

original research paper

## New species of corticioid fungi (Basidiomycota) for Poland found in Białowieża Primeval Forest in 2018–2020

Eugene Yurchenko<sup>1\*</sup>, Marek Wołkowycki<sup>2</sup>

Institute of Forest Sciences, Białystok University of Technology, Piłsudskiego str. 1A, 17-200 Hajnówka, Poland; <sup>1</sup>ORCID 0000-0001-9460-3774; <sup>2</sup>ORCID 0000-0001-5717-5010

\* To whom correspondence should be addressed. Email: [yauheni.yurchanka@pb.edu.pl](mailto:yauheni.yurchanka@pb.edu.pl)

### Abstract

Eight new species of fungi (*Acanthobasidium norvegicum*, *Amylocorticium laceratum*, *Hyphoderma transiens*, *Odonticum septocystidiatum*, *Phlebia cretacea*, *Ph. subulata*, *Steccherinum albidum*, and *Tubulicrinis calothrix*) were identified for Poland after a study of collections from large forests situated in the northeast part of the country. *Leptosporomyces fuscostratus* was confirmed for Polish mycobiota. Main diagnostic features, natural range, substratum preferences, and taxonomic position of these species are discussed. Color images of basidiomata for 9 species, line drawings of microscopic structures for 6 species, and scanning electron microscopy images of important microstructures for 4 species are provided.

**Key words:** Aphyllophorales; geography; micromorphology; Polyporales; wood decay basidiomycetes

Running head: Corticioid fungi from Białowieża forest

### Introduction

Corticioid fungi is an artificial assemblage of the species from the phylum Basidiomycota and class Agaricomycetes, characterized by effused or effused-reflexed basidiomata, one-celled basidia, and hymenophore of various configurations, from smooth to raduloid and reticulately folded, but excluding poroid and lamellate types. Many of these fungi have flat, thin fruitbodies, that develop on dead wood in all seasons, excluding frost periods. They are considered by mycologists as a separate group, accepted historically on the basis of similar macromorphology of basidiomata, ecology, and methodical approaches for study of species. We accept a brief definition of corticioid fungi (Yurchenko, 2020) as non-poroid resupinate Aphyllophorales, following Jülich and Stalpers (1980), and including one genus of Tremellomycetes, *Syzygospora*. The latter has a peculiar morphology of basidia, resembling true homobasidia, and the ability of some species to develop very small film-like basidiomata. We also belong *Dentipratulum*, a genus with hydroid hymenophore, to corticioid fungi, because its fructifications have scarce subiculum (see Holec & Zehnálek, 2021).

Species diversity of corticioid fungi in Poland is relatively well studied. The monograph by Wojewoda (2003) is the most recent catalogue of the all the larger basidiomycetes, found in Poland. It includes 293 species of corticioid fungi as defined above. However, new species are recorded almost every year for the country.

Białowieża Primeval Forest is one of the largest and best-preserved non-montane deciduous forest massif in Europe (Bobic, 2002). It is an area of particular interest for

mycologists (Ruszkiewicz-Michalska et al., 2021) due to its old-aged ecosystems, scarcely modified by human activity, that include both nemoral (associated with e.g. *Quercus robur*) and boreal (associated with *Picea abies* and *Pinus sylvestris*) elements of biota. Larger basidiomycetes have been studied here since 1826, but a monographic treatment of corticioid fungi has not been realized yet (see Kujawa et al., 2018).

In the present paper we give the characteristics of some new species thereby adding to the list of Polish fungi.

## Material and Methods

The new species for Polish mycobiota were identified after microscopic examination of 540 specimens of corticioid fungi, stored in the herbarium of Institute of Forest Sciences, Białystok University of Technology (BLS, Hajnówka). These specimens were collected by Marek Wołkowycki from the northeast part of Poland, in the period 1993–2022; most collections belong to the years 2018–2020. About 95% of the specimens examined were collected in Białowieża Primeval Forest (southeast part of Podlaskie voivodeship), 1% in Knyszyn Primeval Forest (central-east part of Podlaskie voivodeship), and 4% in Piska Primeval Forest (southeast part of Warmińsko-Mazurskie voivodeship).

Macro- and micromorphology was studied on dry basidiomata. The pictures of fresh basidiomata of some species taken soon after their collection were also used to document macromorphology. For microscopic slides, vertical hand sections of the basidiomata were rehydrated in 3% aqueous potassium hydroxide (abbreviated as KOH in the text). Incrustations on hyphae and hymenial elements and amyloid reaction of basidiospores were studied in Melzer's reagent, wherever necessary. Microscopic measurements were done on Nikon Eclipse Ni-U light microscope (Nikon Corp., Japan), mostly under  $\times 1000$  magnification, by NIS-Elements Br imaging software (Nikon Corp.). Spore quotient (Q) was determined as length/width ratio for individual spores.

Scanning electron images of selected microstructures of the fungi were obtained on Phenom G2 pro desktop microscope (Labmate, UK). For these images, pieces of fruitbodies were taken from the herbarium, glued to metallic stands using double-sided adhesive film, and coated with 3.1–3.2 nm layer of gold in a Leica EN ACE200 vacuum coater (Leica Microsystems, Germany).

To confirm that a species was not published for the country before, we used the checklist of Wojewoda (2003), and a checklist in the resource *grzyby.pl* (Snowarski, 2022). Some additional data on species distribution were taken from the Global Biodiversity Information Facility (<https://www.gbif.org>).

Nomenclature of the species mostly follows MycoBank (<https://www.mycobank.org>); systematic position in the hierarchy above genera follows Dictionary of the Fungi system (<http://speciesfungorum.org/names/fundic.asp>), except *Odonticium septocystidium*. Nomenclature of forest communities follows Matuszkiewicz et al. (2012).

## Results

The study revealed that eight species of fungi identified by us had not been published in articles or monographs for Poland earlier. Besides, we found that one species, *Leptosporomyces fuscostratus*, required clarification of its status in Polish biota. The data about these species are given below.

***Acanthobasidium norvegicum*** (J. Erikss. & Ryvarden) Boidin, Lanq., Cand., Gilles & Hugueneu (Stereaceae, Russulales)

Syn. *Aleurodiscus norvegicus* J. Erikss. & Ryvarden

Figures 1A, 3A; 4

The species is distinguished by the following main features: poorly developed subiculum (10–25 µm thick); numerous subcylindrical or fusoid cystidia, having pale brownish-yellow granular or resinous contents in water and KOH; presence of acanthophyses; (1)2-sterigmate basidia; large (9–12 µm long) amyloid basidiospores, covered by warts, easily observable in Melzer's reagent. Some basidia have scarce, short lateral protuberances in their lower half. Occasional basidia have a transverse secondary septum. The acanthophyses of this fungus resemble basidia in shape. Our specimen exhibited mostly 2 apical protuberances on acanthophyses, whereas in pictures published by other authors (Larsson & Ryvarden, 2021; Martini, 2016) the number of protuberances reached 4–7. Spores of this fungus look almost smooth in KOH.

This species is distributed in Western Europe, from Norway and Sweden to Portugal (Bernicchia & Gorjón, 2010; Eriksson & Ryvarden, 1973). Our locality is the easternmost known for the species.

The usual substrata for this species are dead *Calluna* stems and twigs (Eriksson & Ryvarden, 1973). The fungus was reported on *Rubus* in France (Wu et al., 2001).

In molecular phylogeny studies (Tian et al., 2018; Wu et al., 2001), it was proposed to belong *Aleurodiscus norvegicus* to the derivative genus *Acanthobasidium* together with *A. phragmitis* Boidin, Lanq., Cand., Gilles & Hugueneu and *A. weirii* (Burt) L.D. Dai & S.H. He. The generic name indicates that some basidia in *A. norvegicus* have lateral protuberances, and supposedly acanthophyses are immature basidia (Eriksson & Ryvarden, 1973; Martini, 2016).

**Specimen examined:** Białowieża Primeval Forest, near Topiło village, compart. No. 574Ch, *Vaccinio uliginosi-Pinetum*, on dead corticated twigs of *Vaccinium uliginosum*, 1–5 mm diam., coll. M. Wołkowycki, 2 XI 2019 (BLS M-3535).

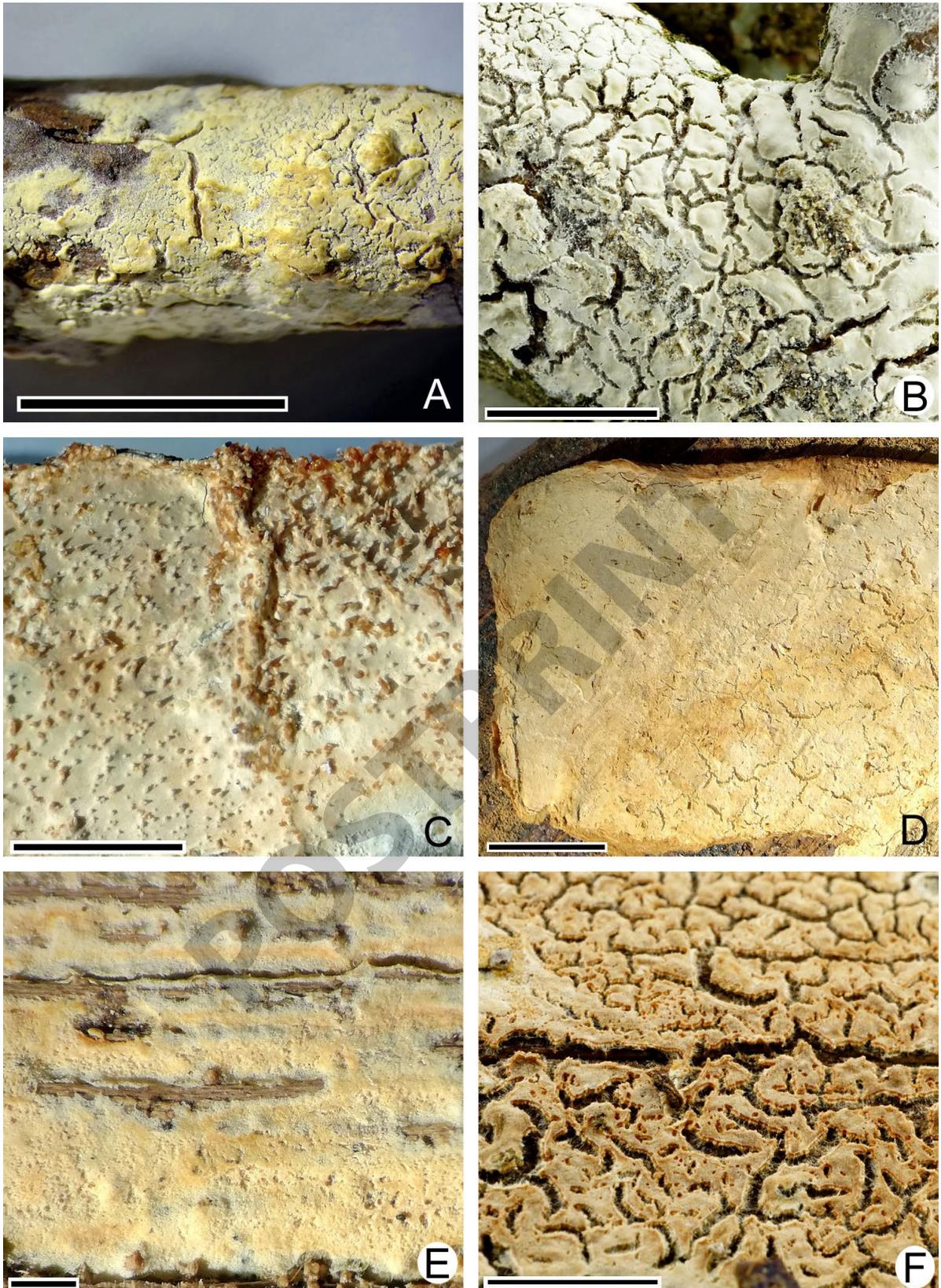
***Amylocorticiium laceratum*** (Litsch.) Hjortstam & Ryvarden (Amylocorticiaceae, Amylocorticiales)

