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LIGNICOLOUS MACROFUNGI OF THE KÉKES NORTH FOREST RESERVE IN THE MÁTRA MOUNTAINS, HUNGARY

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A three-year mycological investigation of the Kékes North forest reserve in the Mátra mountains, Hungary proved the richness of the area in lignicolous macrofungi. Diversity of macrofungi was in close correlation with the developmental phases of the forest as well as with the amount of dead wood of different quality (diameter, stage of decomposition, etc.).

Keywords: diversity, macrofungi, forest reserve, beech forest, coarse woody debris (CWD), Hungary

Introduction

On the initiative of the Ministry of Environmental Protection and Nature Conservation a country-wide project for the research of forest reserves was begun in 1991. Within the frames of this project the marking out of forest reserves, and, in parallel with this, the research in several selected forest reserve areas was started.

Until now 49 forest reserves obtained official protection, and the declaration of the protection is underway in the case of 14 further forests. A European wide concentration of forces and the development of an international network in the field of the research of forest reserves was accomplished by the COST E4 program. Hungary has also joined to the Forest Research Network established by the COST E4 program. [1].

Forest reserves, which have survived without any intentional anthropogenic impacts only in fragments on the whole continent, are excellently suitable for the investigation of the developmental processes of natural forests.

In connection with the mentioned program a three-year mycological surveillance was begun in 1998 in the area of the Kékes North forest reserve in the Mátra mountains in Hungary. Later on, in 2000–2001 the work was continued with some other methods within the frames of the EU5 Nat-man project.

With our efforts the following questions were planned to be answered:

1. Are the forest reserves suitable for the preservation of macrofungal diversity?
2. Are the natural developmental processes of the forest connected with some changes in the composition of the macrofungal assemblages?
3. Are some indicator species present in the macrofungal assemblages, which indicate the nature conservation value of the area?

Material and methods

Description of the forest reserve

The Kékes North forest reserve is situated in the Kékes block of the Mátra mountains, on the northern slope of the peak Kékestető (the highest peak of Hungary), in the area of the so-called Serial Stones (“Sorkövek”). The basic rock of the mountains is pyroxenic andesite tufa which, partially in the form of agglomerates, is characteristic of the area of the reserve [2]. The investigated area has a more or less terraced arrangement, with an average inclination of 30–33º. Its characteristic climate is mountainous, in some northern clefts even subalpine [3]. The yearly average temperature is 5.7 ºC, and the yearly average precipitation amounts to 784 mm.

Characteristic soil type of the area is Ranker and in smaller patches lessivated brown forest soil [4]. The depth of the soil layer is 40–80 cm, with extremes of 30 and 100 cm, depending upon the relief. As a consequence of the volcanic bedrock the chemical reaction of the soil is acidic [pH (in water) = 5.0–5.7, pH (in KCl) = 4.1–4.8] [4].

The core area of the reserve lies on 63.6 ha. The individuals forming the upper crown layer are 160–200 years old. About 2/3 of the core area has never been influenced by any direct silvicultural activity. The dominant tree species of the forest is beech. In the area of the reserve the *Aconito-Fagetum* community has the largest extension. Alongside screes occur either *Phyllitidi-Aceretum subcarpaticum* or *Mercuriali-Tilietum* communities. Where cliffs are covered by a shallow soil layer, *Luzulo-Fagetum subcarpaticum* is characteristic [5].

The main characteristics of the 6 sampling areas are as follows [6]:

— Under the thinned crown layer of the **renewal phase of the *Aconito-Fagetum* community** the saplings begin to grow up. Until the achievement of a significant coverage by the crown layer even 20–40 years may pass, because, as a consequence of further collapses secondary and tertiary gaps come also into existence. Finally, the crown layer is formed by at least 2–3 generations of trees, the coverage of which reaches only about 80% because of becoming sparse as a result of natural selection.

— The **optimal phase of the *Aconito-Fagetum* community** is composed of 80–140 years old trees forming a closed crown layer with a relatively homogenous structure and a large timber volume. By the death of some trees occasionally gaps are formed, which, as a consequence of the high growing capacity of the neighbouring trees, close within 10–15 years, thus preventing any renewal. The summer aspect of the field layer is composed of a small number of species and has a low coverage (an exception is when an invasive species, *Impatiens parviflora* forms the field layer).

