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MICROPLANKTON DOMINANT GROUPS DURING THE 2013/2014 AUSTRAL SUMMER IN ADMIRALTY BAY, KING GEORGE ISLAND, WEST ANTARCTIC PENINSULA

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Abstract: *The present study presents the variability of the microphytoplankton community taxonomic composition during the austral summer of 2013/2014. To this end, water temperature, salinity, dissolved inorganic nutrients, chlorophyll, and phytoplankton were studied in December 2013 (Early Summer) and February 2014 (Late Summer) at five sampling sites and three depths (surface, 15 m, and near the bottom) in the shallow (~30 m) region of Admiralty Bay (AB). Microphytoplankton abundances in AB during the 2013/2014 austral summer were, on average ($4.5 \pm 3.0 \times 10^3$ cells.L^{-1}), similar to those observed during the 2009/2010 austral summer, but 10-fold lower than those registered in 2010/2011. Spatially, three regions were considered in AB. An outer region, near Arctwoski Station, showed higher water temperature (0.76ºC), lower phosphate (1.27µM) and nitrogen (16.9µM) concentrations, and higher silicate (59.8µM) concentrations and microplankton densities (5.4×10^3 cells.L^{-1}) during Late Summer. Phytoplankton cell densities showed a similar order of magnitude between Early and Late Summer, with a maximum value of 1.5×10^4 cells.L^{-1} at Late Summer in the Arctowski region. During Early Summer, dinoflagellates were dominant at Martel and Mackellar Inlets, whereas diatoms were dominant (~70%) in the Arctowski region. During Late Summer, an increasing trend of the contribution of diatoms was also observed from Martel Inlet (~60%) to the Arctowski region (~80%). Our results showed: (i) unusually low average microplankton abundances; (ii) events of dominance of mid-sized diatoms (30-80 µm), e.g., Thalassiosira antarctica, as observed in February 2014, probably associated with cold coastal water and higher silicate concentrations; and (iii) periods of dominance of small dinoflagellates (< 30µm) of the genera Prorocentrum and Protoperidinium.*

Keywords: Diatoms, Dinoflagellates, Monitoring.

Introduction

The phytoplankton community of the western Antarctic Peninsula (WAP) has been investigated to determine whether climate changes effects are responsible for the shifts in their biomass and species composition (Montes-Hugo *et al.*, 2009). Located in the South Shetland Islands (WAP), King George Island (KGI) is characterized by low chlorophyll *a* (Chl.*a*) concentrations (Lange *et al.*, 2014; Schloss *et al.*, 2014) and for a decline in diatom contribution from the 1990's to the 2000's compared with those observed in the continental shelf (Kopczynska, 2008; Lange *et al.*, 2014). Even though large diatom blooms (~20 mg Chl.*a* m^{-3} and ~10^5 cells.L^{-1}) associated with anomalously cold conditions (Schloss *et al.*, 2014) have been registered, the monitoring effort to better understand phytoplankton dynamics should continue. Phytoplankton at Admiralty Bay (KGI) has been studied in the context of the PROANTAR

(Brazilian Antarctic Program) since 2002. The program was interrupted in February 2012 due to a fire that destroyed the Brazilian Antarctic Station. The present study presents the variability of the microphytoplankton community taxonomic composition during the austral summer of 2013/2014.

Materials and methods

Admiralty Bay (62°03'–12'S; 58°18'–38'W), located on King George Island, is a deep fjord-like embayment with 500 m maximum depth in its center (Rakusa-Suszczewski *et al.*, 1993). The maximum depth ranges from 60 m along the shores to 500 m in the center of the bay.

The present study was conducted during two surveys in December 2013 (Early Summer) and February 2014 (Late Summer). Admiralty Bay location and the position of the five sampling stations were described by Barrera-Alba et al. (2012). In situ measurements of salinity and water temperature were performed with a miniCTD Valeport®. Sampling for dissolved inorganic nutrients, microplankton, and chlorophyll *a* was performed in the aliquots of 5 L water samples collected with a Van Dorn bottle from the surface and near the bottom (≈ 30m). Admiralty Bay comprises three sub-regions (Ezcurra, Mackellar, and Marlet) and a main, deeper, central portion. In the present work, we grouped the results according to the location of the sampling station in Marlet Inlet (the inner and less open ocean-influenced, Comandante Ferraz and Botany Point), Arctowski region (the outer and more open ocean-influenced, Thomas Point and Arctowski), and Mackellar Inlet (Machu Picchu). For microplankton (>10µm), 1.9 L aliquots were fixed with 0.1M Sodium Cacodylate buffered formaldehyde (2% f.c.) and kept in the dark immediately after sampling. Samples were analyzed using the settling technique in an inverted microscope (Utermöhl, 1958) with 200x and 400x magnification. For chlorophyll *a* (Chl.*a*) biomass, 0.5 L aliquots of the water sample were filtered onto Whatman® GF/F. The filters were folded, placed into 1.2 mL cryotubes, immediately quick-frozen in liquid nitrogen (−196°C), and stored at −80°C. Concentrations of Chl.*a* were assessed using a modified version of the Neveux and Lantoine's (1993) method. For dissolved inorganic nutrients, 250 mL aliquots of GF/F filtered seawater were stored at −4°C and the analyses were conducted by the "Laboratório de Química Orgânica Marinha" (LabQOM), "Instituto Oceanográfico da Universidade de São Paulo" (IOUSP).

