table 1 for site codes.

RAPID ASSESSMENT OF THE ABROLHOS REEFS, EASTERN BRAZIL (PART 1: STONY CORALS AND ALGAE)

BY

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ABSTRACT

In March-April 2000, a survey applying the Atlantic and Gulf Rapid Reef Assessment benthos protocol was accomplished in the Abrolhos National Marine Park. The Santa Bárbara Island fringing reef and offshore "chapeirões" (isolated columnar reefs) were assessed to evaluate their present status and provide standards for future monitoring programs. The chapeirões were rated as well preserved in terms of the density and health of large (≥25 cm in diameter) stony corals, the density of stony coral recruits, and the scarcity of benthic macroalgae. However, concerns were raised about the fringing reef, particularly off the island's southern coast. Although the causes for its poor condition here are not well understood, the intrinsic oceanographic setting, in particular exposure to storm waves in winter, and the presence of numerous tourist divers and snorkelers during the summer must be investigated.

INTRODUCTION

The southernmost coral reefs in the western Atlantic Ocean are found in Brazil (Fig. 1). They are spread over a distance of approximately 2,000 km between 0°50′ and 19° S latitude. Although some information about the Brazilian reefs has existed for over a century, many reef areas are still poorly known and there are few quantitative assessments of their condition. Along the coast of the state of Bahia (between 12°30′ and 19° S latitude), where most coral reefs occur, few previous reef assessments have been performed (Leão et al., 1997; Castro and Pires, 1999; Leão et al., 1999). In the southern part of Bahia state (at 17°-19° S latitude), the continental shelf widens to 200 km forming the Abrolhos Bank, where the largest and richest of Brazil's coral reefs are scattered over

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an area of approximately 6,000 km^2 (Fig. 1). Isolated bank reefs of varied shapes (elongated, circular, etc.), with dimensions that range from less than 1 km to about 20 km in length, occur nearshore in depths of 10-20 m. Shallow offshore (<10 m deep) fringing reefs border the islands of the Abrolhos Archipelago, and enormous (maximally to 25 m high) isolated mushroom-shaped reef columns, or "chapeirões" (Fig. 2), are found in deeper water. The morphology of these major reef types seems to be related to the underlying substratum (older reefs, Precambrian bedrock, beachrock, etc.), the prevailing hydraulic regime, and their position relative to present sea level (Leão, 1996; Kikuchi and Leão, 1998; Leão and Kikuchi, 1999; Leão et al., 2001).

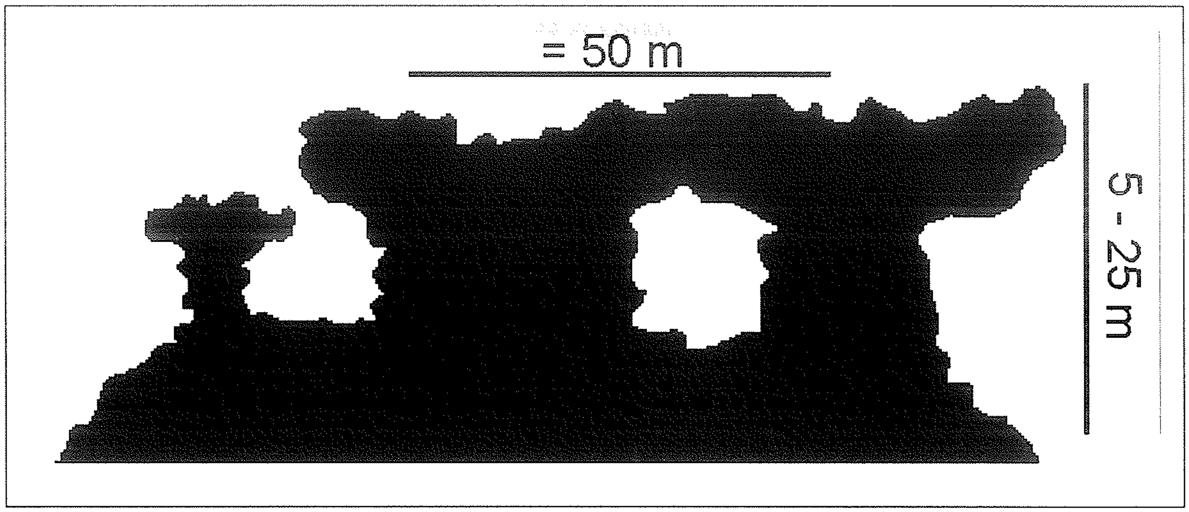

Figure 2. Cross-sectional sketch of the mushroom-like growth form of the Brazilian chapeirões.

