Epibiosis on barnacles at Angra dos Reis, RJ: eutrophication effects.

Mayer-Pinto[1], M.; Viana[1], M. S.; Lavrado[1], H. P.; Silva[1], T. A. and Silva[1], S. H. G.

[1]Departamento de Biologia Marinha, UFRJ, Rio de Janeiro, Brasil (MMP) e-mail: marianam@biologia.ufrj.br

Abstract

Epibiosis on barnacles was evaluated through PVC fouling panels (20 vs 20 cm) immersed during 6 months in three sites with different eutrophication conditions in Angra dos Reis. The hypothesis tested was that epibiosis increases with eutrophication. One grid (20 vs 20 cm) of 100 interceptions was placed on each panel. Basibionts under each interception were analysed and an estimate of frequency of occurrence of their epibionts was obtained. No specific basibiont-epibiont relationship was observed. The two most abundant barnacle species, *Balanus trigonus* and *Balanus reticulatus*, were chosen for quantitative analysis. A grid of one hundred interceptions was placed on the ocular lens of a stereo microscope and the presence of an epibiont under each interception was registered. No significant difference was found between these two barnacles within each site, however there were significant differences between the eutrophic and oligotrophic sites. Spionidae/ Amphipoda (mucous tube) and algae were the epibionts whose abundances better reflected the degree of eutrophication.

Key words: Epibiosis, barnacles, eutrophication, fouling, Balanus

Introduction

The process of fouling, which is very common in the marine environment, consists on the colonization of living or nonliving surfaces by sessile organisms. When fouling occurs on a living substrate, it is called epibiosis. The frequency and intensity of epibiosis is often related to limitation of substrate (Wahl, 1989).

Fouling communities clearly reflect the eutrophication degree of the area where they are established. In general, communities of oligotrophic areas exhibit slow colonization rates and low biomass when compared to communities of eutrophicated areas (Silva, 1998).

On balance, it seems that epibiosis is generally unfavorable for the basibiont organism (Wahl, 1989). Thus, they may either tolerate or defend themselves against fouling. Apparently, barnacles use the first strategy, since they lack any antifouling mechanism, such as production of mucus, antilarval compounds and toxic secondary metabolites (Wahl, 1989; Wahl and Banaigs, 1991; Teo and Ryland, 1995).

Relationships between basibiont and epibiont organisms are rarely species-specific (Wahl and Mark, 1999). Barnacles possess typical characteristics of the basibiont condition described by these authors: they are sessile, long-lived, hard-covered animals with parts of the outer body surface biologically inactive (with regard to filtration, osmorregulation, etc.).

Given all the characteristics mentioned above, barnacles were chosen in this study to verify the influence of eutrophication on the degree of fouling over such basibionts in Angra dos Reis, RJ. Our hypothesis is that epibiosis increases as a function of eutrophication degree.

Materials and Methods

Study sites

Angra dos Reis is located on Ilha Grande Bay, on the southeast coast of Brazil. This bay is considered an oligotrophic system, although some restricted areas are subject to eutrophication by sewage pollution (Silva *et al.*, 1989). The three study sites (Figure 1) have similar water masses in respect to salinity and temperature, but differ in the degree of eutrophication (for more details see Silva, 1998). The eutrophic site, Anil, is only 4 km distant from the oligotrophic one (Esteio). The remaining site, Fazenda, has a moderate degree of eutrophication.

