The influence of forestry on epiphytic lichens and bryophytes at different spatial scales in mixed temperate production forests

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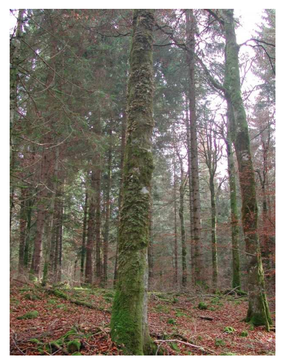
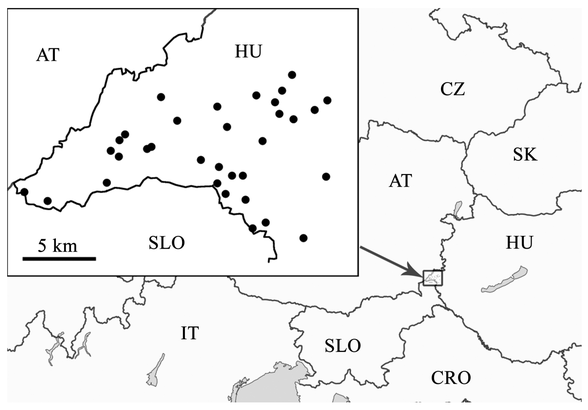
Forestry influences patterns of forest dwelling organisms, controlling forest conditions as tree species composition, stand structure, microclimate, forest continuity. Comparative studies across different management regimes and regions proved that **epiphytic lichens** and **bryophytes** are among the most sensitive organisms, also representing a large amount of forest biodiversity.

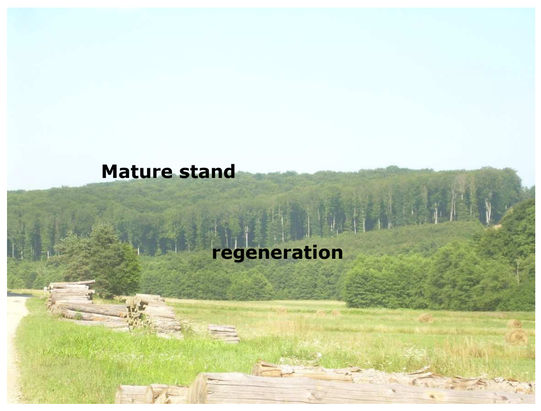
Despite the fact that they occupy the same physical space and are potentially limited by the same environmental conditions, only a few studies simultaneously addressed their patterns and interactions.
Epiphytes are influenced by environmental factors whose importance may depend on the scale of the analysis. Hence, for providing effective conservation strategies the influence of different management-related factors should be evaluated at different spatial scales.

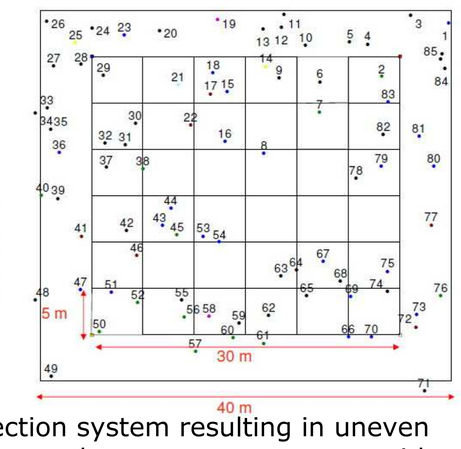


The aim of this study was to evaluate the influence of environmental factors indicative **of stand and tree level conditions** on **species richness** of epiphyte communities in mixed temperate production forests.



The study region was the Őrség National Park at the westernmost part of Hungary. **Thirty-five mature stands** were selected by stratified random sampling from the database of the Hungarian National Forest Service. Stand age was between 70–100 years.
The vegetation is dominated by beech, sessile and pedunculate oak, hornbeam, Scots pine and Norway spruce, forming monodominant and mixed stands as well.