— In the **senescing phase of the *Aconito-Fagetum* community** the 140–180 years old trees form a crown layer with more sublayers. The gaps coming into existence as a result of the collapse of the largest trees cannot be filled in anymore by an increased growth of the remaining trees. The collapse of the trees wounds their neighbours, which, as a consequence, are also due to die in the following years. In the gaps lying or standing broken pieces of trunks can be found. The field layer composed of several species often grows up abruptly, reaching high abundances. This phase does not occur in cultivated forests.

— In the **collapsing phase of the *Aconito-Fagetum* community** the trees are 180–200 years old, the coverage of the crown layer amounts to less than 50%. The number of hollowed and crashed trees is high. The renewal of the tree species constituting the stand begins, whereas the species richness of the field layer further increases. Decaying of the wood and other organic materials occurs on the spot. The heterogeneity of the stand offers habitats for several different animal species as well. This phase does not occur in cultivated forests.

— The investigated **collapsing phase of the *Mercuriali-Tilietum* community** occurs on the very thin soil layer of a steep slope with detritus. Main constituents of the crown layer are *Tilia cordata*, *Fraxinus excelsior*, *Fagus sylvatica* and *Tilia platyphyllos*. Several other characteristics concerning the coverage of the crown layer, the number of hollowed and crashed trees, etc. are similar to those of the previously described sampling area.

— The trees of the **buffer zone** are uniformly 50 years old. *Fagus sylvatica* is actually the only species of the crown layer. Saplings and fallen wood are missing. Only trunks remained on the spot as a result of thinning and some twigs offer substrate for lignicolous fungi. The shrub layer is very poor.

Collecting and processing methods

In order to investigate the connection between diversity and the developmental phases of the forest 6 permanent quadrats of about 500 m^2 were appointed. From 1998 to 2000 sampling was carried out altogether 20 times within the quadrats.

In 2000–2001 macrofungi were sampled 3 times on preliminary appointed 98–100 fallen logs of different dimensions and stages of decomposition.

The sampling areas were visited every 2–3 weeks during the fructification period. In the case of macrofungi which form caps (and mostly gills as well), the number of carpophores was counted during every visit. For the quantitative representation of the abundance of macrofungi, which do not form separate, countable carpophores, a three-step ordinal scale was used. Sections of fruiting bodies of the uncommon species found in the area were put into a collection ("herbarium"). The (micro)habitats and the substrates of the species were registered.

For the identification of the species the comprehensive works of MOSER [7], JÜLICH [8], BREITENBACH–KRÄNZLIN [9], MOSER and JÜLICH [10], CANDUSSO–LANZONI [11] as well as IGMÁNDY [12] and, in the case of some species, several further articles were used.

Diversities were calculated by the program package **NuCoSA** of **T**ÓTHMÉRÉSZ [13]. As a consequence of the different scales used for the estimation of abundances of fungi with countable and noncountable carpophores, we had to simplify – inavoidably with some loss of information – the interval scale of the countable carpophores to an ordinal one, in order to have the possibility to estimate the diversities of the entire macrofungal communities. Besides total diversities of the sampling areas, the diversities of the lignicolous and nonlignicolous assemblages within the samples were estimated separately.

Results and discussion

Already in the first year of our investigations several species were found which were new for the area [14]. On the basis of the distribution of the life forms of the macrofungi (Table I) it can be established that lignicolous species are present in the highest ratio (55.8%) within the forest.

Table I

Distribution of the macrofungi of the Kékes North forest reserve on the basis of their life forms

Life form	Species number	Ratio
Mycorrhizal	34	14
Humicolous	31	12.8
Herbicolous	42	17.4
Lignicolous	135	55.8

Besides species suggested for protection several species were found in the forest reserve, which, on the basis of data in the literature [7, 8, 9, 10, 11, 15, 16, 17], are indicators of natural, undisturbed conditions (Table II).

Table II

Species indicating undisturbed, natural conditions

Datronia mollis (SOMMERF.: FR.) DONK
Meripilus giganteus (PERS.: FR.) P. KARST.
Peziza micropus PERS.: FR.

