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ORIGINAL RESEARCH PAPER

Contribution to the knowledge of fungi of the Kampinos National Park (Poland) with particular emphasis on the species occurring in burnt places

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Abstract

The paper presents 32 species of macrofungi new to the Kampinos National Park, found during the studies on fire-damaged areas after the forest fires in 2015. Three species new to Poland were described and illustrated (*Calycellina leucella*, *Exobasidium julianum*, and *Gymnopilus decipiens*). Four species from Polish red list of macrofungi have been recorded in the Kampinos National Park for the first time: *Botryobasidium vagum* (R), *Geastrum coronatum* (V), *Helicogloea farinacea* (E), *Inonotus cuticularis* (R). During the current studies 17 pyrophilous species new to the Kampinos National Park were found.

Keywords

fungal biota; macromycetes; pyrophilous species; post-fire fungi; Ascomycota; Basidiomycota; Poland

Introduction

The Kampinos Forest is located in central Poland, on the left bank of the Vistula River, west of Warsaw. Almost all its area is protected as the Kampinos National Park (Kampinoski Park Narodowy, KPN). KPN was founded in 1959 to preserve the unique complex of inland dunes and marshy areas. It covers over 38500 ha, therefore it is the second largest national park in Poland. The characteristic landscape of KPN shows the mosaic of dune areas, covered by pine and mixed forest, intersected by a swamp belts occupied by alder and riparian forests or vast, wet meadows [1–4]. The fungi of the Kampinos Forest have been studied for over 140 years. The first information about the mycobiota of this area was published by Berdau [5], who listed 67 fungal species from the vicinity of Warsaw including at least one from environs of Wólka Węglowa village (east part of KPN). Further scarce data were provided by Chełchowski [6,7] and Błoński [8]. First systematic investigation of the fungal diversity in the Kampinos Forest was conducted by Rudnicka-Jezińska in the 1960s. This study was focused on the psammophilic species, inhabiting bare and overgrown dunes [9–11]. Additional data have been provided by other scientist (e.g., [12–17]). At the end of the twentieth century, the mycobiota of KPN was known to consist of 415 species. Intensive field works were conducted in the area of KPN in the years 2012–2014, reported in the monograph of fungi of the Park

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[18]. This work lists 1533 taxa (species, varieties, and forms) of macromycetes, found by the authors (1407 taxa) or mentioned in the previous literature (425 taxa). Although KPN has the highest fire hazard category in Poland and incidental and intentional fires have been quite common in its area [19], the post-fire fungi of KPN have not been studied until now. Hitherto, only two non-obligatory pyrophilous species, *Rhizina undulata* Fr. and *Sphaerospora brunnea* (Alb. & Schwein.) Svrček & Kubička, have been reported from the Kampinos Forest [18,20]. At the end of the spring 2015 (May 7 and June 4), two intentional arsons occurred in the central part of KPN. The surface fire took the area of 10.92 ha in the Laski Forestry (forest compartments No. 76 and 77). This fire-incident made an opportunity for additional study of mycobiota of KPN, with special emphasis on the post-fire fungi. The paper presents the list of the fungi new to KPN found on the burned area. Some interesting findings from other places of the Park are also included.

Material and methods

The burned area (10.92 ha) is located in forest compartments No. 76 and 77 of the Laski Forestry, in the east part of KPN, ca. 2.7 km S from Palmiry village (Fig. 1). About half of it is protected as a part of the Sieraków Strictly Protected Area (OOŚS – Obszar Ochrony Ścisłej Sieraków) (Fig. 2), the rest is subject to active protection. It is covered



Fig. 1 Localization of the study area in Kampinos National Park. Yellow circle – fire-damaged wood.

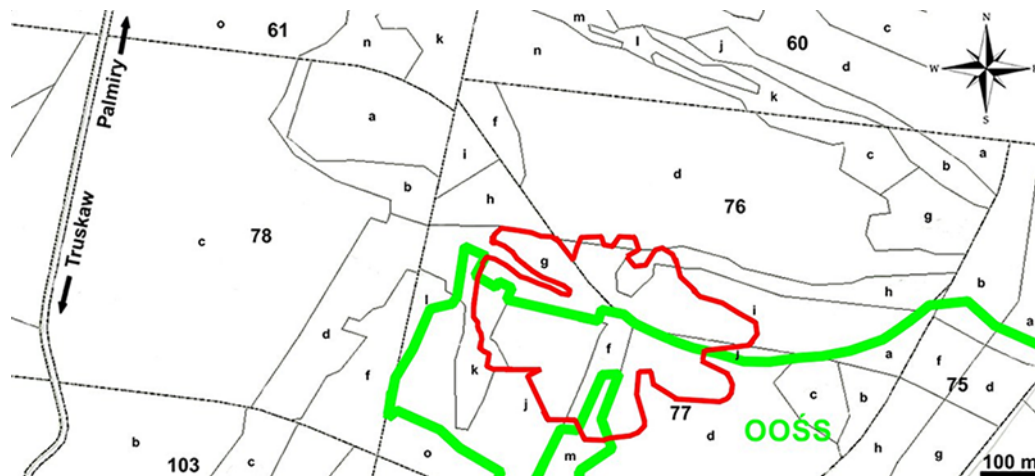


Fig. 2 Localization of burned area in the Kampinos National Park. Red line – borders of burned forest; green line – borders of the Sieraków Strictly Protected Area (OOŚS).