Figures 1B, 5

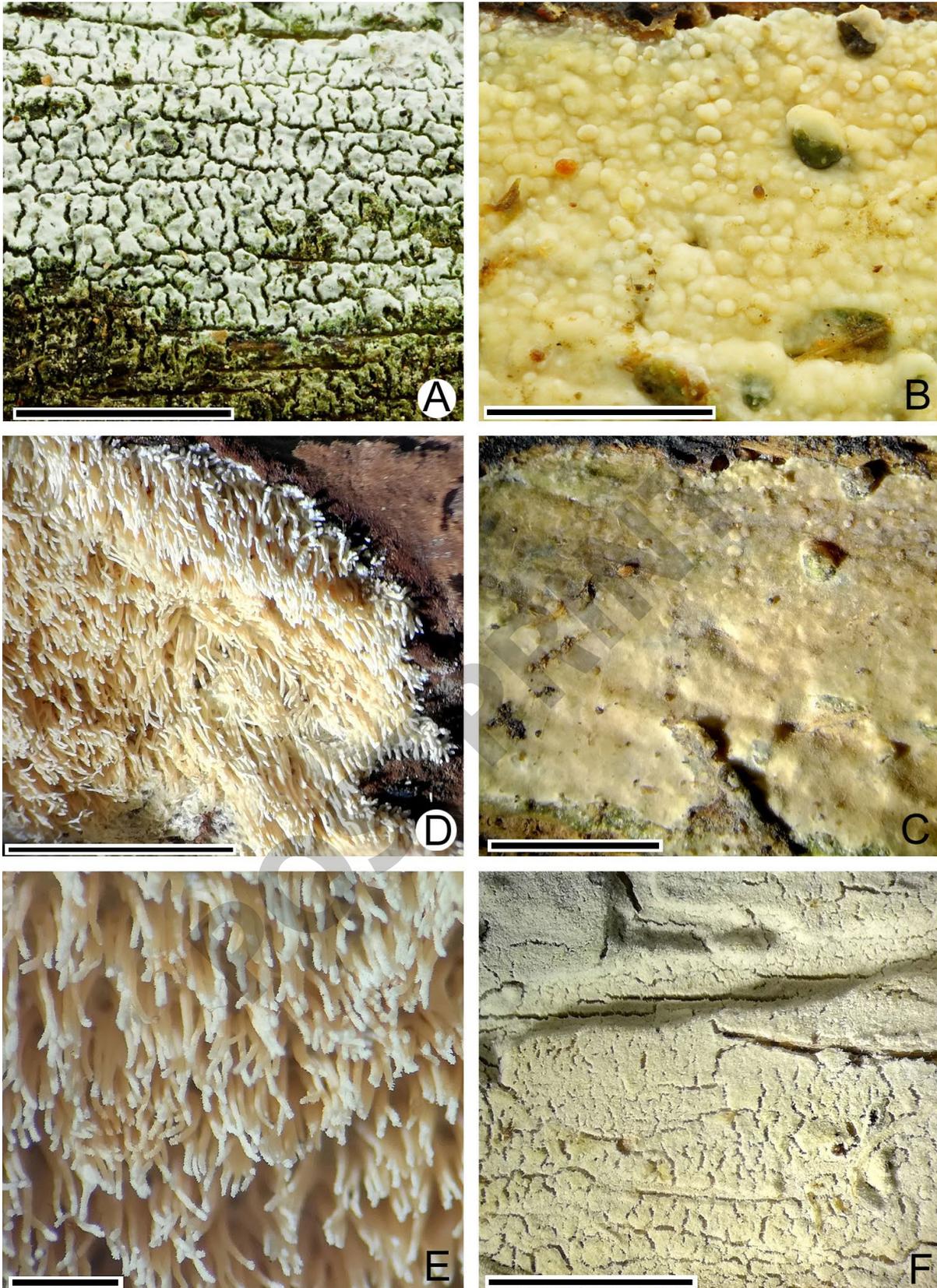
Syn. *Athelopsis lacerata* (Litsch.) J. Erikss. & Ryvarden

The species is distinguished by white, pellicular basidiomata, comparatively narrow hyphae [1.3–2.5(–3.5) µm], substipitate-clavate basidia, and allantoid, but relatively broad spores (Q=2.7–3.3) with well pronounced apiculus and amyloid reaction. Basidia usually have maximal width near their middle part; sterigmata of basidia are short and wide throughout most of their development period. Spores in our specimen turn bluish with pale yellow hue in Melzer's reagent. Additional notable feature is the minutely guttulate contents of hyphae in KOH. Our specimen showed encrusted subhymenium, while this feature was not noted for the species earlier (Eriksson & Ryvarden, 1973; Zmitrovich, 2008). Eriksson and Ryvarden (1973) indicated non-granular protoplasm in the basidioles to be a diagnostic character, but in our specimen hymenial elements are minutely guttulate or granular in water and KOH. Spores in our specimen (6–8 × 2.7–3.3 µm) are somewhat larger, than in descriptions of *A. laceratum* (6–7 × 2.5 µm; Bernicchia & Gorjón, 2010; Larsson & Ryvarden, 2021).

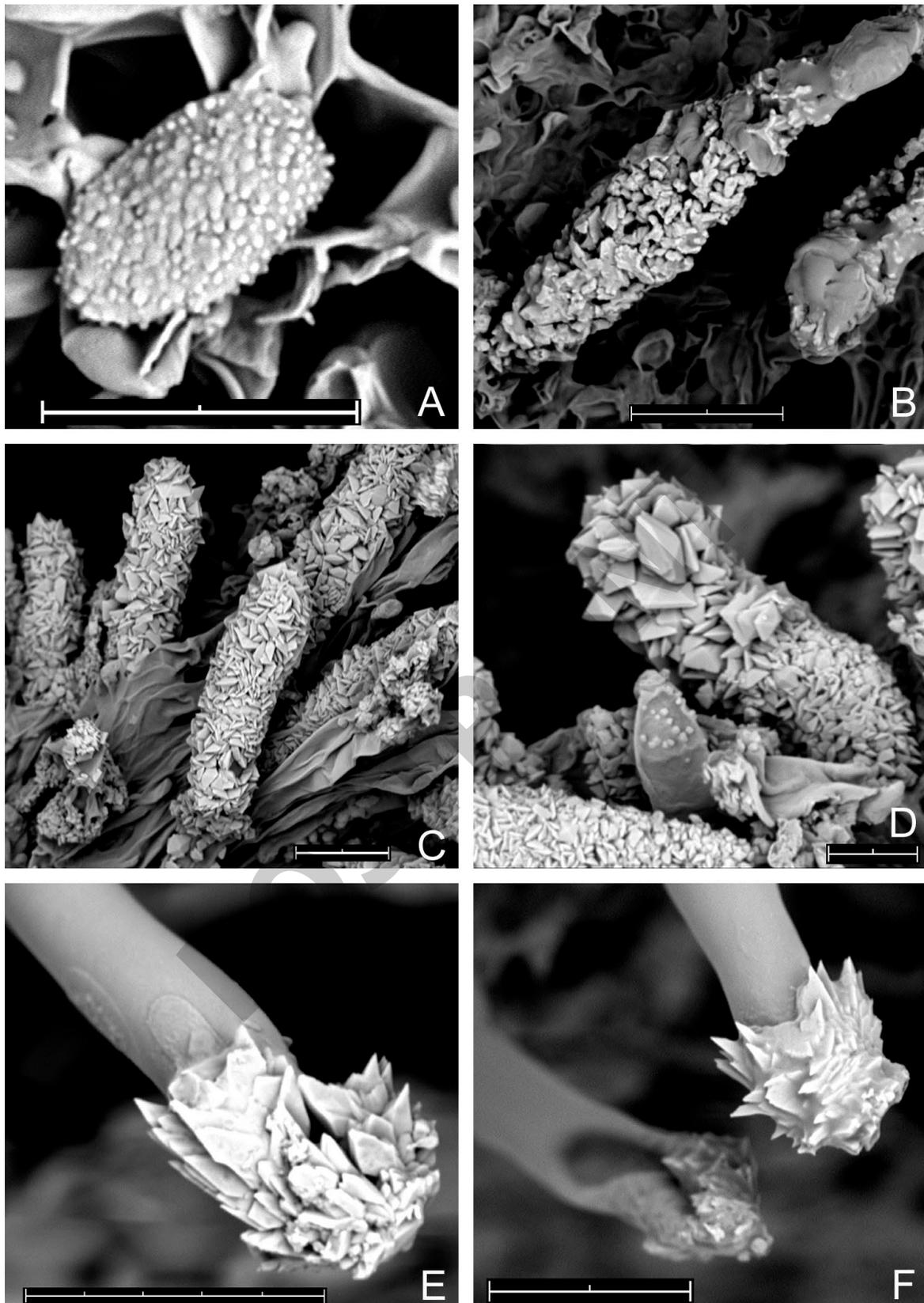
The species has Eurasian distribution from Norway and Sweden to Spain and Turkey (Bernicchia & Gorjón, 2010; Eriksson & Ryvarden, 1973), as well as in the distant parts of the range in North Urals (Kotiranta & Penzina, 1998) and China (Dai, 2011). Its occurrence is rare in all parts of its natural range (Hjortstam, 1980). The fungus called *Athelopsis lacerata*



