SUMMER VARIATION OF ZOOPLANKTON COMMUNITY ON COASTAL ENVIRONMENT OF ADMIRALTY BAY, KING GEORGE ISLAND, ANTARCTICA

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Abstract: This study aims to provide data on the abundance and distribution of zooplankton related to oceanographic parameters of the coastal environment of Admiralty Bay. In December 2009, during the XXVIII Brazilian Expedition, biological samples and physic-chemical data were obtained in four shallow areas, located in front of research stations and a reference area at Botany Point. A total of 15,882 organisms were sorted from 55 samples resulting in a total density of 3.03 organisms/100 m³. Nineteen taxa were identified. The most abundant holoplanktonic organism was copepods and meroplanktonic was echinoderms. The PCA analysis emphasized the importance of phosphate and dissolved oxygen for holoplankton, as nitrite and water temperature for the meroplankton during the four days of sampling.

Keywords: holoplankton, meroplankton, monitoring, Admiralty Bay

Introduction

Zooplankton is a component of the plankton constituted by a diversified group of organisms that live in the water column of the oceans. They have an important role in the recycling of nutrients and are divided in two groups: Holoplankton (stay in the plankton during all their life cycle) and Meroplankton (in the plankton during a part of their life cycle). Some zooplanktonic organisms are considered good hydrological indicators (Boltovskoy, 1981), enabling the identification of different sources of water inputs that comprise the dynamic of an area. Montu & Cordeiro (1986) accomplished the first Brazilian study on the Antarctic zooplankton in the summer of 1982/1983 during the First Brazilian Scientific Expedition to Antarctica. Freire *et al.* (1993) and Santos (1995) studied the zooplankton of Admiralty Bay. Subsequent scientific works by the Antarctic Brazilian program concentrated mainly in the meroplankton (Absher *et al.*, 2003; Freire *et al.*, 2006).

In Admiralty Bay, with the beginning of the austral summer (November-March), starts the supply of larvae or juveniles from the water column or sediment adjacent regions (Freire *et al.*, 2006). The lower variability in temperature and salinity favor an environment with almost no barriers to larval dispersal however is limited by the type of reproduction. With the purpose to contribute to the monitoring program INCT- APA - Thematic Module 3, this study aims to provide data on the abundance and distribution of zooplankton related to oceanographic parameters of the coastal environment of Admiralty Bay.

Materials and Methods

The samples were collected from four shallow areas near research stations and one reference area at Botany Point, in the days 11, 15, 23 and 12/29/2009 (Figure 1).

Plankton samples were collected in three replicates in all stations from five minutes oblique tows at 2 knots from the sea bottom (30 m) to the water surface. A conical net with a 150 μm mesh size and 60 cm diameter equipped with a flowmeter was used. Samples were preserved in 4% buffered formaldehyde. Zooplankton organisms were identified in high taxonomic levels and separated in meroplankton or holoplankton. The values have been corrected to a standard 100 m^3 .

In order to evaluate the community structure of zooplankton in relation to oceanographic dynamics the following characteristic of the water were determined: water temperature ($^{\circ}\text{C}$), salinity, transparency (m), dissolved oxygen ($\text{DO} - \text{mL L}^{-1}$), pH, phosphate ($\text{PO}_4 - \mu\text{mol L}^{-1}$), silicate ($\text{SiO}_4 - \mu\text{mol L}^{-1}$), nitrite ($\text{NO}_2 - \mu\text{mol L}^{-1}$) and nitrate ($\text{NO}_3 - \mu\text{mol L}^{-1}$).

One-way analysis of variance (ANOVA) was used to determine the statistical difference in the density and diversity of taxa among sampling days and stations. Principal Component Analysis (PCA) on a correlation matrix was applied to the data of abundance, spatial distribution of zooplankton and environmental data. When appropriate a $\log(x + 1)$ transformation was employed.

Results

Fifty five samples were collected during the period and a total of 15,882 zooplankton organisms were sorted. The total volume of sampled water was approximately 5,238 m^3 , resulting in a total density of 3.03 organisms. 100m^{-3} . Mean numbers of holoplankton are shown in Figure 2a. Copepods dominated in the majority of stations and dates. The average abundance was nearly constant among stations during the

Figure 1. Location of sampling stations in Admiralty Bay (crosses) and research stations (black squares).

Figure 2. Mean numbers of holoplankton (a) and meroplankton (b) in each station on each day of sampling. Stations: 1 - Ferraz; 2 - Botany Point; 3 - Machu Pichu; 4 - Point Thomas; 5 - Arctowski.

sampled period, except for station 4 on 12/15/2009 and station 5 on 12/29/2009, whose averages were higher. The mean numbers of meroplankton are shown in Figure 2B.

