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DETERMINANT DRIVERS FOR THE COMMUNITY STRUCTURE OF BENTHIC MACROINVERTEBRATES IN COASTAL LAGOONS AT THE RESTINGA DE JURUBATIBA NATIONAL PARK, IN THE STATE OF RIO DE JANEIRO STATE (BRAZIL)

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Abstract: This study aimed to characterize and evaluate factors driving the structure of the benthic macroinvertebrate community in coastal lagoons at the Restinga de Jurubatiba National Park. Sixteen lagoons were sampled in July 2010 during the dry season. At each lagoon, three samples were taken in the central region and three samples were taken near the sandbar. At each point, the limnological variables and the benthic community were collected. Richness and abundance were calculated for each sample. The correlations among the environmental parameters were tested using Pearson's correlation. A Principal Component Analysis using environmental variables was performed to visualize the similarity among samples. Simple regressions were used to assess the correlation between macroinvertebrates' metrics and environmental parameters. A redundancy test was performed to link environmental parameters to the community structure of macroinvertebrates. A total of 1,719 macroinvertebrates were identified in 11 taxa groups that were classified as exclusive marine taxa, five as brackish/marine taxa, seven as freshwater taxa, and two taxa as groups with marine and freshwater representatives. The most abundant taxa were *Leonereis* sp., *Heleobia australis*, and Kalliapseudidae. Richness and abundance were positively related to salinity. The redundancy test indicated pH, salinity, coarse grain size, and dissolved oxygen as the environmental variables explaining the macroinvertebrate community structure variation among the lagoons. Understanding the drivers and dynamics which guide the macroinvertebrates communities' turnover in coastal lagoons is a relevant tool to subsidize environmental management decisions due to the increasing threats around the park.

Keywords: benthic fauna; environmental factors; lentic environments; neotropical lagoons.

INTRODUCTION

Tropical coastal lagoons are important transitional ecosystems between marginal, terrestrial, and marine environments (Kjerfve 1994). Their geophysical characteristics and origins are important features that characterize them as aquatic systems with a complex environmental gradient. They show marked variation in their physical and chemical parameters, such as salinity, electrical conductivity, pH, nutrient content, turbidity in the water column and granulometry and organic matter load in sediment (Tagliapietra 2009, Tlig-Zouari 2009, Netto 2017).

The degree of intrusion of seawater and the hydrological conditions are responsible for the functioning of coastal lagoons (Zaldivar 2008, Netto 2017). These can show high salinity fluctuation, which is mainly regulated by the proximity, connection, as well as water flow and water exchange between the lagoons and the sea. The constant intrusion or the total absence of sea intrusion are important to control the hydrological regime of shallow coastal lagoons and to maintain the stability and functioning in feedback mechanisms for aquatic organisms (Netto 2017, Rosqvist 2010).

Seawater's intrusion can bring with it resources, such as prey and nutrients, and turn water temperatures mild, but it can also affect salt and water homeostasis on aquatic biota. Salinity acts on the osmoregulatory potential of aquatic organisms. A high fluctuation in salinity is generally lethal for marine and freshwater organisms (Sanders *et al.* 1965, Yamamuro 2000, Pechenik *et al.* 2000, Teske & Wooldridge 2003, Kanaya & Kikuchi 2008), and some specialized species can tolerate environmental extremes of salinity levels.

Because coastal lagoons are unstable systems (Krum *et al.* 2021), they may present dominance of marine, freshwater, and often estuarine organisms. Due to the variation of environmental stressors, the only groups of species that are usually found here are those that are able to tolerate such fluctuations of short or long term (varying from days to years) in the parameters regulated by the influence of the sea (Tlig-Zouari 2009), or may present cycles of recurrent successions aimed at stabilizing a condition imposed by the influence of the sea. Nonetheless, few species have sufficient physiological and adaptive potential to live in such conditions.

Macroinvertebrates are critical in some ecosystems processes, as they act in the energy flow to higher trophic levels and in the decomposition of organic matter (Abílio *et al.* 2007), among other functions. In addition, the benthic macroinvertebrates are used to assess the environmental conditions of the freshwater ecosystems because they are widely distributed, have little dislocation capacity, and have a long-life cycle and rapid response to environmental stress. Also, the group consists of a large number of species with different responses and levels of tolerance to the impacts (Martins *et al.* 2008).

Studies have shown that salinity is a stress factor for benthic invertebrates (Piscart 2005, Obolewski 2018, Mrozinska 2021). According to those authors, the increase in the salinity gradient generally results in a decreasing trend in the richness and abundance of benthic species, due to the greater instability of environmental conditions in lagoons with marine intrusions. Thus, salinity acts as the main factor controlling the functioning of coastal lagoons and seems to be the main driver of the distribution of the macroinvertebrates community. Therefore, the salinity is an indispensable monitoring requisite for the proper assessment of the ecological status of those environments and for the development of suitable tools that subsidize environmental management decisions for protecting coastal lagoons.

