SUBTIDAL BENTHIC MARINE ALGAE OF THE TODOS OS SANTOS BAY, BAHIA STATE, BRAZIL

Bianca Veras Marins[1,2], Poliana Silva Brasileiro[1,2], Maria Beatriz de Barros Barreto[3], José Marcos de Castro Nunes[4], Yocie Yoneshigue-Valentin[5] & Gilberto Menezes Amado Filho[1]*

[1] Programa Zona Costeira, Instituto de Pesquisas Jardim Botânico do Rio de Janeiro. Rua Pacheco Leão, 915. CEP: 22460-030. Rio de Janeiro, RJ, Brasil.

[2] Programa de Pós Graduação em Botânica, Museu Nacional, UFRJ. Quinta da Boa Vista, São Cristóvão. CEP: 20940-040. Rio de Janeiro, RJ, Brasil.

[3] Depto de Botânica, Inst. de Biologia, Universidade Federal Rural do Rio de Janeiro (UFRRJ). Antiga Rodovia Rio-São Paulo, km 47. CEP: 23890-000. Seropédica, RJ, Brasil.

[4] Laboratório de Algas Marinhas, Depto de Botânica, Inst. de Biologia, Universidade Federal da Bahia (UFBA). CEP: 40170-210, Salvador, BA, Brasil.

[5] Depto de Botânica, Inst de Biologia, Centro de Ciências da Saúde, Universidade Federal do Rio de Janeiro (UFRJ). Ilha do Fundão. Av. Brigadeiro Trompowsky, s.n. CEP: 21941-900. Rio de Janeiro, RJ, Brasil.

*E-mail: gfilho@jbrj.gov.br

ABSTRACT

The Todos os Santos bay is a Brazilian coastal marine area that was appointed as top priority for biological conservation. However, there are still too few studies about the local composition of marine communities. The aim of the present investigation was to survey the diversity of marine algae in the sub-tidal zone around the reefs of the Todos os Santos bay. Samples from seven different sites in the bay were obtained by scuba diving through qualitative and quantitative methods, being the collections repeated in rainy and dry seasons. One-hundred and forty-two taxa were found: 31 Chorophyta, 27 Ochrophyta, 83 Rhodophyta, and one Macrophyte. Higher diversity and evenness indices were found during the dry season. *Sargassum* spp., *Dictyopteris delicatula*, and *Halimeda opuntia* were the most abundant macroalgae in the bay. Greatest number of species and most abundant samples were obtained in the oceanic region of the bay, while fewer species and less abundant samples were obtained in areas that are more exposed to the effects of human disturbance. The composition of the flora and abundance of macroalgae in each area of Todos os Santos bay seem to be determined by the quality of local seawater (i.e. degree of eutrophication).

Keywords: Macroalgae, tropical bay, reef formation, eutrophication.

RESUMO

ALGAS MARINHAS BENTÔNICAS DO INFRALITORAL DA BAÍA DE TODOS OS SANTOS (BAHIA, BRASIL). Apesar da Baía de Todos os Santos (BTS) ser considerada uma área de extrema importância biológica para a conservação da zona costeira brasileira, poucos estudos sobre as comunidades marinhas de seus ecossistemas foram realizados até o momento. Neste sentido, o objetivo deste trabalho é o de caracterizar a diversidade de algas marinhas do sub-litoral das formações recifais da BTS. Dois tipos de amostragem foram realizados: uma qualitativa e outra quali-quantitativa em sete locais de coleta. Foram identificados 142 táxons, sendo 31 Chlorophyta, 27 Ochrophyta e 83 Rhodophyta, e uma fanerógama marinha. Foi observada uma tendência a maiores valores de diversidade e equitabilidade na época seca. *Sargassum* spp., *Dictyopteris delicatula* e *Halimeda opuntia* foram os táxons que mais contribuíram para a abundância de macroalgas na BTS. O maior número de táxons e os maiores valores de biomassa foram encontrados em local voltado para o mar aberto, enquanto que, os menores valores foram encontrados em locais com algum tipo de distúrbio antrópico. A distribuição da flora e da abundância de macroalgas da BTS é determinada pela condição de eutrofização de cada um dos locais estudados.

Palavras-chave: Macroalga, baía tropical, formação recifal, eutroficação.

INTRODUCTION

In order to successfully implement environmental management and conservation programs in marine ecosystems, it is first necessary to determine the structure and dynamics of the communities and populations of these ecosystems. Nonetheless, the degradation rate of natural systems is still usually faster than the counteracting effects of conservation programs. Partially closed marine systems, such as bays surrounded by cities, figure among the most sensitive coastal environments on the planet.

Todos os Santos Bay (13°S, 38°W) is one of the largest Brazilian bays, with an area of about 1,000 km^2 (Silva *et al*. 1996), located in one of the most important urban centres of Northeastern Brazil. This bay is directly affected the large metropolis of Salvador (2.8 million inhabitants), with its industrial wastes of chemical plants and an oil refinery, and by the activities of a harbour located over its North and Northeast area.

The Todos os Santos Bay – we will refer to it as TSB henceforth – is also important to the local tourism, and shell-fishing is widely spread in its waters. There are many different habitats, such as estuaries, inner bays, mangroves, coral reefs, and rocky coasts within this bay (Silva *et al*. 1996).

The coral reefs and rocky shores of tropical regions are considered the most diverse marine environments on the planet (Munõz & Pereira 1998, Villaça 2002). Brazil is the only country of the South Atlantic Ocean with coral reefs (Castro 1999). The Brazilian reefs of Bahia State are considered the most diverse of the country, and house many endemic species of corals and others organisms (Leão 1996, Castro 1999, Villaça 2002). In Bahia alone Leão (1996) observed as many as five different kinds of coral reefs distributed in five sectors along the coast.

In 2002, the TSB was appointed by the Brazilian Environmental Ministry as an area of oustanding biological importance and of top priority for conservation, chiefly because of its coral reefs (Ministério do Meio Ambiente 2002). The great importance of coral reefs is as much due to their biological diversity as to their elevated biological productivity. The rapid population growth and industrial development around the TSB are negatively affecting the quality of its waters in many ways (Tavares *et al*. 1977, Souza *et al*. 1978, Wallner-Kersanach 1994, Silva *et al*. 1996, Amado-Filho *et al*. 2001, Macedo *et al.* 2001). Along some coastal areas of the TSB the unrestrained urban growth becomes evident, especially in the city perifieries, what is potentially dangerous to coral reefs, according with Leão (1996).

Apart from some studies about the marine algae of some areas of the TSB (Joly *et al*. 1965a,b, Araújo 1984, Santos 1992, Guimarães & Oliveira 1996, Moura *et al* 1999, Nunes 1999, Nunes & Paula 2002, Barros-Barreto *et al*. 2004, Alves & Moura 2005, Nunes, 2005a,b), no comprehensive investigation was done on the benthic flora of the TSB. Thus, the aim of the present study was to contribute to the body of knowledge about the marine biota of sub-tidal reefs of TSB and to analyse the degree of similarity among its different areas and during the different seasons.

MATERIAL AND METHODS

STUDY AREA

The TSB is located at the North part of the coast of Bahia state, as shown in Figure 1. There is an ample diversity of habitats in TSB, reflecting in a great diversity of organisms (Silva *et al*.1996). The local coral reefs were described by Leão (1996) as shallow fringe reefs, more or less continuous, occurring in depths ranging from about water level to up to no more than 10m deep, in the fore reef zone.

The sediment texture of the sea floor of the TSB varies from clay to very thick sand. The climate in this region is tropical humid, and presents two distinct periods: a dry one and a rainy one. The rainy period takes place in April/June, with the precipitation reaching about 930mm, which is almost 45% of the mean total annual rain precipitation of 2,100mm/year. The average value between the highest and lowest temperatures of the year is always higher than 18^{o}C within the TSB region. The lowest temperatures (23.6^{o}C) are usually recorded in July, while the highest temperatures come in March (26.7^{o}C) (Macedo *et al.* 2001).