by a 80–200-year-old fresh pine forest growing on podzols. The tree layer is formed mainly by *Pinus sylvestris* with admixture of *Betula pendula*. The understory layer is very loose and scarce, composed from *Quercus robur*, *Betula pendula*, *Juniperus communis*, *Prunus serotina*, and *Frangula alnus*. The forest floor is dominated by moss (mainly *Pleurozium schreberi* and *Dicranum polysetum*, with admixture of *Dicranum scoparium* and *Hylocomium splendens*), with patches of herbal plants (mainly *Convallaria majalis*) and low shrubs (*Vaccinium vitis-idaea*, *V. myrtillus*). The parts strongly damaged by fire are overgrown with tree seedlings (mainly *Betula pendula*, *Populus tremula*, *P. alba*, and *Salix caprea*) and herbs (e.g., *Conyza canadensis*, *Epilobium roseum*, *Lactuca serriola*, *Leontodon autumnalis*, *Senecio sylvaticus*). *Ceratodon purpureus*, *Polytrichum juniperinum*, and *Marchantia polymorpha* predominate in the moss layer. The degree of fire damage differs strongly in the studied area. Most of its surface (especially the margins) are slightly damaged, i.e., only the litter and low shrubs have been destroyed, the tree bases have been sootened, but the trees are practically unharmed. The inner part of the fire area shows much higher damages: most trees have lost the bark or died due to the action of high temperatures (Fig. 3).

The studies were conducted on 45 permanent plots (10 × 10 m) in the Laski Forestry. Eleven of them were located in the interior of the area destroyed by fire, i.e., represented the part of the area damaged by fire to the highest degree. These plots were selected randomly from the 15 most burned sites of the area. The other plots were located systematically along the borders of the burned area and formed 17 pairs. One plot of each pair was located in the burned area and were characterized by lower degrees of fire damage, while the second one was adjacent to it, but in non-burned forest representing the same plant community. Only a small part of the north edge of the burned area was excluded from the study due to protection zone of the black stork's nest. Additionally, the studies were also made by the route method, both on the burned area as well as in the other parts of KPN. The sporocarps were collected once in 2015 (November) and every month between April and October in 2016.



Fig. 3 Appearance of fire-damaged wood in forest compartment No. 77 of the Laski Forestry, the Kampinos National Park; April 27, 2016. Photograph by A. Szczepkowski.

The specimens collected were identified by the standard methods used in fungal taxonomy, using light-microscope and staining in ammonia, KOH, Congo Red, Melzer's reagent, cotton blue in lactophenol, brilliant cresyl blue (CRB), and sulfovanilin. The drawings of microcharacters were made on the basis of microphotographs, taken with Bresser MicroCam 5.0 digital camera and Bresser Science TRM 301 light microscope. All measurements were made directly through the light microscope under an oil immersion objective ($\times 100$). The spore dimensions were established from measurements of 50 randomly selected, well-formed spores (the deformed or atrophied spores were excluded from analysis). The 95% confidence intervals of the mean were calculated and the lower and upper values are given. For other structures, the extreme size values were presented, obtained after measuring 25 elements. Species descriptions were prepared based on all collected specimens. The fungal names were cited after the Knudsen and Vesterholt [21] and MycoBank [22]. Polish distribution data were taken from checklists [23–25] and online database of Polish fungal literature [26]. Threat categories (E – endangered, R – rare, V – vulnerable) in Poland were given according to “Red list of the macrofungi in Poland” (RL) [27]. Dried specimens were deposited in fungaria of the Institute for Agricultural and Forest Environment, Polish Academy of Sciences (IŚRiL), Division of Mycology and Forest Phytopathology of the Warsaw University of Life Sciences – SGGW (WAML), and private fungarium of B. Gierczyk (BGF); each fungarium number represents different collection.

Results: list of species

During the current studies (2015–2016) in KPN, ca. 220 species of macrofungi were identified. In this paper, 32 species hitherto not mentioned from this area have been presented. The most attention has been paid to the area damaged by surface fire in 2015. The arson in KPN resulted in the fire-damage of 10.92 ha of pine forest. On the burned sites, 21 species new to KPN have been recorded, among them 17 are pyrophilous fungi. Three species hitherto not recorded from Poland have been described. Four of the species identified are red-listed, while the other 12 species are currently known from less than 10 contemporary (found after 1945) localities.

Ascomycota

Anthracobia macrocystis (Cooke) Boud.

Specimens examined. Laski Forestry, forest compartment No.: 77j (OOŚS). A dozen of apothecia on burnt soil mixed with charcoal; XI; leg. A. Szczepkowski, P. Zaniewski, det. T. Ślusarczyk, A. Szczepkowski; WAML: 939, 940.

Notes. Species rather rare in Poland, hitherto known from the Pieniny National Park [28], Roztocze National Park [29], Bielinek Reserve [30], Gorcze Mts [31], Zwierzyniec [32], and Zasieki villages [33].

Anthracobia melaloma (Alb. & Schwein.) Boud.

Specimens examined. Laski Forestry, forest compartment No.: 77d (OOŚS). A dozen of apothecia on burnt soil mixed with charcoal; XI; leg. P. Zaniewski, det. T. Ślusarczyk; WAML: 943.

Notes. Species hitherto mentioned from over 10 localities in Poland.