The Abrolhos reefs are built by a stony coral fauna that is characterized by its very low diversity compared with those of the North Atlantic or Indo-Pacific Oceans, by the endemic character of its major reef-builders, and by the complete absence of species with branching morphologies (Belém et al., 1986; Castro, 1994). Of the 18 species identified so far in Brazilian reefs, 17 are reported from the Abrolhos region. Most common are the six endemic scleractinians (*Mussismilia braziliensis, M. hispida, M. harttii, Siderastrea stellata, Favia gravida and F. leptophylla*), some of which have affinities with modern Caribbean species, while others are related to a Tertiary coral fauna that may have been isolated from the Caribbean Sea by the Amazon River flow, after its reversal due to the elevation of the Andes during the Tertiary. The hydrocoral *Millepora alcicornis* occupies reef-edge habitats, but all Brazilian reefs lack the acroporids which are major components of many reef-crest and fore-reef zones in North Atlantic reefs.

Stony corals inhabiting the nearshore bank reefs are naturally exposed to influxes of terrigenous sediment (Martin et al., 1985). They are now threatened by accelerated urban expansion which has caused an increase in coastal runoff and untreated sewage discharges. The offshore reefs, in contrast, are located away from the mainland and are partially protected by law (see Kikuchi et al., this volume). Previous assessments of potential human impacts in the Abrolhos National Marine Park have referred only to the anchorage of tourist boats in seagrass beds around the islands (Creed and Amado Filho, 1999).

The northern coasts of the Abrolhos islands (Fig. 1) are exposed to relatively high wave energies between September and February, their southern sides to somewhat larger waves from April to August, while the western (leeward) coasts are protected from major wind trends. Their fringing reef flats extend about 30 m from shore, are poorly developed and, during low tides, are subaerially exposed. Seaward, the reefs gradually slope to their edges at depths of 4-5 m where they drop off to a sandy bottom at 8-10 m. The shallow fringing reefs around some of the islands are intensively used for recreational scuba diving and snorkeling. In particular, tourists dive all around Santa Bárbara Island (SAB), most frequently on its southern side.

The windward Parcel dos Abrolhos (PAB) chapeirões, which are located about 2 km east of the Abrolhos islands, form huge mushroom-shaped structures, some of which attain heights of over 20 m. Due to the limited penetration of light beneath the overhangs around their sides, the maximum development of reef corals is at depths of 5-8 m on the tops of the chapeirões. The PAB chapeirões, which are seldom visited by tourists due to difficulty of navigation and rougher sea conditions, are known to be in good condition (personal observations).

Our initial purpose in using the Atlantic and Gulf Rapid Reef Assessment (AGRRA) protocols in the Abrolhos National Marine Park was to collect information on the condition of its offshore reef communities in order to establish standards for a long-term monitoring program in the park. The fish community assessment results can be found in Kikuchi et al. (this volume).

METHODS

Benthic surveys were conducted in eight fringing reef sites around SAB that are considered representative of its northern (three sites), southern (three sites) and western (two sites) coasts. Each site was located in shallow water (3.5-5.5 m) as close as possible to the seaward edge of the reef. The three sites off the southern coast were also strategic choices because they are preferred recreational dive sites. The crests of five representative chapeirões, located at depths of 6-6.5m, were surveyed. All of these sites are routinely exposed to large waves, except for the leeward (western) fringing reef, which experiences strong tidal currents.

Two divers utilized the AGRRA Version 2.0 benthos protocol (see Appendix One, this volume) on each dive. Damselfish algal gardens were not assessed; rather the fish assessment team recorded the sizes and densities of all damselfishes. The average maximum height of all the "large" (>25cm in diameter) corals surveyed in each transect was used to approximate the rugosity of the reef surface. Two days were spent in consistency training before the beginning of the surveys.

Reef environments (the windward fringing reef off southern and northern SAB, the leeward fringing reef off western SAB, and the chapeirões) were compared on the basis of average live stony coral cover, number of large corals per transect, average maximum height of large corals, and number of large corals affected by old partial-colony mortality. Although tests of normality showed that the data did not depart from normal distributions, most of the variances are rather unequal. Thus we chose to perform a Kruskal-Wallis non-parametric ANOVA for multisample hypothesis testing (Zar, 1999). When the null hypothesis was rejected by the Kruskal-Wallis test, we applied a non-parametric Tukey-type method to locate the differences among the data, using the test proposed by Dunn (see Zar, 1999).

RESULTS

Stony Corals

Live stony coral cover averaged about 20% in the chapeirões (Table 1) and was significantly higher than in the SAB fringing reef (Kruskal-Wallis, $p < 0.001$), where corresponding cover estimates ranged from 3.5-12%. The density of large (>25 cm in diameter) stony corals varied between ~0.4/m (southern SAB) and ~1.1/m (western SAB) and was significantly smaller in the southern SAB sites (Kruskal-Wallis, $p < 0.001$). Less variation was seen in the maximum height of the large corals with the tallest, averaging ~30 cm, occurring in the chapeirões (Table 2). However, stony corals in the northern SAB sites and the chapeirões are significantly taller than those in the southern and western SAB sites (Kruskal-Wallis, $p < 0.001$). The mean diameter of the large corals was quite similar in the four surveyed environments varying from about 37 to 48 cm (Table 2).