Besides the natural fluctuations of environmental parameters, other indirect changes caused by anthropogenic activities of great magnitude in areas adjacent to coastal lagoons can generate changes in macroinvertebrates community without directly modifying environmental parameters. Machinery movement, transport of material and high flow of people make noise and visual pollution that eventually generate major disturbances to the local trophic web and can, consequently, pose serious risks to the biodiversity that the coastal lagoons shelter and to the ecosystem services performed.

Tropical coastal lagoons are ecosystems that usually show great anthropic pressure in their surroundings, due to the historical strategic occupation of coastal territories with city and port buildings, the wide financial speculation of the real estate market in the area around the coast, among other factors. As a result, many coastal lagoons have become extinct or are extremely polluted, and the few remaining preserved areas present biodiversity that is strongly threatened to extinction. According to Appiah *et al.* (2017), Esteves *et al.* (2002) and Barbosa *et al.* (2004), coastal lagoons should be prioritized in the preservation plans and in conservation units existing in Neotropical countries.

This study attempts to characterize the benthic macroinvertebrate community in the coastal lagoons at the conservation unit (CU) *Parque Nacional Restinga de Jurubatiba* (north of the state of Rio de Janeiro, Brazil) and analyze the relationship between environmental variation and the structure of this community during the dry season. To do so, we used a set of coastal lagoons (spatial variation) with distinct salinity gradients (freshwater, brackish and marine water) to test the hypothesis that physicochemical and environmental parameters of water column play a significant role in the distribution of macroinvertebrates assemblages in the coastal lagoons from the PARNA Jurubatiba. Furthermore, this conservation unit is starting to suffer the pressure from deforestation in the surroundings, the exploration of the offshore industry on the continental shelf, and the possible construction of a large harbor facility adjacent to the CU.

MATERIAL AND METHODS

Study area

The present study was carried out at 16 coastal lagoons at *Restinga de Jurubatiba National Park* (PARNA Jurubatiba), located in the northeast of Rio de Janeiro State, between 22º05' - 22º20' S and 41º15' - 41º45' W within the Macaé, Carapebus and Quissamã municipalities. This region has a humid tropical climate with average monthly temperatures above 18 °C, relative humidity of 80% and approximately 1100 mm of rain per year (Diegues & Rosman 1998). The rainy season is concentrated between the months of December and March, and the dry season between June and August (Diegues & Rosman 1998). All coastal lagoons studied are shallow and have variations in the perimeter and area. Furthermore, the lagoons are permanently "closed" systems (with no direct and natural connection - inlets - to the sea). Some of them can show an intermittent connection with the sea due to accidental or intentional sandbar opening, or due to seawater intrusion during storm events, generating a great difference in salinity concentration throughout the year, and ranging from freshwater to brackish / saline waters between periods of rain and drought (Caliman *et al.* 2010).

Sampling design of environmental parameters and benthic community

Sixteen lagoons were sampled in July 2010 during the dry season. We chose the dry season for this study because the gradient of environmental variables is pronounced during this period. This means that the influence of the variables on the macroinvertebrates structure and distribution increases during the dry season, whereas there is a homogenization of the variables observed in the lagoons during the rainy season due to the increase in rainfall. Limnological variables were assessed by probe, and samples of water and sediment were taken at the centre and near the sandbar region (the natural sedimentary barriers which impound the lagoon and restrict the direct connection to the sea) at each coastal lagoon.

Environmental variables

The environmental variables: water column physicochemical parameters, sediment grain size and organic matter were measured and collected, respectively, after sampling the benthic macroinvertebrate. The water column physicochemical parameters: temperature (°C), dissolved oxygen (mg/L), and salinity were determined in-situ by a multiparameter probe YSI-85. Following CONAMA N° 357 Brazilian resolution, lagoons were classified as freshwater, brackish and marine environments. Water samples were collected using a polypropylene bottle (1 L) and taken to the laboratory for pH analysis (QUIMIS-Mod. Q400MT). The water depth was measured using a millimetre rope (with an anchor), with distance marks properly distributed all along its length. The sediment grain size was determined using the method proposed by Folk & Ward (1957), where an aliquot of approximately 100 grams of dry sediment passes through a sequence of sieves with openings between 2.5 and 0.4 millimetres for 30 minutes to separate grain size. For the calculation of the organic matter content, the collected sediment was combusted at 550 ºC for 4 hours in a muffle, then the remaining content was calculated by the gravimetric difference obtained before and after the combustion.

