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Macromycetes of the Pieniny National Park (S. Poland)

Barbara GUMIŃSKA

1. INTRODUCTION

The fungus flora of the Pieniny Mts. is very rich and varied. The total number of fungi species which have been found so far is 600. Lists of species were published in five parts (GUMINSKA 1969, 1972, 1976a, 1981, 1990). Several single reports on newly found species have also been published (SKIRGIELLO 1959, WOJEWODA 1966a, 1967, MOSER 1978, 1979). Quantitative investigations on the cap fungi in meadow communities on the northern slopes of the Pieniny Mts. were carried out in nine permanent plots in 1968-72 (GUMINSKA 1976b). The purpose of this paper is to present the most recent situation in researches on the Pieniny National Park fungus flora.

The nomenclature of the species mentioned in the paper has been adopted after the following publications: JÜLICH 1984, MICHAEL et al. 1983a,b, 1985, 1986, 1987, MOSER 1983.

2. GENERAL CHARACTERIZATION OF THE MYCOFLORA OF THE PARK

2.1. BASIDIOMYCETES

As a result of the investigations up to 1990, there are 600 species of macromycetes. Agaricales and Boletales are represented by 405 species (87 genera). The number of species within particular genera varies from one to 28, but only 22 genera have five or more representatives in the Park; 65 genera are most

frequently represented by one to four species.

The genera richest in species are: *Hygrocybe*, *Mycena* and *Lactarius* (Fig. 1). It is interesting that some genera such as *Agaricus*, *Amanita* or *Tricholoma* are represented in the Pieniny mycoflora only by a few species. This may result, however, from not yet completed investigations on the Pieniny Mts. fungus flora - further studies are still under way.

Many terrestrial fungi of *Aphyllorphorales* with clavarioid soft fruit-bodies with smooth or echinaceous hymenophor have been collected. The most frequent in the Pieniny Mts. are *Clavulina cristata* (Holmsk.: Fr.) Schroet. and *C. rugosa* (Bull.: Fr.) Schroet. growing in the forests and *Clavaria fumosa* Pers.: Fr. and *C. fragilis* Holmsk.: Fr. in the meadows. The lignicolous fungi (annual and perennial) with corbel-like, unguliform or fan-shaped fruit-bodies were also studied. Both saprophytes and parasites occurring on living tree trunks and roots were among them. Among the most common in the Park are e.g. *Fomes fomentarius* (L.) Fr., *Heterobasidion annosum* (Fr.) Bref., *Trichaptum abietinum* (Pers. in J.G. Gmelin: Fr.) Ryv., *Trametes hirsuta* (Wulf.: Fr.) Pil., *T. versicolor* (L.) Pil., etc. On the other hand, the fungi with a resupinate type of fruit-bodies growing on wood were collected sporadical-

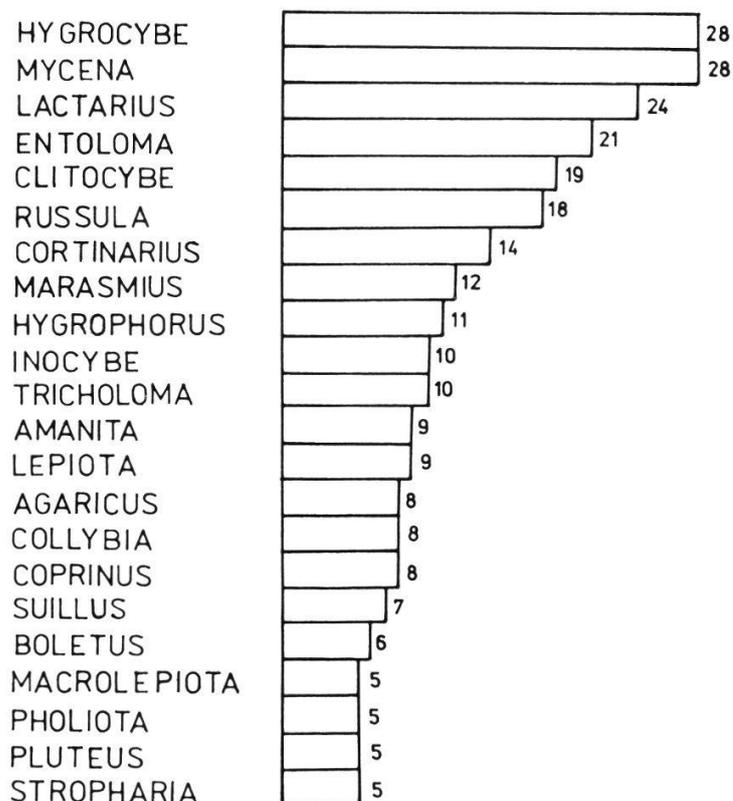


Fig. 1. The most numerous genera of cap-fungi in the Pieniny Mts.

