PhD course in Sustainable Development and Climate Change

University School for Advanced Studies IUSS Pavia - 39° cycle

PLANKTONIC FORAMINIFERA AS PROXY FOR CLIMATE CHANGE

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INTRODUCTION

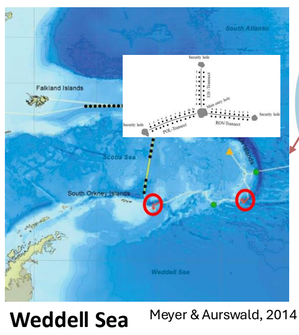
In the context of rapid climate change, polar regions represent extreme environments where the effects of global warming are particularly pronounced. Sea-ice environments host unique microhabitats that are critical for polar ecosystems, yet the faunal composition of these systems remains understudied, particularly planktonic foraminifera, single-celled microorganisms which create a calcium carbonate shell capable of fossilizing and recording surrounding environmental variables.

OBJECTIVE

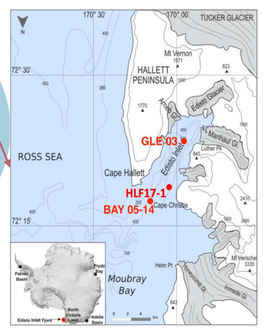
Investigate the presence of distinct morphological characteristics in planktonic foraminiferal species within Antarctic Sea ice cores and sea-water samples from the Weddell and Ross Seas. Specifically, if *Neogloboquadrina pachyderma* (1) develop an adaptive morphological design of their tests compared to those living in the seawater column, and if (2) these morphological designs evolve in a unique sea-ice species confirmed also by molecular analyses.

MATERIALS AND METHODS

Study Area: South Pole

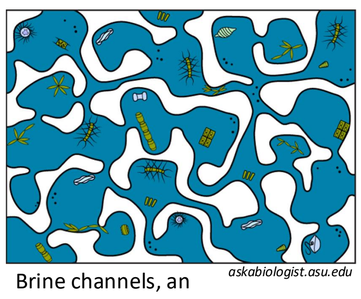


Weddell Sea Meyer & Aurswald, 2014



Ross Sea

Ice matrix:



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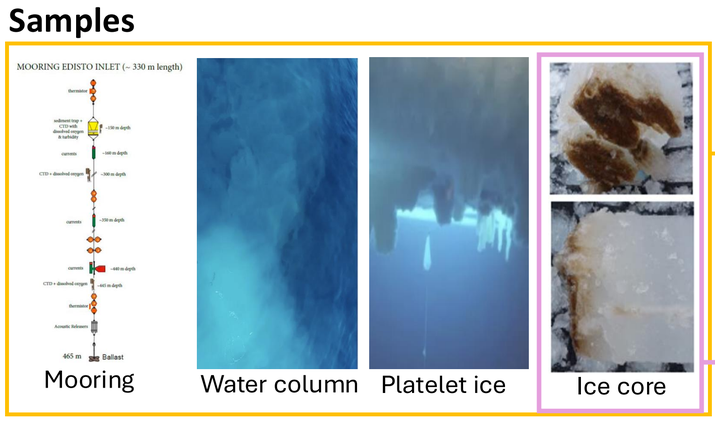
Brine channels, an extreme environment

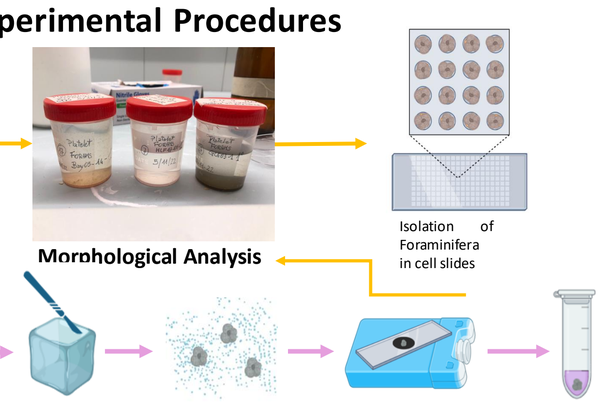
	Sea-ice brines	Seawater
Temp:	0/-20°C	3/5°C
Salinity:	up to 82 PSU	34 PSU