Water circulation within TSB bay is chiefly driven by tides, which are semi-diurnal with a maximum range of 2.7m (Lessa *et al*. 2001). In its main part, salinity in the bay ranges 33.0-36.7ppm, and the temperature of the water varies 24–30^{o}C – a typical variation of open shallow marine areas (Wolgemuth *et al.* 1981). The tidal currents are generally weak, being strongest closer to the mid-tide. Yet, around the entrance of the bay and about Frades Island, a kind of channel is formed between the island and the land, and the currents of these areas can reach 80cm/s (Lessa *et al*. 2001).

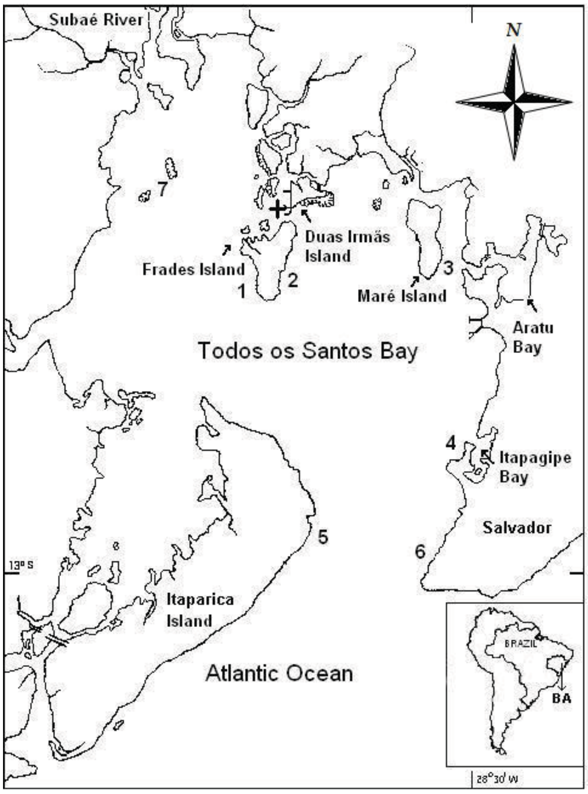

Figure 1. Map of Todos os Santor bay and sampling sites. – (1) Tapera, (2) Paramana, (3) Botelho, (4) Humaitá, (5) Penha, (6) Farol da Barra, (7) Saubara. Detail on the lower right: Location of Bahia State in Brazil.

SAMPLING

A total of seven sites for sampling in the TSB were selected (indicated by numbers in Figure 1) with the objective of representing the overall local phytobenthic diversity. Two of them, namely Tapera (12º48'20''S and 38º38'49''W) and Paramana (12º47'38''S and 38º37'26''W), are located at Frades Island, which is an ecological reserve located at the centre of TSB. Another site, Botelho, is located to the east of Maré Island (12º47'26''S, 38º30'47"W) and in front of Cotagipe channel, which connects the TSB with Aratu Bay; it is worth noting that it is located near to the Aratu Industrial Complex. Humaitá (12º55'08"S, 38º30'30"W) is near to Itapagipe Bay and to the periphery of Salvador, being in one of the most impacted areas in TSB (Wallner-Hersanach, 1994). Another sampling site, Penha (13º59'13"S, 38º36'36"W), located to the east of Itaparica Island, and is of difficult access for it faces open ocean and thus presents stronger waves. Farol da Barra (13º00'30"S, 38º32'01"W) is close to one of the most important touristic sites of Salvador. Finally, Saubara (12º44'29"S, 38º43'06"W) is over a reef located near to the Subaé river, to the northwestern side of TSB.

Sample collection was carried out by scuba-diving, with two different kinds of approach: qualitative and quantitative. Quantitative sampling was done in May and December of 2000, with the objective of including, respectively, a rainy and a dry season. Qualitative sampling was done in the same periods and also in September 2000 (a rainy period) and April 2001 (a dry period) (consult INMET web page). The sampling was done through 'destructive' methods. For quali-quantitative sampling, seven square sections of 20 x 20cm² were randomly distributed along a 20m-long horizontal imaginary line about 1–3m deep. For qualitative sampling, a 100m-long sampling line was traced and algae were therein collected at random. Sampling was always done by the same divers, and they tried to obtain as diverse species as possible. Crustose calcareous algae were not sampled.

After collection, all sampled materials were kept inside plastic bags and fixed with formalin 4%. In the laboratory, qualitatively-sampled materials were separated for later determination of habit, phenology and species, while the quantitatively-sampled materials were identified in species and counted. Species identification was done with the aid of an optical microscope, a steromicroscope, and general and using specialized bibliography (e.g. Joly *et al.* 1969b, Nunes 1998a, 1999, Nunes *et al.* 1999, Nunes & Paula 2000, 2002**.** Nomenclature used followed Wynne (2005).

Algae population of each square section was quantified based on dry weight: after identification, every population from each section was sorted under a stereomicroscope and dried at 60ºC for 48h. The populations were then weighed with an analytical scale. Samples weighting less than 0.001g were assumed to weight 0.0001g. Means are always presented with standard error (S.E.).

DATA ANALYSES

Data from qualitative collections was used to compare the different sites and seasons in terms of number of species and morphological clusters present. Data from quantitative collections was used to evaluate differences between seasons and sampled sites in terms of biomass. In latter analises, means were compared through Cochran's variance analisys by two-way ANOVA, using the STATISTICA software v. 5.0. The following indices were determined and compared for each area and season: Shannon-Wiener Diversity index (H'), Pielou Evenness index (J') (see Brower & Zar, 1997), and percentage importance (Pi%) of each species. The latter is a measure of how much of the biomass value found for each site that species represents. Moreover, a dendrogram was built based on an UPGMA cluster analysis of Bray-Curtis (1957) coefficients, and also a SIMPER (Similarity Percentage Report) analisys based on the Bray-Curtis similarity index with PRIMER software v. 5.0. The SIMPER analyses yielded a list of the species which contributed the most for the clusters detected in the dendogram, in order of importance, until they reach, together, 90% of similarity and dissimilarity between the clusters.

RESULTS

QUALITATIVE DATA

A total of 142 taxa were identified: 31 Chorophyta, 27 Ochrophyta, 83 Rhodophyta, and one seagrass *H. decipiens* Ostenfeld (Table I), totalling 19 orders, 37 families, 75 genera, 132 species, and 11 varieties and forms.

Amongst the Chlorophyta, the order Bryopsidales was the most representative one with 21 taxa, while the order Dictyotales was the most representative of the Ochrophyta. Among Rhodophyta, the order Ceramiales presented the greatest number of taxa (37). *Ceramium* Roth (12), *Caulerpa* J. V. Lamour (10) and *Dictyota* J. V. Lamour (7) were the most representative genera.

The greatest number of taxa (92) was found in Penha, followed by Paramana (60). The lowest numbers of taxa were found in Farol da Barra and Humaitá – 23 and 24, respectively (Figure 2).

The number of species tended to increase during the dry season (Figure 2) in some of the sampled sites.

The greatest difference in number of species between seasons was found between Penha and Humaitá. Tapera and Botelho presented more species during the rainy seasons, while no signifficant difference in number of species found between seasons was perceived in Paramana, Saubara and Farol da Barra (Figure 2), although the species composition of these areas was quite different (Table I).

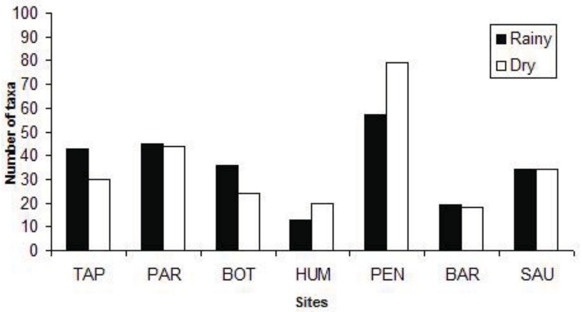

Figure 2. Number of taxa found in each sampled area during the rainy and dry seasons; TAP-Tapera, PAR- Paramana, BOT- Botelho, HUM- Humaitá, PEN- Penha, BAR- Farol da Barra, SAU-Saubara.