Anthracobia nitida Boud.

Specimens examined. Laski Forestry, forest compartment No.: 76i, 77d (OOŚS), 77j (OOŚS). Numerous apothecia on burnt soil mixed with charcoal; V, XI; leg. A.

Szczepkowski, P. Zaniewski, A. Kujawa, B. Gierczyk, det. B. Gierczyk, T. Ślusarczyk; BGF: KPN/160515/0030, KPN/160515/0035, WAML: 941, 947.

Notes. In Poland, species known only from vicinity of Złoty Potok (Częstochowa Upland) [34].

Calycellina leucella (P. Karst.) Dennis ex E. Müll. (Fig. 4)

Specimens examined. Laski Forestry, forest compartment No.: 76i. On decaying *Betula pendula* leaves on non-burned plot; X; leg. & det. B. Gierczyk; BGF: KPN/161023/0024.

Notes. Species new to Poland. Found in many countries (e.g., Finland [35], Germany [36,37], Switzerland [38], Sweden [39], USA [40]), but everywhere recorded sporadically – probably overlooked because of the minute apothecia.

Species description. Apothecia very small, 300–400 µm in diameter, whitish to yellowish. Marginal hairs white, up to 30 µm long with thin-walled, obtuse apex, below thick-walled and immersed in gel. Ectal excipulum of textura prismatica and textura globulosa, built of thick-walled, gelatinized elements. Asci clavate, 50–75 × 7.5–9 µm, eight-spored, with croziers, apical apparatus of *Calycina* type, amyloid. Ascospores hyaline, smooth, thin-walled, fusiform to scutuloid, (12)13–16(17) × (2)2.4–3.2(3.5) µm. Paraphyses cylindrical, septate, with obtuse apex and refractive vacuolar bodies staining blue in CRB.

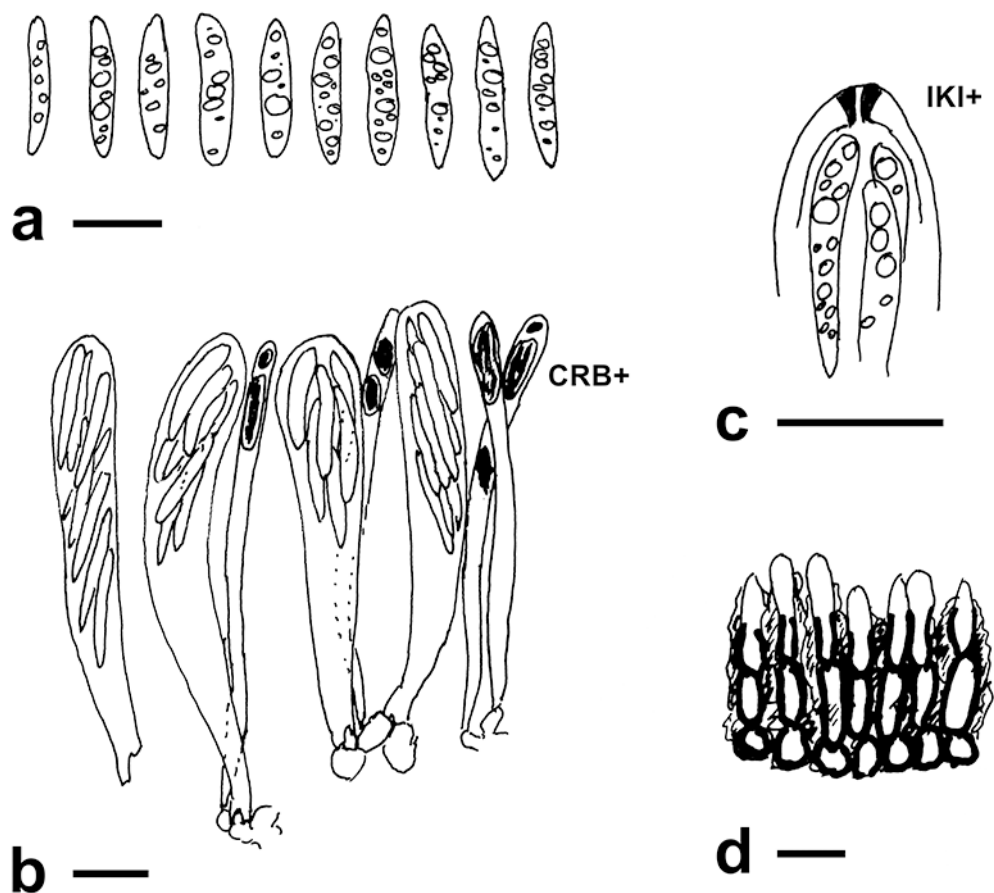


Fig. 4 Microcharacters of *Calycellina leucella*. **a** Ascospores. **b** Asci and paraphyses. **c** Apical apparatus. **d** Marginal hairs immersed in gel. Scale bars: 10 µm.

Colpoma quercinum (Pers.) Wallr.

Specimens examined. Laski Forestry, forest compartments No.: 76i, 77d (OOŚS), 77j (OOŚS), 77k (OOŚS). Very common on dead twigs of *Quercus robur*, both on burned and non-burned areas; IV–X; leg., det. & vid. A. Szczepkowski, B. Gierczyk; BGF: KPN/160515/0015, KPN/160620/0001; WAML: 930.