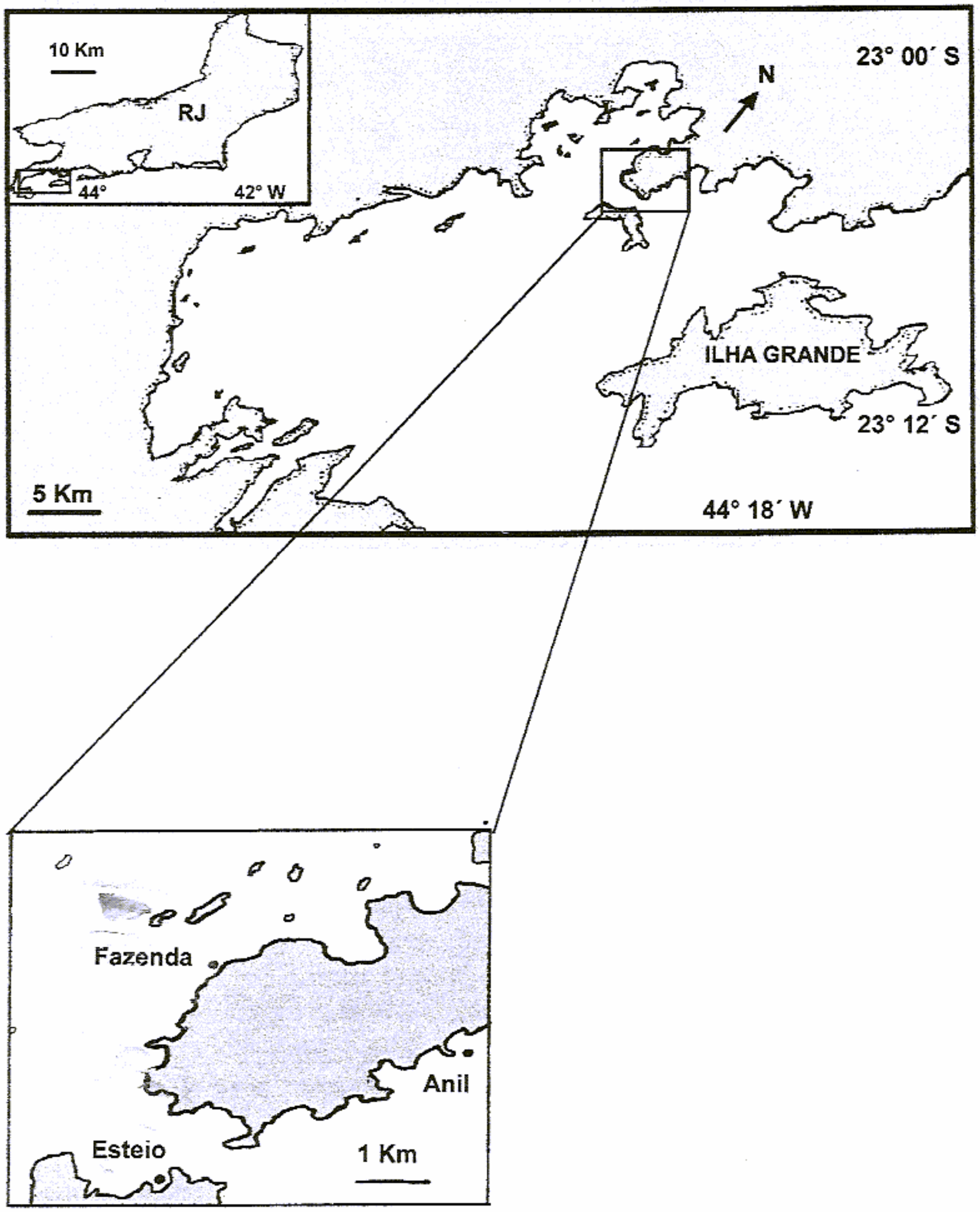

Figure 1. Map of Angra dos Reis region, showing the three study sites. Anil = eutrophic; Fazenda = moderately eutrophic; Esteio = oligotrophic.

Experimental design

On each site, six PVC panels (20 vs 0 cm) were immersed at a depth of 0.5 m, during 6 months (from Sep/96 to Mar/97).

Balanus trigonus Darwin, 1854 and *Balanus reticulatus* Utinomi, 1967 were chosen because they were the dominant basibiont barnacle species. They had their epibionts analysed qualitatively and quantitatively on the three sites through the Intersection Method (Sutherland, 1974). *Balanus reticulatus* was identified for the first time on the southeast coast on artificial substrata in 1998 (Silva, 1998).

