FUNGISTICAL, ECOLOGICAL AND NATURE PROTECTION CHARACTERIZATION OF MACROFUNGI IN THE SURROUNDINGS OF SÁROSPATAK

THESES OF A PHD DISSERTATION

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INTRODUCTION, SCIENTIFIC PRECEDENTS

Sárospatak is well-known because of its historical and historico-cultural traditions, but the natural environment of it is also notable. The fungus flora in the forest associations of the Zemplén Mts. and in the Bodrogköz is also an important part of its natural values. The diversity of macrofungi is caused by the varied environmental conditions.

The Zemplén Mts. (which were previously called Eperjes-Tokaj Mts.) are situated in the north-eastern part of the Hungarian Highlands. The average height of them is between 400 and 500 m. This range of mountains was formed 12-15 million years ago. It is mostly built up of andesite, rhyolite and the tuffs of these rocks, with mainly acidic soil that have been formed on them. The major part of it belongs to the *Tokayense* floristic district inside the *Matricum* floristic area and the floristic province of the *Pannonicum*, but its north-eastern edge is situated in the floristic province of the *Carpaticum*. The lowlands of the Bodrogköz were originated at the northern border of the Great Hungarian Plain between the Tisza and the Bodrog. Its surface at the height of 90-100 m, had been formed by these rivers that left backwaters. Two thirds of this area had been covered with water habitats, but they almost disappeared by the middle of the 19th century after the river control. Its flora belongs to the *Eupannonicum* floristic region inside the floristic province of the *Pannonicum* (as the part of the *Samicum* floristic district).

The climate of this area is mostly influenced by continental effects. The mean anual temperature is 6-8 or 9 °C, the average rainfall is between 600-750 mm per year, the prevailing winds are northern and north-eastern. But these conditions are changed by many other effects that are more optimal for the macrofungi: the geographic structure of the mountains of volcanic origin, the diversity of plants or the chain of the backwaters along the river Bodrog with the remains of the former gallery forests and fennwoods. The more favourable microclimate, the variety of substrates and mycorrhizal connections also increase the diversity macrofungi.

Some mycological data have already been published from the other areas of the Zemplén Mts. (BABOS 1989, RIMÓCZI 1994, ALBERT, DIMA 2005, 2007). Even mycocoenological investigations were conducted here in 1957-58 (BOHUS, BABOS 1960, 1967). They were parts of more extensive or general researches. The only paper of that was focussed on the Zemplén Mts., was written, by KÁNYÁSINÉ (1992). It provides fungistical information about the northern part of the mountains. The mycological investigations of LAŽEBNICEK (1980) in different vertical vegetation zones of the former Czechoslovakia are also notable. There were not found any data of macrofungi from the eastern part of the Zemplén Mts. or from the Bodrogköz. Despite of these facts, the mentioned areas are completely plotted by botanical and phytocoenological surveys (HARGITAY 1939, SIMON 1977, TUBA 1994). The results of my observations between 2000 and 2008 have been published in the last 4 years.

Unfortunately, the importance of macrofungi has not become widely known yet, either nationally. Only a few experts are alive to the significance of them in the ecosystems or in the everyday life. There are many possibilities of consuming mushrooms, e.g. in the fields of silviculture, medicine, gastronomy or ecotourism. For the last few years, more and more mycologists has been pointing to the macrofungi as creatures that have become endangered in a greater extent.

The Hungarian Red List including 280 macroscopic fungus species and 5 subspecies has already been already compiled by RIMÓCZI et al. (1999). In addition 35 species of them have become protected by the 23/2005 (VIII. 31.) Kv VM Ministerial Decree (SILLER et al. 2006). The providing of the almost 3000 different species requires further and more effective steps. The most important reason of protection of macrofungi is the intensifying pollution of the environment that seriously threatens them and their habitats. The first step of preservation would be the detailed mapping of the funga. Beside the investigation of the occurrence of the different species it is also very important that exact information of their habitats and ecology would be known, especially of the endangered ones. This paper would like to complete this research in the Zemplén Mts. and in a part of the Bodrogköz. The preservation of the funga has become current because of the intensifying local and global harmful anthropogenous effects. This part of our country that has got plenty of natural values is seriously threatened by them. The wide preservation and presentation of the natural environment can be a chance in the future for the local communities in this beautiful, but conventionally poor region. The thorough knowledge and effective protection of macrofungi is a priority of this project.

OBJECTIVES

1. Collecting of mycological data, taxonomical evaluation

1.1. Identification and classification of the observed species.
1.2. Supplying the number of species in the different taxonomic groups, comparing the families.

2. Ecological and coenological evaluation

2.1. Research of the climatic conditions that influence the macrofungi of the examined area.
2.2. Monitoring of the frequent species, comparing the funga in the investigated habitats on the base of the environmental factors.
2.3. Supplying the percentage of macrofungi in the different functional groups in connection with the characteristics of their habitats.
2.4. Calculation of the data of similarity in the examined forest habitats.
2.5. Comparing and contrasting the funga of the Zemplén Mts. and of the other parts of the Hungarian Mid-Mts.

