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Macrofungi in the alder forests of the Białowieża National Park

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Abstract

The aim of the present study is to analyze the macrofungi recorded in the phytocoenoses of the *Carici elongatae-Alnetum* Koch 1926 and the *Circaeo-Alnetum* Oberd. 1953 associations in the Białowieża National Park, against the background of various microforms and several types of substrate. An attempt is made to estimate (temporarily) diagnostic value of macrofungi as regards the forest types, mosaic structure of vegetation and the substrate.

The occurrence of over 30 rare and interesting macrofungi was recorded, among others: *Camarops polysperma, Holwaya mucida, Phleogena faginea, Psathyrella olympiana* and *Xylaria corniformis.*

Keywords: fungi, macrofungi, alder forests.

Introduction

In the years 1987–1991 the author participated in the team study undertaken within the Programme CRYPTO in the Białowieża National Park (Faliński 1991)[1]. The aim of that Programme was the better understanding of the role of cryptogamic plants, including over 20 various systematic groups of fungi, in the structure of forest communities.

The study have been performed on the permanent plot (V-100) of the Białowieża Geobotanical Station (forest section 256 of the Białowieża National Park). The area of 140 ha is divided into permanent squares of 1 ha (Fig. 1). The forest complex chosen for the team study is undisturbed, well preserved, shows great diversity of vegetation on relatively small area and is geobotanically well-elaborated and mapped (Rijken 1976, Faliński 1986).

[1] The Programme was sponsored by CPBP (Central Programme of Basic Investigations) 04.10.07 funds.

This contribution is dedicated to Prof. Dr. M. Moser (Innsbruck, Austria), on occasion of his 70th birthday.

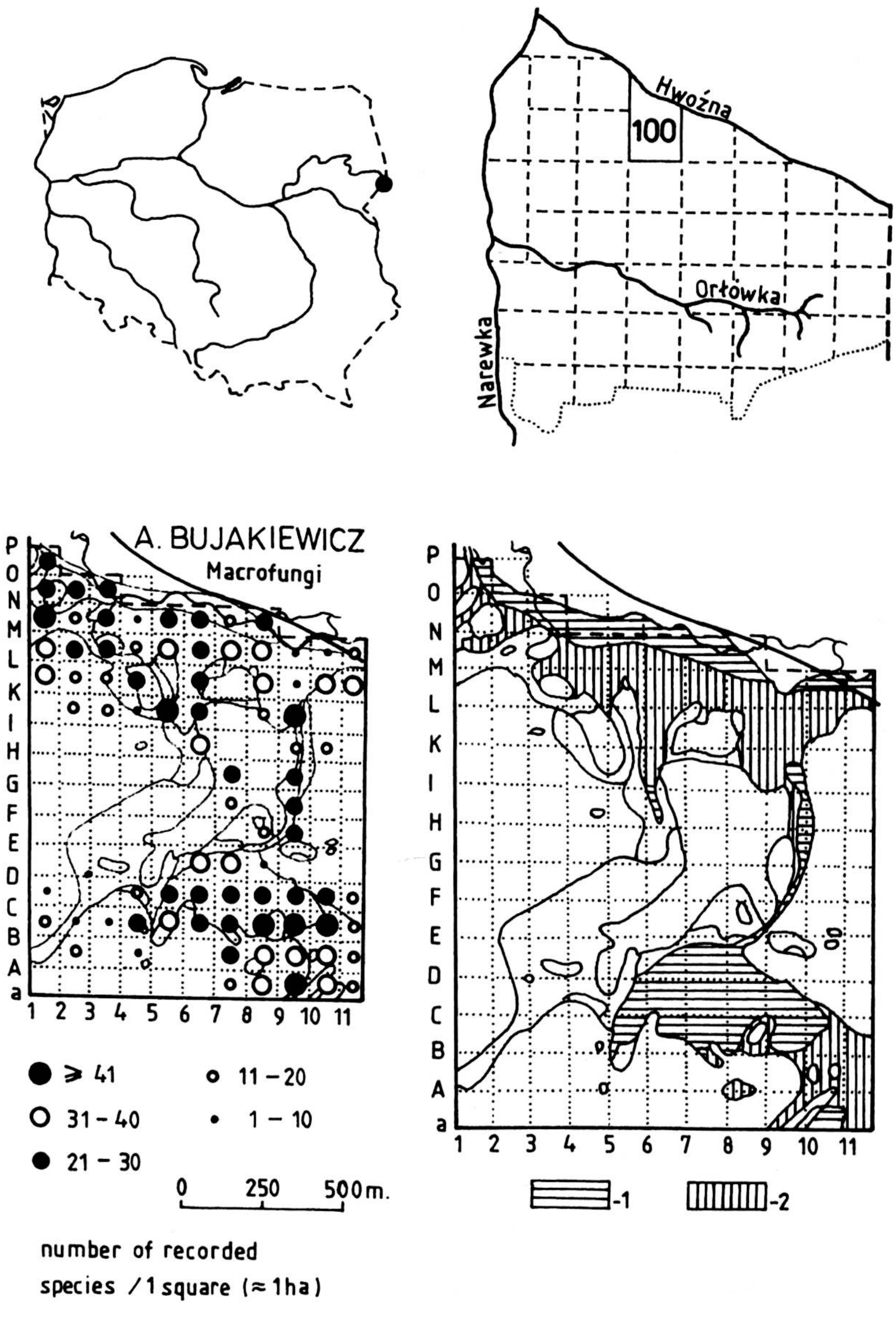

Fig. 1. Localisation of the study area in the Białowieża National Park, distribution of alder forests in a study area, 1 – Carici elongatae-Alnetum, *2 –* Circaeo-Alnetum, *individual number of recorded species/square (= 1 ha) by the author (spots indicate the total number of fungus species recorded in all forest types considered in a given square) (after Bujakiewicz et al. 1992, modified)*

