MICROHABITATES IN THE BEECH NATURAL AND MANAGED FOREST - SHORT REVIEW

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Abstract. *MicroHabitats = MHs are important features for conserving forest biodiversity. Other structural indicators of forest biodiversity have been well studied in recent decades, but these microhabitats do not, partly due to the lack of widely accepted definitions, partly due to lack of knowledge regarding them. Although the number of microhabitat studies has increased recently, the determinants of microhabitat profiles in natural forests in different geographical regions remain unknown. Some of the approaches for studying tree microhabitats used as a proxy for estimating forest biodiversity are briefly presented in this study.The concern for this domain of tree microhabitats used as a proxy for estimating forest biodiversity is a relatively new field for Romania. This brief review first describes the concept of tree microhabitats, virgin forest and managed forest, and then focuses on current approaches to the study of microhabitats, both in terms of the system proposed by the European Forestry Institute (EFI) through the Integrated + project and materialized in the Catalog of tree microhabitats, as well as through the German system, these models being developed in Europe.Comparison between natural forests and managed forests with regard tree microhabitatsis not a completely new idea, from this point of view, forests have been studied in which forest management (management, harvesting of wood) was interrupted - in some cases very recently, in others a long time ago. The advantage of the study started by me is that I can collect data from truly virgin forests, in which wood was never harvested.In order to conserve the biodiversity of forest ecosystems, foresters could, through the applied forest manager, "imitate" the structural characteristics of natural forests favorable to microhabitats: a larger number of large trees and dead trees on the surface unit.Long-term scientific research on the structure, dynamics and biodiversity of high-grade forest ecosystems (virgin forests) is of particular importance for the development, adoption and implementation of forest management measures close to nature, sustainable both economically and ecologically, and favorable for biodiversity.*

Keywords:*microhabitats, natural forest (unmanaged), managed forest,beech forests.*

INTRODUCTION

Natural forests / with a high degree of naturalness have been considered by many researchers as an important source of scientific information for the knowledge of the forest ecosystem in general and for the "extraction" of scientific information to be used in current forestry practice in managed forests. (Brang P., 2005, Tomescu R. et al., 2004-2006).

Biodiversity, or biological diversity, through all the levels at which it manifests itself, from genetic diversity to that of landscapes, is a characteristic of living systems that gives them resilience, the ability to withstand destabilizing factors.

Biodiversity is considered by many researchers as the basis of biological production, ie human well-being. Ecosystems with high biodiversity ensure ecosystem services to human society. To ensure human well-being, the continuity / permanence of ecosystem services must be ensured, especially in the context of global climate change.

Assessing biodiversity in some of the most complex terrestrial ecosystems, forest ecosystems, is not at all easy. In this regard, I propose the comparative study of the close link

between the presence / frequency of tree microhabitatsin the natural and managed forest, as well as the use of the results of this study for current forestry practice.

Tree microhabitatsare of particular importance in forest habitats, with recent studies highlighting their use as a proxy for local taxonomic diversity (Larrieu L. et al. 2014, Kraus D. et al. 2016, Larrieu L. et al. 2018). Current research at European level in the field imposes a new paradigm: maintaining and improving the biodiversity of forest ecosystems, not only by creating reserves, but also by increasing the biodiversity of managed forests.

Tree microhabitats are important for the complexity of forest habitats, whose structural diversity enriches them, thus creating conditions for increasing biodiversity. In general, for the existence of most of the microhabitats identified so far, large trees (especially large diameters) are needed, but also an adequate density of these large trees. (Larrieu L. et al., 2014).

MATERIAL AND METHODS

DEFINITIONS AND CONCEPTS

a. The unmanaged forest

From the beginning of the forest sciences, the specialists had a special interest and respect for the ancient, virgin forests. In order to express this concept of virgin forest, numerous definitions have been issued over time, and the most complete was the recent one (2002), by Professor Josef Fanta1 (University Wageningen, Olanda):