Meroplankton density was high in Machu Picchu station (St. #3) in the days 11, 23 and 29 December 2009. On 12/15/2009 was observed the lowest average abundance in almost all stations during the sampling period. Echinodermata and Polychaete larvae were the first and second most abundant meroplankton, respectively.

The differences observed in the ANOVA resulting from the comparison of the densities (organisms.100m⁻³) between stations and dates were significant (df = 19; F = 2535; p < 0.05) and caused mainly by the amount of organisms in station 4 in 12/15/2009 and 5 in 12/29/2009. The differences between the abundances of meroplankton in the stations and dates were significantly different (ANOVA df = 17; F = 2.57; p < 0.05).

Mean water temperature during the sampling period ranged from -0.13 to -0.59 °C. Average salinity ranged

from 33.16 to 34.32, water transparency ranged from 1.80 to 10.50 m, pH from 7.85 to 8.07, dissolved oxygen ranged from 6.46 to 7.56 mL L⁻¹, phosphate from 1.29 to 2.08 µmol L⁻¹, silicate from 40.53 to 42.63 µmol L⁻¹, nitrite from 0.02 to 0.17 µmol L⁻¹ and nitrate from 12.94 to 19.69 µmol L⁻¹.

PCA of holoplankton, meroplankton and environmental parameters are shown in Figure 3.

The first two components of PCA analyses explain 49.27% of the total variance. Holoplankton abundance is influenced by waters with higher DO and phosphate and less silicate, nitrite, nitrate under lower pH, wind gust and speed in less turbid waters. The second factor indicated that environmental conditions favored meroplankton abundance in waters with higher temperature, DO, pH, nitrite, less phosphate, silicate under low wind gust in more turbid waters. While holoplankton had a high correlation with Factor 1 meroplankton had correlation with Factor 2 and no correlation to each other.

Figure 3. A biplot of the PCA of holoplankton, meroplankton and environmental parameters data; HOLO - holoplankton; MERO - meroplankton; DO - dissolved oxygen; Sal - salinity; Temp - temperature; Phos - phosphate; Nitrat - nitrate; Nitri - nitrite; Silic - silicate; pH; Sec - Secchi disk; W/speed - wind speed; W/gust - wind gust; W/dir - wind direction.

Discussion

Larval forms are common to different groups of marine invertebrates which makes conclusive identification of the species almost impossible. Stanwell-Smith *et al.* (1997) is the only available source for the identification of Antarctic larvae. Due to the very slow development rate of larvae in Antarctic waters (Bosch *et al.*, 1987; Peck 1993; Peck *et al.*, 2007; Stanwell-Smith *et al.*, 1999), differences among larvae from consecutive samples through time may be only successive stages in development of the same specie.

Santos (1995) and Freire *et al.* (2006) observed that Polychaeta larvae occurred at the beginning and end of summer. These results are in accordance with what was observed in the present study, as Echinodermata and Polychaete larvae were detected in the beginning of summer as the first and second most abundant meroplankton respectively. According with Absher & Feijó (1995) mollusk larvae showed temporal variation, occurring in abundance in late summer and almost absent in early summer. In the present study mollusk larvae occurred in small numbers. These facts suggest that larvae of invertebrates can be found differentially throughout the summer. Cruz-Kaled (2011) found the density of veliger larvae of gastropods 124.53 individuals.100m⁻³ during the summer 2002/2003 and 5.35 individuals.100m⁻³ during the summer 2003/2004 at Mackellar Inlet (corresponding to station 3 of the present study). These data when compared with the present study show a large interannual difference in the occurrence of zooplankton organisms, a situation that can be reflected throughout Admiralty Bay, probably due to the variation of oceanographic parameters, reproductive patterns of the species and the interaction with larvae or adults of other planktonic organisms.

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Near the sampling St #5 (Arctowski) penguin's species *Pygoscelis antarctica* and *Pygoscelis adeliae* can be found nesting on rocky cliffs in the coastal region. These birds have a significant impact on the balance of carbon, nitrogen, phosphorus and other minerals in these nesting areas (Tatur, 2002). Ornithogenics soils, derived from the activity of these penguins sampled between Point Thomas (St #4) and Ecology Glacier showed a high content of phosphate, as observed by Schaefer *et al.* (2004). According to Bremer (2008), the combination of nesting habitats with shallow soils allows organic matter to accumulate and some of the material returns to the sea by surface drainage or by percolation.

The dynamics of the water circulation and the wind regime of the bay associated to the presence of the research stations and the discharge of nutrients from the ornithogenic soils in the west coast of the region favors the increase of the primary production and in consequence of the zooplankton. Further studies will be needed to make possible the understanding of the contribution of each one of those factors.

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