Penha presented the highest amount of exclusive taxa (14) while Humaitá had only one exclusive taxon (Table I).The only species that were found in all the sampled sites were *D. delicatula* and *H. spinella*.

Most species found in the TSB are widely spread over the Brazilian coast: 44% occur in the Northeastern, Southeastern and South regions and 39% can be found in the Southeastern and South regions of Brazil. Among these, it should be stressed that *B. pusilla*, *B. pennata*, *B. plumosa*, *C. vagabunda*, *U. fasciata*, *D. delicatula*, *D. cervicornis* f. *cervicornis*, *P. gymnospora*, *C. clavulatum*, *G. crinale*, *J. adhaerens* and *P. subtillissima* occur in practically all the coast of Brazil from Maranhão to Rio Grande do Sul. Only 9% of the species found are restricted to the Northeastern region of Brazil.

Thirty-four percent of the 142 identified taxa were observed to be fertile during the study periods (Table I). Sporophytic taxa figured 75% of the fertile taxa. No fertile chlorophytes were found. Male plants were less frequent (found in 8 taxa) than females (found in 19 taxa). Tapera and Penha presented the highest percentage of fertile taxa (both 30%), although Penha had twice the number of taxa found in Tapera. Botelho had the lowest number of fertile taxa (5%). An increase in the number of fertile taxa was observed during the rainy seasons in Tapera, Paramana and Farol da Barra. The number of fertile taxa did not vary in Saubara between the different seasons. In Botelho, two fertile taxa were observed, only in the dry season.

Regarding the epiphyte-host relationship, *D. delicatula* was an epiphyte of most taxa (30),

Table I. List of the taxa found in the 7 sampled sites of the TSB during rainy (R) and dry (D) seasons, with phenology: (+) Present; (-) Absent; (F) Female; (M) Male; (T) Tetrasporic; (H) Hermaphrodite; (P) Plurilocular.

TAXA	SITES													
	TAPERA		PARAMANA		BOTELHO		HUMAITÁ		PENHA		F. BARRA		SAUBARA	
	R	D	R	D	R	D	R	D	R	D	R	D	R	D
Chlorophyta (31)														
Anadyomene stellata	-	+	-	-	-	-	-	-	+	+	-	-	-	-
Boodleopsis pusilla	+	-	-	-	-	-	-	-	+	+	-	-	-	-
Bryopsis pennata	-	+	+	+	+	-	-	+	-	-	+	+	-	-
Bryopsis plumosa	-	+	-	-	+	-	+	+	-	-	-	-	-	-
Caulerpa brachypus	-	-	+	+	-	+	-	-	-	-	-	-	-	+
Caulerpa cupressoides	-	-	+	+	-	-	-	-	-	+	-	-	-	-
Caulerpa kempfii	-	-	-	-	-	-	-	-	+	+	-	-	-	-
Caulerpa mexicana	+	-	+	+	-	-	-	-	+	+	-	-	+	+
Caulerpa racemosa	-	-	-	-	-	-	-	-	+	+	-	-	+	-
Caulerpa racemosa var. *peltata*	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Caulerpa racemosa var. *occidentalis*	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Caulerpa serrulata	-	-	-	-	-	-	-	-	-	-	+	+	-	-
Caulerpa verticillata	-	-	-	-	-	-	-	-	-	+	-	-	+	-
Caulerpa webbiana	-	-	-	-	-	-	-	-	+	+	-	-	-	-
Caulerpella ambigua	-	-	+	-	-	-	-	-	+	+	+	+	+	+
Cladophora vagabunda	+	-	+	-	-	-	-	-	-	-	-	-	-	-
Cladophora sp	-	-	-	-	+	+	+	+	-	-	-	+	+	-
Codium intertextum	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Derbesia sp	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Dictyosphaeria versluysii	+	-	+	+	-	-	-	-	+	-	-	-	-	-
Entocladia viridis	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Halimeda discoidea	-	-	-	-	-	-	-	-	+	+	-	-	-	-
Halimeda opuntia	+	+	+	+	-	+	-	-	+	+	-	+	-	-
Penicillus capitatus	-	-	-	-	-	-	-	-	+	+	-	-	-	-
Phyllodictyon sp	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Udotea cyathiformis var. *cyathiformis* f. *sublittoralis*	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Udotea flabellum	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Ulva fasciata	-	-	-	-	-	-	-	-	-	-	-	-	+	-
Ulva flexuosa	-	-	-	-	+	-	-	+	-	-	-	-	-	-
Ulva lactuca	-	-	-	-	-	-	+	+	+	-	-	-	-	-
Ventricaria ventricosa	+	+	-	-	-	-	-	-	+	+	-	-	-	-
SUB-TOTAL	**7**	**5**	**8**	**6**	**5**	**4**	**3**	**5**	**13**	**16**	**3**	**5**	**6**	**5**
Phaeophyta (27)														
Dictyopteris delicatula	T	+	+	+	+	+	+	+	T	T	T	+	T	+
Dictyopteris jamaicensis	-	-	-	-	-	-	-	-	-	-	-	-	T	T
Dictyopteris justii	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Dictyopteris plagiogramma	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Dictyota bartayresiana	-	-	-	+	-	-	-	+	+	T	-	-	-	-
Dictyota cervicornis f. *cervicornis*	T	+	+	+	+	+	-	+	-	+	-	-	+	+
Dictyota cervicornis f. *pseudohamata*	T, F	+	+	+	-	+	-	-	-	+	-	-	+	+
Dictyota ciliolata	T	-	T	-	-	-	-	-	-	+	-	-	-	+
Dictyota crenulata	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Dictyota pulchella	-	-	+	-	-	+	-	-	-	+	-	-	-	+
Dictyota mertensii	T	+	-	-	+	+	-	M	+	+	-	-	-	-
Feldmania irregularis	-	-	P	-	-	-	-	-	-	-	-	-	-	-
Hincksia mitchelliae	+	+	P	+	+	+	-	-	-	-	-	-	-	-
Lobophora variegata	+	+	-	-	+	+	-	-	+	+	-	-	+	+
Padina antillarum	-	-	-	-	+	-	-	-	-	-	-	-	+	T
Padina boergesenii	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Padina gymnospora	-	-	-	+	+	T	-	-	-	-	-	-	T	T
Padina sanctae-crucis	-	+	-	-	-	-	-	-	-	T	-	-	-	-
Rosenvingea sanctae-crucis	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Sargassum cymosum	-	-	-	-	-	-	-	-	-	-	-	-	F, M	F, M
Sargassum filipendula var. *filipendula*	+	+	F, M	+	+	-	-	-	-	-	-	-	-	-
Sargassum filipendula var. *montagnei*	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Sargassum furcatum	-	+	+	+	+	-	-	-	-	-	-	-	-	-
Sargassum vulgare var. *vulgare*	+	H	H	+	+	+	-	-	-	H	-	-	-	-
Spatoglossum schroederi	-	+	-	-	+	+	-	+	+	-	+	T	-	-
Sphacelaria tribuloides	-	+	+	+	-	-	-	-	-	-	-	-	-	-
Stypopodium zonale	-	-	-	-	-	+	-	-	-	-	-	-	-	-
SUB-TOTAL	**10**	**12**	**11**	**11**	**11**	**12**	**1**	**5**	**5**	**13**	**2**	**2**	**8**	**10**

Table I (cont.)