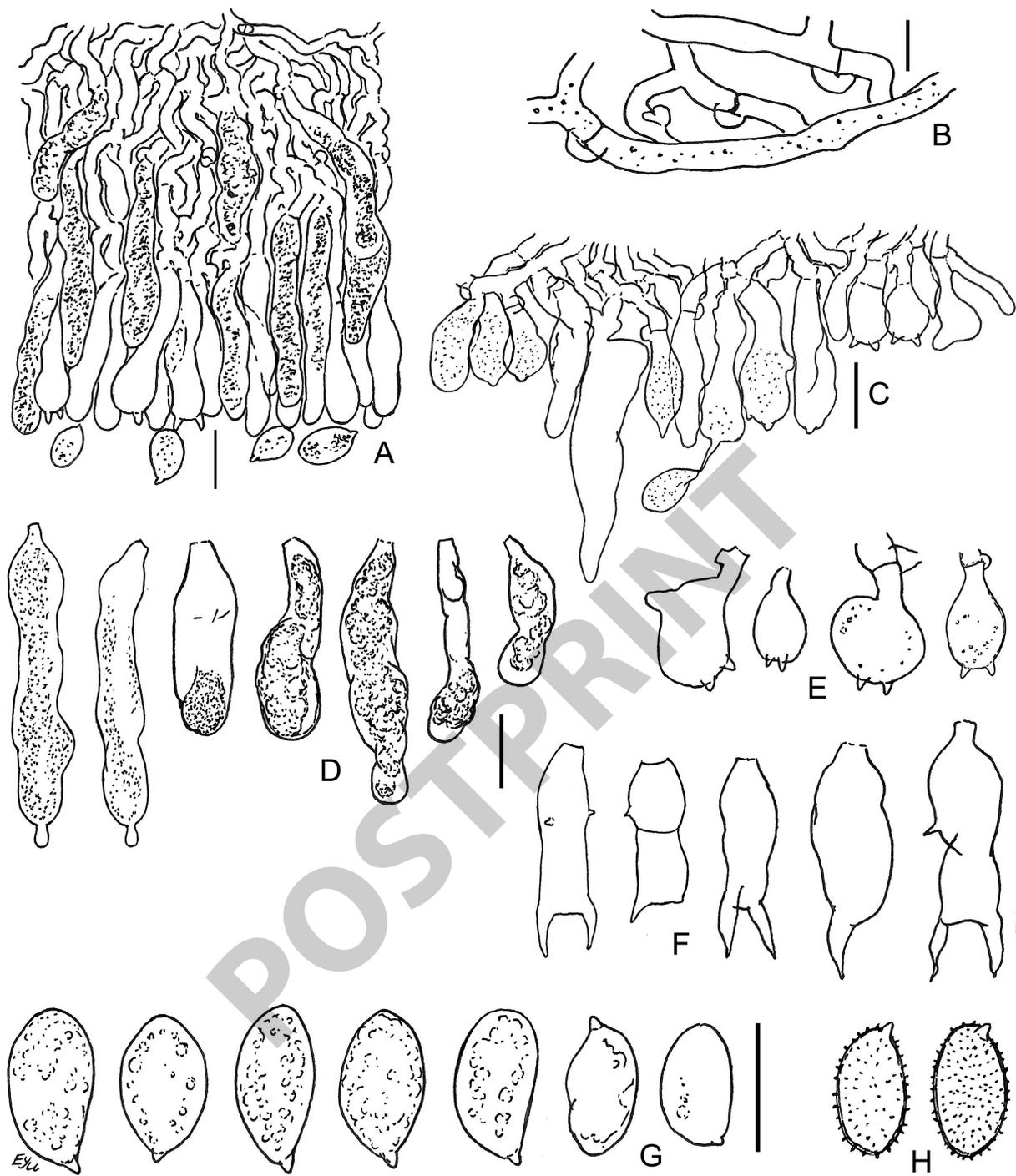
**Figure 1** Outer view of basidiomata in dry state: (A) *Acanthobasidium norvegicum* (BLS M-3535); (B) *Amylocorticiium laceratum* (BLS M-4372); (C) *Hyphoderma transiens* (BLS M-3260); (D) *Leptosporomyces fuscostratus* (BLS M-4778); *Odonticium septocystidium* – (E) BLS M-0596, (F) BLS M-0626. Scale bars = 5 mm for A–D, F; 1 mm for E.



**Figure 2** Outer view of basidiomata: (A) *Phlebia cretacea*, fresh state (BLS M-3745); *Phlebia subulata* (BLS M-4040) – (B) fresh state and (C) dry state; (D, E) *Steccherinum albidum*, dry state (BLS M-1047); (F) *Tubulicrinis calothrix*, dry state (BLS M-0498). Scale bars = 5 mm for A–D, F; 1 mm for E.



**Figure 3** SEM images. (A) *Acanthobasidium norvegicum* BLS M-3535, basidiospore on hymenial surface; (B) *Odonticium septocystidiatum* BLS M-0626, incrustations on projecting part of cystidia; (C, D) *Steccherinum albidum* BLS M-1047, pseudocystidia; (E, F) *Tubulicrinis calothrix* BLS M-0498, apices of cystidia. Scale bars = 10  $\mu$ m.



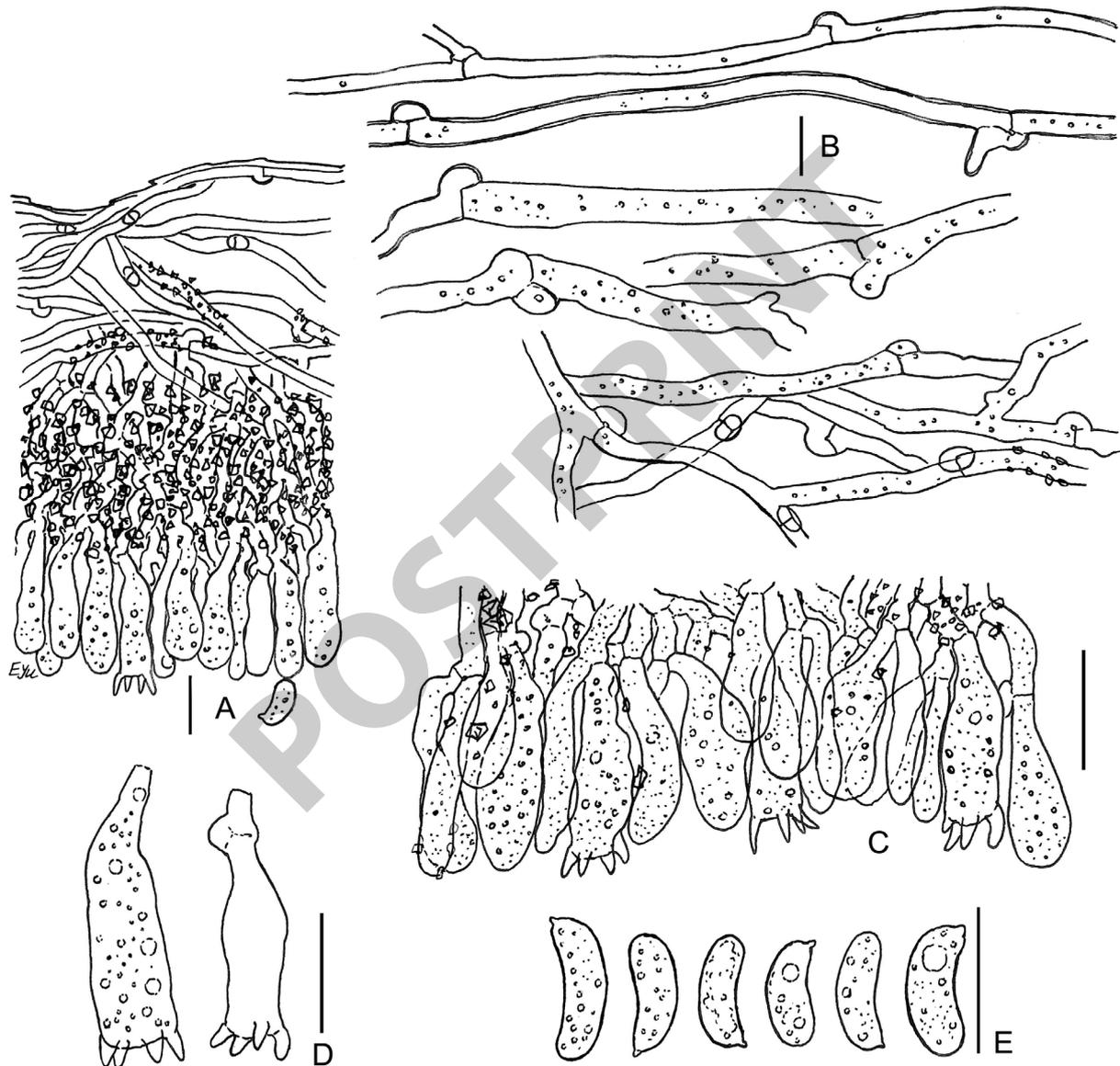
**Figure 4** *Acanthobasidium norvegicum* BLS M-3535: (A) vertical section through basidioma; (B) subicular hyphae; (C) fragment of hymenium; (D) cystidia; (E) cystidioles; (F) basidia; (G) basidiospores in KOH; (H) basidiospores in Melzer's reagent. Scale bars: for A, C–H = 10  $\mu$ m; for B = 5  $\mu$ m.

was reported by Gates (2009) from Tasmania, but the identity of the Tasmanian material with this taxon is difficult because of large geographical disjunction.

The fungus grows on decayed coniferous wood (Eriksson & Ryvarden, 1973), especially strongly decayed wood of *Pinus*; and has also been recorded on *Sarothamnus* (Larsson & Ryvarden, 2021).