ly. These fungi grow abundantly in the Pieniny Mts., especially in inaccessible forests with plenty of rotten tree logs and fallen branches, but they will be studied in the next stages of the investigation.

Within the Basidiomycetes quite a large group form Gasteromycetes. They occur in the Pieniny Mts. both in woods and in clearings. The richest in species is the genus *Lycoperdon* with two common species *L. perlatum* Pers.: Pers. and *L. pedicellatum* Peck. *Geastrum sessile* (Sow.) Pouzar is the most common species in the genus. *Bovista nigrescens* Pers.: Pers. frequently occurs in meadows and glades.

2.2. ASCOMYCETES

Researches upon Ascomycetes in the Pieniny Mts. concern mainly the fungi of the order Pezizales and Helotiales. These fungi occupy various habitats. Many of them grow on soil, forest litter, among fallen leaves and needles, e.g.: *Helvella bulbosa* (Hedw.: Fr.) Kreisel (= *Macroscyphus macropus* [Pers.: Fr.] S.F.Gray), *Humaria hemisphaerica* (Weber in Wiggers: Fr.) Fuck., *Helvella crispa* Scop.: Fr., *H. elastica* Bull.: Fr., etc. In the grass at the edge of forests *Cudonia circinans* (Pers.: Fr.) Fr., *Morchella elata* Fr. (= *M. conica* Pers.) and, rarely, *M. esculenta* (L.) Pers. may be found. *Disciotis venosa* (Pers.: Fr.) Boud. grows on bare soil without any litter. Many Ascomycetes occur on wood remnants or other plant parts lying in the litter: *Hymenoscyphus fructigenus* (Bull.: Fr.) S.F.Gray (on beech fruits), *Ciboria rufofusca* (Weberb.) Sacc. (on fir cone scales), *Ciboria amentacea* (Balbis: Fr.) Fuck. (on hazel catkins), *Mollisia cinerea* (Batsch.) Karst. (on wood remains) etc. Only two species of hypogeous Ascomycetes have been found in the Pieniny National Park: *Elaphomyces granulatus* Fr. and *Choiromyces venosus* (Fr.) Th. Fr. - both very rare. On the fruit-bodies of *Elaphomyces* the parasitic fungi have been found: *Cordyceps ophioglossoides* (Ehrh.: Fr.) Link. and *C. canadensis* Ell. et Ev. (= *C. capitata* [Holmsk.: Fr.] Link.).

2.3. CALCIPHILIOUS AND THERMOPHILOUS FUNGI

Generally speaking, almost all fungi occurring in the Pieniny Mts. belong to species well tolerating lime in the soil, but there are also species which require this type of substratum in order to live.

Sarcosphaera coronaria (Jacq.) Schroet., of which the beautiful fruit-bodies were observed for many years in the Pieniny Mts., belongs to the very inter-

esting calciphilous *Ascomycetes*. This fungus fructified most abundantly in 1965. The fruit-bodies appeared in five different stands dispersed within the Central Pieniny (GUMINSKA 1968) at 570-820 m a.s.l., in June and July only. In the following year this fungus did not appear in the Pieniny, but in June 1967 and 1970 some fruit-bodies were found in a fir wood on Lupiska. In the following years no fruit-bodies were observed until June 1986 when one specimen appeared on the steep edge of a forest path in a *Fagetum carpaticum* association in the upper reaches of the Lonny Potok. On the other hand, in the previously most abundant stand on Lupiska no fruit-body appeared. It seems that the mycelium of *Sarcosphaera coronaria* still exists in the Park but does not produce fruit-bodies (or produces them very rarely) in places formerly occupied.

Lycoperdon mammaeforme Pers. belongs to typical calciphilous puff-balls. In the area of the Pieniny National Park it may be found in many places among grass in meadows and along forest borders, e.g. in Kurnikowka meadow, under Ociemny Wierch, along the Pieninski Potok, and on Zagron. Everywhere it occurs singly, not gregariously. This uncommon fungus was found only once in Poland beyond the Pieniny Mts.

