

SCAR Fellowship - Report 2014/2015

“Microbial diversity across environmental gradients in the Southern Ocean: a spatial, temporal and vertical approach considering the climate changes”.

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Introduction

The Southern Ocean (SO) is currently subject of intense investigations, mainly related to its importance for global biogeochemical cycles and its alarming rate of warming in response to climate change (e.g., Smetacek and Nicol, 2005). This area of the world's ocean accounts for a third of the global ocean CO₂ uptake, and thus plays a major role in the Earth's carbon cycle. The West Antarctic Peninsula (WAP) is considered as one of the main areas experiencing rapid regional warming (Anisimov *et al.*, 2007), as well as glacier retreat (Cook *et al.*, 2005), shortening ice season and reduction of perennial sea ice (Martinson *et al.*, 2008). It's also the only one with maritime climate - which makes it an ideal place to monitor, understand and predict the impacts of the climate change on the marine ecosystems (Schofield *et al.*, 2010). These patterns are in contrast with other regions of the SO, like the eastern part of the AP, in the Weddell Sea, which presents more stable oceanographic conditions (Pritchard *et al.*, 2012).

Microbes play an essential role in ecosystem functioning and are the main drives of the biogeochemical cycling of elements (e.g., Manganelli *et al.*, 2009; Wilkins *et al.*, 2013). Yet, the diversity, activity, and abundance of microorganisms in this system remains poorly studied (e.g. Wilkins *et al.*, 2013; Luria *et al.*, 2014), in particular with regards to changes along environmental gradients, i.e., with depth, from coastal waters to the open ocean, and evaluating the influence of the sea ice edge and the glacier melting. Moreover, the SO has a complexity of environmental variables that may influence the composition of the microbial communities. Consequently,

reference values to access their spatial and temporal dynamics in the water column are still being discussed (Wilkins *et al.*, 2013; Luria *et al.*, 2014; Signori *et al.*, 2014).

Objectives:

The main goals of this proposal were to: 1) Determine the composition, relative abundance and distribution of the microbial communities in different regions of the Southern Ocean: a) Along depth profiles, b) From coastal waters to the open ocean, c) Comparing different years; and 2) Identify the environmental parameters driving the microbial community structure.

Relevance:

This research is in accordance with some SCAR programs like *AntClim21* and *AntEco* and can help to find answers for SCAR scientific objectives like better understanding the ecosystem structure/functioning and the Antarctic biodiversity. The results will be an invaluable contribution to understanding how the dynamic seascape of the Southern Ocean shapes the microbial community composition, considering both spatial and temporal approaches, in light of climate change.

Methods

Sampling Strategy

Here, I took advantage of two sets of samples: one obtained by me and my colleagues during a research cruise to the SO in the austral summer 2014, as part of the project *ProOasis (Surface waters enrichment of Southern Ocean and influences on the marine ecosystem: primary producers to top predators)*; and the second cruise in the austral summer 2015, as part of the project *Interbiota - (Biological interactions in marine ecosystems around the Antarctic Peninsula considering different aspects of climate changes)*, both supported by CNPq (*Brazilian National Counsel of Technological and Scientific Development*). Both cruises were conducted by the Brazilian Navy vessel Npo. Almirante Maximiano (H41).

Samples were collected in areas differently affected by the climate change: Gerlache Strait and the area influenced by the Bellingshausen Sea; Bransfield Strait, including the continental shelf of the South Shetland Islands; around the Elephant Island, and in northeast of the Weddell Sea (Figure 1). For the temporal analyses, ten oceanographic stations were selected to be compared with previous and future cruises, so we can monitor the microbial communities in this area (Figure 2).

Seawater and physical data (temperature, salinity and dissolved oxygen) were collected using a combined Sea-Bird CTD/Carousel 911 system equipped with 24 5-l Niskin bottles. Sampling depths (from surface and deep waters) were selected according to the CTD profiles.

Approximately 1.8 liters of seawater were filtered into 0.2 μm Sterivex filters (Millipore) using the peristaltic pump and subsequently kept frozen at -80°C onboard. For DNA extraction, a protocol previously developed by Boström *et al.* (2004) and Manganelli *et al.* (2009) for low biomass samples was slightly modified by replacing t-RNA with linear acrylamide as co-precipitant. To assess the diversity of the microbial communities, amplicon sequencing of the PCR amplified 16S rRNA gene was performed (*Illumina*). Only for selected samples, we tested the *Ion Torrent* sequencing in order to compare with some previous data obtained by Signori *et al.* (2014) from *Roche 454*.