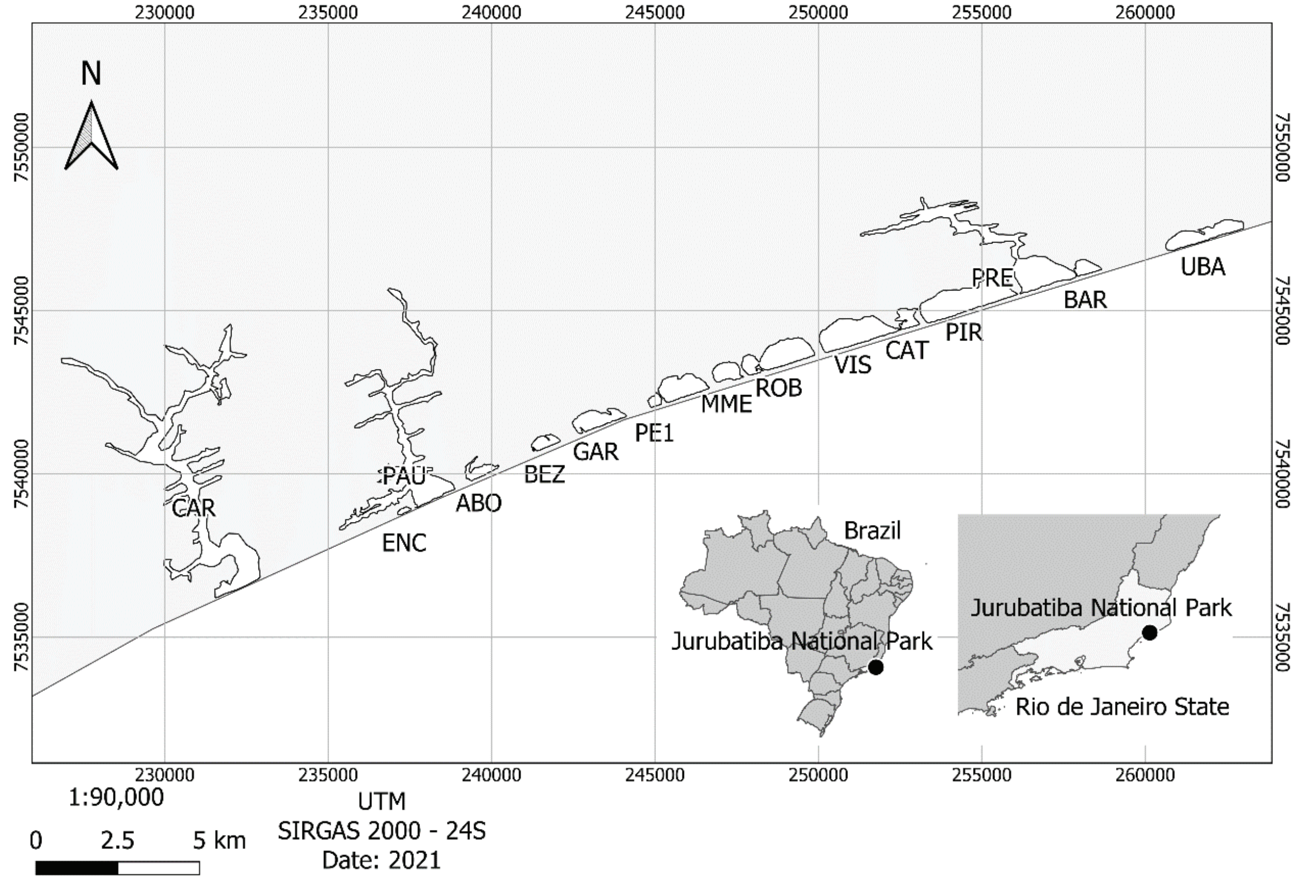

Figure 1. Position and geophysical characteristics of the 16 coastal lagoons at Restinga de Jurubatiba National Park sampled in this study and numbered as follows: CAR -Carapebus, ENC - Encantada, PAU - Paulista, ABO - Amarra Boi, BEZ - Bezerra, GAR - Garças, PE1 - Piripiri 1, PE2 - Piripiri 2, MME - Maria Menina, ROB - Robalo, VIS - Visgueiro, CAT - Catingosa, PIR - Pires, PRE - Preta, BAR - Barrinha, and UBA – Ubatuba.

