The effects of stand characteristics on the understorey in *Quercus petraea* and *Q. cerris* dominated forests

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Abstract

The shelterwood system used in Hungary has many effects on the composition and structure of the herb layer. The aim of our study was to identify the main variables that affect the occurence of herbs and seedlings in Turkey oak-sessile oak (*Quercus cerris* and *Q. petraea*) stands. The study was carried out in the Bükk mountains, Hungary. 122 sampling plots were established in 50-150 year old oak forests, where we studied the species composition and structure of the understorey and overstorey. The occurence of herbs was affected by canopy closure, the heterogenity and patchiness of the stand, the slope and the east-west component of the aspect. The composition of saplings was significantly explained by the ratio of the two major oak species in the stand and the proximity of the adult plants. An important result for forest management was that sessile oaks were able to regenerate almost only where they were dominant in the overstorey.

Introduction

The different types of forest use – harvesting, collecting fuel and litter, grazing, hunting – and the importation of alien species have siginificantly changed the species composition, the structure and the dynamics of our forests (BENGTSSON et al 2000). Forest species – a lot of them have low reproduction and dispersal capacity (HERMY et al 1999) – have to face the reduction and fragmentation of their habitat. In addition, species with good colonization capacity may gain advantage (BENGTSSON et al 2000), so the success of forest species decrease because of various reasons. 20 % of the Hungarian forests are protected, but a lot of these stands are managed with shelterwood system. (STANDOVÁR 2002). In the case of this type of forest management, the species of the understorey are stressed not only by the clear-cutting. The foresters often create stands with few tree species, homogenous structure and one age-group. Several structural component – which are typical in naturally developing forests – are absent in these stands.
In our study we assessed main factors that affect the occurence of herb species and tree seedlings. Are some of the variables affecting understorey species composition typical of naturally developed forests?

Methods

In our study we established 122 sampling plots, 500 m^2 in size, in 50-150 year old *Quercus petraea* and *Q. cerris* dominated stands in the south part of Bükk mountains, Hungary. Each plot consisted of 28 quadrats, 0.5 m^2 in size, where the species list of the understorey was recorded. Besides, we studied the species composition and structure of the shrub layer (in one quadrat, 100 m^2 in size and in four quadrats, 7-7 m^2 in size) and the overstorey (in the whole

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plot, 500 m^2 in size), the canopy closure and abiotic variables. For data analysis we used Redundancy Analysis (RDA) and Generalized Linear Model (GLM).

Results and discussion

The structure of the overstorey had significant effects on the cover of the understorey. (**Table 1.**) The canopy of the young, slim trees are tightly closed, thus sunlight only reaches the ground layer partly. In addition, dense shrub layer can further reduce the amount of light, so the cover of the understorey is low. With the growth of the trees, self-thinning begins (in managed stands it is done by the foresters), and the overstorey opens up. A lower canopy layer can develope, which contains mainly compound species and grown-up shrubs, therefore spatial heterogenity and species diversity increase. In these open, patchy stands more and more heterogenous sunlight reaches the understorey, hence the cover increases (CSONTOS 1996). Interestingly, according to our results the east-west component of the aspect is an important variable, the understorey has grater cover on western slopes. (Although, in absence of Turkey-sessile oak stands in northern slopes, we couldn't examine them.).

Variable	***Sign***	***The variance ratio covered by the variables***	***F-value***
ncs	-	16.64 %	38.08***
kcs	+	11.06 %	25.30***
oatm	+	7.72 %	17.66***
zar	+	6.81 %	15.58**
al	+	4.71 %	10.77**
kitkn	+	2.81 %	6.42*

Table 1. *The significant variables that determine the cover of the understorey.*

In the studied *Quercus petraea – Q. cerris* dominated forests different variables explained the occurrence of herbs and seedlings. There are variables in both groups which are typical for naturally developed forests, for example species-rich shrub layer, relatively high proportion of compound tree species, heterogenous stand structure. These variables could be generated in managed forests too, assuming proper forest management.

The occurrence of herb species was defined by the canopy closure, tree-layer heterogenity and patchiness, the slope and the east-west component of the aspect. The herb species could be categorized into two groups whose occurrence was defined by different variables. Those typical to xeric oak forests and the acidofrequent species mostly preferred the older, groved stands dominated by *Q. petraea* with few associate tree species, and with less dense shrub layer. The second group consisted of generalist and mesic forest species. These preferred taller stands – possibly on deeper soil – dominated by *Q. cerris* with more associate tree species.

