Diversity of wood-inhabiting fungi in natural beech forests in Transcarpathia (Ukraine): a preliminary survey

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Abstract. We found 131 species of wood-inhabiting fungi in two different beech forest types in the Carpathian Mountains of Ukraine. The corticioid and poroid aphyllophorales (Basidiomycetes) showed a remarkably high species richness. Among them species highly depending on large amounts of dead wood, especially logs for growth and fruiting, such as *Dentipellis fragilis.* The woodruff beech forests (*Galio-Fagenion*) harbour a greater number of fungal species than the fir beech forests (*Abieti-Fagenion*). These beech forests in the Carpathian Mountains provide an interesting opportunity to study the beech forests in Europe in their natural appearance, not or hardly influenced by human activity.

Key words: beech forest, Carpathian Mountains, species richness, Ukraine, wood-inhabiting fungi

Introduction

In the temperate zone of Europe, beech forests are the most important vegetation type (Ellenberg 1996). However, large parts of natural, undisturbed beech forests only remain in the Eastern part of Europe (e.g. in the Carpathian Mountains). Forest management and fragmentation have a negative impact on the natural functions of beech forests and their biodiversity (Scherzinger 1996; Küffer & Senn-Irlet 2004). Studies on species richness and composition of various organism groups in undisturbed beech forests are therefore of great interest.

Among the most important organism groups, wood-inhabiting fungi play an important role in the forest ecosystems. Either they decompose dead wood (e.g. the Corticiaceae) or they may live as parasites on living organic material, such as leaves. Studies on leaf parasitic fungi on other hosts such as oak, birch, willow, and alder showed species rich communities in the Ukrainian Carpathians (Lovas 1987, 1998, 2000). A third group lives in a mycorrhizal symbiosis with the forest trees (e.g. the genus *Tomentella*).

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In this study, we focus mainly on two groups of aphyllophoroid wood-inhabiting fungi: the corticioid and poroid basidiomycetes. However, some ascomycetes and anamorphic fungi were included as well. Among them, we may find species representative for the three major ecological groups of fungi: wood-decaying species, parasitic ones, and mycorrhiza-forming species.

Materials and Methods

The fungi were collected in the two main types of beech forests present in the Ukrainian Carpathians: the classical woodruff-beech forest of the lower montane zone (*Galio-Fagenion*) and the mixed fir-beech forests of the upper montane zone (*Abieti-Fagenion*) (Delarze *et al.* 1999). A total of 8 plots of either 50 m² (for the corticioid basidiomycetes) or 250 m² (for the other groups of fungi) were selected randomly: 5 plots in the *Galio-Fagenion* and 3 in the *Abieti-Fagenion.*

The plots were established at three localities in Transcarpathian Province, in the Western part of Ukraine in the Carpathian Mountains (Fig. 1). Two localities in the

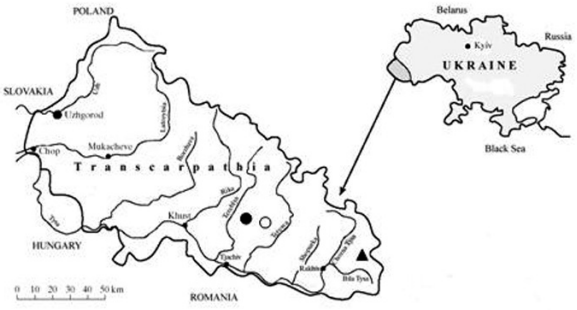

Fig. 1. The locations of the 8 plots in the Transcarpathian province of Ukraine (open circle: *Galio-Fagenion* at Shirokiy Luh; black dot: *Galio-Fagenion* at Mala Uhol'ka; triangle: *Abieti-Fagenion* at Chornohora)

Galio-Fagenion are both north of the town of Tjachiv: Shiroky Luh and Mala Uhol'ka. They are situated between 620 and 670 m and the forests are almost exclusively built by beech trees. The locality in the *Abieti-Fagenion* is situated near the town of Rakhiv, in the Chornohirskiy massive and though called Chornohora. It is situated at 1050 m. It is assumed that all three forests never have been managed.

In every plot dead woody debris, i.e. twigs and branches, including both coarse and fine woody debris (Kruys & Jonsson 1999), as well as very fine woody debris (Küffer & Senn-Irlet 2004) were checked for fungal fruit bodies. Dead woody debris with at least one visible fruit body of an aphyllophoroid basidiomycete (checked with a binocular lens) was removed for further identification.