Macroinvertebrates community sampling

The benthic macroinvertebrate community was sampled using a core sampler (0.018 m²) in the central region of the lagoon as well as a Van Veen Grab sampler (0.045 m²) near the sandbar. It was necessary to use two types of samplers due to the substrate heterogeneity in different regions of the lagoon. Three replicates were taken at each sample site. The samples were packed in plastic bags, fixed in the field with 10% formaldehyde, and taken to the laboratory. At the laboratory, each sample was washed at 1000 and 500 µm sieves to reduce the organic and inorganic material volume and to retain the macroinvertebrate individuals. The remaining material in the sieves was disposed of in white trays and sorted until the removal of all the macroinvertebrate individuals was completed. The sorted macroinvertebrates were preserved at 80% alcohol for future identification under a stereoscopic microscope to the lowest possible taxonomic level using specific identification keys Mugnai *et al.* (2010). The three replicates of each sample site were joined in a single sample for posterior statistical analysis. Community metrics, such as abundance and taxonomic richness, and relative abundance were calculated for one square meter for each sample.

Statistical analysis

The correlation among the environmental parameters was done by a Pearson correlation test, and only the parameters with correlation coefficient between -0.6 and 0.6 were selected for posterior analysis. A Principal Component Analysis (PCA) was used to evaluate the similarity and data distribution among sites regarding the environmental variables. Also, simple regressions were used to assess the variability of macroinvertebrate taxa richness and total abundance regarding the environmental parameters. A redundancy analysis (RDA) for community composition was used to assess how the composition and taxa abundance were linked to the environmental variables, using the Hellinger transformation in the abundance data to better fit using linear methods. Then, the function *forward.sel* from the *Adespatial* package on R was carried out to select the variables that better explain the data variation. Correlation and regression tests were carried out using PAST v3.4 statistical software, and the RDA was carried out in R software (*vegan* package).

RESULTS

A total of 1,719 macroinvertebrates were sampled and identified in 25 taxa and 17 orders. From the total taxa, 11 groups were classified as exclusive marine taxa, five as brackish/marine taxa, seven as freshwater taxa, and two taxa were identified as groups with marine and freshwater representatives (Table 1). Taxa richness and abundance varied between 1 to 7 and 1 to 278, respectively among the sampled sites. The most abundant taxa were *Leonereis* sp. (468 individuals), with high abundance in certain lagoons, *Heleobia australis* (699 individuals) well distributed throughout the coastal lagoons, and the family Kalliapseudidae, with 182 individuals recorded in one lagoon only.

Environmental variables mean values can be observed in Table 2. After the collinearity test, depth, dissolved oxygen, pH, salinity, organic matter content, and coarse, medium, and fine sand fractions were selected to perform the PCA (Figure 2, Table 3). The main variables explained 46% of environmental data variation: dissolved oxygen and coarse sand grain size positively correlated with the first component, pH negatively correlated with the same component, and salinity positively correlated with the second component.

The taxa richness and abundance of individuals were positive correlated to salinity ($R^2 = 0.25$, $p = 0.01$ and $R^2 = 0.28$, $p = 0.01$, respectively). The RDA revealed that the environmental variables explained 40% of the macroinvertebrate community composition (Figure 3, ANOVA, 999 permutation, $F = 1.74$; $p = 0.001$), and the main variables were pH, salinity, coarse grain size, and dissolved oxygen (Figure 3). Some taxa were directly associated with the environmental factors: *Heleobia australis* was correlated with pH, *Nephty* sp. with the medium sand grain size, and some freshwater taxa such as *Gyrinidae* n.i., Hydroptilidae n.i., Chironomidae n.i. and Cordullidae n.i. were associated with the organic matter content.

DISCUSSION

In the present study, two of the total sample points were characterized by freshwater (< 0.5 ppt) and one by marine salinity, while all the others were characterized as brackish waters with salinity variation between 0.1 to 30.2 ppt among all sites. According to Attayde & Bozelli (1998), orthogonal lagoons are completely freshwater systems with some variation in salt concentration in the regions near the sea, due to occasional marine storms. In contrast, parallel lagoons have more marine influence. We found a salinity gradient independent of lagoon orientation an origin, but with a positive association with the proximity of the sample point to the marine environment. In general, sample points near the sand barrier present higher salinity values.

Our results are consistent with other studies, showing a positive linear relationship between species richness with increased salinity concentration (Obolewski 2018, Reizopoulou 2013). According to those authors, the benthic community reaches the highest species richness in areas with the highest salinity and it declined with decreasing salinity, reaching a minimum in the area called Artenminimum, and increased again with a greater influx of freshwater with the appearance of species from freshwater habitats when connected with river inputs. According to Obolewski (2018), in shallow lagoons with regular intrusion like studied lagoons, the abundance of benthic fauna may be high; and marine inputs potentially create the called Windows of Opportunity.

