Temporal and Spatial Variation of Benthic Intertidal Community of a Sandstone Reef in Pernambuco—Brazil as a Tool to Evaluate Bioinvasion

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Abstract: In this study, the superior and inferior intertidal areas of hard substrate were sampled during the rainy season (June and August) and dry season (October and December) of 2015 at Piedade Beach. The percent cover of *Chthamalus bisinuatus*, *Brachidontes solisianus*, *Isognomon bicolor*, *Ulva* spp. and filamentous green algae were measured with a 20 × 20 cm quadrat with one hundred intersections. The quadrats were placed randomly at the sampling sites of Piedade reef. One-way ANOVAs (Analyses of Variance) were used to test the temporal variation of the studied organisms. *Chthamalus bisinuatus* occurred only in the superior mesolitoral where they had an increase in percent cover during the dry season, which wasn't statistically significant. *Brachidontes solisianus* occurred in both superior and inferior levels and had a significant decrease in the superior intertidal during the dry season. *Isognomon bicolor* occurred only in the inferior level and decreased to almost zero in the December. *Ulva* spp. and green filamentous algae had an opposite pattern in the inferior intertidal although only the filamentous algae showed a significant decrease in the dry season. Organisms such as *Chthamalus bisinuatus* resists better the heat and are dominant in the superior intertidal levels of reefs and rocky coasts. *Brachidontes solisianus* didn't change much in the lower intertidal and showed that can coexist with the invasive *Isognomon bicolor*. While the filamentous green showed a decrease in the dry season probably more affected by desiccation than *Ulva* spp. at Piedade reef.

Key words: Bioinvasion, community ecology, sandstone reefs, *Isognomon bicolor*.

1. Introduction

The coastal reefs of the urban Pernambuco regions suffer with algal overgrowth that in intertidal regions compete mainly with mollusks and crustaceans. These algae grow attached to the substrate or as drift in reef pools [1-3]. The increase in biomass and cover of substrate is related to the increment in nutrients and available light after the rainy season, with predictable nutrient accumulation in the algal thallus. Algae, specially the perennial, are affected by the waves action, which cause algal drift on the coast that can happen also with the filamentous green algae [3]. The sedimentation and species' invasion are other harmful

factors that affect the reefs. The invasive bivalve *Isognomon bicolor* comes from the Caribbean sea and could have been introduced in the Brazilian coast by ballast water or ship biofouling [4, 5]. Its occurrence extends from the northeast to south coast of Brazil [6]. This organism settles mainly in the intertidal zone and competes with the bivalve *Brachidontes* and cirripedia such as *Tetraclita* [7]. Studies on intertidal indicate that the biotic factors, as competition for space and predation, more strongly affect the lower limit of the organisms, and the physical factors affect more in the upper limit [8, 9]. *Chthamalus* were observed as competitive superior after substrate cleaning and desiccation in relation to *Brachidontes* on the Piedade reefs [2, 10]. While green algae were found with greater biomass in the months just after the rainy season [11]. *Isognomon bicolor* also had a greater

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density during the rainy season showing that desiccation can maintain bivalves and specially barnacles showing a resistance to bioinvasion during the dry season [2, 5]. Predation by *Stramonita haemastoma* can be preferential over the native organisms *Chthamalus* and *Brachidontes*. The occurrence of cirripedia and *Brachidontes* in the superior and inferior intertidal show that spatial variation can also help coexistence of bioinvasion in addition to seasonality. In this study, percent cover of *Chthamalus bisinuatus*, *Brachidontes solisianus*, *Isognomon bicolor*, *Ulva* spp. and filamentous green algae were measured with the objective of evaluate the spatial variation of these species on the intertidal in dry and rainy periods to demonstrate the possibility of coexistence and resistance to bioinvasion.

2. Materials and Methods

Piedade Beach is located in Jaboatão dos Guararapes district, in the southern littoral of Pernambuco state, between 08°11'08.48'' S and 34°55'04.66'' W-08°11'03.45'' S and 34°55'03.24'' W. The reef is oriented obliquely in relation to the littoral and is covered by water during high tides [1].

The local climate is characteristic of the Tropical Atlantic, with an average air temperature of 26 °C. The annual pattern of rainfall defines two seasons: the dry season (from October through February) and the rainy season (from March through September). Three random 20 × 20 cm quadrats with one hundred intersections were sampled on the upper and lower mesolitoral to evaluate percent cover of dominant algae and benthic invertebrate in the months of June, August (rainy season) and October and December (dry season) of 2015. One-way ANOVAs and Tukey tests were made after square root transforming the data to confirm seasonal variation of the dominant reef biota.

3. Results

Chthamalus bisinuatus was more abundant on upper intertidal than in the lower intertidal. This species was significant more abundant on dry season but not statistically (Fig. 1).

Brachidontes solisianus occurred in both superior and inferior levels and had a significant decrease in the superior intertidal during the dry season ($p < 0.05$) whereas percent cover did not show significant variability in the inferior level ($p > 0.05$).

Fig. 1 Temporal variation of *Chthamalus bisinuatus* at Piedade reef.

Fig. 2 Temporal variation of *Brachidontes solisianus* at Piedade reef.

For *B. solisianus*, percent cover in both months June and August were significantly different than October and December confirming the decrease during the dry season (Fig. 2).

Isognomon bicolor occurred only in the inferior level and decreased to almost zero in the December ($p < 0.05$) which was different from the other 3 sampling

months (Fig. 3).

Ulva spp. and green filamentous algae had an opposite pattern in the inferior mesointertidal (Fig. 4), although only the filamentous algae showed a significant decrease in the dry season ($p < 0.05$) they can be influenced by pollution and grow just after the rainy season in urbanized areas [11, 13].

