Vulnerability and conservation of ancient woodland herbs in the Hungarian Mountains

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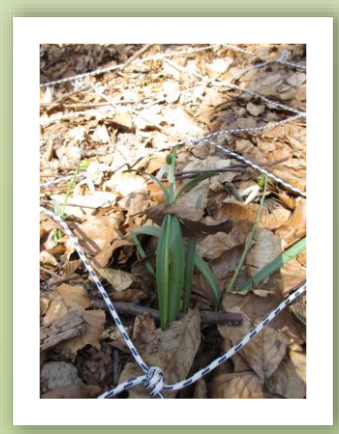
PhD theses



Introduction

Dispersal limitation is a phenomenon that characterizes many plant species. These species do not occur in all suitable habitats within their potential range. Anthropogenic influences can cause species to disappear from a habitat, and dispersally limited species might be missing from such historically altered habitats even if the forests are suitable in the present (Primack and Miao 1992). Long term survival of species in production landscapes depends on dispersal as well as establishment of individuals. If the natural disturbance regime is severly altered by human activities, species adapted to a system of changes might not survive despite dispersal to the habitat.

My PhD dissertation addresses the issue of the vulnerability and conservation of dispersally limited species in the production landscape through the example of ancient woodland herbs (Hermy et al. 1999). This is a group of dispersally limited plant species many of which are common, but there is increasing knowledge about their susceptibility to forest management. I looked at the variables influencing occurrence and abundance of herbs and based on the conclusions I conducted applied research to investigate the possibilities of the forestry industry and the conservation sector in the protection of these specialist herbaceous plant species. Common species are often neglected by conservation (Hoegh-Guldberg és mtsai. 2008) and the problems raised in the dissertation can be relevant for other dispersally limited species groups.

Ancient woodland species have adapeted to the relatively stable conditions under the closed canopy, where most frequent disturbances occur at a fine scale. As a consequence of their adaptation, these herbs are poor dispersers both in space and time. Many common species belong to this group, but they are vulnerable because industrial forest management has drastically changed the natural disturbance regime of temperate deciduous forests (Peterken 1974). It is anticipated that ancient woodland herbs will further decline due to their extinction dept (Vellend és mtsai. 2006).

How long can ancient woodland herbs survive under the disadvantageous distrubance regime created by even-aged forest management practices? Can the vegetation of postagricultural forests develop to be similar to ancient forests? I compared the vegetation of forest stands with contrasting histories to investigate the effects of past land use and current forest management on ancient woodland herbs.

Based on the results, two applied research were conducted. First, the effects of uneven-aged forestry on ancient woodland herbs were assessed in an experimental stand. Second, dispersally limited species were transported in soil blocks to suitable forests, where they do not occur presumably because of human induced changes.

During the forestry experiment the following specific questions were asked:

1. Can ancient woodland species survive the creation of artificial gaps (i.e. small clearings) that are the first interventions of uneven-aged forestry?
2. What trait combinations enable species to colonize gaps quickly?
3. How do herb species partition the gaps? Can spatial patterns be recognized within the gaps?

The aim of the transplantation experiment was to test the success of repatriation using soil blocks. The following specific questions were asked:

1. Which species germinate in the transplanted soil blocks?
2. How much time is required for the species to start dispersing from the soil blocks to the adjacent area?
3. Which species are present in the source and the recipient vegetation and seed bank?

Materials and methods

The landuse history was poorly studied and needed further investigation. This involved research in several national and local archives.

The research on the effect of land use history and current management practices on grouund layer vegetaion was carried out in the Bakony Mountains (Western Hungary). Postagricultural forests as well as young managed stands with no record of previous non-forest land use were investigated. Reference stands were ancient forests under even-aged management that have been regenerated more than 80 years ago. Altogether 40 plots were selected and herb occurrences were recorded in 100 microquadrats on two occasions in 2009.

Principal coordinates analysis (PCoA) as well as multiple response permutation procedure (MRPP) were used to test the differences in herbaceous composition among the land use history groups. Single species preferences were shown using indicator species analysis (ISA). Species that significantly indicated one group of forests, were

classified into functional groups based on ecological traits collected from published databases.

Uneven-aged forestry was studied in the Börzsöny Mountains (Northern Hungary). The Királyrét Forest Directorate created artificial gaps (small clearings) in a submontaneous beech forest. 3 large and 5 small gaps were cut in 2000 (ca. 40 and 15 m diameter, respectively). A long term study was set up to study the regeneration as well as woodland herbs in and around the gaps. Systematic sampling grid was used. Herb species and substrate cover were estimated for 1 m^2 quadrats. Light was measured using a densiometer (forestry equipment).