Some species, specifically characteristic of old forests were also found (Table III).

Table III

Species characteristic of old forests

Oudemansiella mucida (SCHRAD: FR.) HÖHN.
Meripilus giganteus (PERS.: FR.) P. KARST.

Richness in available nutrients, which is the consequence of the decomposing activity of xylophagous fungi, is indicated by the presence of nitrophilous species (Table IV).

Table IV

Macrofungal species of the Kékes North forest reserve indicating abundance of N in their substrate

Agrocybe erebia (FR.) SING.
Agrocybe praecox (PERS.: FR.) FAY.
Bolbitius reticulatus (PERS.: FR.) RICK.
Clitocybe nebularis (BATSCH: FR.) KUMM.
Clitocybe phyllophyla (PERS.: FR.) KUMM.
Collybia butyracea (BULL.: FR.) KUMM.
Coprinus plicatilis (CURT.: FR.) FR.
Entoloma rhodopolium (FR.: FR.) KUMM.
Inocybe geophylla (SOW.: FR.) KUMM.
Lacrymaria lacrymabunda (BULL.: FR.) PAT.
Lepiota cristata (BOLT.: FR.) KUMM.
Lepista nuda (BULL.: FR.) COOKE
Lyophyllum rancidum (FR.) SING.
Melanophyllum haematospermum (BULL.: FR.) KREISEL
Pluteus ephebus (FR.: FR.) GILL.
Pseudoclitocybe cyathiformis (BULL.: FR.) SING.
Stropharia aeruginosa (CURT.: FR.) QUÉL.
Stropharia cyanea (BULL.) TUOMIKOSKI

On the basis of the results obtained in 1999, the diversity values of the total macrofungal assemblages (Figure 1), with the exception of the senescing phase, do not show unambiguous differences. In this case the diversity of the senescing phase is the least among all samples. However, when the diversities of the lignicolous macrofungal assemblages are compared (Figure 2), the collapsing phase seems to be significantly more diverse than any other phase. It seems that the dead wood of the collapsing phase is a very important substrate for macrofungi, significantly increasing their diversity. This proves the existence of some correlation between the natural developmental processes of the forest and the macrofungal assemblage inhabiting it. In natural forests, having a patchy arrangement of the different developmental phases, first of all the collapsing phase seems to be rich in species. The cause of this is the presence of decaying wood, staying in the area after the tree has fallen. The trunks of different dimensions and stages of decomposition offer variable microhabitats for several species wich are either rare or have specific ecological demands (Table V).

Besides species richness Table V also shows the fairly high number of species suggested for inclusion in the Hungarian Red List [18], indicating their high nature conservation values.

Thus, dead wood seems to be a key factor in the maintenance of high diversity in the forest.

Table V

Lignicolous species of the Kékes North forest reserve

Species	**RL cat.**
Agrocybe erebia (FR.) SING.	2
Antrodiella sp.	3
Antrodiella hoehnelii (BRES.) NIEMELÄ	3
Armillaria mellea s.l.	
Ascocoryne cylichnium (TUL.) KORF	
Ascocoryne sarcoides (JACQ.: FR.) GROVES & WILSON	
Auricularia auricula-judae (BULL.: FR.) WETTST.	
Auricularia mesenterica (GMEL.: FR.) PERS.	
Biscogniauxia (Hypoxylon) nummularia (BULL.: FR.) KUNTZE	
Bisporella citrina (BATSCH) KORF et CARPENTER	
Bjerkandera adusta (WILLCH.: FR.) P. KARST.	
Bolbitius reticulatus (PERS.: FR.) Rick.	3
Calocera cornea (BATSCH: FR.) FR.	3
Ceriporia purpurea (FR.) DONK	2
Chondrostereum purpureum (PERS.: FR.) POUZ.	
Clavicorona (Artomyces) pyxidata (PERS.: FR.) DOTY	2
Clitocybe lignatilis (PERS.: FR.) P. KARST.	2
Coprinus alopecia LASCH	
Coprinus disseminatus (PERS.: FR.) S. F. GRAY	
Coprinus lagopides P. KARST.	
Coprinus lagopus (FR.: FR.) FR.	
Coprinus micaceus (BULL.: FR.) KUMM.	
Coprinus picaceus (BULL. FR.) S. F. GRAY	
Coprinus plicatilis (CURT.: FR.) FR.	
Coprinus radians (DESM.: FR.) FR.	
Coprinus silvaticus PECK	
Crepidotus applanatus (PERS.) KUMM.	

