

## NEW, RARE AND ENDANGERED FUNGI IN THE BIAŁOWIEŻA PRIMEVAL FOREST (E POLAND)

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**Abstract:** The ecology and distribution of several rare and endangered basidiomycetes are briefly characterized. The paper gives the first records of *Hapalopilus croceus* (Pers.: Fr.) Donk, *Mycena megaspora* Kauffman and *Psathyrella populina* (Britzelm.) Kits van Wav. fungi for the Białowieża Primeval Forest, and the first findings of *Mycena picta* (Fr.: Fr.) Harmaja, *Phaeolepiota aurea* (Bull.: Fr.) Konrad & Maubl. and *Tubaria confragosa* (Fr.) Kühner ex Harmaja for Poland.

**Key words:** Basidiomycetes, *Corioloopsis*, *Gerronema*, *Hapalopilus*, *Hydropus*, *Mycena*, *Phaeolepiota*, *Psathyrella*, *Serpula*, *Tubaria*, ecology, chorology, Białowieża Primeval Forest

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### INTRODUCTION

About 4000 macroscopic ascomycetous and basidiomycetous fungi occur in Poland, of which as many as 1013 (25%) are on the 'Red List' of endangered species (Wojewoda & Ławrynowicz 1992). In the Białowieża Primeval Forest (later called the Białowieża Forest) the number of these fungi noted is close to 1500, including over 250 endangered ones (*ca* 17%). Many of them are species rarely or very rarely noted in Poland, sometimes relatively frequent only in the Białowieża Forest, for example *Phleogenia faginea* (Fr.: Fr.) Link, *Fomitopsis rosea* (Alb. & Schwein.: Fr.) P. Karst. or *Xylobolus frustulatus* (Pers.: Fr.) Boidin (Wojewoda 1977, 2000). The Białowieża Forest is a compact complex of the best-preserved primeval lowland forests in Central Europe. Because of the abundance of dead wood covering the forest floor, this area is a refuge for many fungi species, which are unique to this location.

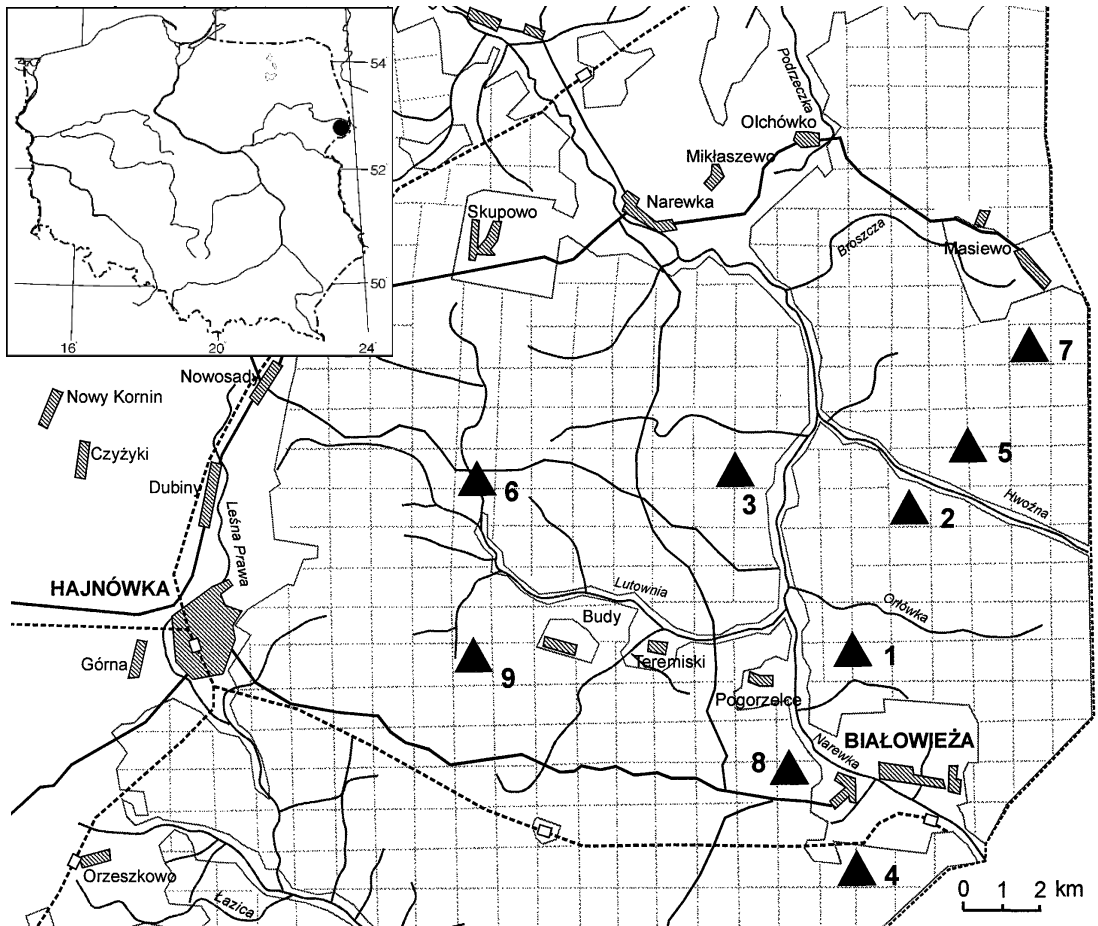
The paper briefly characterizes the distribution, biology and threats for several basidiomycete fungi. The choice of species was dictated by the rarity of their occurrence in Europe. The information is based on field study and literature data.

### BRIEF DESCRIPTION OF THE BIAŁOWIEŻA FOREST

The Białowieża Forest is a unique complex of lowland natural forest with stands of primeval origin surviving in this part of Europe. Its uniqueness is the outcome of its low degree of segmentation, huge variety of ecosystems, and high proportion of multispecies, mixed-age and multilayer tree stands. Here the biggest European mammal, the European bison, has survived after successful restitution.

The whole Białowieża Forest covers 1250 km<sup>2</sup>, 580 km<sup>2</sup> of it in Poland (Faliński 1994). It occupies the folded morainic plain on the periphery of the continental watershed of the Baltic and Black Sea. The Polish part of the Białowieża Forest is located in the Narew River basin with its main watercourse, the Narewka and its tributaries: Leśna Prawa, Hwoźna, Łutownia and Orłówka (Fig. 1). The majority of this area is in the Baltic catchment area.

According to Kondracki's (2001) physical-geographical division the Białowieża Forest is situated in the Wysoczyzny Podlasko-Białoruskie



**Fig. 1.** The Białowieża Primeval Forest, (after Faliński 1986, modified), map showing the localities used for this study: 1 and 2 – strict reserve of the Białowieża National Park (2 – forest section 256), 3 – Pogorzelce Reserve, 4 – Podolany Reserve, 5 – Wilczy Szlak Reserve, 6 – Szczekotowo Reserve, 7 – Głuszczyzna Reserve, 8 – tourist track Żebra Żubra, 9 – Dębowy Grąd Reserve.

high plains subprovince and the Równina Bielska plain mezoregion. Climatically the area is subcontinental, temperate warm and temperate humid, with mean annual temperature of  $+6.8^{\circ}\text{C}$ , mean annual precipitation of 641 mm, and a short growing season of 185 days. The mean duration of snow cover is three months (Faliński 1986).