Notes. Species not rare in Poland, but probably overlooked.

Daldinia decipiens Wollw. & M. Stadler (Fig. 5)

Specimens examined. Laski Forestry, forest compartment No.: 76h. Few stromata on non-burned *Betula pendula* branch; VIII; leg. A. Szczepkowski, det. B. Gierczyk; BGF: KPN/160811/0013.

Notes. In Poland, species hitherto known only from Ochojec Reserve [41] and Biebrza National Park [42].



Fig. 5 Stromata of *Daldinia decipiens* from the Kampinos National Park; August 12, 2016. Photograph by A. Kujawa.

Daldinia vernicosa Ces. & De Not. (Fig. 6)

Specimens examined. Laski Forestry, forest compartments No.: 76h, 77d (OOŚS), 77f (OOŚS), 77g, 77j (OOŚS). Few stromata on partially-burned *Betula pendula* branches roots, root crowns, and trunks, only on the strongly fire-damaged plots; VI–IX; leg. & det. A. Szczepkowski, B. Gierczyk; BGF: KPN/160620/0006, KPN/160714/0009, KPN/160812/0006.

Notes. Species very rare in Poland, known only from Gdańsk and Myszyńiec (wrongly cited as “Myschinjetz”) [43].

Geopyxis carbonaria (Alb. & Schwein.) Sacc.

Specimens examined. Laski Forestry, forest compartment No.: 77d (OOŚS), 77j (OOŚS). Numerous apothecia on burned ground and charcoal; IV; leg. & det. A. Kujawa, A. Szczepkowski; IŚRiL: 13/KPN/14.04.2016, 8/KPN/15.04.2016.

Notes. Species rather common in Poland and known from over 40 localities.



Fig. 6 Stromata of *Daldinia vernicosa* in the Kampinos National Park. **a** June 20, 2016. **b** August 12, 2016. Photographs by A. Szczepkowski.

Inermisia ?fusispora (Berk.) Rifai [= *Byssonectria fusispora* (Berk.) Rogerson & Korf]

Specimens examined. Laski Forestry, forest compartment No.: 76i. Numerous apothecia on burned sandy ground and charcoal, under elk dung; IV; leg. & det. A. Kujawa; IŚRiL: 7/KPN/15.04.2016.

Notes. In Poland, species hitherto known from over 10 localities. According to Pfister [44] the occurrence on burnt ground is typical of *I. fusispora*. Similar species, *Thelebolus terrestris* Alb. & Schwein. [= *Byssonectria terrestris* (Alb. & Schwein.) Pfister] is associated with dung and urinated litter and soil. Macroscopically, these species differ only in the thickness of the myceliar mat under the apothecia, which is 1–2 mm thick for *T. terrestris* and rather scanty for *I. fusispora*. The ascospore size of both species overlaps (18.5–25.5 × 8–10.5 μm vs. 24–29 × 7–11 μm for *T. terrestris* and *I. fusispora*, respectively). The macro- and microscopic characters of the specimens from KPN match better that of the *I. fusispora*, i.e., the ascospore size is 23.5–27 × 7.5–11 μm and the myceliar layer is thin and indistinct.

Lachnellula suecica (de Bary ex Fuckel) Nannf.

Specimens examined. Laski Forestry, forest compartment No.: 76i. Numerous apothecia on non-burned twigs of *Pinus sylvestris*; VII; leg. A. Kujawa, det. B. Gierczyk; BGF: KPN/160714/0008.

Notes. In Poland, species hitherto recorded a few times, from the Karkonosze Mts [45], the Tatry Mts [46–52], and Babia Góra Mt [53]. All Polish records refer to the specimens collected on *Pinus mugo*, except for those from Babia Góra Mt (*Picea abies* and *Pinus mugo*).

***Orbilbia xanthostigma* (Fr.) Fr.**

Specimens examined. Laski Forestry, forest compartment No.: 77k (OOŚS). Numerous apothecia on non-burned *Betula pendula* log; IV; leg. & det. A. Kujawa; IŚRiL: 15/KPN/14.04.2016.

Notes. Species rather common in Poland, known from over 20 localities.

***Peziza echinospora* P. Karst.**

Specimens examined. Laski Forestry, forest compartments No.: 76h, 77g, 77j (OOŚS). Few apothecia on burnt soil mixed with charcoal; V; leg. A. Kujawa, B. Gierczyk, A. Szczepkowski, det. B. Gierczyk; BGF: KPN/160515/0018, KPN/160515/0021, KPN/160515/0034, KPN/160516/0011.

Notes. In Poland, species recorded from over 20 localities.

***Peziza pseudoviolacea* Donadini**

Specimens examined. Laski Forestry, forest compartments No.: 77d (OOŚS), 77j (OOŚS). A few apothecia on burnt soil mixed with charcoal; IV; leg. & det. A. Kujawa, A. Szczepkowski; IŚRiL: 14/KPN/14.04.2016, 9/KPN/15.04.2016.

Notes. Species very rare in Poland, known only from the Gorce Mts, where it was detected as endophyte of roots of *Picea abies* [54].

***Plicaria carbonaria* (Fuckel) Fuckel**

Specimens examined. Laski Forestry, forest compartments No.: 76i. A dozen of apothecia on burnt soil mixed with charcoal, only on the strongly fire-damaged plot; XI; leg. A. Szczepkowski, P. Zaniewski, det. T. Ślusarczyk; WAML: 938.

