Diatom Dynamics in the North Pacific Subtropical Gyre (NPSG)

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Abstract

Diatoms generally comprise minor components of plankton biomass in oligotrophic open ocean ecosystems. However various lines of evidence suggest diatoms are major contributors to annually recurring phytoplankton blooms in the NPSG. Moreover, these diatom-dominated blooms play central roles in the material exchange between the upper ocean and the deep sea at Station ALOHA (22°45' N, 158°W). Our understanding of diatom bloom dynamics is partly hampered by a lack of knowledge on temporal variability in diatom community structure in this ecosystem. In this study, we utilized both microscopic- and molecular-based technologies to investigate temporal and spatial dynamics in diatom assemblages in the NPSG. Group specific quantitative PCR primers targeting diatom rbcL genes were designed and employed to examine time and space dependent changes in the abundances of several major diatom genera. In addition, we evaluated the contributions of several groups of diatoms to particulate matter export at Station ALOHA.

Introduction

Satellite observations:
Satellite remote sensing of surface ocean chlorophyll concentrations in the NPSG indicate recurring summertime phytoplankton blooms.

Direct observations:
In 12 of the past 20 years (1988-2000) shipboard measurements indicate diatoms comprise important components of these blooms.

Characterization of temporal and spatial dynamics in diatom population structure
Examination of the contributions of the specific members of the diatom assemblage to carbon production and export
Identification of the processes controlling diatom productivity

Collect and preserve diatom samples

Time-series:
Monthly cruises to Station ALOHA (2007-2009)
Sampling of upper ocean (0-175 m) suspended cells and sinking particulate material (150 m)
DNA, RNA and slides for microscopic identification of diatoms

Spatial variation:
Gyre-scale (BRZ cruise), Mesoscale (CMORE summer cruises)
Analyses of diatom community structure in the center and along the Northern Edge of the gyre

Identification and quantification of diatoms
Microscopy → Morphology
Molecular-ttech → DNA fingerprint
rbcL gene → Large subunit of RuBisCO

Molecular approach:
- PCR – clone library
- Design diatom specific rbcL gene PCR primers

Results

Phylogenetic relationships among diatom rbcL sequences obtained from the NPSG

QPCR primers
- Aulacoseira-group
- Sellaphora-group
- Chaetoceros-group

Pseudonitzschia-group
Cylindrotheca-group

Vertical distribution of specific diatom groups

Spatial distribution: center vs northern edge of the NPSG

PC flux (mg m⁻² d⁻¹)
PSi flux (mg m⁻² d⁻¹)

Time series: Suspended Cells vs Sinking Flux at Station ALOHA

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