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A DNA-based checklist of the stipitate hydnoids (*Bankeraceae* s.l.) of Czechia

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Based on a long tradition of field research aimed at this group, stipitate hydnoid fungi belong to the best explored macromycetes in Czechia. However, following groundbreaking taxonomic changes emerging from recent molecular studies, previous knowledge of particular taxa and their features has been questioned. To resolve this issue, selected specimens of Czech hydnoids were sequenced to confirm their identity.

Generally, the presence of 39 taxa of *Boletopsis*, *Hydnellum*, *Phellodon*, and *Sarcodon* in the Czech Republic was confirmed, including the recently described species *Boletopsis mediterraneensis*, *Hydnellum bomiense*, *H. fagiscabrosum*, *H. rubidofuscum*, *Phellodon aquiloniniger*, *P. castaneoleucus*, and two so far undescribed taxa of *Boletopsis* and *Hydnellum*, as well as the recently reported *Hydnellum gracilipes*, *H. illudens*, *Phellodon secretus* and *Sarcodon quercinofibulatus*. Ecological requirements of newly delimited species are specified based on collection data from Czech localities, and GlobalFungi data are presented to supplement the current knowledge of the global distribution of particular species. Taxonomic issues, identification limits in species complexes, ecology, and threats to the species are discussed in relevant cases. Several more species, documented from or probably present in Czechia but not sequenced yet, are commented as well.

Key words: *Thelephorales*, ITS, LSU, taxonomy, ecology, GlobalFungi, Czech Republic.

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Vzhledem k dlouhé tradici terénních výzkumů na ně zaměřených patří stipitátní lošáky k nejprozkoumanějším skupinám českých makromycetů. Převratné taxonomické změny, vycházející ze současných molekulárních studií, však bortí zažité poznatky o jednotlivých taxonech a jejich znacích. Aby bylo možné uplatnit současné taxonomické pojetí, byly vybrané položky českých zástupců osekvenovány pro ověření jejich identity.

Celkem byla potvrzena přítomnost 39 taxonů z rodů *Boletopsis*, *Hydnellum*, *Phellodon* a *Sarcodon* na českém území, včetně nedávno popsaných druhů *Boletopsis mediterraneensis*, *Hydnellum bomiense*, *H. fagiscabrosum*, *H. rubidofuscum*, *Phellodon aquiloniniger*, *P. castaneoleucus* a dvou dosud nepopsaných taxonů z rodů *Boletopsis* a *Hydnellum*, jakož i nedávno zaznamenaných druhů *Hydnellum gracilipes*, *H. illudens*, *Phellodon secretus* a *Sarcodon quercinofibulatus*. Ekologické nároky nově vymezených druhů jsou upřesněny s ohledem na nálezové údaje z českých lokalit a data z GlobalFungi doplňují stávající poznatky o rozšíření druhů ve světě. Kde je to vhodné, je diskutována taxonomická problematika, limity určování v druhových komplexech, ekologie a ohrožení druhů. Nakonec je komentováno několik dalších druhů, doložených nebo pravděpodobně rostoucích na českém území, ale dosud nesekvenovaných.

INTRODUCTION

Species of the established genera *Bankera*, *Hydnellum*, *Phellodon*, and *Sarcodon* (*Basidiomycota*, *Thelephorales*), traditionally called "stipitate hydnoid fungi" (e.g. Maas Geesteranus 1975) or shortly "hydnoids", have become iconic macrofungi constantly attracting the attention of both mycologists and the general public. Together with poroid *Boletopsis* species, they are very interesting as ectomycorrhizal partners of trees (Smith & Read 2008) with species-specific ecological requirements. For this reason, some of them can be used as habitat indicators (e.g. Petersen 2012, Bonsdorff et al. 2014). An interesting phenomenon is the formation of assemblages of several species growing together at the same site (Marren 2002, Newton et al. 2002, Peiger 2015, Holec & Kučera 2018). Their decline in the second half of the 20th century (Arnolds 1989, Gulden & Hanssen 1992, Hrouda 2005a, 2005b, Baird et al. 2013) has resulted in inclusion of most hydnoids on national red lists of threatened species (e.g. Benkert et al. 1992, Gärdenfors 2005, Evans et al. 2006, Senn-Irlet et al. 2007, Smith et al. 2016). It has also accelerated the process of their molecular detection from the soil (van der Linde et al. 2009, 2012, Taylor et al. 2014).

The taxonomy of hydnoids is still in progress, both at the species level (e.g. Niemelä et al. 2003, Parfitt et al. 2007, Ainsworth et al. 2010, Pérez-de-Gregorio et al. 2011, Rubio-Casas et al. 2011, Nitare & Högberg 2012, Baird et al. 2013, Das et al. 2013, Vizzini et al. 2013, Grupe et al. 2015, 2016, Loizides et al. 2016, 2020, Mu et al. 2020, Nitare et al. 2021, Song et al. 2021, 2022a, 2022b, Zhou et al. 2022, Svantesson et al. 2024, Lyu et al. 2025) and generic level (Baird et al. 2013, Larsson et al. 2019). The last two studies have clarified generic boundaries of hydnoid genera, showing that *Bankera* species belong to a more comprehensive

Phellodon (Baird et al. 2013), and many European species of *Sarcodon* are in fact members of the monophyletic *Hydnellum* (Larsson et al. 2019).

The most recent taxonomic change has affected the family level, when Song et al. (2025) delimited the separate family *Sarcodonaceae*, comprising *Boletopsis*, *Hydnellum*, *Sarcodon*, and *Neosarcodon* [extra-European genus, informally defined by Larsson et al. (2019) and validly published in Wang et al. (2024)], while *Phellodon* was kept in the *Bankeraceae* (together with the tomentelloid *Amaurodon*). However, as the newly delimited *Sarcodontaceae* (correct orthographic variant, see MycoBank record) contain the type genus of the earlier family *Boletopsidaceae* Bondartsev & Singer ex Jülich (Jülich 1982), the name *Boletopsidaceae* should have been adopted for this family, if it were to be widely accepted.

Despite the recent progress, the delimitation of many species is still unclear, even in such a well-researched continent as Europe. Thoroughly documented and sequenced reference collections are the best pillars for comparing taxonomic concepts across countries and continents. For this reason, we decided to barcode collections of hydnoids from the Czech Republic, a Central European country with a long tradition of hydnoid research (e.g. Pouzar 1956, Hrouda 1992, 1999, 2005a, 2005b, 2008, Dvořák & Hrouda 2005, Tejklová & Kramoliš 2011, Holec et al. 2016, 2017, Kříž 2017, Borovička 2019, Kolényová et al. 2024) and rich hydnoid localities (Holec & Kučera 2018).

Based on the data obtained and following the current state of knowledge, the aims of this study are (i) to credibly confirm the recent occurrence of long-known species in the Czech Republic, (ii) to correctly assign collections of morphologically similar species from different habitats to recently distinguished species, and finally, (iii) to compile a comprehensive overview of Czech representatives of this remarkable group of fungi.

MATERIAL AND METHODS

Studied collections. Samples of recent, well-dried collections from Czechia were selected for sequencing. Most of them were collected by the authors. Several collections from neighbouring Slovakia were also used when sequencing of Czech material failed (such specimens have been retained in the study even if sequencing of Czech material was successful later). One collection from Sweden was used for comparison.

The material was preliminarily identified (our recent collections) or revised (older collections) according to the monograph by Maas Geesteranus (1975) but with respect (or preference, whenever possible) to works by Strid (1997), Dvořák & Hrouda (2005), Hrouda (2008), Nitare & Högberg (2012), Larsson et al. (2019), Nitare et al. (2021), and Svantesson et al. (2024). In each collection, both macro- and microcharacters were studied, especially size, shape and ornamentation of the spores. Final identification was based on the DNA sequences and the current taxonomic literature. The lists of studied collections for each species contain only those successfully sequenced.

Vouchers are kept in herbaria BRNU, CB, HR, PRM, and TUF. For fungarium acronyms, see Index Herbariorum (http://sweetgum.nybg.org/science/ih/). The abbreviation JS stands for collections by J. Souček kept in CB which do not yet have an official fungarium number but can be easily identified through the author's number. If appropriate, specifying data (not mentioned on the original labels) are added in square brackets.

Selected photos of species new to Czechia, very rare, or otherwise interesting species primarily depict the sequenced specimens. When suitable, photos of more representative basidiomata (usually from the same locality and microsite in order to ensure reliable identification) were selected to better illustrate the typical appearance of a species. Further photos, depicting also variability of some other, more common species, are placed in the Electronic supplement.

Data on ecology and distribution. This information is mentioned in a generalised way just to briefly characterise the position of each species in Czech nature. For taxonomically non-problematic species, all currently available records from Czechia (not listed here) were used, mostly based on the summary by Stodůlka (2019). For rare and taxonomically problematic taxa, the features are limited to the sequenced collections.

The following general terms are used.

Mycorrhizal partner trees are mentioned in the form of their abbreviated English names: beech (*Fagus sylvatica*), birch (*Betula* spp.), fir (*Abies alba*), hornbeam (*Carpinus betulus*), larch (*Larix decidua*), linden (*Tilia* spp.), oak (*Quercus* spp.), pine (*Pinus sylvestris*), poplar (*Populus* spp.), spruce (*Picea abies*). If scientific generic names are used for simplicity in Specimens studied (as taken from fungarium labels), *Abies* = *Abies alba*, *Fagus* = *Fagus sylvatica*, *Picea* = *Picea abies*, *Pinus* = *Pinus sylvestris*.

Frequency of occurrence is related to the period since 2010. Rare species: up to 6 localities, scattered species: 7–20 localities, common species: more than 20 localities. The delimitation of these categories is based on the methodology used in the previous version of the Czech Red List of Macromycetes (Holec & Beran 2006); different criteria were used for species evaluation in the current Red List (Zíbarová et al. 2024), hence not applicable for this purpose.

Elevational zonation is used after Kotlaba (1984) as follows – up to 200 m a.s.l.: planar zone (lowland), 200–500 m: colline zone (hills), 500–800 m: submontane zone, 800–1100 m: montane zone, 1100–1400 m: supramontane zone.

Red List status is mentioned according to Zíbarová et al. (2024), legal protection or proposal for legal protection according to Dvořák & Hrouda (2021).

In order to complete global distribution data obtained from other sources, distribution data based on environmental DNA from GlobalFungi database Release 5 (globalfungi.org) was used following the procedure described by Réblová et al. (2022). The search was particularly conducted using separate ITS1 and ITS2 spacers through the Exact hit and BlastN functions. Sequences of all haplotypes from specimens sequenced in our study were used for the search. Summarised results are part of the Electronic supplement.

Specific issues concerning taxonomy and ecology of particular taxa are discussed in the Notes section. For non-problematic species, the Notes section is omitted.

DNA study. Molecular identification was conducted by comparing the ITS (102 specimens) region and LSU rDNA (13 specimens) sequences with reference sequences in the NCBI GenBank using the BlastN search tool. In addition to similarity analysis, the relatedness of these sequences was studied through phylogenetic analysis. ITS and LSU rDNA sequences were obtained from a piece of a basidioma using the ITS1/TS4 and NL1/LR4 primer pairs following the method by Kolařík et al. (2021) or the ITS1F/ITS4B and NL1/NL4 pairs as described in Borovička et al. (2011). The ITS region and LSU rDNA sequences have been deposited in the NCBI GenBank database (Tab. 1).

Tab. 1. Specimens and NCBI GenBank accession numbers of DNA sequences obtained in this study.

Species	Voucher no.	GenBank accession no.	
		ITS	LSU
Boletopsis grisea	CB 23747	PV643840	
Boletopsis leucomelaena	CB 23742	PV643831	
Boletopsis leucomelaena	PRM 952655	PV643865	
Boletopsis mediterraneensis	PRM 899426	PV643771	PV682262
Boletopsis sp.	PRM 900723	PV643847	
Boletopsis sp.	PRM 900724	PV643851	PV682260
Boletopsis sp.	PRM 963858	PV681511	PV682259
Hydnellum aurantiacum	PRM 944045	PV643826	
Hydnellum aurantiacum	PRM 932984	PV643846	PV682263
Hydnellum aurantiacum	sample ID: CH-07	PV643813	
Hydnellum auratile	PRM 901218	PV643799	
Hydnellum auratile	CB 24980	PV643835	
Hydnellum bomiense	CB JS-2022-138	PV643776	
Hydnellum bomiense	CB JS-2022-044	PV643780	
Hydnellum bomiense	CB 23712	PV643828	
Hydnellum bomiense	PRM 933002	PV643859	
Hydnellum caeruleum	PRM 860647	PV643821	
Hydnellum caeruleum	PRM 933001	PV643856	PV682265
Hydnellum caeruleum	PRM 918090	PV643868	PV682264
Hydnellum compactum	HR B015339	PV643849	
Hydnellum concrescens	CB 24410	PV643844	
Hydnellum concrescens	CB 24325	PV643857	
Hydnellum concrescens	PRM 963199	PV643798	
Hydnellum cumulatum	PRM 954348	PV643782	
Hydnellum cumulatum	PRM 933000	PV643827	PV682266
Hydnellum cumulatum	PRM 861437	PV643834	
Hydnellum cumulatum	CB 23186	PV643838	
Hydnellum fagiscabrosum	PRM 933225	PV643829	PV682271
Hydnellum fagiscabrosum	PRM 944598	PV643845	
Hydnellum fagiscabrosum	PRM 861416	PV643863	
Hydnellum fennicum	PRM 932972	PV643796	
Hydnellum ferrugineum	PRM 899150	PV643797	
Hydnellum ferrugineum	PRM 861445	PV643803	
Hydnellum geogenium	PRM 932986	PV643815	PV682267
Hydnellum geogenium	PRM 937008	PV643817	
Hydnellum gracilipes	BRNU 680028	PV643801	
Hydnellum illudens	PRM 958183	PV643818	
Hydnellum illudens	CB 23505	PV643842	
Hydnellum illudens	BRNU 680031	PV710541	
Hydnellum lundellii	PRM 944581	LT714699.1*	

Species	Voucher no.	GenBank accession no.	
		ITS	LSU
Hydnellum martioflavum	PRM 944954	PV643793	
Hydnellum peckii	PRM 861417	PV643795	
Hydnellum peckii	PRM 924915	PV643806	
Hydnellum peckii	PRM 954312	PV643852	
Hydnellum peckii	PRM 899536	PV643853	
Hydnellum peckii	CB 23515	PV643860	
Hydnellum rubidofuscum	CB 24909	PV643824	
Hydnellum rubidofuscum	CB JS-2023-067	PV643830	
Hydnellum rubidofuscum	CB 23493	PV643855	
Hydnellum scabrosum	PRM 861446	PV643848	
Hydnellum scrobiculatum	PRM 954353	PV643775	
Hydnellum scrobiculatum	PRM 952390	PV643785	
Hydnellum scrobiculatum	PRM 954352	PV643790	
Hydnellum scrobiculatum	PRM 954351	PV643792	
Hydnellum scrobiculatum	CB 23736	PV643819	
Hydnellum scrobiculatum	CB 23731	PV643823	
Hydnellum scrobiculatum	CB 21534	PV643841	
Hydnellum scrobiculatum	CB 23752	PV643850	
Hydnellum spongiosipes	PRM 956292	PV643773	
Hydnellum spongiosipes	PRM 861415	PV643867	
Hydnellum suaveolens	PRM 918174	PV643778	
Hydnellum tardum	PRM 956331	PV643781	
Hydnellum tardum	PRM 861427	PV643800	
Hydnellum tardum	PRM 956329	PV643812	
Hydnellum tardum	CB 24071	PV643854	
Hydnellum tardum	CB 23479	PV643858	
Hydnellum sp.	CB 23503	PV643862	
Hydnellum sp.	PRM 963278	PV643837	
Phellodon aquiloniniger	PRM 956373	PV643774	
Phellodon aquiloniniger	PRM 952389	PV643777	
Phellodon aquiloniniger	PRM 956355	PV643779	
Phellodon aquiloniniger	CB 24403	PV643816	
Phellodon aquiloniniger	PRM 860605	PV643866	
Phellodon castaneoleucus	CB JS-2017-262	PV643783	
Phellodon castaneoleucus	CB 24412	PV643825	
Phellodon confluens	CB JS-2019-094	PV643820	
Phellodon confluens	PRM 933389		PV682261
Phellodon fuligineoalbus	PRM 937020	PV643843	
Phellodon melaleucus	PRM 956352	PV643784	
Phellodon melaleucus	PRM 956375	PV643802	
Phellodon melaleucus	PRM 958191	PV643804	

Species	Voucher no.	GenBank accession no.	
		ITS	LSU
Phellodon melaleucus	CB 23832	PV643822	
Phellodon melaleucus	CB 23829	PV643832	
Phellodon melaleucus	CB 23780	PV643833	
Phellodon melaleucus	CB 24067	PV643836	
Phellodon melaleucus	PRM 899140		PV682269
Phellodon niger	CB JS-2022-139	PV643839	
Phellodon niger	PRM 958107	PV643869	
Phellodon secretus	PRM 956376	PV643788	
Phellodon secretus	PRM 958122	PV643791	
Phellodon tomentosus	PRM 899148	PV643786	
Phellodon tomentosus	PRM 956374	PV643787	
Phellodon tomentosus	PRM 956318	PV643789	
Phellodon tomentosus	PRM 937006	PV643814	
Phellodon tomentosus	PRM 915411	PV643861	
Phellodon violascens	PRM 952634	PV643805	
Phellodon violascens	PRM 924441	PV643864	
Sarcodon imbricatus	HR B000013	PV643794	
Sarcodon imbricatus	PRM 924644	PV643807	
Sarcodon imbricatus	PRM 860655	PV643808	PV682268
Sarcodon quercinofibulatus	BRNU 680029	PV643772	
Sarcodon squamosus	PRM 899155	PV643809	
Sarcodon squamosus	PRM 899151	PV643810	PV682270
Sarcodon squamosus	PRM 899149	PV643811	

* The sequence was obtained in the study by Holec et al. (2017), but the accession number was not mentioned in their article, hence it is published here for the first time.