One result of the team study has already been published, i. e. the checklist of 2245 taxa of 7 main systematic groups of plants and fungi, comprising 156 species of algae, provisional list of 1480 species of *Fungi* and slime molds *(Myxomycetes)*, 163 species of lichens *(Lichenes)*, 41 species of liverworths *(Hepaticopsida)*, 104 species of mosses *(Bryopsida)*, 15 species of ferns *(Pteridophyta)* and 286 species of seminal plants *(Spermatophyta)* (Bujakiewicz et al. 1992). Fungi and slime-molds were investigated by nine specialists, including four persons recording macrofungi.

The intention of present paper is to emphasize the specific character of mycoflora of the boggy alder forests studied by the author in the Białowieża Primeval Forest. The results outlined in the present paper are based exclusively on the authors own observations.

I. General characteristic of the area

The localization of the investigated area is presented on Figure 1. The Białowieża Primeval Forest lies between 23°31′ and 24°10′ W and 52°29′ and 52°54′ N, and is situated about 180 km east of Warsaw.

The Białowieża National Park covers an area of 4747 ha of which 4641 ha are forests. The Park exists since 1921 as a nature reserve, in 1932 it acquired the status of National Park which was legally established in 1947.

The terrain is flat, the average altitude is 160–165 m, the mean yearly precipitation 624 mm, the average annual temperature 6.6°C, the growing season 210 days which is 30 days shorter than in western Poland, and the snow cover lasts 50 days longer than in western Poland (Rijken mscr.).

The eastern location of the area is reflected in the occurrence of many boreal (subboreal) and continental plant species and eastern vicariants of central and western european associations. *Picea abies* occurs here in almost every forest community, and *Fagus sylvatica* is lacking.

Generally the northern part of the Park, north of the brook Orłówka is more diversified than the southern one (Fig. 1). The study area in forest section 256 is the most diversified forest of the Białowieża National Park. On the area of 140 ha 6 of the 10 associations of the forest complex are represented (Matuszkiewicz et al. 1954). 36.6% (50. 36 ha) of the area is occupied by the *Tilio-Carpinetum* association, 19.5% (26. 88 ha) by *Peucedano-Pinetum*, 14.0% (19.33 ha) by *Circaeo-Alnetum* (= *Fraxino-Alnetum*), 12.4% (17.09 ha) by *Carici elongatae-Alnetum*, 12.0% (16.59 ha) by *Pino-Quercetum* and 5.2% (7.17 ha) by *Querco-Piceetum* (Matuszkiewicz et al. 1954).

River Hwoźna forms a wide valley and consists of several small streams. The area of the basin is boggy even in dry summers. In spring and autumn water stands above the soil surface.

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II. Material and methods

The method of collecting fungi and recording data was subordinated to general rules accepted by the coordinator of the Programme CRYPTO and co-workers for all groups of plants considered. A special form was used for each square to specify the data for recorded species: forest community (6 types), frequency (3 degrees: rare, numerous, common), microhabitats (10 types), substratum (26 kinds) and remarks (Faliński 1991).

General methods accepted in the team study were not accurate enough to catch the specifity of various groups of fungi, especially fleshy ephemeral fungi. Therefore the results obtained have mostly a mycofloristic character and do not give a complete picture of the mycocoenoses of the studied alder forests. A complete picture asks for several (10–15) observations on each square with alder forest, over several years.

Studies on macrofungi occurring in alder forests were performed in the years 1987–1990, during 27 extensive field trips undertaken in various months of the growing season (8 in September, 5 in August and 5 in October, 4 in May and 4 in June and 1 in July). Recording of fungi was done in 83 squares, mostly in those where alder forests occur, i. e. in 65 squares (Tab. I, Fig. 1). The mycoflora was analysed by means of random line transects along the squares. All species recognized directly in the field were noted, type of microhabitat was established and specimens of fungi for identification in the laboratory were collected. The map on Figure 1 showing an individual number of recorded species of fungi per square by the author refers to all forest associations recognized in a given square.

The majority of squares (50 squares) were visited in four years with one visit, 12 squares were visited with two and 3 squares – with three visits only. The number of inspection days in a season and the number of seasons included, is very important for mycological studies. Since macrofungi grow throughout the year it implies that two or three visits in a year in a given square, will not cover even all common species. It should be noted that only 30 squares have been visited in the late part of the season (September, October) while only 20 squares have been inspected in the early season (May, June).

After a survey of 322 species of macrofungi recorded in the alder forests (Tab. I) 166 presumably indicative and more interesting species were selected and analysed in respect of habitat preferences (Tab. II). A distinction was made into four main ecological groups of fungi as regards substratum: terrestrial, litter, bryophilous and wood-destroying fungi. The sequence of forest associations in the Table II is in accordance with decreasing moisture and generally with increasing fertility of soils.

The presence of the species in the forest association is expressed with a number of records of a given fungus (first number in the column) and the abundance with letters in the potential exponent: r (rare), n (numerous), a (abundant) (Jahn et al. 1967).

It has not been found feasible to make statistical analyses of the material presented in this study, mainly because of the low and varied number of inspections.