According to Reizopoulou (2013), at coastal lagoons, the environmental gradient is shaped mostly by seawater intrusion, and the sharper the spatial variations of salinity, the lower the number of species and the diversity level of the system. We know that PARNA coastal lagoons are differently affected by water intrusions; however, exists a lack of information about it. However, during the dry season, lagoons seem to be more stable regarding environmental variations due to sporadic storm

Table 1. List of taxa registered in each lagoon and its environment (m – marine; br – brackish, fr – freshwater). Lagoons CAR -Carapebus, ENC - Encantada, PAU - Paulista, ABO - Amarra Boi, BEZ - Bezerra, GAR - Garças, PE1 - Piripiri 1, PE2 - Piripiri 2, MME - Maria Menina, ROB - Robalo, VIS - Visgueiro, CAT - Catingosa, PIR - Pires, PRE - Preta, BAR - Barrinha, and UBA - Ubatuba. Sandbar – B, Centre – C.

Taxa	Lagoons	ABO	ABO	PAU	PAU	BEZ	BEZ	ENC	ENC	PRE	PRE	PE1	PE1	PE2	PE2	BAR	BAR	UBA	UBA	PIR	PIR	GAR	GAR	CAT	CAT	MME	MME	CAR	CAR	ROB	ROB	VIS	VIS
	Environment	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**
Ordem Coleoptera																																	
Gyrinidae n.i.	fr					X	X											X															
Elmidae n.i.	fr											X																					
Ordem Trichoptera																																	
Hydroptilidae n.i.	fr	X																															
Ordem Diptera																																	
Ceratopogonidae n.i.	fr							X	X			X					X	X															
Chironominae n.i.	m/fr					X	X	X							X			X			X									X			
Tanypodinae n.i.	fr																				X												
Ordem Odonata																																	
Corduliidae n.i.	fr	X																															
Gomphidae n.i.	fr			X																													
Ordem Tanaidacea																																	
Kalliapseudidae n.i.	m							X												X		X				X	X	X					
Ordem Amphipoda																																	
Hyalellidae n.i.	m																															X	X
Ordem Decapoda																																	
Decapoda n.i.	fr/m																			X													

Table 1. Continues on next page...

Table 1. ...continued

Taxa	Lagoons	ABO	ABO	PAU	PAU	BEZ	BEZ	ENC	ENC	PRE	PRE	PE1	PE1	PE2	PE2	BAR	BAR	UBA	UBA	PIR	PIR	GAR	GAR	CAT	CAT	MME	MME	CAR	CAR	ROB	ROB	VIS	VIS
	Environment	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**	**B**	**C**
Ordem Isopoda																																	
Isopoda n.i.	m/br/fr													X																X		X	
Classe Polychaeta																																	
Laeonereis sp.	m															X	X	X	X	X	X			X	X		X			X	X		X
Nephtys sp.	m			X				X	X													X	X					X	X				
Heteromastus sp.	m			X																X		X	X	X	X	X	X					X	X
Boccardiella sp.	m																				X												
Dipolydora sp.	m																														X		
Sigambra sp.	m																															X	X
Classe Oligochaeta																																	
Tubificinae n.i.	m/br/fr																							X		X	X						X
Tectidrilus sp.	m/br																															X	
Limnodriloides monothecus	m/br																													X			
Classe Bivalvia																																	
Telinidae n.i.	m			X	X			X	X		X									X		X	X			X		X		X	X		
Solenidae n.i.	m																															X	X
Classe Gastropoda																																	
Heleobia australis	m/br			X	X			X	X				X			X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
Thiaridae n.i.	m							X												X													

Table 2. Environmental variables: Area (Km²), Distance (to the sea - m), Depth (m), Temperature (°C), Salinity, Dissolved oxygen (mg/L), pH, Organic matter (%), Coarse sand (%), Medium sand (%), fine sand (%), Silt/Clay (%), Mean, Minimum – Min, Maximum – Max, Standard deviation – SD.

	Min	Max	Mean	SD
Area (m2)	0.0002	6.5	1.23	1.77
Distance (to the sea - m)	71.17	3286.7	444	688.55
Depth (m)	0.50	1.40	0.88	0.24
Temperature (°C)	20.8	24.6	22.7	1.02
Salinity	0.10	30.20	9.42	8.7
Dissolved Oxygen (mg/L)	4.53	8.55	6.79	1.16
pH	3.99	9.8	7.86	1.01
Organic matter (%)	0.000	0.85	0.21	0.21
Coarse sand (%)	0.037	0.94	0.56	0.24
Medium sand (%)	0.003	0.26	0.11	0.08
Fine sand (%)	0.008	0.29	0.05	0.05
Silt/Clay (%)	0.0005	0.95	0.27	0.29

