

CHANGES IN THE VEGETATION OF DOLINES IN AGGTELEK AND BÜKK MOUNTAINS

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Summary: The paper deals with the changes of vegetation on karstic landforms, with special regard to doline vegetation. The role of vegetation is very important in the karstecosystem, due to reducing the amount of runoff on the surface, ensuring the balanced infiltration of water into the karst system and increasing the quantity of aggressive carbon-dioxide in the soil. Dolines are the main sites of intensive infiltration of water into the karsts. My study evaluates the changes of vegetation in the last 70 years and diagnoses the degradation of doline vegetation.

Key words: Karsts, vegetation, Bükk Mts., Aggtelek Karst (Hungary)

1. INTRODUCTION

In our days the sustainable management of karsts is an important issue. The karstic ecosystem should be protected in order for the coming generations to enjoy its beauty and for tourists to visit and help sustain national parks. Surface vegetation is an important element of this system; it decreases surface flow, balances the process of infiltration and increases the amount of aggressive CO₂ in the soil through the function of its roots.

Dolines, considered the most typical surface features of temperate-region karsts, are important monitoring points of infiltration. Therefore it does matter whether the natural vegetation of dolines protects the karst surface from fast surface flow or whether it filters the pollution of modern age.

My earlier research was directed at the analysis of asymmetric doline development and I tried to interpret the role of vegetation in this process. In the present study I analyse the vegetation of dolines on the basis of ecological parameters in order to provide information and help for conservation efforts.

2. STUDY AREA AND METHODS

Our field survey was carried out in the summer season on the Bükk Plateau. 1x1 m quadrates were applied for sampling. A species list was created for each site, also containing species cover (%) (based on the frequently used A-D scale in botany). For the analysis the ecological indices of Zólyomi (1966) were applied. We examined temperature (T), water balance (W), soil reaction (R) and N indication (the latter based on the work of

Jakucs (1961)) for species found in the dolines. The conservation value for each species was defined according to the categories of Simon (1997): E (edaphic), K (edaphic accompanying), V (protected), TZ (tolerant to disturbance) and Gy (weed).

3. DISCUSSION

At the FAO conference in Buenos Aires in 1972 a proposal of the triple function of the forest was accepted, initiated by Hungary; these are the economic, protection and recreation functions. Natural forest management means that besides continuous timber production a healthy and functioning ecosystem is preserved as well as biodiversity. Since Hungary is not very rich in forests, karst areas cannot be withdrawn from active management even though excessive production increases the risk of soil erosion in the case of typical karstic rendzina and brown forest soils. The presence of forest cover enhances the water balance by ensuring the slow and continuous infiltration of precipitation therefore it is highly important in the protection of karst water supplies.

Xerophilic scrub woodlands (*Orno-Cotinion*), dominated by *Quercus pubescens*, are characteristic communities of Hungarian karstlands. There are two major types, separated by the presence of two species: *Cotinus coggygria* in Transdanubia and *Cerasus mahaleb* in the Northern Mountain Range. Mixed karst forests appear on the southern slopes as xerophilic scrub woodlands while on the colder northern slopes as beech forests. The high-mountain type of East-European beech forests (*Fagion medio-europaeum*) covers the limestone surfaces above 700 m as in the Bükk Mts. whereas its middle-mountain type sometimes reaches down into the climatic zone of oak forests. In Aggtelek Mts sessile oak-hornbeam forests (*Quercetum petraeae-cerris*), thermophilous oak forests (*Corno-Quercetum pubescenti-petraeae*) and scrub woodlands (*Ceraso-Quercetum pubescentis*) can be found.

Due to their extensive forest cover, forest management is a basic economic activity in karstlands. In smaller patches, especially in the vicinity of settlements croplands represent a fully anthropogenic landscape while forest management, together with grazing and hay-making in grasslands are considered a more natural way of management.

Deforestation in the beginning of the last century was a typical phenomenon in our mountains and the new, often planted forests meant less diversity compared to the original species composition. The traces of soil erosion and the resulting appearance of bare rock surfaces are sometimes recognisable in Hungarian karsts but they are not characteristic.