The fungi were collected in September 2002, with a single visit at each site.

The collected fruit bodies were identified, following mostly Eriksson & Ryvarden (1973, 1975, 1976), Eriksson *et al.* (1978, 1981, 1984), Hjortstam *et al.* (1987, 1988), Jülich (1984), and Breitenbach & Kränzlin (1986). In addition, for some groups special literature was consulted, among them Kõljalg (1996) for the Tomentelloideae. The nomenclature is based on the checklist in Hjortstam (1997) for the Corticiaceae and on Ryvarden & Gilbertson (1993, 1994) for Polyporales.

Voucher specimens are deposited in ZT and UU.

Results

A total of 131 species were collected in the 8 plots. Out of these, 82 belong to the corticioid basidiomycetes and 24 are poroid basidiomycetes. Heterobasidiomycetes were represented by 7 species. 6 species are anamorphic fungi and 12 ascomycetes, mainly leaf parasites.

Tables 1, 2 and 3 list all the 131 species found in the two beech forest types.

The plots in the *Galio-Fagenion* harboured 92 species, whereas the plots in the *Abieti-Fagenion* showed a total of 78 species.

Table 1. The 113 basidiomycete species found in the 8 plots (+: found in the 250 m² plot, *: mycorrhizal species)

Basidiomycete species	Specimens in *Galio-Fagenion*	Specimens in *Abieti-Fagenion*
**Amphinema byssoides* (Pers. : Fr.) J. Erikss.	-	10
Antrodia serialis (Fr. : Fr.) Donk	-	3
Athelia acrospora Jülich	-	1
Athelia epiphylla Pers. : Fr.	-	1
Athelopsis glaucina (Bourdot & Galzin) Oberw. ex Parmasto	1	-
Basidiodendron eyrei (Wakef.) Luck-Allen	2	-
Bjerkandera adusta (Willd. : Fr.) P. Karst.	-	1
Boidinia subasperispora (Litsch.) Jülich	-	2
Botryobasidium candicans J. Erikss.	1	-
Botryobasidium laeve (J. Erikss.) Parmasto	7	-
Botryobasidium medium J. Erikss	-	2
Botryobasidium pilosellum J. Erikss.	-	10
Botryobasidium pruinatum (Bres.) J. Erikss.	4	-
Botryobasidium subcoronatum (Höhn. & Litsch.) Donk	4	8
Botryobasidium vagum (Berk. & M.A. Curtis) D.P. Rogers	3	4
Botryohypochnus isabellinus (Fr. : Fr.) J. Erikss.	-	4
Calocera cornea (Batsch : Fr.) Fr.	1	-
Ceriporia reticulata (Hoffm. : Fr.) Domański	-	1
Ceriporiopsis gilvescens (Bres.) Domański	3	-
Ceriporiopsis mucida (Pers. : Fr.) Gilb. & Ryvarden	1	1

Table 1. (continued)

