Are changes in solar irradiation and spectral composition reflected in leaf pigment dynamics of the forest understorey species?

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BACKGROUND

Understorey plants utilise spectral changes such as red/far-red ratio as a signal to adjust their growth. The irradiance of ultraviolet radiation in forest understoreys during canopy leaf flush is poorly known. UV-radiation can be damaging, but also may be perceived as a signal by plants. During spring, many understorey plants coordinate their phenology to best utilise the favourable light conditions before canopy closure.

We aim to understand how UV-screening, mostly by epidermal flavonoids, in understorey plant species is related to spectral changes during the growing season.

OBJECTIVES

1. To quantify the changes in solar irradiance and its spectral composition in different forests throughout Europe during canopy spring phenology.
2. To describe the changes in UV-screening and leaf pigments of understorey plants and how these changes relate to the spectral changes.

METHODS

Solar irradiance and spectral composition were measured with portable array spectroradiometer specially calibrated for field measurements of UV-B (Figure 1). Measurements were done at solar noon several times during the spring in various single-species forests canopies. The UV-screening and pigment content of understorey species was measured with an optical leaf clip device (DUALEX) at same sites. Data of species phenology, abundance, canopy plant area index and other site characteristics were also collected.

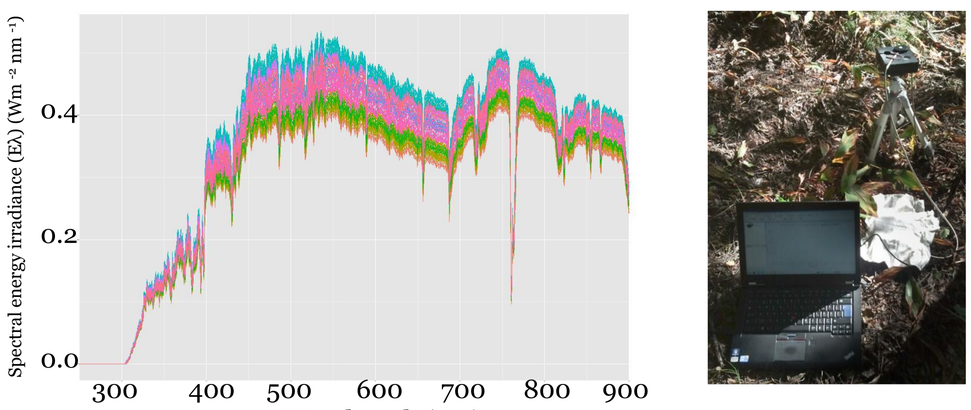

Figure 1. An array spectroradiometer (Maya 2000 Pro, Ocean Optics) in use and a scan of 100 typical solar spectra in a sunfleck under the forest canopy.

RESULTS

- The absolute UV irradiance and PAR declined with canopy closure, but during canopy flushing the ratio of UVB:UVA and UVB:PAR increased. This change was more apparent in trunk shade, probably due to its enhanced proportion of diffuse radiation (Figure 2).
- Most of the over-50 understorey plant species present in our Lammi sites had a trend of declining UV-screening flavonoids during the growing season (Figure 3).
- Some species had more similar UV-screening at different sites, but others were more plastic (Figure 4).

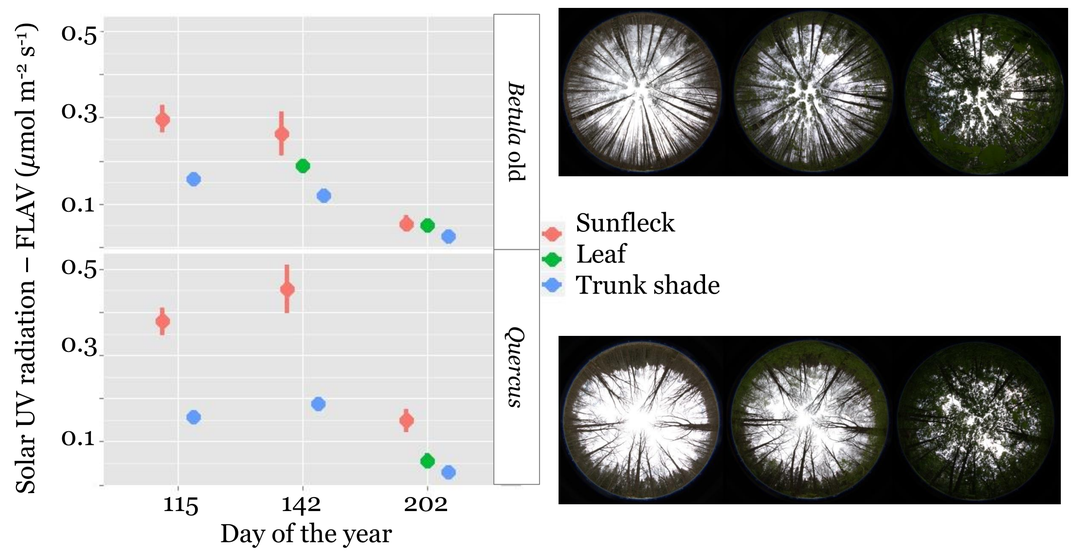

Figure 2. Measured differences in UV irradiance (UV action spectrum for accumulation of flavonoids) in forest understoreys and hemispherical photographs for corresponding day of the year.