Results

Due to technical problems with the miniCTD, salinity and water temperature for the Early Summer (ES) period are not available. For Late Summer (LS), salinity (34.2 ± 0.1) showed an increasing trend from Marlet Inlet to the Arctowski region (Figure 1a). A similar tendency was observed for water temperature (0.65 ± 0.13 °C), with lower values registered at Martel Inlet (0.51 ± 0.09 °C) compared with those in the region directly affected by the central canal (0.76 ± 0.03 °C) (Figure 1b). Dissolved inorganic nutrients showed higher concentrations at LS, on average. Spatially, during ES, phosphate and silicate presented higher concentrations at Mackellar Inlet, whereas nitrogen (nitrite+nitrate) was slightly higher at Marlet Inlet (Figures 1c-e). During LS, a decreasing trend from Marlet Inlet to the Arctwoski region was observed for phosphate and nitrogen, whereas silicate showed an inverse trend. Total chlorophyll *a* concentration was, on average, higher during ES (1.44 ± 0.44 µg.L^{-1}) than during LS (1.26 ± 0.33 µg.L^{-1}). During ES, maximum Chl.*a* concentration (1.90 µg.L^{-1}) was registered at CF, even on average Chl.*a* was higher at Mackellar Inlet (Figure 1f). During LS, a slight increase in Chl.*a* was observed from Martel Inlet towards the Arctwoski region. On average, the fraction lower than 20µm represented >90% of total Chl.*a* throughout the study period (Vanzan et al., this Activity Report). Similar mean cell densities were observed for ES (4.1 ± 1.7 x 10^3 cells.L^{-1}) and LS (4.8 ± 4.0 x 10^3 cells.L^{-1}) surveys. Higher mean values were registered at the Arctowski region during both surveys (Figure 1g), with a maximum cell density of 1.5 x 104 cells.L-1 at this region registered during LS. This maximum was associated with high abundance (10^4 cells.L^{-1}) of centric diatom *Thalassiosira antarctica*. In terms of composition, diatoms and dinoflagellates represented together more than 95% of the total cell density. During ES, dinoflagellates, mainly < 30µm *Prorocentrum* spp. and *Protoperidinium* spp., were dominant at Martel and Mackellar Inlets, whereas diatoms were dominant at the Arctowski region (Figure 1h). During LS, an increasing trend in density and contribution of diatoms was also observed from Martel Inlet to the Arctowski region.