Notes. Species very rare in Poland, known only from the Długie Lake Reserve [55] and Cieszyn [56].

***Plicaria endocarpoides* (Berk.) Rifai [= *P. leiocarpa* (Curr.) Boud.] (Fig. 7)**

Specimens examined. Laski Forestry, forest compartments No.: 76h, 76i, 77f (OOŚS), 77g, 77j (OOŚS). A dozen of apothecia on burnt soil mixed with charcoal, only on



Fig. 7 Apothecia of *Plicaria endocarpoides* from the Kampinos National Park; May 16, 2016. Photograph by A. Kujawa.

the strongly fire-damaged plots; IV–V; leg. A. Kujawa, B. Gierczyk, A. Szczepkowski, det. A. Kujawa, B. Gierczyk; IŚRiL: 9/KPN/14.04.2016, 2/KPN/15.04.2016; BGF: KPN/160515/0023, KPN/160515/0028, KPN/160516/0003, KPN/160516/0007, KPN/160516/0010, KPN/160516/0013.

Notes. In Poland, species recorded from five localities: the Gorce Mts [31], forests near Zasieki [33], Roztocze National Park [29], Janów Forest Landscape Park [57], and Notecka Forest [58].

Plicaria trachycarpa (Curr.) Boud.

Specimens examined. Laski Forestry, forest compartment No.: 76i, 77d (OOŚS), 77g. Few apothecia on burnt soil mixed with charcoal; VII, XI; leg. A. Szczepkowski, P. Zaniewski, det. B. Gierczyk, T. Ślusarczyk; BGF: KPN/160714/0005, WAML: 937, 945, 946.

Notes. In Poland, species recorded only from the Pieniny National Park [28], Długie Lake Reserve [55], and Babia Góra National Park [59].

Trichophaea abundans (P. Karst.) Boud. (Fig. 8)

Specimens examined. Laski Forestry, forest compartments No.: 77g, 77j (OOŚS). Numerous apothecia on burned branches of *Pinus sylvestris*, only on the strongly fire-damaged plots; VI; leg. & det. B. Gierczyk; BGF: KPN/160620/0008, KPN/160621/0001.

Notes. In Poland, species recorded only from Babia Góra Mt [53,59] and the Gorce Mts [31].



Fig. 8 Apothecia of *Trichophaea abundans* from the Kampinos National Park; June 21, 2016. Photograph by M. Snowarski.

Basidiomycota

Agrocybe dura (Bolton) Singer

Specimens examined. Izabelin, near the headquarters buildings of the KPN management. A few basidiocarps on dry lawn; VII; leg. & det. B. Gierczyk; BGF: KPN/160715/0001.

Notes. Species rather common in Poland.

Botryobasidium vagum (Berk. & M. A. Curtis) D. P. Rogers; RL-R

Specimens examined. Laski Forestry, forest compartment No.: 77d (OOŚS). A few basidiocarps on *Pinus sylvestris* log on non-burned plot; IX; leg. & det. T. Ślusarczyk; WAML: 944.

Notes. In Poland, species known hitherto from more than 10 localities.

Coprinellus angulatus (Peck) Redhead, Vilgalys & Moncalvo (= *Coprinus angulatus* Peck non J. E. Lange)

Specimens examined. Laski Forestry, forest compartment No.: 77d (OOŚS), 77g. Numerous basidiocarps on burned soil mixed with charcoal and on burned wood only on the strongly fire-damaged plots; V–VI, X; leg. A. Kujawa, B. Gierczyk, A. Szczepkowski, det. B. Gierczyk; BGF: KPN/160516/0002, KPN/160516/0006, KPN/160621/0007, KPN/161023/0033.

Notes. In Poland, species hitherto known from ca. 20 localities.

Coprinopsis laanii (Kits van Wav.) Redhead, Vilgalys & Moncalvo (= *Coprinus laanii* Kits van Wav.)

Specimens examined. Laski Forestry, forest compartment No.: 78c. A few basidiocarps on decorticated roots of *Pinus sylvestris* on the dirt road in pine forest; IX; leg. & det. B. Gierczyk; BGF: KPN/160917/0003.

Notes. In Poland, species hitherto mentioned only from Jasienica [60]. The record from the Tatry National Park ([25] after [61]) probably concerns different species [62].

Exobasidium juelianum Nannf. (Fig. 9)

Specimens examined. Laski Forestry, forest compartment No.: 77j (OOŚS). A few infected upper parts of the shoots of *Vaccinium vitis-idaea* (both on the leaves and twigs) in pine forest damaged by fire; IX; leg. & det. B. Gierczyk; BGF: KPN/160917/0002.