The Białowieża Forest occupies habitats specific to the plains of the eastern part of the postglacial North European Lowland. Biogeographically this area bears the transitional character of the Boreal-nemoral zone and is dominated by mezo-

eutrophic deciduous and mixed forests, with the pronounced presence of *Picea abies* (L.) H. Karst. and the absence of *Fagus sylvatica* L. Various geographical elements are represented in the plant cover of the area, among others Boreal-Continental species such as *Betula humilis* Schrank, *Linnaea borealis* L., *Polemonium coeruleum* L. and Eurasian-Continental ones such as *Iris sibirica* L. and *Lathyrus laevigatus* (Waldst. & Kit.) Gren.

The Białowieża National Park occupies the most representative and valuable habitats of the Białowieża Forest. It is the oldest of Poland's 23

national parks, established in 1921 and covering 10502 ha, including 3224 ha within the protection zone.

The main part of the park, the strict reserve, is situated between the beds of the Hwożna and Nawarka rivers, and covers 4747 ha. This is where nature enjoys free reign and where ecological processes are entirely undisturbed. Here it is possible to observe among others the slow decomposition of dead trees occupied by various groups of organisms.

The Białowieża National Park is on the world list of Biosphere Reserves and is recognized by UNESCO as a World Heritage Site.

The Białowieża Forest has 990 species of vascular plants, 254 species of mosses, 334 species of lichens and about 2000 species of fungi recorded (Faliński 1994). The plant cover is built of 25 natural plant communities, including 16 forest and brushwood communities and 9 non-forest communities. The largest areas forest growing on brown soils are covered by mezotrophic *Tilio-Carpinetum* oak-linden-hornbeam forest, and the poorest soils (podzols) are occupied by oligotrophic *Peucedano-Pinetum* pine forest. In the river valleys, azonal *Fraxino-Alnetum* ash-alder forest occurs on boggy fertile soils. On peaty ground, *Carici elongatae-Alnetum* bog-alder forest occurs, forming a peculiar mosaic arrangement of hummocks and hollows on the forest floor.

The fungi of the Białowieża Forest are very rich but still poorly known. Many mycologists, specialists on various groups of fungi, have penetrated this Forest. The bibliography of papers on the fungi of the Białowieża Forest contains hundreds of items beginning with 19<sup>th</sup>-century mycological notes (e.g., Błoński 1888). They include taxonomical (e.g., Domański 1965), mycocoenological (e.g., Nespiaik 1959) and phytopathological works (e.g., Orłóś 1961) and a team project (CRYPTO) (e.g., Faliński & Mułenko 1992). The results of the latter give very convincing data on the number of fungi taxa occurring in the Białowieża National Park (Bujakiewicz *et al.* 1995). The team project on plants and fungi was done in forest section 256 in 1987–1991, covering 140 ha in the phytocoenoses of six different plant associ-

ations. Fourteen specialists were involved, nine of them mycologists. They recorded 1992 taxa, including 1380 taxa of fungi (70%) representing 37 orders and 482 genera. Macroscopic ascomycetous and basidiomycetous fungi were dominant (861 taxa, ca 62%). The most were basidiomycetes (607 species; 416 agaric species, 100 aphylloraceous fungi species) and ascomycetes (254 species; 122 Helotiales species). The studies demonstrated the enormous role fungi play in the forest habitat. The number of these fungi occurring in the Białowieża Forest is close to 40% of those estimated for Poland.

#### CHARACTERISTICS OF SELECTED FUNGI

##### *Corioloopsis gallica* (Fr.) Ryvarden

*Funalia gallica* (Fr.) Bondartsev & Singer

*Trametella extenuata* (Dur. & Mont.) Domański

This is a widespread species, although rare in Poland, Europe in general, in North America, North Africa and Asia (Breitenbach & Kränzlin 1986). Towards the north it is rarer, and more often met in the south of Europe (Domański *et al.* 1967). It is a saprobiont growing on wood of deciduous trees and less frequently on living trees, causing white rot (Domański *et al.* 1967). It is associated mainly with *Fraxinus* spp., and also with other hardwood trees such as *Fagus* and *Populus* (Breitenbach & Kränzlin 1986).

*Corioloopsis gallica* lives in natural alluvial ash-alder and oak-elm forests; in Germany it behaves as a thermophilous species (Kriegelsteiner 2000). Domański *et al.* (1967) noted *C. gallica* near Wisła (Beskid Śląski Mts) on *Fagus* and in Białowieża on a fallen log of *Fraxinus excelsior* L.

In Poland *Corioloopsis gallica* is not common (Gumińska & Wojewoda 1985); it has been classified as rare (Wojewoda & Ławrynowicz 1992) and is known from a few localities, some of which confirm that the species favors alluvial habitats. These localities are the Czeszewo Reserve on the Warta River in eastern Wielkopolska (Bujakiewicz 1973), Ojców National Park (Wojewoda 1974) and Radojewo near Poznań, where it was

recorded in the *Violo odoratae-Ulmetum* association in April and May 1997 and 1998 (leg. M. Jaskiewicz, det. A. Bujakiewicz, POZM). It was noted from the Kotlina Chrzanowska basin (Wojewoda 1973), Beskid Niski Mts (Fełenczak 1927, after Wojewoda 1998) and Beskid Śląski Mts (Wojewoda 1998).

In the Białowieża Forest *Corioloopsis gallica* was noted in the strict reserve of the Białowieża National Park in section 256 in the associations *Fraxino-Alnetum* and *Carici elongatae-Alnetum* (Bujakiewicz *et al.* 1992). Recently, basidiomes of this species were noted on fallen branches of *Fraxinus excelsior* in the Dębowy Grąd Reserve in *Tilio-Carpinetum* on 28 April 2000, and along the Żebra Żubra hiking trail near Białowieża (Białowieża Forest, section 426) in *Fraxino-Alnetum* on 1 May 2000 (leg. A. Bujakiewicz).

### ***Gerronema strobodes*** (Berk. & Mont.) Singer

*Chrysomphalina strobodes* (Berk. & Mont.) Singer

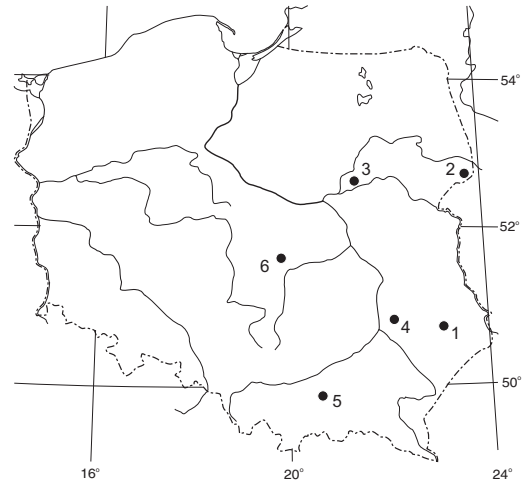
*Clitocybe xanthophylla* Bres.

