Seasonal changes in photosynthetic activity and their relation to the phenology of deciduous plants in the High Arctic, Svalbard

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Understanding the photosynthetic characteristics is essential for predicting the impact of climate change on carbon cycling in Arctic terrestrial ecosystems. However, despite their importance to net primary production, few studies have investigated seasonal changes in photosynthetic activity during the growing season (Muraoka et al., 2002; Starr et al., 2008). In this study, we investigated seasonal changes in photosynthetic activity and their relation to the phenology of deciduous plants in the High Arctic, Svalbard.

Our study site was located at Nybyen, Longyearbyen, Svalbard, Norway (78°12'N, 15°35'E). The three selected plant species are common deciduous plants in Svalbard: *Salix polaris* (dwarf shrub), *Oxyria digyna* (forb), and *Bistorta vivipara* (forb). To investigate photosynthetic activity, we used a portable photosynthesis system (LI-6400, LI-COR). The photosynthetic rates were determined at light saturation (PPFD = 750 μmol m^{-2} s^{-1}) and approximately 10℃. We conducted these measurements every three to five days from July 7 to August 9, 2024.

Both *S. polaris* and *O. digyna* maintained their high photosynthetic rates until July 25, after which these rates began to decrease synchronously with leaf color changes (from green to yellow). In contrast, *B. vivipara* maintained high photosynthetic rates for a longer period than *S. polaris* and *O. digyna* did (at least until August 5). However, the signs of a decline in photosynthetic rates appeared to be synchronized with changes in leaf color, similar to the previous two plant species. Our results indicate that although interspecific differences exist in the duration of high photosynthetic rates, seasonal changes in photosynthetic activity have a strong relationship with phenology. Moreover, since leaf color changes occurred irrespective of air temperature changes (Fig. 1), internal factors might determine phenological changes in the leaves of these deciduous plants.

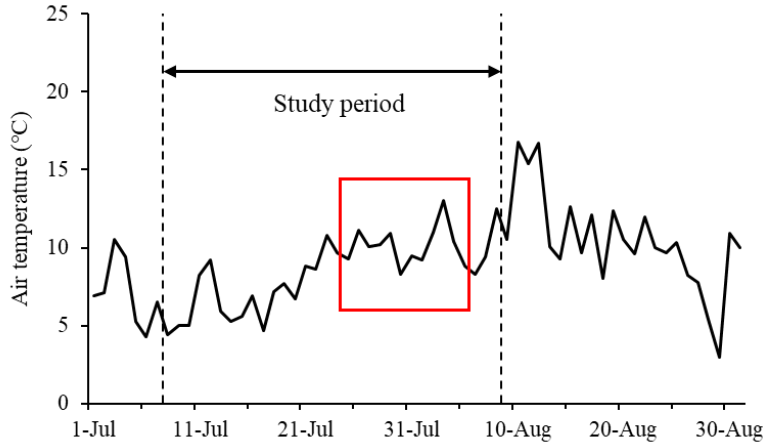

Fig. 1. Hourly air temperature in Longyearbyen from July 1 to August 31, 2024 (https://seklima.met.no/). The range outlined in red shows the period when changes in leaf color began to be observed.

References

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