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CONSEQUENCES OF AN EXTIRPATION TRIAL OF THE TREE OF HEAVEN (*AILANTHUS ALTISSIMA* (MILL.) SWINGLE) ON ROCK GRASSLANDS AND SLOPE STEPPES

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Abstract. Szársomlyó Hill is a valuable nature reserve, where the tree of heaven has expanded its area in the last decades. In 2003 and 2004, the Directorate of the Duna-Dráva National Park conducted a study aiming the eradication of *Ailanthus altissima*. In two grassland communities of the southern hillside, all *Ailanthus* individuals were treated with foliar spray in 15 experimental plots. Two herbicides were applied in four solvents.
The method was successful only on less then half of the treated individuals. The plots with higher *Ailanthus* density must receive repeated treatments. Despite the careful spraying, natural vegetation suffered considerable changes in total cover, and moderate alteration of the species composition. A year after the treatment, the regeneration of the grasslands is obvious.

Keywords: Ailanthus altissima, Banvel 480S, Garlon 4E, invasion, Szársomlyó, Villány Hills.

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Introduction

Invasive species are among the serious problems in natural habitats and nature conservation areas. The problem is acute on both global and local scales (Botta-Dukát 2004) but the defence projects are carried out in particular habitats (Mihály and Botta-Dukát 2004). Forcing back or control of the invasive plants need different methods depending on the traits of a certain species and habitat. This needs a more cautious job in nature reserves. Only considerate treatments should be used in sensitive natural habitats that the extirpation of an invasive species should not cause greater damage than its presence.

Efficiency and suitability of extirpation practices applied in areas of intensive land use are not fully known. In the case of a certain nature reserve, the applicable treatment must be tested carefully for being efficient enough and not causing disproportionately large damage (Márkus 2004).

The spread of the population of tree of heaven is not very intensive on the Szársomlyó Hill, therefore its negative effect on the community structure is expressed mainly not due to the dominance of the population but to allelochemicals that are found in each part of the plant (Heisey 1990), and that should cause the impoverishment of the local flora.

With the experiments carried out with the tree of heaven population on Hill Szársomlyó, Duna-Dráva National Park, we intended to contribute to the knowledge of control of this invasive plant.

Material and methods

Szársomlyó Hill is located in the Villány Hills, in the South of Hungary. It consists of Triassic, Jurassic and cretaceous limestone, to a lesser degree of Triassic dolomite (Lehmann 1975). On the southern slope, the edges of the limestone strata emerge on the surface. The foot of Szársomlyó is covered by loess.

The Sub-Mediterranean climate of Szársomlyó is characterized by hot summer and mild winter. The annual mean temperature is 10.9 °C (Dénes 1994). The temperature regimes of the northern and southern hillsides differ considerably. During the day

the southern slope is much warmer, but in the evening the situation changes because of the greater heat radiation on the weakly wooded southern hillside (Horváth and Papp 1964). The mean annual sum of precipitation is 676-697 mm (Dénes 1997).

Szársomlyó belongs to the phytogeographical district Sopianicum. Its flora and vegetation has been studied for more than 200 years (Lehmann 1975). 754 vascular plant species have been revealed from the hill, 75 of which are protected or strictly protected (Dénes 2000). The Szársomlyó Nature Reserve was founded in 1944 (Dudás and Wágner s.a.).

The vegetation of the two hillsides is totally different. The most part of the northern hillside is covered by Illyrian neutrocline sessile oak-hornbeam forests, *Asperulo-Taurinae carpinetum*. On the southern slope there are three main associations: a karstic shrub-forest, *Inulo spiraeifoliae-Quercetum pubescentis*, a rock grassland community, *Sedo sopianae-Festucetum dalmaticae*, and a slope steppe, *Cleistogeni-Festucetum rupicolae* (Lehmann 1975, Dénes 1998).