*Omphalia bresadolae* Maire

*Omphalia hypoxantha* Bres.

It has been classified as a rare species (R), and rarely occurs in Europe, for example in the Czech Republic, Denmark, Finland, Italy, Norway, Romania, Switzerland (Courtecuisse & Duhem 1995) and Germany (Breitenbach & Kränzlin 1991; Krieglsteiner 1991). It is a saprobiont, producing basidiomes on dead wood in the initial and optimum phases of its decay, or grows on wood partly buried in soil, mainly on *Picea* and *Abies* (Krieglsteiner 2001).

In Poland it has been noted at six localities: Bukowa Góra Reserve, now within Roztocze National Park (Sałata 1972), Białowieża National Park, section 256 (Bujakiewicz *et al.* 1992), Jegiel Reserve north of Wyszaków (Domański 1993), Szklarnia Reserve in the Lasy Janowskie Landscape Park (Flisińska & Sałata 1998), Bukowiec Reserve in the Pogórze Wiśnickie foothills of the Outer Western Carpathians (Miśkiewicz 2000) and Kruszewiec Reserve on the Równina Piotrkowska plain (J. Szkodzik, pers. comm.) (Fig. 2). As fol-



**Fig. 2.** *Gerronema strobodes* (Berk. & Mont.) Singer – distribution in Poland (compiled from literature): 1 – Bukowa Góra Reserve, now within Roztocze National Park (Sałata 1972), 2 – Białowieża National Park (Bujakiewicz *et al.* 1992), 3 – Jegiel Reserve (Domański Z. 1993), 4 – Szklarnia Reserve (Flisińska & Sałata 1998), 5 – Bukowiec Reserve (Miśkiewicz 2000), 6 – Kruszewiec Reserve (J. Szkodzik, pers. comm.).

lows from the distribution map, in general the species has been noted in eastern Poland.

Within the Białowieża Forest *Gerronema strobodes* was reported from the Podolany Reserve, section 500, in the phytocoenosis of *Carici elongatae-Alnetum* on 3 July 2000, on a very decomposed stump of *Picea abies*. This species produces basidiomes in early summer. In July 1988 in section 256 this species was found also in *Carici elongatae-Alnetum* alder forest and at the outskirts of *Pino-Quercetum* alder forest and mixed coniferous forest (Bujakiewicz 1997).

### ***Hapalopilus croceus*** (Pers.: Fr.) Donk

*Aurantiporus croceus* (Pers.: Fr.) Kotl. & Pouzar

The species was assumed to be extinct (Ex) in Poland (Wojewoda & Ławrynowicz 1992). It was noted in the 19<sup>th</sup> century in Silesia (Schroeter 1889) and near Międzyrzec Podlaski (Eichler 1900, after Domański *et al.* 1967). Recently (1995) it was found in the Puszcza Augustowska forest [leg. E. E. Green, K(M) 30608]. Listed as

highly endangered in many countries including Slovakia (Lizoň & Bacigálová 1998), Lithuania (Matelis 1992), Germany (Benkert *et al.* 1992) and Norway, and in Sweden assumed to be extinct (Bendiksen & Høiland 1992). It has been classified in category A of the most endangered species in Europe (Ing 1993).

*Hapalopilus croceus* is a holarctic species, occurring in Europe also in the near Mediterranean zone. Also noted from Asia and North America (Krieglsteiner 2000). In the whole of Europe it is very rare, including Moravia (Černý 1966), Germany (Kreisel 1987; Gerhardt 1997), Scandinavia (Hansen & Knudsen 1997), Spain, Romania, Lithuania and Central Russia.

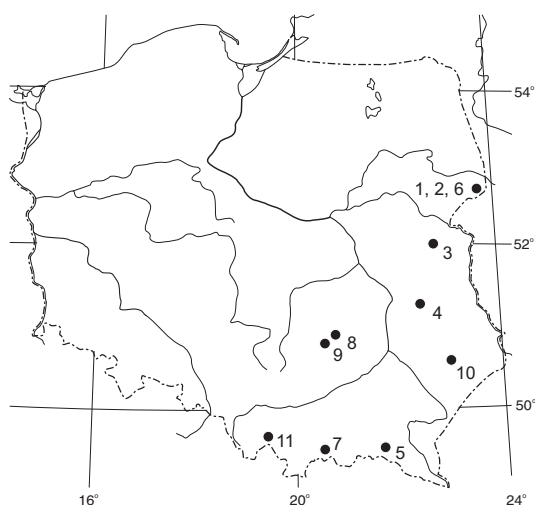
*Hapalopilus croceus* is associated with *Quercus* spp. and *Castanea* sp. as a parasite and saprobiont causing white rot of wood (Domański *et al.* 1967; Kreisel 1987). In terms of habitat it is associated with riverine forests and parks in the area of subcontinental oak-hornbeam forests, and grows on the wood of *Quercus* occurring with *Xylobolus frustulatus* and *Laetiporus sulphureus* (Bull.: Fr.) Murrill (Kreisel 1987).

In the Białowieża Forest *Hapalopilus croceus* was first noted on 13 September 2001 in forest section 666 (near Majdan) (*det.* A. Szczepkowski). This was the first observation of this rare species in over a hundred years. In Norway it has not been noted for 120 years, and in Denmark for about 60 years (Krieglsteiner 2000). The fact of its disappearance has been interpreted as related to climatic changes and the withdrawal of oak trees.

### *Hydropus marginellus* (Pers.: Fr.) Singer

This species has been classified in category E of endangered species. In Poland it has been noted rarely, at present found at 11 confirmed sites (Fig. 3). It is a mountain species (Kotłaba 1960) occurring in Europe and North America in wet and shady forests. Its basidiomes grow on logs and stumps of coniferous trees, mainly *Abies* (Wojewoda 1983; Breitenbach & Kränzlin 1991; Michael *et al.* 1977), but also *Picea* and *Pinus*. *Hydropus marginellus* is a Białowieża Forest relict, a saprobiont characterizing the terminal stage of

wood decay (Krieglsteiner 2001). The distribution of this species in Poland indicates a Boreal-mountain range. It is linked with the following associations: in the Pieniny Mts in the Carpathians with beech-fir forest (Gumińska 1972), in the Beskid Niski Mts with *Dentario glandulosae-Fagetum* and in the Wyżyna Lubelska upland with *Pino-Quercetum* (Flisińska & Sałata 1991), near Kielce with *Quercus roboris-Pinetum* (Łuszczynski 1997), in the Góry Świętokrzyskie Mts with *Tilio-Carpinetum*, *Dentario glandulosae-Fagetum* and *Abietetum polonicum* (Lisiewska 1978), and in the Babia Góra National Park with *Dentario glandulosae-Fagetum* (*leg.* A. Bujakiewicz).