Most calciphilous species occurring in the Pieniny may be found among the pileate fungi. *Cortinarius percomis* Fr. is a typical example. It has fructified only in a mixed spruce-juniper thicket on the southern slopes of the Pieniny Mts. always in September. Some other calciphilous species have been found in single stands, e.g. *Clitocybe alexandri* (Gill.) Konr. (in spruce forest), *Hygrophorus discoideus* (Pers.: Fr.) Fr. (at the edge of spruce forest), *Lactarius acerrimus* Britz. (at the edge of beech forest), *L. insulsus* (Fr.) Fr. (in the meadow). Other species have been widely distributed, e.g. *Agaricus xanthodermus* Genevier and *Lactarius acris* (Bolt.: Fr.) S.F. Gray. In the whole region of Central and Western Pieniny such calciphilous species as *Boletus luridus* Schaeff.: Fr., *Hygrophorus pudorinus* (Fr.) Fr., *Russula delica* Fr., *Lactarius salmonicolor* Heim et Lecl., *L. scrobiculatus* (Scop.: Fr.) Fr., and *Entoloma incanum* (Fr.) Hesler may be found. The first three species are found rather frequently, the others are sporadic.

Some pileate fungi occurring in the Pieniny National Park may be included among thermophilous species. On warm southern slopes of the Pieniny Mts. *Boletus fechtneri* Vel. was found in a *Fagetum carpaticum* association on the slope of Podskalnia Gora in 1966 (WOJEWODA 1967). Outside the Pieniny this species has been observed only once in a *Fagetum* association on calcareous soil (WOJEWODA 1979). Another thermophilous fungus, *Boletus rho-*

doxanthus (Krbh.) Kallenb., has been found only once in the Pieniny, on the slope of Sokolica in a *Fagetum carpaticum* association. Outside the Pieniny it occurs in some places in Poland, mainly in regions with a calcareous substratum. The thermophilous polypores include *Ischnoderma trogii* (Fr.) Donk (= *I. corrugis* [Fr.] Doman. et Orlicz). It was found in the Pieniny in three places in 1970-72. It always grows at the base of *Abies alba* trunks. Beyond the Pieniny it is known only from the Ojcow National Park (calcareous soil) on fir stumps and roots (WOJEWODA 1966b - under the name *Ungulina corrugis* [Fr.] Bourd. et Galz.).

3. FUNGI IN SOME SELECTED PLANT COMMUNITIES OF THE PIENINY NATIONAL PARK

Among the various plant communities occurring in the Park the mycoflora of some forest and meadow associations is well-known. Special attention has been paid to the fungi which, in one way or another, are connected with human activity.

3.1. FOREST FUNGI

Fungi growing under beech and fir

Beech (*Fagus sylvatica* L.) and fir (*Abies alba* Mill.) form the *Fagetum carpaticum* association which covers the greatest part of the northern slopes of the Pieniny Mts. The mycoflora of this community is very rich and varied. Fungi grow in litter on the forest floor, on tree trunks, on fallen logs, on decaying stumps, on fallen leaves and on other plant remains.

Many fungi from different systematic groups are found in the forest litter. From Ascomycetes fructifying through all the vegetative season the following species may be mentioned: *Helvella lacunosa* Afz.: Fr., *Humaria hemisphaerica* (Weber in Wiggers.: Fr.) Fuck., *Otidea onotica* (Pers.: Fr.) Bon., *Peziza succosa* Berk. In moist places, where the forest is not so dense and *Urtica dioica* L. appears, the bright yellow apothecia of *Cheilymenia vitellina* (Pers.: Fr.) Dennis may be seen in autumn. In spring, among decaying beech leaves, *Sclerotinia tuberosa* (Hedw.: Fr.) Fuck. and *Sarcoscypha coccinea* (Scop.: Fr.) Lamb. frequently occur. The fruit-bodies of *Caloscypha fulgens* (Pers.: Fr.) Boud. and *Gyromitra gigas* (Krombh.) Cke. are rather uncommon.