3. Nature protection and medical evaluation connected with the Hungarian Red List

3.1. Supplying the number of species in different RL categories and the list of the protected ones. Emphasizing the differences in the occurrence of some endangered macrofungi.
3.2. Comparison of the investigated habitats on the base of the red listed species.
3.3. Calculation of the percentage of the worth protecting macrofungi in the different functional groups, interpreting the reasons for it according to the environmental factors.
3.4. Supplying detailed information about the occurrence of some rare species that have been observed here.
3.5. Collection of the list of the most serious harmful effects that the macrofungi in the local habitats are threatened by, consideration of the elimination of these problems.
3.6. Proposing alternatives for the coordination of the interests of silviculture and the preservation of fungi.
3.7. Collecting the list of the detected medical macrofungi, listing the medical effects.

MATERIAL AND METHODS

Objective 1

For the collection of the mycological data the macrofungi of 5 different forest types have been investigated primarily. These forest habitats were selected because of their characteristic features and close locations that made the permanent observation possible. The field-work was carried out between the end of March, 2000 and the beginning of August, 2008; the sample areas were investigated on 127 occasions altogether. The data have been completed from other neighbouring areas and from earlier periods. (Some of them have been collected from other observers, this fact was indicated in each case.)

Dates of the field trips were as follows:

2000: 29 Mar, 28 Jun, 3, 21, 23, 25, 27 Jul, 6, 7, 17 Aug, 24, 30 Sept, 6, 7, 15, 19 Oct, 12 Nov, 14, 27, 28, 30 Dec (21 occasions).
2001: 31 Mar, 22 Apr, 16, 23, 26 Jun, 2, 6, 9, 27, 28 Jul, 2 Aug, 21, 28 Sept, 5, 6, 9, 12, 13 Oct, 18 Nov (19 occasions).
2002: 1 Feb, 7, 11, 19, 20 Jun, 2 Jul, 2,12, 14, 20, 24 Aug, 1 Sept, 9, 18, 21 Oct, 18 Nov (16 occasions).
2003: 27, 28 Sept, 3, 7, 10, 22 Oct (6 occasions).
2004: 10 Apr, 12, 13, 30 Jun, 5, 29 Jul, 5, 6, 12, 14, 24 Aug, 29 Oct (12 occasions).
2005: 27 Apr, 5, 15 May, 26 Jun, 11, 26 Jul, 10 Aug, 24 Sept, 29 Oct (9 occasions).
2006: 12 Jun, 15, 16, 19, 22, 30 Aug, 2 Sept (7 occasions).
2007: 25 Mar, 13, 17, 19, 23 Jun, 19 Jul, 19, 22, 24 Aug, 14, 21, 23, 29, 30 Sept, 14 Oct, 9, 13 Dec (17 occasions).
2008: 5 Jan, 2 Feb, 25, 28 Mar, 1, 6, 8, 12, 17, 18, 22 Apr, 18, 21, 28 Jun, 2, 21, 26, 29, 31 Jul, 4 Aug (20 occasions).

For the documentation colour slides and mostly digital photos (from 2004) of the significant amount of species have been made and taken, generally in their original habitat. (A "Zenit-E" camera with 2/58 object glass and a "Panasonic DMC-F1-K" type, 3.2 Mpixel digital camera were used, usually without flashlight.) Most of the species are proved by dried samples that were made following the modified Herpell-method which had been described by BOHUS (1960) and VASAS (1993) (They are stored in my own herbarium in Árpád Vezér Grammar School.)

The classification was based on the identifying books of MOSER (1983*a*,*b*), HANSEN and KNUDSEN (1992,1997), RIMÓCZI and VETTER (eds)(1990) and the work of PÁL-FÁM (2001). The volumes 1-8 of "Gombaválogató" (RIMÓCZI 1995, 2000, 2004, 2005*a*,*b*, 2006, 2007*a*,*b*) and the handbooks of HAGARA (1993), PHILLIPS (1981), LÆSSØE (1998), EVANS and KIBBY (2005) also helped the identification. I followed the nomenclature of BOLLMANN et al. (1996, 2007) and HORAK (2005). The geographical location of the examined areas was based on the MTB (**M**ass**t**isch**b**latt) system of BRESINSKY and DICHTEL (1971) that was adapted on B-A-Z county. (In the MTB-system the whole surface of the earth is covered with one-sixth degree of longitude × one-tenth degree of latitude rectangles.)