Basidiomycete species	Specimens in *Galio-Fagenion*	Specimens in *Abieti-Fagenion*
Ceriporiopsis resinascens (Romell) Domański	1	-
Cristinia helvetica (Pers.) Parmasto	1	1
Daedaleopsis confragosa (Bolton : Fr.) J. Schröt.	-	+
Datronia mollis (Sommerf. : Fr.) Donk	-	1
Dentipellis fragilis (Pers. : Fr.) Donk	1	-
Exidia glandulosa (Bull. : Fr.) Fr.	-	2
Exidiopsis effusa Bref.	-	1
Exidiopsis grisea (Pers.) Bourdot & Maire	-	2
Fomes fomentarius (L. : Fr.) J.J. Kickx	6 +	2 +
Fomitopsis pinicola (Sw. : Fr.) P. Karst.	+	-
Galzinia incrustans (Höhn. & Litsch.) Parmasto	-	1
Ganoderma applanatum (Pers.) Pat.	+	+
Gloeocystidiellum karstenii (Bourdot & Galzin) Donk	-	5
Gloeocystidiellum lactescens (Berk.) Boidin	4	-
Gloeocystidiellum ochraceum (Fr. : Fr.) Donk	-	1
Hericium alpestre Pers.	-	1
Hericium coralloides (Scop. : Fr.) Pers.	1	-
Hyphoderma argillaceum (Bres.) Donk	1	5
Hyphoderma cryptocallimon B. de Vries	-	2
Hyphoderma litschaueri (Burt) J. Erikss. & Å. Strid	3	-
Hyphoderma mutatum (Peck) Donk	5	-
Hyphoderma praetermissum (P. Karst.) J. Erikss. & Å. Strid	5	3
Hyphoderma puberum (Fr. : Fr.) Wallr.	9	-
Hyphoderma setigerum (Fr. : Fr.) Donk	4	-
Hyphodontia abieticola (Bourdot & Galzin) J. Erikss.	-	1
*Hyphodontia aspera (*Fr.) J. Erikss.	-	3
Hyphodontia crustosa (Pers. : Fr.) J. Erikss.	9	2
Hyphodontia nespori (Bres.) J. Erikss. & Hjortstam	-	1
Hyphodontia sambuci (Pers. : Fr.) J. Erikss.	-	1
Hyphodontia subalutacea (P. Karst.) J. Erikss.	1	-
Hypochnicium punctulatum (Cooke) J. Erikss.	2	-
Jaapia ochroleuca (Bres.) Nannf. & J. Erikss.	-	2
Junghuhnia nitida (Fr. : Fr.) Ryvarden	1	-
Leptosporomyces mutabilis (Bres.) Krieglst.	3	-
Lobulicium occultum K.H. Larss. & Hjortstam	-	1
Megalocystidium luridum (Bres.) Jülich	2	2
Merismodes anomalus (Pers. : Fr.) Singer	2	-
Paullicorticium pearsonii (Bourdot & Galzin) J. Erikss.	-	2
Peniophora cinerea (Pers. : Fr.) Cooke	4	-
Peniophora nuda (Fr. : Fr.) Bres.	3	-
Phanerochaete affinis (Burt) Parmasto	20	-
Phanerochaete sanguinea (Fr. : Fr.) Pouzar	1	1
Phanerochaete sordida (P. Karst.) J. Erikss. & Ryvarden	19	1
Phanerochaete tuberculata (P. Karst.) Parmasto	-	15
Phanerochaete velutina (DC. : Fr.) P. Karst.	4	-
Phellinus igniarius (L. : Fr.) Quél.	+	-
Phellinus punctatus (Fr.) Pilát	+	-

Table 1. (continued)

Basidiomycete species	Specimens in *Galio-Fagenion*	Specimens in *Abieti-Fagenion*
Phlebia deflectens (P. Karst.) Ryvarden	1	-
Phlebia livida (Pers. : Fr.) Bres.	3	1
Phlebia radiata Fr. : Fr.	2	1
Phlebia rufa (Pers. : Fr.) M.P. Christ.	-	2
Phlebiella vaga (Fr. : Fr.) P. Karst.	2	4
Physisporinus sanguinolentus (Alb. & Schwein. : Fr.) Pilát	9	-
**Piloderma byssinum* (P. Karst.) Jülich	1	-
Polyporus arcularius (Batsch : Fr.) Fr.	+	-
Polyporus melanopus (Pers. : Fr.) Fr.	1	1
Polyporus squamosus (Huds. : Fr.) Fr.	+	-
Polyporus varius (Pers. : Fr.) Fr.	+	-
**Pseudotomentella mucidula* (P. Karst.) Svrček	-	1
Radulomyces confluens (Fr. : Fr.) M.P. Christ.	7	1
Resinicium bicolor (Alb. & Schw. : Fr.) Parmasto	-	1
Resinicium furfuraceum (Bres.) Parmasto	-	1
Schizopora paradoxa (Schrad. : Fr.) Donk	2	-
Schizopora radula (Pers. : Fr.) Hallenb.	1	-
Scopuloides rimosa (Cooke) Jülich	5	4
Sebacina incrustans (Pers. : Fr.) Tul. & C. Tul.	2	1
Sistotrema brinkmannii (Bres.) J. Erikss.	1	2
Sistotrema efibulatum (J. Erikss.) Hjortstam	1	-
Sistotremastrum niveocremeum (Höhn. & Litsch.) J. Erikss.	-	1
Steccherinum ochraceum (Pers. : Fr.) Gray	1	-
Stereum hirsutum (Willd. : Fr.) Gray	6 +	2 +
Stereum rugosum (Pers. : Fr.) Fr.	+	-
Subulicium rallum (H.S. Jacks.) Jülich & Stalpers	1	-
Subulicystidium longisporum (Pat.) Parmasto	1	-
**Tomentella badia* (Link) Stalpers	-	3
**Tomentella ferruginea* (Pers. : Fr.) Pat.	1	-
**Tomentella sublilacina* (Ellis & Holw.) Wakef.	4	1
**Tomentella terrestris* (Berk. & Broome) M.J. Larsen	-	2
**Tomentella umbrinospora* M.J. Larsen	1	-
Trametes hirsuta (Wulfen : Fr.) Pilát	4 +	-
Trametes versicolor (L. : Fr.) Lloyd	+	+
Trechispora cohaerens (Schwein.) Jülich & Stalpers	1	-
Trechispora farinacea (Pers. : Fr.) Liberta	1	2
Trechispora mollusca (Pers. : Fr.) Liberta	2	4
Trechispora sp.	6	-
Trichaptum fuscoviolaceum (Ehrenb. : Fr.) Ryvarden	-	1
Tubulicrinis subulatus (Bourdot & Galzin) Donk	-	1
Tulasnella violea (Quél.) Bourdot & Galzin	6	-
**Tylospora asterophora* (Bonord.) Donk	-	1
**Tylospora fibrillosa* (Burt) Donk	-	9
Tyromyces caesius (Schrad. : Fr.) Murrill	-	2
Tyromyces chioneus (Fr. : Fr.) P. Karst.	+	-
Vesiculomyces citrinus (Pers.) E. Hagstr.	4	3