Fungi of the order Agaricales play a dominant role among terrestrial fungi liv-

ing in forest humus, e.g. *Amanita rubescens* Pers.: Fr., *A. vaginata* (Bull.: Fr.) Vitt., *Collybia butyracea* (Bull.: Fr.) Kummer, *C. confluens* (Pers.: Fr.) Kummer, *C. peronata* (Bolt.: Fr.) Kummer, *Entoloma hirtipes* (Schum.: Fr.) Mos., *Hebeloma crustuliniforme* (Bull.) Qué., *Hygrophorus eburneus* (Bull.: Fr.) Fr., *H. pudorinus* (Fr.) Fr., *Inocybe geophylla* (Sow.: Fr.) Kummer, *Laccaria laccata* (Scop.: Fr.) Berk. et Br., *L. amethystina* (Huds.) Cke., *Lactarius blennius* (Fr.) Fr., *L. piperatus* (Scop.: Fr.) S.F.Gray, *L. vellereus* (Fr.) Fr., *Lepista nebularis* (Batsch: Fr.) Harmaja, *L. gilva* (Pers.: Fr.) Pat., *Macrolepiota rhacodes* (Vitt.) Sing., *Mycena pura* (Pers.: Fr.) Kumm., *Russula laurocerasi* Melzer, *R. nigricans* (Bull.) Fr., *Tricholoma sulphureum* (Bull.: Fr.) Kumm., *T. terreum* (Schff.) Kummer, *Xerula radicata* (Relhan: Fr.) Dorfelt. On the other hand, the following species are very rare: *Amanita phalloides* (Fr.) Link, *A. regalis* (Fr.) Michael, *Mycena crocata* (Schrad.: Fr.) Kumm., *Rozites caperata* (Pers.: Fr.) Karst., *Russula aurata* (Wich.) Fr., and *R. virescens* (Schaeff.) Fr.

The pileate fungi growing in the forest litter are mainly saprophytes but many of the fungi mentioned form mycorrhiza with fir or beech.

There are plenty of plant remains of different origin in the forest litter. They are often inhabited by saprophytic fungi growing, for instance, on the beech leaves lying on the forest floor (*Mycena stylobates* [Pers.: Fr.] Kumm.), on fallen fir needles (*Hemimycena delicatella* [Peck.] Sing.), on the scales of fir cones (*Ciboria rufofusca* [Weberb.] Sacc.), on dead insects (*Cordyceps sphecocephala* [Klotsch] Berk. et Curt.), on fallen hazel catkins (*Ciboria amentacea* [Balbis.: Fr.] Fuck.), or on small twigs and pieces of wood hidden in the litter (*Marasmius rotula* [Scop.: Fr.] Fr., *Marasmiellus ramealis* [Bull.] Sing., *Polyporus arcularius* Batsch.: Fr., *P. brumalis* Pers.: Fr.).

There are rather few species of parasitic fungi on living tree trunks and root collars in the Pieniny National Park. The most frequent are *Armillaria mellea* (Vahl.: Fr.) Kumm., *Heterobasidion annosus* (Fr.) Bref. and (as weak parasites) *Fomes fomentarius* (L.) Fr. and *Fomitopsis pinicola* (Sw.: Fr.) Karst. *Phellinus hartigii* (Allescher et Schnabl.) Pat., living on fir, is rather rarely found and *Bondarzewia montana* (Qué.) Sing. is a true rarity.

Fallen, decaying tree logs and stumps have a very rich mycoflora. Among mushrooms with lamellate hymenophor the following are very often found on this substratum: *Hypholoma fasciculare* (Huds.: Fr.) Kumm., *Kuehneromyces mutabilis* (Schaeff.: Fr.) Sing. et Smith, or *Xeromphalina campanella* (Batsch.: Fr.) Mre. - while others are rarely met with, e.g. *Oudemansiella mucida* (Schrad.: Fr.) Höhnel, *Panellus serotinus* (Pers.: Fr.) Kühn. or *Pax-*

illus atrotomentosus (Batsch.: Fr.) Fr. Non-lamellate fungi are met very frequently with, e.g. *Daedaleopsis confragosa* (Bolt.: Fr.) Schroet., *Stereum hirsutum* (Willd.: Fr.) Pers. or *Trametes versicolor* (L.) Pil., *Ganoderma lucidum* (Kurt.: Fr.) Karst., *Hericium flagellum* (Scop.) Pers. or *Lentinellus castoreus* (Fr.) K. et M. are rather rare.