**Fig. 3.** *Hydropus marginellus* (Pers.: Fr.) Singer, distribution in Poland (compiled from literature): 1, 2, 6 – Białowieża National Park (Kotłaba & Lazebniček 1967; Anonymous 1968; Bujakiewicz *et al.* 1992), 3 – Mieędzyrzec Podlaski (Eichler 1907), 4 – Świdnik near Lublin (Wyżyna Lubelska upland) (Flisińska & Sałata 1991), 5 – Iwonicz (Beskid Niski Mts) (Flisińska & Sałata 1991), 7 – Pieniny National Park (Gumińska 1972), 8 – Święty Krzyż National Park (Lisiewska 1978), 9 – Kielce (Łuszczynski 1997), 10 – Central Roztocze (Sałata 1972), 11 – Babia Góra National Park (*leg.* A. Bujakiewicz).

In the Białowieża Forest this species is found relatively frequently on dead wood of *Picea* and *Pinus*, mainly in the strict reserve of the Białowieża National Park (Anonymous 1968; Kotłaba & Lazebniček 1967; Bujakiewicz *et al.* 1992): for

example, in section 256 mainly in *Carici elongatae-Alnetum* and *Fraxino-Alnetum* (Bujakiewicz 1997), and in section 370 in *Tilio-Carpinetum* (leg. A. Bujakiewicz, POZM). In the areas neighbouring the strict reserve it was noted in *Tilio-Carpinetum* in the Pogorzelce Reserve (section 252, 27 August 1999, 29 August 2001), Podolany Reserve (section 500, 29 August 2000), Wilczy Szlak Reserve (section 194, 31 August 2000) and Szczekotowo Reserve (section 214, 30 August 2000) (leg. A. Bujakiewicz, POZM).

In the Białowieża Forest *Hydropus marginellus* is not endangered at present. In Slovakia it has been noted on *Abies*, for example in the Dobročský Primeval Forest (Kotlaba & Pouzar 1962) and has not been placed on the 'Red List' of endangered species (Lizoň & Bacigálová 1998).

#### *Mycena megaspora* Kauffman

In Poland it is classified as a vulnerable species (V). It is relatively rare (Lisiewska 1987), its distribution is not well determined yet (Krieglsteiner 2001); it occurs in Europe and North America (Smith 1947). It is a saprobiont growing in wet sites among moss and *Sphagnum* species, also on bare peat among tufts of *Molinia*, *Empetrum* and *Vaccinium*, and on burnt-out heathlands (Maas Geesteranus 1992). Interestingly, it has also been found in alder forests (Krieglsteiner 1984).

At present in Poland it is found at four localities: Święty Krzyż National Park (Lisiewska 1978, 1987), Cedynia Landscape Park (Friedrich 1994), the central Roztocze upland and Wigry National Park (Domański 1997). Recently it was found in the Babia Góra National Park at ca 1600 m a.s.l. in phytocoenoses of *Vaccinietum myrtillii* and *Empetro-Vaccinietum* (leg. A. Bujakiewicz, POZM), supporting the suggestion of the mountain character of the species (Svrček 1956).

In the Białowieża Forest *Mycena megaspora* was noted for the first time in the Głuszec Reserve in section 135 in the phytocoenosis of *Vaccinio uliginosi-Pinetum* in August 1999 and 2000 (leg. A. Bujakiewicz, POZM). This rare and interesting species is threatened by all kind of changes leading to lowering of the water table. For this reason

it is highly threatened in Germany (Benkert *et al.* 1992; Krieglsteiner 2001).

#### *Mycena picta* (Fr.: Fr.) Harmaja

*Mycena picta* is the only representative of the section *Pictae* (A. H. Sm.) Maas Geesteranus. This species is distinguished by its cylindrical pileus with a distinct central depression, broad, distant, slightly decurrent gills covered with ellipsoid, clavate and diverticulate cheilocystidia and amyloid spores (Fig. 4).

*Mycena picta* rarely has been noted in the temperate zone of Europe and North America (Breitenbach & Kränzlin 1991; Hansen & Knudsen 1992; Krieglsteiner 2001). In Europe it has been reported from Finland (Harmaja 1979) and

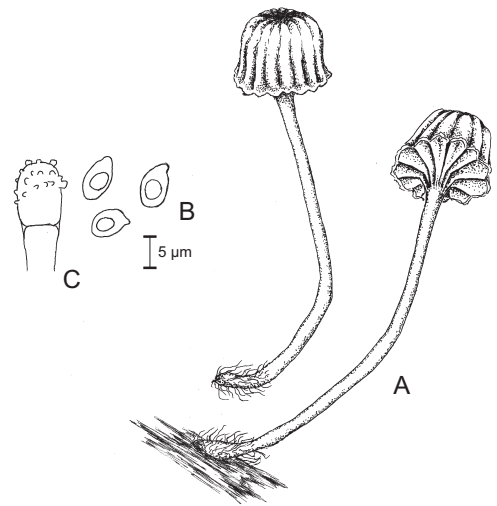


Fig. 4. *Mycena picta* (Fr.: Fr.) Harmaja: A – basidiome, B – spores, C – cheilocystidium, orig. (drawn by Joanna Borkowska).

other Scandinavian countries (Hansen & Knudsen 1992; Bujakiewicz 1993), Holland (Arnolds *et al.* 1995), Germany (Krieglsteiner 1981, 1991, 2001) and Switzerland (Breitenbach & Kränzlin 1991). It occurs in deciduous and mixed forests in litter, on dead wood and on the trunks of living trees such as *Fagus* (Breitenbach & Kränzlin 1991).

*Mycena picta* has not been noted in Poland previously. In the Białowieża Forest it was found along the Żebra Żubra hiking trail near Białowieża, Białowieża Forest Range, section 426 in the phytocoenosis of *Fraxino-Alnetum* on a dry but standing *Alnus glutinosa* (L.) Gaertn. among mosses (*Hypnum cupressiforme*, *Isoetecium alopecuroides*) at a height of ca 70 cm, 31 August 2001 (leg. A. Bujakiewicz, POZM). The microscopic characters of the collected specimen agree with the description by Maas Geesteranus (1992). This site of occurrence confirmed earlier reports of finding this species in alder forest habitats mentioned from Holland (Krieglsteiner 1981) and Norway (Bujakiewicz 1993).

Its broad ecological spectrum, variation of morphological and microscopic features and rarity of occurrence has prompted discussion of its taxonomic classification, finally clarified by Maas Geesteranus (1992). *Mycena picta* is included in the red lists of Holland (Arnolds 1989), Germany (Benkert *et al.* 1992) and Norway (Bendiksen & Høiland 1992). In Poland this species should be classified as vulnerable (V).

***Phaeolepiota aurea* (Bull.: Fr.) Konrad & Maubl.**

*Agaricus aureus* Bull.: Fr.

*Pholiota aurea* (Bull.: Fr.) P. Kumm.