RESULTS AND DISCUSSION

SPECIES OF VERIFIED IDENTITY

Boletopsis grisea (Peck) Bondartsev & Singer, Annales Mycologici 39(1): 47, 1941

Specimen studied: Czech Republic. Southern Bohemia, Třebovice near Ktiš, oligotrophic *Pinus* forest with admixed young *Fagus sylvatica* and *Quercus* [*petraea*], 29 Aug 2020 leg. J. Souček (CB 23747).

Sequence obtained from specimen CB 23747 was identical with two *B. grisea* sequences from NCBI GenBank (AH 45535, MN536749; AB 16-09-113, MN536743).

Ecology and distribution. Growing in association with pine. Bound to oligotrophic sites with acid bedrock rich in quartz (granodiorite, granulite, metaquartzite, migmatite, orthogneiss, paragneiss, and sand). Rare, occurring at

isolated localities from the colline to the submontane zone, rarely in the montane zone.

Distribution based on GlobalFungi: Europe (Sweden), North America (Canada).

Czech Red List status: CR. Proposed for legal protection in the Czech Republic, see Hrouda (in Dvořák & Hrouda 2021: 22–27) for details. The species is highly threatened by eutrophication.

Notes. Collections from some Czech localities, traditionally identified as *B. grisea*, may not belong to this species. Particular attention should be paid to collections with an ecology differing from the above description (see notes under *B. mediterraneensis* and *Boletopsis* sp.).

Boletopsis leucomelaena (Pers.) Fayod, Malpighia 3: 72, 1889

Specimens studied: Czech Republic. Southern Bohemia, Plánička near Černá v Pošumaví, old *Picea* forest with admixed *Abies alba*, on limestone, among mosses and needles, 26 Aug 2020 leg. J. Souček (CB 23742). – Central Bohemia, Český Šternberk, Na Stříbrné, on dolomitic marble under mature *Picea abies* trees, 31 Aug 2019 leg. J. Borovička (PRM 952655).

Sequences obtained from both specimens were identical with *B. leucomelaena* sequence from NCBI GenBank (UPS F-529270, MN536741). The collection from Český Šternberk was described in detail and illustrated with photos in Borovička (2019).

Ecology and distribution. Growing in association with spruce, favourably in spruce-fir forests on calcareous to neutral bedrock (e.g. limestone, flysch, amphibolite). There are collections of this species apparently growing on acid bedrock (assessed on the basis of a geological map), but in at least some of these cases, local base-rich bedrock (marble, amphibolite) was detected in the field. [Some calciphilous macrofungi like *Sarcosphaera coronaria* have also been observed to grow at places with acid topsoil: in such case, however, calcareous rocks were recorded in a close vicinity of the find (Borovička et al. 2024).] Scattered, occurring at isolated localities from the colline to the submontane zone.

Distribution based on GlobalFungi: Europe (Austria, France, Germany, Italy, Romania).

Czech Red List status: EN. Particularly threatened by habitat loss caused by logging due to bark beetle outbreaks.

Notes. Collections from some Czech localities, traditionally identified as *B. leucomelaena*, may not belong to this species. Particular attention should be paid to collections with an ecology differing from the above description (see notes under *B. mediterraneensis* and *Boletopsis* sp.).

Boletopsis mediterraneensis G. Moreno, Carlavilla, Bellanger, Olariaga, P.-A. Moreau, Bidaud, Loizides & Manjón, Persoonia 43: 341, 2019 Fig. 1

Specimen studied: Czech Republic. Central Bohemia, Český kras Protected Landscape Area, Zlatý kůň National Nature Monument, under *Pinus*, 21 Nov 2011 leg. M. Kříž et P. Mikuš (PRM 899426, as *Boletopsis grisea*).

The sequence obtained from our specimen was fully identical with several sequences (e.g. MN536728, MN536716, MN536726) of the specimens identified in Crous et al. (2019) and Vizzini et al. (2023) as *Boletopsis mediterraneensis*. The similarity with the *B. mediterraneensis* holotype (MN536723) was 97.12%.

In Dvořák & Hrouda (2021: 23), a photo of this specimen in situ (Fig. 1) was erroneously presented as *B. grisea*.

Ecology and distribution. Very rare, hitherto only known from one locality in a pine forest on calcareous bedrock in the colline zone. Probably a thermophilic species, known mainly from the Mediterranean.

Distribution based on GlobalFungi: Europe (Italy, Spain), Africa (Canary Islands, Morocco).

Notes. Mycorrhizal association with pine (as opposed to spruce in *B. leucomelaena*) combined with growth on basic substrate (as opposed to acid substrate in *B. grisea*) seem to be the key distinguishing features.

***Boletopsis* sp.** (*Boletopsis* '*bohemica*' nom. prov.) Figs 2–4

Specimens studied: Czech Republic. Praha-Točná, xerothermic oak forest, 10 Oct 2022 leg. L. Opat et V. Klener (PRM 963858). – Central Bohemia, Bohuliby near Jílové u Prahy, on slope of deciduous forest (*Fagus sylvatica*, *Quercus* sp., *Carpinus betulus*), 18 Sep 2002 leg. Z. Veselý (PRM 900724, as *Boletopsis* cf. *leucomelaena*). – Central Bohemia, Luka pod Medníkem, Panský vrch, in deciduous forest (*Quercus*, *Carpinus*), 3 Sep 2002 leg. P. Ričl et P. Šťastný (PRM 900723, as *B. leucomelaena*).

The best hit in the case of ITS rDNA sequences was 95.6% for *Boletopsis tibetana* (type material, NR_182964.1). For LSU rDNA, the best hit was 97.2% (*Boletopsis tibetana*, NG_149025). The specimen does not have sufficient hits to assign it to any sequenced species.

Ecology and distribution. Very rare, known to us from four Czech localities (all of them nearby Prague). These are mostly sloping deciduous oligotrophic forests (oak always being present, and the only tree in at least one case) on acid to neutral bedrock, but often with the co-occurrence of more or less calciphilic funga (e.g. *Hygrophorus arbustivus*, *Hygrophorus russula*, *Leucopaxillus compactus*, *Rubroboletus rhodoxanthus*, *Russula aurea*, and *Tricholoma boudieri*).

Distribution based on GlobalFungi: Europe (Italy), North America (USA, Mexico).

Notes. A hitherto undescribed species recorded since at least 2002, previously misidentified as *B. grisea* or *B. leucomelaena*. The basidiomata are often stouter than those of *B. leucomelaena*, but the pileus surface of young specimens

Fig. 1. *Boletopsis mediterraneensis* (PRM 899426 – for details, see Specimen studied). Photo M. Kříž.

Fig. 2. *Boletopsis* sp. (*B. 'bohemica'*) (PRM 963858 – for details, see Specimens studied). Photo L. Opat.

Fig. 3. *Boletopsis* sp. (*B.* '*bohemica*'), unsequenced, Praha-Točná (Central Bohemia, Czech Republic), xerothermic oak forest with pine, 10 Oct 2022 (PRM 963859). Photo J. Kohout.

Fig. 4. *Boletopsis* sp. (*B.* '*bohemica*'), 10 Oct 2014 (microsite identical to PRM 963859). Photo J. Schneider.

is darker than those of *B. grisea*, often with a dark grey, graphite-like pileus surface, and may turn brownish in dry weather. It represents the only Czech *Boletopsis* species not bound to coniferous trees. The species seems to be threatened by eutrophication.

This *Boletopsis* species is possibly new to science but is only known from fungarium material and documentation by other collectors. We have been searching for it at sites of its former occurrence for several years, but unsuccessfully. We therefore leave the question of its valid naming open until we obtain our own finds but provide molecular data for possible comparison with other researchers.

Hydnellum aurantiacum (Batsch) P. Karst., Meddelanden af Societas pro Fauna et Flora Fennica 5: 41, 1879

= *Hydnellum floriforme* s. auct.

Specimens studied: Czech Republic. Novohradské podhůří, close to Malonty, Hodonický potok stream valley, mossy *Picea* plantation with *Pinus*, 27 Jul 2016 leg. J. Borovička (PRM 944045). – Šumava Mts, 3 km SSW of Rejštejn, Dračí skály rocks (rocky ridge on right bank of Otava river): lower part, SW slope, alt. 630 m, high mixed forest on granite bedrock, under *Picea*, *Pinus*, *Abies*, and *Fagus*, 10 Sep 2014 leg. J. Holec et M. Kříž (PRM 932984). – Bohemian-Moravian Highlands, Chmelná near Nová Cerekev, 22 Sep 2011 leg. J. Borovička (not documented by a fungarium voucher, sample in archive of J. Borovička, ID: CH-07).

Sequences obtained from all specimens were identical with several *Hydnellum aurantiacum* sequences (e.g. MK602711, AF351866) from the studies by Bidartondo & Bruns (2002) and Larsson et al. (2019).

Ecology and distribution. Growing in association with spruce and possibly pine, in coniferous and mixed forests, near-natural as well as man-influenced stands, often on gravel or sandy soil, probably prefers acid bedrock (granite, if bedrock is mentioned). Scattered from the colline to the montane zone.

Distribution based on GlobalFungi: Europe (Finland, France, Norway, Romania, Sweden), North America (Canada).

Czech Red List status: EN.

Notes. Considering the ambiguous concept of the name *Hydnellum aurantiacum* (see Otto 1997), this species was frequently reported as *Hydnellum floriforme* in past decades. Unfortunately, the concept of this name may be ambiguous too, taking into account the original illustrations in Schaeffer (1774), where Tab. CXLVII depicts basidiomata resembling *H. aurantiacum* (possessing orange hues), contrary to Tab. CXLVI, in which Fig. VII shows zonation of the context in longitudinal section, characteristic of *H. compactum* (Electronic supplement, Fig. S17). With regard to the fact that the present work is not a taxonomic study, we have not solved this issue and follow the conclusion by Larsson et al. (2019: 45) of not accepting the use of *H. floriforme*. However, despite the discussions regarding their possible conspecificity, we maintain the traditional

concept of the two species (Maas Gesteranus 1975) – the name *Hydnellum auratile* for the species originally described by Britzelmayr (1892, as *Hydnum auratile*; see below), while retaining *H. aurantiacum* for the species in question.

Hydnellum auratile (Britzelm.) Maas Geest., Persoonia 1(1): 111, 1959

= *Hydnellum aurantiacum* (Batsch) P. Karst. emend. Otto in Boletus 21(1): 4–6, 1997

Specimens studied: Czech Republic. Southern Bohemia, 0.9 km SSE of Vidov, terrace above former marble quarry, solitary *Picea* [withered in 2015], young *Quercus robur*, *Corylus avellana*, among needles, 8 Oct 2014 leg. J. Souček et J. Janda (CB 24980).

Sweden. Gotland, Eksta parish, Ekstastrand, on the ground in pine forest on former sea-wall, 21 Sep 2000 leg. S. Ryman (PRM 901218: Fungi exsiccati suecici no. 3684).

Sequences obtained from specimens PRM 901218 and CB 24980 were 99.5–100% similar to the *H. auratile* sequences (OF242763, MK602715) published by Larsson et al. (2019).

Ecology and distribution. Growing in association with spruce and pine, in coniferous and mixed forests, probably prefers calcareous soils. Rare, occurring at isolated localities from the colline to the submontane zone.

Distribution based on GlobalFungi: Europe (Spain).

Czech Red List status: CR.

Notes. Because of the ambiguous interpretation of the name *Hydnellum aurantiacum* and the presence of orange tones in both species, confusion exists. The orange tones of *H. auratile* are usually present in young basidiomata only. Older basidiomata tend to have ochre, rusty brown or brown tones. The context of *H. auratile* is also uniformly brownish orange to rusty brown, whereas the context of *H. aurantiacum* (*H. floriforme*) tends to be orange-white zoned. Older basidiomata of *H. auratile* resemble *H. concrescens* in shape and have a similar zoned pattern, but the latter always has a brown context without the orange hue typical of the former. Old basidiomata of *H. aurantiacum* (*H. floriforme*) are fleshy, usually without concentric zonation.

Hydnellum bomiense Y.H. Mu & H.S. Yuan, Journal of Fungi 7(10, no. 818): 27, 2021 Fig. 5

Specimens studied: Czech Republic. Šumava Mts, near Černý Kříž, *Picea* forest with admixed *Pinus*, margin of gravel road containing limestone and granulite, 3 Jul 2020 leg. J. Souček (CB 23712). – Šumava Mts, 2.1 km SE of Srní, margin of *Picea* forest, 23 Sep 2014 leg. J. Holec et T. Kučera (PRM 933002). – Novohradské podhůří, 2 km NW of Malonty, Hodonický potok valley, *Picea-Pinus* forest with admixed *Betula* and *Salix*, margin of gravel road, 27 Jul 2022 leg. J. Souček et L. Opat (CB JS-2022-044). – Southern Bohemia, Velmovice near Chýnov, *Picea* forest with admixed *Larix*, in moss at the margin of a marble gravel forest road, 24 Sep 2022 leg. J. Souček et J. Blažej (CB JS-2022-138).

Sequences obtained from specimens CB 23712, PRM 933002, CB JS-2022-044, and CB JS-2022-138 were 99.6–100% similar to the sequence of the *H. bomiense* type material (IFP 019382, NR_174067).

Fig. 5. *Hydnellum bomiense* (PRM 933002 – for details, see Specimens studied). Photo J. Holec.

Fig. 6. *Hydnellum* sp. (*H.* aff. *concrescens*) (PRM 963278 – for details, see Specimens studied). Photo J. Borovička.

Fig. 7. *Hydnellum concrescens* (PRM 963199 – for details, see Specimens studied). Photo J. Borovička.

Fig. 8. *Hydnellum rubidofuscum* (CB 24909 – for details, see Specimens studied). Photo J. Souček.

Ecology and distribution. The sequenced collections originate from sites affected by the presence of artificially added marble gravel in coniferous forests in the submontane zone.

Distribution based on GlobalFungi: Europe (Austria, Czech Republic, Estonia), Asia (Georgia, Russia – Lake Baikal) and North America (USA). The Czech locality is from Moravia, close to Brno-Útěchov (49°17'25.33" N, 16°37'09.22" E; see Electronic supplement).

Czech Red List status: EN.