Crepidotus lundellii PIL.	
Crepidotus mollis (SCHAEFF.: FR.) STAUDE	
Crepidotus variabilis (PERS.: FR.) KUMM.	
Crepidotus sp.	
Cylindrobasidion laeve (PERS.: FR.) CHAMURIS	
Dacryomyces stillatus NEES: FR.	3
Daedalopsis confragosa (BOLT.: FR.) DONK	
Datronia mollis (SOMMERF.: FR.) DONK	3
Disciotis venosa (PERS.: FR.) ARNAUD	2
Exidia glandulosa (BULL.: FR.) FR.	3
Flammulaster limulatus (FR.) WATL. ss. ORTON	2
Flammulina velutipes (CURT.: FR.) P. KARST.	
Fomes fomentarius (L.: FR.) FR.	
Fomitopsis pinicola (SWARTZ: FR.) P. KARST.	
Galerina marginata (BATSCH) KUEHN.	3
Ganoderma lipsiense (BATSCH) ATK.	
Hapalopius rutilans (PERS.: FR.) P. KARST.	
Hericium coralloides (SCOP.: FR.) S. F. GRAY	3
Hydropus subalpinus (v. HOEHN.) SING.	2
Hypholoma fasciculare (HUDS.: FR.) KUMM.	
Hypholoma lateritium (SCHAEFF.: FR.) SCHROET.	
Hypoxylon deustum (HOFF.: FR.) GREV.	
Hypoxylon fragiforme (SCOP.: FR.) KICKX	
Inonotus nodulosus (FR.) P. KARST.	4
Ischnoderma resinosum (SCHRAD.: FR.) P. KARST.	2
Laxitextum bicolor (PERS.: FR.) LENTZ	
Lentinellus cochleatus (PERS.: FR.) P. KARST.	
Lycoperdon echinatum PERS.: FR.	2
Lycoperdon pyriforme SCHAEFF.: PERS.	
Macrotyphula fistulosa (HOLMSK.: FR.) PETERSEN	2
Marasmius alliaceus (JACQ.: FR.) FR.	
Marasmius rotula (SCOP.: FR.) FR.	
Meripilus giganteus (PERS.: FR.) P. KARST.	2
Meruliopsis corium (PERS.: FR.) GINNS	4
Microcollybia cookei (BRES.) LENNOX	2
Micromphale brassicolens (ROMAGN.) P. D. ORT.	
Mycena arcangeliana BRES. (ss. MAAS GEEST.)	3

Mycena crocata (SCHRAD.: FR.) KUMM.	3
Mycena galericulata (SCOP.: FR.) S. F. GRAY	
Mycena haematopus (PERS.: FR.) KUMM.	3
Mycena polygramma (BULL.: FR.) S. F. GRAY	
Mycena renati QUÉL.	3
Omphalina epichisium (PERS.: FR.) QUÉL.	3
Oudemansiella mucida (SCHRAD.: FR.) v. HOEHN.	
Panellus stypticus (BULL.: FR.) P. KARST.	
Panus lecomtei (FR.) CORNER	3
Peniophora incarnata (PERS.: FR.) P. KARST.	4
Peziza micropus PERS.	4
Peziza sp. 1	4
Peziza sp. 2	4
Phlebia merismoides (FR.) FR.	3
Pholiota aurivella (BATSCH: FR.) KUMM.	
Pholiota squarrosa (WEIGEL: FR.) KUMM.	
Phyllotopsis nidulans (PERS.: FR.) SING.	3
Pleurotus dryinus (PERS.: FR.) KUMM.	3
Pleurotus ostreatus (JACQ.: FR.) KUMM.	
Pleurotus pulmonarius (FR.) QUÉL.	
Pluteus cervinus (SCHAEFF.) KUMM.	
Pluteus cyanopus QUÉL.	4
Pluteus ephebus (FR.: FR.) GILL.	4
Pluteus inquilinus ROMAGN.	4
Pluteus nanus (PERS.: FR.) KUMM.	4
Pluteus petasatus (FR.) GILL.	4
Pluteus phlebophorus (DITM.: FR.) KUMM.	4
Pluteus plautus (WEINM.) GILL.	4
Pluteus romellii (BRITZ.) SACC.	4
Pluteus salicinus (PERS.: FR.) KUMM.	4
Pluteus sp.	4
Pluteus thomsonii (BERK & BR.) DENNIS	4
Polyporus arcularius BATSCH: FR.	
Polyporus badius (PERS.) SCHW.	
Polyporus brumalis PERS.: FR.	
Polyporus leptocephalus JACQ.: FR.	
Polyporus squamosus (HUDS.: FR.) FR.	

