Arquivos de Ciências do Mar

DENSITY AND DISTRIBUTION OF *Chiridota rotifera* (POURTALÈS, 1851) (ECHINODERMATA: HOLOTHUROIDEA: CHIRIDOTIDAE) ON PACHECO BEACH, CEARÁ STATE

Densidade populacional e distribuição de *Chiridota rotifera* (Pourtalès, 1851) (Echinodermata: Holothuroidea: Chiridotidae) na Praia do Pacheco, Estado do Ceará

Ana Carolina Martins[1], Inês Xavier Martins[2], Helena Matthews-Cascon[3]

ABSTRACT

The population density and distribution of Chiridota rotifera *on Pacheco Beach, Caucaia, Ceará was investigated in the present study. Sampling was performed from October to December, 2002, and April to July, 2003, using three transects, each 120 m long, from the intertidal to the subtidal zone. The number of individuals was counted with 0,25 m^2 quadrats, and the distribution pattern of specimens was analyzed with the Morisita index. The mean density was 0,8 ind.m^{-2}. The difference between rainy and dry seasons densities was non significant ($p>0.05$). A significant difference on the placement of the specimens in relation to the shoreline during the two seasons was observed ($p<0.05$), with the specimens being found closer to the shoreline during the rainy season. The studied population showed an aggregate distribution.*

***Key words**: Ceará shore, distribution, holothurian, intertidal zone.*

RESUMO

A densidade populacional e distribuição de Chiridota rotifera *na Praia do Pacheco, Caucaia, Ceará foi investigada no presente trabalho. Foram realizadas coletas no período de Outubro a Dezembro de 2002 e Abril a Junho de 2003, utilizando-se três transectos perpendiculares à linha d'água com extensão de 120 metros cada um, desde a região de mesolitoral até infralitoral. Para a contagem de indivíduos, foram utilizados quadrados de 50 cm de lado. Para análise da distribuição dos indivíduos foi utilizado o índice de Morisita. A densidade média encontrada foi 0,8 ind.m^{-2}. A diferença de densidade nas estações seca e chuvosa não foi significativa ($p>0,05$). Houve uma diferença significativa na localização dos organismos em relação à distância da linha de costa nas duas estações ($p<0,05$), sendo os mesmos observados a uma menor distância da linha de costa no período chuvoso. A distribuição dessa espécie foi considerada agregada.*

Palavras-chaves: litoral cearense, distribuição, holotúria, zona entre-marés.

[1] Empresa Brasileira de Pesquisa Agropecuária - EMBRAPA, Amazônia Oriental.
[2] Curso de Engenharia de Pesca, Universidade Federal Rural do Semi-Árido.
[3] Departamento de Biologia, Universidade Federal do Ceará.

INTRODUCTION

Holothuroidea are important members of the sea benthos, playing an essential role on the characterization of the benthic communities and taking active participation in trophic relationships. They occupy several kinds of substrata, being many of them adapted to rocky (or other) substrata. They tend to display aggregated distribution, and might be found in great densities (Hadel *et al*., 1999).

Chiridota rotifera (Pourtalès, 1851) is a small-sized, apode holothurian, reaching 5 cm in length, and 5 mm in diameter. It has twelve short tentacles, and along its cylindrical, vermiform body, it displays white papillae irregularly sorted, where wheel and s-shaped ossicles accumulate (Hendler *et al*., 1995). The coloration of the live animal may range from pink to reddish (Tommasi, 1969).

The geographical distribution of *C. rotifera* ranges from Florida (EUA) to São Paulo (Brazil) (Tommasi, 1969). The individuals of this species are usually found on biodetritic sand among algae, rocks and sea grass, in depths of up to 10 m, despite most of the specimens inhabiting depths of less than 1 m and shallow waters exposed to wave impact (Hendler *et al*., 1995).

In Brazil, this species is widely distributed, been registered for Fortaleza (Ceará) (Lima-Verde, 1969); Salvador, Porto Seguro and Abrolhos Islands (Bahia), Vitória (Espírito Santo), Cabo Frio and Rio de Janeiro (Rio de Janeiro) (Brito, 1962); and São Sebastião (São Paulo) (Tommasi, 1969).

