Response of under-ice phytoplankton populations to light exposure during the Arctic spring bloom

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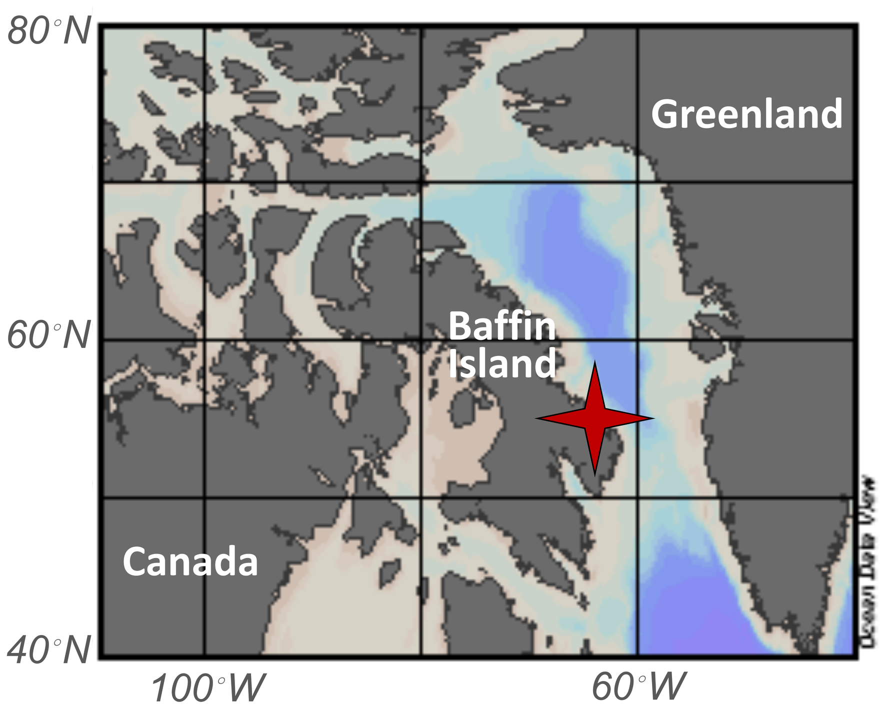
INTRODUCTION

Marine phytoplankton are responsible for approximately 50% of global primary production and are at the base of marine food webs (1). In the Arctic Ocean, one important factor controlling phytoplankton productivity is sunlight, as sea-ice and snow coverage limits light penetration in the water column.

Over the last three decades,

- The extent of the **seasonal sea-ice and snow coverage has decreased in response to climate change**, resulting in **changes in the dynamics of light penetration** (2).
- These changes may cause **important fluctuations of the spring and summer phytoplankton blooms dynamics** with unknown effects on Arctic marine food webs and carbon cycle.

To better understand the **effects of light on Arctic nano- and pico-phytoplankton growth and community composition**, a series of six incubation experiments were performed between May and July 2016 during an ice camp campaign (www.greenedgeproject.info) in the Baffin Island (Figure 1).



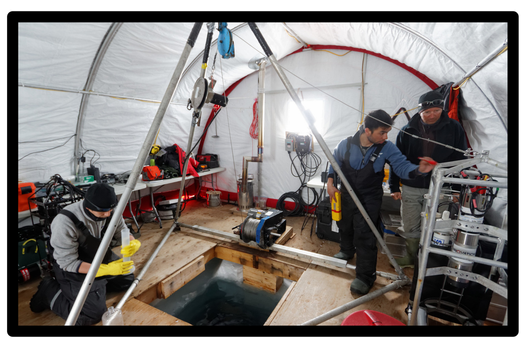


FIGURE 1: Location (red cross) of ice camp campaign in Baffin Island (67°28.78 N, 63°47,37 W)

RESULTS
Onset of spring phytoplankton bloom in mid-june

- Sea-ice coverage at the ice camp decreased rapidly from about 90% in mid-June down to approximately 10% at the end of July.
- As the snow melted and the ice cover decreased, the light level at the surface water increased significantly starting in June.
- With the increase in light level phytoplankton cell concentration increased rapidly (spring bloom peak at the end of June)

