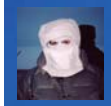

Sedimentary pigments as biomarkers of spatial and seasonal variations in the Beaufort Sea pelagic-benthic coupling

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ABSTRACT

The Arctic Ocean is characterized by broad continental shelves (51% of its surface area), which have high rates of primary productivity. In some areas, much of this production falls to the bottom, supplying rich and active communities of benthic organisms. Characterizing the major sources of production and understanding the fate of the organic matter to the benthos is critical to understand the ecosystem functioning and changes due to global warming. Sedimentary pigments reflect primary production and its pathways in the water column and the sediment. Water column, ice and sedimentary pigments of the South Eastern Beaufort Sea were studied by HPLC analysis during the fall 2003 and summer 2004, in the framework of the CASES project. Phytoplankton species composition showed seasonal variations (more diatoms in the summer) as well as spatial variations (difference between the polynya and the continental shelf areas). These differences were reflected in the sedimentary pigment composition. Moreover, the sedimentary chlorophyll a/phaeopigment ratio, an indicator of the "freshness" of the organic matter reaching the sediment, suggested that the pelagic-benthic coupling is particularly tight in the continental shelf, where the ratios are the highest. In the polynya area, however, considerable recycling occurs in the water column, leading to inputs of more degraded material to the benthos.

INTRODUCTION

Primary production on Arctic shelves can be particularly high. In some areas, a high percentage of biological production sinks and reaches the sea floor where it is cycled by the benthos. In areas where benthic production is not sufficient, benthic community structure and function are tightly linked to production in overlying pelagic zone and vertical flux. Moreover ice algae may be a significant carbon source for these benthic systems.

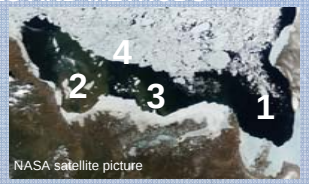
The response of benthic communities to deposition of phytodetritus can be very rapid. Part of the organic matter input is stored in the biomass, another part is respired, and

How does the variation in productivity influence the patterns of organic matter inputs to the benthos? How do benthic processes respond to these variations of inputs?

MATERIALS AND METHODS

Study area

The eastern Beaufort Sea was studied in fall 2003 and summer 2004 during the CASES program. The studied area includes the Cape Bathurst Polynya (1), Mackenzie River delta (2), the continental shelf (3) and slope (4).



Ice algae and phytoplankton pigments

Water was collected at the chlorophyll maximum depth. Ice samples were melted in filtered sea water. These were then filtered, and filters were extracted in acetone for ice algae and phytoplankton pigments prior to analysis by HPLC. Phytoplankton species composition was estimated using the CHEMTAX software.

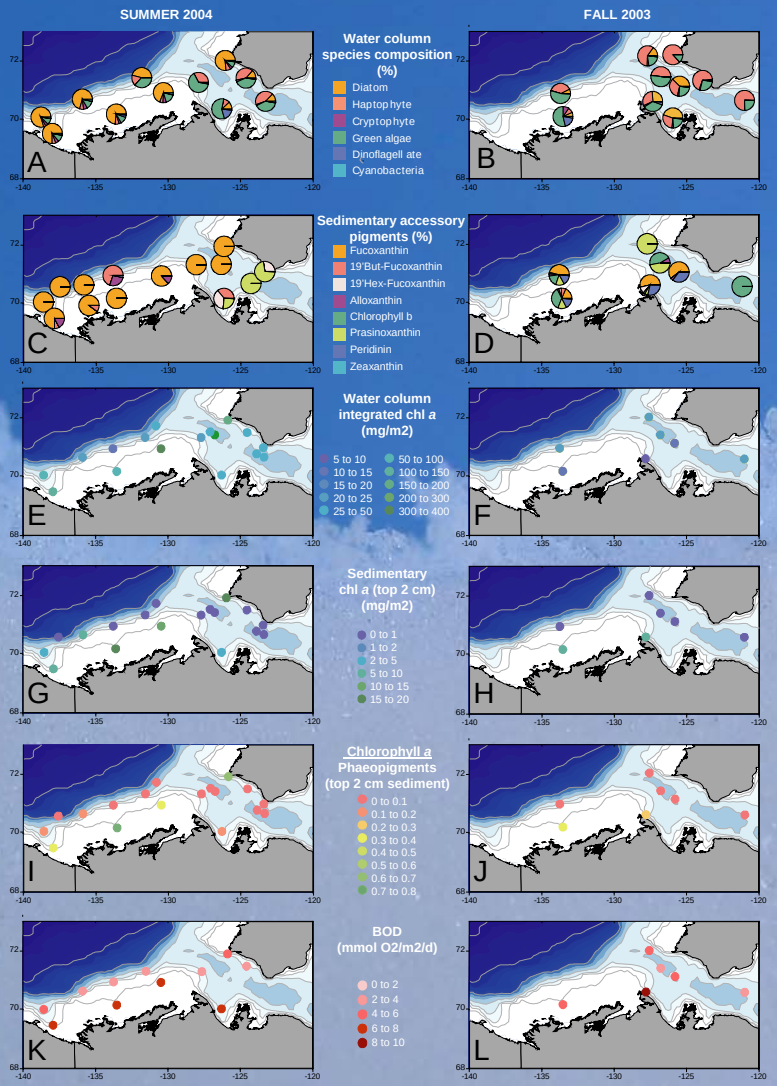
Sediment sampling for sedimentary pigments and benthic respiration

