How does a shifting phytoplankton community composition affect carbon cycling?

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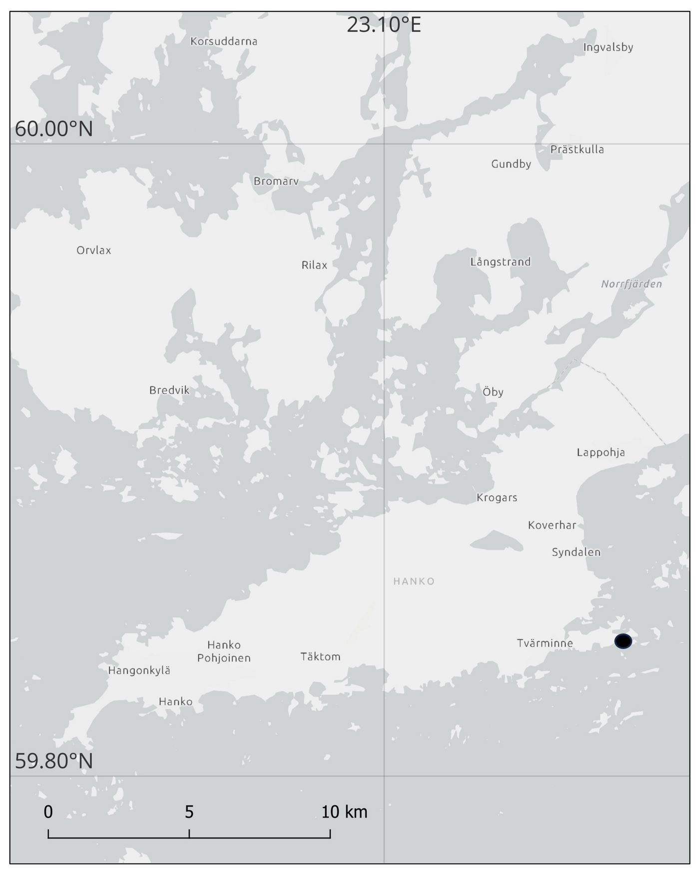
Phytoplankton growth is strongly linked to the annual climatic cycle [1] and studies have shown that phytoplankton reacts quickly to changes in their environment[2]. The seasonal change in environmental conditions favours different groups of phytoplankton species resulting in community shifts and varying carbon dynamics[3].

Methods

- Monitoring frequency between 1-3 weeks (10.2021-10.2022)
- close to Tvärminne Zoological Station
- 25 time points for regular monitoring
- 5 time points for sediment traps (deployed for 24 hours)
- Different analyses were performed (i.e. total & dissolved nutrients, POC/PON, DOC)



Results

Diatoms held 2 times more C (486 µg C l^{-1}) in spring than the other phyla together. Dinoflagellates (37 µg C l^{-1}) had the highest amounts end of April. Cyanobacteria (31 µg C l^{-1}), Chlorophyta (28 µg C l^{-1}), Cryptophyta (6 µg C l^{-1}) all held the highest amounts of C in June and July (Fig. 1)