On the ridge and on the southern slope, tree of heaven, *Ailanthus altissima* (Mill.) Swingle, which is one of the most aggressive invasive plants in Hungary, is expanding its area rapidly. According to Mack et al. (2000), the mere presence of an invasive plant in a nature conservation area is undesirable. What is more, *Ailanthus* is a transformer species (Botta-Dukát et al. 2004): it has a strong effect on the invaded associations by impoverishing the vegetation (Udvardy 1998). *Ailanthus* is able to invade even meso- and oligohemerobic communities in Central and Southern-Europe (Gutte et al. 1987).

The first known data of *Ailanthus* in Hungary were published by J. Barthosságh in 1841 (cit. in Udvardy 2004). He planted *Ailanthus* to the foot of Szársomlyó Hill. There are some circumstances that probably promote the establishment and spread of the tree of heaven on this hill: 1.) Proximity of the settlement. The winged seeds produced by old individuals of *Ailanthus* in Nagyharsány village can easily reach the nature reserve of Szársomlyó. 2.) Disturbance of the grass by trampling of tourists may support the establishment of the tree of heaven, as it can be observed in many cases of invasion (e. g. Bagi 1997, 1999, Szigetvári 2004). 3.) Proximity of the quarry also contributes to the disturbance. 4.) Mine dumps from the former bauxite mines provide a bare ground for invasive species. It is experimentally demonstrated that bare ground encourages the establishment of non-indigenous species (Burke and Grime 1996).

The experimental site was located on the southern slope of Szársomlyó Hill, in two associations: *Sedo sopianae-Festucetum dalmaticae* and *Cleistogeni-Festucetum rupicolae*. We set up twenty-one plots of 5×5 m, fifteen of which were treated with herbicides. Six quadrats served as control. Eight of the fifteen plots treated were established in *Cleistogeni-Festucetum rupicolae* and the other seven in *Sedo sopianae-Festucetum dalmaticae*. Among the controls both associations were represented with three plots, in one of which all individuals of *Ailanthus* were cut with pruning scissors, and in two quadrats no treatment was applied.

The chemical treatment was performed in July 2003 by I. Szidonya with a hand-sprayer. Only the the tree of heaven individuals were sprayed, but a little quantity of chemicals was blown away by the wind which was expected to disturb the grassland species. We wanted to test the effectiveness of two kinds of herbicides, so nine plots were treated with Garlon 4E, and six one with Banvel 480S. The applied concentrations were extremely high (in case of Garlon: 30%, in case of Banvel: 20%) because of the careful method and the small area treated. Solvents were rape oil, diesel oil or Agrol+water in case of 'Garlon' and water or Agrol+water in case of 'Banvel'.

In the plots treated with chemicals four coenological records were made: in the spring of 2003 — before the treatment, and in the spring, summer and autumn of 2004 — after the treatment. Data from the control plots were recorded in the three seasons of 2004. Unfortunately, four of the six control plots were treated in 2004 during a work that was independent of our study. Therefore we established two additional quadrats in order to have control records for autumn.

We examined two main questions: 1.) How successful is the chemical treatment and 2.) What is the effect of herbicides on the surrounding vegetation?

We estimated the percentage cover of the species. Multivariate analyses were computed with SYN-TAX 5.0 program package (Podani 1993). We used Renkonen index and group average clustering algorithm in the classification, and principal components analysis (PCA) as an ordination method.

Results

Although there were only minimal distances among the quadrats, the associations can be distinguished clearly. Steppe meadow is a little bit richer in species. Total cover of the vegetation is much higher in the steppe meadow than in the rock grassland community. Some species were found only

in one of the two associations: *Anacamptis pyramidalis, Dianthus giganteiformis, Eryngium campestre, Festuca rupicola, Geranium columbinum, Melilotus officinalis* and *Viola arvensis* were typical only of *Cleistogeni-Festucetum rupicolae*, whereas *Asplenium ruta-muraria, Ceterach javorkeanum, Colchicum hungaricum, Helianthemum canum* and *Potentilla arenaria* were typical of *Sedo sopianae-Festucetum dalmaticae*.

