SOME ASPECTS OF THE POPULATION BIOLOGY OF SEA HARE *Aplysia dactylomela* RANG, 1828 IN TWO BEACHES FROM CEARÁ STATE, BRAZIL

Biologia populacional da lesma-do-mar *Aplysia dactylomela* *R*ang, 1828 em duas praias do Estado do Ceará, Brasil

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ABSTRACT

This work describes the population biology of the sea hare, Aplysia dactylomela*, at two beaches in Ceará State, Brazil. Their habitats were monthly examined for one-year period, at low tide during daytime and the number, size, spawning and breeding behavior were registered. Feeding habits were determined by observation of seaweed species consumed in the field and by dissecting and examining the gut contents of the sea hares. The results showed that the population density of* A. dactylomela *in tropical waters from Brazil is much lower than those described for populations of temperate and subtropical regions. This might be explained by the intense sun radiation of tropical regions since the other environmental factors were suitable to their settlement. Despite the low density,* A. dactylomela *is found throughout the year, with recruitment peaks on February and March. Both population density and animal size were different in the two beaches, what might be due to differences in seaweed abundance and quality, degree of sun exposure and man-caused pollution.*

Key words*: sea hare,* Aplysia dactylomela*, population biology, seaweed.*

RESUMO

Este trabalho descreve alguns aspectos da biologia populacional da lesma-do- mar Aplysia dactylomela *em duas praias do Estado do Ceará, Brasil. Os resultados referem-se aos registros do número de espécimes, dimensões dos animais, comportamento reprodutivo e desova, ao longo de um ano, durante a maré baixa. Os hábitos alimentares foram determinados a partir da observação das espécies de algas consumidas em campo bem como através da análise do conteúdo intestinal em laboratório. Os resultados mostraram que a densidade populacional da* A. dactylomela *em águas tropicais é mais baixa do que em regiões temperadas ou subtropicais. Isso poderia ser explicado pela intensa radiação solar a que esses animais são expostos nas regiões tropicais, já que todos os outros fatores ambientais eram apropriados para a lesma. A despeito da baixa densidade,* A. dactylomela *foi encontrada em todos os meses do ano, com picos de recrutamento nos meses de fevereiro e março, para as praias de Pacheco e Flexeiras, respectivamente. A densidade populacional bem como o comprimento dos animais diferiu nas duas praias analisadas, podendo-se atribuir essas diferenças à abundância e qualidade nutricionais das macroalgas consumidas pela lesma, ao grau de proteção à radiação solar e à poluição.*

Palavras-chaves*: lesma-do-mar,* Aplysia dactylomela*, biologia populacional, macroalgas.*

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INTRODUCTION

Littoral ecosystems are subject to great variability, therefore, life cycles of marine organisms show marked seasonal patterns in growth, reproduction and abundance, especially in cold temperate seas (Coma *et al*., 2000).

A characteristic feature of life histories of opisthobranchs in general, and of *Aplysia* in particular, is their periodicity of occurrence. Often there are long gaps when no sea hare can be found in areas where they normally dwell (Lederhendler *et al*., 1975; Audersirk, 1979). The likeliest explanation for such gaps in seasonal occurrence of *Aplysia* is that juveniles are often hard to see, that recruitment may depend on larval transport from distant populations, or that the larvae delay their metamorphosis until cued by others events, such as changing season (Carefoot, 1987).

Until recently, little has been know concerning the population ecology of the sea hares. Most of previous studies on *Aplysia* spp. were conducted in temperate and subtropical coasts and have addressed such subjects as periodicity of occurrence, high abundance variability, population structure at different sites and years coinciding with peak algal abundance (Pennings, 1991; Plaut *et al*., 1998; Angeloni *et al*., 1999).

Those research works have shown that the species can have one or more peaks of recruitment, being absent in certain months of the year, usually when the environmental conditions are adverse as in low temperatures and food scarcity. In tropical seas there is less variation in environmental conditions and growth of algae occurs throughout most, if not all, the year, but actual information is by and large lacking on the population biology of *Aplysia*.