Six species accounted for more than 95% of the large corals. In all sites, *Mussismilia braziliensis* was by far the dominant species (comprising >66% of all colonies) especially in the western and northern SAB sites (Table 3, Fig 3). *Millepora alcicornis* and *Montastraea cavernosa* were present in all sites but the former was more common in the chapeirões and the latter in the fringing reef. *Mussismilia hartti* was slightly more abundant in the chapeirões than in the fringing reef. *Favia leptophylla* was found in all sites, while *Siderastrea stellata* was absent from the western side of the island.

Size distributions of *Mussismilia braziliensis*, shown in Figure 4, were unimodal in the western and northern SAB fringing reef and the chapeirões, with the modes in the 30-40 cm interval. However, colonies were more evenly distributed across size classes in the southern SAB sites. Corals greater than 70 cm in diameter were more frequent in the fringing reef (where they formed more than 10% of the population) than in the chapeirões (Fig. 4).

Recent partial-colony mortality (hereafter recent mortality) of large stony corals ranged from 0 to 10% with the highest overall averages (~5-6.5%) in the chapeirões (Table 2, Fig. 5). Estimates of recent mortality for *Mussismilia braziliensis* resembled those of the entire assemblage of large corals except for one southern SAB site and one of the chapeirões where no colonies of this dominant species had incurred any recent tissue loss (Table 3).

Mean estimates of old partial-colony mortality (hereafter old mortality) for large corals overlapped in the four surveyed environments (individual site averages varied twofold, between ~17 and 32%) as shown in Figure 5, although proportionately fewer