Objective 2

For the examination of the environmental effects the local data of precipitation and temperature have been considered. I have got the meteorological data of the measuring point ABE 566 (No 192 200) from the local office of the North-Hungarian Water Management. Each daily data of temperature and precipitation (measured at 7 a.m.) between 2000 and 2007 has been used for the calculation. The average values have been compared with the months of the appearance of macrofungi. The acidity of the soil on the sample areas has also been approximately measured. Solutions were made from the samples of soil with distilled water, and 10 cm^3 of each of them have been tested by "Macherey-Nagel" (used between pH 5.4-7) and "Merck" (used between pH 3.8-5.4) type indicator stripes.

The life forms of macrofungi have also been detected (based on the studies of ARNOLDS et al. 1995, KRIEGLSTEINER 1982, WINTERHOFF 1977), to determine them the handbook of LÆSSOE(1998) has also been used. I followed the "Coenological and ecological characteristics of macrofungi in Hungary" by RIMÓCZI (1994). (If there were more possible types of nutrition of a species: e.g. lignicolous saprobiont or necrotrophic parasite, the more characteristic one has been taken into consideration.) The registered macrofungi have been grouped on the base of their type of nutrition in each examined forest habitat and in the case of the total number of species, too.

The identifying and nomenclature of the observed forest habitats were based on the book of FEKETE et al. (eds) (1997), the "Red Book of the Hungarian Ecosystems" (BORHIDI, SÁNTA 1999), and a new floristical and coenological study about the Zemplén Mts. by SIMON (2005). (The majority of the investigated forest stands could not be found in their original state because of woodfelling. Thus the expression "habitat" was used instead of the "association" in this work.) The researched forest types were as follows:

I. An extrazonal, calcifugous hornbeam-oak forest (the original association must have been a *Luzulo-Carpinetum* Soó ex Csapody 1964)
II. A climatic chestnut oak forest with Turkey oak (*Quercetum petraeae-cerris* Soó 1963)
III. An extrazonal, calcifugous beech forest (*Luzulo nemorosae-Fagetum silvaticae* Meusel 1937)
IV. A planted, black pine-red oak forest (*Quercetum rubrae-Pinetum nigrae* cultum)
V. A gallery forest belt with the remains of the soft-wood (*Senecioni sarracenici-Populetum albae* Kevey in Borhid et Kevey) and hardwood (*Fraxino pannonicae-Ulmetum* Soó in Aszód 1934. corr. 1963) forests

Comparing their funga from the viewpoints of ecology and coenology, the study of BOHUS and BABOS (1963) and the above mentioned work of RIMÓCZI (1994) were followed. For the calculation of similarity, the Jaccard-index (c/a+b-c) has been used. (In this formula "a" and "b" mean the number of the species in the compared habitats, "c" means the number of the common species.) The comparison has also been completed by cluster-analysis using the data of 255 species by SPSS-suite (GAÁL 2004). Comparing approximately the funga of the Zemplén Mts. with the funga of the Pilis , the Visegrád Mts. and the other areas of the northern parts of the North Hungarian Mid-Mts. the works of BENEDEK (2002), TAKÁCS and SILLER (1980), SILLER et al. (2002), TÓTH (1999), RIMÓCZI (1992), RUDOLF and PÁL-FÁM (2005) and RUDOLF et al. (2008) have been used.

Objective 3

The RL categories of the endangered species have also been given, using the proposed Red List of the Hungarian Macrofungi (RIMÓCZI et al. 1999). This work is connected with the preservation of macrofungi in the EU (KOUNE 1999, DAHLBERG, CRONEBORG 2003). Its categories have been determined by the recommendation of the IUCN (= International Union for Conservation of Nature) and the ECCF (= European Council for Conservation of Fungi) meaning as follows: 1 = CR (critically endangered), 2 = EN (endangered), 3 = VU (vulnerable), 4 = LR (lower risk). The protected species have also been indicated, on the base of the list of the 23/2005 (VIII.31.) Kv VM Ministerial Decree (SILLER et al. 2006).

The number of the red listed macrofungi (including each RL category) in the investigated habitats, and of all the detected species taken into consideration have also been supplied. The proportions of the different RL categories and the endangered ones together to the total number of species and the percentages of the RL categories to the worth-protecting macrofungi have also been calculated. Both the number and the percentage of macrofungi in the different functional groups have been supplied in each RL category and among the endangered species altogether. Detailed data were given of 30 rare, worth protecting macrofungi, that have been found during the investigations. For further information about their occurrence, ecology and protection mostly the books of KRIEGLSTEINER (2000*a*,*b*, 2001, 2003) have been used.

I have got data that connected with silviculture and forest plantation from the Administrative Department of Agriculture of B-A-Z County, Sárospatak. The essential information about the "*Pro Silva*" natural methods of silviculture were based on the proceedings of the Zemplén Landscape-protection Area and of the local Zemplén Television that have been made for the courses of nature conservation. The sources of information about some anthropogenous effects were the members of the Union for the Zemplén National Park. Some data of the heavy metal content of macrofungi were taken over from the studies of VETTER (1995, 1998*a*,*b*), the data of the medicinal effects of some species originated from the publications of LELLEY (1991, 1997), SEMEREDŽIEVA, VESELSKÝ (1986), and VETTER (1993, 2000).