Fungi growing under larch

Various species of fungi forming an ectotrophic mycorrhiza with larch roots appear in places where larger groups of this tree occur in the Park. The most frequent larch companions are *Suillus flavus* (With.) Sing., *S. viscidus* (Fr. et Hok.) Rauschert and *Hygrophorus lucorum* Kalchbr. *Lactarius porninsis* Rolland and *Gomphidius maculatus* Fr. are found sporadically under larch. On the other hand, *Suillus tridentinus* (Bres.) Sing., closely connected with larch, is a great rarity. In the Pieniny Mts. it grows only at the foot of Biale Skaly, 700 m a.s.l., in *Carici-Fagetum* with an admixture of larch. Its fruit-bodies appear in August and September. It is a species of Alpine-North Asian distribution with a centre of occurrence in the Alps. In Poland it is also known from the Tatra Mts.

Fungi growing under pine

Pinus sylvestris occurs in the Pieniny Mts. in fairly small numbers. It grows mainly as a single specimen or as small stands, e.g. on the southern slopes of Macelowa Gora. Species of the genus *Suillus* most frequently accompany the pine, e.g. *S. bovinus* (L.) O.K., *S. granulatus* (L.) O.K. and *S. luteus* (L.) Kuntze, S.F. Gray.

Very closely connected with the pine are fungi growing on old pine cones buried in the soil: *Auriscalpium vulgare* S.F. Gray, *Strobilurus tenacellus* (Pers.: Fr.) Sing. and *S. stephanocystis* (Hora) Sing. *Thelephora caryophyllea* Fr. (growing on the soil surface among mosses) and *Rhizopogon roseolus* (Cda.) Th.M.Fr. have been found only in a pine stand on the slope of Macelowa Gora. Beside the species mentioned, fungi growing in other types of forests have also been found under pines in the Pieniny Mts. e.g. *Chroogomphus rutilus* (Schaeff.: Fr.) O.K.Miller., *Hygrophorus gliocyclus* Fr., *Paxillus involutus* (Batsch: Fr.) Fr., *Tricholoma vaccinum* (Pers.: Fr.) Kumm., etc.

3.2. MEADOW FUNGI

General characterization

The meadow mycoflora of the northern slopes of the Pieniny Mts. is poorer than that of the forests. This is quite understandable considering the less varied habitat. Obviously, these fungi species which need more light for life live mostly there. The majority of the fungi occurring in meadows (about 90%) belong to the order *Agaricales*, while species of *Aphylllophorales*, *Boletales*, *Gasteromycetes* and *Ascomycetes* form the remaining 10%. The most poorly represented is the order *Aphylllophorales*, which shows three species only, *Clavaria fumosa* Pers.: Fr., *C. fragilis* Holmsk.: Fr. = *C. vermicularis* Sw.: Fr. (common), and *Ramariopsis kunzei* (Fr.) Donk. The most frequently growing in meadows are *Calvatia utriformis* (Bull.: Pers.) Jaap, *Clitocybe gibba* (Pers.: Fr.) Kumm., *Entoloma sericeum* (Bull.) Quél., *Galerina hypnorum* (Schrank: Fr.) Kühn., *Hygrocybe conica* (Scop.: Fr.) Kumm., *Mycena epipterygia* (Scop.) S.F.Gray, and *M. flavoalba* (Fr.) Quél.

Hygrophoraceae

The fungi of the genus *Hygrocybe*, usually occurring abundantly in autumn, are the greatest mycological curiosity of the meadows in the Pieniny Mts. Because of the bright and intense colour of their caps they often form beautiful patches against the unified grass-green turf of the meadows: red: *H. punicea* (Fr.) Kumm., *H. coccinea* (Schff.: Fr.) Kumm., *H. conica* (Scop.: Fr.) Kumm.; yellow: *H. chlorophana* (Fr.) Wünsche, *H. citrina* (Rea) Lge., *H. obrussea* (Fr.) Wünsche; orange: *H. intermedia* (Pass.) Fay, and pink: *H. calyptraeformis* (Bk. et Br.) Fay. In the Pieniny mountain meadows 28 species of *Hygrocybe* were found, i.e. more than 50% of all those known from Central Europe. The abundance of these fungi in the Pieniny Mts. is connected with the calcareous substratum, because many *Hygrocybe* species are calciphilous. On the other hand, the wealth of *Hygrocybe* species is exceptional in the Pieniny Mts. It is not encountered in other parts of Poland, even in calcareous regions: only six species of this genus grow in the Ojcow meadows and all, except one, also occur in the Pieniny Mts. (WOJEWODA 1974).