Despite its wide distribution, there are few studies on *Chiridota rotifera* biology and ecology. Among those performed in Brazil, are worth noticeable the studies by Hadel (1997) and Kawauchi (1999), that approached mainly the reproductive aspects of this species.

The present study investigated the population density and pattern of distribution of *C. rotifera* on the intertidal zone of the Pacheco Beach - Caucaia, West coast of Ceará, during the period ranging from September, 2002 to June, 2003.

MATERIAL AND METHODS

The Pacheco Beach (03º41'8.8"S/38º38'1.4"W) is located in Caucaia, 20 km West of Fortaleza City, Ceará State. It's a rocky beach constituted by sandstone reefs, also known as beach rocks (Smith & Morais, 1984), which make the environment suitable to colonization by a great number of algae and a significant benthic community. Many of these animals are found in tide pools during low tides. Due to its proximity to the capital city and its tourist potential, Pacheco Beach finds itself severely devastated by anthropogenic activities (Claudino-Sales, 1993).

In order to study the population density of *C. rotifera* three transects were established in the intertidal zone, perpendicular to the shoreline, each 120 m long, seawards, and 100 m apart from each other. The points were marked with a GPS Garmin III Plus device.

Data collection was performed monthly during diurnal spring tides, for six months – from October to December, 2002, and April to June, 2003 – according to an alternation among the three transects, each being sampled twice on the research, once during the dry season (October to December), once during the rainy season (April to June). Tidal level data were supplied by Diretoria de Hidrografia e Navegação da Marinha do Brasil – DHN.

To perform the counting of *C. rotifera* individuals along the transects, quadrats with 50 cm of side were used. For each two quadrats (1 linear meter), the next quadrat was rejected, that is, 0.5 linear meter. In each quadrat, rocks that could be removed were displaced in order to reach the sandy substratum. Specimens found were measured of length with a Vernier caliper (0.1 mm of precision). The measurement was performed with the animal as relaxed as possible. To analyze the results, the data from each 5 meters were considered.

In the quadrats where individuals were found, sediment samples were collected and ranked according to particle size through rough sieving at the Departamento de Geologia, Universidade Federal do Ceará.

Results were submitted to non-parametric statistical tests on the Statistica for Windows 4.0 software. The values of density and location in which the animals were found were analyzed through Mann-Whitney's **U** test, with a level of significance of 5%. U test might be considered analog to Student's t test for independent samples (Callegari-Jacques, 2003).

To analyze the spatial distribution, Morisita's Index of Dispersion was used, according to the formula:

$$I = n \frac{\Sigma x^2 - \Sigma x}{(\Sigma x)^2 - \Sigma x}$$

where, n = number of sample unities; x = number of animals found for each sample unity.

A value of 1 (one) for Morisita's Index of Dispersion reveals a random distribution; values

lower than 1 (one) reveal a uniform distribution; values higher than 1 (one) mean an aggregated distribution, the maximum value being equal to the number of sample unities (Elliot, 1977).

RESULTS

The period from October to December ,2002 characterized as the dry season, with the most dry month being November. The most rainy trimester was from March to May, with over than 60% of the year rain precipitation. The month with the highest rainfall rate was April.

All the sediment found in the intertidal zone of Pacheco Beach was ranked as very fine sand, according to particle size.

A total of 148 individuals were found, 52 during the dry season and 96 during the rainy season. The density of animals during the dry season was of 6 ind $\cdot 10.m^{-2}$, while during the rainy season it was 10 ind $\cdot 10m^{-2}$. Statistical analysis revealed no significant difference on the density of individuals between the two seasons [U = 3.0; p>0.05] (Figure 1).

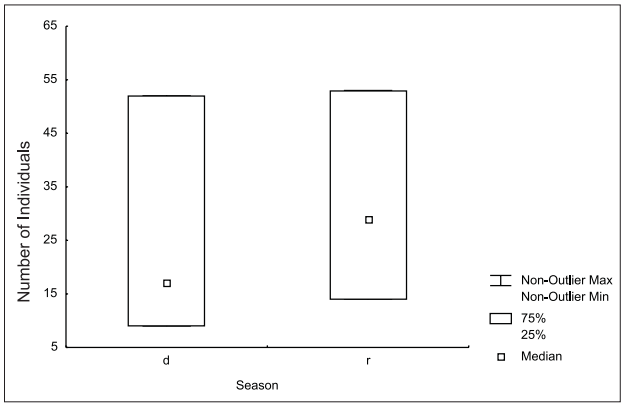

Figure 1 – Density of *Chiridota rotifera* during the dry and rainy seasons on Pacheco Beach (CE), in 2002 and 2003.