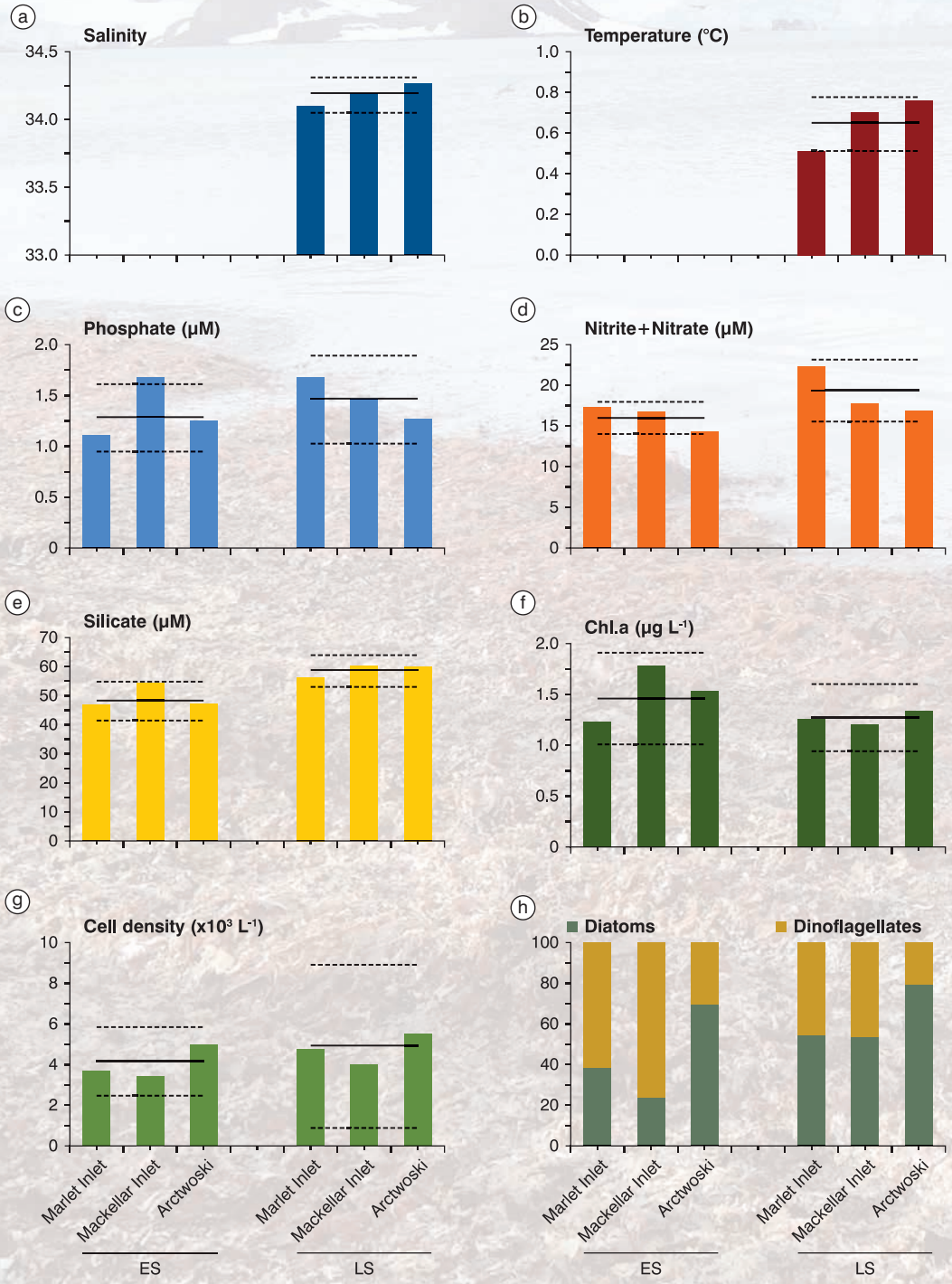

Figure 1. Variations in the mean values of a) salinity, b) temperature, c) phosphate, d) nitrite+nitrate, e) silicate, f) Chlorophyll *a* concentration, g) cell density, and h) microplanktonic diatoms and dinoflagellates (%) at the different regions in Admiral Bay during the Early and Late 2013/2014 Summer. Solid and dashed lines are mean and standard deviation values, respectively.

Discussion

Between the 1970s and the 1990s, studies developed in Admiralty Bay reported microphytoplankton abundances of 10^4 - 10^5 cells.L^{-1} (Kopczynska, 2008). During the first decade of 21st century, Lange *et al.* (2014) reported usually lower (~10^3 cells.L^{-1}) mean abundances, with a shift in the dominant taxonomic groups resulting from high contribution (>90%) of large diatoms (> 80µm) at the beginning of the decade to an increment of small dinoflagellates (< 30µm) in the 2007-2009 period. The results of this study show a trend similar to that observed at the beginning of the 2010s, when mean abundances of 10^3 – 10^4 cells.L^{-1} were registered (Tenenbaum *et al.*, 2010; Barrera-Alba *et al.*, 2012). Spatially, Admiralty Bay comprises three main regions. The outer region, near the open-ocean communication, showed, on average, higher water temperature (0.76ºC), lower phosphate 1.27 µM) and nitrogen (16.9 µM) concentrations, and higher silicate (59.8 µM) and Chl.a (1.32 µg.L^{-1}) concentrations and microplankton densities (5.4 x 10^3 cells.L^{-1}) in LS. In terms of composition, the dominant taxonomic groups comprised dinoflagellates (as in 2009/2010), at Mackellar and Martel inlets, and diatoms (as in 2010/2011), in the outer region. Higher microplankton abundances at that last region during LS were registered when the centric diatom *Thalassiosira antarctica* was predominant. This species has been described as a usual component of the Antarctic phytoplankton, being responsible, together with other centric diatoms such as *Thalassiosira ritscheri* and *Porosira glacialis*, for summer phytoplankton blooms (Schloss *et al.*, 2014). *T. antarctica*, which has been described as presenting a high reservoir of resting spores on the sediment associated with high concentrations of winter and spring sea ice, was usually found in cold coastal waters (Pike *et al.*, 2009). In this sense, mean water temperatures during Late Summer were lower than those described from 2002 to 2008 (Lange *et al.*, 2014) and, together with the recorded higher silicate concentrations, explain the predominance of diatoms observed during this survey.

Conclusion

Dominant groups of microplankton at Admiralty Bay during the 2013/2014 austral summer confirm the trend observed for phytoplankton in studies conducted since 2002: (i) low mean abundances; (ii) events of dominance of mid-sized (> 30-80 µm) diatoms such as *Thalassiosira antarctica*; and (iii) periods of dominance of small dinoflagellates (< 30 µm) of the genera *Prorocentrum* and *Protoperidinium*. Events of bloom or high abundance of *T. antarctica*, as observed in February 2014, could be associated with cold coastal water and higher silicate concentrations.

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