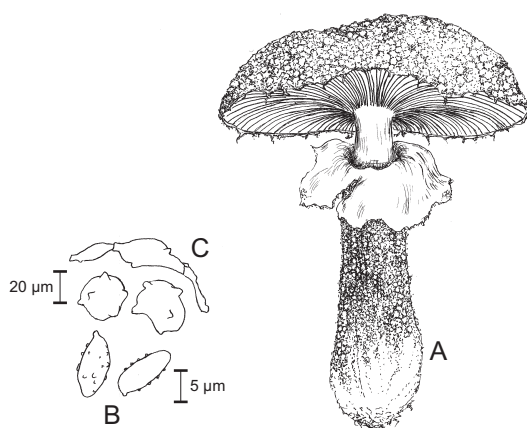
*Pholiota vahlii* (Schumach.: Fr.) J. E. Lange

It is odd that this fungus, with its large and beautifully colored basidiomes, has not been noted in Poland before (Skirgiełło 1977) (Fig. 5). A locality of '*Pholiota aurea* Pers.' from the Kórnik National Forest Inspectorate is given by Zaleski and Golenia (1954), but the habitat given (close connection with *Pinus sylvestris* stump) make the identification rather uncertain. In Europe it is very rare (Courtecuisse & Duhem 1995) for example in Germany (Kreisel 1987; Krieglsteiner 2001), Slovakia (Lizoň 1983) and Lithuania (Urbonas 1999). In Denmark, on the British Isles and in Ireland it is noted more frequently and often subcaespitose (Watling & Gregory 1993). In the temperate zone of the Northern Hemisphere it occurs also in Asia and North America (Michael *et al.* 1981). *Phaeolepiota aurea* is associated with anthropogenic

habitats (parks, cemeteries, roadside verges, gardens, pastures) (Krieglsteiner 2001) and only on the British Isles and in Germany it is recorded in deciduous and mixed forests, and sometimes in grass communities (Michael *et al.* 1981; Watling & Gregory 1992). It is a saprobiont associated with habitats rich in nitrogen compounds and often found together with *Urtica dioica* L. and *Sambucus* (Krieglsteiner 2001). Gerhardt (1995) associates this species with acidic soil, while Michael *et al.* (1981) mentions its occurrence in open deciduous and coniferous forests, in particular in ash-alder forests.

*Phaeolepiota aurea* was noted in Białowieża in the Palace Park near the Nature Education Center of the Białowieża National Park, among grass, on 20 September 1998 (leg. B. Jaroszewicz, det. A. Bujakiewicz).

*Phaeolepiota aurea* has been classified as an endangered species in Holland (Arnolds 1989). It has been claimed to be edible (Courtecuisse & Duhem 1995) although it should not be eaten (Gerhardt 1995). There have been cases of poisoning in North America caused by this fungus (Watling & Gregory 1993). Because of the large size and beauty of the basidiomes it is much desired



**Fig. 5.** *Phaeolepiota aurea* (Bull.: Fr.) Konrad & Maubl. A – basidiome (drawn by Joanna Borkowska), B – spores, C – cells of cup veil (after Watling & Gregory 1993).



and collected, so in Poland it has been suggested for classification as at least rare (R).

***Psathyrella populina*** (Britzelm.) Kits van Wav.

*Psathyrella sylvestris* (Gillet) Moser *sensu auct.*

This species represents the subgenus *Lacrimaria* (*Lacrymaria* Pat.) with a characteristic imbricate-scaly and appendiculate pileus, rhomboidal or triangular spores, and preference for logs of broadleaf trees. *Psathyrella populina* is rare in Europe and North America (Michael *et al.* 1977, 1981; Kits van Waveren 1985; Baumann & Brunelli 1987; Arnolds *et al.* 1995; Hansen & Knudsen 1992; Courtecuisse & Duhem 1995; Urbonas 1999).

It is a saprobiont associated mainly with *Populus* spp. as well as wood of other trees such as *Betula*, *Salix* (Kreisel 1987) and *Fagus* (Kits van Waveren 1985). In Germany it has been noted mainly in mountains (Michael *et al.* 1981; Krieglsteiner 1991). In Poland *Psathyrella populina* has been noted only in the Nowa Wieś Reserve (Wysoczyzna Łoczevska high plain) in a phytocoenosis of *Tilio-Carpinetum stachyetosum* (Ławrynowicz 1973).

In the Białowieża Forest this species was noted in the Wilczy Szlak Reserve, section 194C, in a phytocoenosis *Fraxino-Alnetum*, 28 August 2001 (*leg.* A. Bujakiewicz, POZM). Basidiomes grew on a log of *Fraxinus excelsior* and directly on the ground among wood remains.

*Psathyrella populina* has been included in the red list of endangered fungi in Sweden (*An annotated red data list of fungi from Sweden* 1991). In Poland this species should be placed on the red list as at least rare (R).

***Serpula himantoides*** (Fr.) P. Karst.

This species has been classified as threatened with extinction in Poland (Wojewoda & Ławrynowicz 1992), and although after World War II a few new localities of its occurrence were found (e.g., Kinelska & Roślik 1959; Domański 1963; Bujakiewicz & Fiebich 1993; Piątek & Nabożny 2000) it is still threatened. The only argument against this classification is that it is difficult to

find or easy to overlook. There is a high risk of destroying the population of this fungus because it is a much-desired specimen in mycologist's collections. *Serpula himantoides* is found in well-preserved forests and grows on dead wood of mainly coniferous trees. Because of the frequent practice of removing dead timber from forests, the habitat of this species is disappearing. Therefore this species should be still considered as undangered. It is a saprobiont occurring in Europe, for example in Austria, Germany and Scandinavia (Jülich 1984).

This species does not seem to be associated with the phytocoenosis of a certain forest association, but with aging, freely decaying wood. It causes brown rot, and according to Krieglsteiner (2000) characterizes the late stage of the initial phase and the optimum phase of this decay, although Kreisel (1961) claims that it can also be a parasite.

In the Białowieża Forest *Serpula himantoides* was noted for the second time (Anonymous 1968) on 2 September 2000 in the strict reserve of the Białowieża National Park in forest sections 398C and 399C in phytocoenoses of *Tilio-Carpinetum* on root systems of fallen *Picea abies* (*leg.* A. Bujakiewicz, *det.* M. Piątek, KRAM).

***Tubaria confragosa*** (Fr.) Kühner *ex* Harmaja

*Pholiota confragosa* (Fr.) P. Karst.

*Phaeomarasmium confragosus* (Fr.) Singer

The species has not been noted in Poland previously. In Central Europe it is very rare, for example in Schwarzwald (Gerhardt 1997). According to Courtecuisse and Duhem (1995) it is rare or very rare in Austria, the Czech Republic, Denmark, Finland, France, Germany, Great Britain, Holland, Norway, Romania, Russia, Sweden and the Ukraine. In Northern Europe it is more frequently noted (Moser 1983) and associated with dead wood of deciduous trees (Hansen & Knudsen 1992). It also occurs in Lithuania (Urbonas 1999). It is a saprobiont growing mainly on *Betula* and *Populus*, less frequently on *Alnus* and *Fagus* (Moser 1983; Dähncke & Dähncke 1982). Gerhardt (1997) describes it as a Boreal-mountain





**Fig. 6.** *Tubaria confragosa* (Fr.) Kühner ex Harmaja, a boreal, wood-dwelling fungus (photo Anna Bujakiewicz).

element. It has been noted from Finland growing on fallen branches of *Alnus glutinosa* in the phytocoenosis of the *Lysimachio-Alnetum* association (Brzeg *et al.* 1993; Wojterska *et al.* 2000).