A short introduction of the investigated areas

3 of the 5 monitored forest habitats are situated in the valley of Hotyka Creek, 8 km north-west of Sárospatak, and 1 km of Makkoshotyka, at the south-eastern border of the Zemplén Landscape-protection Area. (MTB-code: 7695.1.) The mild acidic soil of these habitats has been formed on andesite and rhyolite or on tuffs of them. (Some data have been collected from other areas, their locations are given.)

I. An extrazonal **hornbeam-oak forest** is situated on both sides of the "Sóhaj-(Katuska)-pit" and "Nyírjes-pit" at a height of 150-200 m. The sample area is approximately 900 m long and 50-60 m wide. The underwood is poor in flowering plants, because of the dense leafage. The slopes are steep (of 40-50 degrees), they are sporadically covered with a coat of moss, and a thick layer of leaf-mould and decayed wood can be observed on the bottom. This habitat is bordered by an acacia-grove and a black pine plantation. The pH of the soil is approximately 6.0.

II. The previously mentioned area is bounded on the north and north-west by a climatic, **submontane chestnut-oak forest with Turkey oak**. It is situated on the south side of the 421 m high "Kis-Som-(Katuska)-Hill, at 200-240 m. The sample area is 250-300 m wide and 800 m long, the hillside is gently sloping, the ditches are only 3-4 m deep. It is edged with recently reafforested, clearings with hotter microclimate, the shrub stratum is considerable only here. This investigated forest is bordered by an older black pine forest (that was planted 55-60 years ago), and a 35 year old red oak forest. The pH of the soil is about 5.7.

III. A young, **submontane calcifugous beech fores**t is situated on the other side of the Hotyka Creek in the "Ölfák Valley" that opens on the road. It is an extrazonal habitat, on the northern, north-western steep (30-40 degree) slope of a hill, at the height of 160-200 m. The sample area is 300 m long and 50 m wide. The acidic (pH = 5.6) soil is indicated by the thick coat of moss, that is well-observable among the sporadic saplings of beech. Only the bottom of the slope is covered with leaf-mould, it is often half a meter thick.

IV. A **black pine-red oak forest** that was planted 35-45 years ago on the 147 m high Bot-kő Hill, 0.5 km northwards from Sárospatak. The remains of the geyser cones (as the marks of post-volcanic activity) are well-observable on the 150×200 m area. It is rather dry and wind-swept, the thin and rocky soil was formed on rhyolite-tuff that was impregnated by silicic acid, its pH is about 5.4. The saplings of the red oak in the shrub stratum increase humidity and moisture of the soil. (MTB-code: 7695.3.)

V. A **gallery forest belt** is situated on the south banks of two, 3-4 km long backwaters: the Eastern ("Berek") and the Vajdácska ("Oroly") Backwater, 0.5-1 km east of Sárospatak. (The second one belongs to the Long Forest Landscape-protection Area. The MTB-code: 7695.4.) These two neighbouring forest belts are 2500 m long, 30-50 m wide and are situated at a height of 90-100 m. They contain the remains of the soft and hardwood gallery forests. The "navvy-holes" that characterize this habitat were dug out in the second half of the 19th century as the remains of the river control. The microclimatic factors are optimally influenced by them for several reasons. The Eastern Backwater is protected against inundation, the leaf-mould from the forest belt of the Vajdácska Backwater is often carried away by floods. The soil is rich in nitrogen and is covered with floated timber in some places, the pH of it is approximately 6.5.

RESULTS AND CONCLUSIONS

Objective 1: Collecting of mycological data, taxonomical evaluation

321 taxa of macrofungi in **130** genera proved by 2114 data of occurrence have been detected in the investigated area. 21 taxa in phylum *Ascomycota*, 296 taxa in phylum *Basidiomycota* and 4 in phylum *Myxomycota* have been found. (The last ones recently have not been considered as macrofungi.) The largest number of taxa have been found in the families of *Agaricaceae* (15), *Amanitaceae* (12), *Boletaceae* (37), *Coriolaceae* (12), *Cortinariaceae* (21), *Polyporaceae* (13), *Russulaceae* (35) and *Tricholomataceae* (48). The richest genera in species were: the *Agaricus* (10), the *Amanita* (12), the *Boletus* (15), the *Cortinarius* (9), the *Lactarius* (15) and the *Russula* (20). Mostly the taxa of large and frequent families, or genera have been found on the sampling areas. On the base of the type of nutrition most of them are mycorrhizal, lignicolous saprobiont or necrotrophic parasite, thus they are frequent in forest habitats.

