MICROSYMBIONTS OF *Siderastrea stellata* (CNIDARIA, SCLERACTINIA) IN COASTAL REEFS OF CABO BRANCO, STATE OF PARAÍBA, NORTHEASTERN BRAZIL

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ABSTRACT

Microscopic analyses of the epibionts (found in washing water of the coral colonies) and endosymbionts (found in extracted coral tissues) were carried out in partially bleached and unbleached colonies of the stony coral *Siderastrea stellata*. These colonies were collected in coastal reefs of Cabo Branco, Northeast Brazil in June and July 2003. The presence of zooxanthellae was registered, besides diatoms, cyanobacteria, protozoans, worms, and microcrustaceans. Higher taxonomic diversity was found in washing water of healthy colonies. Drawings and photomicrography of some identified organisms are presented.

Keywords: *Siderastrea stellata*; Endosymbiosis; Scleractinian corals; Brazil

RESUMO

MICROSSIMBIONTES DE *Siderastrea stellata* (CNIDARIA, SCLERACTINIA) NOS RECIFES COSTEIROS DE CABO BRANCO, PARAÍBA, NORDESTE DO BRASIL

Análises microscópicas dos organismos epibiontes (efetuadas em água de lavagem das colônias) e endobiontes (presentes nos tecidos dos corais) foram realizadas em colônias branqueadas e sadias do coral *Siderastrea stellata.* Estas colônias foram coletadas em junho e julho de 2003, nos recifes costeiros do Cabo Branco, Nordeste do Brasil. Foi registrado a presença de zooxantelas, diatomáceas, cianobactérias, protozoários, vermes e microcrustáceos. A maior diversidade taxonômica ocorreu nas amostras resultantes da lavagem das colônias sadias. Desenhos e fotomicrografias de alguns dos representantes identificados são apresentados.

Palavras chaves: *Siderastrea stellata*; Endossimbiose; Corais escleractínios; Brasil

INTRODUCTION

The phenomenon of microsymbiosis in marine invertebrates has been recognized over a century, and the most documented and most studied case is the relationship existing among the Cnidaria and the zooxantellae (TRENCH, 1987, 1997). These organisms interact with corals by translocating reduced organic carbon and nitrogen to the host, recycling nutrients (like phosphorous and nitrogen) inside the host's cell and accelerating the deposition of calcium carbonate in coral tissues (MUSCATINE, 1974; COSTA et al., 2004). Zooxanthellae also provide a substantial part of the energy requirement of their hosts by transferring photosynthetically fixed carbon to the coral (MULLER-PARKER; ELIA, 1997).

Besides zooxanthellae, other microalgae have been found associated with several marine invertebrates and cnidarians (TRENCH, 1993; WILD et al., 2004). Many organisms usually belonging to plankton communities also have been found on the surface of corals (PAUL et al., 1986; WILD et al., 2004) and also in the interstitial spaces of the scleractinians calcareous wall (FERRIER-PAGÈS et al., 1998). However, the exact role of these organisms in this epi-endosymbiotic relationship has not been clearly understood yet. Probably, many of these organisms are not necessarily involved in intracellular mutualistic symbiosis (such as the zooxanthellae) and some of them can be r-strategists, taking advantage of the corals, favorable condition. This might be the case of diatoms, which in association with some corals (PIYAKARNCHANA et al., 1986; COSTA et al., 2001), do not seem to have any special function for their hosts. Since this phenomenon has been poorly studied, its advantages and drawbacks remain obscure with respect to most organisms involved. This is an investigative area of worldwide interest.

Although associations between microalgae and marine invertebrates were documented throughout the XIXth century (SASSI et al., 1999), they are still poorly studied in Brazil. Up to date, only Costa et al. (2001) have reported a large diversity of diatoms associated to some haermatypic corals in the coastal reefs of the State of Pernambuco (Brazil).