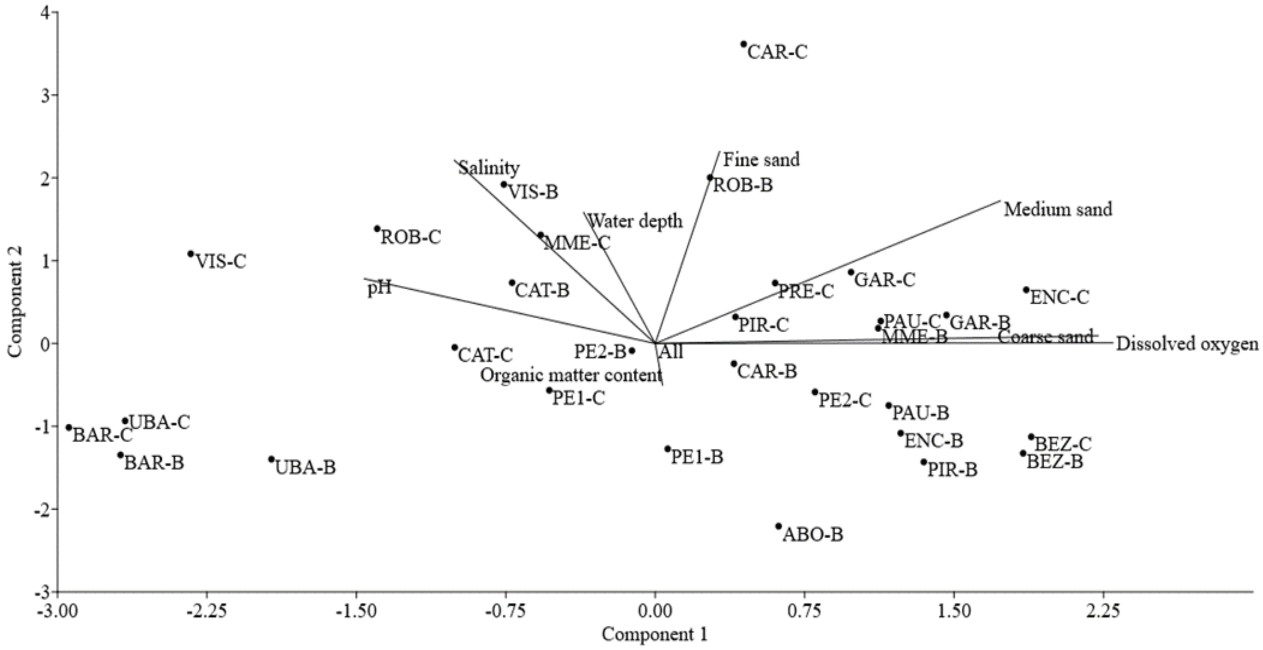

Figure 2. Principal Component Analysis (PCA). Environmental variables: Salinity, pH, Dissolved oxygen, Coarse sand, Medium sand, Organic matter content, Fine sand, and Depth. Lagoons: CAR -Carapebus, ENC - Encantada, PAU - Paulista, ABO - Amarra Boi, BEZ - Bezerra, GAR - Garças, PE1 - Piripiri 1, PE2 - Piripiri 2, MME - Maria Menina, ROB - Robalo, VIS - Visgueiro, CAT - Catingosa, PIR - Pires, PRE - Preta, BAR - Barrinha, and UBA - Ubatuba. Sandbar – B, Centre – C.

and rain events which can directly affect directly environmental parameters of coastal lagoons. Benthic community structure can also reflect differences in intensity of natural instability, with the euryhaline species developing large populations and dominating the more enclosed systems; whereas the marine component of the fauna plays the most relevant role in increasing the level of benthic diversity (Reizopoulo *et al.* 2013). In the present study, euryhaline species such as some Polychaeta, crustacean and gastropods were the most abundant in some lagoons, while most of the registered species were marine representants.

Macroinvertebrates community structure in the coastal lagoons of *Restinga de Jurubatiba National Park* was mainly determined by the environmental variables pH, salinity, grain size, and dissolved oxygen. Also, specific taxa were

