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ROLE OF METEOROLOGICAL EVENTS ON THE MACROFAUNA COMMUNITY AND SEDIMENT COMPOSITION OF THE SHALLOW WATERS OF MARTEL INLET (ADMIRALTY BAY, ANTARCTICA)

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Gabriel Sousa Conzo Monteiro[1,*], Mônica Angélica Varella Petti[1], Maria Clara Eloed Ribeiro dos Santos[1], Beatriz Wolf Grotto[1], Paula Foltran Gheller[1], Edmundo Ferraz Nonato[1], Thaïs Navajas Corbisier[1]

[1]Instituto Oceanográfico, Universidade de São Paulo – USP, São Paulo, SP, Brazil
[*]*e-mail: gabrielmonteiro@usp.br*

Abstract: *The short-term variability of the benthic macrofauna community in the shallow coastal area off the Brazilian Antarctic Station Comandante Ferraz (EACF) was investigated during the austral summer of 2008. Three replicates of sediment samples were obtained by a van Veen grab (0.0275 m²) at 20 m depth, in six periods from 1st February to 7th March. Macrofaunal densities and sediment composition varied during this period and were correlated to the wind field. Annelids (Polychaeta and Oligochaeta) were the most abundant group with density values ranging from 202 ind.0.0275m^{-2} to 330 ind.0.0275m^{-2} followed by Mollusca and Crustacea. The Principal Component Analysis (PCA) showed that the main sediment components that distinguish the samples were the percentage of gravel, silt and clay. These variations may be influenced by many factors and the climatic conditions play an important role in the local hydrodynamics that affect the benthic community, mainly the organisms with swimming capacity. Meteorological events may influence differently the sediment composition and the macrofauna community. Additional analysis is ongoing to better understand the short-term variability of the macrofauna, including the identification of the polychaetes. Moreover, studies concerning the local hydrodynamics and the interaction between wind, water and sediment in Admiralty Bay are needed.*

Keywords: macrofauna, environmental monitoring, wind field, Martel Inlet, Admiralty Bay

Introduction

Admiralty Bay (King George Island) is an Antarctic Specially Managed Area (ASMA) (Figure 1). It is considered a key site to understand the response of Antarctica to global climatic change because the warming trend over the west coast of the Antarctic Peninsula is greater than over the rest of the continent (Marshall *et al.,* 2002). Studies on benthic macrofauna have been done in this area for almost thirty years. This group is frequently used by Antarctic environmental monitoring programs and the lack of knowledge concerning the short-term variation of this fauna may cause misinterpretation of these results which are usually based on sporadic benthic sampling (Underwood, 1991). The present work is part of the International Polar Year (IPY) project "Marine Antarctic Biodiversity in Relation to Environmental Heterogeneity at Admiralty Bay, King George Island, and Adjacent Areas at the Bransfield Strait" (MABIREH) and also contributes to the Instituto Nacional de Ciências e Tecnologia Antártico de Pesquisas Ambientais (INCT-APA).