"[The virgin forest is] a natural forest, in which species of trees and shrubs are found in different stages of their life cycle (in the form of seedlings, young, forest or old forest) and in which dead wood (standing or fallen on the ground) is in different stages of rot, so that the tree has more or less complex vertical and horizontal structures, as a result of a dynamic process, which allows the natural community of trees to last continuously and without time limit, on that territory. In virgin forests, the dynamics of living systems are closely linked to the ecological properties of dominant tree species (including their longevity), the impact of other organisms (eg, insect attacks) and the impact of abiotic factors related to the substrate, climate, topographic complex. and water levels (such as floods, heavy snowfall, floods). A sequence of this dynamic is the temporary appearance of gaps (meshes) in the respective tree, or of the treeless stages on larger areas. Within the respective phytogeographical area, the virgin forests differ, forming specific types of forest communities with composition, spatial structure, dynamics and characteristic global diversity, determined by altitude, topography, macroclimate, nutrient and water resources. The virgin forests thus reflect the natural harmony between the forest community and the abiotic conditions, fully consolidated during a millennial development, continues from the Holocene." (Radu S. et al., 2004).

b. Managed forest

The managed forest is the forest that has undergone anthropic interventions in the past and which is guided, through forestry interventions, in the realization of the socio-economic functions established by arrangement (through functional zoning).

c. Microhabitats

We define a tree-related microhabitat as a delimited structure that occurs on standing dead or alive trees, that it is a particular substrate or habitat and essential for species or communities of species to develop at least part of their cycle life, nourish, shelter or create. MicroHabitats (MHs) are important features for conserving forest biodiversity and are morphologically specific to the tree above the ground, singularities that are not found on every tree. MHs include both biotic tree modifications and abiotic impacts, such as lesions and ruptures, that expose sap and wood and initialize wood degradation structures (saproxylic MHs), as well as elements of external origin that are physically related of tree (epixylic MHs). Although

morphological singularities can also be observed in dead wood or roots, MHs are explicitly limited to standing tree structures to avoid too wide a range. Therefore, we have intentionally excluded the characteristics of dead wood, such as roots, pits and mounds, and particular structures of wood decomposition. We also exclude generic characteristics specific to tree species, such as raw oak or larch bark, acidic or alkaline bark conditions, as well as tree growth defects (such as narrow, sloping or rotated trunks, low horizontal branched), which results from specific abiotic conditions or accidental increases (Larrieu L. et al., 2018).

RESULTS AND DISCUSSIONS

Present approaches to microhabitat studies on trees

MicroHabitats (MHs) are important features for conserving forest biodiversity. Other structural indicators of forest biodiversity have been well studied in recent decades, but these microhabitats have not, in part due to a lack of widely accepted definitions, in part due to a lack of knowledge about them. Although the number of microhabitat studies has increased recently, the determinants of microhabitat profiles in natural forests in different geographical regions remain unknown. Some of the approaches to studying tree microhabitats used as proxies for estimating forest biodiversity are summarized below:

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Microhabitats in lowland beech forests as monitoring tool for nature conservation (Winter Susanne et al., 2008)

This study, conducted by Susanne Winter and Christian Moller, investigates the frequencies of 20 microhabitats (defined, including graphically, by the authors) in mature stands (over 120 years) in the plain beeches of Germany - 12 managed stands, 5 of which were stopped short-term interventions and 5 without interventions for over 100 years. In order to promote the assessment of the naturalness of the stands in the forest inventories and to monitor the biodiversity, the following were analyzed: which microhabitats are characteristic for the reference stands; heterogeneity and frequency of microhabitats; the link between the structural indicators of the stands and the threatened species of saproxylic beetles.

The number and diversity of microhabitats were significantly higher in the reference stands. On average, over 250 microhabitats / ha were found and almost 7 of the 20 types, on average, per plot of 500 m2. 14 microhabitats were significantly more common in the reference stands. Trees with several microhabitats have almost 7 microhabitats / tree and are much more common in the reference trees.

A strong linear correlation was found between the number of microhabitats and the diameter of the trees in the reference stands, not in the managed stands and those recently without interventions. The architecture of the large trees in the reference stands reflects the ecological continuity of these forests.

The frequency of threatened saproxylic beetles in relation to tree microhabitats was analyzed. Only the stands recently left without interventions showed a clear correlation in this respect. The number of threatened saproxylic beetle species is high in reference forests and low in managed forests, regardless of the number of microhabitats.

Conclusion: Microhabitats are a useful tool for monitoring the biodiversity of heterogeneous forests.