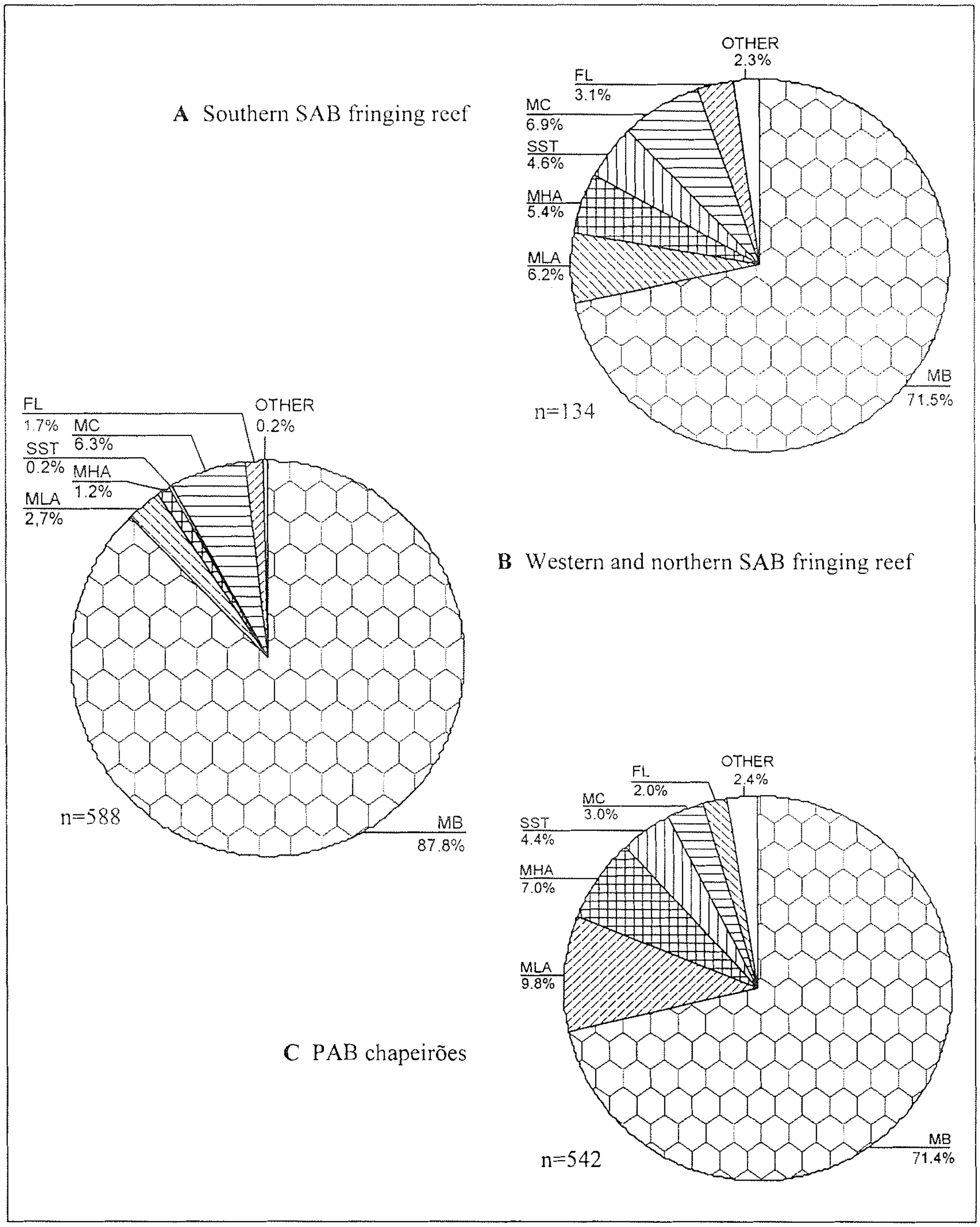

Figure 3. Species composition and mean relative abundance of all stony corals (≥25 cm diameter) in the (**A**) southern and (**B**) western and northern SAB fringing reef, (**C**) PAB chapeirões, in the Abrolhos, Brazil. FL = *Favia leptophyla,* MC = *Montastraea cavernosa,* MLA = *Millepora alcicornis,* MB = *Mussismilia braziliensis,* MHA = *M. hartti,* SST = *Siderastrea stellata.*

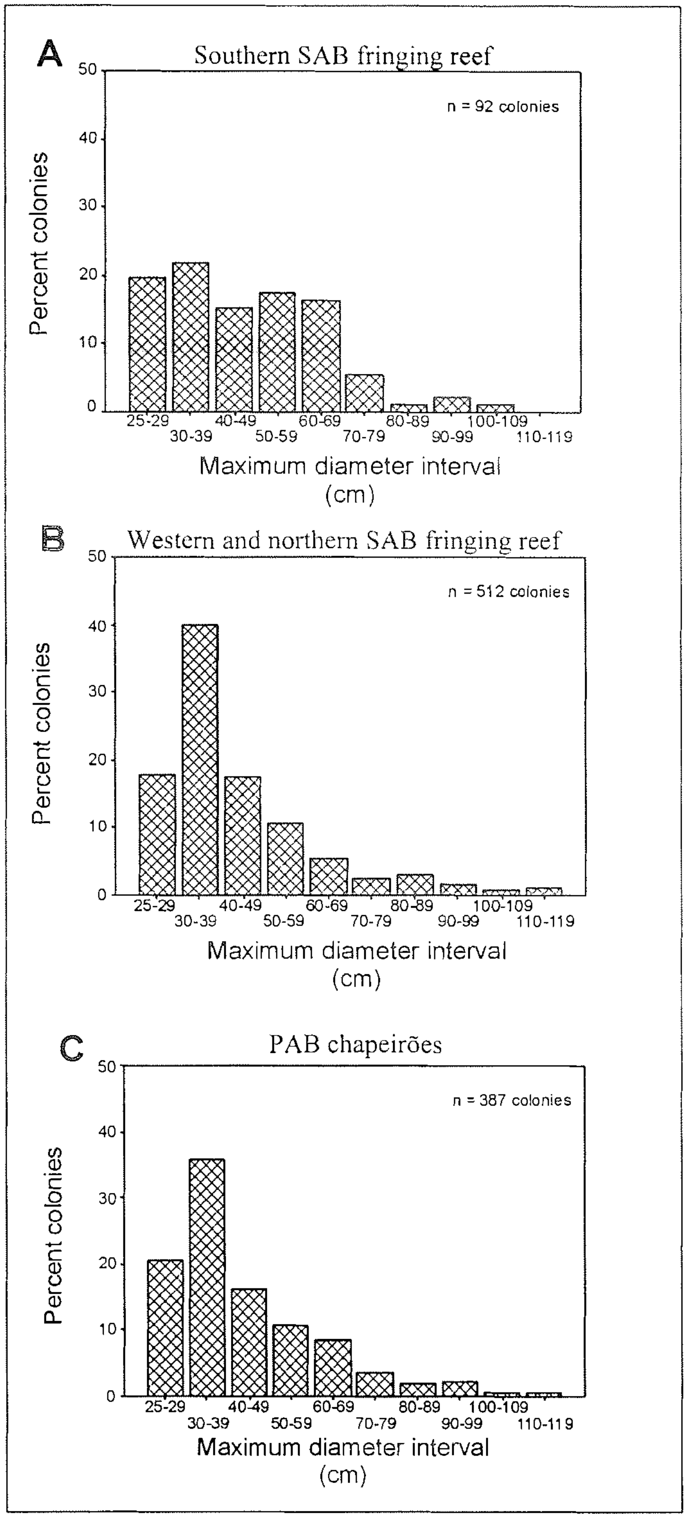

Figure 4. Size-frequency distribution of colonies (≥25 cm diameter) of *Mussismilia braziliensis* in the (**A**) southern and (**B**) western and northern SAB fringing reef, and (**C**) PAB chapeirões in the Abrolhos, Brazil.