The result for the U test (Mann-Whitney's) showed a significant difference on the distribution of the animals in relation to the shoreline between the two seasons [U= 1909.00; p<0.05]. On dry season, 75% of the individuals were present at distances of up to 90 m from the superior intertidal zone. On rainy season, 75% of the individuals were at distances of 72 m at maximum. No holothurians were found in a distance from the superior intertidal zone, smaller than 20 m (Figure 2). The inferior limit for the occurrence of the animals was not determined.

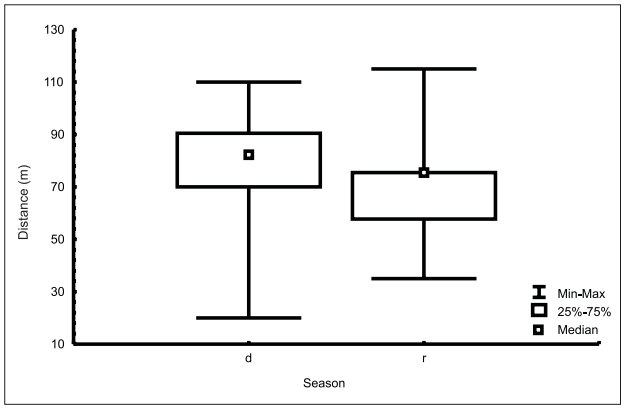

Figure 2 – Distance of occurrence of *Chiridota rotifera* in relation to the shoreline during the dry and rainy seasons, on Pacheco Beach (CE), in 2002 and 2003.

The result of Morisita's Index suggests a high degree of aggregation for these animals, given that the values obtained were much higher than 1 (Table I). 29 groups of organisms were found. The mean value was of circa 5 individuals per group, this value ranging up to 44 holothurians.

DISCUSSION

Benthic marine organisms rarely show uniform distribution, and even in homogeneous areas, both flora and fauna might present an irregular distribution. The spatial distribution is a species characteristic which reflects environmental pressures and behavioral patterns (Parsons *et al.*, 1984).

The gregarious behavior registered in the studied *Chiridota rotifera* population confirms a pattern already observed in many holothurians. According to Hadel *et al.* (1999), many holothurian species display gregarious behavior and are relatively sedentary, what implies the existence of a

Table I - Values of the index of dispersion for each transect, during the dry and rainy seasons.

Transect	1		2		3	
	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season
Morisita's Index (I)	10.34	55.56	6.67	6.15	35.88	19.05
Spatial distribution	Aggregated	Aggregated	Aggregated	Aggregated	Aggregated	Aggregated

structural uniformity for a long period of time. For many marine invertebrates, this type of distribution is a strategy to improve fertilization rates, especially for those that are little movable or completely sessile (Giese & Kanatani, 1987; Levitan *et al*., 1992). Many of these aggregations are related to the feeding habits of the species, mainly among those that feed on suspended material, as *C. rotifera* (Reese, 1966).

In the Istmo do Baleeiro (São Paulo), *C. rotifera* is found aggregated in groups of up to 15 individuals, and are randomly distributed in spots (Hadel, 1997; Kawauchi, 1999). On Pacheco Beach, groups of up to 44 holothurians were recorded. However, groups with a number of individuals above 11 were not commonly found. Thus, the high degree of aggregation was confirmed on Pacheco Beach based on the high values of Morisita's Index of dispersion.

Tropical species tend to reproduce during the hotter months of the year. However, some of the viviparous holothurians, like *Synapta hidriformis* and *C. rotifera*, seem to reproduce all over the year (Clark, 1910; Hyman, 1955). It was evident the presence of animals with different sizes (juvenile and mature) in the same group. Hadel (1997) observed that most juveniles of *C. rotifera* start burying as soon as they are liberated by the adult. Thus, most offspring stay close to the parental individual and only those that don't bury themselves are dispersed. This behavior of aggregation of juveniles was also registered for the apode holothurian *Leptosynapta clarki* (Sewell, 1994).

