Plant eco-physiological responses to multiple environmental and climate changes

The current global changes of temperature, precipitation, atmospheric CO2 and UV-B radiation impact in concert ecosystems and processes in an unpredictable way. Therefore multifactor experimentation is needed to unravel the variability in strength of these drivers, whether the factors act additively or synergistically and to establish cause-effect relations between ecosystem processes. This thesis deals with heath plant responses to global change factors (the CLIMAITE project). In a Danish temperate heath ecosystem elevated CO2, experimental summer drought, and passive nighttime warming was applied in all combinations (based on the scenario for Denmark anno 2075) and the responses after one year of treatment were investigated through a growing season in Hairgrass (Deschampsia flexuosa) and Heather (Calluna vulgaris). In a high arctic heath ecosystem situated in NE-Greenland UV-B exclusion experiments were conducted on Salix arctica and Vaccinium uliginosum during six years. Responses of photosynthesis performance were characterized on the leaf scale by means of leaf gas-exchange (A/Ci curves), chlorophyll-a fluorescence, leaf nitrogen, carbon and δ13C and secondary compounds. The main findings were 1) The different growth strategies of the evergreen Calluna versus the opportunistic bi-phasic Deschampsia affects the photosynthesis response to drought and autumn warming (Paper I); 2) Elevated CO2 and warming synergistically increase photosynthesis in spring and autumn (Paper II and III); 3) Summer drought decreased photosynthesis in both species, but where Calluna maintained photosynthetic metabolism then major proportion of grass leaves wilted down (Paper I); 4) Elevated CO2 did not decrease stomatal conductance, but the treatments affected soil water content positively, pointing to the complex water relations when plants of contrasting growth strategy co-occur (Paper III and IV); 5) Water availability affected the magnitude of photosynthesis to a higher degree than warming and elevated CO2 (Paper II and III); 6) Photosynthetic capacity were closely linked to growth strategy and rewetting stimulation were closely related to high nitrogen leaf content (Paper IV); 7) Responses to elevated CO2, drought and warming could not be deduced from single factor experiments (Paper II and III); 8) Ambient UV-B decreased PSII performance despite stimulation of UV-B absorbing compounds in high arctic plants in both short and long term (Paper V, VII, VIII); 9) Water availability affected the magnitude of photosynthesis to a higher degree than warming and elevated CO2 (Paper II and III); 10) Current UV-B level is a important factor affecting high arctic plants, particularly in years with spring advancement induced by warming (Paper VI). In conclusion, the results in this thesis suggest the responses of temperate heath plant photosynthesis to be imitatively linked with plant growth strategy and water relations, and also that the responses of photosynthesis to the important drivers often interacted. Current UV-B levels decreases productivity in high arctic heath plants, and advanced spring in response to warming may lead to further decrease while other climatic changes as elevated CO2 may negate this. Stimulated productivity of temperate heath plants is likely under the climatic conditions predicted to be prevailing in Denmark anno 2075.

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