Is UV-B adaptability an indicator for invasive potential?

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**Background**

Intensity of ultraviolet-B radiation (280-315 nm) differs fundamentally between northern and southern hemispheres. During the New Zealand summer UV-B radiation is almost twice as high as compared to the same season and latitude in Germany. In consequence, exotic plant species that originate from the northern hemisphere are exposed to higher amounts of UV-B when introduced to the southern hemisphere. These species offer the opportunity to investigate if alien populations show evidence for better adaptation to UV-B radiation. It is thus hypothesized by growing *Echium vulgare* plants from New Zealand and from Germany with and without UV-B in a growth chamber and in a common garden experiment. To assess the potential role of UV-B radiation as an environmental selective filter during plant invasion in New Zealand, we compared invasive and native populations of an invasive species (*E. vulgare*) with native populations of a closely related, non-invasive species (*Echium plantagineum*) in germination characteristics. We expected a higher germination success in invasive populations compared to native populations and a better performance of the invasive species *E. vulgare*.

**Morphology & Productivity**

Both differences between treatments and origin could be observed for *E. vulgare* concerning productivity and leaf traits. The number of foliar hairs per cm² was significantly higher in New Zealand plants regardless of the UV-B treatment (p = 0.002). Additionally, enhanced UV-B radiation caused an increase in hair density on leaves in both origins (p = 0.001).

**Result**

The UV-B exposed plants showed a significantly lower leaf biomass (p = 0.001). This indicates increased use of resources for the benefit of photoprotection and at the expense of productivity.

**Experiment 1:** German and New Zealand seeds of *E. vulgare* were collected from five and four populations, respectively. In a growth chamber, 70 individuals were exposed to increased UV-B radiation by UV-B tubes in addition to normal light. A control group of 70 plants were grown under normal light conditions in an identical growth chamber. Plants were monitored regularly and harvested after twelve weeks.

**Experiment 2:** A common garden experiment was conducted in New Zealand under ambient UV-B radiation. For five weeks 128 individuals grown from seeds of five New Zealand and five German populations were randomized under special frames. Half of them were fitted with UV-B permeable acrylic sheets and the other four with UV-B filtering PET sheets.

**Experiment 3:** Seeds of *E. vulgare* and *E. plantagineum* were included in a germination experiment. Native populations of both species and New Zealand populations of *E. vulgare* were used, totalling twelve populations. Eight seed trays were divided into 24 squares (5 x 5 cm) each and twelve *Echium* seeds per population were sown per square. A UV-B filtering Mylar sheet separated the growth chamber in two halves and additional UV-B tubes (surrounded by cellulose acetate to filter out undesirable wavelengths) were used only in one half. Initially, new seedlings were recorded daily and later every other day. After 18 days the aboveground biomass of every population was harvested separately.

**Conclusions**

*Echium vulgare* has the ability to adapt quickly to high UV-B radiation by changes in leaf morphology, e.g., an increase of leaf dry matter content or foliar hair density. The latter example shows also evidence for a preadaptation of New Zealand populations, as hair density was higher in all New Zealand plants, regardless of the UV-B treatment. Compared to non-invasive *E. plantagineum*, the invasive species *E. vulgare*, especially the invasive New Zealand populations, appears to have an innate advantage in germination success. The possible role of UV-B radiation as an important selection force during invasions on the southern hemisphere has not attracted much attention in the past (but see #). Adaptation to UV-B or the ability to respond quickly to UV-B stress might be an important characteristic of invasive species in this region. Further research should test these suggestions in other alien species and help to detect specific traits that are linked to UV-B protection.

**Germination success**

Germination rates of *E. plantagineum* plants decreased also under UV-B (p = 0.043).

The importance of UV-B as selective filter during invasions in New Zealand is shown by decreased germination of UV-B exposed seeds in New Zealand populations (p < 0.001) and in the absence of UV-B (p = 0.016).