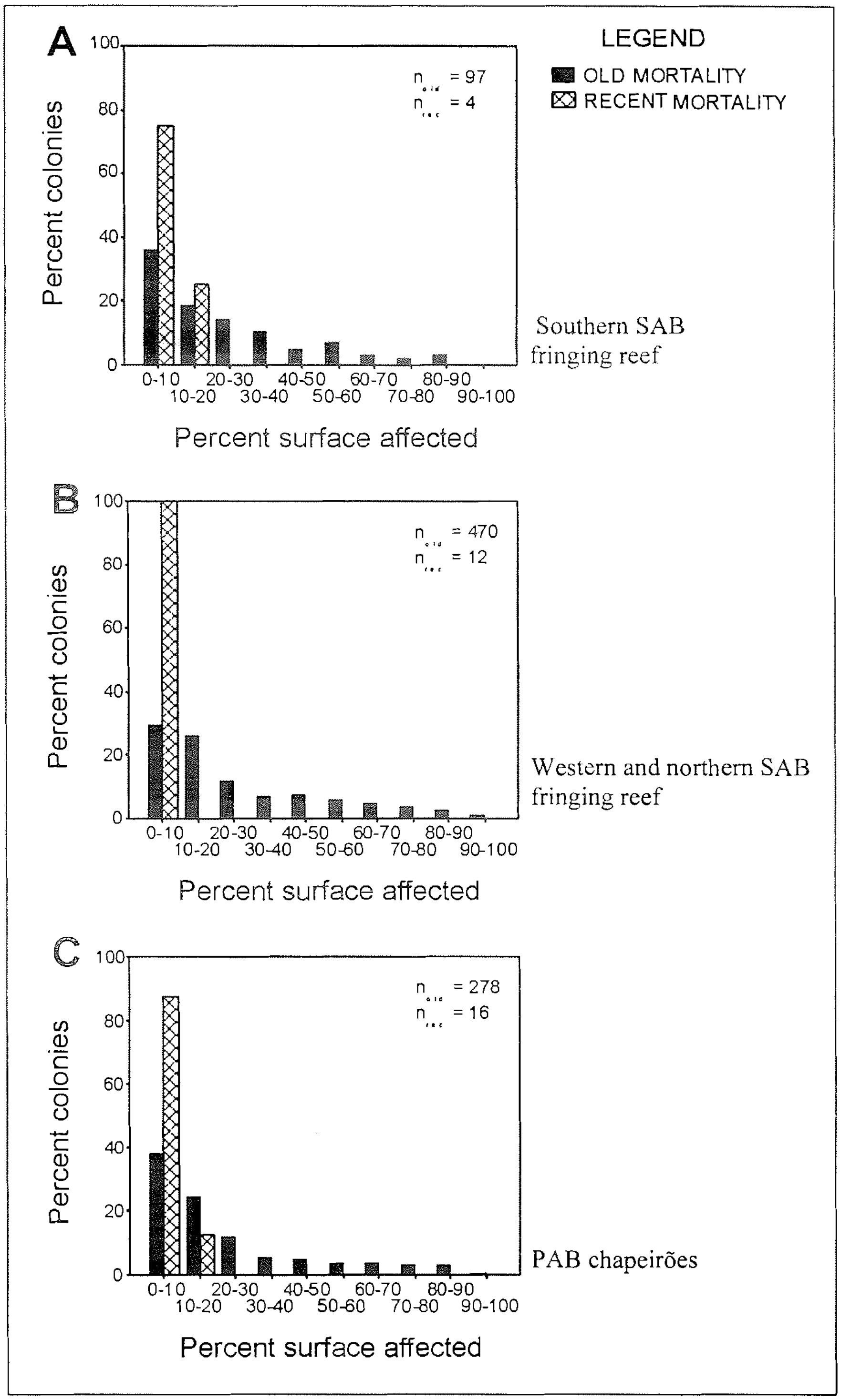

Figure 5. Frequency distribution of recent partial colony mortality and old partial colony mortality of all stony corals (≥25 cm diameter) in the (**A**) southern, (**B**) western and northern SAB fringing reef, and (**C**) PAB chapeirões in the Abrolhos, Brazil.

colonies were affected in the chapeirões than in the fringing reef (~35-62% versus ~64-86%, respectively) (Table 2). The number of colonies with old mortality was significantly greater in the western SAB sites than in the southern SAB sites and the chapeirões (Kruskal-Wallis, $p < 0.001$).

Mean estimates of total (recent + old) partial-colony mortality (hereafter total mortality) exhibited similar patterns to those described for old mortality (Table 2) by overlapping in the four surveyed environments with proportionately fewer colonies being affected in the chapeirões than in the fringing reef (~38-64% compared to 64-84%, respectively). Similar patterns for old mortality and total mortality characteristics were seen in *Mussismilia braziliensis* (Table 3).

No signs of disease were seen in any of the large stony corals in the survey sites (Table 2). No bleached colonies were observed in the northern SAB sites and they were rare (0-3.5% of corals) off the southern and western sides of the island. Levels of bleaching were slightly higher in the chapeirões (1.5-7%).

The density of coral recruits was higher in the chapeirões than in the fringing reef (Table 4). The most common species found as recruits in both habitats were *Siderastrea stellata*, *Agaricia agaricites*, *Favia gravida* and, very rarely, *Mussismilia braziliensis*.