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Profile of tree-related microhabitats in European primary beech-dominated forests (Kozáka D. et al., 2018)

A first large-scale study was conducted by a team led by Daniel Kozáka: 146 test areas in 8 natural beeches in the Carpathians and the Dinaric Mountains. Mixed-effect linear mathematical models were used to test the effect of local sample surface characteristics and spatial variability on the density and diversity (alpha, beta, gamma) of microhabitats.

The total density and diversity of microhabitats was significantly positively correlated with the richness of tree species and the frequency of standing dead trees.

The square root of the tree diameters was significantly positively correlated with the alpha and gamma diversity of the microhabitats.

Both regions (Carpathians, Dinaric Mountains) similarly have high values of microhabitat diversity, and their diversity does not differ between the two regions.

There are significant differences between the two regions in terms of two categories of microhabitats: fungus on tree trunks and epiphytes.

The density and diversity of microhabitats are high in mountain beeches, but the frequency of occurrence and diversity of microhabitats vary greatly spatially.

Conclusion: Understanding these microhabitat profiles helps in future comparisons, for example in terms of newly established reservations, or in improving forest management practices to promote biodiversity.

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Tree related microhabitats in temperate and Mediterranean European forests: A hierarchical typology for inventory standardization (Larrieu L. et al., 2018)

This study clearly shows that tree microhabitats accept a wide range of biodiversity that is not usually supported by other forest structures. From the point of view of monitoring, the information on tree microhabitats is complementary to data on traditionally classified characteristics: structure (dimensions, tree species) and dead wood (type, size, degradation stage).

Understanding the factors influencing the emergence and distribution of tree microhabitats, their link to biodiversity, and quantifying the potential observer effect would ultimately help validate tree microhabitats as indicators of biodiversity (Paillet Y. et al., 2015a). In particular, comparing the performance of tree microhabitatswith that of other indicators (e.g., those used for reporting on forests in Europe) is very necessary (Gao et al., 2015). Tree microhabitatsare expected to play a complementary (or combined) role with other existing biodiversity indicators, such as the profile of dead wood or the diversity of tree species.

Conclusion: Integrating the conservation of tree microhabitats into common forest management practices can help slow down to lose forest biodiversity over time, and monitoring tree microhabitats can prove to be an additional tool for assessing the state of biodiversity in European forests.

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Predictors of Microhabitat Frequency and Diversity in Mixed Mountain Forests in South-Western Germany (Grossmann J. et al., 2018)

This study, explains the emergence of microhabitats from a qualitative perspective, taking into account their diversity. Trees diameter (dbh), tree species and kraft class were useful predictors of microhabitat diversity.

The diversity of microhabitats to hardwood trees was on average higher than in conifers with the same diameter.

The trees that offer the highest frequency and diversity of microhabitats should preferably be selected as habitat trees. According to the results, the species-specific thresholds, which have not been applied so far, can be set at 90 cm diameter for fir and 70 cm diameter for beech.

Conclusion: Over the resulting diameters, the diversity of microhabitats stops growing significantly.

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Snags and large trees drive higher tree microhabitat densities in strict forest reserves (Pailette Y. et al., 2017)

The study is located in France and compared the densities of trees with microhabitats in managed forests (where wood is currently harvested) and 17 strict reservations (where wood is no longer harvested, but was harvested in the past). A total of 222 test areas were investigated, at the plains and the mountains.

Microhabitats densities are generally higher in reservations and this is mainly due to standing dead trees and large live trees.

The difference between reservations and managed forests was greater at mountains than at plains, contrary to other natural features (eg, the amount of dead wood). For the individual microhabitats, 5 out of 11 at the mountains, respectively one at the plain, were significantly more in reservations than the managed forests.

The total density of microhabitats and the density of specific microhabitats increased all the more as more time elapsed since the last harvest of wood from the respective forest. And this growth is based on high frequencies of standingdead trees.

Conclusion: The abandonment of management leads to an increase in the frequency of microhabitats. The dynamics of microhabitats remain little known and only long-term monitoring will help to understand it. The results can inspire foresters to practice forestry that promotes biodiversity.

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Influence of tree characteristics and forest management on tree microhabitats (Vuidot A. et al., 2011)

Higher tree microhabitat densities may explain the differences in biodiversity between natural and managed forests.