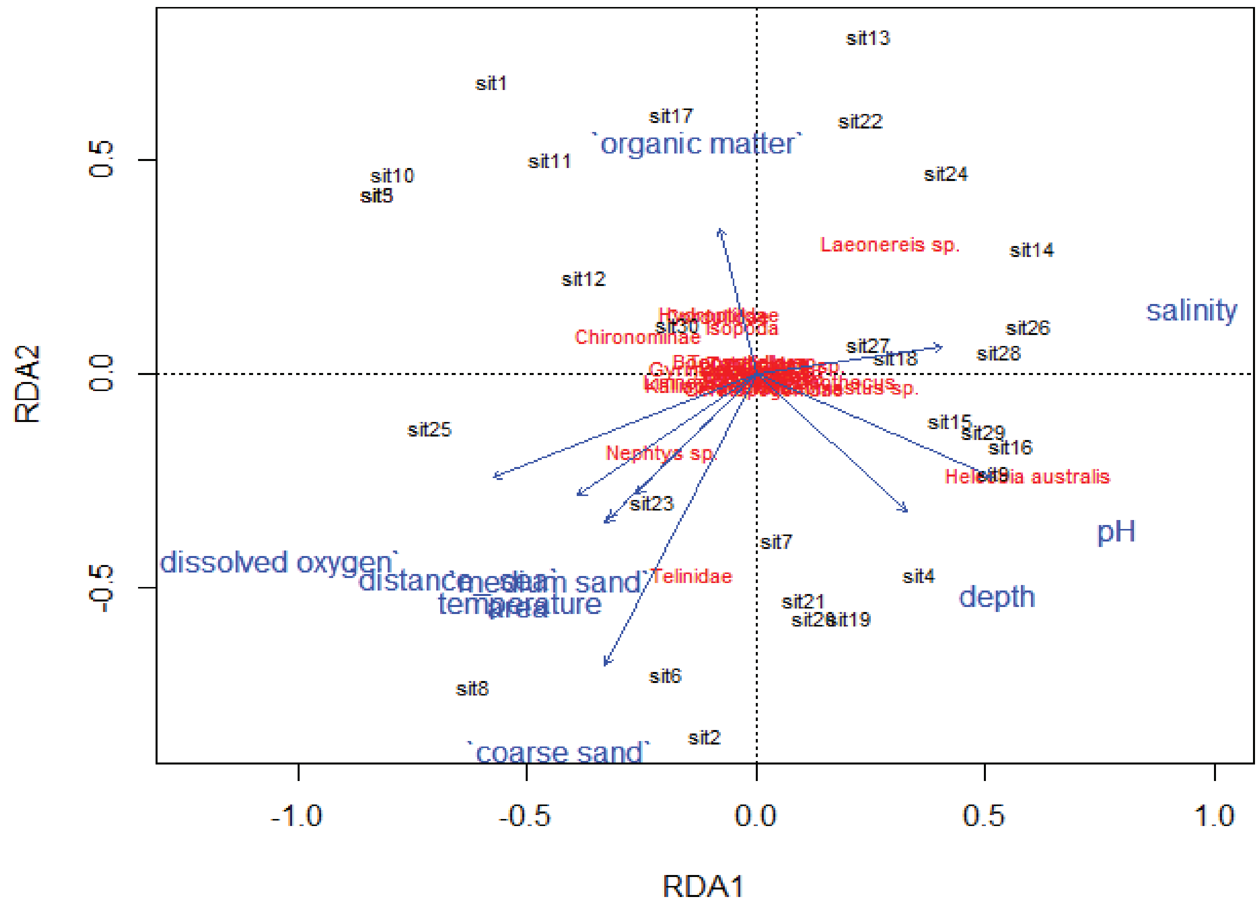

Figure 3. RDA - Environmental variables: salinity, pH, dissolved oxygen, temperature, coarse sand, medium sand, organic matter, fine sand, and depth. Lagoons: sit1)ABO-B, sit2) PAU-C, sit3) BEZ-B, sit4) ENC-C, sit5) BEZ-C, sit6) PAU-B, sit7) ENC-B, sit8) PRE-C, sit9) PE1-C, sit10) PE2-C, sit11) PE2-B, sit12) PE1-B, sit13) BAR-C, sit14) BAR-B, sit15) UBA-B, sit16) UBA-C, sit17) PIR-C, sit18) PIR-B, sit19) GAR-B, sit20) GAR-C, sit21) CAR-B, sit22) CAT-C, sit23) MME-B, sit24) CAT-B, sit25) CAR-C, sit26) ROB-C, sit27) ROB-B, sit28) VIS-C, sit29) VIS-B, sit30) MME-C. Lagoons: CAR -Carapebus, ENC - Encantada, PAU - Paulista, ABO - Amarra Boi, BEZ - Bezerra, GAR - Garças, PE1 - Piripiri 1, PE2 - Piripiri 2, MME - Maria Menina, ROB - Robalo, VIS - Visgueiro, CAT - Catingosa, PIR - Pires, PRE - Preta, BAR - Barrinha, and UBA - Ubatuba. Sandbar – B, Centre – C.

extremely correlated with some of those variables. It was possible to record freshwater organisms' larvae from the families Cordullidae, Gomphidae, and Hydroptilidae in places where water column presented less than 0.5 salinity, and marine and brackish taxa in higher salinity lagoons. Usually, exclusive freshwater taxa have strict requirements associated with freshwater systems for their reproduction, development, and adult life phase, which could limit their survival in higher salinity levels (Pechenik *et al.* 2000, Teske and Wooldridge 2003), and this is real for euryhaline specimens too, like some Polychaetas, which are affected by reduced salinity values.