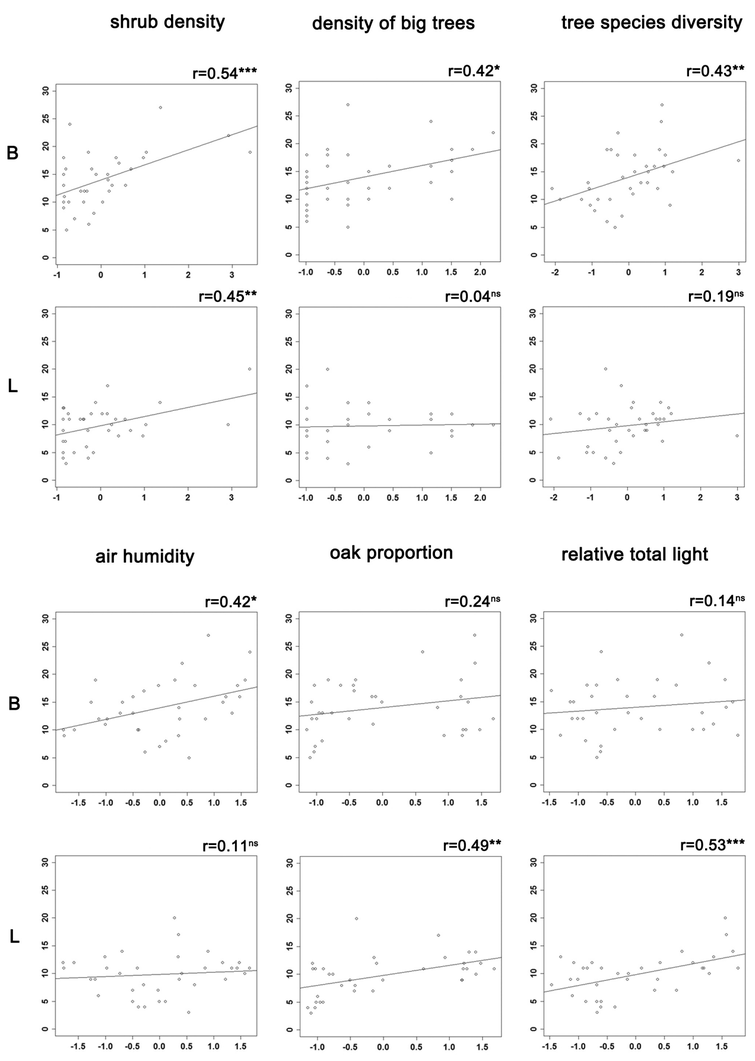
In private forests spontaneous stem selection system resulting in uneven aged stands, while in state forests shelterwood management system with a rotation period of 70–110 years are applied.
Within each stand, a 40 x 40 m^2 plot was pointed out for stand structural measurements. Epiphytic bryophytes and lichens were recorded in 30 x 30 m^2 plots positioned in the middle of the 40 x 40 m2 plots. The occurrence of bryophyte and lichen species was recorded in every living tree with minimum 20 cm DBH from the bottom to 1.5 m height.

General

Both **lichens and bryophytes were strongly influenced by tree species composition** (stand level), **host tree species** (tree level) being among the main determinants for epiphyte species richness. However, the two groups differently responded to other factors, **bryophytes being most sensitive to stand structure and tree size**, while **lichens were mainly influenced by light conditions**.

The influence of landscape and historical factors was not supported by our models. This result may be explained by the relatively high forest cover in the landscape, by the high habitat connectivity, and by the fact that most of our plot have a relatively long forest continuity.