The transplantation of soil blocks was carried out between 3 pairs of plots in the Börzsöny Mountains (Northern Hungary). Source and recipient plots were within a distance of 2 km to ensure local propagule source. At each source plot, 8 25 cm x 25 cm, 15 cm deep soil blocks were cut and were transported in a box to the recipient plot. At each plot, soil samples of the same dimension were collected and seed banks were germinated in a greenhouse. The transplanted soil blocks were visited three times during 2012. Vegetation was also surveyed using microquadrats.

Theses

Vegetation of forests with different land use histories

- Vegetaion of postagricultural forests and young even-aged stands differed from reference stands in a contrasting way.
- Some ancient forest species (e.g. *Corydalis solida*) were missing from secondary stands, whereas several competitive species were only present in the postagricultural forests.
- Young even-aged forests contained only a few ancient woodland species in high frequency.
- More than 40% of herbaceous species showed significant preference for either one of the land use history groups.
- Four distinct functional groups emerged from the classification of species based on reproductive and phenological traits. These groups could be identified with different strategies of herbs that occur in forests. One group could be identified as ancient woodland species. Members of this group reached significantly higher frequencies in reference stands than the two other groups.

Herbaceous vegetation and uneven-aged forestry

- Species present before the management intervention (creation of artificial gaps) were present 8 years later (e.g. *Viola sylvestris*, *Mercurialis perennis*).
- The most successful early colonizing species were capable of long distance dispersal in space and had persistent seed bank. These species could establish in the gaps via the seed bank as well as through new dispersal. Species that became dominant in the gaps (e.g. *Rubus fruticosus*) also exhibit these characteristics pointing to the importance of early colonization.
- Gap size and within-gap position both affect species composition. Species number is greatest in the centre of large gaps, while no significant change in species richness or cover have been observed under the canopy adjacent to the gaps.

Transplantation of ancient woodland herbs

- The transplantation proved to be successful in the short term. At least one species germinated from most transplanted soil blocks. Long term survival and dispersal need to be surveyed for at least two decades before firm conclusions can be made.

- Emerged individuals belonged almost exclusively to the target species group (e.g. *Corydalis cava*, *Galanthus nivalis*, *Anemone ranunculoides*). A few disturbance indicator spcies (e.g. *Chelidonium majus, Urtica dioica*) also emerged from the transplanted soil blocks. These species were not found in the vegetation of the source plots, but occurred in the seed bank.

- The composition of herbaceous vegetation differed between the source and recipient plots even when species used for plot selection were left out of the analysis. Source plots showed high frequency of species such as *Viola sylvestris* and *Ficaria verna*, whereas recipient plots were dominated by *Geranium robertianum* and similar species.

- Frequencies of individual species differed between the vegetation and the seed bank. Germination from the transplanted blocks did not show a clear relationship with either of them. For example, *Viola sylvestris* was found with high frequency in the source vegetation, yet it would not germinate from neither the seed bank nor the transplanted soil blocks.

- No difference could be shown between the composition of the seed bank of source and recipient plots. Seeds of the target species could not be germinated from the seed bank or found in the soil samples partly due to the fact that ancient woodland herbs usually have transient seed bank.

Practical considerations

Even-aged forestry needs to be substituted by alternative management practices over large areas.

- The majority of the populations of common woodland herb species can be found in production forests. Therefore, the quality of forest management highly determines the survival potential of vulnerable ancient woodland herbs.
- The decline of ancient woodland herbs can be attributed to the disadvantageous period of final cut and early regeneration of even-aged forestry.
- Forest management committed to conserving herbaceous biodiversity needs to create continuous canopy over large areas. This requires the use of small clearings and the attenuation of interventions over a long period of time.
- Single and group selection management systems are viable alternatives of even-aged forestry in Hungary. Before selection can be practiced, even-aged stands need to be transformed. It seems that such transitions are possible without harming ancient woodland herbs. Special care needs to be taken for the protection of the soil during harvesting.

Transplantation of ancient woodland herbs might be necessary to forests, where they declined

- Most ancient woodland herbs are dispersally limited. The establishment of such species in suitable habitats is mainly limited by the lack of propagules.
- Spontaneous re-establishment of ancient woodland species in areas affected by severe earlier management can take several decades due to their low dispersal abilities. These species need active translocation to be able to survive.
- The use of soil blocks is beneficial, because vegetation is transplanted instead of selected species. There is no need to collect seeds, and other propagules such as bulbs can also be transported with the soil.

Some species need legal protection.

- Although most species that showed preference for ancient forests are common, legal protection might be part of the solution. Legally protected species are recognized as important and raised awareness alone can have a large effect.

- Based on our studies, populations of *Isopyrum thalictroides* and *Lathyrus vernus* need to be monitored and in case of their decline, legal measures need to be taken.

All three methods are necessary for the successful conservation of ancient woodland herbs. The detailed methods and the relative importance of different measures vary from site to site depending on management history, stand structure and protection status of the area.

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