Gasteromycetes

Gasteromycetes is represented in the Pieniny meadows by eleven species. Nevertheless, some species are so definitely connected with this territory that they play a very essential role in the meadow landscape. The largest and most

striking fruit-bodies are produced by *Calvatia utriformis* (Bull.: Pers.) Jaap growing in many places in meadows and glades. Equally frequent is *Bovista nigrescens* Pers.: Pers. The fruit-bodies of both species are very persistent. They develop in autumn and in the mature state they winter under the snow cover. In spring the fruit-bodies are torn-out of the ground and rolled over the meadows by the wind. This enables the dissemination of their spores. *Lycoperdon perlatum* Pers.: Pers. and *L. pedicellatum* Peck. are also frequent species, while *Bovista plumbea* Pers.: Pers. and *Lycoperdon molle* Pers.: Pers. are rarely found. Other species occur more frequently in dry, well sunlit meadows on southern slopes, e.g. *Bovista pusilla* Batsch.: Pers. and *Vascelum pratense* (Pers.: Pers.) Kreisel.

Among the *Gasteromycetes* *Lycoperdon mammaeforme* Pers. is one of the greatest rarities. This fungus occurs in many places in the Pieniny Mts.

Fairy rings

A formation of fairy rings in the meadows is not very frequent, but happens more often than in the forests. The diameters of these circles differ from 40 cm (*Marasmius oreades* [Bolt.: Fr.] Fr.) to 32 m (*Macrolepiota procera* [Scop.: Fr.] Sing.). Some rings are regular and closed, others in the form of a semicircle, and some are joined together forming irregular curves (GUMINSKA 1976b). In the meadows on the northern slopes of the Central Pieniny fairy rings formed by the following species of fungi have been noticed (the number of fruit-bodies of particular rings is given in brackets): *Clitocybe dealbata* (Sow.: Fr.) Kumm. (42), *C. expallens* (Pers.: Fr.) Kumm. ss. Bres. (122), *Cystoderma amiantinum* (Scop.) Fayod (25), *Lactarius semisanguifluus* Heim et Leclair (14, 20, 43), *Lepista nuda* (Bull.: Fr.) Cke. (12, 15, 30, 60), *Macrolepiota procera* (Scop.: Fr.) Sing. (11, 15), *Marasmius oreades* (Bolt.: Fr.) Fr. (12).

Influence of weather conditions on meadow fungi

In order to investigate the influence of weather conditions on the fructification of meadow fungi, nine experimental plots (600 m² each) have been established (GUMINSKA 1976b). The investigations were carried out during two successive years: 1969 (hot and dry summer) and 1970 (summer of average weather conditions). The observations were made twice a month in each plot in order to record the floristic composition of fungi and the number of fruit-bodies of particular species. The total results are given in Table 1. It is clearly evident that total production of fruit-bodies in the year with hot and dry sum-

Table 1. Comparison of abundance of fungi fructification in the Pieniny Mts. meadows in nine plots in 1969 and in 1970.

1969	Number of fruit-bodies	1970	Number of fruit-bodies
August, 12-14	21	August, 11-14	143
August, 26-29	28	August, 25-27	566
September, 7-12	70	September, 8-14	2504
September, 22-24	149	September, 24-28	4189
October, 4-6	942	October, 9-10	4330
October, 22-23	1591	October, 24-25	265
November, 13-14	122	First short-lived snow November, 6-15	118
Total in the vegetation season	2923	Total in the vegetation season	12115

mer was over four times smaller in comparison with the year of average rainfall and temperature.

The differences in weather conditions in the years 1969 and 1970 also affected the phenology of meadow fungi. Although the beginning of fructification was in both years simultaneous (after meadow mowing) the maximum of fruit-body production occurred in different periods: in 1970 an increase in fructification was noted in the second half of September and first half of October while in 1969 the highest number of fruit-bodies did not appear before the second half of October.

4. FUNGI CONNECTED WITH HUMAN ACTIVITY

The influence of human activity is more distinctly marked in the Pieniny National Park than in other protected areas. It is caused by special circumstances occurring in this region.