Algae and *Diadema antillarum*

Turf algae clearly predominated everywhere except in one of the northern SAB sites (SAB8), and were particularly abundant (>80% relative abundance) in the other two northern sites (Table 4). The relative abundance of macroalgae was higher overall in the fringing reef (<0.5-58%, n=8 sites), where they formed the dominant algal group in one northern site (SAB8), than in the chapeirões (<0.5-7%, n=5 sites). The average height of the macroalgae and the macroalgal index (relative macroalgal abundance x macroalgal height) were also greater in all but one of the SAB sites than in the chapeirões. Crustose coralline algae were relatively more abundant in the chapeirões than in the fringing reef. No individuals of *Diadema antillarum* were found during the surveys.

DISCUSSION

Although the crests of the chapeirões were slightly deeper (6-6.5 m) than the fringing reef (3.5-5.5 m), most sites were similar in terms of the diameter and old partial-mortality of large (≥25 cm) stony corals and in the predominance of turf algae on the substratum. Nevertheless, considering their higher values for live stony coral cover, maximum coral height and coral recruit density, as well as their low macroalgal indices (a proxy for macroalgal biomass), the chapeirões appeared to be in better condition overall than the SAB fringing reef. The worst indicators were found on the southern fringing reef where the density of large corals and live stony coral cover are both particularly low. It should be remembered that the southern SAB reef is most heavily visited by tourists (divers and snorkelers) during the summer.

Species richness among large stony corals may be higher in the more exposed southern fringing reef and the chapeirões than in the western and northern SAB sites. Storms may prevent *Mussismilia braziliensis* (which, due to its characteristic mushroom shape, breaks and tumbles easily) from dominating other species. Although large (>40 cm) colonies of *M. braziliensis* are relatively more common in the southern SAB sites where coral density is low, we found no colonies greater than 110 cm in diameter in this environment. Intense fragmentation and subsequent mortality of the fragments may reduce the abundance both of the small and of the very large (>110 cm) size classes; alternatively recruitment and/or survival of young colonies may be less successful in this habitat.

So far neither outbreaks of disease nor any mass mortality events have been witnessed among the Brazilian stony coral populations. The somewhat higher values of recent partial-colony mortality and the slightly higher percentage of bleached corals that were present in the chapeirões presently lack an explanation. On the other hand, the percentage of colonies with old partial-mortality was substantially higher in the fringing reef than in the chapeirões (Table 2). That the southern SAB sites were not significantly different from the chapeirões can be tentatively explained by the scarcity of large corals (i.e., small sample sizes) off this side of the island.

The density of coral recruits was inversely related to the relative abundance of macroalgae, hence higher in the chapeirões than in the SAB fringing reef. The dominance that we found by recruits of *Siderastrea* and *Agaricia* is expected since the life history strategies of many species in these genera are to concentrate energy in reproduction rather than long-term survival (Bak and Engel, 1979). Clearly, this is not the case for *M. braziliensis*; nonetheless, a few of its recruits were present in this survey.

The higher relative abundance of macroalgae and the much higher macroalgal index values found in the SAB fringing reef compared to the more isolated chapeirões are also expected, given their proximity to the island. In particular, sewage seep from the houses (near SAB8) and imputs from the nesting birds and/or the decomposed remains of dead birds in the "bird's cemetary" on the northwestern coast (near SAB5), would augment nutrients in natural runoff during storms (see Kikucki et al., this volune). Grazing pressures could also be higher in the chapeirões: *Echinometra lucunter*, which is known to be a significant herbivore, is more abundant than *Diadema antillarum* along the eastern coast of Brazil, but its impact in the offshore Abrolhos reefs is not known. However, *E. lucunter* is more common in the fringing reef than the chapeirões (personal observations), as are key herbivorous surgeonfishes and parrotfishes although the latter are smaller off SAB than in the PAB (Kikuchi et al., this volume).

An overall impression given by the AGRRA benthos indicators is that reef condition is fairly good in the chapeirões and in the northern SAB fringing reef, although the cover of live stony corals is low in the latter. Interestingly, the two reef areas that appeared to be in poor condition (i.e., the southern and, to a lesser extent, the western SAB coasts) include the sites preferred by tourists for diving and snorkeling. Thus, closer monitoring and evaluation of the relative impacts of summertime tourism and winter storm damage are warranted.

To have a more complete picture of the entire Abrolhos region, the offshore islands that are inaccessible to visitors will be assessed for comparison with the recreational dive sites at SAB. We will investigate the condition of some chapeirões located near the archipelago which are popular with tourist divers and snorkelers. We also plan to apply the AGRRA protocols in the coastal reefs that have been most severely impacted by anthropogenic effects.

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Table 1. Site information for AGRRA stony coral and algal surveys in the Abrolhos, Brazil.