Samples



Mooring Water column Platelet ice Ice core

Experimental Procedures

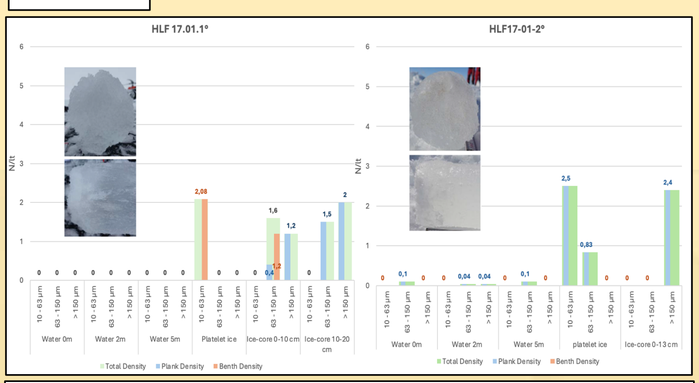


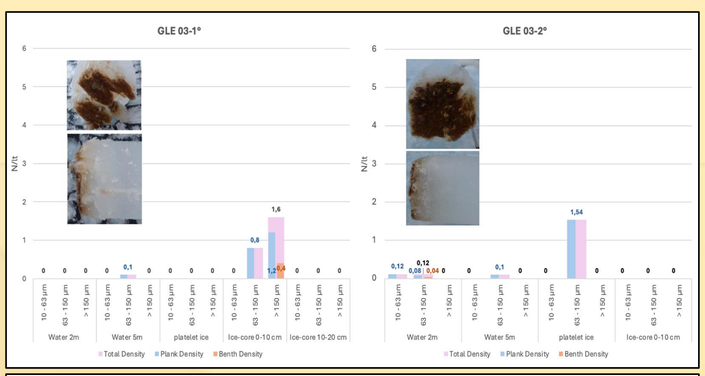
Scraping of the ice core and isolation of Foraminifera in controlled environment and in Rna Later for DNA extraction.

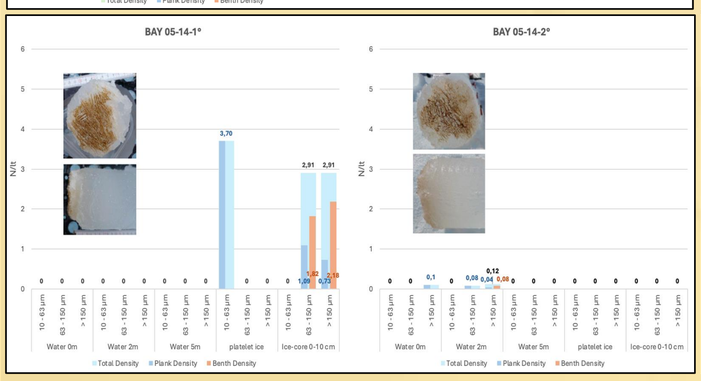
RESULTS

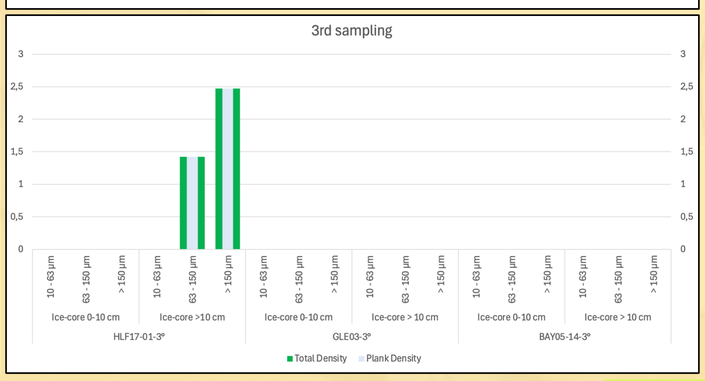
Comparison of faunal densities between Ross Sea and Weddell Sea