Influence of agriculture and meadow management

A vast area in the National Park (in the western part and on the southern slopes) is covered by non-forest grounds which belong to private owners. These grounds are used as crop fields or hay meadows.

After a harvest (mainly of rye or oat) the crop fields are left as stubble fields. Then they are colonized by specific species of fungi different from those growing in the meadows. The most frequent species are: *Agaricus comtulus* Fr., *Cyathus olla* Batsch.: Pers., *Disciotis venosa* (Pers.: Fr.) Boud., *Stropharia coronilla* (Bull.: Fr.) Quél., *S. semiglobata* (Batsch: Fr.) Quél., etc.

Both agriculture and meadow husbandry need the use of carts to transport the corn or hay. Draught horses, but also cows, goats and sheep grazing in private meadows, leave quantities of dung in many places. This is an additional source of nitrogen for the soil. The nitrophilous fungi grow in such places, near or even directly on the dung. *Ascobolus furfuraceus* Pers.: Fr., *Bolbitius vitellinus* Pers.: Fr. and numerous species of the genus *Panaeolus* e.g. *P. papilionaceus* (Bull.: Fr.) Quél., *P. retirugis* (Fr.) Gill., *P. sphinctrinus* (Fr.) Quél. occur frequently. These fungi often grow also in pastures.

Influence of road network rebuilding

The construction of a water dam on the River Dunajec has involved much additional and necessary capital expenditure inside the Park. In recent years new roads have been built in its western part, e.g. the asphalt road from Krosnica to Sromowce Wyzne. This was connected with the clearing of some of the wooded parts and exposure of the territory to light. This, in turn, must have been followed by a change in the mycoflora. The fungi of shady places gave place to heliophilous species. Grass belts were formed along the roads with a saprophytic mycoflora similar to that of tourist routes. Here grow such lamellate fungi as: *Agaricus campestris* L., *Coprinus comatus* (Mull.: Fr.) S.F.Gray, *Lepista sordida* (Schum.: Fr.) Sing., *Marasmius oreades* (Bolt.: Fr.), *Psathyrella gracilis* (Fr.) Quél, etc.

The various species of genus *Entoloma* (*E. papillatum* [Bres.] Dennis, *E. sericeum* [Bull.] Quél.) and *Inocybe* (*I. auricoma* [Batsch] Fr., *I. fastigiata* [Schff.: Fr.] Quél.) are specially frequent.

Fungi on burnt places

Traces of bonfires may often be found in the Park, especially around the fields and meadows and along newly constructed roads. Observations of many burnt places in the Park have shown that for some weeks after a fire no fungi appear. The time when the first fruit-bodies appear is not always identical and depends on many conditions such as rainfalls and suitable temperature. The necessary condition for the appearance of fungi is that the charcoal should be saturated with water. The first to enter the burnt places in the Park are *Pyronema omphalodes* (Bull.: St. Amans) Fuck. and *Ascobolus atrofuscus* Phill. et Plowr. Then appear the bryophytes together with some *Ascomycetes* such as *Anthracobia macrocystis* (Cke.) Boud., *A. melaloma* (Alb. et Schw.: Fr.) Boud., *Geopyxis carbonaria* (Alb. et Schw.) Sacc., *Peziza anthracophila* Dennis, *P. violacea* Pers., *Plicaria trachycarpa* (Currey)

Boud., *Tricharia praecox* (Karst.) Boud., etc. Later, the burnt places are overgrown with flowering plants and then such species appear as *Coprinus angulatus* Peck., *Naucoria pseudoamaraescens* (Kühn. et Romagn.) Kühn. et Romagn., *Pholiota carbonaria* (Fr.: Fr.) Sing., *Psathyrella gossypina* (Bull.: Fr.) Pears. et Dennis, *Tephrocybe ambusta* (Fr.: Fr.) Donk. and *T. anthracophila* (Lasch) Orton (= *T. carbonaria* [Vel.] Donk.). On burnt pieces of twigs *Schizophyllum commune* Fr.: Fr. is often found. It is not before the meadow plants completely cover the burnt place when the other species of fungi, not connected with fire, appear.

5. FINAL REMARKS AND THE PROBLEM OF FUNGUS PROTECTION IN THE PARK

The Pieniny National Park, considering its nature, is among the most interesting and richest regions in Poland. There are many mycological curiosities mentioned in the previous chapters.