The species list is largely drawn up with the nomenclature used by Dennis (1978), Jülich (1984) and Moser (1983). Herbarium specimens of the majority of the species recorded in the study area are deposited in the Herbarium of the Department of Plant Ecology and Environment Protection, Adam Mickiewicz University, Poznań, Poland (POZM).

III. Characteristics of the studied alder forests

Alder forests in Białowieża are joined by spruce *(Picea abies)* in a vegetational mosaic. They are generally characterized by stagnant water *(Carici elongatae-Alnetum)* or a very shallow depth of the ground water *(Circaeo-Alnetum).* The soils are eutrophic, mainly low moor peat soils or bog soils. pH of the soils in A_1 horizon varies between 4.0–5.5 (6.0). The soil is more acid in *Carici elongatae-Alnetum.* The concentration of the highest values of humus content in the A_1 horizon overlaps spatially with the distribution of alder forests. The same holds true for spatial distribution of the exchangeable bases content in the A_1 horizon (Rijken mscr.). Both types of alder forests have similar floristic composition, but with different frequences of some species in each of the forest associations.

1. Black alder bog forest – *Carici elongatae-Alnetum* Koch 1926

Carici elongatae-Alnetum, the most characteristic of the bog forests in the Białowieża Primeval Forest, covers 17.09 ha of the study area. It occupies the deepest part of the basin, and borders meadows along the river Hwoźna (Fig. 1).

Alnus glutinosa is the most important tree but *Picea abies* is constantly present and *Betula pubescens* is often encountered. The canopy is very open so the light penetrates to the forest floor.

There are several variants distinguished in the black alder bog forest: the variant with *Hottonia palustris,* the most typical bog alder forest for the Białowieża Forest, which occurs in the wettest areas; variant with *Veronica beccabunga* and variant with *Phalaris arundinacea.*

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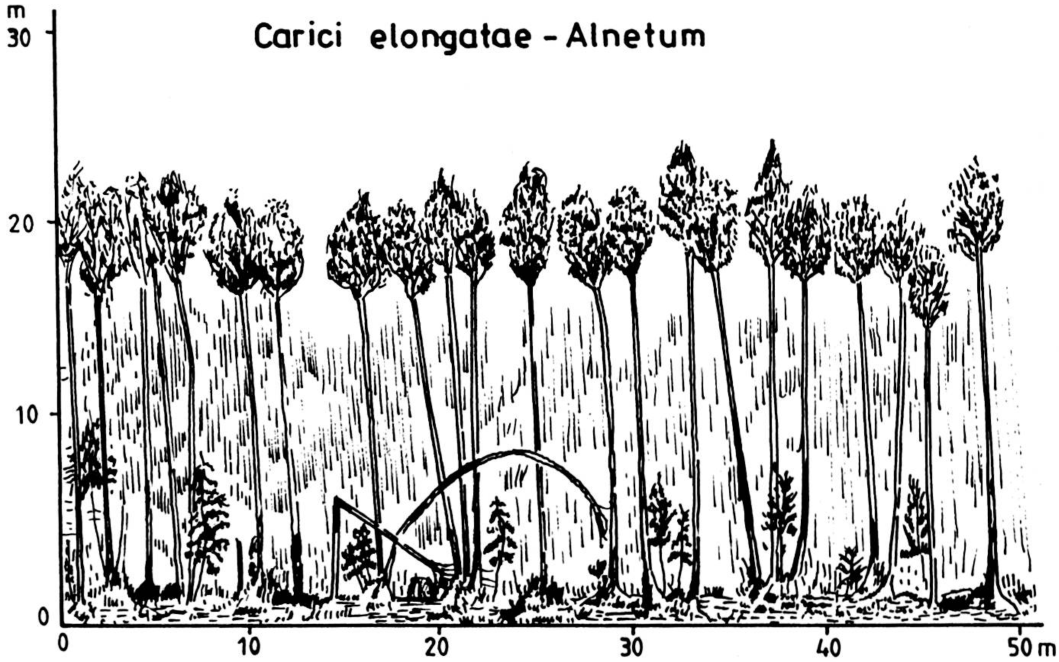