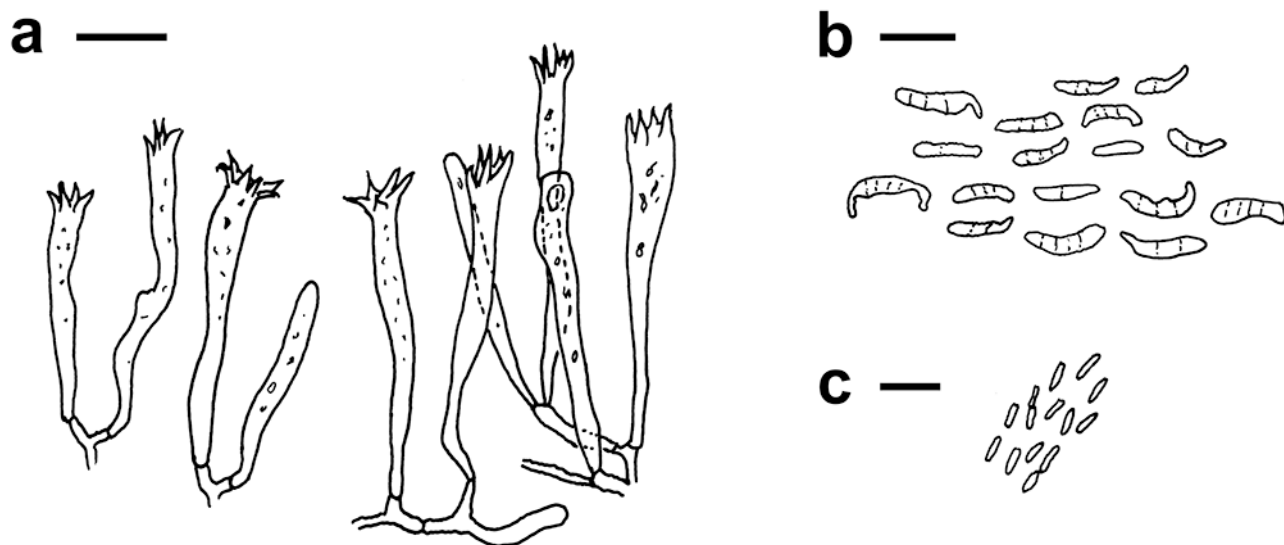


Fig. 9 Microcharacters of *Exobasidium juelianum*. **a** Basidia. **b** Basidiospores. **c** Conidia. Scale bars: 10 μ m.

Notes. Species new to Poland. In Europe, widely distributed but everywhere rare, known, e.g., from Austria [63], Czech Republic [64], Germany [65], Switzerland [66], and Great Britain [67].

Species description. This fungus is a parasite of *Vaccinium vitis-idaea*. The infected plants form stunted, less stout shoots. Their leaves are somewhat rolled or wavy, smaller, softer, and thinner than that of healthy plants. All infected parts are light red or pinkish. The hymenium forms on the underside of the leaves as a whitish, thin, farinose layer. The (sub)cylindrical, somewhat sinuous, $25\text{--}50 \times 5\text{--}6 \mu\text{m}$, 4–6 sterigmate basidia grow out from between the cells of host cuticle. Basidiospores cylindrical, often irregularly curved, hyaline, smooth, 1–5 septate, $(8)9\text{--}12(14) \times (2.2)2.5\text{--}3(3.2) \mu\text{m}$, without iodine reaction. Conidia few, forming at the basidiospores ends, cylindrical, hyaline, smooth, $4\text{--}5 \times 1\text{--}1.2 \mu\text{m}$. Clamps absent. *Exobasidium juelianum* differs from *E. vaccini* (Fuckel) Woronin by the type of infection, which is systemic in the former species (all parts of the shoots are infected) and local in the latter (the fungus forms red galls on individual leaves). The spores and conidia of *E. juelianum* are somewhat shorter than that of *E. vaccini*.

Gastrum coronatum (Schaeff.) J. Schröt.; RL-V

Specimens examined. Nart village. A dozen of last-year specimens on soil and litter near abandoned root cellar; V; leg. & det. A. Szczepkowski; WAML: 855.

Notes. Species not rare in Poland, known from ca. 20 localities.

Gymnopilus decipiens (W. G. Sm.) P. D. Orton (Fig. 10 and Fig. 11)

Specimens examined. Laski Forestry, forest compartments No.: 76h, 76i, 77f (OOŚS), 77g, 77i (OOŚS), 77j (OOŚS). Very numerous specimens on burnt soil and charcoal only on the strongly fire-damaged plots; VI–X; leg. & det. A. Kujawa, B. Gierczyk, A. Szczepkowski; BGF: KPN/160620/0003, KPN/160620/0005, KPN/161023/0032.

Notes. Species new to Poland. Known from many European countries (e.g., France, Czech Republic, Germany, Norway, Sweden), but everywhere very rare [21,68,69].

Species description. Basidiocarps small to medium size. Pileus 10–40(50) mm, convex, distinctly fibrillose felty, sometimes with discrete scales and squamules, orange-brown, reddish-brown, or dirty brown. Lamellae adnexed to adnate, first yellow then orange yellow to yellowish-brown. Stipe 10–30 \times 2–5 mm, fibrillose, brownish, paler than pileus, covered with scanty veil remains. Flesh yellow, taste mild, smell neutral. Basidiospores amygdaliform with suprahilar depression in side view, in frontal view more ellipsoid, rusty brown, distinctly verrucose, dextrinoid at maturity, $(7)7.5\text{--}9.5(10) \times (4)4.5\text{--}5(5.5) \mu\text{m}$. Basidia four-spored, subcylindrical or somewhat clavate, 20–25 \times 5–6.5 μm , staining yellowish-brown in ammonia when old. Cheilocystidia 20–30 \times 6–10 μm , very variable, narrowly fusiform, lageniform, utriform to almost cylindrical, apex obtuse, often capitate (capitulum up to 5.5 μm broad), with granulate content staining yellow-brown in ammonia when old. Pleurocystidia not seen. Lamellar trama regular, composed from incrustated hyphae with brownish content, 6–10 μm broad. Pileipellis formed by densely arranged, interwoven, hyphae $(4)5\text{--}9(10) \mu\text{m}$ broad, covered with rusty zebra-like incrustation. Terminal elements cylindrical to narrowly clavate. Pileo- and caulocystidia absent. Clamps present.