Notes. Recently described species known from China, Estonia, and Costa Rica (Mu et al. 2021). The type material is from a fagaceous forest, while the collections from Czechia are from coniferous forests, with spruce always present, sometimes with admixed pine, larch, birch, or beech. Five sequenced and four unsequenced collections come from the vicinity of forest roads paved with marble gravel, one sequenced collection is from a stream bank.

The original description states a pileus diameter of up to 26 mm. We have observed basidiomata of such dimensions but have also found larger ones, reaching up to around 80 mm (see Fig. 5). Mu et al. (2021) also mention an acrid taste (probably of fresh material, because our dried specimen tastes mild). It is worth noting that some of our collections date from early summer, when most *Bankeraceae* species do not fructify yet. At this time, already old (but still partially alive) basidiomata were present at the site. Therefore, the possibility of fructification in the spring season cannot be ruled out. *Hydnellum scrobiculatum* may be considered similar, but its spores are rounder with less prominent warts (spores of *H. bomiense* are covered with distinct angular warts, often grouped in pairs, similarly to *H. concrescens*, *H. peckii*, and *H. tardum*, but their general shape seems to be slightly rounder on average). *Hydnellum peckii*, which has somewhat similar basidiomata and spores, differs by a striking dark red guttation in young basidiomata. Mu et al. (2021) do not indicate such a phenomenon for *H. bomiense*, nor do our observations.

Hydnellum caeruleum (Hornem.) P. Karst., Meddelanden af Societas pro Fauna et Flora Fennica 5: 41, 1879

Specimens studied: Czech Republic. Šumava Mts, 2.5 km ESE of Srní, Vydra river valley, *Picea* forest 5–8 m from the river, in moss among stones, 23 Sep 2014 leg. J. Holec et T. Kučera (PRM 933001). – Southern Bohemia, south of Vlastiboř near Soběslav, *Pinus* forest named Šmelcovna, 21 Aug 2010 leg. L. Kotlabová (PRM 918090).

Slovakia. Slovenský raj National Park, 3 km S of Betlanovce, vicinity of Glacká cesta forest road, *Picea* forest on limestone, 19 Aug 2012 leg. J. Holec (PRM 860647).

Sequences obtained from specimens PRM 933001, PRM 918090, and PRM 860647 were 99–100 % similar to *H. caeruleum* sequences from several studies, e.g. to voucher SNMH34 (MK907410) published by Larsson et al. (2019) and Kautmanová et al. (2020).

Ecology and distribution. Growing mostly in association with spruce and pine, preferably in acidophilous coniferous and mixed forests. However, occurrence in a spruce stand on possibly calcareous bedrock (two localities in the Bohemian-Moravian Highlands) and an acidophilous beech forest (Chřiby Mts) has also been recorded; these collections have not been sequenced yet. Scattered at isolated localities from the colline to the montane zone.

Distribution based on GlobalFungi: Europe (Estonia, Finland, Germany, Norway, Sweden), North America (Canada, USA).

Czech Red List status: CR. Proposed for legal protection in the Czech Republic, see Hrouda (in Dvořák & Hrouda 2021: 106–111) for details. The species is highly threatened by eutrophication and habitat loss caused by logging due to bark beetle outbreaks.

Notes. Until the 1960s it was considered a characteristic species of oligotrophic pine forests (Pouzar 1961, Pilát 1969). In the following decades it practically disappeared from pure pine stands, later records from this habitat being extremely rare and the probably last one dating back to 2010 (Šmelcovna forest near Vlastiboř, see Specimens studied).

Hydnellum compactum (Pers.) P. Karst., Meddelanden af Societas pro Fauna et Flora Fennica 5: 41, 1879

Specimen studied: Czech Republic. Vidnavsko-osoblažská pahorkatina, Borový National Nature Monument near Žulová, acidophilous *Fagus* forest with admixed *Pinus*, 6 Sep 2022 leg. L. Zíbarová, D. Dvořák et J. Běťák (HR B015339).

Ecology and distribution. Associated with beech at Czech localities, growing on nutrient-poor skeletal soils with a missing or minimal humus layer. Possibly an indicator of relict sites with long continuity of unmanaged or considerately managed forest stands. Rare, occurring at isolated localities in the colline zone.

Distribution based on GlobalFungi: North America (USA).

Czech Red List status: CR. Proposed for legal protection in the Czech Republic, see Běťák (in Dvořák & Hrouda 2021: 115–120) for details.

Notes. No *Hydnellum compactum* sequences are currently deposited in GenBank. However, the sequence of our specimen is highly similar to six sequences [mostly from North America, e.g. 99.7% similarity with KC571718 published by Baird et al. (2013)] labelled *H. cristatum*. There are two possible explanations for this: either misidentification of the specimens, or conspecificity of the two species. Anyway, even if the species are conspecific, the name *H. compactum* will have priority over *H. cristatum*.

Hydnellum concrescens (Pers.) Banker, Memoirs of the Torrey Botanical Club 12: 157, 1906 Fig. 7

= *Hydnellum* group V sensu Ainsworth et al., Fungal Ecology 4: 77, 2010

Specimens studied: Czech Republic. Southern Bohemia, Hluboká nad Vltavou, dike of Munický pond, *Quercus robur*, *Robinia pseudoacacia*, among grass, 14 Sep 2022 leg. J. Souček (CB 24410). – Southern Bohemia, 0.7 km N of Dvorce near Třeboň, dike of Nový u Dvorců pond, *Quercus*, among grass, 11 Jul 2022 leg. J. Válek (CB 24325). – Central Bohemia, Luka pod Medníkem, Panský vrch, under *Quercus* (possibly also *Carpinus* or *Fagus*) on acid soil, oligotrophic forest plantation, 10 Oct 2024 leg. J. Borovička (PRM 963199).

Sequences obtained from specimens CB 24410 and CB 24325 were identical to sequence EU784267 from the *H. concrescens* specimen published by Brock et al. (2008).

Ecology and distribution. Associated with broadleaved trees, namely oaks, at warm sites on acid to neutral soils in the colline zone.

Distribution based on GlobalFungi: Europe (France, Germany, Italy, Poland, Spain), Asia (Georgia), North America (USA).

Czech Red List status: VU. Mainly threatened by eutrophication.

Notes. The issue of species identity (which genetic species should carry the name *H. concrescens*, and which *H. scrobiculatum*) has not been satisfactorily resolved yet. The name *H. concrescens* was used for a group of similar *Hydnellum* species with a more or less zonate pileus and irregular spores covered by angular warts. Many species of this group occurring in the Czech Republic (probably most of them) have already been separated (using biomolecular methods) and some of them validly described. Taxa separated by Ainsworth et al. (2010) as *Hydnellum* group I, were later described under the name *H. rubidofuscum* (Mu et al. 2021). The key included in the Chinese publication does however not contain *H. concrescens*, so distinguishing characters are not provided. Ainsworth et al. (2010) mention a pink or rose tint, especially of immature basidiomata (primordia), thicker and less zonated basidiomata for group I (i.e. *H. rubidofuscum*) in contrast to a fulvous tint, thinner and densely zonate basidiomata for group V (i.e. the original *H. concrescens*). According to our experience, fleshiness may be affected by weather and site conditions, as we have both thin and thick collections of young *H. concrescens* basidiomata (see also Electronic supplement, Fig. S5). Both species also share a very similar ecology and occur on pond dikes mostly in association with oaks (accompanied by species like e.g. *Hydnellum fagiscabrosum*, *Phellodon confluens*, *P. castaneoleucus*, and a probably undescribed species of *Thelephora* with semiresupinate basidiomata). Other taxa of the *H. concrescens* complex known from Czechia and recently distinguished as separate species include *Hydnellum bomiense* and *Hydnellum* sp. (*H.* aff. *concrescens*, see below), both associated with conifers (at least at currently known sites in Czechia, see notes on these species).

Hydnellum cumulatum K.A. Harrison, Canadian Journal of Botany 42(9): 1225, 1964

Specimens studied: Czech Republic. Šumava Mts, 2.5 km ESE of Srní, Vydra river valley, *Picea* forest, in moss among stones, 23 Sep 2014 leg. J. Holec et T. Kučera (PRM 933000). – Šumava Mts, Koryto near Zbytiny, [oligotrophic forest plantation on acid soil], close to strongly rotten [coniferous] stump, in moss and *Vaccinium* under *Pinus* and *Picea*, 20 Aug 2020 leg. J. Borovička (PRM 954348). – Novohradské podhůří, 2 km NW of Malonty, Hodonický potok valley, *Picea-Pinus* forest with mosses and *Vaccinium myrtillus*, 21 Sep 2012 leg. T. Papoušek et J. Holec (PRM 861437); 2.1 km WNW of Malonty, Hodonický potok valley, *Picea-Pinus* forest with mosses and *Vaccinium myrtillus*, 1 Sep 2019 leg. J. Souček et M. Beran (CB 23186).

Specimens CB 23186, PRM 933000, PRM 861437, and PRM 954348 had identical sequences 99.9–100% similar to several *H. cumulatum* sequences (FN185769, JN135172) from the studies by Ainsworth et al. (2010) and Baird et al. (2013). The collection from the Vydra river valley was described in detail and illustrated with photos in Holec et al. (2016).

Ecology and distribution. Growing in association with conifers, mostly in pine-spruce forests, but also in pure spruce or pine stands. Bound to oligotrophic sites with acid bedrock rich in quartz (granite, granulite, migmatite, paragneiss, but also on sand). Scattered, occurring from the colline to the montane zone with most localities in the submontane zone. Older data on the distribution in Czechia were published by Holec et al. (2016).

Distribution based on GlobalFungi: Europe (Austria).

Czech Red List status: EN. Highly threatened by eutrophication and habitat loss caused by logging due to bark beetle outbreaks.

Notes. Based on sequencing results, the recently described species *H. radiatum* seems to be closely related (Song et al. 2022b), and has already been found in Europe, namely in Sweden (Svantesson, pers. comm.). The basidiomata look quite similar, and spore size and echinulate ornamentation are identical (compare Maas Geesteranus 1975). Spines of Chinese specimens of *H. radiatum* are much darker [fuscous to black in the key by Song et al. (2022b), see also their photos], whereas the habitus of Swedish basidiomata is more similar to Czech collections of *H. cumulatum*. However, the sequence similarity is only 84%, hence *H. radiatum* is certainly a different species.

Hydnellum fagiscabrosum A.M. Ainsw. & Nitare, Fungal Systematics and Evolution 7: 238, 2021 Figs 9–10

Specimens studied: Czech Republic. Praha-Točná, Šance hill, under *Quercus*, 8 Aug 2014 leg. L. Opat (PRM 933225, as *Sarcodon scabrosus*). – Southern Bohemia, between Stará Hlína and Střibřec, dike of Vyšehrad fish-pond, under *Quercus* and young *Sorbus*, 25 Aug 2016 leg. J. Holec et T. Kučera (PRM 944598, as *Sarcodon regalis*). – Eastern Bohemia, 1.4 km N of Trusnov, dike of Lodrant fish-pond, 5 m from the water, mixed forest, under *Acer campestre* and *Tilia*, 17 Sep 2012 leg. J. Kramoliš et J. Holec (PRM 861416, as *Sarcodon lepidus*).

Sequences of all the specimens were identical with the sequence from the type specimen of *Hydnellum fagiscabrosum* (NR_185592; Nitare et al. 2021).

Fig. 9. *Hydnellum fagiscabrosum*, basidioma developed during dry weather (PRM 933225 – for details, see Specimens studied). Photo L. Opat.

Fig. 10. *Hydnellum fagiscabrosum*, basidioma developed during wet weather, unsequenced, České Budějovice, Vrbenské rybníky Nature Reserve (South Bohemia, Czech Republic), *Quercus*, *Betula*, 23 Aug 2016 (microsite identical to the 2014 collection deposited under CB JS-2014-080). Photo J. Souček.

Ecology and distribution. Growing in association with broadleaved trees, mainly oak, on acid to neutral soils. Scattered, with strong preference for warm sites like pond dikes and forests on southern slopes. Known from the colline zone.

Distribution based on GlobalFungi: Europe (Finland, Italy, Poland, Romania), North America (USA), South America (French Guiana).

Czech Red List status: EN.

Notes. Recently described species previously identified as *Sarcodon scabrosus* (p. p.), *Sarcodon regalis*, or *Sarcodon lepidus* in the Czech Republic. All of these species differ by notably smaller spores (Nitare et al. 2021). We cannot rule out occurrences around the lower boundary of the submontane zone, since only part of the available fungarium material has been revised or sequenced to date.

Hydnellum fennicum (P. Karst.) E. Larss., K.H. Larss. & Kõljalg, MycoKeys 54: 40, 2019

≡ *Sarcodon fennicus* (P. Karst.) P. Karst.

Specimen studied: Czech Republic. Šumava Mts, 1.4 km ENE of Srní, Vydra river valley: slightly below the confluence with Hrádecký potok, *Picea* forest with *Salix* and *Sorbus*, 10 Sep 2014 leg. J. Holec et M. Kříž (PRM 932972, as *Bankera violascens*).

The sequence of the specimen was identical with numerous *H. fennicum* sequences (e.g. MK602738) from the study by Larsson et al. (2019).

Ecology and distribution. Growing in association with spruce in coniferous forests (pine often being present), mostly at sites rich in *Bankeraceae*. The relationship to bedrock is unclear. Most collections originate from neutral to calcareous soils (on marlite, calcareous-clayey sandstone, margin of a gravel road containing marble), a few from acid soils (on granite, paragneiss). Rare, known from the colline and the submontane zone.

Distribution based on GlobalFungi: no reliable hit in the database.

Czech Red List status: CR. Threatened by habitat loss due to bark beetle outbreaks.

Hydnellum ferrugineum (Fr.) P. Karst., Meddelanden af Societas pro Fauna et Flora Fennica 5: 41, 1879

Specimens studied: Czech Republic. Southern Bohemia, 2.7 km SW of Vesce, forest named Bůrek, *Pinus* forest with mosses, *Vaccinium myrtillus* and lichens, 8 Oct 2010 leg. J. Holec et T. Kučera (PRM 899150). – Novohradské podhůří, 2 km S of Malonty, Kamenice stream valley, *Pinus* forest with admixed *Picea* and *Fagus*, in mosses, 21 Sep 2012 leg. T. Papoušek et J. Holec (PRM 861445).

Sequences obtained from the specimens were identical with sequences from several specimens of *H. ferrugineum*, e.g. JN135185 and EU622340 from the studies by Baird et al. (2013) and van der Linde et al. (2008), respectively.

Ecology and distribution. Growing in association with pine and spruce, in various types of coniferous (pine plantations on sandy soil, acidophilous spruce stands, rarely on serpentinite) and mixed forests. Common, occurring in the colline and submontane, rarely montane zones.

Distribution based on GlobalFungi: Europe (Estonia, France, Spain, Sweden), North America (Canada, USA).

Czech Red List status: VU.

Hydnellum geogenium (Fr.) Banker, Mycologia 5(6): 203, 1913

Specimens studied: Czech Republic. Šumava Mts, 3 km SSW of Rejštejn, Dračí skály rocks, mixed forest, under *Picea*, *Pinus*, *Fagus* and *Abies*, 10 Sep 2014 leg. J. Holec et M. Kříž (PRM 932986). – Eastern Bohemia, close to Proseč, Maštale Nature Reserve: Vranické údolí, under *Picea* and *Betula*, 18 Sep 2010 leg. J. Burel (PRM 937008).

Sequences obtained from the specimens were identical with various *H. geogenium* sequences deposited by van der Linde et al. (2008) and Matheny et al. (2007), e.g. EU627602 and DQ218304.

Ecology and distribution. Growing in association with conifers, most probably spruce, in coniferous and mixed forests on acid, sandy to gravelly soil on granite, gneiss and sandstone bedrock. Rare, occurring at isolated localities from the submontane to the montane zone, rarely in the colline zone.

Distribution based on GlobalFungi: Europe (Switzerland), North America (USA).

Czech Red List status: CR. Proposed for legal protection in the Czech Republic, see Hrouda (in Dvořák & Hrouda 2021: 111–115) for details.

Hydnellum gracilipes (P. Karst.) P. Karst., Meddelanden af Societas pro Fauna et Flora Fennica 5: 41, 1879

Specimen studied: Czech Republic. Southern Bohemia, Novohradské podhůří, Dluhoště, ca 1.2–1.4 km NE of the village, southern slopes of Vysoký kámen hill, adult coniferous stand (*Pinus sylvestris*, *Picea abies*), lying *Picea/Pinus* trunk ca 20 cm in diam. covered by mosses, 4 Oct 2019 leg. M. Kolényová (BRNU 680028; duplicate TUF 135815).

