Community structures and photosynthetic physiological conditions of phytoplankton in the NW subarctic Pacific during SEEDS and SEEDS-II

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Comparisons between SEEDS and SEEDS-II

- Phytoplankton community structure
- Photosynthetic physiology of phytoplankton

*Here we also briefly discuss why a diatom bloom did not occur during SEEDS-II.*
SEEDS and SEEDS-II

SEEDS : 18 July - 1 August 2001 (Days 0-13)
SEEDS-II : 19 July - 21 August 2004 (Day 0-32)
Changes over time in chlorophyll \( a \) concentrations at 5 m inside the each Fe patch during SEEDS and SEEDS-II
Temporal changes in Chl $a$ levels at 5 m inside and outside the Fe patch during SEEDS-II
Relative contributions of each size class of phytoplankton to Chl $a$ levels at 5 m inside the each Fe patch.
Dominant diatom species during the bloom of SEEDS

- **Chaetoceros debilis**
- **Chaetoceros atlanticus**
- **Eucampia groenlandica**
- **Chaetoceros concavicornis**
- **Pseudonitzschia turgidula**

Max. $1 \times 10^4$ cells ml$^{-1}$
Max. 1.8 d$^{-1}$
($= 2.6$ doublings d$^{-1}$)
(Tsuda et al., 2005)
Contributions of each phytoplankton group to Chl $a$ biomass at 5 m inside the Fe patch as estimated by CHEMTAX (HPLC pigment data)
Changes over time in the cell densities of cryptophytes at 5 m during SEEDS-II as measured by flow cytometry

Cell density (x 10^2 cells ml^-1)

Days

In
Out

Cryptophyte Rhodomonas sp.
Photosynthetic potentials of total algal assemblages at 5 m inside the Fe patch during SEEDS and SEEDS-II as estimated by FRRf

No significant difference ($p > 0.05$) between SEEDS and SEEDS-II on surface $F_v/F_m$ ratios until Day 13.
Photosynthetic potentials of total algal assemblages at 5 m inside and outside the Fe patch during SEEDS-II as estimated by FRRf.

Overall, the photosynthetic physiological condition of phytoplankton was improved after the Fe enrichments.
Why didn’t large-sized diatoms make a large bloom during SEEDS-II?

Possibilities

- Zooplankton (especially, mesozooplankton) grazing might suppress diatom stocks?

- Seed populations of bloom-forming diatoms might not exist before the Fe additions?
  - No, *Thalassiosira* spp. (ca. 20 μm in size) predominated in the diatom population.

- Sufficient amount of bioavailable Fe might not be supplied to the large-sized diatoms?
Ferredoxin/flavodoxin assays for micro-sized diatoms (20-200 μm in size) at 5 m during SEEDS-II

- For Fe-deficient algal cells, the Fe-containing protein “ferredoxin” can be replaced by the non-Fe-containing “flavodoxin” at the acceptor side of their photosystem I (La Roche et al., 1996).

- Ferredoxin and flavodoxin were analyzed by SDS-PAGE plus western blotting using their diatom-specific antibodies, respectively.
  - anti-ferredoxin (Suzuki et al., in prep.)
  - anti-flavodoxin (La Roche et al., 1995)
An example of flavodoxin assay for micro-sized diatoms (20-200 μm in size) at 5 m during SEEDS-II

PC: positive control [Fe-limited diatom *T. pseudonana* (CCMP1335)]
MW: Molecular weight marker
Changes over time in the relative abundance of flavodoxin in micro-sized diatoms (20-200 μm in size) at 5 m during SEEDS-II

The growth of micro-sized diatoms could be suppressed by Fe availability even after the Fe additions.
Conclusions

- Fe supply had a crucial effect to improve the photosynthetic physiology of phytoplankton at the study site during summer.

- In SEEDS-II, a diatom bloom did not occur. That could be partly due to the Fe limitation of large-sized diatoms throughout the experiment.