Qualitative analysis

To estimate the frequency of occurrence of epibionts, three panels from each site, randomly chosen, were placed under a stereo microscope. The basibionts under the intersections had all the epibionts present on their surface registered. The frequency was calculated by dividing the number of observations of each species of epibionts by the total number of each basibiont species analysed. Organisms were identified to the lowest taxonomic level as possible.

Quantitative analysis

In order to obtain the percent cover of epibionts, a grid of 1.2 vs 1.2 mm containing a hundred intersections was placed on the ocular lens of a stereo microscope. The chosen basibiont had the epibionts under the intersections registered. Intersections that were not over any basibiont organism were counted and then excluded from the calculations of cover. A total of 45 *B. trigonus* and 42 *B. reticulatus* were counted in the three studied sites.

Data analysis

To verify significant differences among sites in regard to the degree of epibiosis (percent cover) and the number of epibiont taxa on barnacles, an one-way ANOVA was used (Zar, 1996). Mean comparisons were obtained through a Tukey test and homogeneity of variances was checked by a Cochran test.

Results

Qualitative analysis

Cyanophyta was the most frequent epibiont (more than 60%) in all study sites (Table 1). Mucous tubes (formed by amphipods and polychaetes of the family Spionidae) were present on more than 80% of the barnacles in Anil, but it did not reach frequency values higher than 50% in Fazenda and Esteio. Actiniaria occurred on more than 65% of the barnacles in Esteio, but it was absent from Fazenda and Anil.

The colonial ascidian *Symplegma brakenhielmi*, (Michaelsen, 1904) found only in Esteio and Fazenda, showed a frequency of occurrence between 30 and 50%. The bryozoan *Scrupocelaria scrupae* was restricted to Fazenda, where it reached a frequency of occurrence higher than 20%.

The algae *Derbesia* sp, *Polysiphonia* sp and the ascidians *Didemnum ahu* Moniot & Moniot, 1997 and *Styela canopus* (Savigny, 1816) showed high frequency values in Anil (Table 1). None of the basibiont-epibiont associations observed in this study were species-specific, that is, no species of epibiont was found preferentially on a basibiont species with remarkable percent cover values.

Quantitative analysis

Epibiosis on *B. reticulatus* and *B. trigonus* was significantly different (F=4.083; p=0.024 and F=4.826; p=0.014, respectively) between the oligotrophic and the most eutrophicated site, Anil, where values were 30% higher than in Esteio (Fig. 2).

The mean number of epibiont taxa (Fig. 3) was significantly higher in Anil when compared to those from Esteio for both basibiont species, *B. trigonus* and *B. reticulatus* (F=4.719; p=0.014 and F=3.365; p=0.045, respectively). Significant differences on total epibiont cover between these two species were not verified in any of the studied areas.

In none of the studied areas, a group of epibiont was clearly the most dominant, that is to say, none of them showed a percent cover extremely higher than the other dominant groups of a given area. In Anil, the groups Cyanophyta, macroalgae (mainly filamentous chlorophytes), colonial ascidians and mucous tubes accounted for the higher percent cover values. The groups with higher percent cover values in Fazenda were Balanidae, colonial ascidians, macroalgae and Cyanophyta; while Actiniaria, colonial ascidians and Cyanophyta were the dominant ones in Esteio (Fig. 4).

Table 1: Frequency of occurrence of the main epibiont taxa on barnacles (*- made by amphipods and polychaetes of the family Spionidae).