The sequence obtained from the specimen was 99.7% similar to *H. gracilipes* sequence MK602726 from the study by Larsson et al. (2019). The mentioned collection was described in detail and illustrated with photos in Kolényová et al. (2024).

Ecology and distribution. Very rare, hitherto known from only one locality in a coniferous forest on acid soil in the submontane zone (Kolényová et al. 2024).

Distribution based on GlobalFungi: Europe (Estonia, Finland, Norway, Sweden), North America (Canada).

Czech Red List status: CR.

Notes. Species with subtle basidiomata on a very thin stipe, using lying wood, litter and vegetation as support. For this reason, the basidiomata may be

Fig. 11. *Hydnellum illudens* (CB 23505 – for details, see Specimens studied). Photo J. Souček.

easily overlooked and targeted and careful searching is required (as carried out by mycologists specialising in *Corticiaceae*).

Hydnellum illudens (Maas Geest.) Nitare, Fungal Systematics and Evolution 7: 245, 2021 Fig. 11

≡ *Sarcodon illudens* Maas Geest.

Specimens studied: Czech Republic. Southern Bohemia, Vyšný near Český Krumlov, young *Pinus* forest on amphibolite-marble, among needles and mosses, 19 Sep 2019 leg. J. Souček (CB 23505). – Central Bohemia, Koněprusy, under *Pinus nigra* (but also with *Quercus* seedlings) on calcareous soil, 11 Sep 2022 leg. J. Herčík et P. Nouzovský (PRM 958183). – Bohemian-Moravian Highlands, Žďár nad Sázavou, 2.5 km W of the castle, surroundings of Vápenice forest quarry, under *Picea*, *Abies*, and *Pinus*, 14 Aug 2011 leg. D. Dvořák (BRNU 680031).

Sequences obtained from the specimens were 99.55–100% similar to various *H. illudens* sequences (e.g. MW144352) from the study by Nitare et al. (2021).

Ecology and distribution. Growing in association with pines, possibly also with oaks, on (almost bare) calcareous bedrock with a very thin layer of litter and humus. Rare, known from three localities in the colline to the submontane zone.

Distribution based on GlobalFungi: Europe (Austria, Estonia, France, Italy, Lithuania, Spain).

Czech Red List status: CR. Probably highly threatened by eutrophication.

Notes. *Hydnellum scabrosum* also grows in pine forests on nutrient-poor soils but prefers acid (silicate) bedrock. Its basidiomata are on average larger and lack ochraceous and fulvous tones, which may be present even on the spines of old or dried basidiomata of *H. illudens* (Nitare et al. 2021).

One of the collections (BRNU 680031), represented by one small and rather dark basidioma, was originally identified by D. Dvořák as *Sarcodon scabrosellus*, nom. prov. Since the Red List assessment of *Hydnellum scabrosellum* in Zíbarová et al. (2024) was based solely on this collection, this is erroneous, thus *H. scabrosellum* is so far not known from the Czech Republic.

Hydnellum lundellii (Maas Geest. & Nannf.) E. Larss., K.H. Larss. & Kõljalg, MycoKeys 54: 41, 2019

≡ *Sarcodon lundellii* Maas Geest. & Nannf.

Specimen studied: Czech Republic. Bohemian-Moravian Highlands, ca 1.5 km WSW of Chmelná near Nová Cerekev, forest stand named Chmelná, coniferous forest, under *Pinus* and *Picea*, 29 Jul 2016 leg. J. Holec et T. Kučera (PRM 944581).

The specimen had a sequence identical with *H. lundellii* (MK602758) from the study by Larsson et al. (2019). The mentioned collection was described in detail and illustrated with photos in Holec et al. (2017).

Ecology and distribution. Associated with spruce, mostly on calcareous soil. Rare, known from three localities in the submontane zone.

Distribution based on GlobalFungi: Europe (Lithuania), Central and North America (Puerto Rico, USA).

Czech Red List status: CR. Highly threatened by habitat loss caused by logging due to bark beetle outbreaks.

Notes. As the species is reported to be mostly basiphilic, it may seem contradictory that the studied specimen originated from Chmelná forest, dominated by an acid spruce stand. However, according to recent field surveys at this locality, other basiphilic fungi also occur here (not only hydnoids, but also e.g. *Tricholoma aurantium*). We assume the possible presence of a small area of some base-rich rock not included in the geological map – outcrops of such rocks (marbles and amphibolites) occur in that area. According to our experience, its presence is usually not manifested by a change in forest vegetation, but by the presence of a basiphilic fungal community.

Hydnellum martioflavum (Snell, K.A. Harrison & H.A.C. Jacks.) E. Larss., K.H. Larss. & Kõljalg, MycoKeys 54: 42, 2019

≡ *Sarcodon martioflavus* (Snell, K.A. Harrison & H.A.C. Jacks.) Maas Geest.

Specimen studied: Czech Republic. Javorníky Mts, near Francova Lhota, between Tisůvek and Čubův kopec, under *Abies*, *Picea*, and *Pinus*, 11 Aug 2016 leg. M. Kříž, L. Opat et T. Pavelka (PRM 944954).

The specimen had a 99.4% sequence similarity to *H. martioflavum* MK602763 from the study by Larsson et al. (2019). The mentioned collection was described in detail and illustrated with photos in Kříž (2017).

Ecology and distribution. Recently known from one locality in the submontane zone, in fir-spruce-pine forest, growing on sandstone and claystone bedrock of the Carpathian flysch belt. This corresponds to the general knowledge summarised by Kříž (2017) that the species lives in association with spruce on base-rich soils.

Distribution based on GlobalFungi: no reliable hit in the database.

Czech Red List status: CR.

Hydnellum peckii Banker ex Peck, Bulletin of the New York State Museum 157: 34, 1912

Specimens studied: Czech Republic. Šumava Mts, 0.8 km SSW of Včelná pod Boubínem, western slope, *Picea* forest with admixed *Pinus*, in needles, 24 Sep 2019 leg. J. Souček (CB 23515). – Southern Bohemia, close to Velmovice near Chýnov, Dubské vrchy, margin of *Picea* forest, in moss and *Vaccinium myrtillus*, 31 Aug 2010 leg. P. Špinar (PRM 899536). – Bohemian-Moravian Highlands, Krucemburk, Staré Ransko, in mixed young *Picea/Fagus* plantation, moist place, 6 Aug 2020 leg. J. Borovička (PRM 954312). – Eastern Bohemia, close to Proseč, Maštale Nature Reserve: slope above Voletínský potok stream, mixed forest: *Picea*, *Pinus*, *Sorbus*, *Acer*, *Fagus*, among needles, 17 Sep 2012 leg. J. Kramoliš et J. Holec (PRM 861417). – Javorníky Mts, Nový Hrozenkov, Vranča stream valley, coniferous forest, under *Picea*, rarely *Abies* and young *Fagus*, 20 Jun 2014 leg. M. Graca, V. Balner et J. Holec (PRM 924915).

Sequences obtained from the specimens had 99.8% similarity to the sequence from *H. peckii* (MK602733) deposited by Larsson et al. (2019).

Ecology and distribution. Growing in association with spruce, more rarely with pine, in coniferous and mixed forests, on acid as well as alkaline bedrock. Common, occurs in the colline and submontane, rarely montane zones.

Distribution based on GlobalFungi: Europe (Estonia, France, Switzerland), Asia (Georgia), North America (Canada, USA).

Czech Red List status: VU. After the reduction in acid rain by desulphurisation of coal-fired power stations in the mid-1990s, a return of this species has been observed. However currently, logging due to bark beetle outbreaks in spruce forests and eutrophication of pine forests are serious threats.

Hydnellum rubidofuscum Y.H. Mu & H.S. Yuan, Journal of Fungi 7(10, no. 818): 29, 2021 Fig. 8

= *Hydnellum* group I sensu Ainsworth et al., Fungal Ecology 4: 76, 2010

Specimens studied: Czech Republic. Southern Bohemia, 1.8 km W of České Vrbné, Vrbenské rybníky Nature Reserve, dike of Domin pond, *Quercus* [*robur*], among grass, 17 Aug 2014 leg. J. Souček (CB 24909). – Southern Bohemia, 1.1 km N of Klec, dike between Láska and Naděje ponds, *Quercus* [*robur*], among grass, 14 Sep 2019 leg. J. Souček et J. Janda (CB 23493). – Southern Bohemia, Třeboň, dike of Velké Stavidlo pond, *Quercus*, *Salix*, *Alnus*, *Betula*, in litter and sparse grass, 11 Oct 2023 leg. J. Souček et L. Opat (CB JS-2023-067).

Phylogenetically, our specimens formed a well-supported clade (98%) consisting of *Hydnellum rubidofuscum* (98.5% similarity to sequence NR_174071 from the type material, Mu et al. 2021) and sequences labelled *H. concrescens* (99.8%, KC571714, Baird et al. 2013).

Ecology and distribution. Associated with broadleaved trees, namely oaks, at warm sites on acid to neutral soils in the colline zone.

Distribution based on GlobalFungi: Europe (Estonia), Asia (China).

Notes. Recently described species sharing general macroscopic, microscopic and ecological characteristics with *Hydnellum concrescens*. Ainsworth et al. (2010) present distinguishing macroscopic features, but in our experience, these do not always fit (see notes on *H. concrescens*).

Phylogenetically, Asian specimens of *H. rubidofuscum* and North American specimens labelled by Baird et al. (2013) as *H. concrescens* form two sister clades (Song et al. 2022). Our specimens fit to the '*H. concrescens*' clade. However, *H. concrescens* is a name applicable to another species (see *H. concrescens* in this paper). Thus, the Czech *H. rubidofuscum* and probably also North American specimens labelled as *H. concrescens* by Baird et al. (2013) may represent an undescribed species.

We do not characterise the distribution or frequency of occurrence of this species. Without sequencing, there is currently no way to reliably distinguish fungarium material of this species from that of *H. concrescens*.

Hydnellum scabrosum (Fr.) E. Larss., K.H. Larss. & Kõljalg, MycoKeys 54: 42, 2019

≡ *Sarcodon scabrosus* (Fr.) P. Karst.

Specimen studied: Czech Republic. Novohradské podhůří, 2 km S of Malonty, Kamenice stream valley, *Pinus* forest with admixed *Picea* and *Fagus*, in moss and needles, 21 Sep 2012 leg. T. Papoušek et J. Holec (PRM 861446).

Sequence obtained from specimen PRM 861446 was identical with reference sequences of *H. scabrosum* MK602743, MK602744, and MK602745, published by Larsson et al. (2019).

Ecology and distribution. Growing in association with spruce and pine in coniferous and mixed forests. Scattered in the colline and submontane zones.

Distribution based on GlobalFungi: Europe (Austria, Estonia, Finland, Germany, Lithuania, Norway, Russia, Sweden), North America (Canada).

Czech Red List status: EN.

Notes. Collections from coniferous forests with an areolate (not scaly) pileus surface have been commonly identified as *Sarcodon glaucopus* (currently *Hydnellum glaucopus*). Based on specimens sequenced by us, they belong to *H. scabrosum*, while *H. glaucopus* in its current delimitation (Nitare & Högberg 2012) has not yet been found in the Czech Republic [this is a species of spruce forests on nutrient-rich alkaline soils, known from the Nordic countries (Nitare & Högberg 2012, Nitare et al. 2021), represented by GenBank sequences MK602743, MK602744, and MK602745, whereas the assignment of some other sequences to *H. glaucopus* is probably erroneous]. On the other hand, most specimens formerly identified as *S. scabrosus*, originating from habitats with broadleaved trees (fishpond dikes, beech stands), probably represent *H. fagiscabrosum* (see above).

Hydnellum scrobiculatum (Fr.) P. Karst., Meddelanden af Societas pro Fauna et Flora Fennica 5: 41, 1879

= *Hydnellum subsuccosum* s. auct.

Specimens studied: Czech Republic. Šumava Mts, Zbytiny, coniferous forest with *Picea* and *Pinus*, 29 Aug 2020 leg. J. Souček (CB 23752). – Koryto near Zbytiny, in [oligotrophic] *Picea abies* forest plantation, in [mineral soil and] fallen needles, 19 Aug 2020 leg. J. Borovička (PRM 954351). – Southern Bohemia, 0.8 km NNE of Kladenské Rovné, young *Picea* forest, in needles, 9 Aug 2020 leg. J. Souček (CB 23731). – Southern Bohemia, 1.6 km NE of Zliv, forest fringe above wall of former sand quarry, *Pinus*, *Betula pendula*, 22 Aug 2017 leg. J. Souček (CB 21534). – Novohradské hory, 0.8 km SE of Staré Hutě, damp *Picea* forest, in needles, 23 Aug 2020 leg. J. Souček (CB 23736). – Bohemian-Moravian Highlands, Velký Ježov near Smilovy Hory, in moss and needles under mature *Pinus* and *Picea* trees (forest plantation), 20 Aug 2019 leg. J. Borovička (PRM 952390). – Bohemian-Moravian Highlands, Staré Ransko near Krucemburk, in moist *Picea abies* forest plantation [on gabbro bedrock], in fallen needles, 25 Aug 2020 leg. J. Borovička (PRM 954352, PRM 954353).

Sequences obtained from the specimens had 99.4% similarity with various *H. subsuccosum* sequences (e.g. JN135178) from the study by Baird et al. (2013).

Ecology and distribution. Growing mostly in association with spruce and pine (found also near Douglas fir in a forest named Svákov near Soběslav, but the specimen has not been sequenced), in coniferous and mixed forests, on gravelly, sandy, or clayey soils. Rare collections from broadleaved forests (oak) may belong to other species in the *H. concrescens* complex. Scattered in the colline and submontane zones.

Distribution based on GlobalFungi: Europe (Austria, Sweden), North America (Canada).

Czech Red List status: NT.

Notes. The correct naming of recently genetically delimited species has not been resolved yet (see also notes on *H. concrescens*). The summary of ecology and distribution of *H. scrobiculatum* is mostly based on fungarium material identified in the traditional sense (Maas Gesteranus 1975), i.e. by spores having rounded warts in contrast with truncate, angular warts in other species of the *H. concrescens* complex.

Hydnellum spongiosipes (Peck) Pouzar, Česká Mykologie 14(2): 130, 1960

Specimens studied: Czech Republic. Eastern Bohemia, 1.4 km N of Trusnov, dike of Lodrant fishpond, 5 m from the water, mixed forest, under *Acer campestre* and *Tilia*, 17 Sep 2012 leg. J. Kramoliš et J. Holec (PRM 861415). – Eastern Bohemia, Klenovka near Přelouč, on mineral soil covered by mosses and debris, *Quercus rubra* forest plantation, 13 Jul 2021 leg. J. Borovička (PRM 956292).

Sequences obtained from the specimens were 99.8% similar to *H. spongiosipes* sequence KC571744 from the study by Baird et al. (2013).

Ecology and distribution. Growing in association with oak and linden (at least one of these two trees was always present, but also other broadleaved trees occurred at the sites), mostly on fishpond dikes. Rare, isolated localities in the colline zone.

Distribution based on GlobalFungi: Europe (Italy), North America (Mexico, USA).

Czech Red List status: CR.

Hydnellum suaveolens (Scop.) P. Karst., Meddelanden af Societas pro Fauna et Flora Fennica 5: 41, 1879

Specimen studied: Czech Republic. Eastern Bohemia, close to Proseč, Maštale Nature Reserve, under *Picea abies*, 15 Jul 2009 leg. L. Tmej (PRM 918174).

The specimen showed high sequence similarity to various published sequences of *H. suaveolens* (99%, e.g. MK602736, Larsson et al. 2019).

Ecology and distribution. The species appears to grow in association with spruce (always present, sometimes with pine, fir, or broadleaved trees admixed in the stand) in coniferous and mixed forests. Rare, isolated localities in the colline and submontane zones.

Distribution based on GlobalFungi: no reliable hit in the database.

Czech Red List status: CR. Highly threatened by habitat loss caused by logging due to bark beetle outbreaks.