3.1. The zonation of vegetation in Bükk Mountains

With the increasing height above sea level several zonal forest types can be distinguished in Hungarian karsts. The series can be best followed in Bükk Mts.

- Turkey oak-sessile oak forests can be found up to 450 m height above sea level – on southern slopes up to 700 m. Acidofrequent oak forests are also situated in this zone.
- Sessile oak-hornbeam forests can be found on practically any kind of bedrock at 400-600 m asl.
- At 600-700 m asl middle-mountain beech forests are situated mixed with other species, e.g. ash, hornbeam and sessile oak. Beech forests with wood melick (*Melica uniflora*)

indicate a dry environment; in the case of this type even a small change in the environment can lead to fast degradation.

- On the Bükk-plateau high-mountain beech forests are characteristic (Bükk even means beech tree). The deforestation occurring in the last century caused considerable degradation in these stands; in many cases they were replaced by red fescue (*Festuca rubra*) hay meadows or *Nardus* swards. At the bottom of the dolines the extreme heat fluctuation (summer night frosts) prevents the successful regeneration of beech.

The presence of azonal associations reflects the specific characteristics of the bedrock, the relief, the soil and the microclimate. Lots of relict and endemic species are related to these communities. One of the unique associations of karsts is the limestone beech forest with rocky grassland. Linden and service forests can be found on steep rocky slopes whereas linden and ash forests usually occupy south- and west-looking slopes. As their name shows linden scree forests are usually found on rock flows whereas mesic rocky forests, rich in *Acer pseudoplatanus*, are the typical community of ravines (Vojtkó 2002). Acidofrequent oak forests occupy warm and dry sites; timber production in their case often results in the ultimate destruction of the community. Rocky beech forests occur on northern slopes, while karstic scrub woodlands prefer hot surfaces with very shallow soil on the southern slopes. The latter usually appear in mosaic with slope steppes and rocky grasslands, of which the proportion is only about 0.8%. The typical associations of dolines in this region are alpine grasslands due to the specific microclimate characterising the surface depressions.

Because of their height above sea level, Bükk Mts. are mostly covered by mesophilic beech forests, mixed rocky forests and acidofrequent forests. The high-mountain type of Middle-European beech forests (*Fagion medio-europaeum*) can be found in the areas above 700 m asl, while the other type reaches down even into the zone of oak woodlands. Hungary's biggest consistent forest area can be found on the Bükk-plateau; 95% of the area of Bükk National Park (41.197 ha in all) is covered by forests.

3.2. The vegetation of dolines

Removing the forest cover of the dolines resulted in their reforestation being either very slow or even impossible; however some species of the original forest vegetation can still be found. After the deforestation juniper (*Juniperus communis*) appeared in the dry valleys and dolines forming secondary associations, indicating a loss of nutrients in the soil.

At the same time the uniformisation of the earlier species-rich doline vegetation occurred; this phenomenon was further intensified by farming, mostly grazing and hay-making. Taking into account the extreme temperature fluctuation characteristic of the dolines after the removal of the protecting forest cover, the decrease in species diversity seems logical. In earlier investigations we found the micro- and macroflora a very important factor in the ecosystem of dolines. The species structure of macroflora in the forests and dolines of the Bükk Mts. was examined by Bacsó and Zólyomi (1934). Analysing the relationship between microclimate and vegetation they showed that the vegetation of the highly varied karst surface reflects both soil and microclimate characteristics.

During their survey of the now entirely protected doline of the Nagymező they described a xerophilic *Festucetum sulcatae* community on the south-looking slope, whereas in the bottom they found *Nardus* swards (*Nardetum montanum festucetosum ovinae*). The following species were found in this association in the course of their investigations: mat grass (*Nardus stricta* (TZ)), sulphur cinquefoil (*Potentilla recta* (K)), sheep's fescue

(*Festuca ovinae* (K)), yellow bedstraw (*Galium verum* (K)), sweet vernal grass (*Antoxanthum odoratum* (E)), marsh gentian (*Gentiana pneumonanthe* (V)), spring sedge (*Carex caryophyllea* (K)), devilsbit scabious, (*Succisa pratensis* (K)), common wood-rush (*Luzula multiflora* (K)), stemless carline thistle (*Carlina acaulis* (V)), catsfoot (*Antennaria dioica* (K)).