Despite the existence of several works on planktonic and benthic marine diatoms in Brazil (SASSI, 1987; SILVA-CUNHA; ESKINAZI-LEÇA, 1990, MOREIRA-FILHO et al., 1999, among others), there is still a lack of studies on microsymbionts of marine invertebrates in Brazil. In this paper we investigate the microbiota associated to the scleractinian coral *Siderastrea stellata*, found abundantly in the coastal reefs of Cabo Branco, Northeastern Brazil.

MATERIAL AND METHODS

Four partially bleached and unbleached colonies of stony coral *Siderastrea stellata* were collected in June and July 2003 at sites with one meter of maximum depth at low tides, in coastal reefs of Cabo Branco (7^o 9'6''S, 34^{o}47'35''W) (João Pessoa, Paraíba state). The samples were collected with a chisel and hammer, were kept in plastic bags with filtered seawater (Whatmann GFC fiber glass filters) and transported to the laboratory in hermetic conditions. Each colony was transferred to an independent plastic bucket of 10 L capacity and carefully washed with slow jets of filtered seawater with some droplets of detergent to extract some organisms adhered to the surface. The organisms present in this washing water were concentrated by reverse filtration using a 20μm mesh size nylon tissue. Coral tissues were then removed with a high-pressure jet of water (Water Pik™) and transferred to a clean plastic bag. Extracted and concentrated materials were preserved with 4% neutralized formaldehyde and analyzed under a compound microscope. Permanent slides were prepared for diatoms by submitting the samples to the oxidation process suggested by Hasle; Fryxell (1970). Digital images of some specimens were captured with a PIXERA camera coupled to a PC microcomputer. The diatoms were identified based on Cupp (1943), Hendey (1964), Ricard

(1987), Silva-Cunha; Eskinazi-Leça (1990), and Pacobahyba (1992). Synonyms were confirmed by consulting Moreira Filho et al. (1999). Classifications followed Simonsen (1979).

RESULTS

Besides zooxanthellae (Fig. 1), we found 21 diatom taxa in the studied material (belonging to 6 families, 13 genera and 13 species, most of them of the Order Pennales). One taxon of cyanobacteria was also identified besides some unidentified protozoans, worms, and microcrustaceans (Table 1). Most of the taxa were present in the washing water of the colonies (Fig. 2).

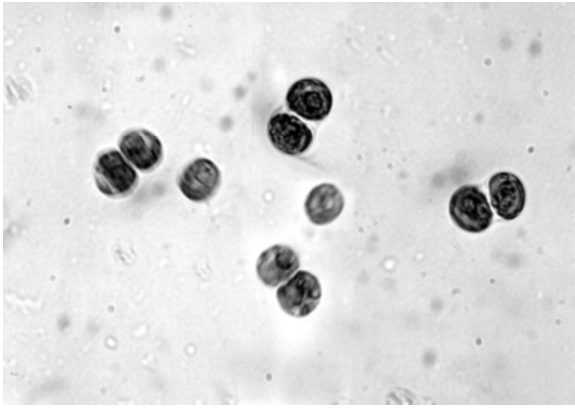


Figura 1 – Zooxanthellae of *Siderastrea stellata*, of the coastal reefs of Cabo Branco, João Pessoa, Northeastern Brazil.

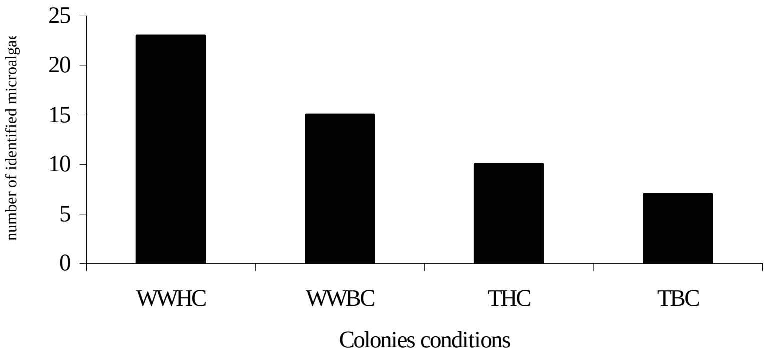


Figura 2 – Quantity of microalgae found in association with the coral *Siderastrea stellata* collected in the coastal reefs of Cabo Branco, João Pessoa, Northeast Brazil. (WWHC = Washing Water of Healthy Colonies, WWBC = Washing water of Bleaching Colonies; THC = Tissue of Healthy Colonies; TBC = Tissue of Bleaching Colonies).