Sediment cores were collected from a boxcore. Top 2 cm of sediment were separated in two. Half was extracted in acetone for pigment analysis by fluororometer. Half was studied by HPLC. Larger cores were incubated for benthic oxygen demand (BOD).

HPLC analysis

Chlorophyll *a* is used as a marker of fresh organic matter while phaeopigments represent degradation products. Other accessory pigments are markers of phytoplankton taxonomic groups. HPLC analysis was performed using the method of Chen (2001).

SPATIAL PIGMENT CONCENTRATION AND BENTHIC OXYGEN DEMAND DURING SUMMER 2004 AND FALL 2003



CORRELATION BETWEEN SEDIMENTARY PIGMENTS, PHYTOPLANKTON, AND BOD

Phytoplankton species importance

Spatial and seasonal variations in phytoplankton compositions are reflected in the sedimentary pigments composition.

In the summer (B and D), sediment pigments reflect the water column phytoplankton species composition: shelf sediments show more diatom pigments (Fucoxanthin), and the polynya more green algae pigments (Chlorophyll *b*). It is important to notice that sedimentary fucoxanthin can also come from ice algae diatoms, but these techniques do not allow us to distinguish phytoplankton diatoms from ice algae diatoms.

In the fall (A and C), the high composition of small cells in the water column is reflected in an eclectic sedimentary pigment composition.

Local inputs of chlorophyll *a*

There is a significant correlation between the total integrated chlorophyll *a* in the water column and the surface sedimentary chlorophyll *a* (E and F).

The highest sedimentary chlorophyll *a* contents are found on the shelf, while they are the lowest in the polynya

Degradation pigments

The ratio chlorophyll *a*/phaeopigments (I and J) is the lowest in the polynya, suggesting inputs of more degraded material there, while fresher organic matter reaches the benthos on the continental shelf.

Benthic oxygen demand

BOD is the highest on the continental shelf (K and L). The correlation with the sedimentary chlorophyll *a* is significant. In the polynya, where the inputs of fresh organic matter are low (low chlorophyll *a* content and low ratio), the BOD is the lowest.

CONCLUSION

Organic matter inputs to the benthos

Inputs of organic matter are clearly dependent on the local overlying primary production. In the summer, the high content of fucoxanthin in the continental shelf suggest that phytoplankton, but also probably ice-algae, diatoms are the main source of food to the benthos.

In the polynya area, inputs of organic matter are always low and extremely degraded, suggesting a weaker pelagic-benthic coupling.

Benthic response

The activity of benthic communities clearly depends on the inputs of fresh phytodetritus. Benthic processes are the highest on the continental shelf, where the organic matter inputs are the highest.

The pelagic-benthic coupling is particularly tight on the continental shelf, while in the polynya, most of processes seem to occur in the water column.

Reference

Chen, N.H., Bianchi, T.S., McKee, B.A., Bland, J.M., 2001. Historical trends of hypoxia on the Louisiana shelf: application of pigments as biomarkers. Organic Geochemistry 32(4), 543-561.

Acknowledgments

We would like to thank S. Brugel for sharing chlorophyll and other data. Thanks are also due to officers and crew of R/V Amundsen, S. Blondeau and P. Massot and CASES scientists especially A. Chuchioto, H. Hegaret, A. Aitken, T. Connelly, C. McClelland, and others... We are extremely grateful to Jason Perl for providing pigment standards. This investigation is part of the CASES project and received funding from NSF (OPP-0326371 to PER).

Photo: Sergiy Samalev