Helicogloea farinacea (Höhn.) D. P. Rogers [= *H. pinicola* (Bourdot & Galzin) Baker; *Saccoblastia farinacea* (Höhn.) Donk]; RL-E

Specimens examined. Laski Forestry, forest compartments No.: 77j (OOŚS). A few basidiocarps on twigs of *Frangula alnus*; V; leg. & det. B. Gierczyk; BGF: KPN/160515/0022.



Fig. 10 Basidiocarps of *Gymnopilus decipiens* from the Kampinos National Park. **a-c** June 20, 2016. Photographs by A. Szczepkowski (**a**) and A. Kujawa (**b,c**).

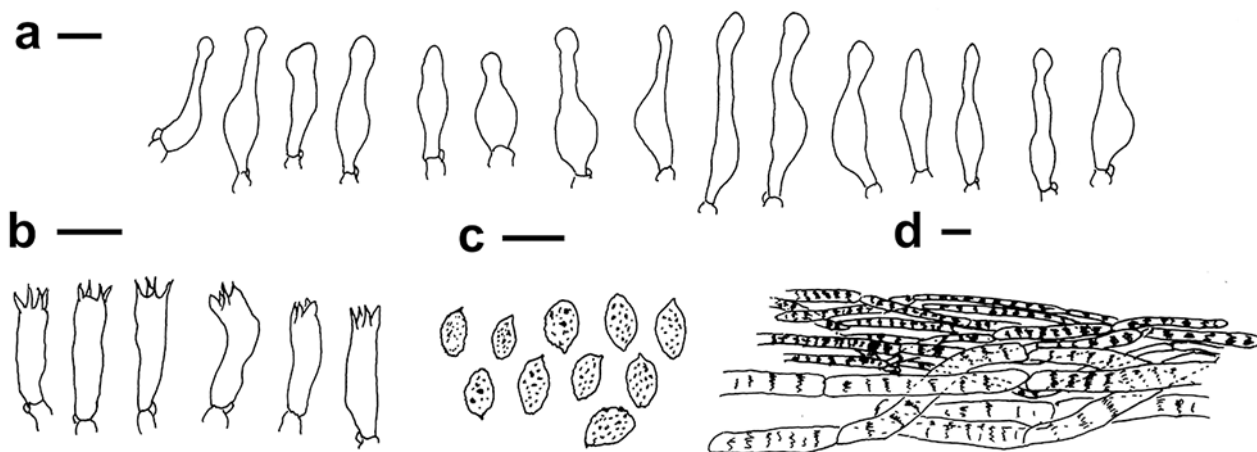


Fig. 11 Microcharacters of *Gymnopilus decipiens*. **a** Cheilocystidia. **b** Basidia. **c** Basidiospores. **d** Pileipellis. Scale bars: 10 μ m.

Notes. In Poland, species hitherto collected only in Tatry National Park on *Picea abies* [70,71].

Inonotus cuticularis (Bull.) P. Karst.; RL-R

Specimens examined. Buffer zone of KPN, Palmiry village, Kusocińskiego Street. Many basidiocarps on the basis and on trunk of dead *Acer platanoides* in the avenue; VIII; leg. & det. A. Szczepkowski; WAML: 859.

Notes. Species not rare in Poland.

Lyophyllum anthracophilum (Lasch) M. Lange & Silverstein

Specimens examined. Laski Forestry, forest compartments No.: 76h, 76i, 77g, 77d (OOŚS), 77f (OOŚS), 77j (OOŚS), 77k (OOŚS). Numerous basidiocarps on burnt soil and charcoal; V, X; leg. & det. A. Kujawa, B. Gierczyk, A. Szczepkowski; BGF: KPN/160516/0012, KPN/161023/0003, KPN/161023/0008, KPN/161023/0009, KPN/161023/0013, KPN/161023/0022, KPN/161024/0006.

Notes. Species common in Poland.

Mycena septentrionalis Maas Geest.

Specimens examined. Laski Forestry, forest compartments No.: 76i, 77d (OOŚS). Numerous basidiocarps on soil and litter in both fire-disturbed and reference plots; X; leg. & det. B. Gierczyk; BGF: KPN/161023/0017, KPN/161024/0007.

Notes. Species known from over 20 localities in Poland.

Peniophora pini (Schleich.) Boidin

Specimens examined. Laski Forestry, forest compartments No.: 77d (OOŚS), 77f (OOŚS), 77j (OOŚS), 77k (OOŚS). Many specimens on the bark of the *Pinus sylvestris* branches, both on burned and non-burned plots; V–VII; leg., det. & vid. A. Szczepkowski; WAML: 931, 932.

Notes. Species rather common in Poland.

Pholiota highlandensis (Peck) Quadr.