Hydnellum tardum Maas Geest., Die Terrestrischen Stachelpilze Europas (Verhandelingen der Koninklijke Nederlandse Akademie van Wetenschappen, Afdeling Natuurkunde, ser. 2, vol. 65): 98, 1975 Figs 12, 13

Specimens studied: Czech Republic. Šumava Mts, 0.5 km W of Žlábek, Kraví hora, [~150 years old] coniferous forest with *Picea*, *Abies alba*, and admixed *Pinus*, in needles, 10 Sep 2019 leg. J. Souček (CB 23479). – Southern Bohemia, Třebovice near Ktiš, oligotrophic forest [on acid soil], under *Pinus* and *Betula*, 12 Aug 2021 leg. J. Souček et J. Borovička (PRM 956329). – Southern Bohemia, 0.9 km ENE of Hrádek near Trhové Sviny, oligotrophic *Pinus* forest with admixed *Picea*, bare soil, 18 Sep 2021 leg. J. Souček et J. Janda (CB 24071). – Bohemian-Moravian Highlands, ca 1.5 km WSW of Chmelná near Nová Cerekev, forest named Chmelná, dense *Picea-Pinus* stand, 19 Sep 2012 leg. J. Burel et J. Holec (PRM 861427); ibid., in young oligotrophic *Picea* forest plantation [on acid soil], in needles and mineral soil, 18 Aug 2021 leg. J. Borovička (PRM 956331).

Sequences of *H. tardum* have not been published so far. Phylogenetically, it is a sister species to *H. concrescens*. The greatest similarity of our sequences was indeed found to this species (91%, e.g. EU784267, Brock et al. 2008). However, comparison with a sequence of the *H. tardum* holotype or later collected specimens from the type locality (not existing yet) would be desirable.

Ecology and distribution. Associated to conifers. Our collections indicate a relation to both pine and spruce. Bound to oligotrophic sites with acid bedrock (granite, granodiorite, migmatite, paragneiss, or metaquartzite). Rare, occurring from the colline to the submontane zone.

Distribution based on GlobalFungi: Europe (Estonia), Asia (South Korea).

Czech Red List status: CR. Highly threatened by eutrophication and by logging due to bark beetle outbreaks.

Notes. Pinkish tones are usually cited as the main distinguishing feature (Maas Geesteranus 1975). Old basidiomata, however, usually lack them but may, on the contrary, appear in some other species. *Hydnellum rubidofuscum* is probably the most notable example. Both species also have similar spore characteristics. The main differentiating factor seems to be their ecology: *H. rubidofuscum* is associated with broadleaved trees, while *H. tardum* grows in association with conifers on nutrient-poor acid soils. Pinkish tones may rarely also be present in basidiomata of *H. scrobiculatum* (J. Souček, pers. obs.), which has different spores (with rounded, less prominent warts).

***Hydnellum* sp.** (*Hydnellum* aff. *concrescens*) Fig. 6

Specimens studied: Czech Republic. Southern Bohemia, Vyšný, young *Pinus* forest on amphibolite-marble, among needles and mosses, 19 Sep 2019 leg. J. Souček (CB 23503). – Central Bohemia, Příbram-Brod, uranium tailing pile rich in carbonate minerals, under *Quercus* and *Pinus*, among lichens, 18 Oct 2024 leg. J. Borovička (PRM 963278).

Specimens PRM 963278 and CB 24412 had identical ITS sequences. The sequence from voucher CB 23503 showed only 95.74% similarity with *H. dianthifolium* sequence KX619420 (Loizides et al. 2016), representing the closest hit to our taxon. This means that our specimens represent a different, apparently undescribed species.

Fig. 12. *Hydnellum tardum*, young basidiomata, unsequenced, 31 Aug 2019 (later collected and deposited under CB 23479 – for details, see Specimens studied). Photo J. Souček.

Fig. 13. *Hydnellum tardum*, unsequenced, moderately mature basidiomata, 24 Aug 2019 (microsite identical to PRM 956329 – for details, see Specimens studied). Photo J. Souček.

Ecology and distribution. Our sequenced collections come from pine stands on almost bare calcareous bedrock with a thin layer of litter in the submontane zone.

Distribution based on GlobalFungi: Europe (France, Italy, Portugal, Spain, Switzerland).

Notes. Undescribed species known particularly from the Mediterranean area, where it grows in association with pines on limestone bedrock (K.-H. Larsson, pers. comm.). The basidiomata are quite variable in shape and colour: small, thin and funnel-shaped in dry seasons, but quite fleshy, irregular and coalescent during long periods of wet weather. They are generally more similar to *Hydnellum concrescens* than to *Hydnellum scrobiculatum*. On the other hand, spores are slightly more regular with less pronounced warts [slightly similar to the spores of *H. scrobiculatum*, see e.g. Holec et al. (2016)], only slightly smaller, about 4 µm in length (J. Souček, pers. obs.). *Hydnellum concrescens* and *H. rubidofuscum* are associated with broadleaved trees, *H. cumulatum* and *H. tardum* grow on acid soils. *Hydnellum scrobiculatum* is usually more thick-fleshed (pileus margins being solid, not flexible), prefers acid to neutral soils, and grows mostly (but not only) in association with spruce. There are other Czech collections, which probably represent this species, but these have not been sequenced (nor revised) yet. Nevertheless, it may be quite rare in Czechia, namely because of its ecological requirements (nutrient-poor pine forests on calcareous bedrock are rare per se and extremely prone to eutrophication).

This taxon is above referred to as '*Hydnellum* aff. *concrescens*' because of its morphological similarity, but is phylogenetically quite distant from the true *H. concrescens*. Voucher CB 23503 had 95.74% similarity with *H. dianthifolium* KX619420. Phylogenetically, it forms a well-supported clade (BS = 99%) with *H. dianthifolium* voucher ML902162HY (KX619420) published by Loizides et al. (2016). Both taxa clustered with *H. bomiense* (95%). Taking into account an ongoing comprehensive study on *H. concrescens* complex by British and Nordic authors, we will here not formally describe a new species based on the Czech collections.

Phellodon aquiloniniger A.M. Ainsw. & Svantesson, Fungal Systematics and Evolution 15: 15, 2024 Fig. 14

= *Phellodon* group V s. Ainsworth et al., Fungal Ecology 4: 76, 2010

Specimens studied: Czech Republic. Southern Bohemia, Polná na Šumavě, young *Picea* forest with admixed *Abies alba* and, at greater distance, *Pinus*, in needles, 13 Sep 2022 leg. J. Souček (CB 24403). – Novohradské hory, Bělá near Malonty, in oligotrophic *Pinus* forest on acid bedrock, mixed with *Picea* and *Betula*, 21 Sep 2021 leg. J. Borovička (PRM 956355, as *Phellodon niger*). – Bohemian-Moravian Highlands, Velký Ježov near Smilovy Hory, in moss and needles under mature *Pinus* and *Picea* trees (forest plantation), 20 Aug 2019 leg. J. Borovička (PRM 952389, as *Phellodon*

Fig. 14. *Phellodon aquiloniniger* (CB 24403 – for details, see Specimens studied). Photo J. Souček.

Fig. 15. *Phellodon niger* (CB JS-2022-139 – for details, see Specimens studied). Photo J. Souček.

niger). – Bohemian-Moravian Highlands, Chmelná near Nová Cerekev, in oligotrophic *Picea* forest plantation mixed with *Pinus*, 2 Sep 2021 leg. J. Borovička (PRM 956373, as *Phellodon niger*); ibid., Markvarecké polesí forest stand, under *Picea* and *Pinus*, 16 Aug 2012 leg. M. Kříž et P. Mikuš (PRM 860605, as *Phellodon niger*).

Sequences obtained from the specimens had 99.5–100% similarity to various sequences (e.g. EU622372 and FN185816) identified by Ainsworth et al. (2010) as the *Phellodon niger* group V. The identity to the reference specimens published by Svantesson et al. (2024) was 98.6–98.8% (PQ226281, holotype of *P. aquiloniniger*) and 99.6–100% (PQ226279, PQ652218, PQ226285)

Ecology and distribution. Growing in association with spruce and pine in various types of coniferous (from sandy pine to humid spruce stands) and mixed forests, preferably on acid soils. Several fungarium specimens, potentially associated with broadleaved trees, as well as specimens from habitats on calcareous bedrock (see below), may belong to different taxa in the sense of Ainsworth et al. (2010) and Svantesson et al. (2024). Anyway, *P. aquiloniniger* appears to be common, recently occurring not only from the colline to the submontane zone (just as in the 20th century), but with an increasing number of localities in the montane zone.

Distribution based on GlobalFungi: Europe (Estonia, Finland, Sweden), North America (Canada, Mexico).

Czech Red List status: NT.

Notes. The name *Phellodon niger* was traditionally used for this species in central Europe. Although lots of specimens deposited in Czech fungaria have not been revised, it is likely that a vast majority of collections labelled *P. niger* represent *P. aquiloniniger* as evidenced by especially their ecology (those originating from acid pine or spruce forests).

Phellodon castaneoleucus A.M. Ainsw., Fungal Systematics and Evolution 15: 20, 2024 Figs 16–17

= *Phellodon* group IX s. Ainsworth et al., Fungal Ecology 4: 76, 2010

Specimens studied: Czech Republic. Southern Bohemia, Hluboká nad Vltavou, dike of Munický pond, under *Quercus* [*robur*], *Tilia* [*cordata*] and *Robinia pseudoacacia*, among litter and sparse grass, 14 Sep 2022 leg. J. Souček (CB 24412). – Southern Bohemia, Frahelž, dike of Naděje pond, under *Quercus* [*robur*], *Pinus* [*sylvestris*], and *Salix* sp., among sparse grass, 26 Oct 2017 leg. J. Souček et J. Novotný (CB JS-2017-262).

Specimens CB JS-2017-262 and CB 24412 had identical ITS sequences fully matching *Phellodon* group IX (FN185826.1) sensu Ainsworth et al. 2010 and had 98.9% similarity with the holotype specimen of *P. castaneoleucus* (PQ226292, Svantesson et al. 2024).

Ecology and distribution. Associated with broadleaved trees, most likely *Fagaceae* (Ainsworth et al. 2010). Rare, known from two localities in the colline zone, documented by reliably identified, i.e. sequenced specimens. Some other collections (identified as *P. melaleucus* but originating from broadleaved

Fig. 16. *Phellodon castaneoleucus*, young basidiomata (CB 24412 – for details, see Specimens studied). Photo J. Souček.

Fig. 17. *Phellodon castaneoleucus*, mature basidiomata, unsequenced, 30 Sep 2022 (microsite identical to CB 24412 – for details, see Specimens studied). Photo J. Souček.

stands, not sequenced yet) may possibly belong to this species, hence its real distribution in Czechia remains unknown.

Distribution based on GlobalFungi: Europe (France, Greece, Italy, Spain), Asia (Georgia).

Notes. Recently described species (Svantesson et al. 2024). When young, both colour (light brown, hazelnut-like) and shape of the basidiomata are reminiscent of *Phellodon tomentosus*, later the shape becomes less regular and somewhat closer to *P. melaleucus*. However, it seems that even mature basidiomata lack the steely grey tinge which is sometimes present in basidiomata of *P. melaleucus* (J. Souček, pers. obs.).

Phellodon confluens (Pers.) Pouzar, Česká Mykologie 10(2): 74, 1956

Specimens studied: Czech Republic. Southern Bohemia, Frahelž, dike of Naděje pond, under *Quercus* [*robur*] and *Populus* [*tremula*], among litter, 14 Sep 2019 leg. J. Souček et J. Janda (CB JS-2019-094). – Eastern Bohemia, near Petrovice close to Týniště nad Orlicí, dike of Malá Houkvice fishpond, under *Quercus*, *Carpinus*, and *Betula*, 1 Oct 2014 leg. J. Wipler et V. Samková (PRM 933389).

The sequence obtained from specimen CB JS-2019-094 had 99.5% similarity with the sequence of *P. confluens* (e.g. KC571756.1) published by Baird et al. (2013).

Ecology and distribution. Growing in association with oak, rarely beech, in broadleaved and mixed forests, commonly on fishpond dikes, on bare loamy soil or in leaf litter. Scattered in the colline zone.

Distribution based on GlobalFungi: Europe (Italy, Romania), Central and North America (Panama, USA).

Czech Red List status: EN. Legally protected in the Czech Republic, see Hrouda (in Dvořák & Hrouda 2021: 101–106) for details.

Phellodon fuligineoalbus (J.C. Schmidt) Baird, Fungal Diversity 62: 63, 2013

≡ *Bankera fuligineoalba* (J.C. Schmidt) Coker & Beers ex Pouzar

Specimen studied: Czech Republic. Bohemian-Moravian Highlands, Chmelná near Nová Cerekev, forest stand named Chmelná, mixed forest: *Pinus*, *Picea*, under *Pinus sylvestris*, 20 Sep 2008 leg. J. Burel (PRM 937020).

The sequence obtained from specimen PRM 937020 had 99.7–100% similarity with various *P. fuligineoalbus* sequences (e.g. EU622322 and JN135196) published by van der Linde et al. (2008) and Baird et al. (2013).

Ecology and distribution. Growing in association with pine in coniferous and mixed forests, preferably in oligotrophic pine stands on sandy soils and also in pine relicts on rocky outcrops. Rare, occurring at isolated localities from the colline to the submontane zone.

Distribution based on GlobalFungi: Europe (Estonia, Finland), North America (Canada).

Czech Red List status: CR. Proposed for legal protection in the Czech Republic, see Hrouda (in Dvořák & Hrouda 2021: 4–9) for details. Habitats of the species are highly threatened by eutrophication.

Phellodon melaleucus (Sw. ex Fr.) P. Karst., Revue Mycologique (Toulouse) 3(9): 19, 1881

= *Phellodon connatus* s. auct.
= *Phellodon* group I s. Ainsworth et al., Fungal Ecology 4: 76, 2010

Specimens studied: Czech Republic. Šumava Mts, Zbytiny, *Picea* forest, among mosses and needles, 4 Oct 2020 leg. J. Souček (CB 23832). – Koryto near Zbytiny, in oligotrophic *Picea* forest plantation, [in mineral soil and fallen needles], 22 Sep 2021 leg. J. Borovička (PRM 956352). – Šumava Mts, 0.4 km WNW of Žlábek, Kraví hora, coniferous forest with *Picea* and *Abies alba*, rocks, needles, 1 Oct 2020, leg. P. Moran (CB 23829). – Southern Bohemia, 2.3 km NNW of Munice, Blana forest district, *Picea*, *Pinus*, oligotrophic site among mosses and *Vaccinium vitis-idaea*, 22 Sep 2020 leg. J. Souček (CB 23780). – Southern Bohemia, 4.4 km NE of Suchdol nad Lužnicí, near Bukové kopce Nature Reserve, on gravel road in coniferous forest with *Abies alba*, admixed *Picea* and *Pinus*, 8 Sep 2021, leg. J. Novotný, T. Papoušek et J. Souček (CB 24067). – Southern Bohemia, 2.5 km E of Chlum u Třeboně, Rašeliniště Pele Nature Reserve, at margin of asphalted forest road, under *Picea*, *Pinus*, *Betula*, and *Populus tremula*, 7 Oct 2010 leg. J. Holec et T. Kučera (PRM 899140). – Central Bohemia, Borovsko near Bernartice, bank of Švihov water reservoir, very close to water level and reed plants, under *Betula*, *Pinus*, and *Picea*, on serpentinite bedrock, 5 Sep 2022 leg. J. Borovička (PRM 958191). – Bohemian-Moravian Highlands, Chmelná near Nová Cerekev, in rather young oligotrophic *Picea* forest plantation, 2 Sep 2021 leg. J. Borovička (PRM 956375).

Sequences obtained from all specimens had 99.5–100% similarity to various sequences of *P. melaleucus* (MH118171, FN185794, EU622363) published in van der Linde et al. (2008), Ainsworth et al. (2010), and Zmitrovich et al. (2018). The similarity with epitype sequence PQ226322 (Svantesson et al. 2024) was 99.9%.

Ecology and distribution. Generally, *P. melaleucus* has been reported to grow in association with different trees in coniferous (mostly spruce and pine) and mixed forests on various soil types (sandy, loamy, clayey), rarely in broadleaved forests (oak, hornbeam, beech), occurring quite commonly from the colline to the submontane zone, more rarely in the montane zone.