Table 1 – Quantity of colonies of the coral *Siderastrea stellata* collected in the coastal reefs of Cabo Branco, João Pessoa, Paraíba, Brazil, where associated microsymbiotic organisms were found (**WWHC** = Washing Water of Healthy Colonies, **WWBC** = Washing water of Bleaching Colonies; **THC** = Tissue of Healthy Colonies; **TBC** = Tissue of Bleaching Colonies).

MICROSYMBIONTS	WWHC	WWBC	THC	TBC
Amphora angusta Gregory	1		3	1
Amphora sp.				1
Amphora turgida Gregory	2	1		
Bacillaria paxillifer (O. Müller) Hendey	1	1		
Climacosphenia moniligera Erhenberg	2			
Cocconeis scutellum Ehrenberg	3	2	1	1
Coscinodiscus sp. cf *C. nitidus* Gregory	1	1		
Coscinodiscus sp. Erhenberg	1			
Cylindrotheca closterium (Ehr.) W. Smith	4	1		
Grammatophora marina (Lynbye) Kutzing	2	1		
Licmophora gracilis (Erhenberg) Gronow	3		1	
Navicula directa Cleve-Euler	3	3	2	1
Nitzschia longissima (Bréb.) Cl. & Grun.	2			
Nitzschia sp. cf. *N. socialis* Cleve-Euler	3	3	1	
Nitzschia sp. 1	2		1	
Nitzschia sp. 2	4	2		
Paralia sulcata Erhenberg & Kutzing	3	1		
Pinularia sp.	3	1	1	
Pleurosigma elongatum Smithby	4	3	2	3
Pleurosigma intermedium Smith	3	2	1	1
Synedra sp.	2	1		
Unidentified diatoms	2		3	2
Oscillatoria sp.	4	1		
Protozoans	2			
Unidentified microcrustaceans	2			
Unidentified worms	2			

Higher taxonomic diversity was registered in the washed colony samples and the most frequent taxa were the diatoms *Cylindrotheca closterium* and *Pleurosigma angulatum* and the cyanobacteria *Oscillatoria* sp. (Plate 1). In extracted tissues of the unbleached corals a smaller number of symbionts were found, and the diatom *Amphora angusta* (Plate 1) was the most frequent taxon. In bleaching colonies, the microsymbiont diversity was the lowest when compared to healthy colonies. Here, the most frequent taxa were *Navicula* sp., *Nitzschia* sp. cf *N. socialis* and *Pleurosigma elongatum* (Plate 1). In extracted tissues of bleaching corals, smaller organism's diversity was registered, being *Pleurosigma elongatum* the most frequent taxon. Ten taxa were common to both extracted coral tissues and washing water from colonies (Table 1).

Plate 1a – Some specimens of the microbiota found in association with the coral *Siderastrea stellata* in the reefs of Cabo Branco, João Pessoa, Nortehast Brazil: A = *Coscinodiscus* sp. (90 to 110µm); B = *Coscinodiscus* sp. cf *C. nitidus* (25 to 35µm); C = *Paralia sulcata* (60 to 70µm); D = *Cocconeis scutellum* (45 to 55µm); E = *Climacosphenia moniligera* (210 to 250µm); F = *Grammatophora marina* (35 to 50µm); G = *Licmophora gracilis* (80 to 95µm); H = *Navicula* sp. (40 to 50µm. For diatoms the numbers in parentheses indicate the total length or the diameter of the frustules.