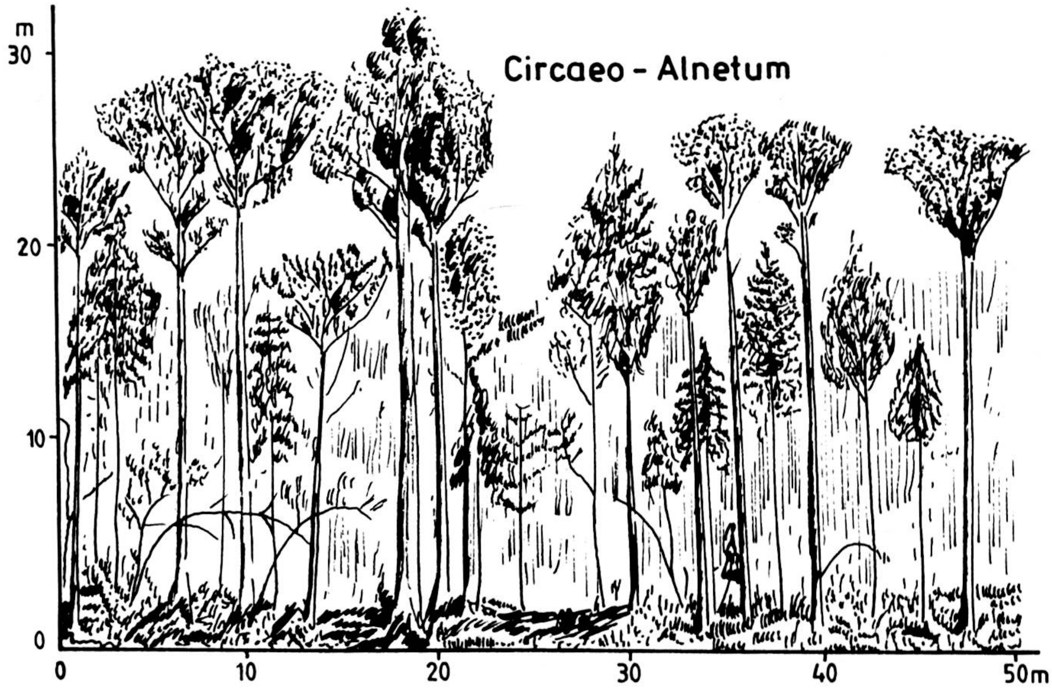

The mosaic structure of the forest is well developed only in the variant with *Hottonia palustris,* where hummocks (elevations) formed by alder and spruce stand here and there in the depressions filled with stagnant water. Hummocks and depressions develop in the result of vertical water fluctuations. Water appears on the surface in spring, at the end of summer and in the autumn.

In the depressions on a muddy black peat an eutrophic vegetation occurs of the order *Phragmitetalia,* and many ferns, as *Dryopteris thelypteris* and *D. cristata.*

The hummocks with a more acid moor peat have a deep coherent moss cover, many coniferous forest species *(Vaccinium myrtillus, Maianthemum bifolium* etc.), and the most characteristic *Carex elongata* which overgrows the peripheral parts of the hummocks and the fallen logs.

The hummocks vary in size, in height and the distance from one to another. The variant with *Veronica beccabunga* is known from only one place in the forest section (around stakes H_{10} and I_{10}), where there are no shrubs, no elevations and depressions.

The variant with *Phalaris arundinacea* links to the formerly mown *Phragmitetalia* along the Hwoźna river and has exclusively *Alnus glutinosa* in the tree layer.

2. Streamside alder-ash forest – *Circaeo-Alnetum* Oberd. 1953 (= *Fraxino-Alnetum* Mat. 1952)

Circaeo-Alnetum is a vicarious eastern form of the *Pruno-Fraxinetum* occurring in the western Europe.

The alder-ash forest occupies 19.33 ha of the study area and is concentrated mainly in the river valley. It occurs on wet, very fertile forest black soils with a horizontal movement of the ground water (Matuszkiewicz 1952).

In the tree layer *Fraxinus excelsior* and *Alnus glutinosa* dominate together with *Quercus robur, Picea abies, Acer platanoides* and seldom *Carpinus betulus* and *Tilia cordata.*

The canopy is not dense so the lower layers are luxuriant, especially a shrub layer that consists mainly of *Corylus avellana, Euonymus europaea* and *Padus avium.*

In the herb layer *Chaerophyllum hirsutum, Urtica dioica, Lysimachia vulgaris, Filipendula ulmaria* and *Cirsium oleraceum* predominate and develope profusely in June.

The association has been splited up into three main variants – variant with *Stellaria holostea,* resembling *Tilio-Carpinetum,* typical variant and variant with *Ribes nigrum,* that occurs on wettest soil. The last variant is related to *Carici elongatae-Alnetum.*

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IV. Mycoflora of the alder forests

First mycocoenological studies in Poland were performed by Nespiak (1956, 1959) just in the Białowieża National Park, among others in the *Alnetum glutinosae typicum* Meijer Dress 1936 (in forest sections 341, 345) and in the *Circaeo-Alnetum* Oberd. 1953 (in forest sections 314, 340). In the forest section 256 studies on macrofungi were performed by Nespiak (1959) only in the *Pineto-Vaccinietum myrtilli* Kobendza 1930 Br.-Bl. et Vlieger 1939.

Some data on macrofungi growing in the alder forests in the Białowieża National Park (study area in forest section 256) were included in general elaboration of the alder forests in Europe (Bujakiewicz 1989).

In the study area *Carici elongatae-Alnetum* and *Circaeo-Alnetum* are often in contact and it is difficult to avoid influence from adjoining forest types *(Tilio-Carpinetum, Pino-Quercetum* and *Querco-Piceetum).* In the *Carici elongatae-Alnetum* fungi occur numerously mainly in summer and early autumn (stagnant water in spring and autumn), while in the *Circaeo-Alnetum* carpophores can develop in spring, summer and autumn. Only in June their fruiting is usually limited by luxuriant field layer.

The most striking and distinguishing feature of the mycoflora of the studied alder forests in comparison with other forests investigated in Poland is the presence of fungi connected with conifers, especially with *Picea abies* as a host, which occurs naturally in the boreal areas, in all types of forests. The influence of *Picea* on the mycoflora of alder forests is evident in all ecological groups (Tab. II).

There is a distinct group of highly host-specific ectomycorrhizal symbionts of *Picea* which grow among mosses on hummocks in the *Carici elongatae-Alnetum* and on local mounds in the *Circaeo-Alnetum,* e.g. *Dermocybe cinnamomeolutea, D. sanguinea, Russula emetica* and *Paxillus involutus.* The latter species is a symbiont of *Picea* as well as of *Alnus* (Molina 1981).