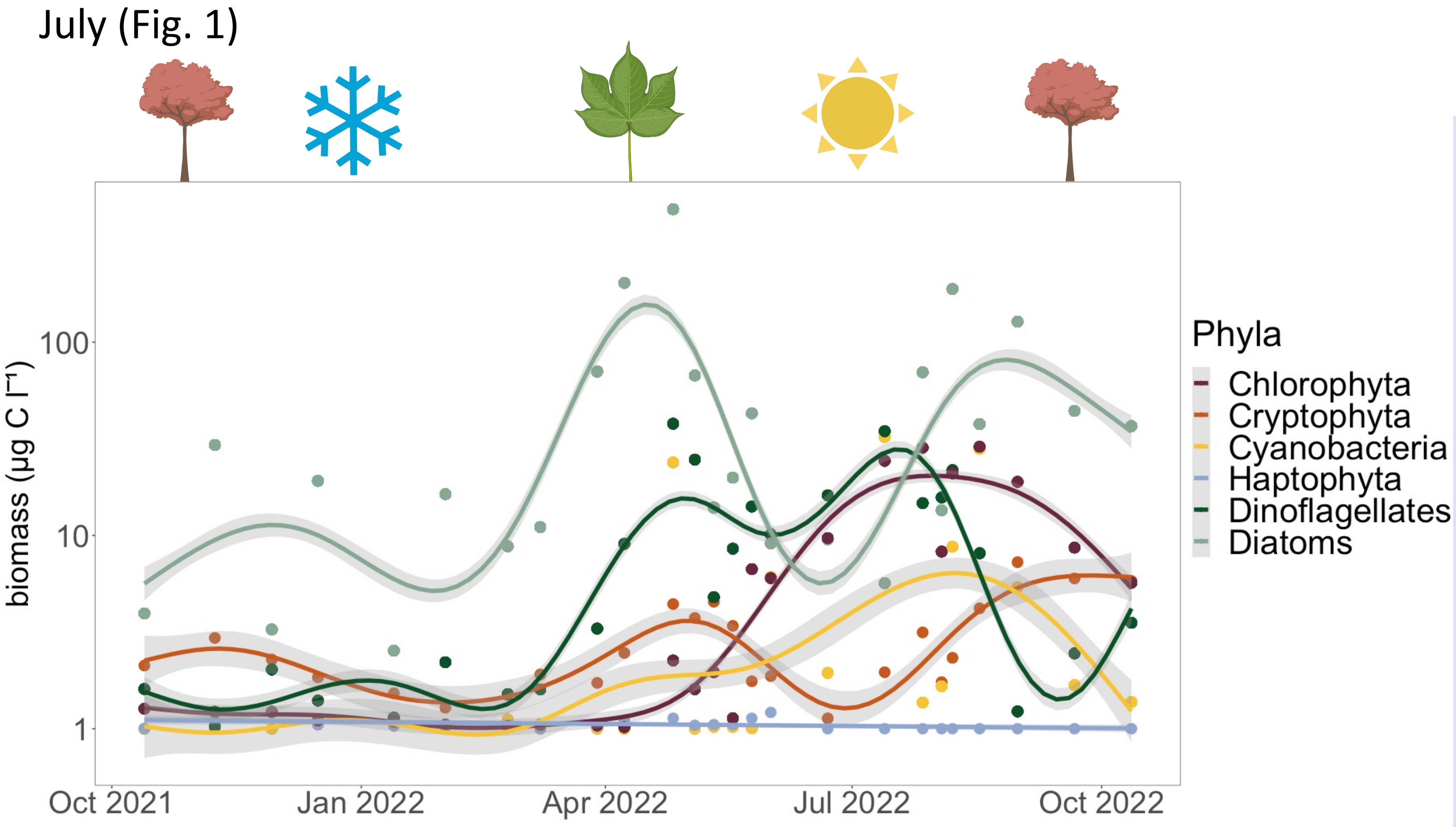


Fig. 1: Annual changes in Phytoplankton carbon per Phylum (Oct. 2021 – Oct. 2022). A smoother was used for visualisation and the grey areas indicate the 95% confidence interval. The y-axis is log10 transformed

The sediment trap data suggests that carbon sinks down at the end of the growing season and stays in the pelagic system during the year (Fig. 2).