Further characteristic species included: common milkwort (*Polygala vulgaris* (K)), *Gentianella livonica* (V), frog orchid (*Coeloglossum viride* (V)), moonwort (*Botrychium lunaria* (V)), *Gentiana austriaca* (V). Jakucs (1961) also found alpine pasture grasslands, formed as a result of the inversion caused by the extreme microclimate of the doline.

In the two dolines at Kurtabérc and three at Nagymező where I carried out my surveys false oat-grass (*Arrhenatherum elatius* (TZ)) and mat grass (*Nardus stricta* (TZ)) showed the highest surface cover % values. Hedge bedstraw (*Galium mollugo* (K)) and greater knapweed (*Centaurea scabiosa* (K)) were also present with high cover values nearly everywhere except for the southern slope.

I found the following further species everywhere within the dolines: yellow bedstraw (*Galium verum* (K)), *Ranunculus polyanthemus* (TZ), tall oat-grass (*Arrhenatherum elatius* (TZ)), stemless carline thistle (*Carlina acaulis* (V)), strawberry (*Fragaria vesca* (K)) and purple-stem catstail (*Phleum phleoides* (K)).

In the bottom of the dolines the following species were frequent: common nettle (*Urtica dioica* (TZ)), self-heal (*Prunella vulgaris* (TZ)), Russian dock (*Rumex confertus* (TZ)), barren strawberry (*Waldsteinia geoides* (K)) and cocksfoot (*Dactylis glomerata* (TZ)). These species are ecologically neutral, common elements of tall grass communities.

Species usually present with lower percentage cover: *Iris graminea*, yarrow (*Achillea millefolium* (TZ)), strawberry (*Fragaria vesca* (K)), *Ranunculus polyanthemus* (TZ), prostrate speedwell (*Veronica prostrata* (TZ)), common valerian (*Valeriana officinalis* (V)), bloody cranesbill (*Geranium sanguineum* (K)), hoary plantain (*Plantago media* (TZ)), squinancywort (*Asperula cynnanchica* (K)), dropwort (*Filipendula vulgaris* (K)), heath dog violet (*Viola canina* (K)), saw-wort (*Serratula tinctorica* (TZ)), Russian dock (*Rumex confertus* (TZ)), Cypress spurge (*Euphorbia cyparissias* (GY)), alpestrine clover (*Trifolium alpestre* (K)) and salad burnet (*Sanguisorba minor* (K)) – the latter two are not present on southern slopes.

In the 1930's 60% of the doline species were natural accompanying species, whereas nearly 7% were edaphic, 23% protected and 7% disturbance tolerant. According to my results, nearly 70 years later, only 36% of the doline species were natural accompanying species, 12% protected, 4% weed and 40% disturbance tolerant. Comparing the survey of Bacsó and Zólyomi (1934) with my own results the degradation tendency of the dolines' vegetation becomes evident.

The different elements of the dolines' vegetation were characterised with their conservation values according to the method of Simon (1997). It is clear that although protected species can still be found, nearly half of the plants still present are disturbance-tolerant and weed species indicating degradation (Fig. 1).

The species we found in the dolines were also characterised with the ecological indicators of Zólyomi (1966). Considering the temperature index, there is no significant difference. Slightly higher values occur on the northern side (the south-looking slope) of the doline indicating that this side is drier and warmer. This specialty affects the other ecological characteristics as well; there are no weeds on the southern slopes and most of the

protected species occurred here as well. On the northern slopes the disturbance-tolerant species are present in high numbers (Fig. 2).