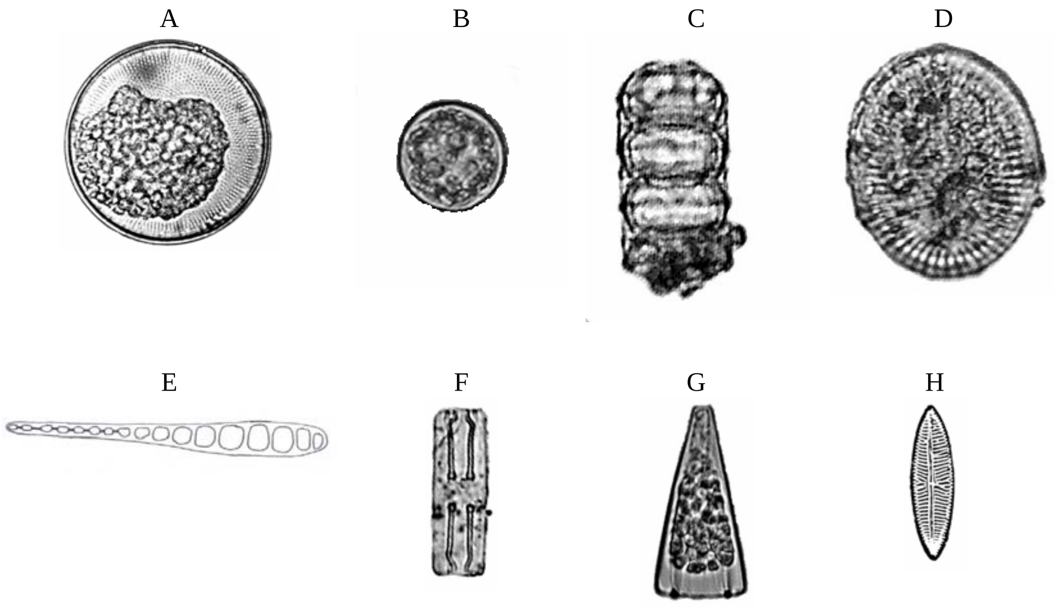
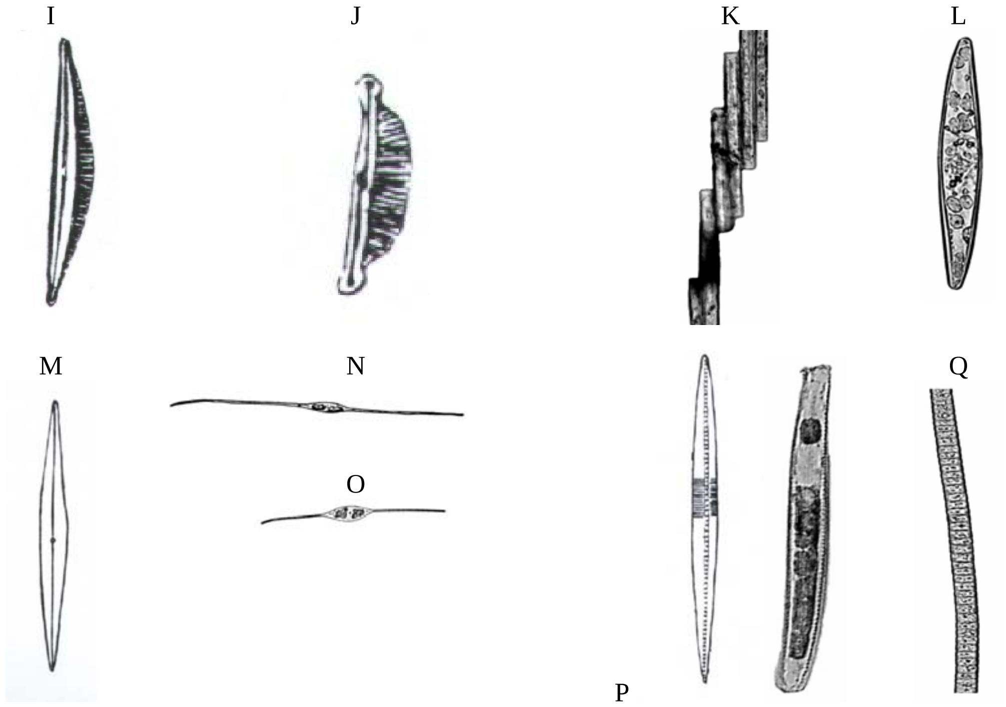