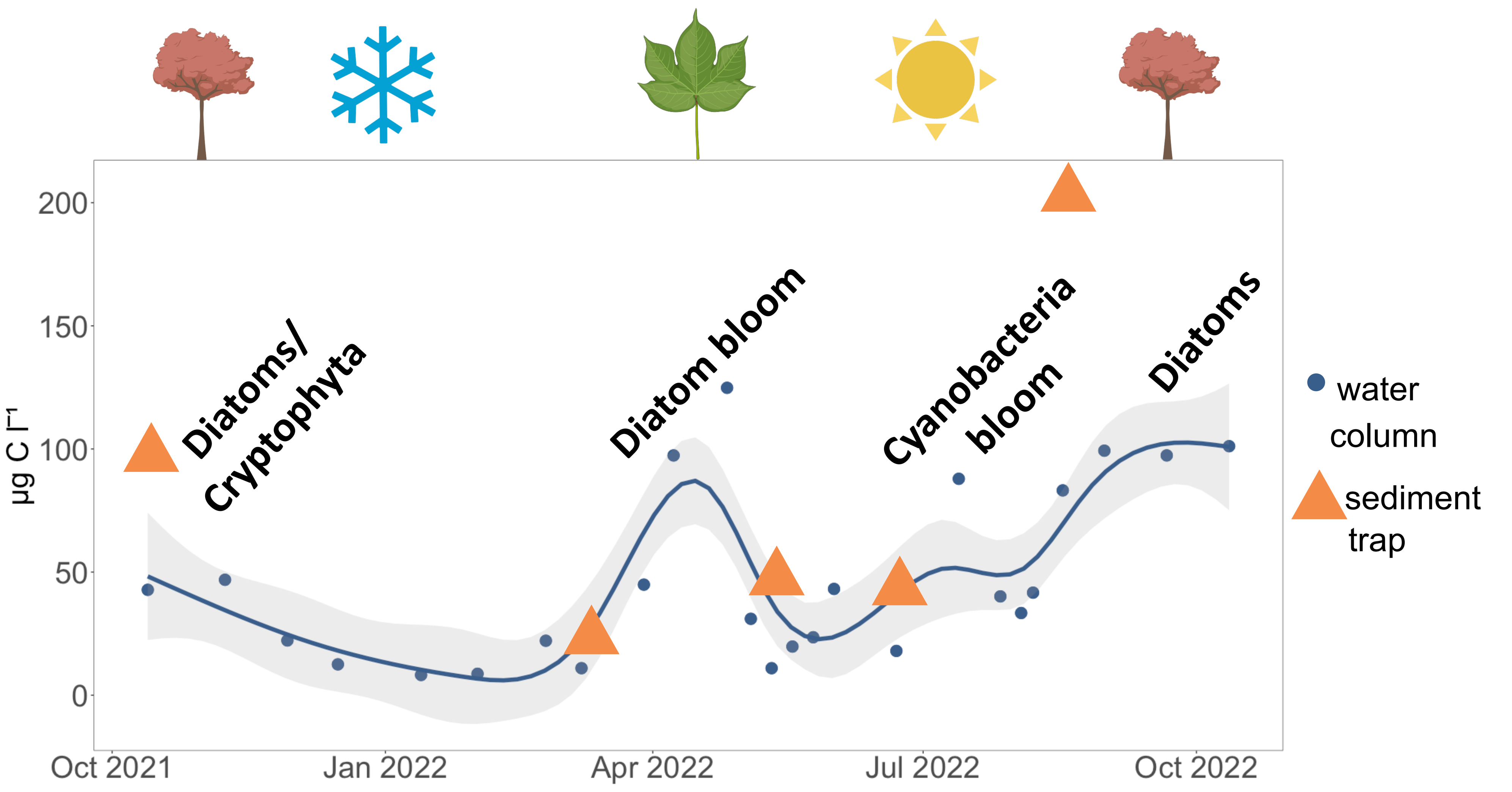


Fig. 2: Calculated Carbon in Phytoplankton from Chlorophyll a content following Jakobsen and Markager[4]. Values from Estuarian Stations used (C=24*CHL^0.98). Phytoplankton groups indicate the respective dominance for each season. A smoother (blue line) was used for visualisation and the grey area indicates the 95 % confidence interval.

Summary

Spring (III-V)
- Diatom bloom
- declining nutrients
- high POC/PON ratio
- highest C in phytoplankton
- low Evenness

Summer (VI-VIII
- Cyanobacteria bloom
- lower C in phytoplankton
- lower POC/PON ratio

Autumn (IX-XI)
- highest rate of C sinking
- relatively high C content in phytoplankton
- low POC/PON ratio
- high Evenness

Winter (XII-II)
- little production in water column
- low POC/PON ratio
- low nutrient content

Our results highlight the complex relationships between phytoplankton biomass, community composition and carbon dynamics, with strong seasonal variations observed throughout the year. It emphasises the critical role of keystone species for carbon transport and production in spring, and the importance of diversity for ecosystem productivity in summer.

ACKNOWLEDGMENTS

Pro Mare Balticum Walter and Andrée de Nottbeck Foundation sr
Coast Clim Coastal Ecosystem and Climate Research
KONE FOUNDATION
FinMARI Finnish Marine Research Infrastructure

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