	Balanus reticulatus			*Balanus trigonus*		
	Esteio	Fazenda	Anil	Esteio	Fazenda	Anil
Cyanophyta	69.2	80.0	75.6	70.5	86.5	73.8
Chlorophyta						
Bryopsis pennata J.V. Lamour		3.3	4.2			
Bryopsis plumosa (Huds.) C. Agardh			18.4			9.5
Cladophora montagneana K tzing			4.9			5.6
Derbesia sp.	4.7	11.4	35.5		6.5	39.4
Phaeophyta						
Dictyota sp.	2.8					
Padina sp.					1.3	
Rhodophyta						
Acanthophora sp.	2.4			16.7	1.0	
Ceramium flaccidum (K tz.) Ardiss.	6.0	10.0	9.1		6.0	22.5
Polysiphonia sp.			36.4		1.3	37.6
Solieria sp.	1.2		7.9			3.7
Hydrozoa						
Clytia sp.		33.3			9.7	
Obelia dichotoma (Linnaeus, 1758)					3.2	
Obelia sp.		24.8	10.4			
Anthozoa						
Actiniaria	80.8			67.0		
Bivalvia						
Isognomon sp.	2.2					
Cirripedia						
Balanus amphitrite Darwin, 1854	3.8				1.0	
Balanus eburneus Gould, 1841	14.8	10.0	7.2	13.5	7.5	
Balanus improvisus Darwin, 1854	4.0					
Balanus reticulatus Utinomi, 1967	20.4	9.5	4.2	9.3	2.3	
Balanus trigonus Darwin, 1854	19.1	14.8	10.2	19.5	20.4	
Balanidae recruit	9.4	32.9	14.8		26.0	13.2
Bryozoa						
Bugula ditrupae Busk, 1858					1.0	
Scrupocellaria cornigera Osburn, 1914		6.7			1.3	
Scrupocellaria scrupae Busk, 1852		26.2			25.7	
Ascidiacea						
Botryllus niger (Herdman, 1886)	22.1		27.9	38.5	5.0	5.6
Didemnum ahu Monniot & Monniot, 1987		6.7	48.1		3.7	35.2
Diplosoma listerianum Milne-Edwards, 1841	6.9		7.4	12.5	1.3	4.8
Phallusia nigra Savigny, 1816				4.2		
Symplegma brakenhielmi (Michaelsen, 1904)	33.7	37.6		44.6	49.2	
Styela canopus (Savigny, 1816)		3.3	17.2		5.8	32.5
Styela sp.	1.2					
Styelidae	2.2					
Mucous tube*	9.8	49.5	90.9	8.3	33.0	84.9

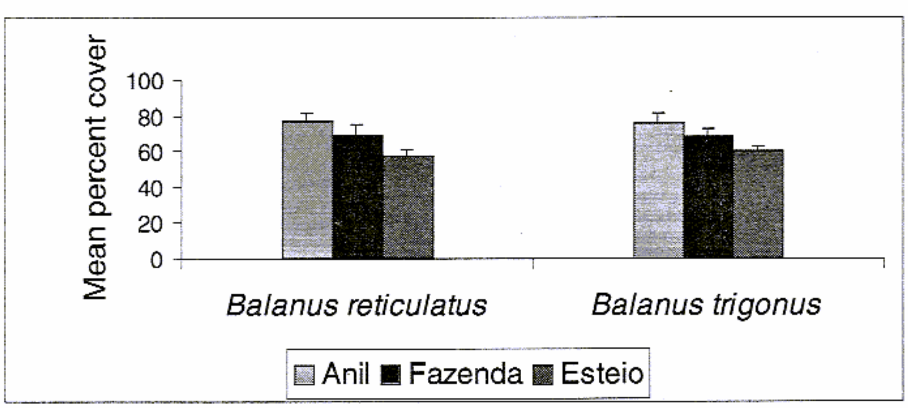

Figure 2: Mean percent cover (± SE) of epibiont on barnacles *Balanus reticulatus* and *Balanus trigonus* in the three study sites at Angra dos Reis, RJ. Anil = eutrophic; Fazenda = moderately eutrophic; Esteio = oligotrophic.