A. dactylomela inhabits shallow tropical shoreline regions, eats red and green algae and lays large number of fertilized eggs in sting-like gelatinous masses close to the sea surface. It is hermaphroditic and nocturnally active but may be exposed to sunlight as it rests during the day (Carefoot, 1987). Although this species has a worldwide distribution (Eales, 1960) few studies have been dedicated to this sea hare in Brazil, all of them just describing its occurrence (Marcus & Marcus, 1955; Marcus, 1972; Rios, 1994). Recently, Bezerra et al. (2004) studied the relationship between seaweed diet and purple fluid production and Bezerra *et al*. (2006) describes its ink gland using light microscopy and histochemical tests.

This paper aims to report some aspects of *A. dactylomela* population dynamics in two beaches of Ceará State, contributing therefore to the knowledge of its ecology in tropical waters of South Atlantic.

MATERIALS AND METHODS

Population studies and feeding habits

Aplysia dactylomela population was monitored at Ceará State, Northeast Brazil, between August, 2000 and July, 2001.The site 1 is located on Pacheco beach (38°38′48″W, 03°41′24″S) which is particularly rich in the green seaweed *Ulva fasciata*. The site 2 is located on Flexeiras beach (39°25′45″W, 03°22′18″ S) densely rich in red algae, particularly *Hypnea musciformis* and *Gracilaria* sp. The habitats were monthly examined during daytime at low tide and the number, size of live animals, spawning and breeding behaviors registered. The sizes of the sampling device were 50 x 60 m and 20 x 30 m for sites 1 and 2, respectively, established according to the topographic characteristics of the beaches. Both sites belong to intertidal zones of beach rock. Site 1 showed shallow tidepools (0.30 m deep) whereas site 2 consisted of much deeper tidepools (up to 2 m deep).

Feeding habits were monthly investigated by observing the seaweed species consumed in the field and by dissecting under a stereomicroscope the gut contents of the sea hares brought to the laboratory and capturing the images with a digital camera (Sony – Mavica, Japan). Comparisons of total number and average size of specimens found at the two study sites were done by Student´s t-test, with $\alpha = 0.05$.

RESULTS

The results of population monitoring studies are shown in Figure 1. During the study period 202 specimens were recorded in the two sites. Both number and size of animals differed significantly between the two beaches ($t = 4.43$, $p < 0.0001$; $t = 9.131$, $p < 0.0001$, respectively). In site 1 (Pacheco beach) 47 snails were registered, accounting for 23.36% of total number,

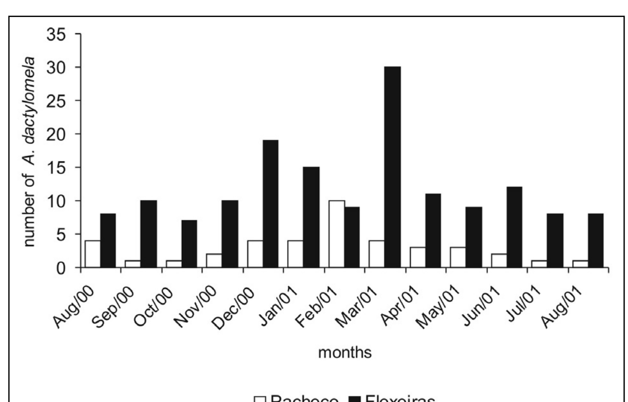

Figure 1 - Number of *Aplysia dactylomela* specimens found at Pacheco Beach (site 1) and Flexeiras Beach (site 2) along the year, at low tide during daytime.

whereas in site 2 (Flexeiras beach) 155 snails were found, accounting for 76.73% of total number. The sea hares found in site 1 showed an average length of 12.17 ± 3.10 cm whilst those in site 2 averaged 19.06 ± 4.82 cm. Mean sea hares size on each month are shown in Figure 2.