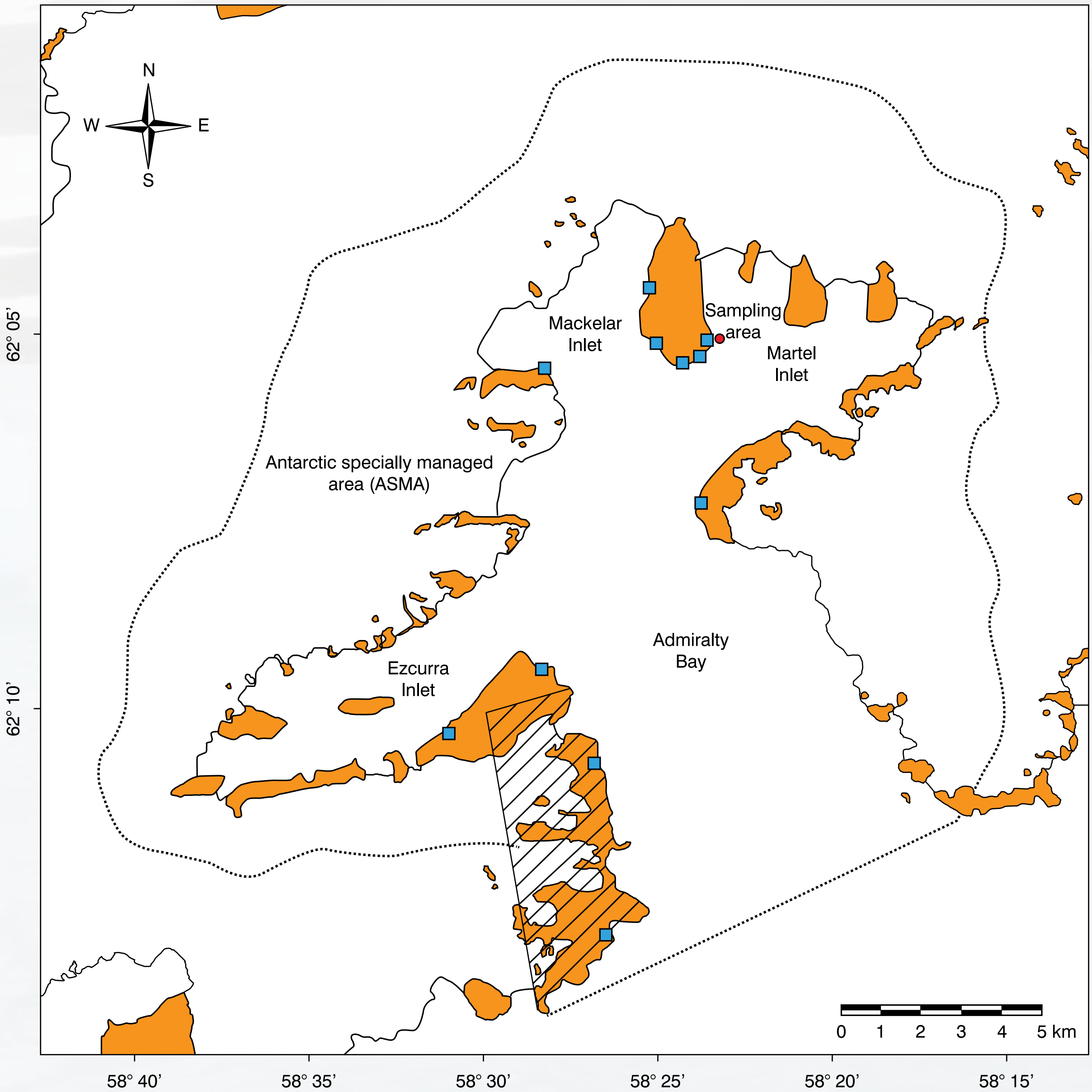

Figure 1. Admiralty Bay, King George Island, Antarctica. Circle: sampling area. Empty squares: Antarctic research stations, modules and refuges (modified from Simões *et al.*, 2004).

Objective

This study aims to evaluate the wind influence on the short-term variation of the macrofaunal community and sediment composition during the austral summer of 2008 at the shallow coastal area, closer to the Brazilian Antarctic Station (Figure 2a).

Methodology

Six samples (three replicates each) of sediment were obtained using a van Veen grab (0.0275 m^2) (Figure 2b) at 20 m depth almost weekly, from 1st February to 7th March 2008. In laboratory, the sediment volumes were measured and then washed through sieves of 0.5 mm mesh size. The