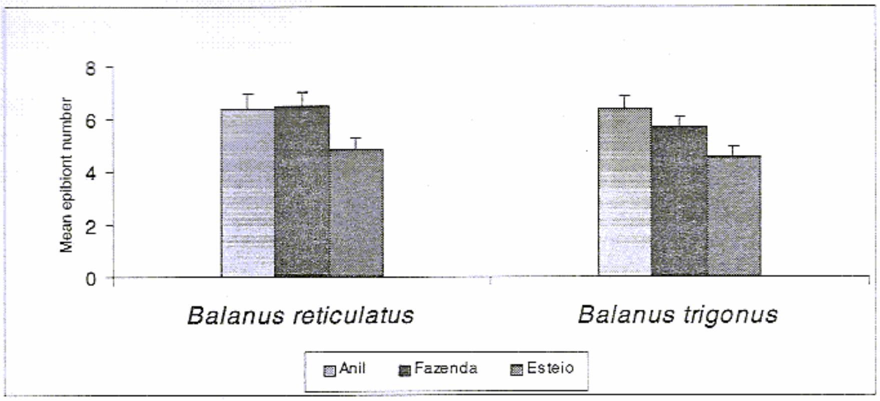

Figure 3: Mean number (± SE) of epibiont taxa on barnacles *Balanus reticulatus* and *Balanus trigonus* in the three study sites at Angra dos Reis, RJ. Anil = eutrophic; Fazenda = moderately eutrophic; Esteio = oligotrophic.