A number of authors put this species in the genus *Amylocorticium* because of the amyloid spore wall (Hjortstam, 1980; Hjortstam & Ryvarde, 1979; Larsson & Ryvarde, 2021). Molecular data (Binder et al., 2010) confirmed its phylogenetic position in the order Amylocorticiales. However, its generic position is not yet clear; DNA sequences show its relation to *Amyloxenasma*, whereas basidia and spore shape have similarity with *Melzericium*.

**Specimen examined:** Białowieża Primeval Forest, near Topiło village, compart. No. 601B, *Salicetum pentandro-cinereae*, on dead, mostly corticated branches of *Salix cinerea*, 7–13 mm diam., and on old thalli of *Parmelia sulcata*, coll. M. Wołkowycki 18 IX 2020 (BLS M-4372).



**Figure 5** *Amylocorticium laceratum* BLS M-4372: (A) vertical section through basidioma; (B) subicular hyphae; (C) fragment of hymenium; (D) basidia; (E) basidiospores. Scale bars: for A, C–E = 10 µm; for B = 5 µm.

***Hyphoderma transiens*** (Bres.) Parmasto (Hyphodermataceae, Polyporales)

Figure 1C

The species is distinguished by its odontoid hymenial surface usually with scattered aculei and presence of various tinges of ochraceous, rich crystalline deposits in the subhymenium, scarce subcylindrical enclosed leptocystidia, and middle-sized [(7.5–)8.5–10.5 µm long], cylindrical basidiospores. Micromorphology of this fungus was illustrated earlier by Yurchenko and Kotiranta (2011).

The species has large natural range, situated predominantly in warm-temperate areas. In Europe the range extends from Britain, Sweden, and Estonia to Portugal, Italy, Croatia, and Ukraine (Bernicchia & Gorjón, 2010). It was also recorded in Madeira (Telleria et al., 2008), Azores (Telleria et al., 2009), and Canary Islands (Beltrán-Tejera et al., 2015). In Asia it was reported from Russian Caucasus, Georgia, Azerbaijan, northeast Turkey (Ghobad-Nejhad et al., 2009), Iran (Ghobad-Nejhad & Hallenberg, 2012), India (Sanyal et al., 2017), Middle Urals (Shiryayev et al., 2010), China (Dai, 2011), and Japan (Maekawa, 2021). There are records of the material, named *H. transiens*, from Brazil (Chikowski et al., 2020; Hjortstam & Bononi, 1987), and named *Hyphoderma* aff. *transiens*, from Cameroon (Spirin & Ryvarden, 2020). There are two records of this species in GBIF, belonging to Poland, based on specimens in GB herbarium: GB-80037 (collected in 1962) and GB-80036 (collected in 1973).

The fungus grows saprobically mostly on hardwood (*Fagus*, *Quercus*), and has also been recorded on *Tilia*, *Cornus* (Bernicchia & Gorjón, 2010; Volobuev & Arzhenenko, 2018), and *Ulmus* (Shiryayev et al., 2010). Our specimens indicate a distinct preference of this fungus to the dead wood of *Tilia cordata* in *Tilio-Carpinetum* forest association in the study area.

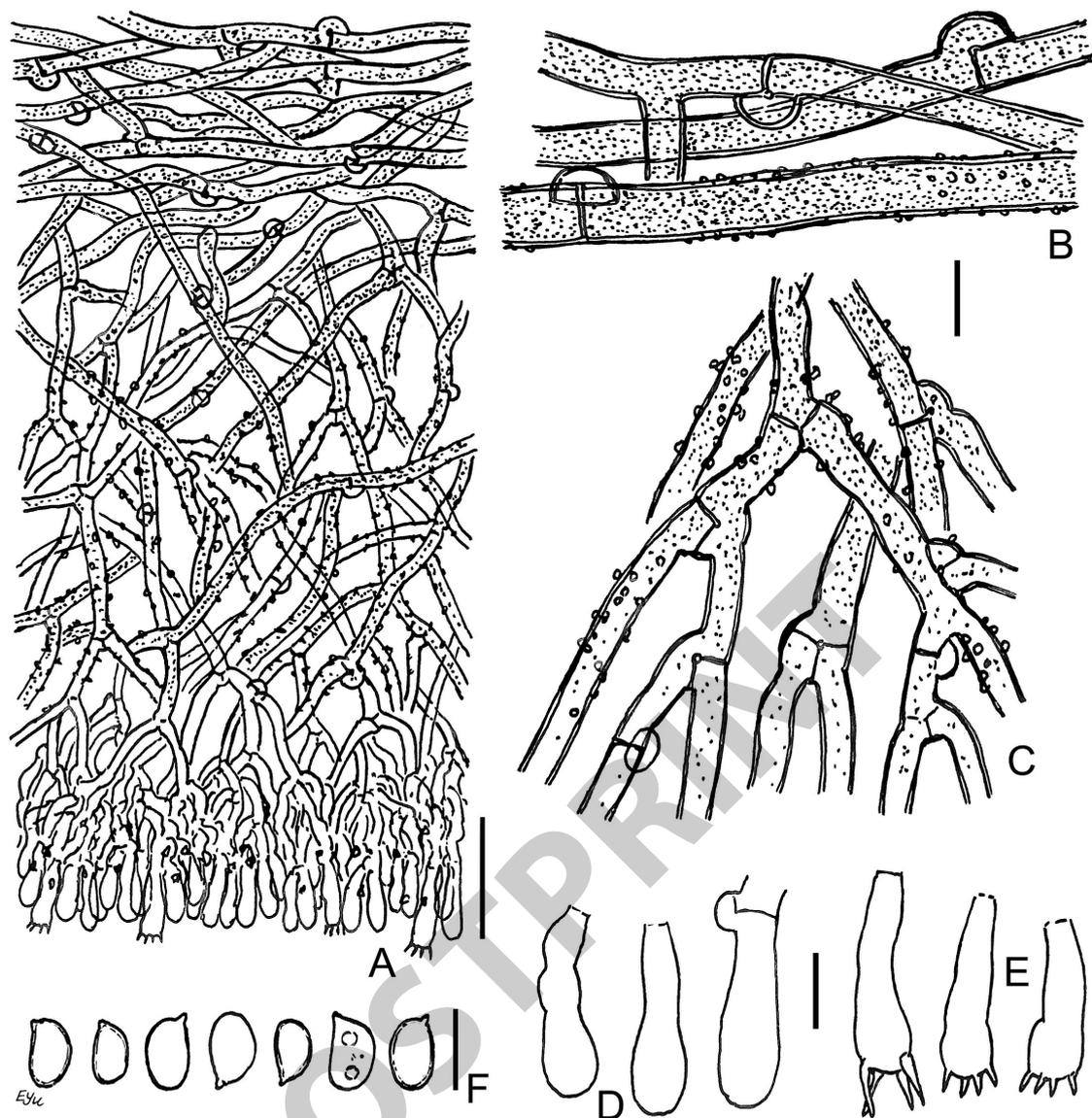
**Specimens examined:** Białowieża Primeval Forest, near Hajnówka, compart. No. 386C, *Tilio-Carpinetum*, on fallen wood of *Tilia cordata*, coll. M. Wołkowycki, 29 IX 2018 (BLS M-0381); near Czerlonka village, compart. No. 442D, *Tilio-Carpinetum*, on fallen wood of *T. cordata*, coll. M. Wołkowycki, 1 VII 2020 (BLS M-3260); near Czerlonka village, compart. No. 418A, *Tilio-Carpinetum*, on fallen wood of *T. cordata*, coll. M. Wołkowycki, 10 IX 2020 (BLS M-4304).

***Leptosporomyces fuscostratus*** (Burt) Hjortstam (Atheliaceae, Atheliales)

Figures 1D, 6

The species is distinguished by the following main features: distinctly pellicular, wide basidioma with dark cream hymenial surface, quickly turning brown-black from KOH; well-developed subiculum, consisting of brown hyphae near substratum; encrusted hyphae in middle subiculum; small-sized basidia [10–12(–13.5) × 3.2–4(–4.5) µm]; lack of cystidial elements; small spores [(3–)3.2–3.7(–4.5) × 2–2.8 µm]. The hyphae of the middle subiculum are pale brown, and turn into colorless subbasidial ones. The walls of subicular hyphae can be described as nearly thickened. Wall of many spores looks slightly thickened at ×1000 magnification.

The species has a broad distributional range in the northern hemisphere. In Europe it extends from Ireland, Norway, and Finland to Spain, Italy, and Croatia (Bernicchia & Gorjón, 2010). In Asia the localities are scattered from the Caucasus region and Middle Urals to Kamchatka and Primorye (Kotiranta et al., 2016; Shiryayev et al., 2010; Zmitrovich, 2008), China (Dai, 2011), and Japan (Maekawa, 2021). It is known to be found in Canada and USA, including Florida (Ginns & Lefebvre, 1993). There was a record of this species for Poland in GBIF, based on a specimen in the herbarium of Gothenburg University (GB), collected in 1963 (GB-107190).



**Figure 6** *Leptosporomyces fuscostratus* BLS M-4778: (A) vertical section through basidioma; (B) basal hyphae; (C) subicular hyphae; (D) basidioles; (E) basidia; (F) basidiospores. Scale bars: for A = 20  $\mu$ ; for B–F = 5  $\mu$ m.

The fungus grows predominantly on decayed gymnosperm wood: *Picea*, *Pinus*, *Larix*, *Abies*, *Pseudotsuga*, *Thuja* (Bernicchia & Gorjón, 2010; Ginns & Lefebvre, 1993; Kotiranta et al., 2016; Shiryaev et al., 2010; Zmitrovich, 2008). In North America it was also recorded on *Acer* and *Populus*, and supposedly considered as a psychrophilic species (Ginns & Lefebvre, 1993).

The fungus under the name *L. fuscostratus* was published for Poland only once by Karasiński et al. (2015), from Kampinos and Białowieża national parks. In this source *Confertobasidium olivaceoalbum* (Bourdot & Galzin) Jülich is noted as a synonym of *L. fuscostratus*. However, after the publication by Ginns and Lefebvre (1993), the current name accepted for *C. olivaceoalbum* is *Scytinostromella olivaceoalba* (Bourdot & Galzin) Ginns & M.N.L. Lefebvre. The latter is a fungus, having rare skeletal hyphae and fusiform gloeocystidia in hymenium (Bernicchia & Gorjón, 2010). Both types of elements were not observed in our specimen, and hence we address it as *L. fuscostratus*, and confirm this species for Polish mycobiota.