TAXA	SITES													
	TAPERA		PARAMANA		BOTELHO		HUMAITÁ		PENHA		F. BARRA		SAUBARA	
	R	D	R	D	R	D	R	D	R	D	R	D	R	D
Rhodophyta (83)														
Acanthophora spicifera	-	-	-	-	+	-	-	+	-	-	-	-	+	+
Acrochaetium densum	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Acrochaetium microscopicum	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Acrothamnion butleriae	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Aglaothamnion felliponei	+	-	+	+	+	-	-	-	-	+	-	-	-	-
Amansia multifida	-	-	-	-	-	-	-	-	+	T	+	+	-	-
Amphiroa anastomosans	+	+	+	+	-	-	-	-	-	+	+	-	-	-
Amphiroa beauvoisii	+	+	T	+	-	-	-	-	T	+	-	-	-	-
Amphiroa fragilissima	T	T	T	+	-	-	+	-	T	+	-	-	+	+
Amphiroa rigida	-	-	T	+	-	-	-	-	+	-	+	+	-	-
Anotrichium tenue	+	-	+	-	+	-	+	-	+	+	-	-	-	-
Asparagopsis taxiformis	-	-	-	+	+	-	-	-	+	+	-	-	-	-
Botryocladia occidentalis	-	-	-	-	-	-	-	-	+	F	-	-	-	-
Bryothamnion seaforthii	-	-	-	-	-	-	-	-	+	F	-	-	-	-
Bryothamnion triquetrum	-	-	-	-	-	-	-	-	T	-	-	-	-	-
Callithamnion corymbosum	-	-	+	+	+	-	-	-	+	-	-	-	-	-
Centroceras clavulatum	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Ceramium brevizonatum var. *caraibicum*	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Ceramium cf. *camouii*	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Ceramium cimbricum f. *flaccida*	-	-	-	-	-	+	-	-	-	T	-	-	-	T, M
Ceramium clarionense	-	-	-	+	-	-	-	-	+	+	-	-	-	-
Ceramium cf. *codii*	-	-	-	-	-	-	-	+	-	+	-	-	-	+
Ceramium comptum	-	-	-	+	-	-	+	-	+	+	-	+	-	-
Ceramium dawsonii	-	-	-	+	-	-	+	-	-	-	M, T	-	-	-
Ceramium deslongchampsii	+	-	-	-	-	-	-	-	+	-	-	-	-	-
Ceramium flaccidum	T, M	+	F	+	-	+	+	+	T	T	-	-	-	-
Ceramium luetzelburgii	-	-	+	-	-	-	-	-	+	+	-	-	-	-
Ceramium cf. *serpens*	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Ceramium vagans	-	-	+	+	-	-	-	-	+	-	-	-	-	-
Champia parvula	+	+	-	-	-	-	-	-	-	+	-	-	-	-
Champia veiillardii	-	-	+	+	-	-	-	-	T	T	-	-	-	-
Chondracanthus acicularis	-	-	-	-	-	-	-	-	-	-	F	-	-	-
Chondrophycus translucidus	+	-	+	-	-	-	-	-	-	-	-	-	-	-
Corallina oficinalis	+	-	+	-	-	-	-	-	+	+	-	-	-	-
Crouania attenuata	-	-	-	-	-	-	-	-	-	+	-	-	-	+
Cryptonemia crenulata	-	-	-	-	+	-	-	-	-	T	-	-	-	+
Dasya sp	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Dichotomaria marginata	-	-	-	-	+	-	-	-	+	+	-	-	-	-
Dichotomaria obtusata	-	-	-	-	+	-	-	-	-	-	-	-	+	+
Dipterosiphonia dendritica	-	-	-	-	+	-	-	-	+	+	-	-	-	-
Dohrniella antillarum var. *brasiliensis*	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Erythrotrichia carnea	+	-	-	-	+	-	-	-	-	+	+	-	-	-
Galaxaura rugosa	-	+	+	-	-	-	-	-	+	-	-	-	-	-
Gelidiella acerosa	+	-	T	-	-	-	-	-	T	+	-	-	T	+
Gelidiella ligulata	-	-	-	-	-	-	-	-	+	-	+	+	-	-
Gelidiopsis planicaulis	T	-	+	-	-	-	-	-	+	T	-	-	+	+
Gelidiopsis variabilis	+	-	-	-	+	+	-	-	-	+	+	+	-	-
Gelidium crinale	-	+	-	+	-	-	-	-	+	+	+	+	-	-
Gelidium floridanum	-	-	-	-	-	-	-	-	-	F	-	-	-	-
Gelidium sp	+	+	-	-	+	-	+	+	+	+	F	+	+	-
Gracilaria cervicornis	-	-	T, F, M	+	+	-	-	-	-	T	-	-	F	F
Gracilaria cornea	-	-	-	-	-	-	-	-	F	-	-	-	+	-
Gracilaria curtissiae	-	-	-	-	-	-	-	-	F	-	-	-	-	-
Gracilaria sp	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Gracilaria sp2	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Gracilaria sp3	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Gracilaria sp4	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Haliptilon cubense	-	-	-	-	-	-	-	-	T	+	-	-	+	-
Haliptilon subulatum	-	-	-	-	-	-	-	-	+	+	-	-	+	-
Heterosiphonia crispella	-	-	-	+	+	-	-	-	-	-	-	-	-	+
Herposiphonia secunda	+	-	-	-	-	-	-	-	+	F	-	-	-	-

Table I (cont.)

TAXA	SITES													
	TAPERA		PARAMANA		BOTELHO		HUMAITÁ		PENHA		F. BARRA		SAUBARA	
	R	D	R	D	R	D	R	D	R	D	R	D	R	D
Herposiphonia tenella	+	-	+	+	+	+	-	-	+	+	+	+	-	-
Hypnea musciformis	+	+	-	-	+	-	+	T	T	T	-	-	+	+
Hypnea spinella	+	T	T	-	+	T	T	T	+	T	-	+	+	-
Jania adhaerens	+	+	+	+	-	-	-	-	+	+	+	+	+	+
Laurencia filiformes	-	+	T	+	+	+	-	T	-	-	-	-	+	-
Meristotheca gelidium	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Neosiphonia ferulacea	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Neosiphonia tongatensis	T, F	-	-	F	-	-	-	-	-	-	-	-	-	-
Ochtodes secundiramea	-	-	-	-	-	-	-	-	T, M	T	T, F	T	-	-
Petroglossum undulatum	-	-	-	-	-	-	-	-	+	+	-	-	+	T, F
Polysiphonia denudata	F	-	-	+	+	+	-	+	-	-	-	-	-	-
Polysiphonia scopulorum	+	-	-	-	-	-	-	-	-	+	-	-	-	-
Polysiphonia subtilissima	T, F	-	-	-	-	-	-	-	-	-	-	-	-	-
Pterocladiela caerulescens	+	+	-	-	-	-	+	+	+	-	-	-	-	-
Shalingia subintegra	-	-	+	+	-	-	-	-	-	+	+	-	-	-
Solieria filiformes	-	-	+	F, T	-	-	-	-	-	+	-	-	-	-
Spyridia filamentosa	-	-	-	-	-	-	-	-	-	+	-	-	+	-
Stylonema alsidii	+	-	-	+	+	-	-	-	-	-	-	-	-	-
Tricleocarpa cylindrica	-	-	-	+	-	-	-	-	+	+	-	-	-	-
Trichogloea requienii	-	-	-	-	-	-	-	-	-	T	-	-	-	-
Wrangelia argus	-	-	-	+	-	-	-	-	-	T	-	-	-	-
Wurdemania miniata	-	-	-	-	-	-	-	-	-	-	-	-	+	-
SUB-TOTAL	**26**	**13**	**26**	**27**	**20**	**8**	**9**	**10**	**39**	**50**	**14**	**11**	**20**	**19**
Marine Monocotyledone (1)														
Halophila decipiens	-	-	-	-	-	-	-	-	-	-	-	-	-	+
SUB-TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
TOTAL = 142	**43**	**30**	**45**	**44**	**36**	**24**	**13**	**20**	**57**	**79**	**19**	**18**	**34**	**35**

followed by *A. fragilissima* and *H. spinella* which were epiphyte of 24 and 22 taxa, respectively. The species with more epiphyte taxa were *S. vulgare* var. *vulgare*, *G. cervicornis*, *H. opuntia*, *D. cervicornis* var. *pseudohamata*, and *G. crinale* (14, 13, 11, 11, and 10, respectively).