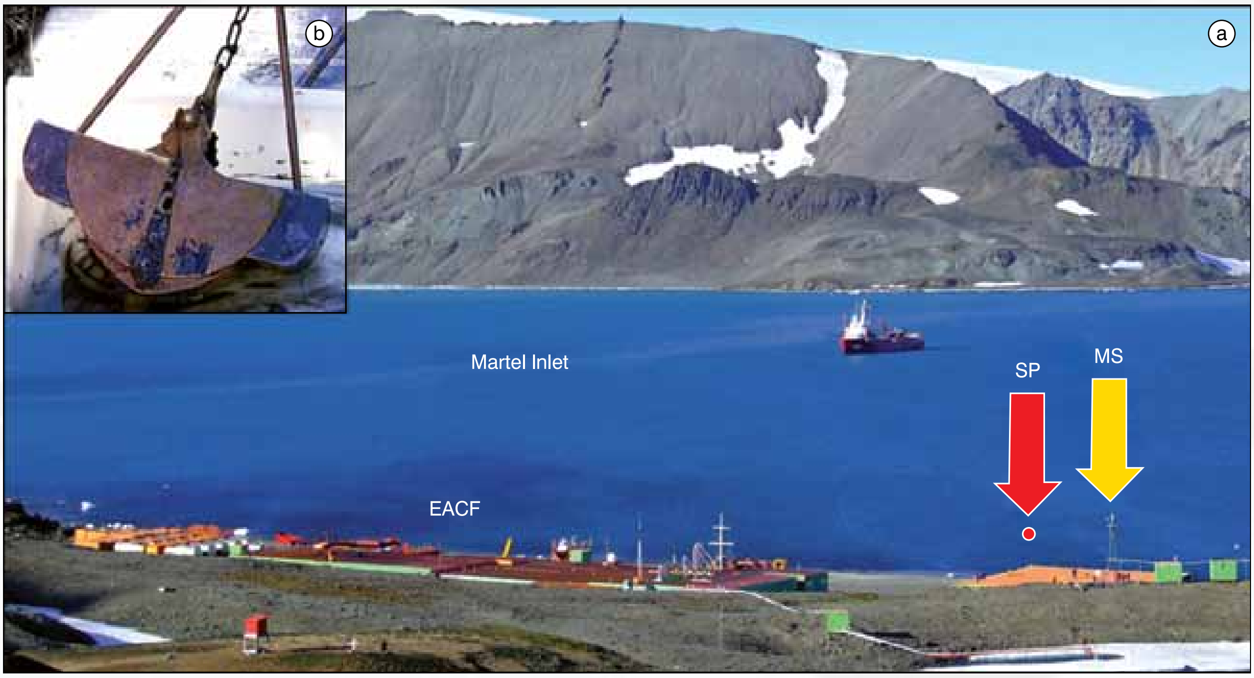

Figure 2. a) Martel Inlet (Sampling Point (SP); meteorological station (MS)). b) Sediment sampler.

wind field was provided by the Brazilian National Institute of Space Research (INPE, 2009). The records of wind speed and direction were taken every three hours next to the sampling point, reaching a total of 334 records. Kruskal-Wallis variance analysis was performed (*a posteriori* test Student-Newman-Keuls) to verify significant differences on macrofauna density, sediment composition and wind field. Spearman Rank Correlation was used to correlate biological and environmental variables.

Results

Wind

Wind records were analyzed in each period between sampling and 7 days before the first one. The main factor that creates surface currents is the moderate wind (from 4 to 10 m/s). Strong winds (more than 10 m/s) create intense turbulence at the water surface which may affect the bottom surface of shallow depth (Pruszak, 1980). Moderate wind direction was classified in two sectors: i) Sector I (brings surface water to Martel Inlet) and ii) Sector II (removes surface water from Martel Inlet). The prevalence of moderate winds at sector II during the 5th sample may have generated bottom currents as a consequence of the surface currents created (Figure 3a). These currents may be capable of resuspending the finer fractions of sediment and transport them to deeper areas of the inlet. The occurrence of strong winds was significantly higher ($p < 0.05$) at the 3rd, 4th and 5th samples (Figure 3b).

Sediment

The greatest percentage of gravel was found at the end of this study, varying from 2 to 5.7% in the first four samples and from 16 to 27% in the last two. A significant decrease in the percentage of silt and clay was verified between the first three samples and the last three ones ($p < 0.05$) (Figure 4a). Small variations were recorded in the organic matter and calcium carbonate in the sediment during the period. The Principal Component Analysis (PCA) showed that the main sediment components that distinguish the samples were the percentage of gravel, silt and clay (Figure 4b). No iceberg grounds were recorded at the sampling point during the study period.

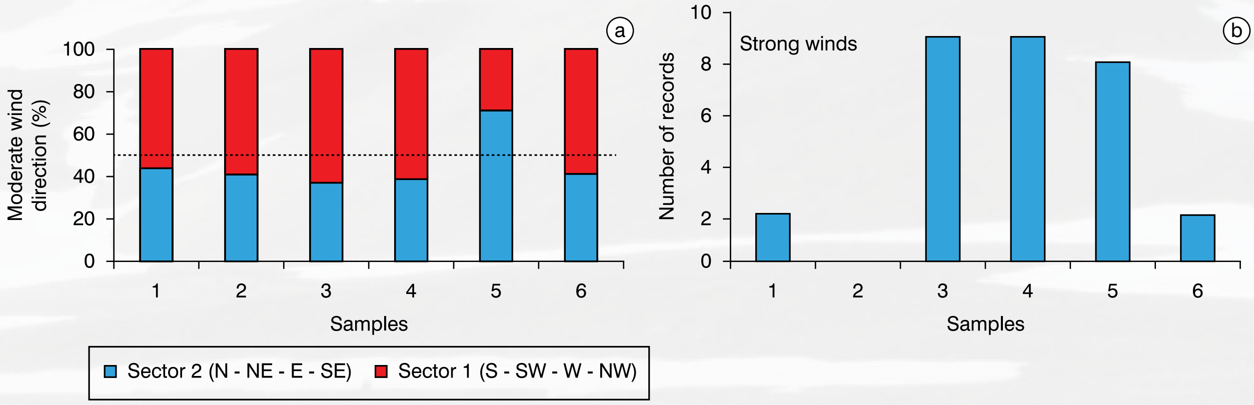

Figure 3. a) Moderate wind direction (%) and b) Strong wind records.