Fig. 3 Temporal variation of *Isognomon bicolor* at Piedade reef.

Fig. 4 Temporal variation of algae at Piedade reef.

4. Discussion

Intertidal biota are subjected to the influence of temporal variation related to environmental factors such as temperature which can increase desiccation and salinity that may change due to rainfall. *Chthamalus bisinuatus* showed an increase in the lower and upper intertidal during the dry season, which was not significantly different from the rainy season ($p > 0.05$), this species has been shown to be superior competitor than *Brachidontes solisianus* resisting more to desiccation and growing on the mollusk shell [2].

The zonation patterns and temporal variation of intertidal organisms can maintain biodiversity and allow coexistence with exotic species in intertidal regions, however, competition of *Isognomon bicolor* has decreased cirripedia and bivalve density in Arraial do Cabo, RJ intertidal [12]. *Stramonita haemastoma* was observed on the inferior mesolitoral such as *Colisela subrugosa* during the rainy season which can affect predation of invertebrates and algae and the outcome of competition [4]. Reef sedimentation which occurred at the beach filling of Piedade Beach can be harmful to the local biota [13] by burrowing invertebrates and algae and stressing photosynthesis and recruitment. Previous studies detect the greater density of *Brachidontes solisianus* during the dry season [5] which can show greater resistance to desiccation when compared to *Isognomon bicolor* which together attest the coexistence of these species besides the harmful effect of bioinvasion.

References

- [1] Simões, I. P., Guimaraens, M. A., Oliveira-Carvalho, M. F., Valdevino, J., and Pereira S. M. B. 2009. "Floristic Evaluation and Ecological Succession of Macroalgae in Reefs at Piedade Beach-PE." *Neotropical Biology and Conservation* 4: 49-56.
- [2] Guimaraens, M. A., Luz, B. R. A., Silva, J. F., and Carneiro, J. P. S. 2011a. "Modeling the Succession of Barnacles and Mussels on a Sandstone Reef in Pernambuco State, Brazil." *Hydrobiologia* 658 (1): 365-72.
- [3] Guimaraens, M. A., Macedo, S. J., Oliveira-Carvalho, M. F., Burgos, D. C., and Pereira S. M. B. 2012. "Modeling Temporal Variations of *Gracilaria* Greville and *Hypnea* J. V. Lamouroux (Rhodophyta) Assemblages on a Midlittoral Reef Platform at Piedade Beach, Pernambuco State, Brazil." *Brazilian Journal of Botany* 35 (4): 377-84.
- [4] López, M. S., Coutinho, R., Ferreira, C. E. L., and Rilov, G. 2010. "Predator-prey Interactions in a Bioinvasion Scenario: Differential Predation by Native Predators on Two Exotic Rocky Intertidal Bivalves." *Marine Ecology Progress Series* 403: 101-12.
- [5] Guimaraens, M. A., and Dias, V. 2015. "Temporal Variation of Population Structure of the Invasive *Isognomon bicolor* (Mollusca, Bivalvia), *Brachidontes solisianus* (Mollusca, Bivalvia) and *Ulva* spp. (Chlorophyta, Ulvales) Biomass, Pernambuco-Brazil." *International Journal of Marine Science* 43: 1-5.
- [6] Domaneschi, O., and Martins, C. M. 2002. "Isognomon bicolor (C.B. Adams) (Bivalvia: Isognomonidae) First Register to Brazil and Redescription of the Species and Considerations about the *Isognomon* distribution at the Brazilian Coast." *Revista Brasileira de Zoologia* 19: 611-27.
- [7] Breves-Ramos, A. 2004. "Distribution, Abundance and Population Structure of *Isognomon bicolor* (Adams, 1845) on the Litoral of Rio de Janeiro State, Brazil." Ph.D. thesis, Universidade Federal do Rio de Janeiro.
- [8] Connel J. H. 1961. "Influence of Interspecific Competition and Other Factors on Distribution of Barnacle *Chthamalus stellatus*." *Ecology* 42 (4): 710-23.
- [9] Louthan A. M., Doak D. F., and Angert A. L. 2015. "Where and When do Species Interactions Set Range Limits?" *Trends in Ecology and Evolution* 30 (12): 780-92.
- [10] Almeida, L. R., Guimaraens, M. A., Luz, B. R. L., and Porto-Neto, F. F. 2008. "Interaction between Colonization and Ecological Succession Processes of Biofouling Communities at Piedade Beach." *Tropical Oceanography* 36: 40-6.
- [11] Guimaraens, M. A., Silva, J. M. A., and Falcão, D. 2011b. "Temporal Variability in Macroalgae Recruitment and Succession on Sandstone Reefs at Piedade Beach-PE, Brazil." *Neotropical Biology and Conservation* 6 (3): 170-7.
- [12] Ferreira, C. E. L., Junqueira, A. O. R., Villaca, M. C., and Lopes, R. M. 2009. "Marine Bioinvasions in the Brazilian Coast: Brief Report on History Events, Vectors, Ecology, Impacts and Management of Non-indigenous Species." *In*

Biological Invasions in Marine Ecosystems, edited by Rilov, G. and Crooks, J. A. Berlin: Springer-Verlag, 459-77.

[13] Portugal, A. B., Carvalho, F. L., Carneiro, P. B. M., Rossi

S., and Soares, M. O. 2016. "Increased Anthropogenic Pressure Decreases Species Richness in Tropical Intertidal Reefs." *Marine Environmental Research* 120: 44-54.