Plate 1b – Some specimens of the microbiota found in association with the coral *Siderastrea stellata* in the reefs of Cabo Branco, João Pessoa, Nortehast Brazil: I = *Amphora angusta* (40 to 55µm); J = *Amphora turgida* (20 to 30µm); K = *Bacillaria paxillifer* (55 to 75µm); L = *Pleurosigma elongatum* (90 to 100µm); M = *Pleurosigma intermedium* (90 to 100µm); N = *Nitzschia longissima* (180 to 200µm); O = *Cylindrotheca closterium* (80 to 90µm); P = *Nitschia* sp. cf *N. socialis* (65 to 75µm); Q = *Oscillatoria* sp.(length *ca* 2mm, diameter 8 to 12µm). For diatoms the numbers in parentheses indicate the total length or the diameter of the frustules



DISCUSSION

High diversity of epi-endosymbionts associated to *Siderastrea stellata* clearly indicates that other roles should be expected besides the classical interspecific mutualism existing between corals and zooxanthellae. Herndl; Velimirov (1985) have suggested that corals could be able to cultivate other microorganisms than zooxanthellae inside their own tissues, adding some contribution to the reef productivity and trophic web. These authors also have found a large quantity of bacteria besides intact specimens of phytoplankton and zooplankton inside the gastric cavity of the mediterranean coral *Cladocora cespitosa*.

All diatoms we found in association with *S. stellata* are common to the littoral zone, where they occur as epibenthic (COSTA et al., 2001), as they can also be found in the plankton (SASSI, 1987). The presence of such organisms in the studied material is according to Costa et al. (2001), who found 17 taxa of diatoms associated with the corals *Favia gravida* and *Porites astreoides* collected in the South of the State of Pernambuco (Northeast Brazil) coastal reefs. In other areas of the world this kind of study is also being carried out as in Piyakarnchana et al. (1986), who found 92 diatom species on the surface of seven species of corals collected in the Sichangs Islands, Gulf of Tailand.

The presence of yellow-green algae in several hosts (as Porifera, Cnidaria and Mollusca) was considered since the last XIXth century (BRANDT 1881, 1882) and several examples of relationships are also well documented. For example: in the oligotrichidean protozoans several diatoms have been found in association with loricas of several species of Tintinnina, particularly from *Eutintinnus* (JORGENSEN, 1924; BALECH, 1962; SASSI et al., 1999) and *Codonellopsis* (KOFOID; CAMPBELL, 1939). Symbiosis in marine organisms seems to be a common feature, although badly understood.

In our opinion, the association between corals and other organisms than zooxanthellae could not constitute a perfect example of mutualistic interaction, since probably it is more important for the roomer than for the hosts. Reefs have normally a large diversity of diatoms and several of them could be successful as epizoic forms, using excreted products by corals (WILD et al., 2004). Some of the species that we found could be opportunists, getting advantage from the favorable conditions provided by corals. Worms and microcrustaceans use corals either as refuge areas or because these cnidarians offer them nutritional resources in abundance. The high diversity found in association with healthy colonies seems to corroborate this hypothesis and leads us to suggest that the study of the taxonomical diversity of these microsymbionts could possibly be used as a good index to assess the health conditions of the coral reefs. Several representatives of the microbiota found in the extracted tissues also could be present inside the gastric cavity of corals as reported by Herndl; Velimirov (1985), but probably this is due to recent ingestion and not necessarily to endosymbiotic forms (FERRIER-PAGÈS et al., 1998). However, much of these ideas are only speculative; they serve to indicate that greater efforts need to be made to elucidate this very interesting kind of interspecific relationship in the marine environment.

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