QUANTITATIVE DATA

The mean dry biomass found for all square sections of the TSB was 273±48 g.m^{-2}. Penha presented the highest mean biomass: 367±46 g.m^{-2}. An increase in biomass was observed during the rainy seasons in all sites except Penha (compare Table II, Table III, and Figure 3).

Regarding the Pi% of each species, those of the Ochrophyta group (mainly *Sargassum* spp., *D. delicatula* and *L. variegata*) were the most abundant species in Tapera, Botelho, Saubara, and Farol da Barra. In Paramana the chlorophyte *H. opuntia* was the most abundant species, while in Humaitá the Rhodophyta *H. spinella* was the most abundant. In Penha, *B. seaforthii* (Rhodophyta) was the most abundant during the rainy season, while in the dry season the Ochrophyta was most abundant (Table IV).

The mean Diversity index (H') and Eveness index (J') of the TSB were 1.36 and 0.39, respectively. A tendency to increased values of H' and J' was observed in Paramana and Penha and also in samples from the dry seasons (Table V).

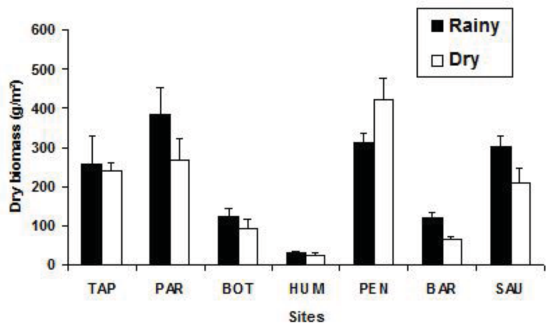

Figure 3. Mean biomass recorded for each sampled site during rainy and dry seasons. Vertical lines stand for standard error; TAP-Tapera, PAR-Paramana, BOT- Botelho, HUM- Humaitá, PEN- Penha, BAR- Farol da Barra, SAU-Saubara.

Table II. Bi-factorial ANOVA results of biomass. Independent factors considered were sampled site and season.

Source	*df*	*MS*	*F*	*P*
Sites	6	357.93	22.59	<0.0001
Seasons	1	2.66	0.17	0.68
Sites x Seasons	6	29.60	1.87	0.10
Error	84	9903.26		

Table III. Tukey test results of the comparison between the biomass values found in each sampled site (significant *p* values in bold);. TAP-Tapera, PAR-Paramana, BOT- Botelho, HUM- Humaitá, PEN- Penha, BAR- Farol da Barra, SAU- Saubara.

TAP	PAR	BOT	HUM	PEN	BAR	SAU
TAP	0.345	**0.007**	**0.000**	**0.036**	**0.003**	0.978
	PAR	**0.000**	**0.000**	0.931	**0.000**	0.063
		BOT	0.337	**0.000**	0.999	0.067
			HUM	**0.000**	0.562	**0.000**
				PEN	**0.000**	**0.004**
					BAR	**0.027**
						SAU

Table IV. Mean biomass (g.m $^{-2}$) and percentual of importance (Pi%) of taxa which represented more than 1% of the total mean biomass found in each sampling site and season; (S.E.) Standard Error

Taxon/ Season	g.m $^{-2}$	S.E.	Pi(%)	Taxon/ Season	g.m $^{-2}$	S.E.	Pi(%)
Tapera							
RAINY				DRY			
L. variegata	142.3	62.8	55.5	*L. variegata*	79.6	39.5	33.7
S. vulgare	55.6	18.1	21.7	*S. filipendula*	63.4	29.4	26.9
D. delicatula	25.8	2.8	10.0	*S. vulgare*	58.6	21.2	24.8
S. filipendula	21.6	18.3	8.4	*D. cervicornis*	8.0	2.8	3.4
V. ventricosa	3.5	3.5	1.4	*H. opuntia*	6.9	4.4	2.9
				G. crinale	6.8	4.4	2.9
				D. delicatula	4.9	1.5	2.0
				S. furcatum	4.3	4.3	1.8
				S. schroederi	2.4	1.4	1.0
Paramana							
RAINY				DRY			
H. opuntia	182.3	91.8	47.8	*H. opuntia*	99.7	40.3	36.9
S. vulgare	90.9	48.9	23.8	*C. officinalis*	64.5	19.8	23.9
S. filipendula	54.1	27.9	14.2	*S. furcatum*	31.4	11.1	11.6
C. mexicana	13.9	5.9	3.6	*A. fragilisima*	24.8	7.1	9.2
C. brachypus	13.7	5.8	3.6	*S. vulgare*	16.6	16.6	6.2
A. rigida	7.7	3.5	2.0	*S. filipendula*	11.4	11.4	4.2
A. fragilissima	5.7	2.4	1.5	*A. anastomosans*	8.4	2.9	3.1
D. delicatula	5.2	1.3	1.4	*D. cervicornis*	6.4	1.5	2.4
				J. adhaerens	5.3	5.3	1.9
Botelho							
RAINY				DRY			
S. vulgare	59.9	21.9	48.8	*S. vulgare*	49.9	21.7	53.7
S. schroederi	50.8	14.0	41.4	*S. filipendula*	15.8	15.8	16.9
P. tetrastomatica	5.8	5.8	4.7	*D. cervicornis*	13.3	8.1	14.3
S. furcatum	2.4	2.4	1.9	*P. gymnospora*	7.7	5.9	8.2
				S. zonale	1.7	1.7	1.8
				G. variabilis	1.7	1.7	1.8
				D. delicatula	1.4	0.7	1.5
Humaitá							
RAINY				DRY			
H. spinella	19.5	3.0	61.7	*H. spinella*	9.4	4.5	36.9
B. plumosa	11.5	2.5	36.5	*S. schroederi*	5.2	4.6	20.6
P. caerulescens	0.5	0.3	1.6	*B. plumosa*	3.2	2.1	12.5
				D. cervicornis	2.4	0.5	9.5
				D. bartayresiana	2.2	2.2	8.5
				P. caerulescens	1.7	1.1	6.6
				U. lactuca	0.8	0.4	2.9
				D. mertensii	0.6	0.6	2.2

Table IV (cont.)

Taxon/ Season	g.m $^{-2}$	S.E	Pi(%)	Taxon/ Season	g.m $^{-2}$	S.E.	Pi(%)
Penha							
RAINY				DRY			
B. seaforthii	202.1	16.9	64.6	*D. delicatula*	122.6	32.1	29.1
D. delicatula	59.3	9.8	18.9	*B. seaforthii*	64.3	30.9	15.3
L. variegata	38.6	16.5	12.3	*D. justii*	53.1	27.3	12.6
A. multifida	5.0	4.9	1.5	*D. mertensii*	41.9	24.2	9.9
				L. variegata	26.1	15.2	6.2
				D. marginata	24.5	17.9	5.8
				C. kempfii	14.8	5.3	3.5
				H. opuntia	14.7	13.3	3.5
				H. discoidea	12.8	5.7	3.0
				B. occidentalis	10.6	9.8	2.5
				P. undulatum.	9.2	6.0	2.2
				1. S. schroederi	5.6	3.3	1.3
				J. adhaerens	5.5	3.4	1.3
				G. acerosa	5.5	5.1	1.3
				U. cyathiformis	4.4	4.1	1.0
Farol da Barra							
RAINY				DRY			
D. delicatula	80.0	12.5	66.4	*D. delicatula*	53.0	4.6	78.2
G. pusillum	23.3	5.3	19.4	*G. ligulata*	10.5	3.6	15.4
G. ligulata	13.4	8.3	11.1	*G. pusillum*	1.7	1.1	2.5
1. J. adhaerens	1.7	1.7	1.4	*S. schroederi*	1.2	0.9	1.8
				A. multifida	0.9	0.5	1.3
Saubara							
RAINY				DRY			
S. cymosum	153.1	19.1	40.3	*S. cymosum*	129.2	26.9	52.8
G. acerosa	13.8	13.8	3.6	*G. cervicornis*	80.3	28.1	32.8
P. gymnospora	10.5	4.6	2.5	*D. obtusata*	10.5	6.7	4.3
G. cervicornis.	5.0	2.7	1.1	*C. officinalis*	8.5	4.2	3.5
D. delicatula	3.8	1.8	1.0	*A. fragilisima*	5.0	3.9	2.1
				J. adhaerens	3.9	3.1	1.6
				P. gymnospora	3.6	3.4	1.5