Psathyrella conopilus (FR.: FR.) A. PEARS. ET DENNIS	3
Psathyrella fusca (SCHUM.: FR.) A. PEARS.	3
Psathyrella microrhiza (LASCH: FR.) KONR. & MAUBL.	3
Psathyrella murcida (FR.) V. WAVEREN	3
Psathyrella piluliformis (BULL.: FR.) P. D. ORT.	3
Psathyrella populina (BRITZ.) KITS	2
Psathyrella spadicea (SCHAEFF.) MRE.	3
Pseudoclitocybe cyathiformis (BULL.: FR.) SING.	3
Ramaria stricta (PERS.: FR.) QUÉL.	
Ramicola centunculus (FR.) VEL.	3
Rhodotus palmatus (BULL.: FR.) MRE.	2
Schizophyllum commune FR.: FR.	
Schizopora paradoxa (SCHRAD.: FR.) DONK	
Scutellinia scutellata (L.: FR.) LAMB.	4
Spongipellis pachyodon (PESR.) KOTL. et POUZ.	3
Spongiporus lacteus (FR.) AOSH. & KOBAY.	3
Spongiporus subcaesius (DAVID) DAVID	3
Steccherinum ochraceum (PERS.: FR.) S. F. GRAY	
Stereum hirsutum (WILLD.: FR.) S. F. GRAY	
Stereum rameale (PERS.: FR.) BURT.	
Stereum subtomentosum POUZ.	
Trametes cervina (SCHW.) BRES.	
Trametes gibbosa (PERS.: FR.) FR.	
Trametes hirsuta (WULLF.: FR.) FR.	
Trametes multicolor (SCHAEFF.) JÜL.	
Trametes versicolor (L.: FR.) PIL.	
Tremella mesenterica RETZ in HOOK.	
Trichaptum biforme (FR. in KLOTZSCH) RYV.	
Tubaria furfuracea (PERS.: FR.) GILL.	
Tubaria sp.	
Volvariella bombycina (SCHAEFF.: FR.) SING.	3
Xerula radicata (RELHAN: FR.) DOERF.	
Xylaria hypoxylon (L.: HOOKER) GREV.	
Xylaria polymorpha (PERS. ex MERAT) GREV.	

Key to the signs used:

RL cat.=Red List category
0= IUCN: Extinct or vanished species
1= IUCN: Critically endangered species
2= IUCN: Strongly endangered species
3= IUCN: Endangered species
4= IUCN: Lower risk, species to be preserved or potentially inclined to become endangered