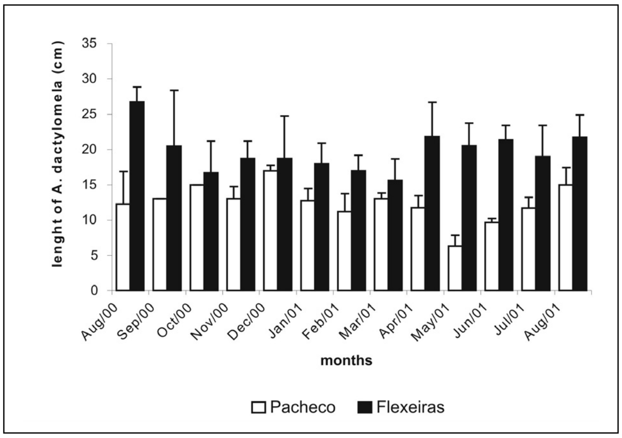

Figure 2 - Average length of *Aplysia dactylomela* specimens found at Pacheco Beach (site 1) and Flexeiras Beach (site 2) at low tide, during daytime.

Sea hares from Pacheco were frequently found surrounded by the green alga *U. fasciata* and to a much lesser extent by some red alga species such as *Gracilaria* sp. In site 2, however, the snails were surrounded by red algae, mainly *H. musciformis* and some brown species. The analysis of gut contents from specimens collected showed that the snails consumed mainly those alga species surrounding them. Thus, the gut contents of specimens collected in site 1 consisted of about 70% of *U. fasciata* (and traces of red species) whereas the gut contents of those from site 2 comprised over 90% of *H. musciformis* (photographs not included).

DISCUSSION

This work describes for the first time some aspects of the population biology of the sea hare, *Aplysia dactylomela*, in tropical waters of South Atlantic and discusses the possible factors that might influence its occurrence and distribution. The highest population density observed in the present work was 0.05 animals/m^2 in Fleixeiras beach (site 2). This value was much lower than those registered for the same species in the Caribbean (Carefoot, 1985) and New Zealand (Willan, 1979 *apud* Carefoot, 1987), namely 0.6 and 1.6 animals/m^2, respectively. Generally *Aplysia* populations are much greater in temperate and subtropical regions than in tropical waters (Plaut *et al*., 1998; Angeloni *et al*., 1999). Nevertheless, some data have shown that these numbers might oscillate from as low as 0.03 for *A. californica*, in Southwest California to as high as 5.0 animals/m^2 for *A. parvula*, in New Zealand (Carefoot, 1987).

Comparing our data to those obtained for *A. dactylomela* in New Zealand, the absolute density we found was approximately 30 times lower (Willan, 1979). The factors that might influence the density of those organisms are food availability, salinity, wave exposure, predators, substratum type, crevices, desiccation and sunlight. In this study food availability would not be a limiting factor for settlement of these animals since in both sites the algae that composed their diet were abundant, being sufficient to support a much larger population of sea hares than that we registered. Besides, these seaweeds were available along all the year. As to the salinity factor, it is known that sea hares generally avoid areas of extremely low salinity due to either intolerance of it or to lack of suitable food items (Carefoot, 1987). This was not the case since in both sites the salinity was kept around 35. Both sites presented topographic characteristics suitable for the settlement of the animals, with the presence of rock crevices and sediments for burrowing which could protect them against wave exposure. During this study no case of adult snails predation was observed in the field, supporting the general statement that sea hares have very few predators known to feed regularly on them (Johnson & Willows, 1999). In very rare occasions we could find dead animals that might have been overexposed to air, trapped in shallow tidepools during low tide.