Objective 2: Ecological and coenological evaluation

The Zemplén Mts. and the western part of the Bodrogköz – despite the frequently observable, adverse continental climatic effects – are rich in macrofungi. The diversity means the taxonomical and ecological variety of species. It is caused basically by the geological and floristic variety of the area that are advantageous from more aspects.

- The greater humidity in the deep valleys and ditches that characterizes the mountains of volcanic origin is advantageous for the development of the fruit bodies. The diversity is increased by the short-distance differences in height.

- It is also increased by the fact that the dividing line between the *Pannonicum* and the *Carpaticum* floristic provinces can be found in the investigated area, with a more southern location, that previously has been considered (SIMON 2005). Another boundary within the *Pannonicum* between the North Hungarian Mid-Mts. (*Matricum* floristic area) and the north part of the Great Hungarian Plain (*Eupannonicum* floristic area) is also located here. Thus the vital processes and the diversity of macrofungi are positively influenced by the higher diversity of the ligneous plants as producers.

- The forest belts along the River Bodrog and its backwaters – as the remains of the former large soft- and hardwood gallery forests – are also favourable habitats for many species of macrofungi. The wide variety of the substrates, the various possibilities of the mycorrhizal connections and the higher humidity also ensure optimal conditions for the development of both the vegetative mycelium and the fruit bodies. The network of the "navvy-holes" that have been formed as the results of the river controlling works is also an important environmental factor in the water supply and conservation of these habitats. In addition, the "navvy-holes" effect the appearance of the fruit bodies of some species from the *Leccinum*, *Xerocomus* or *Morchella* genera, forming a kind of pattern and vertical distribution. They are possibly connected with the changing level of water in the soil and the different intensity of light.

The appearance of the fruit bodies – as it has been expected – primarily depended on the precipitation and the changing of temperature. Calculating the average values, the maximum in monthly rainfall (77.7 mm) was observed in June, the maximum temperature (18.8 °C) was experienced in July. The maximum number of species (190) was detected in August, despite the lower average values of precipitation and temperature in this month. This observation points to the role of other environmental factors. It also proves the fact, that longer time is required for the process of the sexual reproduction and the development of the fruit bodies in the case of the different macrofungi. Apart from the significant summer and autumnal periods, the appearance of the fruit bodies of some cold tolerating species (e.g. *Alnicola subconspersa*, *Auriculariopsis ampla*, *Flammulina velutipes*, *Hygrophoropsis aurantiaca*, *Hygrophorus hypothejus*, *Mycena epipterygia*, *Pleurotus ostreatus, Tremella mesenterica*) was often remarkable in the early winter days in the planted black pine forest and in the gallery forest belts.

The largest number of macrofungi has been detected in the investigated hornbeam-oak forest and in the gallery forest belt (177 species of 85 genera and 116 species of 69 genera). This fact was caused by the advantageous environmental factors (mentioned above) that have become the most effective here. (Firstly, the higher humidity and the wet soil as microclimatic factors; secondly, the diversity of the ligneous plants that are the possible mycorrhyzal partners of macrofungi or ensure wide variety of substrates.) A lower number of species has been detected in the investigated chestnut oak forest with Turkey oak and in the calcifugous beech forest (65 species of 30 genera and 56 species of 34 genera) because of the more extreme environmental conditions: the dryer microclimate and the more acidic soil. Despite the similarly adverse environmental factors, 77 species in 53 genera have been observed in the planted red oak-black pine forest. The most possible reason could be the diversity of the planted trees and the presence of the red oak.

By the type of nutrition: 25 % of the registered species were terricolous- and 24 % of them were lignicolous saprobiontes, the percentage of the necrotrophic parasites was 8 %. The highest proportion was the rate of the mycorrhizal ones in each investigated habitat, 43 % of the examined species altogether. The percentage of the terricolous saprobiontes was the lowest in the investigated chestnut-oak forest with Turkey oak and in the calcifugous beech forest (9 % and 11 %), simultaneously with the highest percentage of the mycorrhizal species (68 % and 61 %).

This fact proves, that these forests are less optimal habitats for the macrofungi, because the species that are connected with the roots of trees have got more optimal conditions of survival. The lignicolous saprobiontes and the necrotrophic parasites were observed with the highest percentage in the gallery forest belt (their 39 % is close to the proportion of the ectomycorrhizal macrofungi). It is related to the predominance of the soft wooded *Salix* and *Populus* species that characterize this habitat. The lowest percentage of the mycorrhizal ones (comparing with the other habitats) is caused by the soil that is rich in N (ARNOLDS 1988, KOST, HAAS 1989) and the dense undergrowth (BUJAKIEWICZ 1989).