In the boggy depressions, especially around the hummocks, ectomycorrhizal symbionts of *Alnus* grow numerously but only *Naucoria scolecina* and ?*Laccaria lateritia* are abundant. Generally the majority of ectomycorrhizal species show preferences for poor soils, on richer soils they are almost always of scattered occurrence. In the studied alder forests they form a group of rather small diversity and low abundance; 15 species are *Alnus* symbionts, 16 are confined to *Picea,* and 27 have broader host spectrum *(Betula, Picea, Pinus, Quercus, Tilia). Carici elongatae-Alnetum* is poorer in ectomycorrhizal species (28) than *Circaeo-Alnetum* (54) and is much poorer in number of species. The obtained patterns in the flora of ectomycorrhizal species call however for further considerations. Interesting observations on mycorrhiza of various black alder bog forests were performed by Truszkowska (1953).

Litter gives no special distinguishing species except *Dasycyphus controversus* which grows in masses on fallen canes of *Phragmites australis,* almost exclusively in *Carici elongatae-Alnetum* and *Typhula erythropus* common on decaying leaves mainly in *Circaeo-Alnetum.* The group of saprophytic species (humus, litter) shows less variation with respect to soil type and to tree species and generally has much broader host spectrum. There is however a very restricted number of saprophytic fungi with a clear moist habitat character dependence e.g. *Bolbitius pluteoides, Collybia cookei, Coprinus cortinatus, C. plicatilis, Daedaleopsis confragosa, Entoloma juncinum, Humaria hemisphaerica, Marasmius epiphyllus, Mycena acicula, M. renati, M. speirea, Naucoria escharoides, N. scolecina.* They prefer moist and rich habitats (Grieser 1992, Watling 1982). In the studied forests saprotrophs are mostly confined to alder but a group of saprotrophic fungi confined to conifers is also remarkable, e.g. *Entoloma rhombisporus, Hemimycena gracilis, Micromphale perforans, Marasmius androsaceus.*

Alder forests are generally well distinguished by fungi growing among mosses on hummocks in the *Carici elongatae-Alnetum* and/or on mossy logs. *Galerina vittaeformis* seems to be exclusive of the study area. A group of species, *Galerina hypnorum, Rickenella fibula* and *R. setipes,* is a constant team confined to black alder bogs in various localities (Bujakiewicz 1973, 1989).

There are several groups of wood destroying fungi that generally confirm the previous investigations on the diagnostic value of macrofungi in the alder forests. The first considers those forming durable tough carpophores on *Alnus,* among others *Inonotus radiatus, Coriolopsis extenuata* and *Stereum subtomentosum* (Bujakiewicz 1989). The occurrence of *Coriolopsis extenuata* is significant because it is considered to be a very rare fungus in the northern part of Europe, more common in southern part of the continent (Domański et al. 1967).

Another group of fungi growing on dead wood comprises fleshy fungi forming ephemeral fruitbodies *(Mycena, Bolbitius, Simocybe, Delicatula, Pluteus, Clitopilus). Mycena renati* occurs in June commonly, unlike in other lowland alder forests in Poland. According to Kubičkowa et al. (1981) it grows mainly on *Fagus* and *Carpinus* but is also recorded in the communities belonging to the alliance *Alno-Padion* Knapp. emen. Medwecka, mainly in the Carpathian region. It seems to have borealmontane distribution in Poland. It occurs also in the boreal grey alder forest in Norway. According to Kreisel (1987) *M. renati* is rare in the lowlands which has been recently confirmed by Winterhoff (1993).

Gerronema strombodes and *Psathyrella olympiana* seem to distinguish the *Carici elongatae-Alnetum.* Both species are rare in Europe, the latter one is reported from France (Waveren 1985) and recently from alder forests in Germany (Winterhoff 1993).

There is a distinct group of stromatic fungi of *Pyrenomycetes* occurring constantly on woody substrata. The most interesting are *Eutypella cerviculata, Ca-*

marops polysperma and *Xylaria corniformis*. The first one is rather common in the alder forests in Poland, however often overlooked, but two latter fungi, especially *Camarops polysperma* are very rare in Europe (Winterhoff 1993, Chlebicki et al. mscr.). Stromatic fungi have been studied in the Białowieża Forest by Truszkowska (1959).

A striking feature of the studied mycoflora is the scarce and scattered occurrence of fruitbodies expressed by low number of records. The majority of species are rarely met in records above 1 or 2 and the abundance was noted as "a" (abundant) only with 31 species out of 322. It supposedly reflects the character of the primeval alder forests where fungi usually do not grow abundantly because of the specific moisture conditions and profusely developed green vegetation. Contrary to managed forests fungi are in balance with other organisms and provide only additional characteristics to the intricate mosaic of the natural forest ecosystem. Considering number of species, number of records and number of squares (Tab. I) it is evident that the *Carici elongatae-Alnetum* has much lower values.

The correlation between number of species and the number of inspections is not quite uniform. It depends on the season of collecting, on the diversity of vegetation in a given square being in contact with alder forests etc. The differences in the occurrence of mycorrhizal species are strongly dependent on the combinations of tree species and soil types. Alder forests occurring in northern part of the permanent plot (N_8, M_6) have lower numbers of mycorrhizal species, probably because there is no *Picea* in the treestand along the Hwoźna river.

The majority of fungi occurring in the *Circaeo-Alnetum* are common with the *Carici elongatae-Alnetum* and the *Tilio-Carpinetum*. A rare fungus *Holwaya mucida* and its conidial stage *Crinula caliciformis* occurred several times in the *Circaeo-Alnetum* (Tab. II) on fallen twigs and branches of *Tilia*. It has been recently found in Switzerland in the riverside forest, most likely on *Tilia* (Roth 1991). *Phleogena faginea* grows mainly on *Carpinus* and is common in the Białowieża National Park but extremely rare outside this area (Wojewoda 1977).

