The South African SIBEX I Cruise to the Prydz Bay region, 1984: I. Introduction, track charts and cruise description

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The primary aim of the South African SIBEX I cruise was to contribute towards the identification of the dominant physical, chemical and biological oceanographic features of the ocean in the vicinity of Prydz Bay for two main reasons; (1) to examine the validity of a hypothesis that there existed a major gyre north of Prydz Bay, and (2) to lay the background for a more process-orientated SIBEX II follow-up cruise.

Die hoofdoel van die Suid-Afrikaanse SIBEX I-vaart was om 'n bydrae te lewer tot die identifisering van die oorwegende fisiese, chemiese en biologiese oseanografiese kenmerke van die oseaan naby Prydzbaai. Hiervoor was daar veral twee redes, naamlik (1) om die geldigheid te ondersoek van 'n hipotese dat daar noord van Prydzbaai 'n omvangryke sirkulasiekolk bestaan, en (2) om die agtergrond te skep vir 'n meer prosesgeoriënteerde SIBEX II-opvolgvaart.

Introduction

The primary aim of the Second International Biomass Experiment (SIBEX I) was to identify the dominant physical, chemical and biological oceanographical features of a region of the Antarctic seas in the vicinity of Prydz Bay. This aim had two principal functions: firstly to examine the validity of earlier hypotheses set up by Russian studies and seemingly confirmed by the Australian investigations during 1981, that a major gyre north of Prydz Bay, in which large swarms of krill had been observed, dominated the oceanology of the eastern region of the Indian Ocean sector. Secondly, we had been charged with providing a basis for the development of process-orientated research during SIBEX II. This demanded an accurate description of the physical and chemical structure of the chosen grid area.

Infiltrating these studies, particularly in the upper layers of the grid area, were studies directed primarily at understanding the vertical and horizontal structure of phyto- and bacterioplankton, their mutual interaction and how this interaction may be governed by the physical and chemical structure of this oceanic region.

This collection of preliminary SIBEX I results is presented to the literature for the immediate convenience of workers still active in this ongoing investigation. It is the consensus of the authors that they do not indicate completed research nor, in most cases, even a completed phase. However, due to the interdisciplinary nature of the exercise it is expedient at this time to table the results for the common benefit of all participants.

Track charts and cruise description

At 16h00 SAST (GMT + 2) on the 15th March 1984, *SA Agulhas* left Cape Town for Prydz Bay, Antarctica, to take part in phase one of the Second International Biomass Experiment. The apparent noon positions along the track to and from the survey area are shown in Figure 1. Additional research was conducted during nine days spent at the Prince Edward Island Group and along two transects across the Antarctic Polar front.

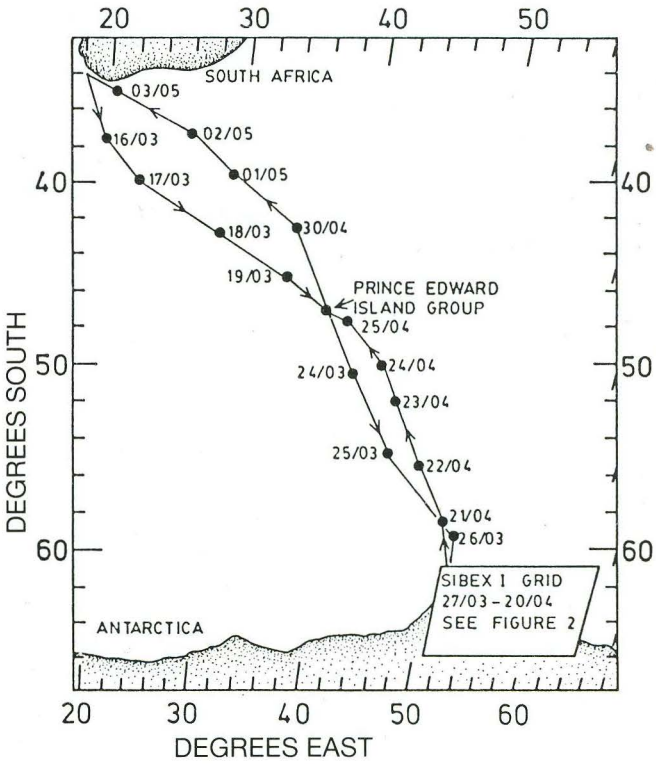

Fig. 1. A track chart showing the apparent noon positions of *SA Agulhas* to and from the SIBEX I survey area at Prydz Bay.

The survey grid, as initially agreed at a SIBEX planning meeting held at Wilderness, South Africa, 1983, was to comprise 50 stations arranged in seven east/west columns 2° apart and extending from 52 – 64°E with seven stations 40′ apart extending from 62 – 66°S per column. The 50th station would be a repeat of station one. Unfortunately the position of the pack-ice made it impossible to occupy all the stations and the grid was modified as shown in Figure 2a. This loss of six stations led to a discrepancy in the station numbers with the hydrographic stations numbered sequentially from one

to 46 (Fig. 2a) while the netting stations were numbered according to the original survey plan from number one to 50 (Fig. 2b).