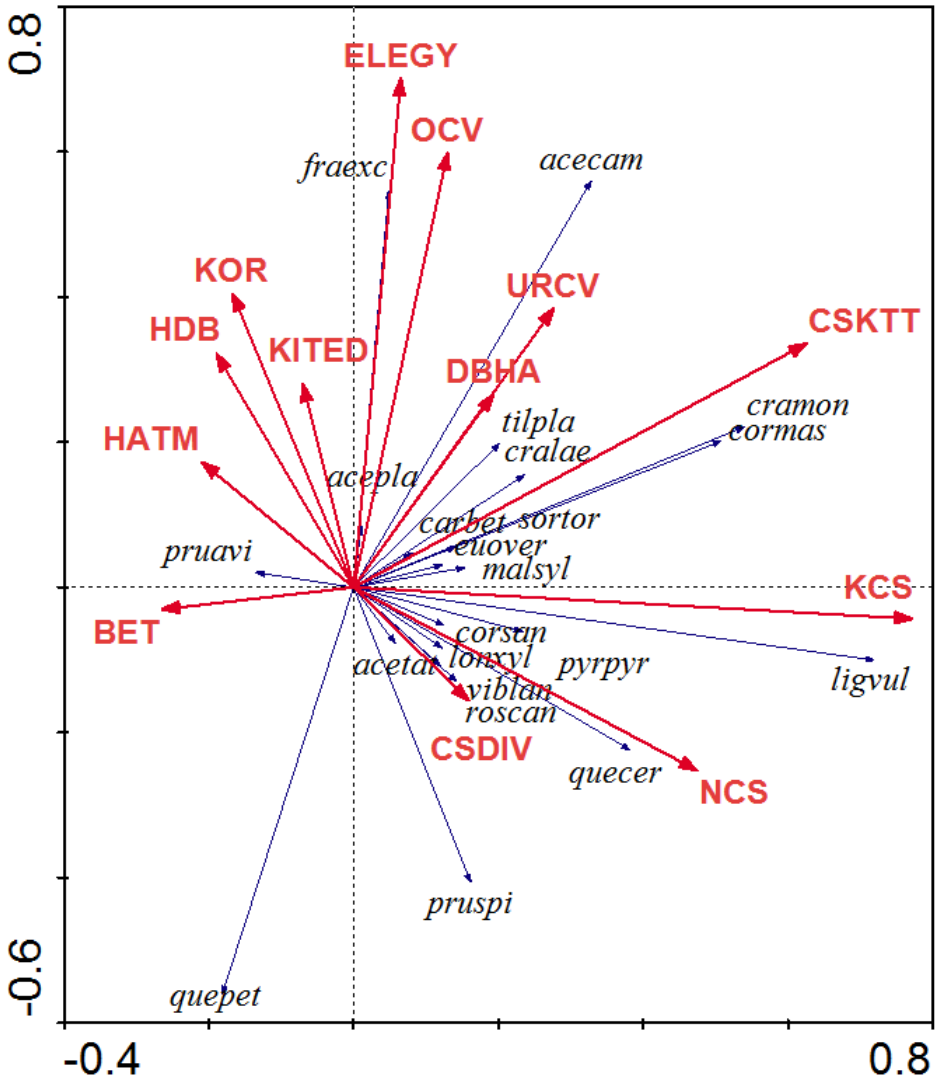

Figure 1. *The most significant variables that determine the occurrence of tree species in the understorey.*

Abbreviations of the species' names*: acecam – Acer campestre, aceplat – Acer platanoides, acetat – Acer tataricum, carbet – Carpinus betulus, cormas – Cornus mas, corsan – Cornus sanguinea, cralae – Crataegus laevigata, cramon – Crataegus monogyna, euover – Euonymus verrucosus, fraexc – Fraxinus excelsior, ligvul – Ligustrum vulgare, lonxyl – Lonicera xylosteum, malsyl – Malus sylvestris, pruavi – Prunus avium, pruspi – Prunus spinosa, pyrpyr – Pyrus pyraster, quecer – Quercus cerris, quepet – Quercus petraea, roscan – Rosa canina, sortor – Sorbus torminalis, tilpla – Tilia platyphyllos, viblan – Viburnum lantana.*

Abbreviations of the variables*: kor – the age of the stand, kitkn – deviation from East, kited – deviation from North, dbha – the number of living trees per ha, oatm –the mean diameter of living trees, ocv – coefficient of variation of the diameter of living trees, urcv – coefficient of variation of the diameter of trees in dominant social status, al – the ratio of trees in the lower canpoy layer, elegy – ratio of compound species, csktt – proportion of Turkey oaks within the oaks, bet – the ratio of unhealthy trees, zar – the mean openness of canopy, hdb – number of standing dead trees per ha, hatm – the average diameter of standing dead trees, ncs – the number of high shrubs(>1.3 m) per ha, kcs – the number of low shrubs per ha, csdiv – species diversity of shrubs.*

The occurrence of seedling species was primarily defined by the characteristics of the shrub layer and the species composition of the overstorey (**Figure 1**.) . Interestingly, even anemochore species need proximity to the parent plant in order to regenerate. This

phenomenon is particularly relevant in the case of the barochor and zoochor sessile oak, which is an important species for forest management, but is very difficult to regenerate. According to our results the presence of sessile oak is not sufficient for successful regeneration, it has to be dominant in the overstorey. The other relevant stand characteristic that defines the appearance of tree seedlings and shrubs is the ratio of the two oak species in the overstorey. Most of the shrub species prefer stands with Turkey oak dominance. There are multiple explanations for these phenomena. It is possible that the shift in the ratio of the sessile and Turkey oaks is because of the improper forest management that disturbs the territory periodically, thus the shrubs can gain importance. Another theory involves the soil as a factor of the overstorey species composition. While turkey oak prefers soil with neutral pH in Hungary, sessile oak is more tolerant. Thus, as the soil becomes more acidic, the ratio of the two species shifts toward the sessile oak (GENCSI and VANCSURA 1992). According to field experiences, most shrub species dislike acidic soil as well. The third explanation is based on the different soil use of the two oak species (GENCSI and VANCSURA 1992). Sessile oaks take up more water thus drying the soil so that it becomes unfavourable for shrubs. (Further detalis: ADAM 2010.)

Summarizing our results we conclude that the age of the stand has a strong – though indirect – effect on the occurrence of the understorey species. The understorey composition that is typical of older, more naturally-developed forests is not impossible to attain in managed stands, especially with the appropriate management.

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