Distribution based on GlobalFungi: Europe (Estonia, Finland, Germany, Italy, Lithuania, Netherlands, Norway, Poland, Sweden), Asia (South Korea), North America (Canada).

Czech Red List status: NT.

Notes. The assessment of ecology and distribution is based mostly on previous morphological identification (*P. melaleucus* sensu Maas Geesteranus 1975) of fungarium specimens, which may belong to different taxa (*P. melaleucus* s. str., *P. castaneoleucus*, possibly also *P. ellisianus* and *P. secretus*), and the ecological amplitude of recently delimited taxa may be narrower (see also *P. castaneoleucus*). Nevertheless, sequenced specimens of *P. melaleucus* s. str. (Svantesson et al. 2024) were collected in pure stands of both broadleaved and coniferous

trees, so we can assume that this species really does have a wide ecological amplitude.

Phellodon niger (Fr.) P. Karst., Revue Mycologique (Toulouse) 3(9): 19, 1881

Fig. 15

= *Phellodon* group III s. Ainsworth et al., Fungal Ecology 4: 76, 2010

Specimens studied: Czech Republic. Southern Bohemia, Vyšný, Výří vrch, under *Pinus sylvestris* on calcareous soil, 13 Sep 2022 leg. J. Souček et J. Borovička (PRM 958107). – Southern Bohemia, Velmovice near Chýnov, *Picea* forest with admixed *Pinus*, *Fagus*, and *Betula*, in moss at the margin of a marble gravel forest road, 24 Sep 2022 leg. J. Souček et J. Blažej (CB JS-2022-139).

The sequence obtained from specimen PRM 958107 had 99.4% similarity with sequence FN185818 identified by Ainsworth et al. (2010) as *Phellodon niger* group III. The sequence of specimen CB JS-2022-139 had 99.7% similarity with *P. niger* sequences PQ226350 and PQ226357 (epitype of *P. niger*) studied by Svantesson et al. (2024).

Ecology and distribution. Associated with pine on calcareous bedrock covered by a thin layer of soil. Rare species, known only from the submontane zone.

Distribution based on GlobalFungi: Europe (Croatia, Denmark, Estonia, France, Italy, Portugal, Spain, Switzerland), Asia (India, Turkey), Africa (Canary Islands, Morocco), North America (USA).

Notes. A species very similar to *Phellodon aquilonigerr*. According to Svantesson et al. (2024), the main diagnostic characters should be the flat to convex, not infundibuliform pileus without concentric colour zonation in *P. aquiloniniger*, and infundibuliform to flat (rarely convex) pileus, with or without concentric colour zonation in *P. niger*. However, according to our experience, these features are somewhat related to weather conditions, especially humidity and soil moisture. Dry stands or dry weather may result in less fleshy basidiomata of *P. aquiloniniger* with a more or less infundibuliform (concave) pileus, which is zonated, probably because of repeatedly interrupted growth (Electronic supplement, Fig. S20; compare with Fig. S21). Consequently, the occurrence on calcareous bedrock (especially when covered by a thin to absent layer of organic litter) seems to be the best character of *P. niger*. The only sequenced collections are from the above-mentioned localities, but there are a few other Czech collections which could represent this species when considering their ecology. Our collections come from a pure *Pinus sylvestris* plantation and a *Picea*-dominated mixed forest, corresponding to the conclusion by Svantesson et al. (2024) that the species is an ectomycorrhizal symbiont of conifers, especially pines.

Phellodon secretus Niemelä & Kinnunen, Karstenia 43(2): 38, 2004 Figs 18–19

Specimens studied: Czech Republic. Bohemian-Moravian Highlands, Chmelná near Nová Cerekev, rather young oligotrophic *Picea* plantation, 2 Sep 2021 leg. J. Borovička (PRM 956376); ibid., rather young *Picea* plantation on acid soil, on mossy forest path, 16 Sep 2022 leg. J. Borovička (PRM 958122).

The sequence obtained from specimen PRM 956376 was identical with the *P. secretus* exholotype sequence MH118170 published by Zmitrovich et al. (2018).

Ecology and distribution. Associated with pine and spruce at oligotrophic sites. Rare, known from two localities of very high conservation value (rich in species of *Bankeraceae* and *Tricholoma*) in the colline and submontane zones.

Distribution based on GlobalFungi: Europe (Estonia, Finland, Italy, Sweden), North America (Canada, USA).

Czech Red List status: CR. Threatened by eutrophication and by logging due to bark beetle outbreaks.

Notes. A species forming small basidiomata which may grow solitarily or gregariously on soil (resembling small basidiomata of *Phellodon melaleucus*) or form semiresupinate basidiomata on lying wood or vegetation which are used as support (see also notes on *Hydnellum gracilipes*). As reported by Wainhouse et al. (2024), both species can form pileate basidiomata as well as fruitbodies adhering to lying logs, which cannot be considered a distinguishing character. Compared to *P. melaleucus*, basidiomata of *P. secretus* are rather smaller, thin-fleshed, sometimes with a more pronounced radial pattern on the pileus.

Ainsworth and Svantesson (pers. comm.) consider the presence of zonation in *P. melaleucus* a good feature to distinguish it from *P. secretus*, but Czech collections do not support the usability of this feature in *Phellodon* species. It usually depends on the weather, and if the growth of the basidioma is continuous in stable wet conditions, no zonation is visible. On the other hand, if wet and dry periods alternate and the growth is repeatedly interrupted, a zonation is evident (see also notes on *P. niger*).

The species appears to be associated with a wider spectrum of trees than previously considered. Czech collections were associated with pine and spruce, while Wainhouse et al. (2024) discussed the possibility that *P. secretus* is able to form mycorrhizal partnerships with both *Fagaceae* and *Pinaceae* (their collection came from *Castanea* litter, but planted pine was present at a distance of ca 10 m).

Fig. 18. *Phellodon secretus*, basidiomata developed during wet weather (PRM 956376 – for details, see Specimens studied). Photo J. Borovička.

Fig. 19. *Phellodon secretus*, unsequenced, Suchdol nad Lužnicí (South Bohemia, Czech Republic), oligotrophic pine forest on sand, 25 Sep 2022 (CB JS-2022-145). Photo J. Souček.

Phellodon tomentosus (L.) Banker, Memoirs of the Torrey Botanical Club 12: 171, 1906

= *Phellodon* group VIII s. Ainsworth et al., Fungal Ecology 4: 76, 2010

Specimens studied: Czech Republic. Novohradské hory, Bělá near Malonty, 2.1 km S of Malonty, left bank of Kamenice stream, *Picea* and *Pinus* forest, in moss, 28 Sep 2008 leg. J. Holec (PRM 915411). – Southern Bohemia, 1.8 km ENE of Borkovice, Píščitý vrch, *Pinus sylvestris* forest with mosses, *Vaccinium myrtillus* and lichens, 8 Oct 2010 leg. J. Holec et T. Kučera (PRM 899148). – Bohemian-Moravian Highlands, Chmelná near Nová Cerekev, forest stand named Chmelná, under *Picea*, *Pinus*, and *Fagus*, 9 Aug 2008 leg. J. Burel (PRM 937006); ibid., in oligotrophic *Picea* plantation mixed with *Pinus*, 2 Sep 2021 leg. J. Borovička (PRM 956374). – Bohemian-Moravian Highlands, Staré Ransko near Krucemburk, in mature *Picea abies* forest plantation on base-rich soil [gabbro bedrock], 6 Aug 2021 leg. J. Borovička (PRM 956318).

Sequences obtained from the specimens were identical with various *Phellodon tomentosus* sequences including AM263367 published by Ainsworth et al. (2010). The similarity with the epitype specimen (PQ226370, Svantesson et al. 2024) was 99.8%.

Ecology and distribution. Hard to characterise, taking into account the morphological similarity of the newly distinguished species. Based on old-concept data, *P. tomentosus* grows in association with spruce and pine in various types of coniferous (from sandy pine to humid spruce stands) and mixed forests, commonly in needle litter or moss cover, and its occurrence is scattered in the colline and submontane zones, exceptionally in the montane zone. According to our experience (J. Souček, pers. obs.), pine is often admixed in spruce stands (even at localities where only *Picea* was mentioned in previous records or on fungarium labels), hence association with *Pinus* (mentioned by Svantesson et al. 2024) may be really common in Czechia, even if association with *Picea* cannot be fully excluded.

Distribution based on GlobalFungi: Europe (Estonia, Finland, Norway, Sweden), Asia (China), North America (Canada).

Czech Red List status: NT.

Notes. Except for the mentioned sequenced collections, fungarium material was not revised, so we cannot exclude the possibility that some of the fungarium collections represent *Phellodon dititomentosus* Svantesson. Svantesson et al. (2024) mention pinkish tints developing in otherwise white areas, a change not observed in dried collections of *P. tomentosus*, as a possibly diagnostic feature of *P. dititomentosus*, but we cannot consider it a generally usable character. Commenting on habitat preferences, Svantesson et al. (2024) stated that *P. dititomentosus* is associated with *Picea* forests on fertile alkaline soil (based on observations from the Nordic countries), rather than the acid *Pinus* forests hosting *P. tomentosus*, but they do not mention acid *Picea* stands, which represent a common habitat of these fungi in the Bohemian massif. However, if ecological requirements of *P. dititomentosus* are really limited to base-rich spruce forests, its occurrence in Czechia cannot be excluded, but is then expected to occur rarely at isolated localities.

Phellodon violascens (Alb. & Schwein.) A.M. Ainsw., Index Fungorum 401: 1, 2019

≡ *Bankera violascens* (Alb. & Schwein.) Pouzar

Specimens studied: Czech Republic, Southern Bohemia, Novohradské hory, Bělá near Malonty, *Picea* forest plantation, in needles, 2 Sep 2014 leg. J. Borovička (PRM 924441). – Central Bohemia, Staré Nespeřice, in young *Abies alba* forest plantation, 12 Sep 2019 leg J. Borovička (PRM 952634).

The sequence obtained from specimen PRM 924441 had 99.2–99.7% similarity with various *P. violascens* sequences, including EU627600 published by van der Linde et al. (2008).

Ecology and distribution. Growing in association with spruce (possibly also with fir), in coniferous and mixed forests (both natural and man-influenced, sometimes also waterlogged), mostly in needle litter. Common, occurring from the colline to the montane zone.

Distribution based on GlobalFungi: Europe (France, Italy, Spain).

Czech Red List status: NT.

Sarcodon imbricatus (L.) P. Karst., Revue Mycologique (Toulouse) 3(9): 20, 1881

Specimens studied: Czech Republic. Central Bohemia, near Borovsko, Hadce u Želivky Nature Reserve, *Pinus* forest with admixed *Picea* on serpentinite soil, 11 Oct 2014, leg. J. Borovička (PRM 924644). – Bohemian-Moravian Highlands, Staré Ransko near Krucemburk, sub *Picea* and *Fagus*?, 15 Sep 2017 leg. P. Petelík (HR B000013).

Slovakia. Liptovská kotlina, 3.5 km N of Východná, ridge between Hlboký jarok and Hybica streams, under *Picea*, *Pinus* at 10 m distance, 21 Aug 2012 leg. J. Holec (PRM 860655).

Sequences obtained from all specimens were identical with various *S. imbricatus* sequences, including MK602748 and JX271810 published by Vizzini et al. (2013) and Larsson et al. (2019), respectively.

Ecology and distribution. Growing mostly in association with spruce, more rarely with pine, in coniferous and mixed forests. Although records from spruce and mixed stands still prevail, recent collections from purely pine stands (which morphologically appear to be *S. imbricatus*, although not having been sequenced) suggest that the species may not exclusively be bound to spruce, hence this cannot be taken as a character distinguishing it from *S. squamosus*. Species with a rather wide ecological amplitude, growing on various soil types on acid as well as calcareous or serpentinite bedrock. Common, occurring from the colline to the montane zone.

Distribution based on GlobalFungi: Europe (Austria, Czech Republic, Estonia, Finland, France, Germany, Italy, Lithuania, Norway, Romania, Russia – Ural Mts, Sweden, Switzerland), Asia (China, Georgia, Turkey), North America (Canada, USA).

Czech Red List status: NT.

Sarcodon quercinofibulatus Pérez-De-Greg., Macau & J. Carbó, Revista Catalana de Micologia 33: 26, 2011

Specimens studied: Czech Republic. Central Bohemia, Kněžičky, game preserve ca 1.6–2.2 km S of the village, open *Quercus* forest with *Molinia*, 22 Aug 2012 leg. D. Dvořák (BRNU 680029, duplicate TUF 135818).

Slovakia. Štiavnické vrchy Mts, Nová Dedina, valley of Podlužianka stream, site named Žuhračka, ca 3.5 km N of the village, open mixed broadleaved forest (*Quercus petraea*, *Q. cerris*, *Carpinus betulus*), 10 Sept 2014 leg. D. Dvořák (BRNU 697631, duplicate TUF 135817; ITS sequence in UNITE: UDB0799583).

The sequence obtained from specimen BRNU 680029 had 99.7–100% similarity to various *S. quercinofibulatus* sequences such as MT237502, JX271814, and MK602773, published by Vizzini et al. (2013) and Larsson et al. (2019).

Ecology and distribution. In Czechia known from a single locality in the colline zone. The site is known for rich occurrence of thermophilic members of the *Boletaceae*.

Distribution based on GlobalFungi: North America (USA).

Czech Red List status: CR.

Notes. Macroscopically very similar to *Sarcodon imbricatus*, which usually has larger and more pronounced scales, but this character may be quite variable (see note on *S. leucopus* below). The main distinguishing character seems to be their ecology: *S. imbricatus* grows mainly in association with spruce (rarely also pine, see above), while *S. quercinofibulatus* grows in association with deciduous trees, e.g. oak, especially at warm sites.

Sarcodon squamosus (Schaeff.) P. Karst., Hedwigia 28: 366, 1889

Specimens studied: Czech Republic. Southern Bohemia, 2.7 km SW of Vesce, forest named Bůrek, *Pinus* forest with mosses, *Vaccinium myrtillus*, and lichens, 8 Oct 2010 leg. J. Holec et T. Kučera (PRM 899149). – Southern Bohemia, 6.4 km SSW of Kardašova Řečice, Cikarské polesí forest district, *Pinus* forest with young *Picea*, *Vaccinium vitis-idaea*, mosses, and *Cladonia*, 14 Oct 2010 leg. J. Holec et T. Kučera (PRM 899155). – Southern Bohemia, SE of Drahov, forest named V Čílově, near forest road surrounded by young *Pinus* forest and highgrown *Pinus-Picea* forest, 14 Oct 2010 leg. J. Holec et T. Kučera (PRM 899151).

ITS sequences obtained from the specimens were identical with various *S. squamosus* sequences including JX271821 and MK602768 published by Vizzini et al. (2013) and Larsson et al. (2019), respectively.

Ecology and distribution. Growing in association with pine in coniferous and mixed forests, mostly in oligotrophic pine stands with lichens, heath or bilberry undergrowth on bedrock rich in quartz (of all igneous, metamorphic, and sedimentary origin), rarely on serpentinite. Scattered in the colline and submontane zones.

Distribution based on GlobalFungi: Europe (Estonia, Finland, Germany, Lithuania, Norway, Poland, Spain, Sweden).

Czech Red List status: VU.

SPECIES DOCUMENTED OR REPORTED FROM CZECHIA BUT NOT YET MOLECULARLY VERIFIED

Hydnellum mirabile (Fr.) P. Karst., Meddelanden af Societas pro Fauna et Flora Fennica 5: 41, 1879 Figs 20–21

Specimens studied: Czech Republic. Bohemian-Moravian Highlands, Chmelná near Nová Cerekev, forest west of the village, east of Brůdek stream valley, *Picea-Pinus* stand, 6 Jul and 23 Jul 2009 leg. J. Burel (deposited in the personal fungarium of Jiří Burel).