The dendrogram built based on the similarity index accused the existence of four distinct clusters of sampled sites (Figure 4). Two clusters consist of a single sampled site each: cluster 1 represented by Saubara (56%) and cluster 2 represented by Humaitá (46%). Clusters 3 and 4 consist of two (Farol da Barra and Penha) and three sampled sites (Tapera, Paramana and Botelho), respectively. The SIMPER (Table VI, A and B) analyses revealed that clusters 1 and 2 differed mainly by the presence and relative abundances of *S. cymosum* (contributed with 90% for the formation of cluster 1) and *H. spinella* (contributed 72% for the formation of cluster 2). Cluster 3 is characterised by *D. delicatula* contributing with 81%, and cluster 4 is characterised by the contribution of *S. vulgare* of 62%.

DISCUSSION

Thirteen of the 143 observed taxa were recently recorded for the first time in the area by other authors: five were found in the coast of Bahia State by Barros-Barreto *et al*. (2004), three were also found for the first time in the northeast region of Brazil by Barros-Barreto *et al*. (2004), and a total of five were found in the Brazilian coast by Villaça & Jensen, (2006), Barros-Barreto (2006), and Barros-Barreto *et al*. (2004).

The orders Bryopsidales, Dictyotales, and Ceramiales were the most abundant during this study. Yoneshigue *et al.* (2006) mentioned these orders as the main groups of macroalgae recorded by the REVIZEE Program for benthic diversity of

Table V. Indices of Diversity (H') and Evenness (J') found for both seasons for every sampled site.

SITE	SEASON					
	RAINY		DRY		MEAN VALUE	
	H'	J'	H'	J'	H'	J'
Tapera	1.50	0.47	1.61	0.45	1.56	0.46
Paramana	1.56	0.51	1.79	0.53	1.68	0.52
Botelho	1.10	0.33	1.41	0.44	1.26	0. 39
Humaita	0.75	0.36	1.69	0.58	1.22	0.47
Penha	1.06	0.36	2.29	0.61	1.68	0.49
F. da Barra	1.00	0.39	0.75	0.31	0.87	0.35
Saubara	0.81	0.31	1.30	0.42	1.06	0.37

the Brazilian continental shelf. Villaça *et al.* (2006) found the same orders to be the dominant groups when studying the flora of the northeastern Brazilian coastal region of Fernando de Noronha, São Pedro and São Paulo island, the Archipelago of Abrolhos and in the Trindade and Martin Vaz complex of islands. The same authors found similar relative proportions of Ochrophyte and Rhodophyte in Atol das Rocas, but registered a higher proportion of Cladophorales order, instead of Bryopsidales, as found in our study.

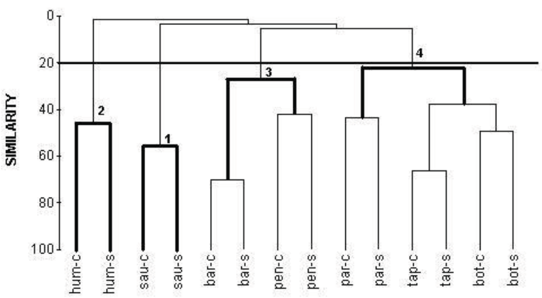

Figure 4. Cluster analysis of the relative dry biomass of each taxon in each sampled site and season, with Bray-Curtis distance. Four clusters are indicated with bold lines, with 30–56% of mean similarity.

The contrasting difference between the great number of taxa found in Penha and Itaparica Island and the low number of taxa found in Farol da Barra and Humaita that could be correlated with the seawater condition of these areas. Seawater in Farol da Barra and Humaita is much eutrophic (Macedo *et al*. 2001), while seawater in Penha is visibly much more clear and clean. We think this illustrates how the environmental conditions drive the distribuition of marine flora in the TSB, accounting for the observed differences in number of species, composition and abundance of macroalgae observed between these sampled sites.

Similarly to what was found in previous studies in the northeastern Brazilian coast, Ochrophyta were the most abundant macroalgae in the TSB (Coutinho *et al.* 1993, Amado Filho *et al*. 1997a, Villaça & Pitombo 1997, Muñoz & Pereira 1998, Figueiredo 2000, Costa Jr. *et al.* 2002, Villaça 2002, Paula *et al.*, 2003, Villaça *et al.* 2006).

Sargassum spp. and *D. delicatula* contributed with about 12% for the similarity between the sampled sites and seasons. Both genera were described by Figueiredo (2000) as the most important brown algae in the area at depths of 5–10 m in the Archipelago of Abrolhos, while Villaça *et al* (2006) reported having observed *Sargassum* spp. and Dictyotales partially covering the base of the coral reefs. *D. delicatula* was found in all sampled sites and seasons and contributed with 80% for the formation of cluster 3. This species is recorded for the Caribbean Region in many different habitats (Hay *et al*.1988, Littler & Littler 2000), being usually found in association with *Sargassum* spp. in tropical waters (Hay *et al*. 1988, Figueiredo 2000).

Although *H. spinella*, *Amphiroa* spp., *D. delicatula* and *D. cervicornis* were observed in the TSB mainly as epiphytes, their abundance and distribution in the sampled sites reflect their importance to the TSB benthic communities. These taxa were also registered as epiphytes in seagrass beds in the archipelago of Abrolhos (Paula *et al.* 2003), and in the coral reefs of the coast of Salvador (Nunes 1997). These results highlight the ecological importance of these taxa for the structure of phytobenthic populations of the Brazilian northeastern region.

It should be highlighted that the genus *Halimeda* was found in great quantities in Paramana and Tapera. This is one of the most commonly found calcified

Table VI. Results from SIMPER analysis. A. Average similarities within the clusters indicated by the cluster analysis (cut off = 90%) and the % of contribution of each species contribution for the clusters formation. B. Average difference between the different clusters and % of each species contribution for the formation of the clusters.

A.

CLUSTERS	**1**	**2**	**3**	**4**
AVERAGE SIMILARITY IN EACH CLUSTER (%)	56.11	45.99	37.04	32.82
SPECIES				
Sargassum vulgare				61.98
Sargassum filipendula				15.52
Halimeda opuntia				7.28
Lobophora variegata				6.66
Dictyopteris delicatula			80.50	
Bryothamnion seaforthii			7.88	
Gelidiella ligulata			5.00	
Sargassum cymosum	89.72			
Amphiroa fragilissima	3.48			
Hypnea spinella		71.82		
Bryopsis plumosa		24.32		

B.