The values of similarity of the funga in the investigated habitats have also been compared by calculation of the Jaccard-index. It was the highest (0.34) between the observed hornbeam-oak forest and the gallery forest belt. (This fact was caused by the advantageous environmental conditions and the large number of species.) The Jaccard-index was relatively high (0.3) between the chestnut oak forest and the calcifugous beech forest. It was possibly related to the ecological and coenological factors (e.g. the pH of the soil, the similar substrates and mycorrhizal partners), the distance of the habitats and the microclimatic factors were less important. The lowest values of the Jaccard-index (below 0.2) were found between the red oak-black pine plantation and the other habitats. It is due to the different ecological requirements and taxonomical characteristics of the *Pinus* species. (Further investigations are required fore the more accurate calculation of similarity.)

Comparing of the funga (of the investigated habitats) in the Zemplén Mts. with the results of different fungistical researches from other areas of the *Matricum* some important differences and similarities can also be mentioned. The number of species was much greater in the mixed, planted forests than in the beech forests as the investigations in the Pilis- and Visegrád Mts. (BENEDEK 2002) have also proved. The high percentage of the mycorrhizal species (more than 50 %) in the chestnut oak forest with Turkey oak was also similar to my observations.

The occurrence of some species that are connected with roots also depended rather on the ligneous plants as mycorrhizal partners than on the habitat. Some rare species that are characteristic of the chestnut oak forest with Turkey oak e.g. the *Boletus regius*, *B. rhodopurpureus* or the *Leccinum tessellatum* were remarkable, too. The fact, that the similarity of the funga is less determined by the geographical distance (BOHUS, BABOS 1960) has also been proved by these observations.

The investigations in the forest reserves of the Mátra and Bükk Mts. (TAKÁCS, SILLER 1980, SILLER et al. 2002) indicated the significantly higher percentage of the necrotrophic parasites and lignicolous saprobiontes (56 % altogether), than in these habitats. The most important reasons of it are the less disturbed sampling areas, by which the lignicolous macrofungi are positively influenced, ensuring decayed wood as substrate for them. The relatively higher rate of the lignicolous species in the observed gallery forests of the Bodrogköz was caused by the floated timber and the anthropogenous effects. The mycological researches in the Gyepes Valley of the Heves-Borsod Hills (TÓTH 1999) have also indicated the high percentage (exceeding 60 %) of the mycorrhizal macrofungi; simultaneously with it the low proportion of the saprobiontes in the beech forests with acidic soil covered with a thin layer of leaf-mould. According to the results of the investigations (mostly in degraded forest stands) in the Cserehát Hills (RUDOLF 2003, RUDOLF, PÁL-FÁM 2005, RUDOLF et al. 2008) the higher percentage of the terricolous saprobiontes and simultaneously the lower one of the mycorrhizal species have been found in the observed associations, caused by the anthropogenous effects. The percentages of the different life forms to the total number of species have been found almost the same. The investigated habitats of the Zemplén Mts. could be categorized in between the forest reserves of the Bükk and Mátra Mts. and the anthropogenously influenced forest stands of the Cserehát Hills on the base of the disturbance.

Objective 3: Nature protection and medical evaluation

166 of the registered species can be found on the Red List of the Hungarian Macrofungi: 25 in category 2 (EN), 101 in category 3 (VU) and 40 in category 4 (LR). The macrofungi in category 3 have been detected with the greatest percentage (61 %) among the endangered ones. (This high rate of the "vulnerable" species is generally observed in Hungary.) It is important to emphasize that almost 52 % of the detected species are endangered. Among the 35 protected macrofungi 6 species have been found: *Amanita vittadinii* (Moretti) Vittadini, *Dendropolyporus umbellatus* (Pers. : Fr.) Jülich, *Hericium erinaceus* (Bulliard : Fr.) Pers., *Strobilomyces strobilaceus* (Scopoli : Fr.) Berkeley, *Volvariella bombycina* (Schaeffer : Fr.) Singer, *Xerocomus parasiticus* (Bulliard : Fr.) Quélet.

Many species mostly in categories 2 and 3 (e.g. *Amanita caesarea*, *Artomyces pyxidatus*, *Boletus regius*, *B. pseudoregius*, *Leccinum tessellatum*, *Tremella mesenterica*) are relatively common here, but some others (e.g. *Boletus calopus*, *B. appendiculatus*, *Otidea onotica*, *Ramaria botrytis*, *Xerocomus moravicus*) are less frequent as it was expected considering their RL categories. These results of the observations are caused by the environmental factors of this area, and can give more exact data about the habitats and the frequency of the endangered species.