The species is well recognisable by the habitus of the basidiomata. The mentioned record is documented by photos of both young and mature basidiomata (figures in this study, Mikšík 2015: 182), which well fit the description of the species (Maas Geesteranus 1975: at first velutinous to somewhat woolly, then hispid, pitted, or forming a matt woolly surface from which long, flexuous hairs made up of agglutinated hyphae emerge) as well as available photos (Nitare 2015). Therefore, even though not sequenced, its presence in Czechia can be considered proven. The Czech Red List status is CR.

Recently described or resurrected *Phellodon* species

Besides *P. niger* and *P. aquiloniniger* (see above), *P. frondosoniger* and *P. melilotinus* were distinguished in the *Phellodon niger* complex by Svantesson et al. (2024). *Phellodon frondosoniger* A.M. Ainsw. & Svantesson (= *Phellodon* group VII s. Ainsworth et al. 2010) clearly differs in ecology, being associated with *Fagaceae*, hence specimens formerly identified as *P. niger* originating from pure broadleaved stands very probably belong to this species. Unfortunately, no Czech specimens have been sequenced yet.

Concerning *Phellodon melilotinus* (Quél.) Svantesson (= *Phellodon* group VI s. Ainsworth et al. 2010), the authors stated: "… differs only by small, subtle morphological features and possibly its host species. We recommend DNA sequencing in all but the clearest of cases." Therefore, some specimens identified as *P. niger* collected in conifer stands may belong to *P. melilotinus* (the authors mention its association with *Picea*, but admit association is possible with other conifers too), but thorough revision and sequence data are needed to confirm presence of the species in Czechia.

Concerning possible occurrence of *P. dititomentosus* Svantesson, see notes on *P. tomentosus*.

Species probably extinct in Czechia

Hydnellum fuligineoviolaceum (Kalchbr.) E. Larss., K.H. Larss. & Kõljalg [≡ *Sarcodon fuligineoviolaceus* (Kalchbr.) Pat.] is not documented by

Fig. 20. *Hydnellum mirabile*, unsequenced, young basidiomata, Chmelná near Nová Cerekev (Bohemian-Moravian Highlands, Czech Republic), oligotrophic spruce forest, 6 Jul 2009 (voucher in personal fungarium of Jiří Burel). Photo J. Burel.

Fig. 21. *Hydnellum mirabile*, unsequenced, moderately mature basidiomata, 23 Jul 2009 (microsite identical to Fig. 18, voucher in personal fungarium of Jiří Burel). Photo J. Burel.

any fungarium specimen originating from the Czech Republic, but was reported by Pospíšil (1949) from the Moravian Carpathians:

Czech Republic. [Hostýnské vrchy], Kateřinice, eastern slope of Dubcová hill, ca 450 m a.s.l., mixed forest named Pagáčeny (*Picea*, *Abies*, *Fagus*), 3 Oct 1943, as *Sarcodon fuligineo-violaceus*.

Despite the fact that it is only a single record in a diploma thesis, probably not documented by a voucher (or the voucher was lost, which is understandable during World War II), we can accept it as a rather credible record for several reasons: Pospíšil's knowledge of botany and mycology was very good (especially since he became a famous bryologist in the following decades), he also reported several other stipitate hydnoid fungi from different locations on Dubcová hill (not far from each other), including the rare species *Hydnellum geogenium* (see also Pilát 1949) and *H. suaveolens*, and also, *H. fuligineoviolaceum* was quite an unmistakable taxon in that time.

Currently we can of course discuss possible confusion with *Hydnellum roseoviolaceum* Nitare (Nitare et al. 2021). Nevertheless, that species was described from lichen-rich pine stands on acid sandy soil, a habitat quite different from Pospíšil's record. For comparison, in other historical records of *H. fuligineoviolaceum* from the Western Carpathians in Slovakia, Kalchbrenner (in Fries 1874) mentions pine forest, and Hrouda (2005b) reports a *Pinus-Picea* stand from the Strážovské vrchy Mts, while spruce or spruce-fir stands (if trees are mentioned) occur at localities of *H. fuligineoviolaceum* in Austria and southern Germany (ÖMG on-line, Krieglsteiner 2000), being habitats more similar to Dubcová hill.

Hydnellum versipelle (Fr.) E. Larss., K.H. Larss. & Kõljalg [≡ *Sarcodon versipellis* (Fr.) Nikol.] is a species occurring in the Alps and the Carpathians but considered extinct in Czechia (hence its Red List status is RE). Basidiomata of the species are quite conspicuous and well recognisable already in the field, so overlooking or misidentifying it is highly improbable. Historical records from the Czech Republic are mentioned by Hrouda (1999). It is interesting that a collection by V. Pospíšil from Dubcová hill (the same locality as of *H. fuligineoviolaceum*, see above) was not mentioned in his diploma thesis, but the specimen is deposited in Leiden fungarium (L), where it was identified two decades later by Maas Geesteranus & Nannfeldt (1969; as *Sarcodon versipellis*). We have not been successful in sequencing historical fungarium material (Holička hill near Vodňany, Jul 1936 leg. J. Herink, PRM 28406).

Sarcodon leucopus (Pers.) Maas Geest. & Nannf. represents a similar case as *H. versipelle* – current occurrence of the species is not reliably confirmed in Czechia (red-listed in the CR category, but probably not recorded here in the 21st century). The specimen from Staré Ransko (HR B000013, see above), erroneously identified by P. Hrouda as *S. leucopus*, appears to be *S. imbricatus* after sequencing, having an untypically smooth, almost scaleless pileus (Electronic

supplement, Fig. S1). We have not been successful in sequencing old fungarium material of *S. leucopus* (PRM 163557, PRM 617192, PRM 872249).

CONCLUSIONS

This study provides a first comprehensive DNA-based checklist of stipitate hydnoid fungi (*Bankeraceae* s.l.) in Czechia, combining traditional field research with modern molecular techniques to clarify taxonomic uncertainties and update species distributions. By sequencing 104 specimens, we confirmed the presence of 39 taxa, including recently described species such as *Boletopsis mediterraneensis*, *Hydnellum bomiense*, *H. fagiscabrosum*, *H. rubidofuscum*, *Phellodon aquiloniniger*, and *P. castaneoleucus*. The study has moreover generated sequences of *Hydnellum compactum* and *H. tardum* for the first time, providing reference material for further studies. Sequences of two species of *Boletopsis* and *Hydnellum* which have not been formally described yet are now also available for other researchers. The integration of GlobalFungi database data has significantly expanded our understanding of the global distribution of these fungi, revealing occurrences in regions previously undocumented in the literature, such as Asia, Africa, and Central and South America.

The ecological requirements of each species were refined using collection data from Czech localities, highlighting their role as habitat indicators and their sensitivity to environmental changes, such as eutrophication. The study also underscores the importance of molecular tools in resolving species complexes, particularly in genera like *Hydnellum* and *Phellodon*, where morphological similarities often lead to misidentification.

This work not only updates the taxonomic and ecological knowledge of Czech hydnoids, but also serves as a basis for future research and conservation efforts. The inclusion of GlobalFungi data demonstrates the value of environmental DNA in tracking fungal diversity across continents, offering new insights into their biogeography. By bridging traditional mycology with modern genomics, this study enhances our ability to monitor and protect these ecologically significant fungi in a rapidly changing world.

Last but not least, we show how enthusiastic and educated fungus collectors can contribute to scientific progress. For example, the putative new species of *Boletopsis* was first discovered by amateur mycologists at sites of their interest, their engagement helping the scientific community to progress, enhancing knowledge of the fungal diversity in Czechia.

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REFERENCES

AINSWORTH A.M., PARFITT D., ROGERS H.J., BODDY L. (2010): Cryptic taxa within European species of *Hydnellum* and *Phellodon* revealed by combined molecular and morphological analysis. – Fungal Ecology 4: 65–80. DOI: https://doi.org/10.1016/j.funeco.2009.07.001

ARNOLDS E. (1989): Former and present distribution of stipitate hydnaceous fungi (Basidiomycetes) in The Netherlands. – Nova Hedwigia 48: 107–142.

BAIRD R., WALLACE L.E., BAKER G., SCRUGGS M. (2013) Stipitate hydnoid fungi of the temperate southeastern United States. – Fungal Diversity 62: 41–114. DOI: https://doi.org/10.1007/s13225-013-0261-6

BENKERT D., DÖRFELT H., HARDTKE H.J., KREISEL H., SCHMID H., WINTERHOFF W. (1992): Rote Liste der gefährdeten Großpilze in Deutschland. – DGfM, NABU, Eching.

BIDARTONDO M.I., BRUNS T.D. (2002) [2001]: Extreme specificity in epiparasitic *Monotropoideae* (*Ericaceae*): widespread phylogenetic and geographical structure. – Molecular Ecology 10(9): 2285–2295. DOI: https://doi.org/10.1046/j.1365-294X.2001.01358.x

BONSDORFF T. VON, KYTÖVUORI I., VAURAS J., HUHTINEN S., HALME P., RÄMÄ T., KOSONEN L., JAKOBSSON S. (2014): Sienet ja metsien luontoarvot [Indicator fungi]. – Norrlinia 27: 1–272. [in Finnish with English summary]

BOROVIČKA J. (2019): Nález vzácné hrbolatky černobílé – *Boletopsis leucomelaena* v přírodní památce Na Stříbrné u Českého Šternberka [Rare species *Boletopsis leucomelaena* found in Na Stříbrné Nature Monument near Český Šternberk]. – Mykologický Sborník 96 (4): 117–121. [in Czech]

BOROVIČKA J., KOLAŘÍK M., HALASŮ V., PERINI C., PARKER A.D., GRYNDLER M., COHEN J.D., HRŠELOVÁ H., PASTORINO R., ŽIGOVÁ A., PARRA SÁNCHEZ L.A. (2024): Taxonomic revision of the genus *Sarcosphaera* (*Ascomycota*: *Pezizales*) in Europe and North America revealed unexpected diversity. – Mycological Progress 23: 69. DOI: https://doi.org/10.1007/s11557-024-02006-7

BOROVIČKA J., NOORDELOOS M.E., GRYNDLER M., OBORNÍK M. (2011): Molecular phylogeny of *Psilocybe cyanescens* complex in Europe, with reference to the position of the secotioid *Weraroa novaezelandiae*. – Mycological Progress 10: 149–155. DOI: https://doi.org/10.1007/s11557-010-0684-3

BRITZELMAYR M. (1892): Hymenomyceten aus Südbayern 11 (Theil VIII): Polyporei, Hydnei, Thelephorei, Clavariei und Tremellinei. – R. Friedländer & Sohn, Berlin.

BROCK P.M., DÖRING H., BIDARTONDO M.I. (2008) [2009]: How to know unknown fungi: the role of a herbarium. – New Phytologist 181(3): 719–724. DOI: https://doi.org/10.1111/j.1469-8137.2008.02703.x

CROUS P.W. et al. (2019): Fungal Planet description sheets: 951–1041. – Persoonia 43: 223–425. DOI: https://doi.org/10.3767/persoonia.2019.43.06

DAS K., STALPERS J.A., STIELOW J.B. (2013): Two new species of hydnoid-fungi from India. – IMA Fungus 4: 359–369. DOI: https://doi.org/10.5598/imafungus.2013.04.02.15

DVOŘÁK D., HROUDA P. (2005): Ježaté houby. Lošáky a korálovce [Tooth fungi. Hydnoid and hericioid genera]. – Masarykova univerzita, Brno. [in Czech]

DVOŘÁK D., HROUDA P., eds (2021): Metodika druhové ochrany hub – příloha Mykorhizní druhy [Methodology of fungal species protection – appendix Mycorrhizal species]. – Masarykova univerzita, Brno and Ministerstvo životního prostředí, Praha; available at http://www.czechmycology.org/_docs/ODOIMZ-priloha_Mykorhizni_druhy-20210113.pdf [in Czech]

EVANS S.E., HENRICI A., ING B. (2006): Red data list of threatened British fungi. – http://www.britmycolsoc.org.uk/files/2013/3537/5755/RDL_of_Threatened_British_Fungi.pdf [accessed 6 June 2016]

FRIES E.M. (1874): Hymenomycetes Europaei sive epicriseos systematis mycologici, editio altera. – Ed. Berling, Upsaliae.

GÄRDENFORS U., ed. (2005): Rödlistade Arter i Sverige 2005 / The 2005 redlist of Swedish species. – ArtDatabanken, SLU, Uppsala. [in Swedish and English]

GRUPE A.C., BAKER A.D., UEHLING J.K., SMITH M.E., BARONI T.J., LODGE D.J., HENKEL T.W. (2015): *Sarcodon* in the Neotropics I: new species from Guyana, Puerto Rico and Belize. – Mycologia 107: 591–606. DOI: https://doi.org/10.3852/14-185

GRUPE A., VASCO-PALACIOS A.M., SMITH M.E., BOEKHOUT T., HENKEL T.W. (2016): *Sarcodon* in the Neotropics II: four new species from Colombia and a key to the regional species. – Mycologia 108: 791–805. DOI: https://doi.org/10.3852/15-254

GULDEN G., HANSSEN E.W. (1992): Distribution and ecology of stipitate hydnaceous fungi in Norway, with special reference to the question of decline. – Sommerfeltia 13: 1–58. DOI: https://doi.org/10.2478/som-1992-0001

HOLEC J., BERAN M., eds (2006): Červený seznam hub (makromycetů) České republiky [Red List of fungi (macromycetes) of the Czech Republic]. – Příroda, Praha, 24: 1–282. [in Czech]

HOLEC J., KUČERA T., HROUDA P., BUREL J. (2016): *Hydnellum cumulatum* (*Basidiomycota*, *Bankeraceae*) opět roste v České republice [*Hydnellum cumulatum* (*Basidiomycota*, *Bankeraceae*) grows again in the Czech Republic]. – Mykologické Listy 133: 19–30. [in Czech with English abstract]

HOLEC J., KUČERA T., KOLAŘÍK M. (2017): Vzácný lošák *Sarcodon lundellii* (*Basidiomycota*, *Bankeraceae*) poprvé doložen z České republiky [The rare hydnoid fungus *Sarcodon lundellii* (*Basidiomycota*, *Bankeraceae*) documented from the Czech Republic for the first time]. – Mykologické Listy 136: 42–48. [in Czech with English abstract]

HOLEC J., KUČERA T. (2018): Hydnoid fungi of the family *Bankeraceae* – their assemblages and vegetation ecology in Central Europe, Czech Republic. – Fungal Ecology 32: 40–48. DOI: https://doi.org/10.1016/j.funeco.2017.11.007

HROUDA P. (1992): Československé druhy rodů *Bankera* Coker et Beers ex Pouz., *Phellodon* P. Karst., *Hydnellum* P. Karst. a *Sarcodon* P. Karst. [Czechoslovak species of the genera *Bankera* Coker et Beers ex Pouz., *Phellodon* P. Karst., *Hydnellum* P. Karst. and *Sarcodon* P. Karst.]. – Ms., diploma thesis, Charles University, Prague.

HROUDA P. (1999): Hydnaceous fungi of the Czech Republic and Slovakia. – Czech Mycology 51: 99–155. DOI: https://doi.org/10.33585/cmy.51202

HROUDA P. (2005a): *Bankeraceae* in Central Europe. 1. – Czech Mycology 57: 57–78. DOI: https://doi.org/10.33585/cmy.57103

HROUDA P. (2005b): *Bankeraceae* in Central Europe. 2. – Czech Mycology 57: 279–297. DOI: https://doi.org/10.33585/cmy.57308

HROUDA P. (2008): Hydnaceous fungi in Central Europe with special regard to the Czech Republic and Slovakia. – https://www.sci.muni.cz/botany/mycology/hydna.htm [accessed 3 June 2016]

JÜLICH W. (1982): Higher taxa of Basidiomycetes. – Bibliotheca Mycologica 85: 1–485.

KAUTMANOVÁ I., KAUTMAN V., KUČERA V., ARENDT D. (2020): Re-collection of secotioid *Entoloma calongei* in Europe. – Mycotaxon 135(2): 405–414. DOI: https://doi.org/10.5248/135.405

KOLAŘÍK M., STĘPNIEWSKA H., JANKOWIAK R. (2021): Taxonomic revision of the acidophilic genus *Acidiella* (*Dothideomycetes*, *Capnodiales*) with a description of new species from Poland. – Plant Systematics and Evolution 307: 38. DOI: https://doi.org/10.1007/s00606-021-01753-4

KOLÉNYOVÁ M., DVOŘÁK D., HROUDA P. (2024): *Hydnellum gracilipes*: nový druh pro Českou republiku [*Hydnellum gracilipes*: species new to Czechia]. – Mykologické Listy 156: 14–21. [in Czech with English abstract]

KOTLABA F. (1984): Zeměpisné rozšíření a ekologie chorošů (*Polyporales* s. l.) v Československu [Geographical distribution and ecology of polypores (*Polyporales* s. l.) in Czechoslovakia]. – Academia, Praha.