On the other hand, groups considered to be mostly freshwater like Chironomidae, Ceratopogonidae, and Oligochaeta were also associated with higher salinity sites (salinity > 7). Although those families are mainly freshwater groups, they also have marine and estuarine representatives, *e.g.* Telmatogetoninae and Dasyheleinae (Chironomidae subfamilies) (Trivinho-Strixino 2019). Since it was not possible, in the present study, to identify the individuals from these groups in lower taxonomic levels, we can presume that the individuals found in higher salinity lagoons possibly are marine individuals of these families. Marine and brackish taxa, as the polychaetes *Laeonereis* sp., *Nephtys* sp., *Heteromastus* sp., *Boccardiella* sp., *Dipolydora* sp., *Sigambra* sp., and some microcrustaceans and bivalves were more abundant at high salinity levels sites (salinity > 7).

The gastropod *Heleobia australis* was the most abundant taxon. This group was recorded in almost every site; however, it was not found in sample points with low pH (< 3.9) and salinity (< 0.5). During the dry season, pH seems to be higher and homogeneous in the lagoons than in the rainy season, when the values drop off with the fulvic and humic acid inputs from the Restinga soils washing (Hollanda-Carvalho 2003), due to the increase in the rainfall. pH influences the development of the snails' shells, which cannot be formed at low pH values, since snails use calcium carbonate to produce their shell, and it is hard to obtain it when most of the carbon forms in water are carbon acid, as observed by Callisto (1998). Also, *Heleobia australis* was not frequently recorded in low salinity concentrations. According to Neves *et al.* (2011), this taxon could support a high salinity gradient, but, in their experiment, they recorded more death of individuals as the gradient reducing the salinity concentrations until fresh water, or reducing the abundance in the benthos system by using different strategies, like floating or burying deeply into the substrate, with the salinity variation.

The sediment grain size also had an important influence on macroinvertebrates structure and distribution along the sites. The genus *Dipolydora* sp., *Leonereis* sp., and *Sigambra* sp. were more associated to coarse grain size in sites near de sandbar, and individuals from the family Capitellidae were associated with organic substrates in the center of the lagoon. Leitão (2014), while studying the group Polychaeta in one of the costal lagoons at Jurubatiba national park (Visgueiro lagoon), found an association between the grain size and the occurrence of some Polychaeta species. Also, the results obtained in our study and those obtained by Leitão (2014) are similar regarding pH and salinity as the two major variables influencing Polychaeta spatial and temporal distribution in the Visgueiro lagoon.

According to Figueiredo *et al.* (2006), Gonçalves *et al.* (2002), and Callisto *et al.* (1998), variation in the sediment characteristics can influence *Heleobia australis* biomass (Gonçalves 1998), which increases with organic material inputs and its density (Callisto 1998). However, this group didn't show differences regarding biomass among the substrates where they were recorded. On the other hand, the family Tellinidae was found in association with coarse sand, even though studies about this group in coastal lagoons indicate it is associated with medium/fine sand and mud, in places with approximately 70% of organic matter content (Tagliapietra 2012). No differences between the orientation of the lagoon were observed regarding the macroinvertebrates community.

Finally, we believe that we need to assess the macroinvertebrate's community in more depth, because the continued work in a few lagoons by the group of study in the last few years made us realize that this community is more extensive than registered here. Nonetheless, the present study brings an understanding of the overall macroinvertebrates' community distribution within the environmental gradient throughout almost every lagoon of the PARNA.

The results of this study show that the benthic macroinvertebrates community distribution from coastal lagoons from PARNA *Restinga de Jurubatiba* are associated and subjugated to environmental factors such as salinity, pH, dissolved oxygen, and grain size. According to the bibliography, those characteristics change drastically between the rainy and the dry season, also leading to a modification in the macroinvertebrates community. However, the hydrological period was not contemplated in this study, which leaves this question unanswered. The study of the drives that guide the macroinvertebrates communities' turnover between lagoons and hydrological periods is extremely important to understand, monitor, and assess these environments which suffer from increasing threatens around the park. Finally, our study offers a simple macroinvertebrate community distribution sampling spread tin all lagoons, which allows a holistic understanding of the factors that influence the benthic community as a whole along the park.

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