The greatest number of the endangered macrofungi (83 taxa) have been found in the hornbeam-oak forest. The percentage of the red listed species were the highest in the investigated chestnut-oak forest and in the calcifugous beech forest (more than 50 %). In the more disturbed habitats: in the planted red oak-pine forest and in the gallery forest belt it was significantly lower (about 41 %). The most remarkable species of the investigated habitats are as follows:

I. Hornbeam-oak forest: *Agrocybe erebia*, *Amanita caesarea, Artomyces pyxidatus, Dendropolyporus umbellatus, Lycoperdon mammiforme, Meripilus giganteus, Mutinus caninus, Otidea onotica, Pulveroboletus gentilis, Strobilomyces strobilaceus.*

II. Chestnut oak forest with Turkey oak: *Amanita caesarea, Boletus appendiculatus, B. pseudoregius, B. regius, B. rhodopurpureus, B. rhodoxanthus, B. torosus, Leccinum tessellatum, Xerocomus moravicus.*

III. Calcifugous beech forest: *Boletus calopus, B. regius, Hericium coralloides, Hydnellum compactum, Lycoperdon echinatum, Ramaria botrytis, Sarcodon imbricatus, Strobilomyces strobilaceus*.

IV. Planted red oak-black pine forest : *Antrodia albida, Mycena crocata, M.epipterygia, Tremella mesenterica.*

V. Gallery forest belt: *Agaricus bohusii, Hygrocybe psittacina, Pluteus aurantiorugosus, Verpa conica, Volvariella bombycina.*

By the type of nutrition the majority of macrofungi in category 2 were terricolous and lignicolous saprobiontes (48 % altogether) that often require special substrates, in categories 3 and 4 and among the red listed species the ectomycorrhizal ones were predominant. Comparing with the proportions of different life forms to the total number of species the percentage of the mycorrhizal species (63%) has been found much higher among the endangered macrofungi. It was possibly connected with the destruction of the calcifugous and the hardwood gallery forests as their habitats.

The anthropogenous effects that macrofungi directly or indirectly are threatened by have become more intensive recently, thus immediate steps must be taken to turn back these adverse processes. One of the most important problems is the increased gathering and export of the *Boletus aereus*, *B. edulis, B. reticulatus* and *Cantharellus cibarius* as they are the most popular species from the gastronomic aspect. Besides these macrofungi all of the rare species of the same habitats are damaged by the mushroom gatherers, especially the similar (e.g. *Boletus pseudoregius*, *Leccinum tessellatum*) or the vivid coloured (e.g. *Boletus regius*, *B. rhodopurpureus*, *B. rhodoxanthus*, *B. torosus*) species. The limitation, regulation and controlling of gathering in the case of the edible *Boletus* and *Cantharellus* species are absolutely necessary. It would be desirable to increase considerably the number of the protected species, or to have the law observed to a greater extent and more effectively in the future.

Some energetic projects that have been planned in the Zemplén Mts. in the last few years are also disquieting. Firstly, they are not prepared from the viewpoints of nature conservation and environmental protection; secondly, both the special ecosystems and their funga in this region would be drastically destroyed by them. Some of these dangerous effects – e.g. a heavy metal and cyanide containing slurry pool in the basin of the Bodrog in Slovakia – can cause international problems. This situation should be handled cautiously because of the heavy metal (e.g. Hg, Cd and Cu) accumulating ability of some macrofungi (VETTER 1995).

The reassuring solution of the problems of nature conservation and environmental protection by which the macrofungi are also damaged by requires a complex attitude, including the extension of the local people's knowledge about macrofungi and the amplification of the local organizations that are connected with them. The revival of the gastronomic traditions of this region that are rich in dishes with mushroom food connecting with other possibilities of tourism (e.g. eco-, village, and wine tourism) could promote the local tourist trade. The protection of the areas that are valuable from the viewpoint of mycology to a greater extent would also be necessary. (In this region it would be the declaration of the Zemplén Landscape-protection Areas as Zemplén National Park.)

The silviculture that has also got overriding importance in the Zemplén Mts. is connected directly with the presence of macrofungi in many different ways. The mycologists and some of the experts of silviculture have already pointed to the fact, that the forest habitats including their funga can only be preserved by the natural silvicultural treatments. The priorities of the *Pro Silva* methods: the continuous woodfelling without deforestation, the preservation of diversity and keeping the decayed wood can ensure the conservation of macrofungi.

The occurrence of 48 species of medical macrofungi has been detected from the observed areas. The data of their mostly preventive use have been found in the special literature. Their local application is not known (except that of the *Ganoderma lucidum*).

NEW SCIENTIFIC RESULTS AND CONCLUSIONS

321 species in 130 genera have been detected by the author in the north-eastern part of the Zemplén Mts. and from the western border of the Bodrogköz (mostly beside the backwaters of the Bodrog). There had not been any mycological researches carried out on the mentioned areas before. The data of 86 taxa from the Zemplén Mts. and the data of all the 130 taxa from the Bodrogköz can be considered as new information. 166 species from the Hungarian Red List of Macrofungi and 6 from the 35 protected ones have been found on the investigated areas. Among the protected species the *Amanita vittadinii* (Mor.) Vitt. from the Zemplén Mts. and the *Volvariella bombycina* (Schaeff.: Fr.) Sing. from the Bodrogköz can be considered as new data.