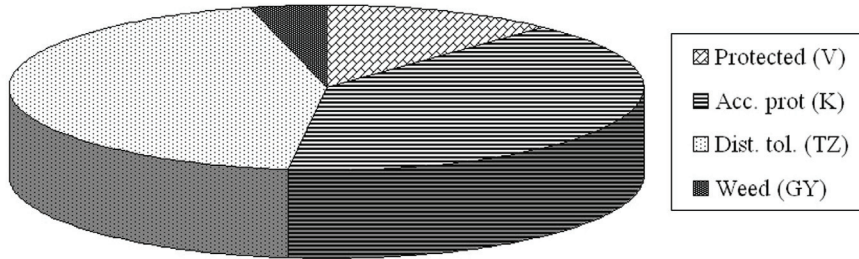


Fig. 1 Distribution of the species after the conservation values which are present everywhere in the dolines

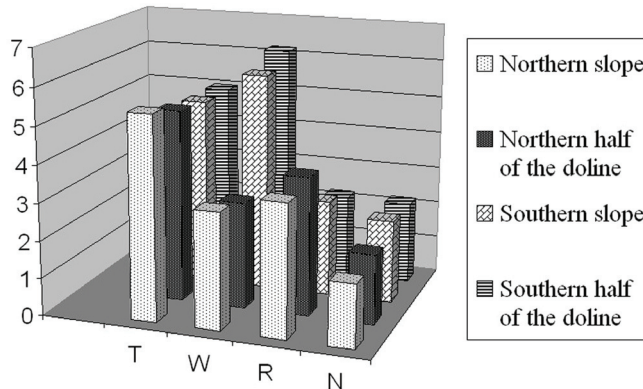


Fig. 2 Average values of ecological indicators in transect of northern and southern in the doline

There is less difference along the east-west transect. There are very few species which only grow on eastern slopes but there are several which occur on this side the most frequently. Considering the temperature index, the western slopes are less extreme than the eastern slopes. There is considerable difference in the distribution of water balance indices but it does not appear in the means (Fig. 3).

On the eastern slope the species of drier sub-mediterranean woodlands and warmer steppe climate appear. It is interesting that a few species requiring wetter conditions (*Aconitum*, *Colchicum*) also occur. Examining the eastern and western slopes from the conservation value's point of view, they give very similar distributions but the results come from very different species.

This draws our attention to the fact that in the east-western transect, which seems identical in many respects, species occur in very different ecological conditions because the daily distribution of radiation is significantly different on these two slopes (earlier temperature maximums on the western slope, later on the eastern). Another point of interest is the frequent appearance of the same species on the northern and western slopes.

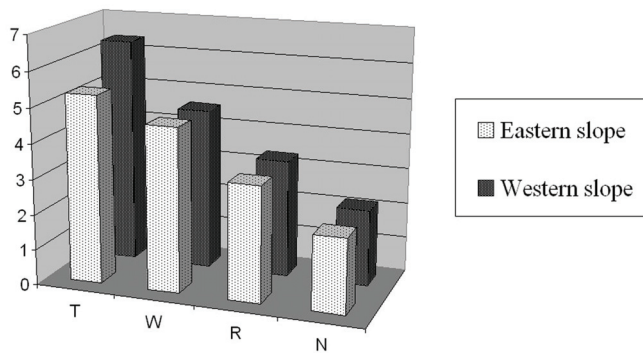


Fig. 3 Average values of ecological indicators on eastern and western slopes in the doline

4. CONCLUSION

An important objective of the survey was to investigate the changes of the dolines' vegetation over the last 70 years. Compared to the results from the 1930's the vegetation of the dolines in the Bükk Mts. shows the signs of degradation. We can also state that in the micro-environment of the open dolines (those without forest cover) the different slopes have different vegetation cover due to microclimatic differences and the resulting ecological conditions (Bárány-Kevei and Horváth 1996). Despite the fact that most of the present species are characteristic of the main associations, the rocky grasslands, slope steppes, *Nardus* swards and alpine meadows and that they are basically identical, in the bottom of the dolines we found tall grass associations. This is where the infiltrating waters are gathered, due to the elevation. Specific species can be found in the highest proportion on the southern and western slopes and these are the two most similar slopes as well.

There is no doubt that changes in the vegetation will have an effect on the quality of the infiltrating waters and the further development of the dolines. Since dolines are suitable monitoring points of the water in the karst system, it is important to continue the research of the vegetation cover which plays such an important role in the karstecosystem.

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