Some recorded species represent a montane distribution, e.g. *Pleurocybella porrigens*, *Tricholomopsis decora* (Jahn 1969) and *Fomitopsis rosea* (Jahn 1979), while *Crepidotus applanatus*, *Dentipellis fragilis*, *Mycena laevigata* and *Pholiota scamba* are probably borealmontane in distribution (Bujakiewicz 1979, Neubert 1969). Nespiak (1959, 1953) considers as boreal also *Tephrocybe palustris (= Collybia paludosa)* and *Omphalina ericetorum (= Omphalia umbellifera)*. The latter fungus represents the group of *Basidiolichenes* (Olech 1970, Lamoure 1993).

Several more or less rare species were recorded from the study area, namely: *Bolbitius pluteoides*, *Clitopilus hobsonii*, *Cortinarius alneus*, *C. casimiri*, *Entoloma byssisedum*, *E. euchroum*, *Hericium clathroides*, *Inocybe calamistrata*, *Mycena atroalba, M. olida, Mniopetalum globisporum, Naucoria suavis, Pleurotus langei, Pluteus gracilis, P. griseopus, P. hispidulus, P. leoninus, P. pseudospileus, Polyporus melanopus and Simocybe sumptuosa.*

A detailed comparison with the results obtained by Nespiak (1959) is rather difficult and not reasonable because of the different method of studying fungi. Nevertheless Nespiak (l.c.) stresses also the highest indicative value of *Delicatula integrella, Naucoria escharoides, Rickenella setipes, Mycena rubromarginata, M. speirea and Naucoria scolecina* and the significant impact of *Picea* in the Białowieża alder forests. Contrary to Nespiak's (l.c.) results, *Circaeo-Alnetum* is much richer in macrofungi.

General comparison of mycoflora of alder forests with the other types in the study area will be presented in further publications.

Conclusions and remarks

During 1987–1990 macrofungi were investigated in the Białowieża National Park in the phytocoenoses of *Carici elongatae-Alnetum* and *Circaeo-Alnetum.*

The study area is a representative of the Białowieża Primeval Forest, with very diversified vegetation. 27 collecting field trips to the study area (mostly each trip covering different part of the forest section) yielded 1577 records on macrofungi representing 322 fungal taxa (209 *Agaricales*, 49 *Aphyllophorales*, 24 *Helotiales*, 14 *Xylariales s.l.)*, including 80 terrestrial (mycorrhizal and saprobic), 180 lignicolous, 48 occurring on litter and 14 on other substrata. The type of substratum and ectomycorrhizal connections are the most significant factors governing distributional patterns of macrofungi. The natural occurrence of *Picea abies* in the alder forests in Białowieża contributes immensely to distinguishing groups of macrofungi, both ectomycorrhizal and saprotrophic.

The habitat conditions of the natural alder forests in Białowieża turned out to be very specific for macrofungi. The growing season was much shorter in the black alder bog forest *(Carici elongatae-Alnetum)*, than in the other forest types because of the stagnant water. Eutrophic soils with well developed humus layer and a deep cover of leaves and needles nourished a very specific mycoflora with fungi forming ephemeral fruitbodies and confined to moist and fertile habitats. These two factors clearly limited the number of terrestrial fungi and above all ectomycorrhizal species, which were scarce and showed scattered occurrence. Ectomycorrhizal species contribute only 18% in the studied alder forests (in spite of the broad spectrum of host trees, e.g. *Alnus, Betula, Carpinus, Quercus, Tilia, Picea, Pinus)*, lignicolous 55%, terricolous saprobic fungi (litter and humus) 21% and others 6%.

The high number of records and degrees of abundance of the more ephemeral species *(Mycena, Bolbitius, Delicatula, Clitopilus, Pluteus, Simocybe)* reflects the high humidity conditions. Differences in humidity between *Carici elongatae-Alnetum* and *Circaeo-Alnetum* are in this case insignificant for fungi.

The wood-destroying fungi show high species diversity and the highest degree of abundance. Especially representatives of *Aphyllophorales s.l.* are very abundant, e.g. *Fomitopsis pinicola* and *Stereum hirsutum.* This group of fungi play an important part in decaying timber and contribute largely to changes and succession of the forest (Orłoś 1960). They predominate in the Białowieża National Park quantitatively and as regards ecological value almost in all forest types, mostly in *Carpinetum* and *Alnetum* (Orłoś 1961). The richness and specifity of wood-inhabitating fungi of the Białowieża National Park was also indicated and valued by Domański (1967).

The material gathered is further characterized by absence or scarce occurrence of many, elsewhere common, highly host-specific ectomycorrhizal alder symbionts, as *Russula pumila (= R. alnetorum), Lactarius lilacinus,* and *Gyrodon lividus* which are absent, and *Cortinarius bibulus* and *Lactarius obscuratus* which are sparse. The absence of *Gyrodon lividus* is significant. It seems to be more common in western Europe (Carbiener 1981) but is present also in the floodplain forests in Estonia (Kalamees 1980, Bujakiewicz 1989). *Lactarius lilacinus* was recorded from the Białowieża National Park by Nespiak (1959), but from the *Saliceto-Franguletum* association.

The same holds true for many lignicolous and terricolous species of *Coprinus, Conocybe, Cystolepiota* and *Psathyrella,* elsewhere common in alder forests and in Białowieża absent or sparsely recorded.

The fruiting, structural and distributional pattern of macrofungi in the studied alder forests must of course be interpreted with some reservations mainly because of the general methods of recording species (which imposed superficial floristic investigation) and low number of inspections.