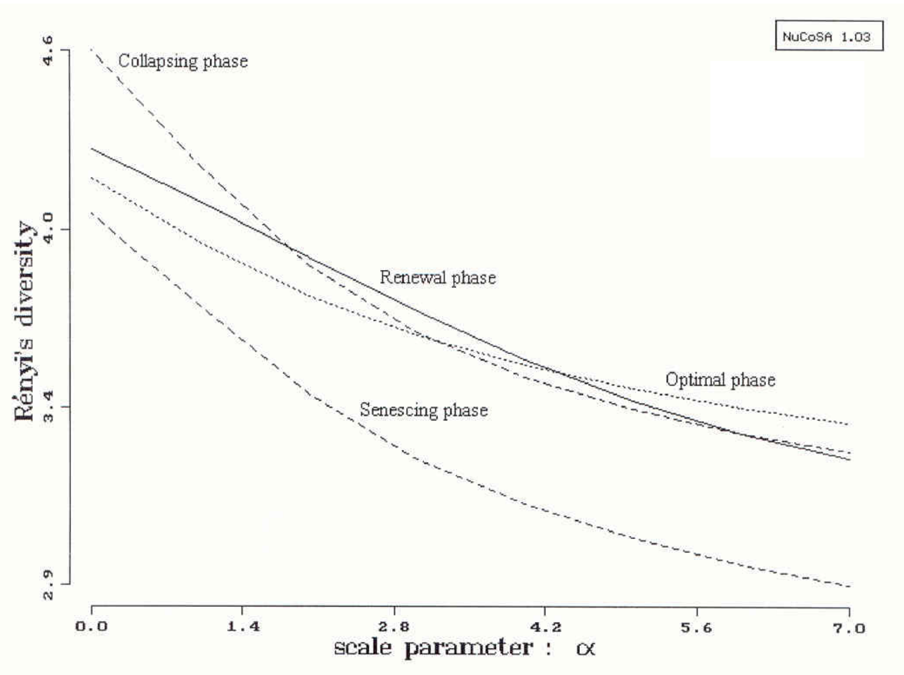

Figure 1. Diversity ordering of the total macrofungal assemblages of the renewal, optimal, senescing and collapsing phases of the *Aconito-Fagetum* plant community, respectively

Summary

Mycological investigations carried out in forest reserves are important not only for the preparation of inventories, but are also good means to reveal processes of the circulation of matter in natural forests.

There seems to be a significant correlation between the number of macrofungal species present and the developmental phases of the forests. First of all the collapsing phase is rich in lignicolous species, obviously as a result of the presence of significant amount of dead wood. Dead wood seems to be a key factor in the promotion of high diversities of macrofungal assemblages in forests. Among lignicolous macrofungi several species were found wich are either rare and/or have specific ecological demands. Some indicators of specific ecological factors have been also identified.

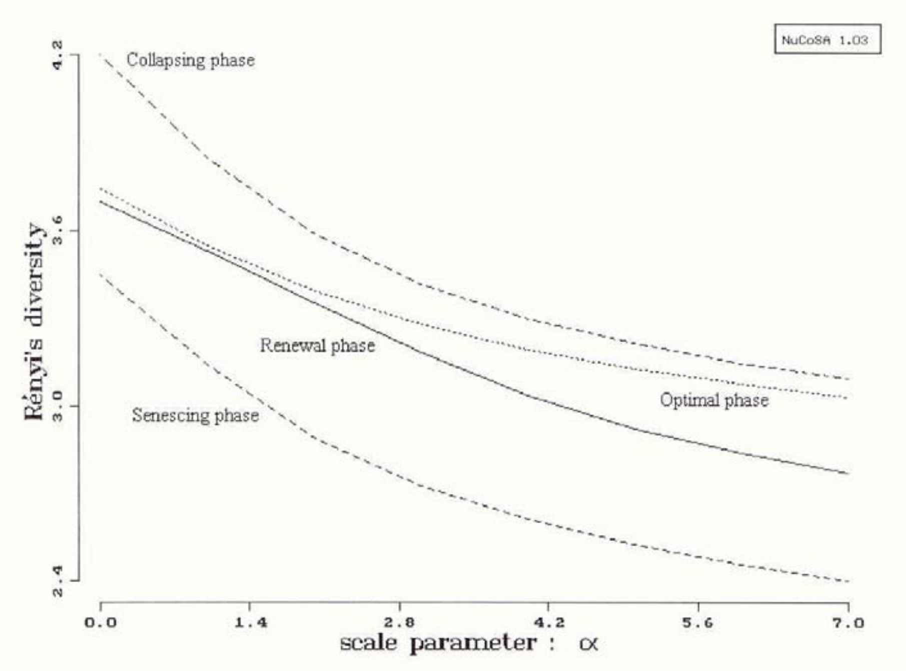

Figure 2. Diversity ordering of the xylophagous macrofungal assemblages of the renewal, optimal, senescing and collapsing phases of the *Aconito-Fagetum* plant community, respectively

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