**Specimen examined:** Białowieża Primeval Forest, near Orzeszkowo village, compart. No. 435A, *Tilio-Carpinetum*, on naked fallen wood of *Pinus sylvestris*, coll. M. Wołkowycki 2 I 2021 (BLS M-4778).

***Odonticum septocystidium*** (Burt) Zmitr. & Spirin (Irpicaceae, Polyporales)

Syn.: *Candelabrochaete septocystidia* (Burt) Burds.; *Phanerochaete septocystidia* (Burt)

J. Erikss. & Ryvardeen

Figures 1E, 1F, 3B

The species is identifiable by its brown ochraceous hymenial surface in mature basidiomata, large (60–145 µm long), semi-immersed cystidia, having 4–11 simple septa and thus consisting of short cells, absence of clamps at all septa, and small-sized, (5.5–)6–7(–8) × 1.8–2 µm, allantoid basidiospores. Granules of resinous matter are abundant on hyphae and cystidia; this matter is yellow in water, but turns brown or orange-brown in KOH. The fungus can develop large basidiomata, 10–20 cm long and more. The micromorphology pictures for this species were published by Eriksson et al. (1978), Martini (2017), and, Volobuev and Arzhenenko (2018).

The natural range of the species includes mostly warm-temperate areas. It is known to be found in Europe (from Norway and Finland to Spain and Ukraine; Bernicchia & Gorjón, 2010), and Canary Islands (Beltrán-Tejera et al., 2013). In Asia it was documented from Caucasus region (Bernicchia & Gorjón, 2010), Iran (Ghobad-Nejhad et al., 2009; Ghobad-Nejhad & Hallenberg, 2012), Middle Urals (Shiryaev et al., 2010), and Kyrgyzstan (under the name *Odonticum raitviirii* Parmasto; Eriksson & al., 1978). In North America it was reported from seven states of USA situated in the north, east, and northeast of the country (Ginns & Lefebvre, 1993). Type locality of the species is in Jamaica (Parmasto et al., 2009). Moreover, there are records from Brazil (Hjortstam & Ryvardeen, 2007) and Australia (Bougher & Barrett, 2020).

The fungus grows on decayed wood of angiosperms (Eriksson et al., 1978), including *Populus tremula* (Volobuev & Arzhenenko, 2018), *Tilia* and *Ulmus* (Shiryaev et al., 2010), on the wood and bark of *Acer*, *Betula*, *Liriodendron*, seldom on gymnosperms – *Pinus* (Ginns & Lefebvre, 1993).

Owing to having clampless hyphae, this species was added in the genus *Phanerochaete*; because of the presence of septocystidia, it was classified in the genera *Candelabrochaete* and *Odonticum*. However, molecular phylogeny studies suggested the natural position of the species in one clade with *Ceriporia* and *Leptoporus* (Justo et al., 2017; Li et al., 2022). Consequently, the species seems to belong to the Irpicaceae family.

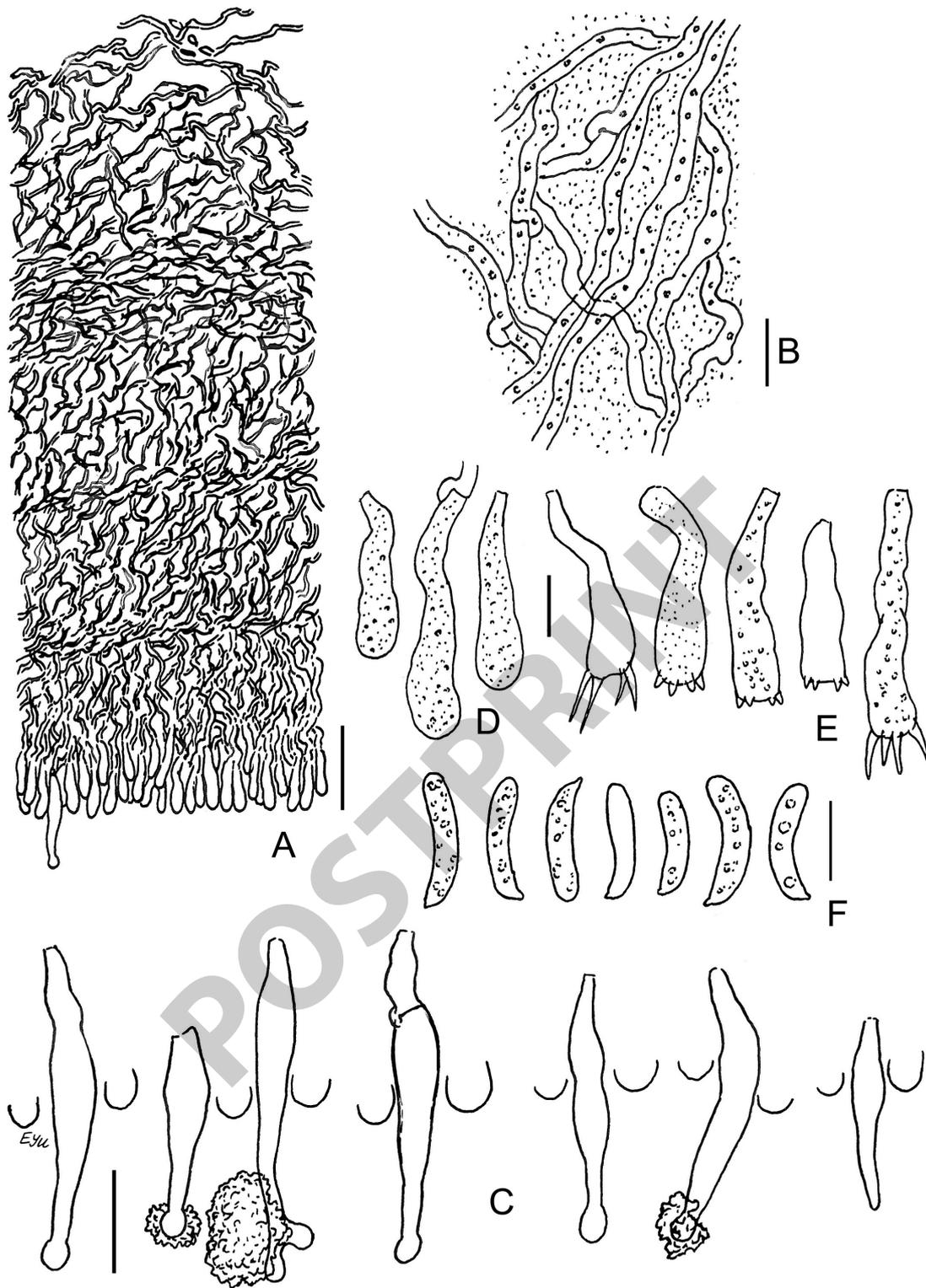
**Specimens examined:** Białowieża Primeval Forest, near Hajnówka, compart. No. 384D, *Fraxino-Alnetum*, on fallen, partly corticated *Salix cinerea* wood, coll. M. Wołkowycki, 31 X 2018 (BLS M-0596); near Czerlonka village, compart. No. 443Aa, *Tilio-Carpinetum*, on naked fallen wood of *Populus tremula*, coll. M. Wołkowycki, 31 X 2018 (BLS M-0626); near Czerlonka village, compart. No. 390A, *Ficario-Ulmetum minoris*, on dead wood of *P. tremula*, coll. M. Wołkowycki, 30 IX 2020 (BLS M-4456).

***Phlebia cretacea*** (Romell ex Bourdot & Galzin) J. Erikss. & Hjortstam (Meruliaceae, Polyporales)

Syn.: *Cabalodontia cretacea* (Romell ex Bourdot & Galzin) Piątek

Figures 2A, 7

The species is distinguished by the presence of small (21–28 × 3.5–4 µm), capitate cystidia, and narrow, allantoid basidiospores (Q=4.2–5.4). The capitulum of some cystidia bears a cap of amorphous, colorless matter, easily dissolvable in KOH. Subicular hyphae in our specimen are associated with abundant coccoid algae.



**Figure 7** *Phlebia cretacea* BLS M-3745: (A) vertical section through basidioma; (B) subicular hyphae; (C) cystidia; (D) basidioles; (E) basidia; (F) basidiospores. Scale bars: for A = 20  $\mu$ m; for B, D–F = 5  $\mu$ m; for C = 10  $\mu$ m.

The species' natural range includes Europe (Norway, Sweden, Finland, Estonia, France, Belgium; Bernicchia & Gorjón, 2010) and North America – Canada and USA, where it is rare (Ginns & Lefebvre, 1993). An isolated locality in the southern pre-Urals was also reported to

have this species (Safonov, 2015). There are four records of this species for Poland in GBIF, based on specimens in GB herbarium, collected in 1973: GB-115560, 115561, 115562, 115563.

The fungus grows on decaying wood of gymnosperms, e.g., decorticated wood of *Pinus* and *Picea* (Eriksson et al., 1981), and on *Thuja* (Ginns & Lefebvre, 1993). It has a tendency to inhabit semi-open habitats (Eriksson et al., 1981).

**Specimen examined:** Białowieża Primeval Forest, near Czerlonka village, compart. No. 489D, *Tilio-Carpinetum*, on naked, fallen wood of *Pinus sylvestris*, coll. M. Wołkowycki, 15 VII 2020 (BLS M-3745).

### ***Phlebia subulata*** J. Erikss. & Hjortstam

Figures 2B, 2C, 8

The species is distinguished by basidioma of hard corneous consistency in dry state, densely arranged, narrow [1–2(–3)  $\mu\text{m}$  wide] subicular hyphae, presence of scarce subulate leptocystidia, and small-sized [3.7–4(–4.3)  $\times$  2.4–2.6(–3.2)  $\mu\text{m}$ ], ellipsoid basidiospores (Q=1.5–1.7). Subiculum in our specimen is associated with abundant coccoid algae.

The natural range of this fungus includes Europe (from Norway and Finland to Spain, Serbia, and Ukraine; Bernicchia & Gorjón, 2010), and Middle Siberia (Kotiranta & Shiryaev, 2015). This species has been reported from Belarusian part of Białowieża Primeval Forest (Yurchenko, 2020). There is a record of the species from Poland in GBIF, based on a specimen from GB herbarium GB-118046, collected in 1973.

