

### Nunataks as glacial refugia? A molecular phylogeographic case study with *Draba aizoides* René Fächter, Alex Widmer and Matthias Baltisberger

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Foto R. Fächter

Abb. 7: *Draba aizoides*

Where have alpine plants survived the ice ages? The nunatak-hypothesis states that they survived on single mountain tops surmounting the general ice-level (nunataks). In contrast, according to the tabula-rasa-hypothesis, all alpine populations became extinct during the Last Glacial Maximum, and those that survived in peripheral refugia re-immigrated after the retreat of the glaciers.

*Draba aizoides* L. (Brassicaceae) is a yellow flowered, perennial alpine rosette plant. It was chosen as a model species as it shows extensive intraspecific cpDNA sequence variation (*trnL* intron and *trnL*-F spacer) which exceeds interspecific variation among other, closely related *Draba* species. A PCR-RFLP test was designed in order to distinguish seven groups of haplotypes (out of a total of eleven detected haplotypes). Their frequency and distribution was assessed for 19 populations distributed over large areas of the Swiss Alps. In addition, horizontal starch gel electrophoresis of isozymes was conducted for a subset of populations to gain information on the nuclear genetic constitution of populations and for comparison to the chloroplast genome data.

No effect of isolation by distance was found for the isozyme loci. This suggests that postglacial recolonisation history has had a strong impact on the genetic constitution of extant populations. By comparing pairs of populations, each pair including a population from a presumed nunatak and one from a non-nunatak area, genetic variability (numbers of alleles and observed heterozygosities) observed in nunatak areas was not found to be consistently higher.

The geographical distribution of cpDNA haplotypes revealed an extremely low haplotypic diversity in the Northern Alps. Only the three presumed nunataks Stockhorn, Faulhorn and Säntis harboured haplotypes that were unusual for this region. Hence, these areas could be confirmed as glacial refugia. In addition, the Dent de Morcles in the Lower Rhone valley most probably also acted as a glacial refugium.

Generally, higher levels of diversity were observed in the Central Alps. This, combined with the fact that three rare haplotypes were found only there, strongly suggests that Central Alpine glacial refugia of *D. aizoides* existed. Accordingly, the tabula-rasa-hypothesis was not supported by the available data.

### *Gentianella* Moench sect. *Gentianella* – a model of Quaternary evolution

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The small gentians (*Gentianella* Moench sect. *Gentianella*) exhibit biological and biogeographical features which make them a model group for studying evolutionary processes in the European flora during the Quaternary as the section comprises widespread taxa occurring nearly all over Europe as well as narrowly distributed endemics concentrated in or nearby refugial areas around the Alps. So far, by applying isozymes we found some evidence for higher genetic diversity in *G. austriaca* populations of refugial areas than in those of presumably recolonised areas in higher parts of the north-eastern Alps. In some contact zones between widespread taxa and the endemics introgressive or hybridisation processes might have taken place as can be judged from morphology. The differentiation into seasonal (ecological) vicariads in some taxa very likely is caused by postglacial disruptive selection due to human impact. Molecular and morphological evidence point to a polytopic origin of the widespread taxa *G. germanica* and *G. amarella*. And finally, all the European taxa are polyploids with evidence for allopolyploidy in *G. austriaca*. So far, the diploid level is known only from the Caucasus region.

Currently we are examining evolutionary processes and relationships in European *Gentianella* sect. *Gentianella* by applying different molecular methods, cytogenetic analyses and a re-evaluation of morphological characters. This research focuses on the reconstruction of how the European polyploids have formed, a process that might have taken place recurrently. We investigate the