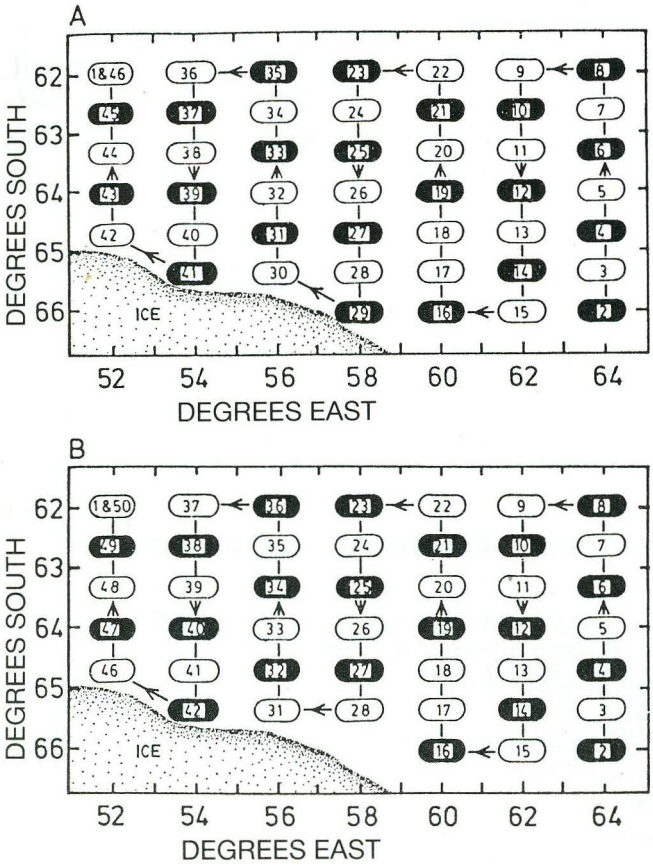

Fig. 2. The SIBEX I survey grid showing the edge of the pack-ice and the station numbering plans employed for;

a. the hydrological survey and

b. the netting survey

Closed ovals represent night stations.

At each of the stations, the following samples were taken:

1. A CTD cast to the bottom, provided an indication of temperature and salinity profiles.
2. 2ℓ Niskin bottles were cast to the standard depths agreed upon, viz. 0, 10, 20, 30, 50, 75, 100, 150, 200, 300, 500, 1000, 2000 m and 15 m above the bottom. These samples were used for nutrient (PO_4P, NO_3N, NO_2N, NH_4N and SiO_2), salinity, dissolved oxygen and trace metal analysis. In addition, the concentration of chlorophylls *a, b* and *c* and their breakdown products in the shallow samples (less than 200 m) was determined.
3. The surface zooplankton community was sampled with a weighted neuston net (0,96 m^2 mouth aperture, 950 μm mesh) towed on the surface at 1,25 $m.sec^{-1}$ for 10 – 15 mins. Paired Bongo nets (0,28 m^2 aperture, 500 and 300 μm mesh) hauled obliquely from 250 – 300 m, sampled the zooplankton through this depth.
4. At each of the day stations light attenuation profiles were measured and water was drawn from depths within the euphotic zone for chlorophyll *a* determinations and for measurements of potential primary production using an onboard incubator. The phytoplankton community was sampled by hauling a small (0,07 m^2 aperture, 30 μm mesh) net vertically from 100 m. In addition to the above, ornithological observations were made at the daylight stations and whenever *SA Agulhas* was underway during the day.
5. Regular depth soundings were taken while the ship was on station and while underway to substantiate the GEBCO data.

Summary of results

Within the time limits of SIBEX I, and having regard to the time of the year during which these investigations were carried out, the reported data and their preliminary analysis are unable to support the initial hypothesis on the presence of a major gyre in the region. Three features emerge strongly from the studies directed at phyto- and bacterioplankton: (1) the vertical distribution of phytoplankton was patchy, particularly below 75 m so that application of the P/I model to obtain integrals of production would be unwise and thus require a more critical examination of methods to measure primary productivity; (2) that detritus is the dominant source of particulate organic carbon, due largely to the senescent state of the phytoplankton community upon which the bacterial community in the deep layers of the upper mixed layers subsist; (3) that mineralisation of organic nitrogen sources in the upper mixed layers maintains production. Bottom water at 5 km depth is too remote to have any material effect.

No links between these primary and heterotrophic carbon fixing processes and either the microzooplankton or krill were established largely because of the original aims of this scientific programme. However, the phytoplankton and microbial studies showed explicitly that we need to look for the intercalating role of pico- and nanoplankton as the Antarctic krill, *Euphausia superba* is only able to filter particles greater than 10 μm effectively. They are therefore unable to make use of the bacterial production.

The distribution of krill-eating seabirds suggests a correlation with the distribution of krill in the grid. When this analysis is complete it may prove to be a useful affirmation of their value as indicators in pelagic food studies.

Acknowledgements

A great many individuals and organisations played key roles in the preparation for and implementation of the SIBEX I Cruise. Two organisations, namely, the Department of Transport and the South African Scientific Committee on Antarctic Research (SASCAR) of the Council for Scientific and Industrial Research (CSIR), were primarily responsible for making the *SA Agulhas* available and bearing the costs thereof, and for funding the research projects carried out during the voyage. The Sea Fisheries Research Institute loaned essential net and laboratory equipment and supplied onboard technical backing, and the National Research Institute for Oceanology assisted with the preparation of equipment for the cruise.

The Master, officers and crew of the *SA Agulhas* are thanked for their invaluable cooperation and assistance throughout the cruise. The pilots and crew of the SANARP helicopter which accompanied the voyage are also thanked for their exemplary cooperation throughout the voyage and indeed during the pre-voyage preparation phase.

Finally, SASCAR is thanked for the arranging and hosting of a series of workshops after the cruise. This volume is the product of those workshops.