The fungus grows on fallen wood of gymnosperms (*Picea*, seldom *Pinus*), and is associated with primeval coniferous forests with *Hylocomium* and *Vaccinium* (Eriksson et al., 1981). Our specimen was found in a broadleaved forest with admixture of *Picea*.

**Specimen examined:** Białowieża Primeval Forest, between Hajnówka and Topiło village, compart. No. 463A, *Tilio-Carpinetum*, on fallen, naked wood of *Picea abies*, coll. M. Wołkowycki, 31 VIII 2020 (BLS M-4040).

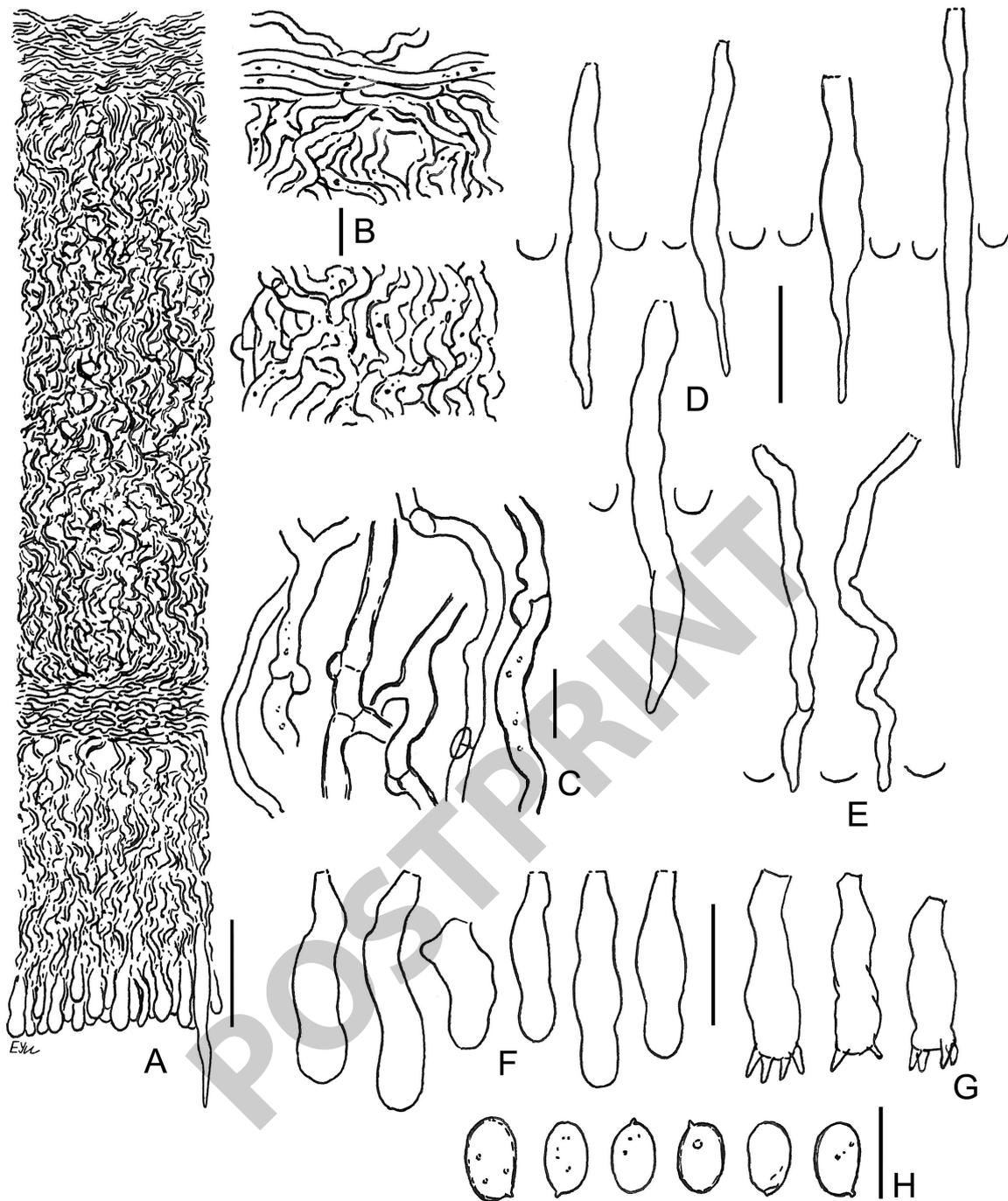
### ***Steccherinum albidum*** Legon & P. Roberts (Steccherinaceae, Polyporales)

Figures 2D, 2E, 3C, 3D

The species is distinguished by effused basidioma, whitish hymenial surface with pale ochraceous tinge, comparatively long (0.7–1.7 mm), fairly slender (0.09–0.16 mm diam.), densely arranged (8–11/mm) hymenophoral aculei, and minute [(2.5–)3–3.3  $\times$  (1.2–)1.3–1.5  $\mu\text{m}$ ], suballantoid basidiospores. The species protologue was based on a single specimen (Legon & Roberts, 2002). According to the original diagnosis, the fungus has effused-reflexed basidioma, less dense (5–6/mm), but longer (2–3 mm) aculei, and slightly larger spores [3–3.5(–4)  $\times$  1.5  $\mu\text{m}$ ], than in our material. Besides, skeletal elements in our specimen were observed only in basal parts of pseudocystidia, and sterile margin is narrow (about 0.5 mm) or absent. Suballantoid spores is an unusual feature for the genus *Steccherinum* in general. Our specimen can be named more correctly as *S. albidum* s.l., until richer material is collected for this little-known taxon.

The distributional range of the species includes the type locality in Britain, on dead wood of *Fagus* (Legon & Roberts, 2002), and two localities in Switzerland (GBIF data, occurrences SWISSFUNGI-CH-633787 and -744524). Moreover, a specimen published under the name *Steccherinum albidum* aff. was found in Mexico (Spirin & Ryvardeen, 2016); it has larger spores, than in the European material.

**Specimen examined:** Białowieża Primeval Forest, between Hajnówka, Topiło village, and Czerlonka village, compart. No. 487B, *Tilio-Carpinetum*, on decaying bark of *Quercus robur*, coll. M. Wołkowycki, 18 X 2018 (BLS M-1047).

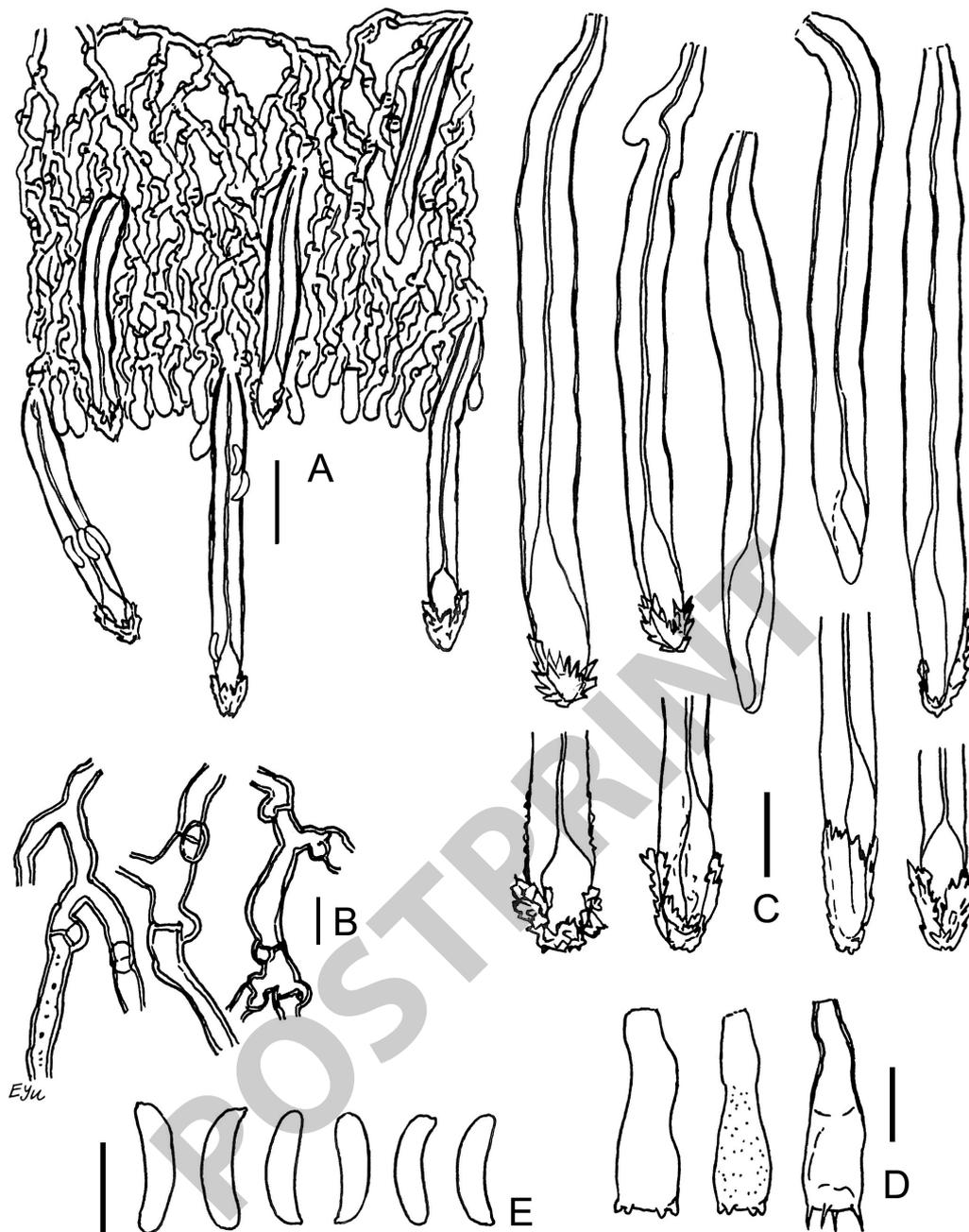


**Figure 8** *Phlebia subulata* BLS M-4040: (A) vertical section through basidioma; (B) hyphae in subcicular texture; (C) separate subcicular hyphae; (D) cystidia; (E) hyphidia; (F) basidioles; (G) basidia; (H) basidiospores. Scale bars: for A = 20  $\mu\text{m}$ ; for B, C, H = 5  $\mu\text{m}$ ; for D–G = 10  $\mu\text{m}$ .