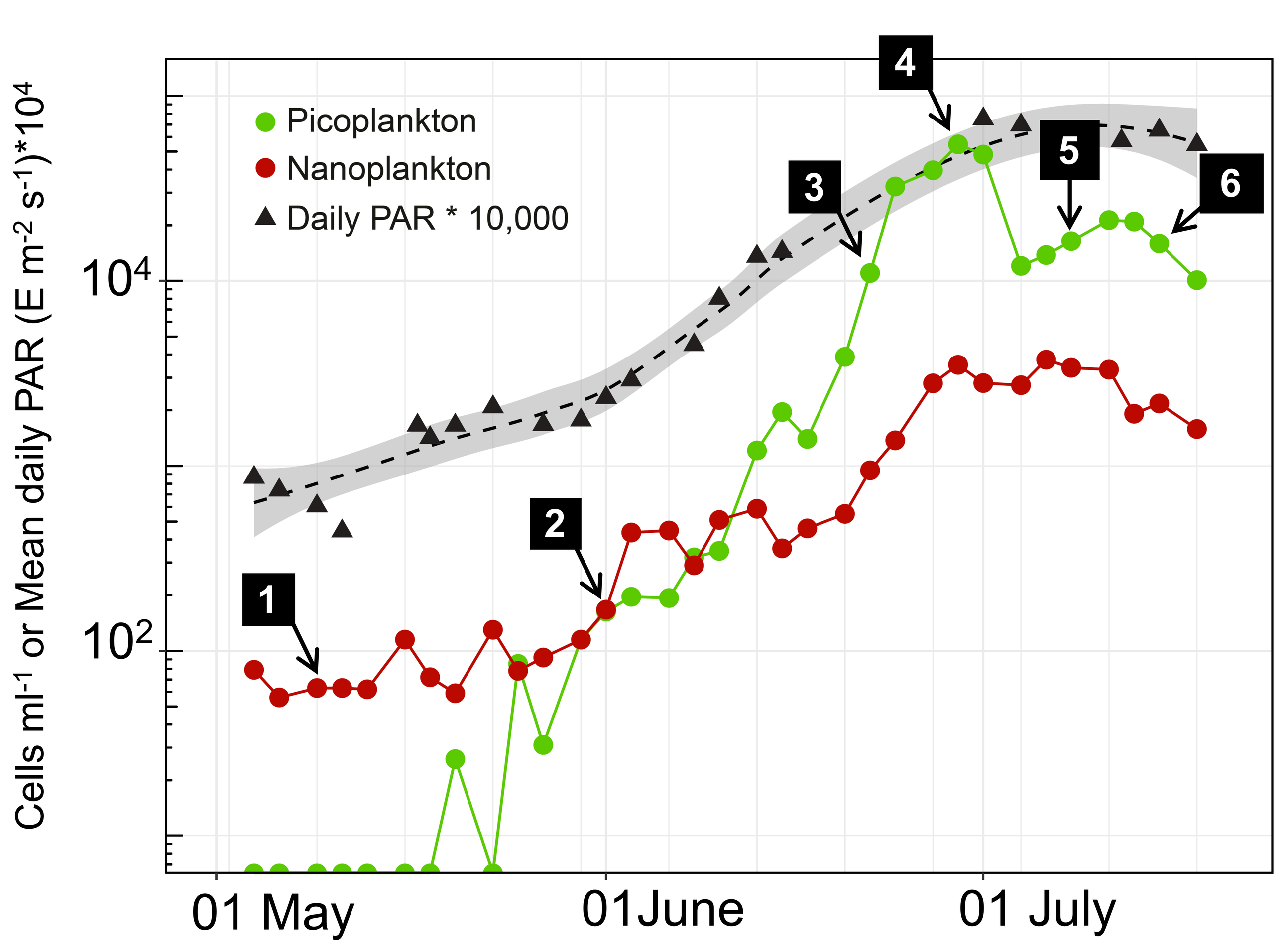


FIGURE 2: Light level (PAR) and Pico and nano phytoplankton cell concentration over the duration of the ice camp campaign (1.5 m). Black arrows and numbers indicate the date in which each incubation experiment started.

METHODS

The experiments were performed with surface sea-water collected through a permanent hole in the sea-ice. Incubations were performed in the laboratory for 7 to 8 days at 4°C in the dark (control) and in the light at 100 µE m^{-2} s^{-1} (in biological triplicates). Phytoplankton growth was analyzed by flow cytometry. For each experiment, samples for RNA and DNA were taken at the beginning (duplicates) and at the end of the incubations (for each biological replicate).

RESULTS: Rapid response to light in experiments performed before the onset of the spring bloom

Pico- and nano-phytoplankton cell concentration **increased up to 15-fold with light** for the two (1 & 2) experiments performed **before the onset of the spring phytoplankton bloom** (Fig. 3).

In contrast for the four (3-6) other experiments performed later in the season cell concentration decreased both in the dark and the light, demonstrating that light was clearly not limiting any more (Fig. 3).

