Change of dominant phytoplankton groups in the eutrophic coastal sea due to atmospheric deposition

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Abstract

Nutrient stoichiometry and input of trace metals may profoundly affect the growth and community structure of phytoplankton. A bioassay experiment was designed to explore the key components in atmospheric deposition that affect marine phytoplankton growth by adding aerosols and analogues nutrients and Cu to the surface water of the coastal East China Sea (ECS). Our results showed that atmospheric deposition alongwith the input of phosphate could largely enhance the chlorophyll a (Chl a) concentrations in this eutrophic water. Phosphorus addition lifted the proportions of *T. oceanica* in Diatoms and *B. brevisulcata* in Dinoflagellates. *T. oceanica* replaced *S. costatum* and became the dominant diatom species after the *Chl a* peak, probably associated with the N/P ratio approaching to 16. Atmospheric aerosols containing affluent N and little P showed limited promotion to *Chl a*, and the positive effect was very likely due to the soluble Cu and other trace metals supplied by the aerosol. Moreover, soluble aerosol Cu was found to be conducive to the relative abundance of most dominant class Coscinodiscophyceae, and both soluble aerosol Fe and Cu seemed to be very important for increasing the proportion of *S. costatum*. Soluble metals could be the key components in aerosols controlling the phytoplankton composition in the eutrophic sea and such impact might exceed affluent P provided by other exogenous sources.

Water sampling & aerosol additions

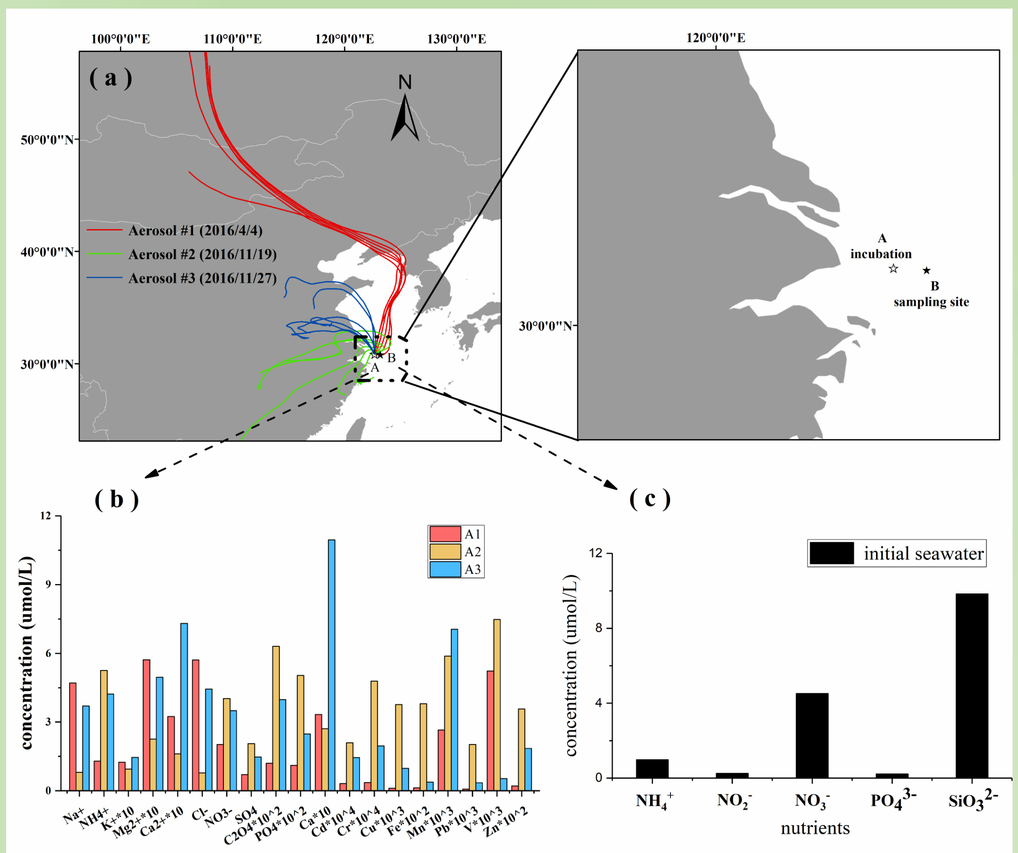

Fig 1. A map showing the sampling sites of aerosols and surface seawater for the bioassay experiment, three colored lines represent 72-h air mass back trajectories (at 100 m height) starting from the sampling site during the sampling dates (a), column figures are soluble aerosol components added to each treatment during the incubation (b) and nutrients' concentrations in initial seawater (c).