Site name	Site code	Relative exposure/ Reef type	Latitude (° ′ S)	Longitude (° ′ W)	Survey date(s)	Depth (m)	Benthic transects (#)	≥25 cm stony corals (#/10 m)	% live stony coral cover (mean ± sd)
Santa Bárbara Island									
South 1	SAB1	exposed/fringing	17 58.89	38 41.71	Mar 28 00	4	10	3	3.5 ± 1.3
South 2	SAB2	exposed/fringing	17 57.82	38 42.06	Mar 29 00	5.5	13	4	6.5 ± 4.3
South 3	SAB3	exposed/fringing	17 57.92	38 42.22	Mar 30 00	5.5	10	5.5	8.0 ± 6.3
Leeward 1	SAB4	sheltered/fringing	17 57.75	38 42.40	Mar 31-Apr 1 00	3.5	18	10.5	7.5 ± 5.0
Leeward 2	SAB5	sheltered/fringing	17 57.85	38 42.20	Apr 1- 2 00	4.5	12	12	12.0 ± 4.9
North 3	SAB6	exposed/fringing	17 57.60	38 42.11	Apr 4-5 00	3.5	10	6	7.0 ± 5.2
North 2	SAB7	exposed/fringing	17 57.68	38 41.98	Apr 5-6 00	4.5	10	12.5	11.5 ± 6.1
North 1	SAB8	exposed/fringing	17 58.04	38 41.54	Apr 9-10 00	4	10	7	7.0 ± 4.3
Parcel dos Abrolhos									
Chapeirões 2	PAB2	exposed/chapeirões	17 59.00	38 40.04	Mar 21 00	6.5	9	11	20.0 ± 10.5
Chapeirões 3	PAB3	exposed/chapeirões	17 59.52	38 40.17	Mar 22 00	6.5	10	11	23.0 ± 8.1
Chapeirões 4	PAB4	exposed/chapeirões	17 58.08	38 39.34	Mar 23 00	6.5	10	12	22.0 ± 7.5
Chapeirões 5	PAB5	exposed/chapeirões	17 57.31	38 39.20	Mar 24 00	6.0	11	9.5	22.5 ± 6.4
Chapeirões 6	PAB6	exposed/chapeirões	17 56.40	38 39.36	Mar 25 00	6.0	11	9.5	14.5 ± 5.7

Table 2. Size and condition (mean ± standard deviation) of all stony corals (≥25 cm diameter) by site in the Abrolhos, Brazil.

Site name/	Stony corals			Partial-colony mortality (%)			Stony corals (%)				
Site code	#	Diameter (cm)	Height (cm)	Recent	Old	Total	Recent mortality	Old mortality	Total mortality	Standing dead + Diseased	Bleached
Santa Bárbara Island											
South 1/SAB1	30	42.0 ± 17.3	14.0 ± 11.7	10.0 ± 7.1	24. 5 ± 26.2	25.5 ± 27.2	6.5	73.5	73.5	0	3.5
South 2/SAB2	50	41.0 ± 16.5	23.5 ± 16.3	0	17.0 ± 15.7	17.0 ± 15.7	0	64	64	0	2
South 3/SAB3	54	47.5 ± 21.7	20.0 ± 14.3	3.0 ± 2.8	23.5 ± 20.6	24.0 ± 20.6	3.5	79.5	79.5	0	0
Leeward 1/SAB4	188	46.5 ± 20.0	20.5 ± 13.7	2.5 ± 2.1	31.5 ± 24.9	32.0 ± 24.8	1.5	85.5	84.5	0	2.5
Leeward 2/SAB5	144	37.0 ± 11.4	17.0 ± 18.0	3.0 ± 2.0	17.0 ± 18.1	17.0 ± 18.0	3.5	80	82.5	0	2
North 3/SAB6	58	45.0 ± 23.9	26.0 ± 14.6	5	21.0 ± 20.9	21.0 ± 21.3	1.5	74	74	0	0
North 2/.SAB7	126	43.0 ± 19.7	25.0 ± 14.6	5	20.5 ± 19.3	21.0 ± 19.3	1.5	75.5	75.5	0	0
North 1/SAB8	72	36.0 ± 13.1	23.0 ± 9.6	3	21.0 ± 22.9	20.5 ± 22.8	1.5	78	79	0	0
Parcel dos Abrolhos											
Chapeirões 2/PAB2	101	38.5 ± 16.2	26.5 ± 15.4	6.5 ± 2.5	22.5 ± 23.8	22.5 ± 23.5	4	62.5	64.5	0	7
Chapeirões 3/PAB3	110	39.0 ± 17.8	30.5 ± 21.7	6.5 ± 2.9	19.0 ± 19.0	18.5 ± 18.8	3	56.5	58	0	2
Chapeirões 4/BAP4	121	48.0 ± 36.9	30.0 ± 19.9	5	18.5 ± 20.3	18.5 ± 20.3	1	58.5	58.5	0	1.5
Chapeirões 5/PAB5	104	39.0 ± 17.6	24.0 ± 20.5	5.0 ± 0.0	23.0 ± 23.4	23.0 ± 23.4	3	43.5	43.5	0	4
Chapeirões 6/PAB6	106	47.5 ± 24.3	37.0 ± 27.1	5.0 ± 0.0	19.5 ± 20.0	18.5 ± 19.5	4.5	35	38.5	0	3

Table 3. Size and condition (mean ± standard deviation) of all *Mussismilia braziliensis* (≥25 cm diameter) by site in the Abrolhos, Brazil.