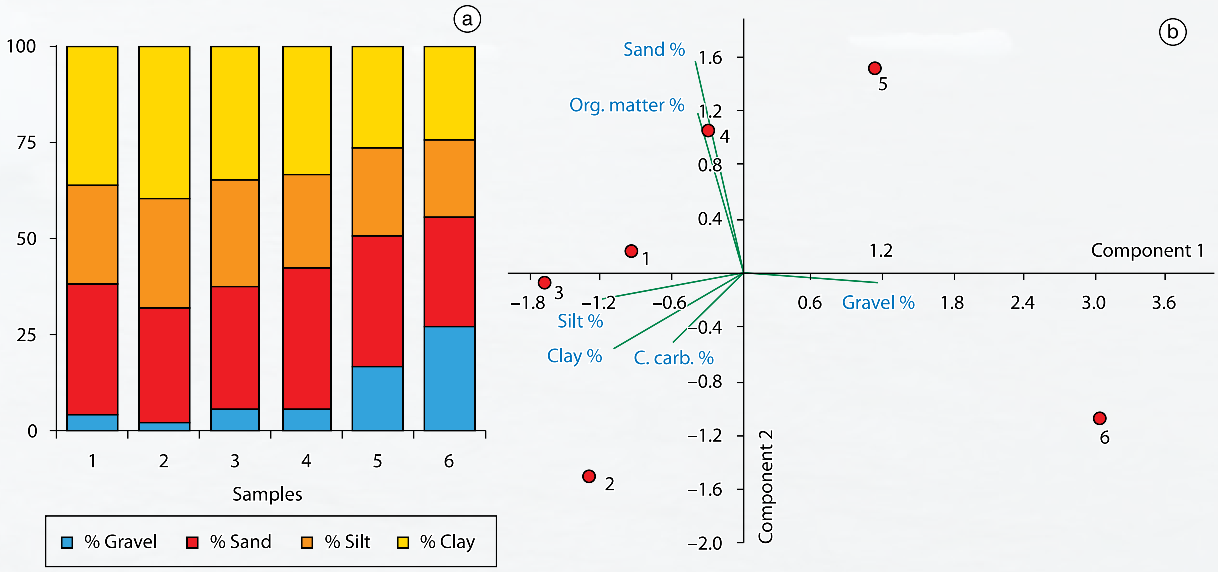

Figure 4. a) Sediment fractions (%) in each sample. b) Principal Component Analysis of the sediment fractions.

Macrofauna

A total of 12,260 organisms were recorded, belonging to nine taxonomical groups: Platyhelminthes, Nematoda, Priapulida, Nemertea, Arthropoda, Annelida, Mollusca, Echinodermata e Chordata. The most abundant groups (96% of the total) were Annelida (max. 330 ind.0.0275 m^{-2} - min. 202 ind.0.0275 m^{-2}), Mollusca (max. 280 ind.0.0275 m^{-2} - min. 83 ind.0.0275 m^{-2}) and Crustacea (max. 316 ind.0.0275 m^{-2} - min. 66 ind.0.0275 m^{-2}). Total macrofauna density did not present significant variations (Figure 5a). Polychaeta had their greatest density in the 6th sample, significantly higher than the 2nd, 3rd and 5th samples ($p < 0.05$). Mollusca were represented by Gastropoda and Bivalvia (the latter being 10 times more abundant than Gastropoda) with no significant variation in density for the studied period. The main groups of crustaceans were Amphipoda and Cumacea which showed similar densities, with a positive shift at the 3rd, 4th and 5th samples. The Amphipoda density at the 3rd and 4th samples was significantly higher than the 1st and 2nd sample ($p < 0.05$). Benthic swimmer organisms (Amphipoda, Cumacea and Isopoda), showed higher densities in the 3rd, 4th and 5th