Three aerosols

Aerosol 1 : **desert dust** (Al, Ca and Fe) + **marine source** (Ni, V, Na^+, Mg^{2+} and Cl^-);

Aerosol 2 : **secondary aerosol** (SO_4^{2-}, PO_4^{3-}, NH_4^+ and NO_3^- oxalate and soluble metals);

Aerosol 3 : **soil dust** (Al, Ca, Fe, Mn) + **anthropogenic pollutants** (Zn, Cd and Pb).

Initial water

DIN 5.74 μM, PO_4^{3-} 0.22 μM, SiO_3^{2-} 9.84 μM and N:P > 16:1

Chl a concentration

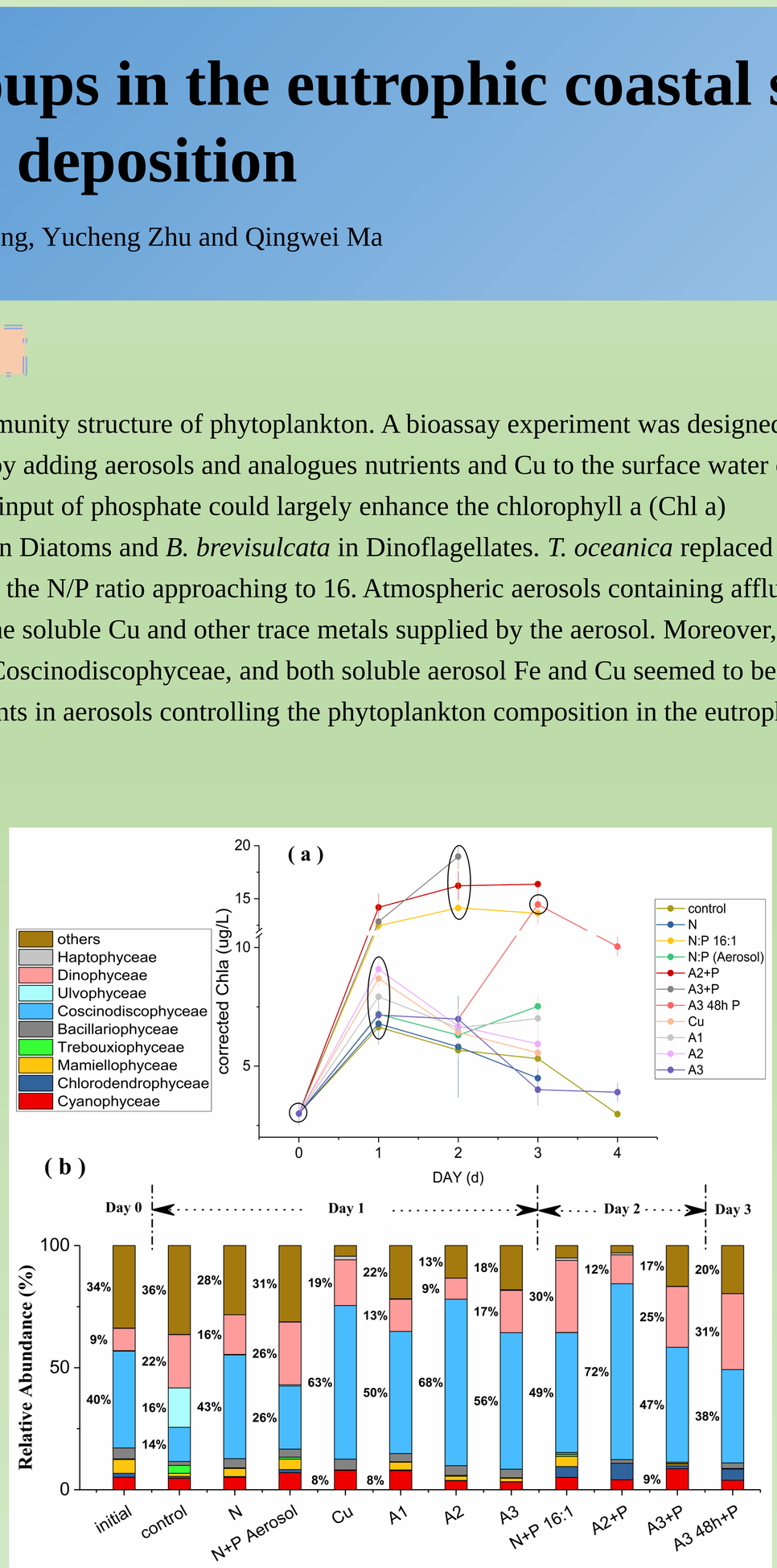

Fig 2. Change of *Chl a* concentrations (a) and relative abundances of dominant phytoplankton groups (b) in different treatments during the bioassay experiment. Circles in (a) highlight the sample with the maximum *Chl a* in each treatment used for analysis of phytoplankton community structure.