According to Nybakken (1997), organisms that inhabit the intertidal zone are adapted to withstand and minimize the stress of daily exposition due to low tides. Moreover, this zone is known as the place where there's more action of the waves, henceforth exerting influence on the existing communities.

There are several factors that regulate the population density on the intertidal zone. The upper limit is determined by the ability of the organism to withstand physical factors, while the lower limit is probably determined by biological interactions (Dayton, 1971).

Individuals of *Chiridota rotifera* are commonly found on the intertidal zone, being specially common in tide pools during low tides (Hendler *et al*., 1995). It can be observed that no specimens of *C. rotifera* were found in the first 20 m below the shoreline, probably because this region stays exposed for too long periods during low tides, not allowing the survival of these organisms under these extreme environmental conditions. It's noticeable, also, that the tide pools were formed closer to the upper littoral during the rainy season, what could explain the fact that the specimens were found closer to the shoreline, when compared to those found during the dry season.

The lower limit wasn't determined because it would take a different methodology, since underwater search for individuals of *C. rotifera* would be impaired by the suspension of sediment, that would make the visualization of the animals impossible, mainly in Pacheco Beach, which displays a strong hydrodinamism. Hendler *et al*. (1995) registered that most of the individuals of *C. rotifera* are found down to 1 m deep, though some might be found down to 10 m deep.

Arakaki *et al*. (1999), studying the spatial distribution of the Chiridotidae holothurian *Polycheira rufescens* (Brandt, 1835), observed that the size of the rocks may have an influence on the occurrence of these individuals, since large rocks make up better microhabitats when physical stability is taken, and also as a refuge against desiccation, strong wave impacts and predators. Kawauchi (1999), however, observed that the higher the number of large-sized stones, the smaller was the population density of *Chiridota rotifera*, because smaller quantities of sand were accumulated among the rocks. On Pacheco Beach, this latter pattern was confirmed for *C. rotifera*. Rocks that were considered as large-sized ones were those not subject to removal by hand.

During the months, it was observed that not always the same number of individuals was found on the same place. It was observed that some stones didn't stay in the same place, making the sediment inhabited by *C. rotifera* displaced elsewhere.

Characteristics of the substratum, food availability, light intensity, salinity fluctuations and the presence of predators or conspecific adults are said to be the most relevant variables that exert influence on the distribution of the holothurians (Mercier *et al*., 2000). The distributional patterns of many tropical species of holothurians are also explained by hydrodynamic factors.

According to Pawson (1966), the number of holothurians in a given area varies according to food availability, and tends to be higher in areas where the sediment has a higher organic content. On Pacheco Beach, the sediment is entirely constituted by very fine sand, this not being a limiting factor for the distribution of *C. rotifera* on this beach.

It was not observed predation on *C.rotifera* during the period of sampling. There are few cases of natural predation on holothurians, as these organisms developed many anti-predatory strategies (Hyman, 1955). Kawauchi (1999) suggested the unpalatability

of *C. rotifera* as a probable cause for the absence of natural predator of this species.

The area of study shows a topography that enables protection for the animals against the wave impact, as well as fissures on the rocks, and sediments that allow burial. Almost all of the animals were found buried and hidden in grottos, and only a small number appeared among the seaweed, despite the lack of supporting evidence, as reported by Hendler *et al*. (1995).

Acknowledgements - We thank Dr. Luis Parente, from the Laboratório de Geologia Marinha Aplicada of the Universidade Federal do Ceará for the sediment analysis and Dr. Paulo Cascon for comments on the manuscript.

REFERENCES

Arakaki, S.; Yamahira, K. & Tokeshi, M. Sex change and spatial distribution pattern in an intertidal holothurian *Polycheira rufescens* in the reproductive season. *Researches on Population Ecology*, v.41, p.235-242, 1999.

Brito, I.M. Ensaio de catálogos dos Equinodermas do Brasil. *Centro de Estudos Zoológicos,* v.13, p. 326-338, 1962.

Callegari-Jacques, S.M. *Bioestatística: princípios e aplicações*. Artmed, 255 p., Porto Alegre, 2003.

Clark, H.L. The development of an apodous holothurian (*Chiridota rotifera*). *.J. Exper. Zool.,* v. 9, p. 497-516, 1910.