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This contribution is dedicated to Prof. Dr. M. Moser (Innsbruck, Austria), on occasion of his 70th birthday.

Table I
Survey of data concerning macrofungi studied in alder forests in the Białowieża National Park (section 256) in years 1987–1990)

Phytosociological unit	CeA	Total number	CA
Number of squares visited	33	65	47
Number of records	592	1577	985
Number of species	194	322	281
Number of species in groups:			
Agaricales	131	209	179
Aphyllophorales s.l.	35	49	42
Auriculariales	–	1	1
Boletales	1	4	4
Dacrymycetales	2	3	3
Deuteromycetes	–	2	2
Heliotiales	11	24	22
Hypocreales	1	2	2
Lycoperdales	2	2	1
Nidulariales	–	1	1
Pezizales	2	6	5
Phacidiales	–	1	1
Sordariales	–	1	1
Tremellales	3	3	3
Xylariales s.l.	6	14	14

Explanations:
CeA – *Carici elongatae-Alnetum* Koch 1926
CA – *Circaeo-Anetum* Oberd. 1953

Table II
Macrofungi occurring in alder forests in the Białowieża National Park (section 256 in years 1987–1990)

L.f.		Alliance / Association / Number of records	Alnion CeA 488		A.-P. CA 780
		Totally		1281	
		Ground			
		Number of records	83		215
		Number of records in depressions -D on hummocks - H	D_{48}	H_{35}	
S		*Coprinus cortinatus*	1 r		
M		*Naucoria alnetorum*	5 r-n		1 r
M		*Cortinarius casimiri*	1 r		3 r
M		*Cortinarius hemitrichus*	1 r		3 r
M		*Hebeloma sacchariolens*	1 r		4 r-n
M		*Inocybe petiginosa*	1 r		5 r-n
S		*Bolbitius pluteoides*	1 r	1 r	
M		*Cortinarius alnetorum*	3 r	1 r	2 r
M		*Lactarius obscuratus*	2 r	3 r	3 r
M		*Cortinarius helvelloides*	1 r	1 r	4 r-n
M		*Cortinarius paleaceus*	1 r	2 r	6 r
M		*Naucoria scolecina*	16 n-a	3 n	18 n-a
M		*Naucoria escharoides*	13 n	3 n	16 n
M		*Lactarius theiogalus*	1 r	2 n	12 n-a
M	P	*Russula emetica*		4 n	4 n-a
M	P	*Dermocybe cinnamomeolutea*		4 n	6 n
M		*Paxilus involutus*		3 n	15 n-a
M	P	*Russula ochroleuca*		1 n	2 n-a
S		*Entoloma rhombisporum*		1 r	3 r
M	P	*Dermocybe sanguinea*		1 n	10 n-a
M		*Laccaria lateritia*		1 n	10 n-a
M		*Laccaria laccata*		2 r	7 r-n
S		*Hygrocybe miniata*		1 r	2 r
M		*Lactarius subdulcis*		1 r	2 r
M		*Laccaria proxima*		1 r	2 r
S		*Laccaria amethystina*			15 n-a
M		*Leotia lubrica*			11 n-a
S		*Humaria hemisphaerica*			9 r
M		*Cantharellus tubaeformis*			8 r-n
S		*Cyathipodia macropus*			8 r
S		*Thelephora penicillata*			7 r-n
M		*Naucoria bohemica*			5 r
M		*Laccaria tortilis*			3 r
M		*Inocybe geophylla v. viol.*			2 r
S		*Hygrocybe cantharellus*			2 r
S		*Entoloma juncinum*			2 r
M		*Cortinarius bibulus*			2 r
M		*Cortinarius alneus*			1 r

		Litter Number of records	67		134
		Mollisia amenticola	1 r		
		Dasyscyphus controversus	8 n-a		1 r
		Dasyscyphus nudipes	3 n-a		1 r
		Hymenoscyphus imberbis	2 r-n		1 r
		Coprinus plicatilis	2 r		1 r
		Mycena amygdalina	2 r-n		1 r
		Hymenoscyphus scutula	3 n-a		3 n-a
	P	*Mycena tenella*	3 r-n		4 r-n
		Mycena vitilis	2 r-n		5 r-n
		Mycena pterigena	2 n		6 n-a
		Dasyscyphus virgineus	2 n-a	1 n	1 n
		Mycena acicula	5 r-n	1 n	3 r-n
		Collybia cookei	1 n	3 r	7 r-n
	P	*Hemimycena gracilis*	1 n	3 n-a	11 n-a
		Mycena galopoda	5 r-n	1 n	16 r-n
		Mycena chlorinella	5 r-n	1 n	12 r-n
		Typhula erythropus	2 n	1 n	7 n-a
		Mycena sanguinolenta	1 r-n	9 r-n	24 r-n
		Mycena speirea	18 n-a	1 n	10 r-n
	P	*Micromphale perforans*		2 n	1 n
	P	*Marasmius androsaceus*		1 n	4 n-a
	P	*Strobilurus esculentus*		1 n	5 r-n
		Marasmius epiphyllus			5 n
		Hymenoscyphus fructigenus			3 r-n
		Marasmius bulliardi			3 r
		Mycena cyanipes			3 r
		Rustroemia luteovirescens			3 r
		Wood Durable fruitbodies of *Aphyll. s.l.* Number of records	152		173
		Merulius tremellosus	2 r-n		
		Vuilleminia comedens	2 r-n		
		Dentipellis fragilis	1 r		
		Skeletocutis nivea	1 r		
		Tyromyces stypticus	1 r		
		Polyporus ciliatus	7 r		2 r
		Inonotus radiatus	12 r-n		7 r-n
		Coriolopsis extenuata	3 r		2 r
		Stereum subtomentosum	14 n-a		10 n-a
		Daedaleopsis confragosa	4 r-n		5 r-n
		Trametes hirsuta	4 r-n		5 r-n
		Fomes fomentarius	14 n-a		11 n-a
		Polyporus arcularius	2 r-n		1 r
		Hymenochaete rubiginosa	2 r-n		3 r
	P	*Fomitopsis rosea*	1 r		2 r-n
	P	*Tyromyces caesius*	1 r		2 r-n
		Polyporus badius	1 r		3 r-n
		Bjerkandera adusta	7 r-n		11 r-n
		Schizopora paradoxa	3 n-a		12 n-a
		Ganoderma applanatum	8 r-n		18 r-n