Specimens examined. Laski Forestry, forest compartments No.: 76h, 76i, 77g, 77d (OOŚS), 77f (OOŚS), 77g, 77j (OOŚS), 77k (OOŚS). Very numerous basidiocarps on burnt soil and charcoal; IV–XI; leg., det. & vid. A. Kujawa, B. Gierczyk, A. Szczepkowski, T. Ślusarczyk; IŚRiL: 5/KPN/14.04.2016; BGF: KPN/160515/0005, KPN/160515/0017, KPN/160715/0004; WAML: 935.

Notes. Species common in Poland.

Psathyrella pennata (Fr.) A. Pearson & Dennis

Specimens examined. Laski Forestry, forest compartments No.: 76h, 76i, 77g, 77f (OOŚS), 77j (OOŚS). Numerous basidiocarps on burnt soil and charcoal, only on the strongly fire-damaged plots; IV–VII, XI; leg., det. & vid. A. Kujawa, B. Gierczyk, A. Szczepkowski; IŚRiL: 3/KPN/15.04.2016, 4/KPN/15.04.2016; BGF: KPN/160515/0016, KPN/160515/0024, KPN/160515/0029, KPN/160515/0031, KPN/160515/0033, KPN/160516/0008, KPN/160516/0009, KPN/160516/0018, KPN/160620/0004, KPN/161023/0001; WAML: 936.

Notes. Species hitherto mentioned from over 10 localities in Poland.

Tomentella terrestris (Berk. & Broome) M. J. Larsen

Specimens examined. Laski Forestry, forest compartments No.: 77f (OOŚS). A few basidiocarps on partially burned *Pinus sylvestris* log; VIII; leg. & det. B. Gierczyk; BGF: KPN/160811/0007.

Notes. In Poland, species mentioned only from a few localities: the Lubiaszów Reserve, Łaznów Reserve [72], Ochojec Reserve [41], and in ectomycorrhizal association with *Abies alba* in Pomerania (Kartuzy, Lipusz, Osusznica, and Sławno villages) [73,74].

Discussion

The current studies increases the number of macrofungal taxa known from KPN up to 1565 (1374 Basidiomycota and 191 Ascomycota). Among the recorded taxa, there are a few species quite common in Poland (e.g., *Colpoma quercinum* or *Mycena septentrionalis*), which are not pyrophilous and are quite abundant in the studied area, but had not been found in KPN previously. This indicates that even intensive, 3-year-long field works are too short to complete the fungal species list of a certain area. Although in the previous studies conducted in KPN the post-fire habitats (e.g., places after campfires or trees damaged by lightning) were carefully examined for the presence of pyrophilous fungi, the list of these species included only two taxa [18]. During the current studies, 19 species of fungi associated with charcoal and burned places were found, i.e., 17 new to KPN (*Anthracobia macrocystis*, *A. melanoma*, *A. nitida*, *Coprinellus angulatus*, *Daldinia vernicosa*, *Geopyxis carbonaria*, *Gymnopilus decipiens*, *Inermisia ?fusispora*, *Lyophyllum anthracophilum*, *Peziza echinospora*, *P. pseudoviolacea*, *Plicaria carbonaria*, *P. endocarpoides*, *P. trachycarpa*, *Pholiota highlandensis*, *Psathyrella pennata*, *Trichophaea abundans*) and both taxa mentioned earlier (*Rhizina undulata*, *Sphaerospora brunnea*). Moreover, most of them produced numerous sporocarps, even thousands of specimens (*Gymnopilus decipiens*, *Lyophyllum anthracophilum*, *Pholiota highlandensis*, *Psathyrella pennata*, *Rhizina undulata*). Therefore, one could conclude that for the occurrence and development of these species, large-scale fires are essential. After the first year of study, the recorded number of post-fire fungi in KPN (19) is the highest compared to other published results from Poland. Adamczyk et al. [34] recorded 18 species on 20 old camp-fires (a 3-year-long study), 17 taxa were found on 10 burned places in the Gorce Mts [31] (over 2-year-long observations), while 16 species were found in the fire-destroyed part of Jelonka Reserve [75] (6-year-long observations). Results obtained on large-area fire places in managed forests have shown a distinctly lower diversity of pyrophilous mycobiota (species number between 8 and 13) in these ecosystems [33,58,76]. These differences and uniqueness of KPN may be the result of a few factors. Firstly, the burned area is, in part, a long-term protected one as the Sieraków Strictly Protected Area and it is overgrown by a ca. 200-year-old forest. Moreover, the KPN is very often damaged by fires of different range, ca. 80 times every year (about half of all fires recorded in national parks in Poland). These give post-fire organisms a good opportunity to outlast and propagate.

Three species new to Poland were collected in the studied area. One of them are post-fire species, i.e., *Gymnopilus decipiens*. Next two species, *Calycellina leucella* and *Exobasidium julianum*, are not associated with burnt places. A few of the species recorded are very rare in Poland, hitherto mentioned from single localities (*Coprinopsis laanii*, *Helicogloea farinacea*). *Peziza pseudoviolacea* has been hitherto mentioned from Poland only as an endophyte of roots of *Picea abies* [54]. Current findings are the first observations of the apothecia formation by this species in this area. *Lachnellula suecica* was found on the new substratum (*Pinus sylvestris*), since the past findings from Poland were associated with *Pinus mugo* and *Picea abies* [23,53].

The studies on fire-damaged areas of KPN will be continued in the coming years and the results and analyses of changes in the fungal biota during the habitat regeneration will be published.

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