Claudino-Sales, V. Sistemas Naturais e Degradação sócio-ambiental no Estado do Ceará, p. 9-36, in *Diagnóstico Sócio-ambiental do Estado do Ceará: o Olhar da Sociedade Civil*, 1993.

Dayton, P.K. Competition, disturbance and community organization: the provision and subsequent utilization of space in rocky intertidal community. *Ecol. Monogr.*, v.41, p.351-89, 1971.

Diretoria de Hidrografia e Navegação, Tabua de Marés 2003. Disponível em www.mar.mil.dnh.br

Elliot, J.M. *Some methods for the statistical analysis of samples of benthic Invertebrates*. Freshwater Biological Association, 144 p., Cumbria, 1977.

Fundação Cearense de Meteorologia e Recursos Hídricos, Monitoramento Hidroambiental de 2003. Disponível em www.funceme.br

Giese, A.C. & Kanatami, H. Maturation and spawning, p.251-329, *in* Giese, A.C.; Pearse, J.S.& Pearse, V.B. (eds.), *Reproduction of marine invertebrates. IX. General aspects: seeking unity in diversity*.. Blackwell Scientific Publication, Palo Alto, 1987.

Hadel, V.F. *Reprodução e comportamento de* Chiridota rotifera *(Echinodermata: Holothuroidea) em laboratório*. Tese de Doutorado, Universidade de São Paulo, Instituto de Biologia, 190 p., 1997.

Hadel, V.F.; Monteiro, A.M.G.; Ditadi, A.S.F.; Tiago, C.G. & Tommasi, L.R. Echinodermata, pp. 261-271 *in* Migotto, A. & Tiago, C.G. (eds.), *Biodiversidade do Estado de São Paulo, Brasil: síntese do conhecimento ao final do século XX. Parte 3: Invertebrados marinhos.* FAPESP, São Paulo, 1999.

Hendler, G.; Miller, J.E.; Pawson, D.L. & Kier, P.M. *Sea stars, Sea urchin and allies. Echinoderms of Florida and the Caribbean*. Smithsonian Institution Press, 390 p., Washington, 1995.

Kawauchi, G.I. *Estratégias reprodutivas e de dispersão em* Holothuroidea apoda *(Echinodermata)*. Dissertação de Mestrado, Universidade de São Paulo, Instituto de Biologia, 122 p., 1999.

Levitan, D.R.; Sewell. M. & Chia, F.S. How distribution and abundance influence fertilization success in the sea urchin *Strongylocentrotus franciscanus*. *Ecology*, v.73, p.248-254, 1992.

Lima-Verde, J.S. Primeira contribuição ao inventário dos equinodermas do Nordeste Brasileiro. *Arq. Ciên. Mar*, v.9, n.1, p.9-13, 1969.

Mercier, A.; Battaglene, S.C. & Hamel, J-F. Periodics movement, recruitment and size-related distribution of the sea cucumber *Holothuria scabra* in Solomon Islands. *Hydrobiologia*, v. 440, p.81-100, 2000.

Nybakken, J.W. *Marine Biology: an ecological approach*. Assison-Wesley Education Publishers Inc., 481 p., 1997.

Parsons, T.R.; Takahashi, M. & Hargrave, B. *Biological oceanographic processes*. Pergamon Press, 220 p., Oxford, 1984.

Pawson, D.L. Ecology of holothurians, p. 63-71, *in* Boolotian, R.A. (ed.), *Physiology of Echinodermata.* Interscience Publishers, New York, 1966.

Reese, E.S. The complex behaviour of echinoderms, p. 157-218, *in* Boolotian, R.A. (ed.), *Physiology of Echinodermata.* Interscience Publishers, New York, 1966.

Sewell, M.A. Birth, recruitment and juvenile growth in the intraovarian brooding sea cucumber *Leptosynapta clarki* (Echinodermata:Holothuroidea) in British Columbia. *Mar Ecol. Progr. Ser.*, v.114, p.149-56, 1994.

Smith, A.J. & Morais, J.O. Estudos preliminares sobre a geologia ambiental costeira do estado do Ceará, nordeste do Brasil. *Arq. Ciên. Mar,* v.23, p.85-96, 1984.

Tommasi, L.R. Lista dos Holothuroidea recentes do Brasil. *Contr. Inst. Oceanogr. Univ. São Paulo*, v.15, p.1-39, 1969.