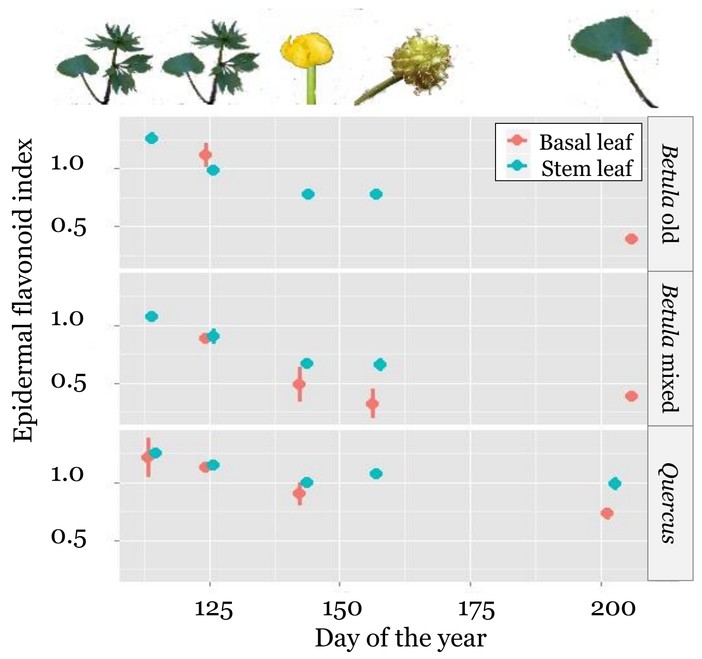

Figure 3. Change in leaf epidermal flavonoids in spring ephemeral *Ranunculus cassubicus* coll. during its spring phenology.

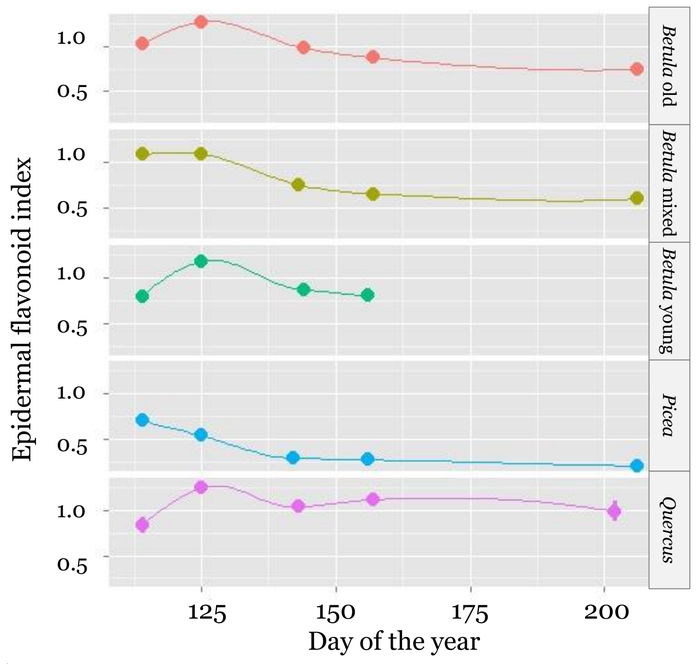

Figure 4. Epidermal flavonoid index of *Anemone nemorosa* leaves during spring under different tree canopies.

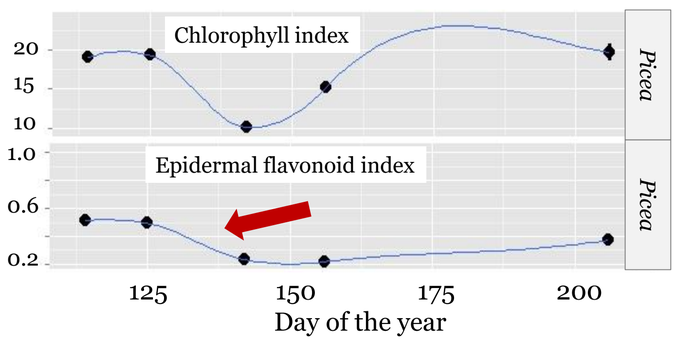

Figure 5. Change in chlorophyll and epidermal flavonoid index of *Oxalis acetosella* during the spring. The arrow indicates the production of new leaves .

•Young leaves compared to older tended to have lower UV-screening, possibly reflecting the seasonal changes. The chlorophyll content of the leaves did not necessarily follow a similar pattern to that of leaf epidermal flavonoids (Figure 5).

CONCLUSIONS

The UV-screening of most understorey plants species tended to follow a similar pattern to change in absolute UV irradiation. However plants had fine-tuned species- and site-specific changes.

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