Microphenological response in *B. nana* to GDD5

Fabian. E. Z. Ercan[1] , W. Z. Hoek[1], D. Blok[2], F. Wagner-Cremer[1]
[1] Paleoecology, Department of Physical Geography, Utrecht University
[2] Department of Physical Geography and Ecosystem Science, Lund University

Intro:

Global warming is lengthening the growing season in high latitudes. This trend needs to be evaluated against the natural variability and the historic baseline. Proxy-data can supplement the limited temporal range of instrumental data to grasp spring season dynamics further back in time. Leaf phenology is sensitive to the thermal conditions during the growing season. Here we apply a microphenological proxy, quantifying Growing Degree Day [T=5°C] (GDD5[1]) as the Undulation Index (UI [2]) in *Betula nana* epidermal cells from annual monitoring and herbarium leaf samples. We estimate imprints of spring thermal properties from Disko Bay, Greenland and Kevo, Finland, localities capturing a broad range of (sub-) arctic growth climates.

Figure 1. Ontogenic development of the cuticle in various stages of maturation and associated UI.

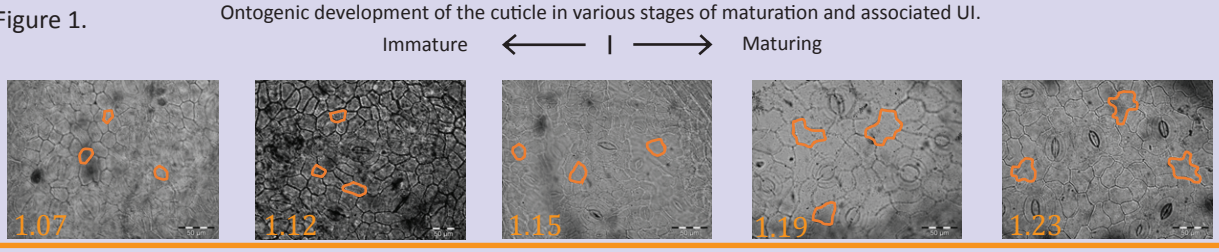

Figure 2. a

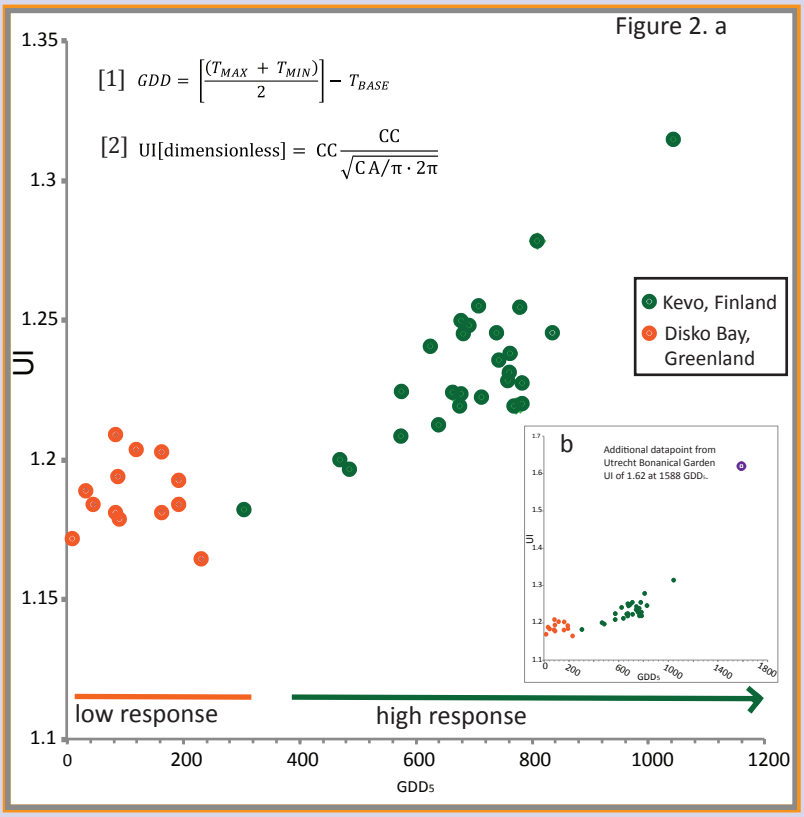

Figure 1 - Method:

B. nana leaf cuticles in successive developmental stages showing the lateral epidermal cell expansion during leaf maturation and associated UI values (equ. 1). Leaf growth and maturation are strongly related to GDD5. Very immature leaves still in the cell differentiation stage (UI<1.15; average stomatal length <35µm) however are omitted in further analysis.

[1] GDD is the cumulative grand total of temperature for each day from a base temperature.
[2] UI indicates the relation between cell circumference and cell area representing the sinuosity of the epidermis cell wall.

Figure 2 - Results:

(a) UI of *B. nana* from annual monitoring at Kevo starting in 1996 (69°34'N 26°42'E, green dots), and herbarium samples from Disko Bay, (69°13'N 51°06'W, orange dots) against GDD5. The strong response observed in Kevo over 300 – 1200 GDD5 seems to level off under Greenlandic low 11.95 - 230.2 GDD5. The Greenlandic growing season may cover the lower response limit of UI to GDD5 indicating sub-optimal growth condition.
(b) Purple datapoint: UI of 1.62 at 1588 GGD5 from Utrecht Botanical Garden shows that UI responsiveness to GDD5 in *Betula nana* is not yet reached under current arctic natural conditions.

Discussion and Conclusion:

Our results demonstrate the sensitivity of *B. nana* leaf development over the arctic Growing Degree Day [T=5°C] (GDD5) range from <100 to >1000 GDD5. It is noteworthy that the lateral cell expansion and undulation is suppressed under low GDD5, accelerating above a threshold of ~300 GDD5. This data-set shows the potential of the UI as proxy to deduce past spring thermal conditions beyond the instrumental record from historical leaf collections of fossil cuticles preserved in peat and lake sediments in arctic regions. Such long-term records may help to place ongoing growing season changes into a broader context of natural

Universiteit Utrecht
F.E.Z.Ercan@uu.nl

NWO
Netherlands Organisation for Scientific Research