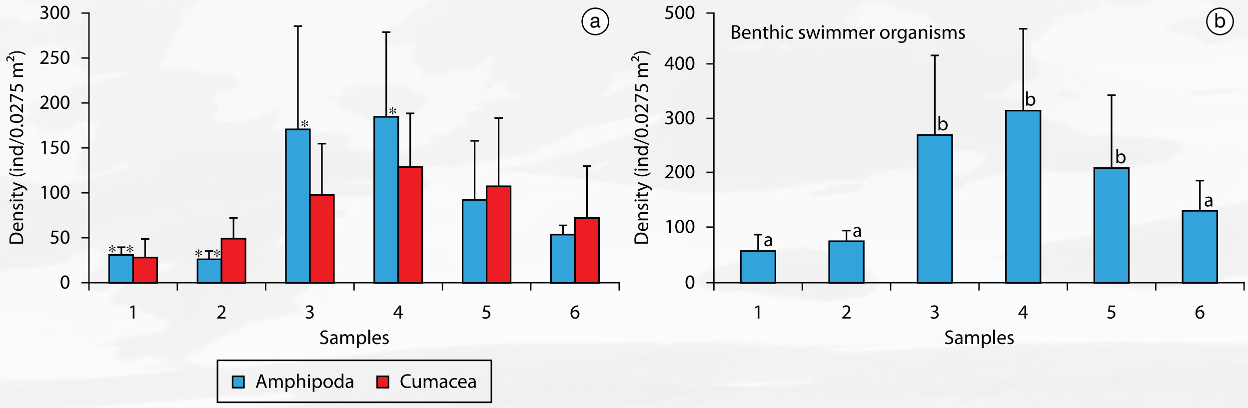

Figure 5. a) Mean density (+SD) variation of the Amphipoda and Cumacea; * and ** indicates significant differences between samples. b) Mean density (+SD) variation of the benthic swimmer organisms (Amphipoda, Cumacea and Isopoda); *a* and *b* indicate significant differences between these two groups of samples ($p < 0.05$).

samples in comparison to the other ones ($p < 0.05$) (Figure 5b) and this variation was positively correlated ($R = 0.88$ and $p < 0.05$) to the occurrence of strong winds.

Discussion

Macrofaunal densities may be influenced by many factors, one of them related to the climatic conditions that play an important role in local hydrodynamics affecting the benthic community, mainly the organisms with swimming capacity. The categorization of the wind data according to intensity and direction allowed to better explain the sediment composition and macrofauna community short-term variation. Other authors have used the wind data to interpret some biological results in the same studied area (Brandini & Rebello, 1994; Skowronski, 2002), but they have not classified the wind, difficulting the detection of its influence on the communities. There is some evidence that two types of hydrodynamic effects generated by climatic conditions may result in different physical disturbance for sediment and macrofauna community: i) strong turbulence generated by strong winds and ii) currents generated by intermediate winds (Pruszak, 1980). Currents seem to affect mainly the sediment by resuspending and transporting fine fractions without transporting organisms that may overcome the current and continue in the same place. Turbulence, generated by strong winds, seems to vertically resuspend both sediment and organisms from the first sediment layers but not transport them. Organisms with great mobility in the water column may move to other areas while returning to the bottom while other animals and sediment fractions resuspended just sink to the same (or nearby) area that they belonged to before the turbulence. The effect of hydrodynamics on organisms has been documented before by some authors (Bell *et al.*, 1997; Grant *et al.*, 1997) but there are no studies for Admiralty Bay or other Antarctic regions concerning the hydrodynamic influence on the benthic community. We cannot state with certainty that those events are causing the variation found on macrofauna because Antarctic benthos of shallow waters present a remarkable patch distribution in the area (Bromberg, 2004), which may interfere in the interpretation of the results. This is a preliminary discussion since the interaction between wind, water and sediment is almost unknown in Admiralty Bay. Additional studies are ongoing to better understand the short-term variation of macrofauna. The identification of Polychaeta species is being carried out. This group has a great variability of feeding, mobility and life habits and further study can be helpful to better interpret the variations of the whole community.

Conclusions

Significant short-term variation on the macrofauna density was found for some taxonomical groups, just the same as for sediment composition and wind field for the area.

Hydrodynamics generated by strong and moderate winds may affect differently the macrofauna and the sediment composition. A long time series of meteorological data is available online and it is an important tool to comprehend the benthic ecosystem functioning in shallow waters nearby EACF.

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