The species has been reported from North America where it grows on dead wood of deciduous and coniferous trees in the Great Lakes region and along the Pacific coast (Smith & Hesler 1968).

In the Białowieża Forest *Tubaria confragosa* was noted in section 419 (Zwierzyniec) in September 2000 and in section 666 (Majdan) in September 2001 (*leg.* A. Bujakiewicz, POZM). The specimens from the Białowieża Forest were characterized by a distinct membranous and permanent whitish ring and the development of 6–8 basidiomes in clusters (Fig. 6). In the Białowieża Forest *T. confragosa* seems not to be rare, but in the country it should be classified as vulnerable (V) and placed on the red list.

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## REFERENCES

- AN ANNOTATED RED DATA LIST OF FUNGI FROM SWEDEN. 1991. *Windahlia* **19**: 87–130.
- ANONYMOUS 1968. Compte-rendu du IV-ème Congrès des Mycologues Européens, Warszawa 1966. *Acta Mycol.* **4**(2): 181–198.
- ARNOLDS E. 1989. A preliminary red data list of macrofungi in the Netherlands. *Persoonia* **14**(1): 77–125.
- ARNOLDS E., KUYPER T. W. & NOORDELOOS M. E. 1995. Overzicht van de Paddenstoelen in Nederland. Nederlandse Mycologische Vereniging, Den Haag.
- BAUMANN P. & BRUNELLI F. 1987. Ein wenig bekannter Saumpilz: *Psathyrella populina*. *Schweiz. Z. Pilzk.* **9**(10): 170–174.
- BENDIKSEN E. & HØILAND K. 1992. Red list of threatened macrofungi in Norway. In: *Directorate for Nature Management Report 1992–6*: 31–42.
- BENKERT D., DÖRFELT H., HANDTKE H.-J., HIRSH G., KREISEL H., KRIEGLSTEINER G. J., LÜDERITZ M., RUNGE A., SCHMID H., SCHMITT J. A., WINTERHOFF W., WÖLDECKE K., ZEHFUSS H.-D., EINHELLINGER A., GROSS G., GROSSE-BRAUCKMANN H., NUSS J. & WÖLFEL G. 1992. Rote liste der gefährdeten Grosspilze in Deutschland. IHW Verlag, Eching.
- BŁOŃSKI F. 1888. Spis roślin skrytopłciowych zebranych w 1887 r. w Puszczy Białowieskiej. In: F. BŁOŃSKI, K. DRYMMER & A. EJSMOND, Sprawozdanie z wycieczki botanicznej odbytej do Puszczy Białowieskiej w lecie 1887 roku. *Pamiętn. Fizjogr.* **8**: 75–96.
- BREITENBACH J. & KRÄNZLIN F. 1986. Fungi of Switzerland. **2**. Heterobasidiomycetes, Aphyllophorales, Gasteromycetes. Verlag Mykologia, Lucerne.
- BREITENBACH J. & KRÄNZLIN F. 1991. Fungi of Switzerland. **3**. Boletes and agarics 1. Strobilomycetaceae and Boletaceae, Paxillaceae, Gomphidiaceae, Hygrophoraceae, Tricholomataceae, Polyporaceae (lamellate). Edition Mykologia, Lucerne.
- BRZEG A., BUJAKIEWICZ A., RUSIŃSKA A., SZWED W., TOBOLEWSKI Z. & WOJTERSKI T. 1993. Flora of the island Seili in southwestern Finland. In: J. B. FALIŃSKI & Z. MIREK (eds), Polish Geobotanical Investigations Abroad. *Wiadom. Bot.* **37**(3/4): 21–23.
- BUJAKIEWICZ A. 1973. Higher fungi in the alluvial and alder