The Pieniny Mts. fungus flora becomes poorer and poorer from year to year. First of all the fruit-bodies of edible mushrooms disappear. *Boletus edulis* Bull.: Fr. was a common mushroom in the twenties of this century. Even in the sixties single stands of *Boletus edulis* could be found at Wielkie Zalonie, in Kurnikowka meadow, on Lupiska, on Kras and in other places. Now it is a great rarity. In the last few years it has not been observed at all. This is caused both by changes in the natural environment and the constant gathering of mushrooms not only by local inhabitants but also by tourists wandering outside the tourist routes.

Species of rare fungi may be found in various places and in different habitats all over the Park. The localities of these fungi are not stable in general. It happens indeed that some species may be observed in the same place for several successive years but in many cases a mycelium stops fructification after producing fruit-bodies in one vegetation season. It does not die completely, however, but migrates to another place where, sometimes after several years, it starts to bear fruit-bodies again. Such a migration of mycelium has been observed in many cases, e.g. in *Phallogaster saccatus* Morgan. Fruit-bodies of this fungus grew rather abundantly in the beech forest on the northern slope of Ociemny Wierch in September 1968. The next year fruit-bodies did not appear, but in 1970 fructification was abundant again. In 1971 only a few fruit-bodies were found in this place. During several subsequent years this mushroom did not produce fruit-bodies in this place or even in close vicinity.

It was not until 1986 that the fruit-bodies of *Phallogaster saccatus* were found again on the same slope of the mountain and in the same plant community, but in a stand 200 m distant from the original place (though almost at the same altitude). A similar "wandering" of mycelium has been observed in *Sarcosphaera coronaria* (Jacq.) Schroet., as described in the previous chapters. The appearance of fruit-bodies of the same species in other places may be caused not only by the mycelium migration. A new centre of mycelium development may be created from spores transported by wind, water, insects etc. As follows from the observations mentioned the problem of rare fungus protection in the Pieniny must be connected with the necessity of protecting the biotopes in which they occurred. This is, however, connected with suitable management in the National Park.

There are some threats which may badly affect the mushroom vegetation:

- Giving up the meadow mowing may result in the cessation of fungus fructification or even the complete extinction of mycelium. Therefore, meadows, at least some of them, should be mowed every year and the hay should be removed. One of the most interesting sites from the mycological point of view is, undoubtedly, Stolarzowka meadow where some rare mushrooms grow, such as *Camarophyllus lacmus* (Schum.) Lge., *Coprinus friesii* Quél., *Marasmius litoralis* Quél. and some interesting species of the genus *Hygrocybe*.
- Any disturbance of forest litter (e.g. raking, digging etc.) may damage or completely destroy the mycelium of many very rare fungus species fully deserving protection. This refers mostly to the terrestrial fungi of such interesting species as *Amanita regalis* (Fr.) Michael, *Cortinarius percomis* Fr., *Hygrophorus hyacinthinus* Quél., *Cystolepiota bucknalii* (Berk. et Br.) Sing., *Macrolepiota puellaris* (Fr.) Mos., *Phylloporus rhodoxanthus* (Schw.) Bres., *Suillus tridentinus* (Bres.) Sing., etc.
- The removing of old, blown-down tree trunks from the forest may bring about the extinction of many rare species of fungi which are closely connected with decaying wood. The following fungi species belong here: *Bondarzewia montana* (Quél.) Sing., *Fomitopsis rosea* (Alb. et Schw.: Fr.) P.Karst., *Ganoderma lucidum* (Curt.: Fr.) Karst., *Hericium flagellum* (Scop.) Pers., *Phlebia radiata* Fr. (= *Ph. aurantiaca* [Sow.] P. Karst.), *Pycnoporus cinnabarinus* (Jacq.: Fr.) P. Karst.

But in the Pieniny Mts. there are rare species which unfortunately cannot be saved. The hypogean fungus *Hysterangium separabile* Zeller may be mentioned as an example. The only Polish stand in the lower part of the

Harczy Grunt valley lies in a place which will be flooded by the waters of the lake formed by the dam built on the Dunajec river.

SUMMARY

Recent researches on macromycetes of forests and meadows in the Pieniny National Park are presented with some notes on the ecology and the distribution of the species. The problem of fungus protection in the Park is discussed.

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