

Marginal plant populations – special ecogeographical adaptations that need *in situ* conservation

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Abstract

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Marginal plant populations have low adaptative capacity. They show, however, a higher degree of morphological and genetic variation. This may be due to the fact that their genetic structure is under strong selection pressure.

The northern species margin

Natural plant distribution in Europe comes to a northern margin for several species in the Nordic area. Hardwoods, like oak (*Quercus robur*), ash (*Fraxinus excelsior*), elm (*Ulmus glabra* and *U. laevis*), maple (*Acer platanoides*) and linden (*Tilia cordata*) find their northern species margins between 60-64° deg. N. latitude and the absolute northern treeline, composed of Scots pine (*Pinus sylvestris*) and Norway spruce (*Picea abies*) runs at about 69° deg. N. latitude. Several of the cultivated grasses also their northern species margins in the Nordic area.

Variation at the species margin

Phenological studies on northern marginal tree populations indicate decreasing variation on adaptively important traits, like growth rhythm (initiation and cessation) close to the northern margin. This is probably a direct effect of low temperature on character expression. Morphological studies on presumably adaptively unimportant traits do not indicate a similar decrease in variation close to the margin, rather special morphological traits are more often expressed in isolated pockets of the species' marginal distribution. Extensive studies on plant populations on the basis of isoenzymes also indicate high degrees of genetic variation at the northern margins, suggesting direct advantage of

heterozygosity. Summarizing a large number of investigations on tree populations gives us a general idea about species structure:

- populations retain high amounts of genetic variation
- gene loci are generally occupied by several alleles
- individual trees are highly heterozygous, often roughly conforming to expected heterozygosity under random mating
- genetic variation within populations (stands) is large
- clines in gene frequencies, following latitudinal transects, can sometimes be found but are just as often absent
- linkage disequilibrium (supergenes) are almost absent in strongly outbreeding trees
- seed embryos and young natural plant stands of trees show an excess of homozygotes
- old tree stands often show an excess of heterozygotes, indicating continuous natural selection against inbreds
- different populations of trees at the margin often show gene frequency differences that are probably due to geographic isolation

Natural selection at species margins

Studies on long-living tree populations indicate very strong natural selection close to the northern treeline. This results in very high mortality even in local populations; only a few genotypes survive to maturity and produce offspring to the next generation. Thus the population is under continuous heavy natural selection through the whole life cycle, which may be hundreds of years. The best adapted genotypes may sometimes turn to vegetative propagation under such conditions. This can be seen in populations of *Picea abies* and *Populus tremula* close to the treeline, the former regenerating through branch rooting, the latter through root sprouts.

Conserving marginal plant populations

Marginal plant populations are particularly precious genetic resources. Their genetic structure is under continuous natural selection pressure and must be conserved *in situ*. It has been shown in populations of meadow fescue (*Festuca pratensis*) that population regeneration under more favourable environmental conditions can drastically change the population structure and adaptation in only one generation of transplanted cultivation.

Experimental plantations of Scots pine (*Pinus sylvestris*) have indicated that natural selection may save only 1-5 percent of the regenerating tree population. The conserved genotypes have a unique and highly heterozygous genome.

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