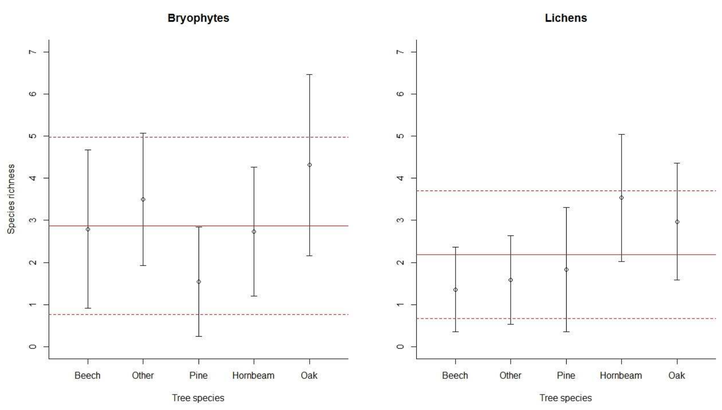
Plot level



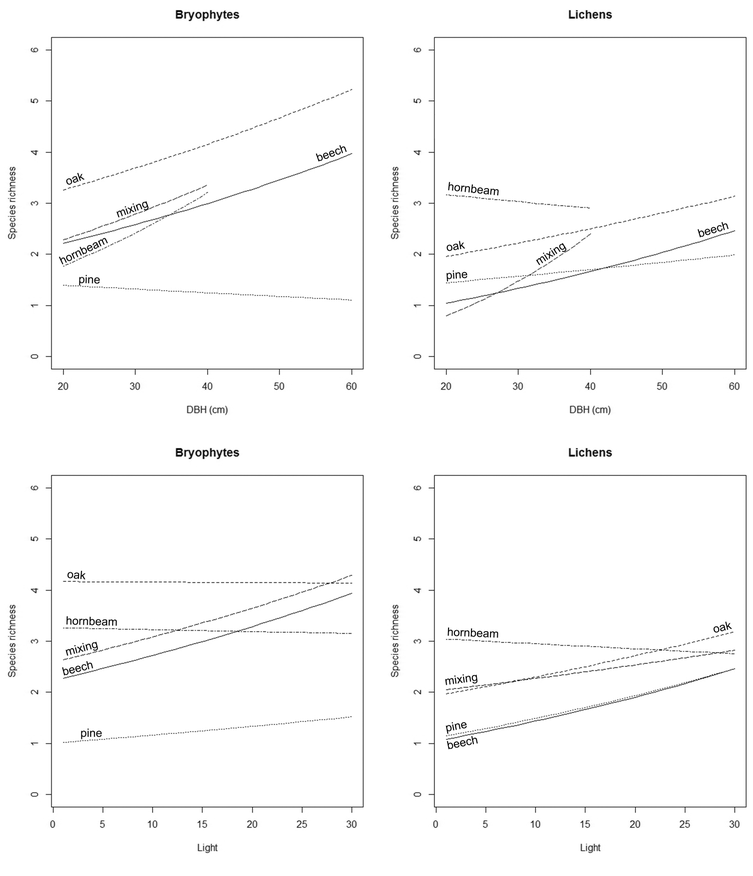
Sixty bryophyte and forty-four lichen species were recorded in 35 plots on 971 trees. For bryophytes the mean stand level species richness was 14.00±5.01(SD), the range was 5-27, while for lichens the mean was 9.83±3.69(SD), the range was 3-20.
Bryophyte and lichen richness were significantly positively correlated to each other (r=0.39, p=0.019, df=34).

Correlations of bryophyte (B) and lichen (L) species richness between some selected explanatory variables, indicated as columns. Vertical axes: species richness values; horizontal axes: standardized values of the explanatory variables. 'r=' represents the correlation coefficients (n=35); their significance is indicated by stars: ns= non-significant; *= p<0.05; **= p<0.01; ***= p<0.001

Tree level



Mean tree level species richness was 2.87±2.11 (SD) for bryophytes and 2.19±1.52 (SD) for lichens.
For bryophytes oak, for lichens oak and hornbeam were the most species rich hosts.
Correlation between tree level species richness of bryophytes and lichens was 0.34 (p<0.001)



Predicted tree level species richness of bryophytes and lichens using tree species, DBH and relative light as explanatory variables. For hornbeam and mixing trees the range of diameter was lower than for other trees, because the abundance of larger individuals is low in the studied region.

For bryophytes tree size effect was strong on every broad-leaved species, while on conifers size effect was not found. Light effect was strong on beech and mixing tree species, while bryophyte species richness on oak, pine and hornbeam was independent from light conditions.
For lichens, tree size and light were not influential for species richness on hornbeam.

Conclusions

Our study indicates that patterns of epiphytes richness within mixed temperate production forests are influenced by drivers acting at different spatial scales.

Most predictors that were included in the models can be directly influenced by management. The main strategy for improving epiphyte diversity should include the maintenance of tree species diversity in mixed stands, the improvement of the proportion of deciduous trees (mainly oaks), the conservation of large trees, the presence of shrub and regeneration layer, and the creation of heterogeneous light conditions.

Tree selection system and selective cutting would be the best management for these conditions.

In shelterwood forests the retention of groups of mature trees at the final harvest could be important for epiphytes diversity. They became over-mature trees or dead wood in the next generation of the stand, provide "safe sites" for the survival of epiphytes and mitigate microclimate stress after harvest. The elongation of rotation period and regeneration time would be also important.

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