- forests of Wielkopolska Province. *Prace Komis. Biol.* **35**(6): 1–91. Warszawa-Poznań (in Polish with English summary).
- BUJAKIEWICZ A. 1993. General remarks on macrofungi occurring in boreal and temperate grey alder forests. *Blyttia* **3–4**: 99–110.
- BUJAKIEWICZ A. 1997. Agaricales. In: J. B. FALIŃSKI & W. MULENKO (eds), *Cryptogamous plants in the forest communities of Białowieża National Park. Ecological atlas. (Project CRYPTO 4)*. *Phytocoenosis* **9** (N.S.), *Suppl. Cartographiae Geobotanicae* **7**: 304–407.
- BUJAKIEWICZ A. & FIEBICH R. 1993. *Serpula himantoides* (Fr.) Bond. ex Parm. in Poland. *Acta Mycol.* **28**(2): 219–225.
- BUJAKIEWICZ A., LISIEWSKA M., SADOWSKA B. & SKIRGIELLO A. 1992. *Aphyllorphorales, Agaricales*. In: J. B. FALIŃSKI & W. MULENKO (eds), *Cryptogamous plants in the forest communities of Białowieża National Park. Checklist of cryptogamous and seminal plant species recorded during the period 1987–1991 on permanent plot V-100 (Project CRYPTO)*. *Phytocoenosis* **4** (N.S.), *Archivum Geobotanicum* **3**: 23–44.
- BUJAKIEWICZ A., CHLEBICKI A., CHMIEL M., LISIEWSKA M., MAJEWSKI T., MULENKO W. & SKIRGIELLO A. 1995. Fungi. X. 14. Summary. In: J. B. FALIŃSKI & W. MULENKO (eds), *Cryptogamous plants in the forest communities of Białowieża National Park (Project CRYPTO). General problems and taxonomic groups analysis*. *Phytocoenosis* **7** (N.S.), *Archivum Geobotanicum* **4**: 159–164.
- COURTECUISSE R. & DUHEM B. 1995. Collins field guide mushrooms & toadstools of Britain and Europe. Harper Collins Publ., London.
- ČERNÝ A. 1966. *Phaeolus croceus* (Pers.: Fr.) Pat. a new polypore for Czechoslovakia. *Česká Mykol.* **20**(2): 90–96.
- DÄHNCKE R. M. & DÄHNCKE S. M. 1982. 700 Pilze in Farbfotos. AT Verlag Aarau, Stuttgart.
- DOMAŃSKI S. 1963. Fungi lignicoli in regione Mazury in Polonia septentrionalis annis 1956–1961 collecti. *Monogr. Bot.* **15**: 295–323.
- DOMAŃSKI S. 1965. Wood inhabiting fungi in Białowieża virgin Forest in Poland. II. The mucronelloid fungus of the *Hericium*-group: *Dentipratulum bialoviesense* gen. et sp. nov. *Acta Mycol.* **1**: 5–11 (in Polish with English summary).
- DOMAŃSKI S., ORŁOŚ H. & SKIRGIELLO A. 1967. Polyporaceae pileatae, Mucronoporaceae pileatae, Ganodermataceae, Bondarzewiaceae, Boletopsidaceae, Fistulinaceae. In: J. KOCHMAN & A. SKIRGIELLO (eds), *Flora Polska. Rośliny Zarodnikowe Polski i Ziemi Ościennych*. **3**. Grzyby. Państwowe Wydawnictwo Naukowe, Warszawa (in Polish).
- DOMAŃSKI Z. 1993. Macromycetes rezerwatu 'Jegiel'. *Acta Mycol.* **28**(2): 185–199.
- DOMAŃSKI Z. 1997. Nowe stanowiska rzadkich i interesujących grzybów w Polsce. Privately published, Warszawa (in Polish with English summary).
- EICHLER B. 1900. Materiały do flory grzybów okolic Międzyrzecz. *Pamiętn. Fizjogr.* **16**: 157–206.
- EICHLER B. 1907. Trzeci przyczynek do flory grzybów okolic Międzyrzecz. *Pamiętn. Fizjogr.* **19**: 1–40.
- FALIŃSKI J. B. 1986. Vegetation dynamics in temperate lowland primeval forsts. Ecological studies in Białowieża Forest. *Geobotany* **8**: 1–537.
- FALIŃSKI J. B. 1994. Concise geobotanical atlas of Białowieża Forest. *Phytocoenosis* **6** (N.S.), *Suppl. Cartographiae Geobotanicae* **6**: 3–34.
- FALIŃSKI J. B. & MULENKO W. (eds) 1992. Cryptogamous plants in the forest communities of Białowieża National Park. Check-list of cryptogamous and seminal plant species recorded during the period 1987–1991 on the permanent plot V-100 (Project CRYPTO). *Phytocoenosis* **4** (N.S.), *Archivum Geobotanicum* **3**: 1–48.
- FLISIŃSKA Z. & SALATA B. 1991. The materials for the study of the macromycetes flora of a few regions of South-Eastern Poland. *Ann. Univ. Mariae Curie-Skłodowska, C*, **46**(2): 13–19 (in Polish with English summary).
- FLISIŃSKA Z. & SALATA B. 1998. New localities of interesting macromycetes in the South-East Poland. *Ann. Univ. Mariae Curie-Skłodowska, C* **53**: 201–209 (in Polish with English summary).
- FRIEDRICH S. 1994. Sociological-ecological characterization of mycoflora of forest communities in the Cedyński Landscape Park. *Rozpr. Akad. Roln. Szczecin* **161**: 1–100 + 28 tab. (in Polish with English summary).
- GERHARDT E. 1995. Pilze-BLV Bestimmungsbuch mit Schnellbestimm-System. Multico, Warszawa.
- GERHARDT E. 1997. Der grosse BLV Pilzfürher für unterwegs. BLV Verlagsgesellschaft, München.
- GUMIŃSKA B. 1972. Mycoflora of the Pieniny National Park (Part II). *Acta Mycol.* **8**(2): 149–174 (in Polish with English summary).
- GUMIŃSKA B. & WOJEWODA W. 1985. Grzyby i ich oznaczanie. Wyd. 3. Państwowe Wydawnictwo Rolnicze i Leśne, Warszawa.
- HANSEN L. & KNUDSEN H. (eds) 1992. Nordic Macromycetes. **2**. Polyporales, Boletales, Agaricales, Russulales. Nordsvamp, Copenhagen.
- HANSEN L. & KNUDSEN H. (eds) 1997. Nordic Macromycetes. **3**. Heterobasidioid, aphyllorphoroid and gastromycetoid basidiomycetes. Nordsvamp, Copenhagen.
- HARMAJA H. 1979. *Mycena picta* n. comb., an agaric new to Finland. *Karstenia* **19**: 52–53.
- ING B. 1993. Toward a red list of endangered European macrofungi. In: D. N. PEGLER, L. BODDY, B. ING & P. M. KIRK (eds), *Fungi of Europe: Investigation, Recording and Conservation*, pp. 231–237. Royal Botanic Gardens, Kew.
- JÜLICH W. 1984. Die Nichtblätterpilze, Gallertpilze und Bauchpilze (Aphyllorphorales, Heterobasidiomycetes, Gastro-