Site name/ site code	*M. braziliensis*			Partial-colony mortality (%)		*M. braziliensis* (%)			
	#	% of total	Diameter (cm)	Recent	Old	Recent mortality	Old mortality	Total mortality	Bleached
Santa Bárbara Island									
South 1/SAB1	20	66.5	45.5 ± 18.4	0	25.0 ± 31.3	0	70	70	0
South 2/SAB2	33	66	45.0 ± 16.3	0	14.5 ± 16.0	0	72.5	72.5	0
South 3/SAB3	40	74	50.5 ± 23.9	3.0 ± 2.8	20.5 ± 20.8	5	77.5	77.5	0
Leeward 1/SAB4	172	91.5	47.0 ± 19.4	2.5 ± 2.1	31.5 ± 25.8	1.5	85	85	1.5
Leeward 2/SAB5	118	82	37.5 ± 11.6	5.0	16.0 ± 17.2	1.5	83	84	1.5
North 3/SAB6	57	98.5	45.5± 24.1	5.0	21.5 ± 21.1	2	73.5	73.5	0
North 2.SAB7	114	90.5	43.5 ± 20.5	5.0	21.5 ± 19.9	2	74.5	74.5	0
North 1/SAB8	55	76.5	36.5 ± 14.4	3.0	20.0 ± 23.0	2	76.5	78	0
Parcel dos Abrolhos									
Chapeirões 2/PAB2	67	66.5	37.5 ± 15.9	5.0± 0	25.5 ± 26.2	4.5	71.5	73	7.5
Chapeirões 3/PAB3	81	73.5	38.0 ± 15.0	6.5 ± 2.9	17.0 ± 18.4	3.5	59.5	61.5	2.5
Chapeirões 4/BAP4	82	68	41.5 ± 15.4	0	19.0 ± 21.0	0	56	56	0
Chapeirões 5/PAB5	77	74	38.0 ± 13.3	5.0 ± 0	21.5 ± 21.2	4	45.5	45.5	1.5
Chapeirões 6/PAB6	80	75.5	47.0 ± 21.4	5.0 ± 0	18.5 ± 18.2	5	35	39	2.5

Table 4. Algal characertistics (mean ± standard deviation), density of stony coral recruits and *Diadema antillarum* by site in the Abrolhos, Brazil.

Site name/ site code	Quadrats #	Relative abundance (%)			Macroalgal		Recruits (#/.0625 m^2)	*Diadema* (#/100 m^2)
		Macroalgae	Turf algae	Crustose coralline algae	Height (cm)	Index[1]		
Santa Bárbara Island								
South 1/SAB1	50	13.0 ± 17.9	76.5 ± 17.7	10.5 ± 11.1	2.5 ± 0.9	36	0.48	0
South 2/SAB2	62	13.5 ± 18.0	78.0 ± 21.0	8.2 ± 7.5	3.5 ± 0	49	0.65	0
South 3/SAB3	50	17.5 ± 15.6	72.5 ± 15.0	10.0 ± 8.2	4.0 ± 0	69	0.82	0
Leeward 1/SAB4	90	13.5 ± 17.7	78.5 ± 21.5	8.0 ± 14.5	2.5 ± 0	34	0.62	0
Leeward 12/SAB5	60	36.0 ± 31.6	56.0 ± 30.2	8.0 ± 9.3	2.5 ± 0	94	0.95	0
North 3/SAB6	50	<0.5 ± 0.7	93.5 ± 8.3	6.5 ± 8.4	2.0 ± 0	<1	0.88	0
North 2/SAB7	50	7.0 ± 12.8	82.5 ± 20.4	10.5 ± 17.1	2.5 ± 0	16	1.84	0
North 1/SAB8	50	58.0 ± 28.9	37.0 ± 27.4	5.5 ± 7.9	2.5 ± 14.0	133	0.4	0
Parcel dos Abrolhos								
Chapeirões 2/PAB2	50	7.0 ± 21.5	70.0 ± 29.6	22.5 ± 23.9	1.0 ± 0.8	7	2.9	0
Chapeirões 3/PAB3	50	4.5 ± 11.2	59.5 ± 26.3	36.0 ± 23.8	1.0 ± 0.5	6	2	0
Chapeirões 4/PAB4	50	3.0 ± 6.8	77.5 ± 21.7	19.5 ± 19.7	1.5 ± 0.4	5	2.1	0
Chapeirões 5/PAB5	50	4.5 ± 11.7	65.5 ± 32.5	30.0 ± 30.0	2.0 ± 0.9	9	2.2	0
Chapeirões 6/PAB6	50	<0.5 ± 0.5	75.0 ± 26.8	25.0 ± 26.5	1.0 ± 0	<1	2.7	0

[1]Macroalgal index = % relative abundance of macroalgae x macroalgal height