Ross Sea

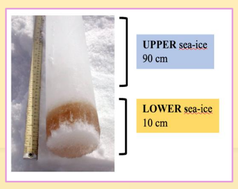


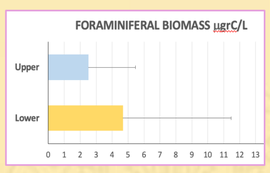


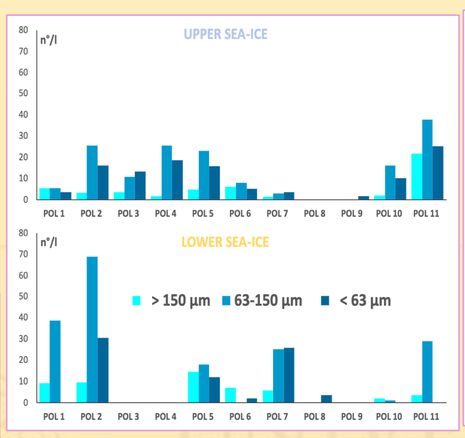


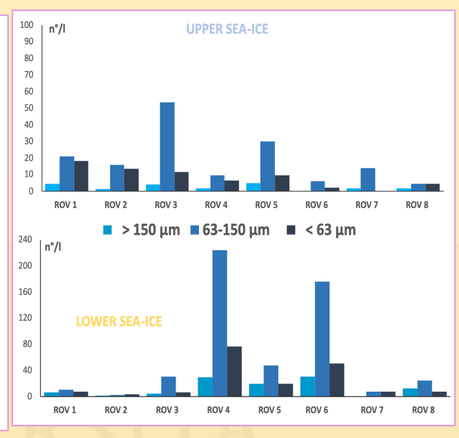


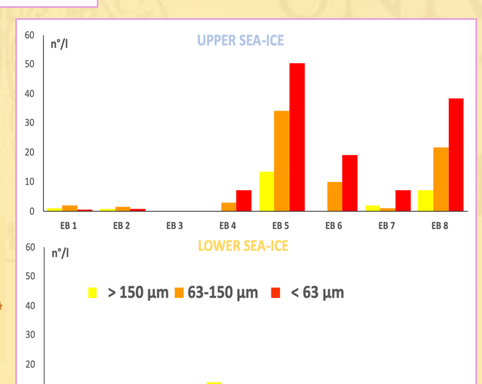
Weddell Sea

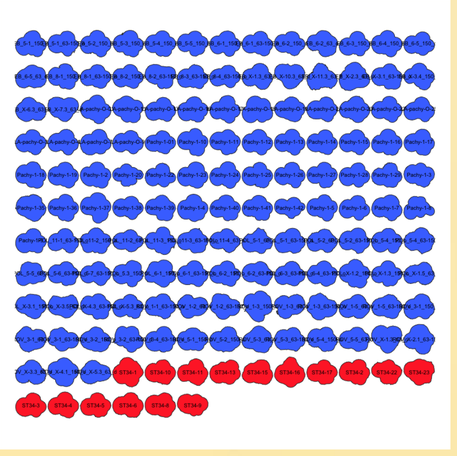










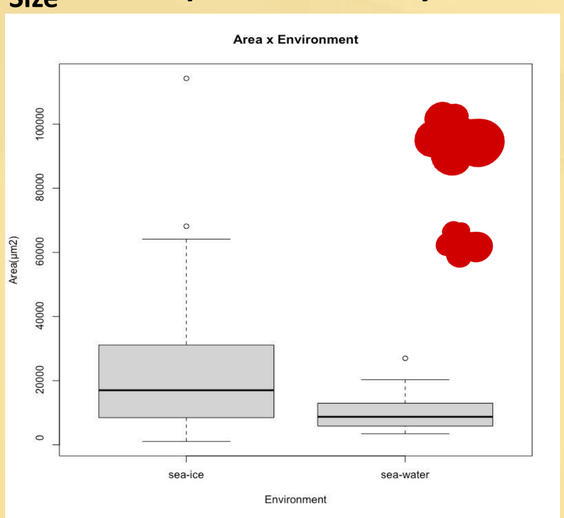


Shapes contour

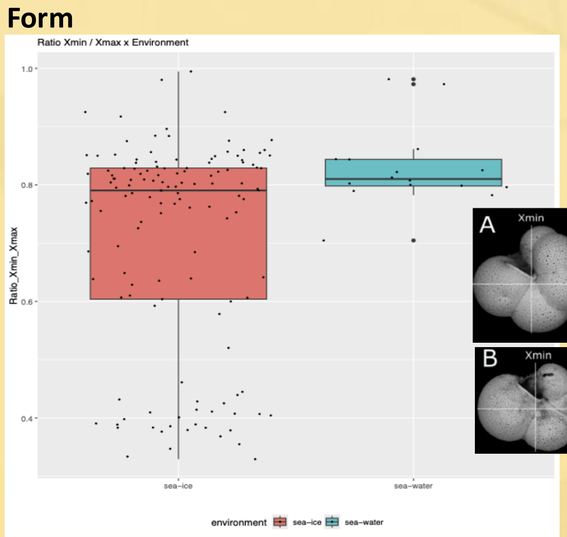
Can we use this specific foraminifera elemental signature as proxy for paleoclimatic reconstructions?

Morphometric Analysis

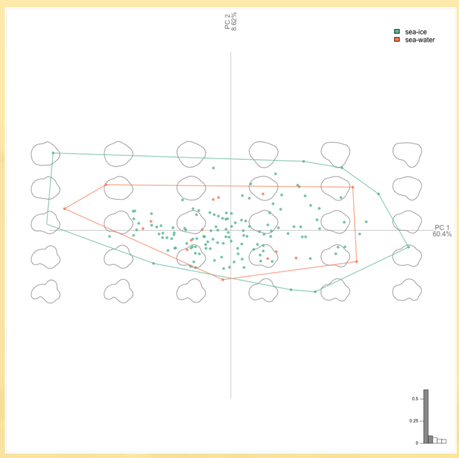
Size



Form



LDA: Distinction of the matrices



PCA: Shape distribution

Morphological differences were found between specimens from sea-ice and sea-water environments, in two sampling areas from different part of the South-Pole. This difference was investigated through morphometric analysis on the samples from the **Weddell Sea**. Specimens of *Neogloboquadrina pachyderma* show differences in size, with specimens of the sea-ice presenting a greater area then the specimens of the water column, and in shape, more pronounced in the horizontal dimension than in the vertical one, resulting in a more rhomboid shape rather than a square one. Statistical analysis revealed that groups are significantly different.