The author compares the funga of 5 different forest habitats: an extrazonal hornbeam-oak forest, a climatic chestnut-oak forest with Turkey oak, an extrazonal, calcifugous beech forest, a planted red oak-black pine forest and a gallery forest belt (including the remains of a soft and a hardwood gallery forests). The comparison is based on taxonomical data, types of nutrition and RL categories of the detected species, the values of similarity are also given. Connections have been found with the observed environmental and microclimatic factors.

It can be stated on the base of the investigations that the red oak and black pine that are not indigenous trees of this region (and their presence of is considered undesirable from the viewpoint of nature conservation) could be advantageous for a great number of macrofungi. Firstly, they could become possible mycorrhizal partners, secondly they can ensure adequate substrates for some saprobiontes. Besides, mostly the *Quercus rubra* influences optimally the microclimatic factors (e.g. the humidity of it). These facts are proved by the occurrence of some red listed species in the planted black pine and red oak forests nearby Makkoshotyka, or by the diversity of the planted forest of the Bot-kő Hill. The use of these species in reafforestation is proposed only to the areas that have temporarily become unfavourable for the native vegetation, the original associations cannot be substituted for them.

PUBLICATIONS WRITTEN IN THE THEME OF THE DISSERTATION

Diploma work

EGRI, K. (1988): Mikológiai megfigyelések a Zempléni-hegységben. – Szakdolgozat, ELTE-TTK, Növényökológiai és Növénytársulástani Tanszék, Budapest.

Scientific publications

EGRI, K. (2000): Különböző erdőtípusok gombavegetációjának összehasonlítása a Zempléni-hegységben és környékén. – *Acta Biol. Debrecina Suppl. Oecol. Hung*. **11**(1): 54.

EGRI, K. (2001): XIX. századi nagy magyar mikológusok a Felvidéken: Kalchbrenner Károly és Hazslinszky Frigyes. – *Mikol. Közlem., Clusiana* **40**(1-2): 145-154.

EGRI, K. (2005): Adatok Sárospatak környékének nagygombáiról. – *Mikol. Közlem.*, *Clusiana* **44**(1-2): 23-35.

EGRI K. (2007): A Zempléni-hegység védendő tinórufajai. – *Természet Világa* **138/5**: 225-226.

EGRI, K. (2007): Újabb adatok a Zempléni-hegység és a Bodrogköz veszélyeztetett nagygombáiról. – *Mikol. Közlem., Clusiana* **46** (2): 5-20.

EGRI, K. (2008): Újabb adatok ritka nagygombafajok előfordulásáról Zemplénben. – *Folia Historico-naturalia Musei Matraensis* **32**: 19-25.

Scientific publications (in press)

EGRI, K. (2008): Mycological observations in the forests of the Bodrogköz (NE Hungary). – *Thaiszia*

EGRI, K. (2008): Data about macrofungi of Zemplén (NE Hungary). – *Thaiszia*

Scientific lectures and posters

EGRI, K. (2006): Védendő nagygombák a Zemplén erdeiben. Előadások és poszterek összefoglalói, Aktuális Flóra-és vegetációkutatás a Kárpát-medencében VII. Országos Konferencia, Debrecen, 2006. 02. 24-26. *Kitaibelia* **11**(1): 46.

EGRI, K. (2006): Adatok Zemplén védendő nagygombáiról. – *Folia Historico-naturalia Musei Matraensis* **30**: 399-405. I. Zemplén-kutató Konferencia, 2006. 04. 15-16., Tokaj.

EGRI, K. (2007): Mozaikképek a bodrogközi legelők védelemre szoruló nagygomba-világáról. „Gyepterületeink védelme: kutatás, kezelés, rekonstrukció és gazdálkodás"- IV. Magyar Természetvédelmi Biológiai Konferencia, Tokaj, 2007.03.29-31. Előadások és poszterek összefoglalói , 53.

EGRI, K. (2007): Nagygombák a Bodrog-menti ártéri erdőkben. Macrofungi in the gallery forests along the river Bodrog. – Előadások és poszterek összefoglalói 330-331. Lippay János-Ormos Imre-Vas Károly Tudományos Ülésszak, 2007. 11. 7-8. Budapest

EGRI, K. (2008): Macrofungi in a planted forest on the Bot-kő Hill near Sárospatak (NE Hungary). Előadások és poszterek összefoglalói, IV. Magyar Mikológiai Konferencia, Debrecen, 2008. 05.29-31. *Acta Microbiol. et Immunol. Hung.* **55**(2): 186.

Chapter of book

EGRI, K. (2008): A Bodrogköz erdőinek gombavilágáról. In: FRISNYÁK, S., TUBA, Z.(eds): Bodrogköz: A magyarországi Bodrogköz tájmonográfiája. pp. 427-433.

Popular science

EGRI, K. (2006): Gombászösvényeken: Folyópartokon, ősszel. – *Természetbúvár* **61**(5): 47.