- mycetes). In: H. GAMS, *Kleine Kryptogamenflora* 2b/1. Basidiomyceten 1. VEB G. Fischer Verlag, Jena.
- KINELSKA J. & ROŚLIK D. 1959. Les champignons ramassés en 1955 dans la forêt réservée de mèleze à Mala Wies. *Monogr. Bot.* **8**: 143–151 (in Polish with French summary).
- KITS VAN WAVEREN E. 1985. The Dutch, French and British species of *Psathyrella*. *Persoonia Supplement* **2**: 1–300.
- KONDRACKI J. 2001. Geografia regionalna Polski. Wyd. 2. Wydawnictwo Naukowe PWN, Warszawa.
- KOTLABA F. 1960. Poznamky k mykoflore statni prirodni rezervace 'Mionsi'. *Ochr. Přír. (Prague)* **15**: 70–78.
- KOTLABA F. & LAZEBNÍČEK J. 1967. The Fourth European Mycological Congress, Poland 1966. *Česká Mykol.* **21**(1): 54–59.
- KOTLABA F. & POUZAR Z. 1962. Agarics and boleti (*Agaricales*) from the Dobročský Virgin Forest in Slovakia. *Česká Mykol.* **16**(3): 173–191.
- KREISEL H. 1961. Die phytopathogenen Grosspilze Deutschlands. VEB G. Fischer Verlag, Jena.
- KREISEL H. (ed.) 1987. Pilzflora der Deutschen Demokratischen Republik. Basidiomycetes (Gallert-, Hut- und Bauchpilze). VEB Gustav Fischer Verlag, Jena.
- KRIEGLSTEINER G. J. 1981. Über einige neue, seltene kritische Makromyzeten in der Bundesrepublik Deutschland. II. *Z. Mykol.* **47**(1): 63–80.
- KRIEGLSTEINER G. J. 1984. Über neue, seltene, kritische Makromyzeten in der Bundesrepublik Deutschland. V. *Z. Mykol.* **50**(1): 41–86.
- KRIEGLSTEINER G. J. 1991. Verbreitungsatlas der Grosspilze Deutschlands (West). I. Ständerpilze. B: Blätterpilze. Eugen Ulmer GmbH & Co., Stuttgart.
- KRIEGLSTEINER G. J. 2000. Die Grosspilze Baden-Württembergs. **1**. Verlag Eugen Ulmer, Stuttgart.
- KRIEGLSTEINER G. J. 2001. Die Grosspilze Baden-Württembergs. **3**. Verlag Eugen Ulmer, Stuttgart.
- LISIEWSKA M. 1978. Flora of macromycetes of the Świętokrzyski National Park. *Acta Mycol.* **15**(1): 21–43 (in Polish with English summary).
- LISIEWSKA M. 1987. *Mycena*. In: J. KOCHMAN & A. SKIRGIELLO (eds), *Flora Polska. Rośliny Zarodnikowe Polski i Ziemi Ościennych*. **17**. *Grzyby*. Państwowe Wydawnictwo Naukowe, Warszawa-Kraków (in Polish).
- LIZOŇ P. 1983. Rare and otherwise interesting Slovak macromycetes 1. *Acta Rer. Natur. Mus. Nat. Slov., Bratislava*. **29**: 79–93.
- LIZOŇ P. & BACIGÁLOVÁ K. 1998. Fungi. In: K. MARHOLD & F. HINDÁK (eds), *Checklist of non-vascular and vascular plants of Slovakia*, pp. 101–227. VEDA, Bratislava.
- ŁAWRYNOWICZ M. 1973. Higher macroscopic fungi in the oak-hornbeam forests of the central Poland. *Acta Mycol.* **9**(2): 133–204 (in Polish with English summary).
- ŁUSZCZYŃSKI J. 1997. Interesting macromycetes found in the Kielce town (Central Poland). *Acta Mycol.* **32**(2): 207–228.
- MAAS GEESTERANUS R. A. 1992. *Mycenas of the Northern Hemisphere*, 1 and 2. North-Holland, Amsterdam-Oxford-New York-Tokyo.
- MATELIS A. 1992. Gyslotoji Krempliodudė. In: K. BALEVICIUS (ed.), *Red Data Book of Lithuania*, pp. 336–337. Lietuvos Republikos aplinkos apsaugos departamentas, Vilnius.
- MICHAEL E., HENNIG B. & KREISEL H. 1977. Handbuch für Pilzfreunde. **3**. VEB G. Fischer Verlag, Jena.
- MICHAEL E., HENNIG B. & KREISEL H. 1981. Handbuch für Pilzfreunde. **4**. VEB G. Fischer Verlag, Jena.
- MIŚKIEWICZ A. 2000. Rare, threatened and new for Poland macromycetes found in Bukowiec reserve (W Carpathians). *Acta Mycol.* **35**(2): 197–216.
- MOSER M. 1983. Keys to agarics and boleti. Publ. Roger Phillips, London.
- NESPIAK A. 1959. The investigations on the character of the correlations between the higher fungi and wood associations in the National Park of Białowieża. *Monogr. Bot.* **8**: 3–141 (in Polish with English summary).
- ORŁOŚ H. 1961. Fungi in the forest environment, division of Fungi into ecological groups and appraisal of their biological function. *Sylvan* **4**: 61–68 (in Polish with English and Russian summaries).
- PIĄTEK M. & NABOŹNY P. 2000. *Serpula himantioides* – rare fungus species found in Sandomierz Basin. *Chrońmy Przyrodę Ojczystą* **56**(6): 113–118 (in Polish).
- SALATA B. 1972. Recherches sur les champignons supérieurs dans les hêtraies et les sapinières du Roztocze Central. *Acta Mycol.* **8**(1): 69–140 (in Polish with French summary).
- SCHROETER J. 1889. Pilze. In: *Cohn's Kryptogamen-Flora von Schlesiens* **3**(1), Die Pilze Schlesiens I. J. U. Kern's Verlag, Breslau.
- SMITH A. H. 1947. North American species of *Mycena*. University of Michigan Press, Ann Arbor.
- SMITH A. H. & HESLER L. R. 1968. The North American species of *Pholiota*. Hafner Publ. Co., New York and London.
- SKIRGIELLO A. 1977. Matériaux à la connaissance de la distribution géographique des champignons supérieurs en Europe. *V. Acta Mycol.* **12**(2): 155–189 (in Polish with English summary).
- SVRČEK M. 1956. Fungi novi, rari vel minus cogniti Agaricarium in Cechoslovakia III. *Česká Mykol.* **3**: 174–183.
- URBONAS V. 1999. Polyporales, Boletales. In: V. URBONAS (ed.), *Mycota Lithuaniae*. **8**(3). Institutum Botanicae Lithuaniae, Vilnius.

- WATLING R. & GREGORY N. M. 1993. Cortinariaceae p.p. *Galerina*, *Gymnopilus*, *Leucocortinarius*, *Phaeocollybia*, *Phaeogalera*, *Phaeolepiota*, *Phaeomarasmius*, *Pleuroflam-mula*, *Rozites* & *Stagnicola*. British Fungus Flora. Agarics and boleti. **7**. Royal Botanical Garden, Edinburgh.
- WOJEWODA W. 1973. 'Macromycetes' of the district of Chrzanów and of the town's Jaworzno environs. *Stud. Ośrod. Dokument. Fizjogr.* **2**: 57–86 (in Polish with English summary).
- WOJEWODA W. 1974. Macromycetes of the Ojców National Park. I. The flora. *Acta Mycol.* **10**(2): 181–265 (in Polish with English summary).
- WOJEWODA W. 1977. Tremellales, Auriculariales, Septobasidiales. In: J. KOCHMAN & A. SKIRGIEŁŁO (eds), *Flora Polska. Rośliny Zarodnikowe Polski i Ziem Ościennych.* **8. Grzyby**. Państwowe Wydawnictwo Naukowe, Warszawa (in Polish).
- WOJEWODA W. 1983. Grzyby towarzyszące jodle. In: A. JAWORSKI & K. ZARZYCKI. Ekologia. In: S. BIAŁOBOK (ed.), *Jodła pospolita Abies alba* Mill. Nasze Drzewa Leśne. **4**: 414–417. Państwowe Wydawnictwo Naukowe, Warszawa–Poznań.
- WOJEWODA W. 1998. The macrofungi (Basidiomycotina) of the Beskid Niski Mts. (the Polish Carpathians) Part I. The Heterobasidiomycetes and Aphyllophorales *Studia Ośrod. Dokument. Fizjogr.* **25**: 295–333 (in Polish with English summary).
- WOJEWODA W. 2000. *Xylobolus frustulatus* (Pers.: Fr.) Boid. In: W. WOJEWODA (ed.), *Atlas of the geographical distribution of fungi in Poland.* **1**: 56–61. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.
- WOJEWODA W. & ŁAWRYNOWICZ M. 1992. Red list of threatened macrofungi in Poland. In: K. ZARZYCKI, W. WOJEWODA & Z. HEINRICH (eds), *List of threatened plants in Poland.* 2 ed. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków, pp. 27–56.
- WOJTERSKA M., BALCERKIEWICZ S., BRZEG A., BUJAKIEWICZ A., KASPROWICZ M., ŁUSZCZYŃSKI J., RUSIŃSKA A., SZWED W., TOBOLEWSKI Z., WOJTERSKA H. & WOJTERSKI T. 2000. Vegetation of Seili and adjacent islands, SW Finland. Proceedings IAVS Symposium, pp. 190–194, 2000. Opulus Press, Uppsala.
- ZALESKI K. & GOLENIA A. 1954. Fungi – wood parasites and saprophytes of state forests Kórnik (Province Poznań, Poland) collected in 1948–1949. *Acta Soc. Bot. Poloniae* **23**(3): 617–634 (in Polish with English summary).

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