KRIEGLSTEINER G.J. (2000): Die Großpilze Baden-Württembergs. Band 1. – Ulmer, Stuttgart.

KŘÍŽ M. (2017): Lošák oranžovonohý – *Sarcodon martioflavus* – v České republice [*Sarcodon martioflavus* in the Czech Republic]. – Mykologické Listy 136: 33–40. [in Czech with English abstract]

LARSSON K.H., SVANTESSON S., MISCEVIC D., KÕLJALG U., LARSSON E. (2019): Reassessment of the generic limits for *Hydnellum* and *Sarcodon* (*Thelephorales*, *Basidiomycota*). – MycoKeys 54: 31–47. DOI: https://doi.org/10.3897/mycokeys.54.35386

LOIZIDES M., ALVARADO P., ASSYOV B., ARNOLDS E., MOREAU P.-A. (2016): *Hydnellum dianthifolium* sp. nov. (*Basidiomycota*, *Thelephorales*), a new tooth-fungus from southern Europe with notes on *H. concrescens* and *H. scrobiculatum*. – Phytotaxa 280(1): 23–35. DOI: https://doi.org/10.11646/phytotaxa.280.1.2

LOIZIDES M., ŠEVČÍKOVÁ H., ROSSI C., MOREAU P.-A. (2020): Taxonomic challenges posed by the genera *Hydnellum* and *Phellodon* highlighted by two interesting collections on the Atlantic coast of Spain. – In: Paz Conde A., Lavoise C., eds, Myco-Liébana: 81–96. Sociedad Ibérica de Micología, Móstoles.

LYU P., ZENG W., YANG H.-H., LIU E.-D., LI Y.-C. (2025): The genus *Boletopsis* (*Bankeraceae*, *Thelephorales*) in China. – Biodiversity Data Journal 13: e142835. DOI: https://doi.org/10.3897/BDJ.13.e142835

MAAS GEESTERANUS R.A. (1975): Die terrestrischen Stachelpilze Europas. – North-Holland Publishing Company, Amsterdam and London.

MAAS GEESTERANUS R.A., NANNFELDT J.A. (1969): The genus *Sarcodon* in Sweden in the light of recent investigations. – Svensk Botanisk Tidskrift 63(4): 401–440.

MARREN P. (2002): Stipitate hydnoid fungi in England. – Field Mycology 3: 120–123. DOI: https://doi.org/10.1016/S1468-1641(10)60546-4

MATHENY P.B. et al. (2007): Contributions of *rpb2* and *tef1* to the phylogeny of mushrooms and allies (*Basidiomycota*, Fungi). – Molecular Phylogenetics and Evolution 43(2): 430–451. DOI: https://doi.org/10.1016/j.ympev.2006.08.024

MIKŠÍK M. (2015): 1000 českých a slovenských hub [1000 Czech and Slovak fungi]. – Svojtka & Co., Praha.

MU Y.-H., HU Y.-P., WEI Y.-L., YUAN H.-S. (2020): Hydnaceous fungi of China 8. Morphological and molecular identification of three new species of *Sarcodon* and a new record from southwest China. – MycoKeys 66: 83–103. DOI: https://doi.org/10.3897/mycokeys.66.49910

MU Y.-H., YU J.-R., CAO T., WANG X.-H., YUAN H.-S. (2021) Multi-gene phylogeny and taxonomy of *Hydnellum* (*Bankeraceae*, *Basidiomycota*) from China. – Journal of Fungi 7(10): 818. DOI: https://doi.org/10.3390/jof7100818

NEWTON A.C., HOLDEN E., DAVY L.M., WARD S.D., FLEMING L.V., WATLING R. (2002): Status and distribution of stipitate hydnoid fungi in Scottish coniferous forests. – Biological Conservation 107: 181–192. DOI: https://doi.org/10.1016/S0006-3207(02)00060-5

NIEMELÄ T., KINNUNEN J., RENVALL P., SCHIGEL D.S. (2003): *Phellodon secretus* (*Basidiomycota*), a new hydnaceous fungus from northern pine woodlands. – Karstenia 43: 37–44. DOI: https://doi.org/10.29203/ka.2003.391

NITARE J. (2015): *Hydnellum mirabile*. – The IUCN Red List of Threatened Species 2015: e.T70408415A70408439. DOI: https://doi.org/10.2305/IUCN.UK.2015-4.RLTS.T70408415A70408439.en [accessed 4 April 2025]

NITARE J., AINSWORTH A.M., LARSSON E., PARFITT D., SUZ L.M., SVANTESSON S., LARSSON K.-H. (2021): Four new species of *Hydnellum* (*Thelephorales*, *Basidiomycota*) with a note on *Sarcodon illudens*. – Fungal Systematics and Evolution 7: 233–254. DOI: https://doi.org/10.3114/fuse.2021.07.12

NITARE J., HÖGBERG N. (2012): Svenska arter av fjälltaggsvampar (*Sarcodon*) – en preliminär rapport [The genus *Sarcodon* in Sweden – a preliminary report]. – Svensk Mykologisk Tidskrift 33(3): 2–49. [in Swedish with English abstract and identification key]

ÖSTERREICHISCHE MYKOLOGISCHE GESELLSCHAFT (ÖMG, on-line): Datenbank der Pilze Österreichs. Bearbeitet von Dämon W., Hausknecht A., Krisai-Greilhuber I., http://austria.mykodata.net [accessed 4 April 2025]

OTTO P. (1997): Kommentierter Bestimmungsschlüssel der terrestrischer Stachelpilze Deutschlands mit taxonomischen und nomenklatorischen Anmerkungen. – Boletus 21(1): 1–21.

PARFITT D., AINSWORTH A.M., SIMPSON D., ROGERS H.J., BODDY L. (2007): Molecular and morphological discrimination of stipitate hydnoids in the genera *Hydnellum* and *Phellodon*. – Mycological Research 111: 761–777. DOI: https://doi.org/10.1016/j.mycres.2007.05.003

PEIGER M. (2015): Selected representatives of hydnaceous fungi (*Bankeraceae*), their ecology and indicative value in forest ecosystems. – Ms., diploma thesis, Technical University, Zvolen, https://opac.crzp.sk/?fn=detailBiblioForm&sid=A083EEC66BFEBB1DDDDED80842BF [in Slovak with English summary]

PÉREZ-DE-GREGORIO M.Á., MACAU N., CARBÓ J. (2011): *Sarcodon quercinofibulatum*, una nueva especie del género con hifas fibulíferas. – Revista Catalana de Micologia 33: 25-30.

PETERSEN J.H. (2012): The Kingdom of Fungi. – Princeton University Press, Princeton and Oxford.

PILÁT A. (1949): Lošák sírožlutý (*Calodon sulphureum* [Kalchbr.] Quél.) na Moravě a v Čechách [*Calodon sulphureum* (Kalchbr.) Quél.in Moravia and in Bohemia]. – Česká Mykologie 3(1–2): 16–19. [in Czech]

PILÁT A. (1969): Houby Československa ve svém životním prostředí [Czechoslovak fungi in their environment]. – Academia, Praha. [in Czech]

POSPÍŠIL V. (1949): Rostlinná společenstva horního Pobečví se zvláštním zřetelem k vyšším houbám [Plant communities in upper Bečva basin with special regard to macromycetes]. – Ms., diploma thesis, depon. in Department of Botany and Zoology, Masaryk University Campus, Brno. [in Czech]

POUZAR Z. (1956): Příspěvek k poznání našich kloboukatých lošáků [Contribution to knowledge of our pileate hydnoids]. – Česká Mykologie 10: 65–78. [in Czech]

POUZAR Z. (1961): Lošákovec blankytný – *Hydnellum caeruleum* (Hornem. ex Pers.) P. Karst. – Česká Mykologie 15: 131–132. [in Czech]

RÉBLOVÁ M., HERNÁNDEZ-RESTREPO M., SKLENÁŘ F., NEKVINDOVÁ J., RÉBLOVÁ K., KOLAŘÍK M. (2022): Consolidation of *Chloridium*: new classification into eight sections with 37 species and reinstatement of the genera *Gongromeriza* and *Psilobotrys*. – Studies in Mycology 103: 87–212. DOI: https://doi.org/10.3114/sim.2022.103.04

RUBIO-CASAS L., RUBIO-ROLDÁN L., CATALÀ S. (2011): *Sarcodon amygdaliolens*, nueva especie de *Sarcodon* encontrada en la Península Ibérica. – Boletín de la Sociedad Micológica de Madrid 35: 43–56.

SCHAEFFER J.C. (1774): Fungorum qui in Bavaria et Palatinatu circa Ratisbonam nascuntur icones nativis coloribus expressae, Vol. 4. – Ratisbonae.

SENN-IRLET B., BIERI G., EGLI S. (2007): Rote Liste. Grosspilze. Rote Liste der gefährdeten Arten der Schweiz. Ausgabe 2007. – BAFU, WSL, Bern.

SMITH S.E., READ D.J. (2008) Mycorrhizal symbiosis. Third Edition. – Academic Press, London.

SMITH J.H., SUZ L.M., AINSWORTH A.M. (2016): Red List of Fungi for Great Britain: *Bankeraceae*, *Cantharellaceae*, *Geastraceae*, *Hericiaceae* and selected genera of *Agaricaceae* (*Battarrea*, *Bovista*, *Lycoperdon* & *Tulostoma*) and *Fomitopsidaceae* (*Piptoporus*). – http://fungi.myspecies.info/sites/fungi.myspecies.info/files/Smith%20et%20al.%20%282015%29.pdf [accessed 4 June 2016]

SONG C.-G., CHEN Y.-Y., LIU S., XU T.-M., HE X.-L., WANG D., CUI B.-K. (2022a): A phylogenetic and taxonomic study on *Phellodon* (*Bankeraceae*, *Thelephorales*) from China. – Journal of Fungi 8(5): 429. DOI: https://doi.org/10.3390/jof8050429

SONG C.-G., JI X., LIU S., HE X.-L., CUI B.-K. (2021): Taxonomy and molecular phylogeny of *Phellodon* (*Thelephorales*) with descriptions of four new species from Southwest China. – Forests 12: 932. DOI: https://doi.org/10.3390/f12070932

SONG C.-G., SUN Y.-F., WU D.-M., GAO N., LIU S., XU T.-M., CUI B.-K. (2022b): Morphology and molecular phylogeny reveal five new species of *Hydnellum* (*Bankeraceae*, *Thelephorales*) from China. – Frontiers in Microbiology 13: 1049007. DOI: https://doi.org/10.3389/fmicb.2022.1049007

SONG C.G., XU T.M., XU Y.H., WANG D., ZENG L., FAN X.P., SUN Y.F., CUI B.K. (2025): Systematic revision, molecular phylogeny and divergence times of *Thelephorales* (*Basidiomycota*). – Mycosphere 16(1): 296–422. DOI. https://doi.org/10.5943/mycosphere/16/1/5

STODŮLKA T. (2019): Recentní výskyt lošáků v České republice [Recent occurrence of hydnaceous fungi in the Czech Republic]. – Ms., bachelor thesis, depon. in Department of Botany and Zoology, Masaryk University Campus, Brno. [in Czech]

STRID Å. (1997): *Bankeraceae*. – In: Hansen L., Knudsen H., eds, Nordic Macromycetes, Vol. 3, pp. 308–315. Nordsvamp, Copenhagen.

SVANTESSON S., LARSSON E., LARSSON K.-H., PARFITT D., SUZ L.M., AINSWORTH A.M. (2024) [2025]: The genus *Phellodon* (*Thelephorales*, *Basidiomycota*) in Europe: Four new species, one new combination, four new typifications and a first European record. – Fungal Systematics and Evolution: 15: 1–45. DOI: https://doi.org/10.3114/fuse.2025.15.01

TAYLOR A.F.S., HOLDEN E.M., KILKENNY N., POTTS J.M., GENNEY D.R. (2014): Development of a surveillance scheme for priority fungi in Scotland. – Scottish Natural Heritage Commissioned Report No. 762.

TEJKLOVÁ T., KRAMOLIŠ J. (2011): *Hydnellum spongiosipes* (Peck) Pouzar has been found after 12 years in the Czech Republic. – Acta Musei Reginaehradecensis S. A. 33: 74.

VAN DER LINDE S., ALEXANDER I.J., ANDERSON I.C. (2008): A PCR-based method for detecting the mycelia of stipitate hydnoid fungi in soil. – Journal of Microbiological Methods 75: 40–46. DOI: https://doi.org/10.1016/j.mimet.2008.04.010

VAN DER LINDE S., ALEXANDER I.J., ANDERSON I.C. (2009): Spatial distribution of sporocarps of stipitate hydnoid fungi and their belowground mycelium. – FEMS Microbiology Ecology 69: 344–352. DOI: https://doi.org/10.1111/j.1574-6941.2009.00716.x

VAN DER LINDE S., HOLDEN E., PARKIN P.I., ALEXANDER I.J., ANDERSON I.C. (2012): Now you see it, now you don't: The challenge of detecting, monitoring and conserving ectomycorrhizal fungi. – Fungal Ecology 5: 633–640. DOI: https://doi.org/10.1016/j.funeco.2012.04.002

VIZZINI A., CARBONE M., BOCCARDO F., ERCOLE E. (2013): Molecular validation of *Sarcodon quercinofibulatus*, a species of the *S. imbricatus* complex associated with *Fagaceae*, and notes on *Sarcodon*. – Mycological Progress 12: 465–474. https://doi.org/10.1007/s11557-012-0851-9

VIZZINI A., PERRONE L., CURTI M., ERCOLE E., CITTADINI M. (2023): Segnalazione di *Boletopsis mediterraneensis* (*Bankeraceae*, *Thelephorales*) per il Lazio e prima raccolta confermata molecolarmente per l'Italia. – Rivista Micologica Romana 1: 19–45.

WAINHOUSE M., DETHERIDGE A.P., GRIFFITH G.W., DOMBROWSKI A., WOODS R., AINSWORTH A.M. (2024): Above- and below-ground detection of *Phellodon secretus*, a tooth fungus new to Britain. – Field Mycology 25(2): 51–58. DOI: https://doi.org/10.63482/4vf03r86

WANG D., FENG H., ZHOU J., LIU T.-H., ZHANG Z.-Y., XU Y.-Y., TANG J., PENG W.-H., HE X.-L. (2024): New insights into the stipitate hydnoid fungi *Sarcodon*, *Hydnellum*, and the formerly informally defined *Neosarcodon*, with emphasis on the edible species marketed in Southwest China. – IMA Fungus 15: 8. DOI: https://doi.org/10.1186/s43008-023-00138-1

ZHOU H.-M., ZHAO Q., WANG Q., WU F., DAI Y.-C. (2022): Two new species of *Boletopsis* (*Bankeraceae*, *Thelephorales*) from Southwest China. – MycoKeys 89: 155–169. DOI: https://doi.org/10.3897/mycokeys.89.83197

ZÍBAROVÁ L., KOLÉNYOVÁ M., TEJKLOVÁ T., ZEHNÁLEK P., eds (2024): Červený seznam hub (makromycetů) České republiky [Red list of fungi (macromycetes) of the Czech Republic]. – Příroda, Praha, 46:

1–192; available at https://czechmycology.org/_docs/P46_cerveny+seznam_houby.pdf [in Czech with English summary]

ZMITROVICH I.V., SHCHEPIN O.N., MALYSHEVA V.F., KALINOVSKAYA N.I., VOLOBUEV S.V., MYASNIKOV A.G., EZHOV O.N., NOVOZHILOV YU.K. (2018): Basidiome reduction in litter-inhabiting *Thelephorales* in boreal forest environments: morphological and molecular evidence. – Current Research in Environmental & Applied Mycology 8(3): 360–371. DOI: https://doi.org/10.5943/cream/8/3/7