- N supply could hardly facilitate the growth of phytoplankton in eutrophic ECS
- Aerosol deposition + exogenous P would be crucial to primary productivity
- Aerosols and Cu could further enhance *Chl a* concentration

- Soluble metals in aerosols were conducive to the growth of two dominant classes: Coscinodiscophyceae and Dinophyceae
- Surplus N promoted Mamiellophyceae

Phytoplankton community

Atmospheric substance vs dominant species

- Soluble Fe and Cu were likely to facilitate the relative abundance of Coscinodiscophyceae, wherein *S. costatum* was mostly favored.
- *T. oceanica* was more competitive than *S. costatum* under the relatively low N/P ratios approaching to 16
- Water masses containing affluent P may combine with atmospheric deposition and cause a large increase in *B. brevisulcata* biomass

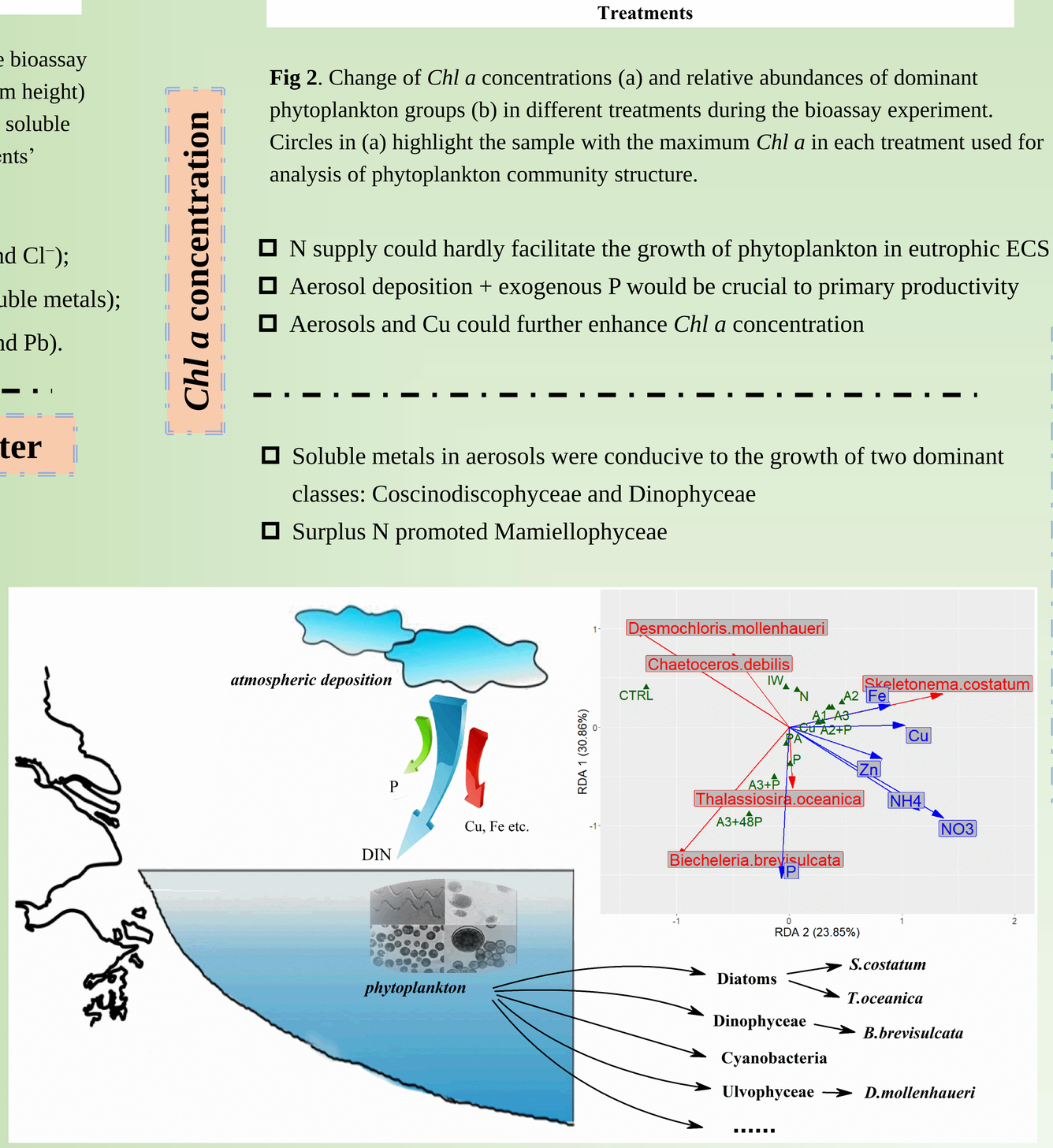

Fig 3. Atmospheric nutrients and soluble metals control the dominant species of phytoplankton (RDA).

Summary

Atmospheric deposition was not able to largely enhance the *Chl a* in the eutrophic system, however it could play a critical role in regulating the phytoplankton composition and dominance species.

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