		Stereum hirsutum	12 n-a	26 n-a
	P	*Trichaptum abietinum*	15 n-a	19 n-a
	P	*Fomitopsis pinicola*	25 n-a	29 n-a
		Schizophyllum commune		4 r-n
		Polyporus melanopus		1 r
		Stromatic fungi and anamorphs: Number of records	19	25
		Daldinia concentrica	6 r-n	1 r
		Hypoxylon multiforme	5 r-n	3 r-n
		Hypoxylon fuscum	2 n-a	2 n-a
		Hypoxylon howeianum	2 r-n	2 r-n
		Ustulina deusta	2 n	2 n-a
		Diatrype favacea	2 r-n	3 r-n
		Crinula calyciformis		5 r
		Xylaria polymorpha		3 r-n
		Xylaria corniformis		2 r
		Camarops polysperma		1 r
		Eutypella cerviculata		1 r
		Fleshy fungi: Number of records	118	152
		Gerronema strombodes	3 r	
		Hericium clathroides	2 r	
		Psathyrella olympiana	2 r	
	P	*Pleurocybella porrigens*	1 r	
		Pholiota alnicola	5 r-n	2 r-n
		Mycena niveipes	3 r-n	1 r
		Exidia plana	10 r-n	8 r-n
	P	*Hydropus marginellus*	4 r-n	2 r-n
		Ascocoryne cylichnium	3 r-n	2 r-n
		Psathyrella candolleana	4 r-n	4 r-n
		Scutellina scutellata	4 r-n	3 r-n
	P	*Mycena viridimarginata*	6 r-n	4 r-n
		Panellus serotinus	5 r-n	4 r-n
		Pholiota aurivella	3 r-n	2 r-n
		Crepidotus variabilis	2 r	2 r
		Hohenbuehelia reniformis	1 r	1 r
	P	*Tricholomopsis decora*	1 r	1 r
		Mycena olida	1 r	1 r
		Simocybe centuculus	1 r	1 r
		Simocybe sumptuosa	1 r	2 r-n
		Bolbitius reticulatus	1 r	2 r-n
		Pluteus griseopus	1 r	3 r-n
		Clitopilus hobsonii	2 r-n	4 r-n
		Mycena renati	3 n	5 n-a
		Delicatula integrella	3 n-a	7 n-a
		Mycena epipterygioides	2 r-n	5 r-n
		Galerina unicolor	10 n-a	12 n-a
	P	*Gymnopilus hybridus*	2 r-n	3 r-n
		Mycena lineata	2 r-n	3 r-n
	P	*Mycena laevigata*	4 r-n	5 r-n
		Galerina triscopa	1 r	3 r-n

		Crepidotus subsphaerosporus	1 r	3 r-n
		Mycena haematopoda	1 r	6 r-n
	P	*Xeromphalina campanella*	2 n	7 n-a
		Panellus stypticus	3 n	9 n-a
		Pluteus cervinus	4 r-n	12 r-n
		Mycena rubromarginata	5 r-n	10 r-n
		Armillaria mellea s.l.	9 r-n	13 n
		Bisporella citrina		4 n
		Mycena viscosa		3 n
		Crepidotus applanatus		2 r
		Crepidotus sphaerosporus		2 r-n
		Galerina stylifera		2 r
		Mycena purpureofusca		2 r
		Nidularia farcta		2 r-n
		Pluteus semibulbosus		2 r
		Holwaya mucida		1 r
		Phleogena faginea		1 r
	P	*Pholiota scamba*		1 r
		Pleurotus langei		1 r
		Mosses		
		Number of records	50	58
		Omphalina ericetorum	5 r-n	
		Galerina vittaeformis	6 r-n	
		Galerina stordalii	1 r	
		Galerina palustris	1 r	
		Tephrocybe palustris	2 r	1 r
		Hypholoma elongatipes	1 r-n	1 r
		Galerina atkinsoniana	1 r	1 r
		Galerina laevis	2 r	2 r
		Galerina heterocystis	1 r	2 r
		Galerina hypnorum	2 r-n	3 r
		Rickenella setipes	8 r-n	14 r-n
		Rickenella fibula	20 n	32 n-a
		Galerina pumila		1 r
		Mniopetalum globisporum		1 r

Explanations:

A-P – *Alno-Padion* alliance
CeA – *Carici elongatae-Alnetum* Koch 1926
CA – *Circaeo-Alnetum* Oberd. 1953
L.f. – life form: M – mycorrhizal (based mainly on Trappe (1962) Lange (1993)
S – saprophytic (humus, litter)
P – *Picea abies*
a, n, r – degree of abundance (Jahn et al. 1967)
a – abundant
n – numerous
r – rare