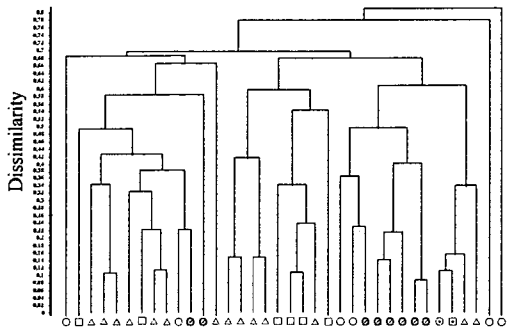

Fig. 1 Result of classification in case of *Sedo sopianae-Festucetum dalmaticae* (○: records before treatment, □: first records after treatment, △: second and third records after treatment, ⊗: controls, ⊙: extraordinary plots before treatment, ⊡: extraordinary plots after treatment)

On the dendrogram it's obvious, that the records of treated and untreated plots do not form clearly separated groups, they can, however, be grouped with a few exceptions (Fig 1). In order to eliminate the seasonal variability, we compared the coenological records of the spring seasons before and after the treatment. Generally there could be observed considerable differences among treated and control plots with only three exceptions (one in case of *Sedo sopianae-Festucetum dalmaticae* – see Fig. 1, and two in case of *Cleistogeni-Festucetum rupicolae*; they will be marked as extraordinary plots on Fig. 1.), which can be explained variously: 1.) Sweeping away of the herbicide by the wind seems not to have remarkable effects on the vegetation. 2.) Among the solvents probably the rape oil is the least harmful to the plants. The coenological structure of the plots where rape oil was the solvent of the herbicide, changed less than that of the others. But further experiments are needed to verify this observation. 3.) The most important observation is the following: in the quadrats where not great differences can be seen between treated and untreated states, the initial cover of *Ailanthus* was the smallest. We can clearly state from the cenostate transformation of the experimental plots, that it is advisable to begin the eradication of the tree of heaven as early as possible, not only because the fight against this invasive species is more successful in this way, but also because this is a chance to minimize the damage in the surrounding vegetation. This is especially important in nature reserves and other valuable areas.

On the PCA scattergram (Fig. 2) the plots form two slightly overlapping groups. The records made in the spring after the treatment belong to one group, and the others together with the controls to the other one. This suggests that: 1.) the treatment has a considerable influence on the vegetation, but 2.) the regeneration of the vegetation is relatively fast. As a consequence of the treatment both associations suffer changes, but after a year they can be found near the original state.

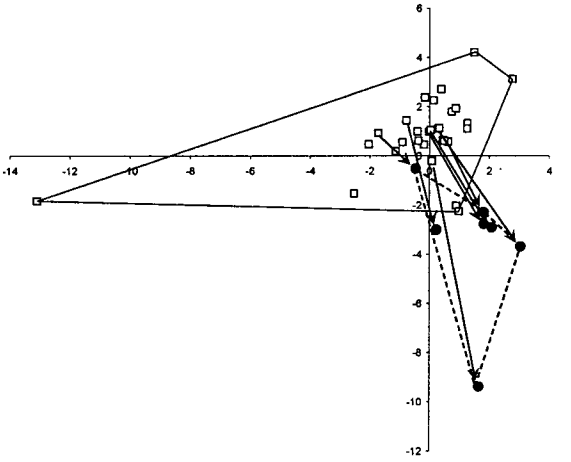

Fig. 2 Result of ordination in case of *Sedo sopianae-Festucetum dalmaticae* (Arrows indicate the transformation of the cenostate due to the treatment. □ spring records before the treatment and control plots; ● next year spring records after the treatment)

In case of *Sedo sopianae-Festucetum dalmaticae* chemicals increase the seasonal differences. This phenomenon is easy to understand: both chemicals damage mainly perennial plants (*Festuca dalmatica, Artemisia alba* and others), and with the decline of these species annual herbs win greater importance. In contrast, in case of *Cleistogeni-Festucetum rupicolae* the seasonal differences are not increased, which is an unexpected and surprising result.

According to the classification and ordination (Figs 1 and 2), neither of the chemicals seems to be less harmful to the natural vegetation.