Thus, the more plausible factor that could account for the low density of *A. dactylomela* population was the intensity of sunlight. The State of Ceará, where the two sampling sites are located, is under intense solar radiation along the year and lies in the semi-arid region of Northeastern Brazil, which is characterized by lack of definite seasons and by the occurrence of cyclic droughts. The natural concentration of stratospheric ozone, generally less near the Equator than at higher latitudes (Cutchis, 1982), together with the lower solar zenith angle in tropical regions, means that the tropics receive more UV radiation (Green *et al*., 1979; Frederick *et al*., 1989). According to Shick *et al*. (1996), the direct damaging effects of UV radiation upon tropical shallow water organisms may include decrease in respiration, in growth and calcification rates leading to death. Indirect UV radiation may damage shallow water organisms by photochemical reactions that produce reactive oxygen molecules like H_2O_2 (Shick *et al*., 1996). Besides, the transparency of tropical seawaters allows more efficient penetration of UV radiation in shallow water habitats (Kirk, 1994). Thus, the low density of *A. dactylomela* population observed in this work might be attributed to the fact that sea hares were under unfavorable conditions, i.e. under effect of intense sunlight, which in turn may have led to the production of fewer eggs (Plaut *et al*., 1996).

Concerning the different number of animals observed in the two beaches (Figure 1), several possibilities for explanation are speculated. The first would be that in site 2 besides the tidepools were much deeper (about 2 m deep) than those of site 1 (about 0.50 m) there were greater amounts of seaweeds than in site 1, leading to a more efficient filtration of sunlight. Second, the animals in site 2 consumed mainly red seaweeds and this might have favored a greater egg production when compared to those in site 1 fed on *U. fasciata*, a green alga species. In fact, studies have shown that *A. punctata* fed on different seaweeds present different weight of spawn produced. Snails fed with the red seaweed *Plocamiun coccineum* produced 43.6 g of spawn whilst the ones fed with the green species *U. lactuca* showed a spawn weight of 21.5 g (Carefoot, 1967). Moreover, it has been described that the occurrence of mycosporine-like amino acids (MAA), which been associated to UV protection in eggs of *A. dactylomela*, is greater in red seaweeds (Carefoot *et al*., 1998). MAA strongly absorb UV radiation in the 310-360 nm range and are widely believed to act as sunscreens against biologically damaging ultraviolet B (UVB, 280-320 nm) and ultraviolet A (320-400 nm) wavelengths. Greater concentrations of MAA are found in shallow marine habitats and lower MAA levels in organisms inhabiting greater depths (Carefoot *et al*., 2000).

Another factor that could, at least in part, account for the lower density of snails in site 1 could be the degree of environmental pollution in Pacheco Beach, that consists of a much more urbanized area than that of site 2. Although no registered data exist on this it has been observed in Pacheco Beach an apparent reduction in biodiversity when compared to Flexeiras Beach.

As far as the size of sea hares is concerned, the fact that the specimens from site 1 were smaller than those from site 2 could be accounted for by the different diet composition in the two places and its nutritional value. Thus, while *U. fasciata*, the main seaweed consumed by specimens from Pacheco Beach, has a total protein content of 6.26% (Ramos *et al*., 1998), the red ones consumed by specimens from Flexeiras, such as *H. musciformis*, have a total protein content of 16.88% (Guedes *et al*., 1988). Besides, the amino acid composition of the protein is another relevant factor to the usefulness of seaweeds as food. Although *Aplysia* prefers green seaweeds, the amino acids of the protein from these seaweeds have poor nutritional value when compared to the red ones (Carefoot, 1987).

In this work *A. dactylomela* specimens were found throughout the year in the two study sites, with one peak of recruitment in the first half of the year. These results agree with those for other *Aplysia* species or populations (Gev *et al*., 1984; Plaut *et al*., 1998).

In conclusion, the population density of *A. dactylomela* in tropical waters from Brazil is much lower than that of sea hares from temperate and sub-tropical regions. This might be due to the intense sun radiation of tropical regions since the other environmental factors were suitable for its settlement. Although its density is low, *A. dactylomela* is found throughout the year, with a recruitment peak at first half of the year. The differences in sea hare's number and size in the two studied sites might be accounted for by differences in seaweed abundance and quality, different degree of sun exposure and distinct pollution levels.

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