***Tubulicrinis calothrix* (Pat.) Donk (Hymenochaetaceae, Hymenochaetales)**

Figures 2F, 3E, 3F, 9

The species is distinguished by lycocystidia, which have apically asymmetrically thickened wall, and often bear a cap of crystals that are partially dissolvable in KOH. Some amount of cystidia have symmetrical wall thickening; sometimes this symmetry depends on cystidium projection on microscopic slide. Thus for reliable species identification, at least 20 cystidia should be studied.



**Figure 9** *Tubulicrinis calothrix* BLS M-0498: (A) vertical section through basidioma; (B) subicular hyphae; (C) cystidia and their apices; (D) basidia; (E) basidiospores. Scale bars: for A = 20 µm; for B, D, E = 5 µm; for C = 10 µm.

The species has hemicosmopolitan distributional range, with a preference for warm-temperate regions. Type locality of it is in Tunisia, North Africa (Parmasto et al., 2009). In Europe it is known to be found from Norway and Finland to Portugal, Italy, and Greece (Bernicchia & Gorjón, 2010). Asian part of the range includes Turkey (Bernicchia & Gorjón, 2010), Middle Urals (Shiryayev et al., 2010), Middle and East Siberia (Kotiranta & Shiryayev 2015; Kotiranta et al., 2016; Shiryayev & Kotiranta, 2015), Primorye (Viner & Kokaeva, 2017), China (Dai, 2011), and Japan (Maekawa, 2021). In North America it is known to occur in Canada and USA (Ginns & Lefebvre, 1993). Other regions where the species was found include Canary Islands (Beltrán-Tejera et al., 2013), Venezuela (Liberta & Navas, 1978), Hawaii (Gilbertson et al., 2001), and Réunion (Hjortstam & Ryvarden, 2007). There were 7

records of this species in GBIF, belonging to Poland, based on specimens in GB herbarium and collected in 1973: GB-100377, 100378, 100379, 100380, 100381, 100382, 100383.

The fungus grows mostly on dead wood of *Pinus*, *Picea*, *Larix*, *Abies* (Bernicchia & Gorjón, 2010; Kotiranta & Shiryayev, 2015; Kotiranta et al., 2016; Shiryayev & Kotiranta, 2015; Shiryayev et al., 2010); in North America it is known to grow on *Pseudotsuga*, *Tsuga*, *Quercus* (Ginns & Lefebvre, 1993); in Canary Islands it occurs on unusual substrata like *Euphorbia* (Beltrán-Tejera et al., 2013) and *Cistus* (Beltrán-Tejera et al., 2015). In Poland the fungus was found on an unusual host too (*Populus tremula*).

**Specimen examined:** Białowieża Primeval Forest, near Czerlonka village, compart. No. 543Ba, *Peucedano-Pinetum*, on naked, fallen *Populus tremula* wood, coll. M. Wołkowycki, 6 XI 2018 (BLS M-0498).

## Discussion

The number of species of the fungi within a country is not a fixed value, since new species are added almost every year to the country list. This can be attributed to inclusion of new areas for collection, thorough examination of habitats, studying more herbarium material, taking into account new taxonomic publications, growth of taxonomic experience of mycologists, and supposedly also expansion of the natural ranges of the species due to changes in environment. The effectiveness of the process of studying corticioid fungal diversity in Poland can be evaluated from our data. Most of the herbarium material from this study was collected during three years and only from three forested areas in the northeast part of the country. The research added eight species to the biota: *Acanthobasidium norvegicum*, *Amylocorticium laceratum*, *Hyphoderma transiens*, *Odonticium septocystidium*, *Phlebia cretacea*, *Ph. subulata*, *Steccherinum albidum*, and *Tubulicrinis calothrix*, which constitutes about 3% of the total corticioid fungal diversity known in 2003 (Wojewoda, 2003). The specimens of new species constitute 2.2% of the total number of collections examined. All nine species described in this paper were found in Białowieża Primeval Forest, but they are still not recorded in Knyszyn and Piska Primeval Forests. It should be noted, that all nine species were found out of the borders of Białowieża National Park, a core of Primeval Forests, which is a special protected area with strict regulation for collecting fungi. From the nine species described above, only *Phlebia subulata* was known from the Belarusian part of Białowieża Primeval Forest.

We have found that the records of five species from Poland (*Hyphoderma transiens*, *Leptosporomyces fuscostratus*, *Phlebia cretacea*, *Ph. subulata*, *Tubulicrinis calothrix*) were added earlier in the GBIF database (<https://www.gbif.org>). All of them were based on specimens from GB herbarium (University of Göteborg, Sweden). We confirmed these species from the recently collected original material.

From nine species discussed, six (*Amylocorticium laceratum*, *Hyphoderma transiens*, *Leptosporomyces fuscostratus*, *Odonticium septocystidium*, *Ph. subulata*, *Tubulicrinis calothrix*) have Eurasian or broader distribution range and three (*Acanthobasidium norvegicum*, *Phlebia cretacea*, *Steccherinum albidum*) have European or Euro-American distribution. Two species (*Hyphoderma transiens*, *Odonticium septocystidium*) occur predominantly in warm-temperate regions belonging to nemoral and mediterranean biomes. Along with identified species, about 14% of the studied specimens still belong to unclear material without specific and sometimes without generic epithet, and suggests the need for further biodiversity studies.

**Financing.** The work of E. Yurchenko was supported by grant BPN/SZN/2021/1/00001 within the framework of the program NAWA “Solidarni z Białorusią – Solidarni z naukowcami” (2022). The work of M. Wołkowycki got support from the grant POPC.02.03.01-00-0063.18-00 “e-Puszcza. Podlaskie cyfrowe repozytorium przyrodniczych danych naukowych” (2019–2022).

**Authors’ Contributions.** EY: creating the concept of the paper, identification of specimens, writing the main text, preparation of illustrations, MS formatting; MW: planning field works, collecting specimens, managing the herbarium and photographic bank, preliminary identification of specimens.

**Acknowledgments.** We are thankful to Konrad Wilamowski (Institute of Forest Sciences, Białystok University of Technology) for the help with the SEM images and usual digital photographs of the fungi. The authors are grateful to the two anonymous reviewers for critical consideration of the manuscript.

## References

- Beltrán-Tejera, E., Rodríguez-Armas, J. L., Telleria, M. T., Dueñas, M., Melo, I., Díaz-Armas, M. J., Salcedo, I., & Cardoso, J. (2013). *Corticoid fungi from arid and semiarid zones of the Canary Islands (Spain). Additional data. 2.* <http://www.mycotaxon.com/resources/checklists/Beltran-v123-checklist.pdf>. Summary: *Mycotaxon*, 123, 491–492. <https://doi.org/10.5248/123.491>
- Beltrán-Tejera, E., Rodríguez-Armas, J. L., Telleria, M. T., Dueñas, M., Melo, I., Salcedo, I., & Cardoso, J. (2015). *Corticoid fungi of the western Canary Islands. Chorological additions.* <http://www.mycotaxon.com/resources/checklists/Beltran-v130-4-checklist.pdf>. Summary: *Mycotaxon*, 130(4), 1213–1214. <https://doi.org/10.5248/130.1213>
- Bernicchia, A., & Gorjón, S. P. (2010). *Corticaceae s.l.* Edizioni Candusso.
- Binder, M., Larsson, K.-H., Matheny, P. B., & Hibbett, D. S. (2010). Amylocorticiales ord. nov. and Jaapiales ord. nov.: Early diverging clades of Agaricomycetidae dominated by corticoid forms. *Mycologia*, 102(4), 865–880. <https://doi.org/10.3852/09-288>
- Bobiec, A. (2002). Białowieża Primeval Forest, the largest area of natural deciduous lowland forest in Europe. *International Journal of Wilderness*, 8(3), 33–37.
- Bougher, N. L., & Barrett, M. D. (2020). Fungi and slime moulds recorded in surveys at Kings Park and Bold Park – urban bushlands Perth, Western Australia. *The Western Australian Naturalist*, 31(4), 191–251.
- Chikowski, R. S., de Lira, C. R. S., Larsson, K.-H., & Gibertoni, T. B. (2020). *A checklist of corticoid fungi (Agaricomycetes, Basidiomycota) from Brazil.* <http://www.mycotaxon.com/resources/checklists/Chikowski-v135-2-checklist.pdf>. Summary: *Mycotaxon*, 135(2), 467. <https://doi.org/10.5248/135.467>
- Dai, Y.-C. (2011). A revised checklist of corticoid and hydroid fungi in China for 2010. *Mycoscience*, 52(1), 69–79. <https://doi.org/10.1007/S10267-010-0068-1>
- Eriksson, J., Hjortstam, K., & Ryvarde, L. (1978). *The Corticiaceae of North Europe. Vol. 5: Mycoaciella – Phanerochaete.* Fungiflora.
- Eriksson, J., Hjortstam, K., & Ryvarde, L. (1981). *The Corticiaceae of North Europe. Vol. 6: Phlebia – Sarcodontia.* Fungiflora.
- Eriksson, J., & Ryvarde, L. (1973). *The Corticiaceae of North Europe. Vol. 2: Aleurodiscus – Confertobasidium.* Fungiflora.

