Annual ring studies on plants in permafrost areas of the high arctic

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1 GROWTH OF ARCTIC HERBS AND SHRUBS

Most perennial plants in the high arctic develop annual rings with a width from 0.05 mm/y to a maximum of 0.3 mm/y. Dwarf shrubs reach an age of 50 to 140 years (e.g. *Betula nana, Salix arctica, Salix polaris, Empetrum nigrum* or *Cassiope tetragona*) whereas herbs of various families with distinct rings live between 3 and 35 years. Table 1 illustrates the age structure of 36 high arctic zone herbs and dwarf shrubs which varies from 2 to 26 years (the latter: *Melandrium triflorum*) in herbs and from 4 to 145 (the latter: *Dryas octopetala*) years for shrubs.

The analysis of annual rings in plants of the high arctic is a scientific challenge: Most plants are creeping, form eccentric stems/rings, and growth occurs only on the protected side near or in the soil. During years with extremely cold summers they do not form rings at all or rings exist only on small parts of the stem. Processes of mass movement on permafrost ground like (episodic) solifluction and continuous soil creeping may injure the stem and destroy locally living tissue and/or induce scars. All these signs of disturbances can be used for the reconstruction of summer temperatures, the intensity of soil movement and even rare mechanical events like landslides. (Figure 1)

Table 1. Age of 29 arctic herbs and 7 dwarf shrubs from Svalbard (1), Yamal (12), NE Greenland (18) and Banks Island (5)

Group	Age (y)			
	1-5	6-10	11-20	21-145
Herbs	9	18	1	1
Dwarf shrubs	1	2	3	1

2 ENVIRONMENTAL FACTORS

A better understanding of solifluction and creeping processes influenced by climatic change is crucial. Predictor variables describing and modelling them have already been identified from morphology, exposition, soil mechanics, and microclimate of each site within arctic research programmes supported by sophisticated instrumentation. Standardised networks for continuously recording the data together with the results of mass movement are still lacking due to the complex technology and high costs.

3 INDICATORS FOR CLIMATE CHANGE MODELLING

As a proxy for climate variation annual tree rings have frequently been evaluated whereas the potential of arctic herbs and dwarf shrubs has not yet been explored in detail.

The productivity of arctic plants responds mostly to summer temperature and soil water content with clear effects on cell size and cell wall thickness. Therefore we suggest the use of appropriate herbs and shrubs as a supplemental information source for mass movement processes where data gaps between well-equipped monitoring stations otherwise cannot be filled. Averaged variation of soil displacement including flow anomalies could be analysed much easier. Additionally, the development, calibration and reliability of deterministic or multivariate statistical models describing slow rhythmic processes could be improved as well.

Once the steering variables of permafrost active layer dynamics in solifluction sheets or nonsorted circles/stripes are found, annual ring analysis of herbs and shrubs could improve the explanatory power of models, e. g. when searching for discriminant functions during dichotomic yes/no-decisions.

3.1 *References*

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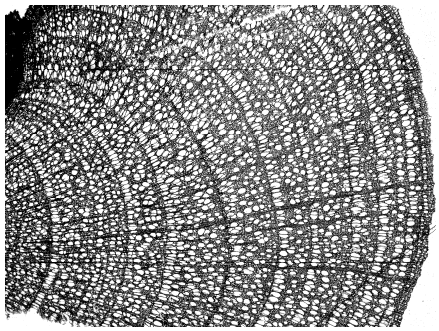

Figure 1. Annual rings in the dwarf shrub *Dryas octopetala*, indicating some environmental influences