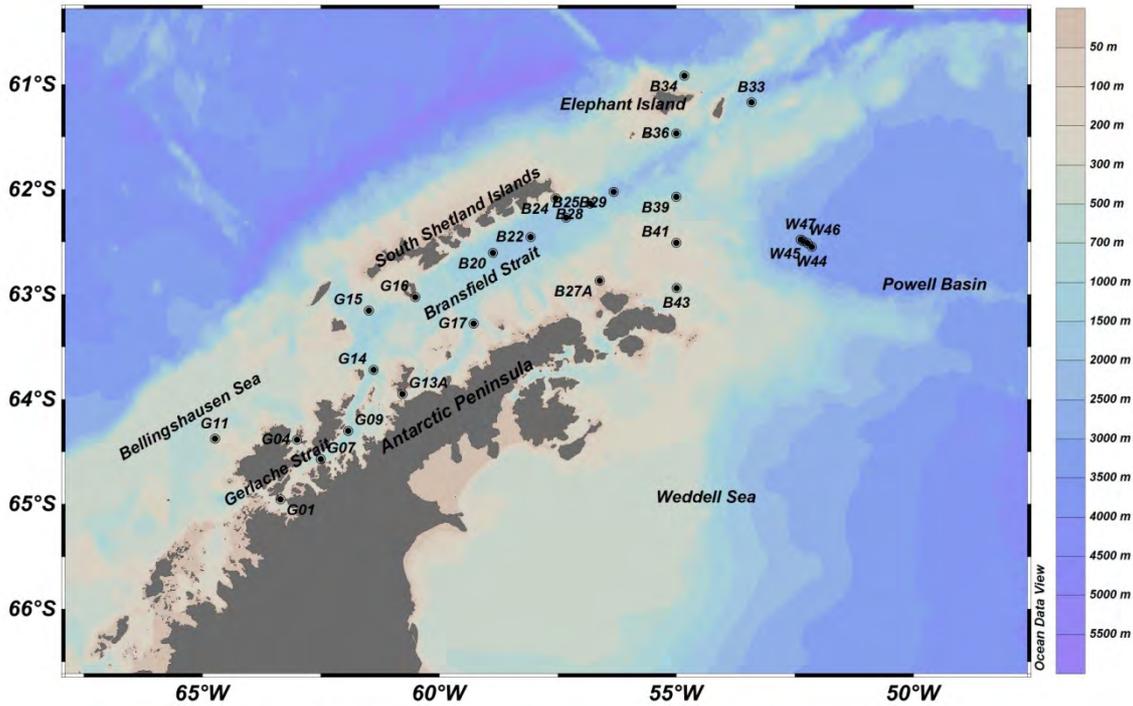


Figure 1. Sampling map of the oceanographic cruises developed in February 2014 and 2015, to evaluate the spatial distribution of the microbial communities considering the sea ice edge and the ice melting.

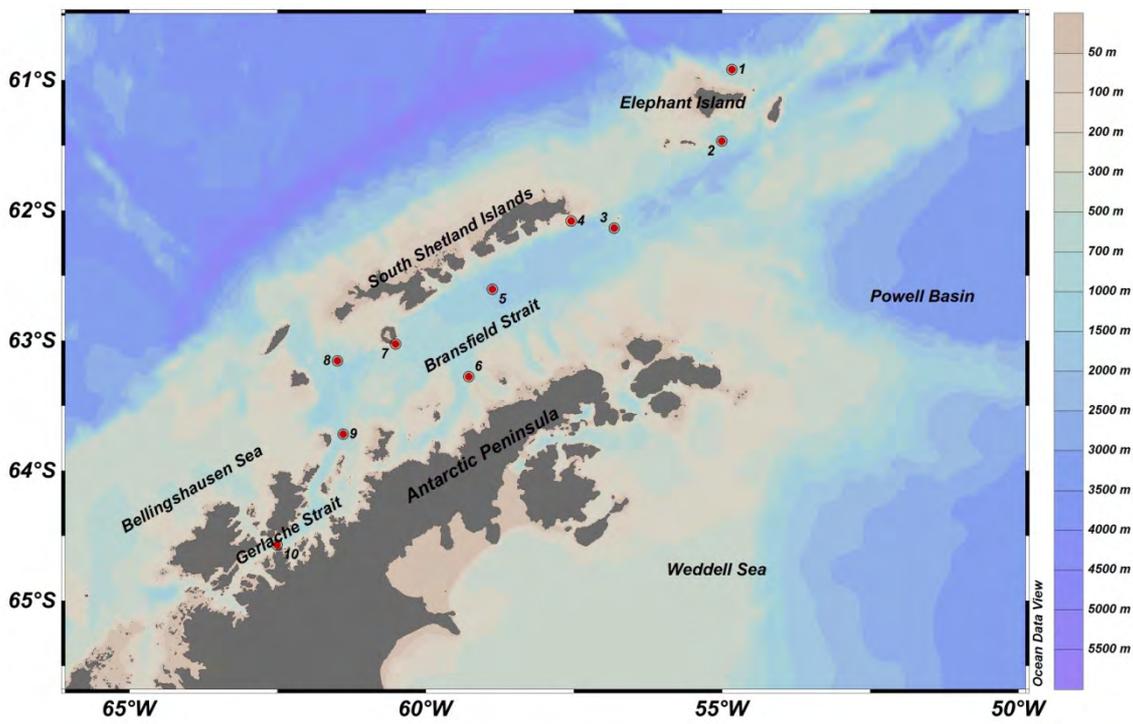


Figure 2. Sampling map of the ten monitoring stations for the temporal analyses of the microbial communities (Bacteria and Archaea) in the Southern Ocean.

Next Steps

As part of my post doc research (in the Institute of Oceanography at the University of São Paulo, in collaboration with the Woods Hole Oceanographic Institution), I am analyzing the data generated by the sequencing that has been performed. Then I will combine the microbial genetic data with the oceanographic factors measured during the cruises, as well as with the phytoplankton community data (18S rRNA) that was performed in selected oceanographic stations. Manuscripts about the microbial distribution in the Southern Ocean, considering regions differently affected by the climate change, as well as different time sets, are being prepared.

Further Scientific Activities

During this period, besides having the opportunity to watch some interesting seminars offered by the Woods Hole Oceanographic Institution and the Marine Biological Laboratory, I had the chance to participate in the “OCCI (Ocean Climate Change Institute) Climate Retreat - Polar Sciences” (June 4. 2015, National Academic Science, Jonsson Center, Woods Hole), where I briefly presented my work about the microbes in the Southern Ocean. I also participated in the “Ocean Carbon and Biogeochemistry Summer Workshop” (July 20-23, Quisset Campus), where I watched many presentations and made new connections.

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