The influences of tree characteristics on a set of tree microhabitats in 75 test areas in unmanagement and managed forests in France were studied. The hypothesis from which the article starts is the following: the number of different microhabitats / tree and the frequency of occurrence of a type of microhabitat on a tree is higher in unmanaged forests than in managed

forests, and this difference could be related to some tree characteristics : diameter, vitality, species.

Unmanagement forests contain several trees that could have microhabitats (large trees, standing dead trees) at the level of stand.

At the level of the individual tree, however, the forest management did not influence the microhabitats, only the characteristics of the tree influence: the large trees and the standing dead trees have more microhabitats.

The number and frequency of microhabitats vary by species: quercinea and beech have several microhabitats, but the frequency of some types of microhabitats is higher on spruce and fir.

Even if microhabitats are not evenly distributed in unmanaged and managed forests, two trees with similar characteristics, in similar stational conditions, have the same number and the same probability of microhabitat occurrence, regardless of the type of forest management.

Conclusion: In order to conserve biodiversity, foresters could reproduce in managed forests characteristics of natural forests -the standing dead trees, veteran trees, etc. Microhabitats should be targeted by forest management monitoring.

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Comparison of the microhabitats in virgin beech forest and managed forests in Semenic National Park (Futterer Sarah, Diener Erika Melitta, 2017)

The concern for this domain of tree microhabitats used as a proxy for estimating forest biodiversity is a relatively new domain for Romania. However, in the summer of 2017, a small exploratory study was conducted in the Semenic area, by 2 German students from the University of Applied Sciences in Weihenstephan-Triesdorf, under the coordination of PhD. Daniel-OndTurcu.

This study considered the approach of microhabitats both in terms of the system proposed by the European Forestry Institute EFI (Kraus et al., 2016) and in terms of the German system (Winter, Susanne, 2009, 2015).

The conclusions of this study crystallize the fact that in virgin forests almost every tree offers the presence of at least one microhabitat, and the Bavarian concept (of the Bavarian State Forestry Administration - BaySF) to keep 10 biotope trees per hectare is too little to maintain a satisfactory level of biodiversity in managed forests (Futterer Sarah, Diener Erika Melitta, 2017).

CONCLUSIONS

The comparison between natural forests and managed forests in terms of tree microhabitats is not a completely new idea (Paillet Y. et al., 2017, Winter Susanne et al., 2008, etc.). From this point of view, forests were studied in which forest management was interrupted (management, timber harvesting) - in some cases very recently, in others very long ago (eg La Fointainebleu in France, with over 100 years ago). The advantage of the study I started is that I can take data from truly virgin forests, in which no wood has ever been harvested.

Many of the cited authors note the importance of large trees and standing dead trees for the density and diversity of microhabitats.

To conserve the biodiversity of forest ecosystems, foresters could ensure, through applied forest management, an "imitation" of the structural characteristics of natural forests favorable to microhabitats: an adequate / larger number of large trees and sufficient standing dead trees per unit area to ensure the critical number of microhabitats for the sustainable conservation of biodiversity.

QUESTIONS FOR FUTURE INVESTIGATIONS:

How do the frequency and diversity of microhabitats depend on the size of the trees? To continue / detail the study (Vuidot A. et al., 2011).

Managed forests in Western Europe differ from those in Romania. There were many "cycles" of "culture" of the forest, sometimes even during the Roman Empire (or even earlier). In our case, there are large areas, especially in the mountainous area, where 1-2 such cycles have been completed. Could differences be highlighted between trees that are in the first cycle of anthropogenic transformation from virgin forests to managed forests and those that are in the second cycle?

Can a threshold be set for forests managed with these characteristic structural elements - number of standing dead trees, number of large trees, specific to us, to ensure a convenient level of biodiversity?

It is truly remarkable that very few have raised the issue of tree age. Are there differences, in terms of microhabitats, between trees of similar size and different ages? Derived from here, also on the time scale: what is the dynamics of microhabitats on standing dead trees, from the moment of death until the fall to the ground, respectively until the total decomposition?

Can tree damage in logging evolve into microhabitats and, as a consequence, contribute to forest biodiversity? To what extent do they compensate for the microhabitats that existed in the forest before the intervention?

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