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Factors shaping genetic diversity of the shrub birch (*Betula humilis* Schrk.) in populations at the south-western margin of its range

Abstract

The genetic diversity of plant populations results from the history of the species and contemporary factors, such as evolutionary processes, habitat conditions and species biology. As many peripheral populations are also ecologically marginal, their genetic diversity and demographic performance are particularly influenced by currently acting factors.

The shrub birch, *Betula humilis* Schrk., is a glacial relict in central and western Europe, and its continuous geographical range has a south-western boundary in Poland. The species grows mostly in fens and wet meadows, but being a poor competitor, it declines in dry habitats due to overgrowth by brushwood and forest plants. The number of *B. humilis* populations in Poland decreased approximately fourfold during the twentieth century. Although lowered genetic variation was noted in the smallest and most isolated stands, some populations of *B. humilis* located in north-eastern Poland still exhibited a high level of genetic diversity.

The primary aim of my PhD thesis was to define the factors that currently shape the genetic diversity of *B. humilis* populations at the south-western margin of its distribution. I investigated the efficiency of generative reproduction, the frequency of hybridisation with closely related tree congeners and the clonal architecture of the shrub birch populations under different habitat conditions. I expected that effective sexual reproduction and crossbreeding with common close relatives would positively impact genetic diversity. I also tested if aggregated clonal growth hindered crossing between genetically distinct individuals in *B. humilis* populations.

SSR (simple sequence repeat) marker analysis of the *B. humilis* population located in the Wizna mire, one of the largest declining fens in Poland, revealed that the shrub birch propagated exclusively by clonal growth (Chapter I). Only three genetically distinct specimens were found, which implied that generative reproduction was either absent or unsuccessful. The analysis of AFLP (amplified fragment length polymorphism) loci and sexual reproduction efficiency, conducted in eight marginal and three sub-central populations located in Poland and Belarus, revealed no significant correlations between genetic diversity

and reproductive parameters, such as the number of flowers, seed mass and the number of germinated seeds (Chapter II). However, germination capacity was higher in sub-central localities than in marginal stands as well as in wet habitats than in dry sites. This implies that unfavourable habitat conditions can be a significant factor leading to decrease in genetic diversity of shrub birch populations, especially in peripheral localities. Using the AFLP markers, analysis of the frequency of hybridisation between *B. humilis* and its close relatives *B. pendula* and *B. pubescens* was conducted in populations with different habitat conditions (Chapter III). Only three potential hybrids were detected in the shrub birch populations, although all of them were found in dry stands. This implies that low groundwater levels can intensify overgrowth by widespread birches and thus facilitate interspecific crossing through pollen swamping. Clonal structure analysis of the shrub birch was carried out in six populations by genotyping a total of 522 ramets at seven SSR loci (Chapter IV). The study showed that ramets belonging to the same clone were mostly aggregated. Nevertheless, the substantial clonal and genetic diversities implied that the clumped growth of the shrub birch clones did not prevent successful crosspollination.

These studies confirmed previous observations that the genetic diversity of marginal populations of the shrub birch was substantial. However, the primary factors responsible for the current maintenance of *B. humilis* populations are favourable habitat conditions, i.e., groundwater levels high enough to prevent the succession of competitive plants, which leads to shading, disrupts sexual reproduction of the light-demanding shrub birches, and causes population decline.

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