From Frost to Heat: Heather's Thermal Limits

A thermal tolerance study of *Calluna vulgaris*

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Climate Change and the Risks to Heathlands

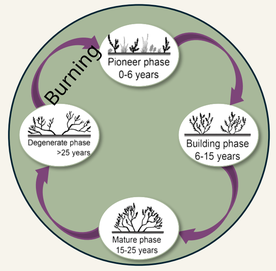
- Climate change is altering temperature conditions and the occurrence of extreme temperature events, potentially affecting plant survival and performance.[1,2]
- Both heat and cold stress can impair photosystem II (PSII) function, which can be assessed using chlorophyll fluorescence (F_v/F_m). Thermal tolerance can be quantified using T_{50}, the temperature at which F_v/F_m declines by 50% relative to its unstressed value.[3,6]
- The extent of thermal responses may be associated with plant functional traits, which reflect differences in growth, resource use and plant structure. As these traits change throughout development, thermal tolerance may also vary between developmental stages.[4,5,6]
- Coastal heathlands are semi-natural ecosystems maintained through traditional management practices, including grazing and controlled burning. Without continued management, vegetation succession may lead to the establishment of other woody species.[7,8]
- *Calluna vulgaris* is a dominant species in coastal heathlands, where vegetation development is commonly described through four age classes: pioneer, building, mature and degenerate. Differences in plant structure and physiology between these phases may also be associated with variation in thermal tolerance. Understanding how thermal tolerance varies between these phases may help explain how heathlands respond to climate change.[7,8]

Testing Thermal Tolerance of *C. vulgaris* at Lygra Heathlands

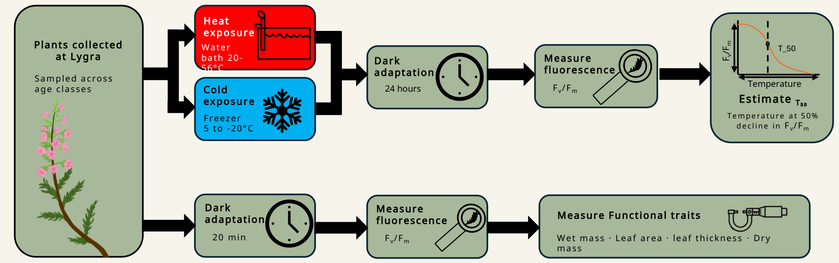
Study site: Lygra coastal heathland



Burning cycle and age classes of *C. vulgaris*[9]



Autumn sampling from a larger seasonal campaign



Preliminary Results

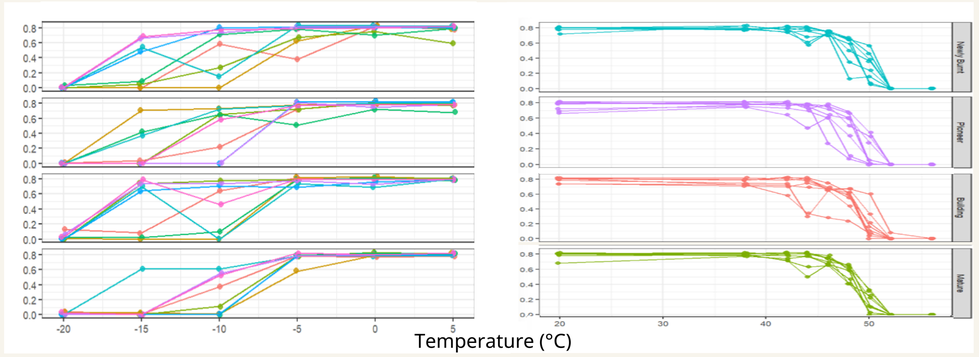


Fig. 2: Changes in chlorophyll fluorescence (F_v/F_m) in response to cold (left) and heat (right) exposure across age classes of *C. vulgaris*. Each lines represents individual plants. Colors distinguishes individual plants in cold response and age classes in heat response.

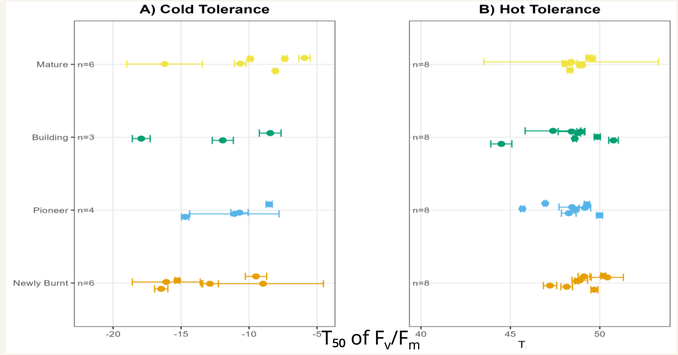


Fig. 3: Preliminary cold and heat T_{50} estimates across age classes. Individual points represents individual estimates ($\pm 1SE$).

Research Aims

1. Does heat and cold tolerance differ among the age classes of *C. vulgaris?*
2. Do plant functional traits vary among the different age classes?
3. Are plant functional traits associated with variation in heat and cold tolerance?



Preliminary observations

- Cold T_{50} estimates range from approximately -18 to -6 °C, with mature plants generally showing fewer negative values, potentially indicating lower cold tolerance. Considerable variation is observed within groups.
- Heat T_{50} estimates are more closely grouped, mostly around 45–50 °C, with substantial overlap between developmental stages.
- Further data cleaning and statistical analyses are needed to determine whether these apparent patterns are consistent.

Ecological implications

- Measured daily mean air temperatures near Lygra averaged 7.5 °C (1957–2025), with the lowest daily mean of -13.9 °C (1987), which is within the preliminary cold T_{50} range. Although air and experimental leaf temperatures are not directly comparable.[10]
- If mature plants are less cold tolerant, reduced burning could increase the proportion of vulnerable mature *C. vulgaris.* Seasonal sampling may help determine whether this pattern persists beyond autumn.

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