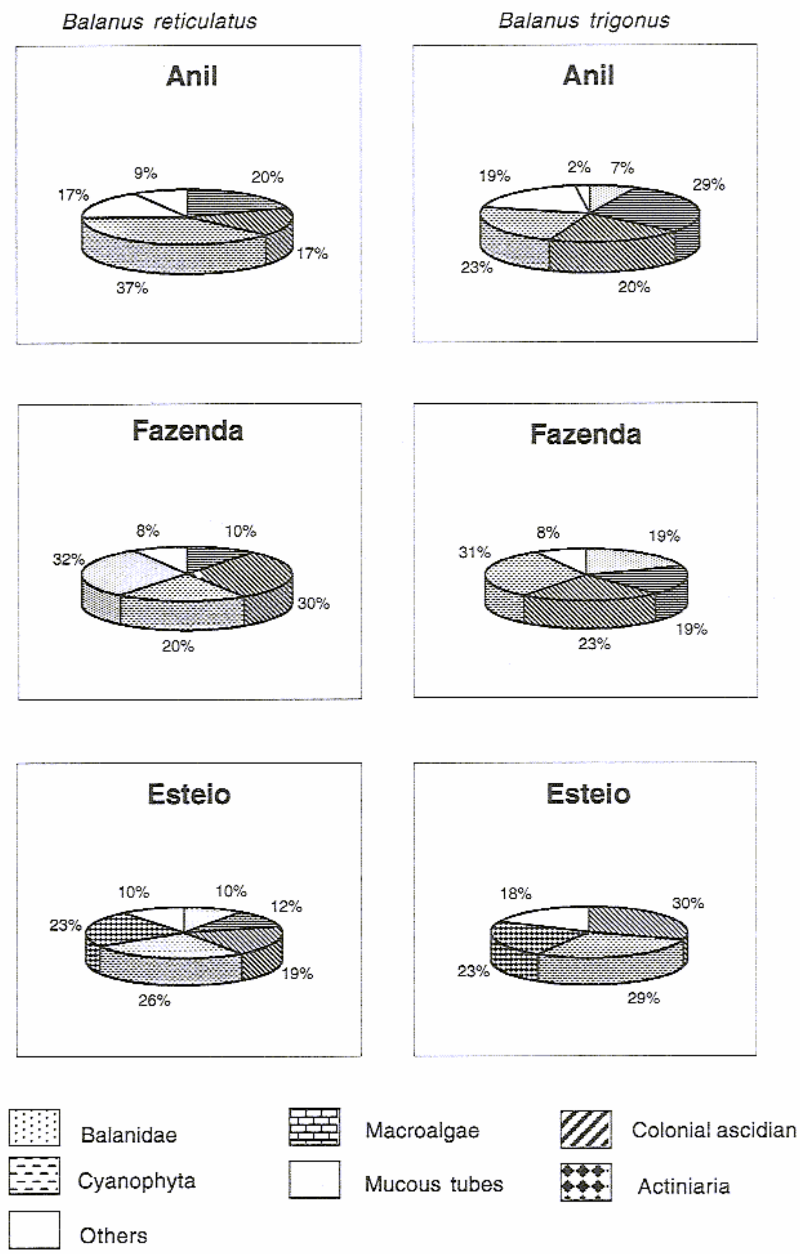

Figure 4: Percent cover of the main groups of epibionts on barnacles *Balanus reticulatus* and *Balanus trigonus* in the three sites at Angra dos Reis, RJ. Anil = eutrophic; Fazenda = moderately eutrophic; Esteio = oligotrophic

Discussion

In moderately eutrophicated areas, a higher nutrient availability can accelerate the development of fouling communities in relation to oligotrophic areas (Silva, 1998). An extreme degree of eutrophication, on the other hand, can lower biomass, favouring opportunistic species and decreasing the total number of fouling organisms (Hargrave and Thiel, 1983; Moran and Grant, 1989).

This relationship between fouling communities and eutrophication degree was verified by Silva (1998) on the same study sites. In the present study, the highest degree of epibiosis found in Anil followed, respectively, by Fazenda and Esteio is probably related to environmental eutrophication because of a higher nutrient availability and faster colonization rates of fouling communities in the most eutrophicated site. Moreover, older and/or stressed (by sewage, for example) organisms are more susceptible to fouling (Wahl, 1989).

Sessile or sedentary species which have rigid surfaces and lack antifouling defenses can, occasionally, tolerate an almost unrestricted colonization of their body surfaces (Wahl, 1989; Davis and White, 1994). Therefore, barnacles seem to be suitable organisms to evaluate the influence of the degree of eutrophication on epibiosis. On the contrary, ascidians from the same region did not show this relationship (unpublished data), probably due to the fact that many of these organisms possess delicate surfaces (tunics) and antifouling chemical defenses (Wahl and Banaigs, 1991; Teo and Ryland, 1995).

Even though some basibiont-epibionts associations found by Davis and White (1994) were species-specific, the majority of epibionts can be found in an enormously variety of substrates (Wahl and Mark, 1999). In the present study, species-specific associations were not observed either.

In Anil, filamentous chlorophytes were one of the most frequent and abundant groups. This may be attributed to the fact that, in areas of high organic pollution, these algae have their growth and reproduction favoured (Borowitzka, 1972; Murray and Littler, 1978; Fletcher, 1996). Mucous tubes formed by amphipods and polychaetes of the family Spionidae were also very frequent and abundant in this region. These organisms are considered opportunistic and are favoured in conditions of organic pollution (Rastetter and Cooke, 1979; Gray, 1981).

The ascidians *D. ahu* and *S. canopus* were very frequent on the most eutrophicated site. *S. brakenhielmi* was not present in this site, but it was very frequent on the oligotrophic one. Silva (1998) has already suggested that these species are negative indicators of organic pollution, while *D. ahu* and *S. canopus* seem to be opportunistic species and possible positive indicators of organic pollution.

The species of Actiniaria found in this work was one of the most frequent and abundant in Esteio, the only site where it was found. Silva (1998), however, found this species in Fazenda. Its absence from Anil, the most eutrophicated site, suggests that this species may be sensitive to organic pollution.

Balanus reticulatus and *B. trigonus* showed no significant differences in respect to the degree to which they were fouled, probably because they present similar characteristics of body surfaces, with very wrinkled carapaces. This kind of substrate retains more water and is more favorable to fouling (Richmond and Seed, 1991). Possibly, differences could have been noticed if species with flatter and smoother carapaces, like those of *Balanus eburneus* Gould 1841,for example, had been chosen.

Thus, given the significant differences in the percent cover and number of epibiont taxa between the most eutrophicated area and the oligotrophic one, the degree of epibiosis on barnacles clearly reflects the degree of eutrophication in the region of Angra dos Reis. Therefore, the use of epibiosis can be a good indicator of the environmental quality in the region studied.

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