In accordance with the results of the coenological records, the effectiveness of the spraying on the tree of heaven after nine months is over 99%. After the treatment all leaves of *Ailanthus* fell down. To the next spring tree of heaven appeared only in 27% of the plots, attaining a total cover of more than

0.1% in a single quadrat. The success didn't last long: to the summer of the same year *Ailanthus* appeared in 53% of the plots (its average cover was 3.35%). In autumn the cover of *Ailanthus* reached or exceeded the initial cover in more than 25% of the quadrats. There is a considerable difference between the two associations: the effect of the treatment on the Ailanthus seems to be more long-lasting in case of *Cleistogeni-Festucetum rupicolae*.

Total or nearly total extirpation of the tree of heaven was successful in 40% of the plots. On the rock grassland Banvel seemed to be more effective of the two chemicals, but on the slope steppe there was not a great difference between Banvel and Garlon. Cutting with scissors was not very effective.

Having examined the total cover of the vegetation, damaging effect of the treatments is obvious (Fig. 3). Average total cover of *Sedo-sopianae-Festucetum dalmaticae* decreased from 75% to 46.4%. (Only the spring records were compared, to exclude the effects of seasonal changes!) Average total cover of *Cleistogeni-Festucetum dalmaticae* changed from 99.4% to 68%. After some months a regeneration process resulted in the increase of average total cover to 56.7% *(Sedo sopianae-Festucetum dalmaticae)* and 81.9% *(Cleistogeni-Festucetum rupicolae),* resp. In autumn total cover decreased again, but this occurred probably due to the seasonal variability.

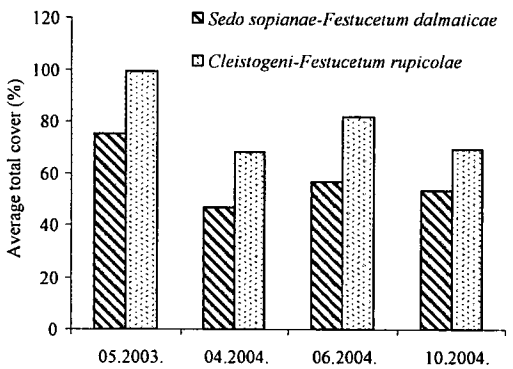

Fig. 3 Average total cover of *Sedo sopianae-Festucetum dalmaticae* and *Cleistogeni-Festucetum rupicolae*. Treatment took place in the summer of 2003

Of course, in the regeneration not only the total cover of the vegetation is important, but also the species composition. The treatment had the most drastic effect on the *Festuca* species. For example on the slope steppe, the average cover of *Festuca dalmatica+Festuca rupicola* dropped from 73.1% to 26.9%! Unfortunately in case of these species regeneration seems to be slow. To the autumn of 2004 they reached only 55% (rock grassland community) and 31% (slope steppe) of their original cover. Beside the *Festuca* species, *Artemisia alba, Thymus praecox, Sanguisorba minor, Potentilla arenaria, Ligustrum vulgare, Rosa canina* and *Crataegus monogyna* were remarkably susceptible to the chemical treatment.

The species number of each treated quadrat increased by the next spring after the treatment compared to the before-treatment spring. This phenomenon can be explained as follows: 1.) The after-treatment records were made in April, one month earlier than the before-treatment ones. In April probably more species can be observed than in May, though there were species which disappeared due to the chemicals. 2.) Most species are insensible to this kind of treatment.

Discussion

Both associations suffered a considerable change due to the treatment. If the initial cover of *Ailanthus* to be treated is low, then less damage is expected in the vegetation. It is expedient to start the fight against this invasive species as early as possible. Neither chemical seems to be less harmful to the plants. Regeneration of the vegetation is relatively fast. In case of *Sedo sopianae-Festucetum dalmaticae* the treatment increases seasonal differences (chemicals damage mainly perennial plants).

Eradication of *Ailanthus* was successful only in 40% of the quadrats for longer time. Total cover of the grass decreased rapidly, which can be assigned mainly to the negative effect of the herbicides on the perennial plants. Some species are very susceptible to the treatment. It is evident that every attempt of extirpation of the tree of heaven must be carried out with much care in a nature reserve in order to avoid unnecessary damages of the other plants.

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