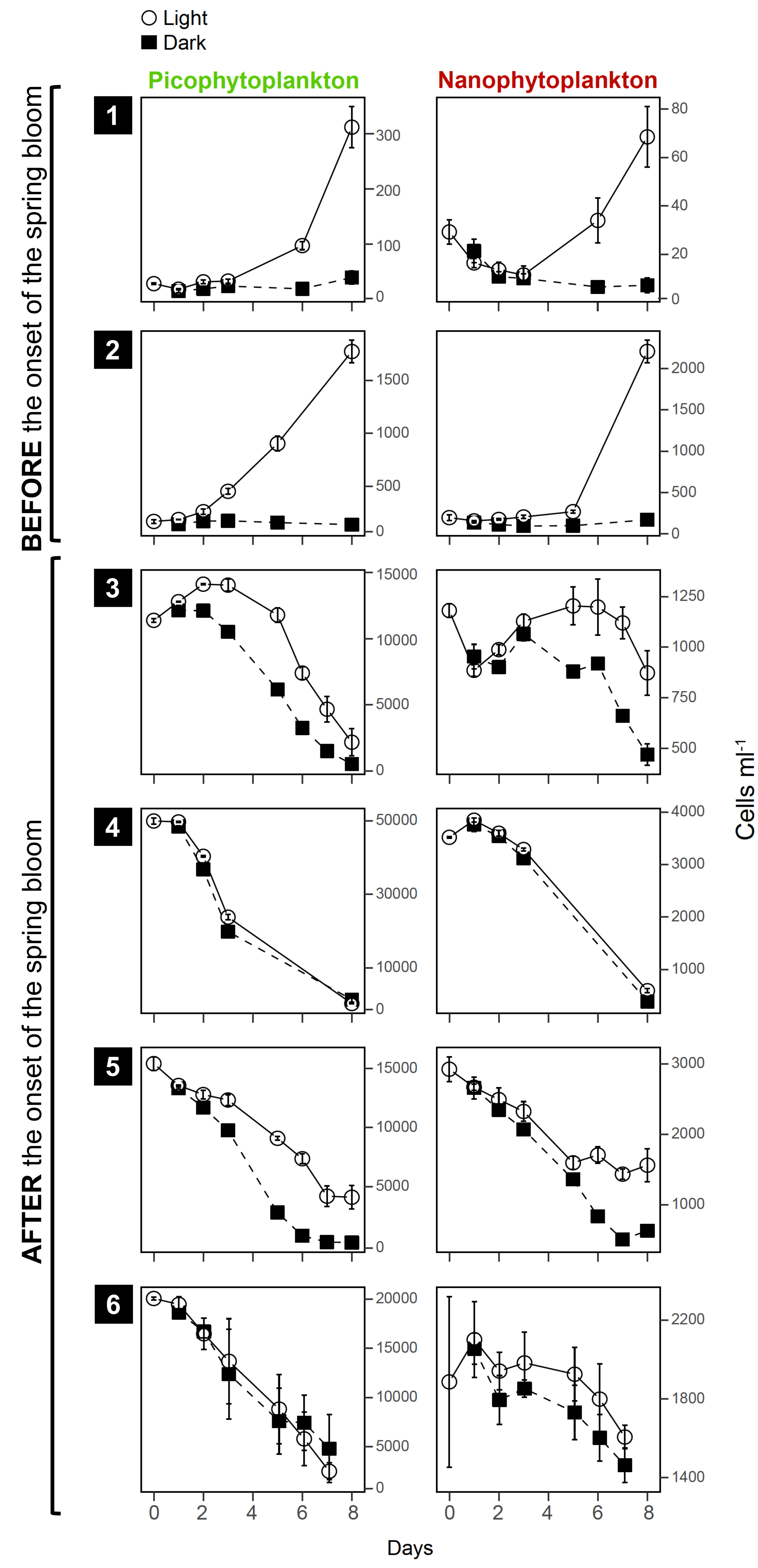


FIGURE 3: Changes in pico- and nano-phytoplankton cell abundance over each incubation experiment (1-6; black squares). Control (dark) and treatments (light)

CONCLUSIONS & FUTURE DIRECTIONS

- Decrease of the Arctic seasonal ice and snow coverage will change the dynamics of the phytoplankton blooms as light will penetrate in the water column earlier in the season.
- Based on our results, light appears to be an important phytoplankton growth limiting factor when ice and snow coverage is still about 90%.
- To better understand these effects of light we are currently determining how the structure of the phytoplankton community changed during these incubations (using 16S and 18S rRNA metabarcoding)

References & Acknowledgements

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