Table 2. The 12 ascomycete species found in the 8 plots

Ascomycete species	Specimens in *Galio-Fagenion*	Specimens in *Abieti-Fagenion*
Coccomyces coronatus (Schumach.) De Not.	+	+
Gloeosporium fagi (Desm.) Westend.	+	-
Hypoxylon fragiforme (Pers. : Fr.) J. Kickx f.	+	+
Mamiania fimbriata (Pers. : Fr.) Ces. & de Not.	+	-
Massarina eburnea (Tul. & C. Tul.) Sacc.	-	+
Microsphaera alphitoides Griffon & Maubl.	+	+
Microsphaera divaricata (Wallr.) Lév.	+	-
Mycosphaerella ulmi Kleb.	+	-
Phyllactinia suffulta (Rebent.) Sacc.	+	+
Taphrina carpini (Rostr.) Johanson	+	-
Valsa ambiens (Pers. : Fr.) Fr.	+	+
Xylaria carpophila (Pers. : Fr.) Fr.	+	-

Table 3. The 6 anamorphic fungi species found in the 8 plots

Anamorphic fungi	Specimens in *Galio-Fagenion*	Specimens in *Abieti-Fagenion*
Cytospora leucosperma (Pers. : Fr.) Fr.	+	+
Libertella faginea Desm.	+	+
Melanconium atrum Link	+	-
Phomopsis rudis (Sacc.) Höhn.	+	-
Septoria rubi Westend.	+	-
Tubercularia vulgaris Tode : Fr.	-	+

Discussion

Considering the short period we collected in the Ukrainian beech forests (i.e. a single week) the number of fungal species found is remarkably high. During an earlier study in the same region 88 species were detected (Gorova 1979). Similar surveys in Western Europe showed fewer species, e.g. Grosse-Brauckmann (1999) found in a woodruff beech forests in Germany 155 aphyllophoroid species, however, over three years. In an extensive survey in many different forest types, including coniferous and deciduous forests, in the Region of Salzburg (Austria), Dämon (2001) found 294 species. In Belarus Yurchenko (2003) listed 281 species of non-poroid aphyllophorales, however, in various forests types and mainly out of literature sources.

A great variability of different characteristics of the dead woody debris seems to be a major factor contributing to fungal biodiversity, by creating a wide range of niches. Various volumes and diameters, i.e. logs, branches or twigs, and degree of decomposition tend to favour species rich fungal communities (Heilmann-Clausen & Christensen 2003, Küffer & Senn-Irlet 2004).

The natural beech forests of the Carpathian Mountains harbour many fungal species, which are rare in Western Europe, such as *Hericium* spp., probably due to a specific habitat loss. Thus, many of them are listed in the Red Lists of e.g. Switzerland (Senn-Irlet *et al.* 1997) or Germany (DGfM & NaBu 1992). Species depending on old and well decayed logs, such as *Dentipellis fragilis,* seem especially sensible to forest management activities. They have been found fruiting abundantly in the natural beech forests of Transcarpathia.

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