PAIRED ANALYSIS OF THE CLUSTERS	**1x2**	**1x3**	**1x4**	**2x3**	**2x4**	**3x4**
AVERAGE DIFFERENCE BETWEEN THEM (%)	99.80	98.21	95.71	99.20	97.93	94.33
SPECIES						
Amphiroa fragilissima	4.18	2.62	2.51			
Bryopsis plumosa				4.06	3.45	
Bryothamnion seaforthii		11.52		18.53		12.94
Corallina oficinalis	7.15	4.85	5.53		3.75	2.53
Dichotomaria obtusata	3.33	2.26	2.24			
Dictyopteris delicatula		16.50		38.68		18.62
Dictyopteris justii		2.00		2.98		2.22
Dictyota cervicornis					2.84	1.74
Dictyota mertensii				2.59		1.87
Gelidiella acerosa	2.89	1.76	1.73			
Gelidiella ligulata		1.76		5.01		2.18
Gelidium sp.		1.74		4.41		2.11
Gracilaria cervicornis	13.22	8.90	8.78			
Halimeda opuntia			8.54		13.62	9.80
Hypnea spinella	5.18			8.03	6.71	
Lobophora variegata		2.74	7.72	4.31	13.66	10.10
Padina gymnospora	2.74	1.72	1.42			
Sargassum cymosum	51.58	32.94	32.38			
Sargassum filipendula			5.68		10.5	6.67
Sargassum furcatum					2.35	1.53
Sargassum vulgare			12.32		25.48	14.96
Spatoglossum schroederi			2.49	1.51	6.37	3.26

algae found in coral reefs of the Brazilian northeastern coast (Leão 1982, Carvalho 1983, Martins *et al.* 1991, Coutinho *et al*. 1993, Villaça & Pitombo 1997, Costa Jr. *et al*. 2002), besides being one of the most common taxa found in coral reefs (Lirman 2001) and one of the most important sources of carbonates to the reef systems (Adey 1998, Villaça 2002).

No significant variation in the diversity and evenness indices was detected between the different seasons, but the indices tended to be higher in the dry season. This is probably due to the more stable environmental conditions of this period, during which there is little variation in water salinity, sediments and sewage income (Wallner-Kersanach 1994).

In short, with the present study we have illustrated: 1) the rich marine flora of the TSB: 142 taxa 2) that these species are not uniformly distributed among the seven sampled sites; 2) that there was a trend towards higher diversity and eveness indices during the dry seasons; 3) that the local floristic composition was based on a benthic community structure chiefly composed by *Sargassum* spp., *D. delicatula*, and *Halimeda* spp; 4) that the environmental and seawater conditions were determinant for the composition and abundance of the flora in the TSB.

REFERENCES

ADEY, W.H. 1998. Coral reefs: algal structured and mediated ecosystems in shallow, turbulent, alkaline waters. *Journal Phycology*, New York, 34: 393-406.

ALVES, A.M. & MOURA, C.W.N. 2005. O gênero *Codium* (Chlorophyta, Codiaceae) no recife costeiro da Ilha de Itaparica, Bahia, Brasil. Pp 485-516. *In*: Anais da X Reunião Brasileira de Ficologia; Sociedade Brasileira de Ficologia (orgs.). Museu Nacional. Rio de Janeiro. 562p.

AMADO FILHO, G.M.; ANDRADE, L.R.; REIS R.P; BASTOS, W. & PFEIFFER, W.C., 1997a. Heavy metal concentration in seaweed species from the Abrolhos reef region, Brazil. *In*: 8th International Coral Reefs Symposium, Panama, Proceedings (2): 1843-1846.

AMADO FILHO, G.M.; SALGADO, L.T.; REZENDE, C.E. & PFEIFFER, W.C. 2001. Concentração de metais pesados em populações da macrófita marinha Halodule wrightii Aschers, provenientes da Baía de Todos os Santos - BA. Pp 141-150. *In*: *R. MORAES; M. CRAPEZ; W. PFEIFFER; M. FARINA; A. BAINY; V. TEIXEIRA.* (eds.) Efeitos de poluentes em organismos marinhos. Brasil: Arte e Ciência, Villipress. 286p.

ARAÚJO, T.M.F. 1984. *Morfologia, composição, sedimentologia e história evolutiva do recife de coral da Ilha de Itaparica, Bahia.* Dissertação de Mestrado em Geologia – Instituto de Geociências da Universidade Federal da Bahia. Salvador. 92p.

BARROS-BARRETO, M.B.B.; BRASILEIRO, P.S.; NUNES, J.M.C. & AMADO FILHO, G.M. 2004. Algas marinhas bentônicas do sub-litoral das formações recifais da Baía de Todos os Santos — 1. Novas ocorrências. *Hoehnea* 31 (3): 321-330.

BARROS-BARRETO, M.B.B. 2006. *Sistemática molecular da tribo Ceramieae (Ceramiaceae-Rhodophyta) no Brasil.* Tese de Doutorado. IBqM, UFRJ. 160p.

BRAY, R.J. & CURTIS, J.T. 1957. An ordination of the upland forests communities of southern Winsconsin. *Ecologycal Monography*, 27: 325-349.

BROWER, J.E. & ZAR, J.H. 1997. *Field and Laboratory Methods for General Ecology*. New York: McGraw-Hill. 226p.

CARVALHO, F. de A.F. 1983. *Bionomia bêntica do complexo recifal do litoral do estado da Paraíba, com ênfase nas macrófitas***.** São Paulo. Tese (Doutorado em Oceanografia). Instituto Oceanográfico, Universidade de São Paulo. 184p.

CASTRO, C.B. 1999. Avaliação e ações prioritárias para a aconservação da biodiversidade da zona costeira e marinha – recifes de coral. http://www.bdt.fat.org.br/workshop/costa/recifes (acessado em 28 de Março de 2007)

COSTA JR., O.S.; ATRILL, M.J.; PEDRINI, A.G. & DE-PAULA, J.C. 2002. Spatial and seasonal distribution of seaweeds on coral reefs from Southern Bahia, Brazil. *Botanica Marina*, Berlin, 45: 346-355.

COUTINHO, R.; VILLAÇA. R.C.; MAGALHÃES, C.A.; GUIMARAENS, M.A.; APOLINARO, M. & MURICY, G. 1993. Influência antrópica nos ecossistemas coralinos da região de Abrolhos, Bahia, Brasil. *Acta Biol. Leopoldinensia*, Porto Alegre, 15 (1): 133-144.

FIGUEIREDO, M.A. de O. 2000. Recifes de corais ou recifes de algas? *Ciência Hoje*, Rio de Janeiro, 28 (166): 74-76.

GUIMARÃES, S.M.P.B. & OLIVEIRA, E.C. 1996. Taxonomy of the flattened Solieriaceae (Rhodophyta) in Brazil: *Agardhiella* and *Meristiella*. *Journal of Phycology*. 32: 656-668.

HAY, M.E.; DUFLJ, J.E.; FENICAL, W. & GUSTAFSON, K. 1988. Chemical defense in the seaweed *Dictyopteris delicatula***:** differential effects against reef fishes and amphipods. *Marine Ecology Progress Series*. 48: 185-192.

INMET, web page- http://www.inmet.gov.br/produtos (Acessado em 17 de outubro de 2003).

JOLY, A.B.; CORDEIRO-MARINO, M.; YAMAGUISHI-TOMITA, N.; UGADIM, Y.; OLIVEIRA FILHO, E.C. & FERREIRA, M.M. 1965a. Additions to the marine flora of Brazil V. *Arq. Est. Biol. Mar.* Univ. Ceará 5 (1): 65-78.

JOLY, A.B.; UGADIM, Y.; DIAZ G., J.J.; YAMAGUSHI-TOMITA, N.; CORDEIRO-MARINO, M. & YONESHIGUE-BRAGA, Y. 1969b. Additions to the marine flora of Brazil- X. *Rickia* , São Paulo, 4: 61-74.

JOLY, A.B.; CORDEIRO-MARINO, M.; UGADIM, Y.; YAMAGUISHI-TOMITA, N. & PINHEIRO, F.C. 1965b. New marine algae from Brazil. *Arq. Est. Biol. Mar.* 5 (2): 79-92.

LEÃO, Z.M.D.A.N. 1982. *Morphology, geology and developmental history of the southern coral reefs of western Atlantic, Abrolhos bank, Brazil.* Tese (Doutorado em Geologia Marinha), Coral Gables, Florida, University of Miami. 218p.

LEÃO, Z.M.D.A.N. 1996. The coral reefs of Bahia: Morphology, distribution and the major environmental impacts. *Anais da Academia Brasileira de Ciências*, Rio de Janeiro, 68: 439-452.