Elliptical coefficients (through harmonics) were obtained with Fourier Analysis, which enabled shape contour analysis (PCA, LDA). Forms representative of the sea-ice environment are more comparable to each other than those associated with the water column variable, which are less uniform. LDA matrix shows that **53%** of the individuals from sea-ice were **correctly classified as sea-ice**, 47% of sea-ice individuals were misclassified as sea-water. **62%** of **sea-water** individuals were correctly classified, whereas 38% were misclassified as sea-ice.

FUTURE ANALYSIS

- **DNA analysis** currently at the University of Stirling.
- **Elliptical Fourier Analysis** on shape contours of specimens from the Ross Sea and comparison with those previously conducted in the Weddell Sea.
- **Morphological and ultrastructural analysis** of the shell using Scanning Electron Microscopy **(SEM)**, **X-ray imaging and NanoSIMS.**

CONCLUSIONS

The morphological distinction between the two environmental variables is moderate, but preliminary results suggest a **potential morphological signal** discriminating foraminiferal specimens associated with the two matrices. The difference in size suggests a **hyper calcification** caused by supersaturated conditions of $CaCO_3$, due to the **high salinity** state of the **brine channels** of the ice. These last are also the probable cause of the **variability in size** and form of the *N. pachyderma* forced to live in this constrained dimension.

PARTNERS :

- CNR-ISP Bologna LASAGNE Project PNRA19_0069
- OGS Trieste, PLEASE Project
- MNHN Paris