- Gates, G. M. (2009). *Coarse woody debris, macrofungal assemblages, and sustainable forest management in a Eucalyptus obliqua forest of southern Tasmania. Submitted in fulfilment of the requirements for the Degree of Doctor of Philosophy.* University of Tasmania.
- Ghobad-Nejhad, M., & Hallenberg, N. (2012). Checklist of Iranian non-gilled/non-gasteroid hymenomycetes (Agaricomycotina). Summary. *Mycotaxon*, 119, 493–494. <https://doi.org/10.5248/119.493>
- Ghobad-Nejhad, M., Hallenberg, N., Parmasto, E., & Kotiranta, H. (2009). A first annotated checklist of corticioid and polypore basidiomycetes of the Caucasus region. *Mycologia Balcanica*, 6, 123–168.
- Gilbertson, R. L., Desjardin, D. E., Rogers, J. D., & Hemmes, D. E. (2001). Fungi from Mamane-Naio vegetation zone of Hawai'i. *Fungal Diversity*, 6, 35–69.
- Ginns, J., & Lefebvre, M. N. L. (1993). *Lignicolous corticioid fungi (Basidiomycotina) of North America: Systematics, distribution and ecology.* APS Press.
- Hjortstam, K. (1980). Notes on Corticiaceae (Basidiomycetes) VII. A synopsis of the genus *Amylocorticium* Pouz. *Mycotaxon*, 11(2), 430–434.
- Hjortstam, K., & Bononi, V. L. R. (1987). A contribution to the knowledge of Corticiaceae s. l. (Aphylllophorales) in Brazil. *Mycotaxon*, 28(1), 1–15.
- Hjortstam, K., & Ryvarden, L. (1979). Notes on Corticiaceae (Basidiomycetes) V. *Mycotaxon*, 10, 201–209.
- Hjortstam, K., & Ryvarden, L. (2007). Checklist of corticioid fungi (Basidiomycotina) from the tropics, subtropics, and the southern hemisphere. *Synopsis Fungorum*, 22, 27–146.
- Holec, J., & Zehnálek, P. (2021). Remarks on taxonomy and ecology of *Dentipratulum bialoviesense* based on records from Boubínský prales virgin forest in the Czech Republic. *Czech Mycology*, 73(2), 121–135.
- Jülich, W., & Stalpers, J. A. (1980). *The resupinate non-poroid Aphylllophorales of the temperate northern hemisphere.* North-Holland Publ. Co.
- Justo, A., Miettinen, O., Floudas, D., Ortiz-Santana, B., Sjakvist, E., Lindner, D., Nakasone, K., Niemela, T., Larsson, K. H., Ryvarden, L., & Hibbett, D. S. (2017). A revised family-level classification of the Polyporales (Basidiomycota). *Fungal Biology*, 121, 798–824. <https://doi.org/10.1016/j.funbio.2017.05.010>
- Karasiński, D., Kujawa, A., Gierczyk, B., Ślusarczyk, T., & Szczepkowski, A. (2015). *Grzyby wielkoowocnikowe Kampinoskiego Parku Narodowego. Macrofungi of the Kampinos National Park.* Petit s.k. na zlecenie Kampinoskiego Parku Narodowego.
- Kotiranta, H., & Penzina, T. (1998). Notes on the North Ural Aphylllophorales (Basidiomycetes). In V. A. Mukhin & H. Knudsen (Eds.), *Arctic and alpine mycology*. 5 (pp. 67–81). Yekaterinburg Publishers.
- Kotiranta, H., & Shiryayev, A. G. (2015). Aphylllophoroid fungi (Basidiomycota) in Tunguska River basin, central East Siberia, Russia. *Karstenia*, 55, 25–42.
- Kotiranta, H., Shiryayev, A. G., & Spirin, V. (2016). Aphylllophoroid fungi (Basidiomycota) of Tuva Republic, southern Siberia, Russia. *Folia Cryptogamica Estonica*, 53, 51–64.
- Kujawa, A., Szczepkowski, A., Gierczyk, B., & Ślusarczyk, T. (2018). Ile gatunków grzybów rośnie w Puszczy Białowieskiej? Wystawy grzybów źródłem nowych danych [How many fungal species grow in the Białowieża Forest? Exhibitions of fungi as a source of new data]. *Sylwan*, 162(11), 933–940.
- Larsson, K.-H., & Ryvarden, L. (2021). *Corticioid fungi of Europe. Vol. 1. Acanthobasidium – Gyrodontium.* Fungiflora.
- Legon, N., & Roberts, P. (2002). *Steccherinum albidum*: a new species from southern England. *Czech Mycology*, 54(1–2), 7–9.
- Li, Y., He, S.-H., Chen, C.-C., Nakasone, K. K., & Ma, H.-X. (2022). Global taxonomy and phylogeny of Irpicaceae (Polyporales, Basidiomycota) with descriptions of seven new

- species and proposals of two new combinations. *Frontiers in Microbiology*, 13, 911978. <https://doi.org/10.3389/fmicb.2022.911978>
- Liberta, A. E., & Navas, A. J. (1978). Notes on Venezuelan Corticiaceae (Basidiomycetes). *Canadian Journal of Botany*, 56(15), 1777–1781. <https://doi.org/10.1139/b78-212>
- Maekawa, N. (2021). Taxonomy of corticioid fungi in Japan: Present status and future prospects. *Mycoscience*, 62, 345–355. <https://doi.org/10.47371/mycosci.2021.10.002>
- Martini, E. (2016). *Acanthobasidium norvegicum*. Excerpts from Crusts & Jells: Descriptions and reports of resupinate Aphyllorphorales and Heterobasidiomycetes. № 37. <http://www.aphyllo.net>
- Martini, E. (2017). *Phanerochaete septocystidia* (Burt) J. Erikss. & Ryvarden. Excerpts from Crusts & Gells: Descriptions and reports of resupinate Aphyllorphorales and Heterobasidiomycetes. № 106. <http://www.aphyllo.net>.
- Matuszkiewicz, W., Sikorski, P., Szwed, W., & Wierzbna, M. (Eds). (2012). *Zbiorowiska roślinne polski. Lasy i zarośla. Ilustrowany przewodnik* [Plant communities of Poland. Forests and thickets. An illustrated handbook]. Wydawnictwo naukowe PWN [PWN Publishing House].
- Parmasto, E., Nilsson, H., & Larsson, K.-H. (2009). *Cortbase. A nomenclatural database of corticioid fungi (Hymenomycetes). Vers. 2.1.* <http://andromeda.botany.gu.se/cortbase.html>
- Ruszkiewicz-Michalska, M., Kozłowska, M., Wilk, M., Janik-Superson, K., Mułenko, W. (2021). The known, the unknown, and the expected: 130 years of research on non-lichenized fungi and fungus-like organisms in the Białowieża Primeval Forest, Poland. *Forests*, 12, 518. <https://doi.org/10.3390/f12050518>
- Safonov, M. A. (2015). Check list of wood-destroying basidiomycetes of Orenburg Cisurals (Russia). *Vestnik of Orenburg State Pedagogical University*, 2(14), 29–46.
- Sanyal, S. K., Devi, R., & Dhingra, G. S. (2017). New records of *Hyphoderma* (Meruliaceae, Polyporales) for India. *The Scientific World Journal*, 2017, Article 3437916. 11 pp. <https://doi.org/10.1155/2017/3437916>
- Shiryayev, A. G., & Kotiranta, H. (2015). Aphyllorphoroid fungi (Basidiomycota) of the middle part of Yenisei River basin, East Siberia, Russia. *Karstenia*, 55, 43–60.
- Shiryayev, A. G., Kotiranta, H., Mukhin, V. A., Stavishenko, I. V., & Ushakova, N. V. (2010). Aphyllorphoroid fungi of Sverdlovsk region, Russia: biodiversity, distribution and the IUCN threat categories. Goschitskiy Publisher.
- Snowarski, M. (2022, April 30). *Atlas grzybów. grzyby.pl. Gatunki w publikacjach po 2000 r.* [Atlas of fungi. grzyby.pl. Species in publications after 2000]. <https://grzyby.pl/grzyby-makroskopijne-Polski-w-literaturze-mikologicznej-gatunki.htm>
- Spirin, V., & Ryvarden, L. (2016). Some basidiomycetes (Aphyllorphorales) from Mexico. *Synopsis Fungorum*, 35, 34–42.
- Spirin, V., & Ryvarden, L. (2020). Aphyllorphorales of Africa, 42. Some corticioid species from Cameroon. *Synopsis Fungorum*, 42, 16–20.
- Telleria, M. T., Melo, I., Dueñas, M., Salcedo, I., Cardoso, J., Rodríguez-Armas, J. L., & Beltrán-Tejera, E. (2008). Corticioid fungi (Basidiomycota) from Madeira Island. <http://www.mycotaxon.com/resources/checklists/telleria-v106-checklist.pdf>. Summary: *Mycotaxon*, 106, 419–422.
- Telleria, M. T., Melo, I., Dueñas, M., Rodríguez-Armas, J. L., Beltrán-Tejera, E., Cardoso, J., & Salcedo, I. (2009). Diversity and richness of corticioid fungi (Basidiomycota) on Azores Islands: a preliminary survey. *Nova Hedwigia*, 88(3–4), 285–308. <https://doi.org/10.1127/0029-5035/2009/0088-0285>

- Tian, Y., Ghobad-Nejhad, M., He, S.-H., & Dai, Y.-C. (2018). Three new species of *Aleurodiscus* s.l. (Russulales, Basidiomycota) from southern China. *MycKeys*, 37, 93–107. <https://doi.org/10.3897/mycokeys.37.25901>
- Viner, I. A., & Kokaeva, L. Yu. (2017). New occurrences of corticioid and poroid fungi (Basidiomycota) in Kedrovaya Pad Nature Reserve, Primorye Territory, Russian Far East. *Folia Cryptogamica Estonica*, 54, 43–50.
- Volobuev, S., & Arzhenenko, A. (2018). Aphyllorphoroid fungi (Basidiomycota) in forests of the middle part of Luga River valley, Leningrad Oblast, Russia. *Karstenia*, 57, 37–48.
- Wojewoda, W. (2003). *Checklist of Polish larger basidiomycetes. Krytyczna lista wielkoowocnikowych grzybów podstawkowych Polski*. W. Szafer Institute of Botany, Polish Academy of Sciences.
- Wu, S.-H., Hibbett, D. S., & Binder, M. (2001). Phylogenetic analyses of *Aleurodiscus* s.l. and allied genera. *Mycologia*, 93(4), 720–731. <https://doi.org/10.1080/00275514.2001.12063203>
- Yurchenko, E. (2020). *Corticioid fungi of Belarus: An identification book*. Kolorgrad.
- Yurchenko, E., & Kotiranta, H. (2011). Rare or little known corticioid basidiomycetes from southern Belarus. *Mycotaxon*, 115, 383–400. <https://doi.org/10.5248/115.383>
- Змитрович [Zmitrovich], И. В. [I. V.] (2008). *Определитель грибов России. Порядок Афиллофоровые. Вып. 3. Семейства Ателиевые и Амиллокортициевые [Definitorium fungorum Rossiae. Ordo Aphyllorphorales. Fasc. 3. Familia Atheliaceae et Amylocorticiaceae]*. Товарищество научных изданий КМК [KMK Publishers].