LESSA, G.C.; DOMINGUEZ, J.M.L.; BITTENCOURT, A.C.S.P. & BRICHTA, A. 2001. The tides and tidal circulation of Todos os Santos Bay, Northeast Brazil:

a general characterization. *Anais da Academia Brasileira de Ciências* 73 (2): 245-261.

LIRMAN, D. 2001. Competition between macroalgae and corals: effects of herbivore exclusion and increase algal biomass on coral survivorship and growth. *Coral Reefs*, Berlim, 19 (4): 392-399.

LITTLER, D.S. & LITTLER, M.M. 2000. *Caribean reef plants*. Off Shore Graphics, Inc. Washington, D. C. 542p.

MACEDO, L.M de F.C.; ROSSI, W.C.; GOMES, A.C.O.B.; SANTOS, L.P.; JÚNIOR, A.S. 2001. Avaliação da qualidade das águas costeiras superficiais-Baía de Todos os Santos, praias de Salvador. Relatório técnico. Centro de Recursos Ambientais. http://www.cra.ba.gov.br (Acessado em 31 de Janeiro de 2006).

MARTINS, D.V.; CORDEIRO-MARINO, M.; BOCCANERA, N.B. & NUNES, J.M. de C. 1991. Clorofíceas marinhas bentônicas do Município de Salvador, Bahia, Brasil. *Hoehnea*, São Paulo, 18 (2): 115-133.

MINISTÉRIO DO MEIO AMBIENTE. 2002. Avaliação e ações prioritárias para a conservação da biodiversidade das Zonas Costeira e marinha. PASSOS, C. M. DE O., PEREIRA, R. M. & MONTENEGRO, M. M (Eds), Brasil. 72p.

MOURA, C.W.N; CORDEIRO-MARINO, M.; GUIMARÃES, S.M.B.P. 1999. *Trichogloea requienii* (Montagne) Kützing (Rhodophyta: Liagoraceae) no litoral do Brasil. *Revista Brasileira de Biologia,* 59 (1): 151-159.

MUÑOZ, A.O.M. & PEREIRA, S.M.B. 1998. Estrutura de comunidades de macroalgas em formações recifais do estado de Pernambuco, Brasil. *In*: Anais IV Congresso Latino Americano de Ficologia, Caxambu, (2): 287-297.

NUNES, J.M. de C. & PAULA, E.J. 2002. Constituição e distribuição das Phaeophyta da Região Metropolitana de Salvador, Bahia, Brasil. *Iheringia, Série Botânica*, Porto Alegre, 57: 113-130.

NUNES, J.M. de C. & PAULA, E.J. 2000. Estudos taxonômicos do gênero *Padina* Adanson (Dictyotaceae- Phaeophyta) no litoral do estado da Bahia, Brasil. *Acta Botanica Malacitana***,** Universidade de Málaga, 25: 21-43.

NUNES, J.M. de C. 1997. Hypneaceae, Rhodymeniaceae, Ceramiaceae e Rhodomelaceae das praias de Placafor e Itapoã, município de Salvador, Bahia, Brasil. *Biotemas*, Florianópolis, 10 (2): 61-75.

NUNES, J.M. de C. 1999. *Phaeophyta da região metropolitana de Salvador, Bahia, Brasil*. Dissertação (Mestrado em Ciências biológicas-Botânica), Programa de pós-graduação em Botânica, Instituto de Biologia, Universidade de São Paulo. 271p.

NUNES, J.M. de C. 1998a. Catálogo de algas marinhas bentônicas do Estado da Bahia. *Acta Botanica Malacitana,* Universidade de Málaga, 23: 5-21.

NUNES, J. M.; SANTOS, A.C.C.; MINERVINO, A. & BRITO, K.S. 1999. Algas marinhas bentônicas do Município de Ilhéus, Bahia, Brasil. *Acta Botanica Malacitana*, Universidade de Málaga, 24: 5-12.

NUNES, J.M. de C. 2005a. *Rodofíceas marinhas bentônicas do Estado da Bahia, Brasil.* Tese de Doutorado, Universidade de São Paulo. 410p.

NUNES, J.M. de C. 2005b. A família Liagoraceae (Rhodophyta, Nemaliales) no estado da Bahia, Brasil. *Hoehnea* 32 (3): 429-444.

PAULA, A.F.; FIGUEIREDO, M.A.O. & CREED, J.C. 2003. Structure of the macroalgal community associated with the seagrass *Halodulle wrightii* Ascherson in the Abrolhos Marine National Park, Brazil. *Botanica Marina*, Berlin, 46 (5): 413-424.

SANTOS, G.V. dos. 1992. *Composição e microdistribuição de comunidades de algas bentônicas no recife de coral da praia de Coroa (Ilha de Itaparica, Bahia, Brasil)*. Dissertação de Mestrado. Universidade Federal Rural de Pernambuco. 170p.

SILVA, E.M. da; ACCIOLY, M. da C.; NAVARRO, M. de F.T. & CHASTINET, C. de B.A. 1996. Baía de Todos os Santos: situação atual e perspectivas. *Revista Econômica do Nordeste*, Fortaleza, 27 (2): 207-232.

SOUZA, S.P.; TAVARES, T.M. & BRADÃO, A.M. 1978. Distribuição do chumbo, cádmio e zinco em sedimentos no Estuário do Rio Subaé. *Supl. Ciência e Cultura (Supl.)*, 30: 406.

TAVARES, T.M.; PESO, M.C. & SOUZA, S.P. 1977. Estudo da contaminação de mercúrio na água, sedimentos e moluscos da Enseada dos Tanheiros. *Ciência e Cultura (Supl.)* 32: 544.

VILLAÇA, R. & JENSEN, V.K. 2006. *Dictyopteris jamaicensis* Taylor (Phaeophyceae - Dictyotales): nova ocorrência para o Atol das Rocas e primeira descrição para a costa brasileira. *Arquivos do Museu Nacional*, Rio de Janeiro, 64 (3): 215-221.

VILLAÇA, R. & PITOMBO, F.B. 1997. Benthic communities of shallow-water reefs of Abrolhos, Brazil. *Revista Brasileira de Oceanografia***,** São Paulo, 45 (1/2): 35-43.

VILLAÇA, R. 2002. Recifes biológicos. Pp 229-248. *In*: R.C. PEREIRA & A. SOARES-GOMES, (orgs.). Biologia marinha, Rio de Janeiro: Interciência..382p

VILLAÇA, R.; PEDRINI, A.G.; PEREIRA, S.M.B. & FIGUEIREDO, M.A.O. 2006. Flora marinha bentônica das ilhas oceânicas brasileiras. Pp 105-146. *In:* R.J.V. ALVES & J.W.A. CASTRO (Orgs). Ilhas oceânicas brasileiras da pesquisa ao manejo - MMA, SBF, Brasília. 340p.

WALLNER - KERSANACH, M. 1994. *Assessment of trace of metal pollution of Todos os Santos bay, Brazil, on the basis of measurements of bivalves and sediments***.** Alemanha. Tese (Doutorado em Geociências), Universidade de Bremen.114p.

WOLGEMUTH, K.M.; BURNETT, W.C. & MOURA, P.L. 1981. Oceanography and suspended material in Todos os Santos Bay. *Revista Brasileira de Geociências*. 11 (3): 172-178.

WYNNE, M.J. 2005. A checklist of benthic marine algae of tropical and subtropical western Atlantic: first revision. *Nova Hedwigia*. 152p.

YONESHIGUE-VALENTIN, Y; GESTINARI, L.M.S. & FERNADES, D.R.P. 2006 - Macroalgas. Pp 67-105. *In: H.P. LAVRADO & B.L. IGNÁCIO, (Eds.)*. Biodiversidade bentônica da região central da Zona Econômica Exclusiva Brasileira. Rio de Janeiro: Museu Nacional (Série Livros n. 18). 389p.

Submetido em 16/03/2008.
Aceito em 22/05/2008.