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Butyriboletus regius and *Butyriboletus fechtneri*: typification of two well-known species

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The paper deals with type material of two species of the genus *Butyriboletus*, which were described from the Czech Republic, originally as *Boletus regius* (Krombholz 1983) and *Boletus fechtneri* (Velenovský 1922). For both species lectotypes are designated, for *B. fechtneri* also an epitype. The authors present macro- and microscopic descriptions of these species based on the study of rich material including collections from the area of the type localities. Characters distinguishing both species from similar taxa are discussed.

Key words: lectotype, epitype, nomenclature, taxonomy, Czech Republic.

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Janda V., Kříž M., Kolařík M. (2019): Hřib královský – *Butyriboletus regius* a hřib Fechtnerův – *Butyriboletus fechtneri*: typifikace dvou dobře známých druhů. – Czech Mycol. 71(1): 1–32.

Článek se zabývá typovým materiálem dvou druhů rodu *Butyriboletus*, původně popsaných z České republiky jako hřib královský – *Boletus regius* (Krombholz 1832) a hřib Fechtnerův – *Boletus fechtneri* (Velenovský 1922). Pro oba druhy je stanoven lektotyp, pro *B. fechtneri* též epityp. Autoři rovněž předkládají makro- a mikroskopický popis druhů založený na studiu bohatého materiálu, včetně sběrů z území typových lokalit. Možné záměny obou druhů za podobné taxony jsou diskutovány.

INTRODUCTION

The genus *Butyriboletus* D. Arora & J.L. Frank is a group of edible boletes characterised by firm flesh, a yellow reticulate stipe, yellow pores of tubes which in most cases turn blue when bruised, and a mild, yellowish context, in most species turning blue when exposed. The genus contains species formerly united within sect. *Appendiculati* Estadès & Lannoy of the genus *Boletus* s.l. (Arora &

Frank 2014). The original narrower concept by Arora & Frank (2014) was later broadened by Wu et al. (2014, 2016) to include all taxa of Clade 46 defined using multilocus molecular data. This led to inclusion in *Butyriboletus* of all the species formerly placed in the genus *Exsudoporus* Vizzini, Simonini & Gelardi (Vizzini 2014), therefore more than twenty species distributed in the northern hemisphere, mainly in North America, Europe and Asia, are currently comprised in *Butyriboletus* (Arora & Frank 2014, Wu et al. 2016).

Five European species have been documented by e.g. Marques & Muñoz (2006), Šutara et al. (2009) and Assyov (2012); a sixth one, *B. roseogriseus* (Šutara, Graca, M. Kolařík, Janda & Kříž) Vizzini & Gelardi was described later (see Šutara et al. 2014, Janda & Kříž 2016). Except for the type species of the genus, *B. appendiculatus* (Schaeff.) D. Arora & J.L. Frank, all other European representatives formerly considered members of section *Appendiculati* of genus *Boletus* s.l. were described from the area of former Czechoslovakia.

Two of them, *B. regius* (Krombh.) D. Arora & J.L. Frank and *B. fechtneri* (Velen.) D. Arora & J.L. Frank, had not been typified to date. Therefore we decided to explore historical material and documents to find out relevant elements of the original material. In both cases we chose a lectotype. Moreover, we designate a selected, molecularly analysed and confirmed collection of *B. fechtneri* as an epitype. We also obtained a sufficient number of collections of both species from the area of their type localities to provide detailed macroscopic and microscopic descriptions.

Material and methods

M o r p h o l o g i c a l s t u d y. Macroscopic characters were studied on fresh fruitbodies collected at several localities in the Czech Republic, mainly in the area of the Bohemian Karst. Microscopic mounts were made from dried material in ammoniacal Congo Red, 5% KOH solution, Melzer's solution and water, and studied under Olympus CX21, CX31 and CX41 light microscopes with an oil-immersion lens at a magnification of 1000×. In order to ascertain the variability of the microscopic characters of some anatomical structures and their changes in the course of development, these structures were examined on both young and mature fruitbodies from several localities. Spore sizes were measured on several fruitbodies from different localities (always at least 20 spores of each fruitbody). In the results, the main range of 90% of the measured values is presented. The main data range is complemented with extreme spore sizes of very small (probably immature) and extremely large spores, which are presented in parentheses. The Q_{av} value is the average value of spore length and width ratio. Drawings of microscopic characters (see Figs. 2 and 11) were made free hand.

Molecular analysis. Genomic DNA from voucher PRM 946297 was isolated using DNeasy UltraClean Microbial Kit (Qiagen, Hilden, Germany). A ribosomal DNA (rDNA) fragment, containing the internal transcribed spacers (ITS1 and ITS2) and the 5.8S subunit, was amplified with primers ITS1 and ITS4 (White et al. 1990). PCR amplification, purification and sequencing was according to Šutara et al. (2014) and deposited in the EMBL database (Tab. 1). Sequences were compared with data from the NCBI GenBank database using a BlastN similarity search including those published by Arora & Frank (2014), Šutara et al. (2014), Zhao et al. (2015), and Liang et al. (2016). The phylogenetic analysis followed Kubátová et al. (2018). A matrix containing concatenated ITS and LSU sequences was aligned in MAFFT 6 using the G-INS-i strategy (Katoh et al. 2009) and manually edited. The final alignment contained 34 sequences and 1368 characters (from the original 1585 positions), of which 944 were conserved, 413 variable and 282 parsimony-informative. Bayesian phylogenetic (MB) analyses were performed using MrBayes v3.1.2 (Ronquist & Huelsenbeck 2003). A metropolis-coupled Markov chain Monte Carlo search algorithm with 2,000,000 generations was used. Trees were sampled every 1000 generations. Chain convergence was determined with Tracer 1.4 (http://tree.bio.ed.ac.uk/software/tracer), and the first 20% of trees were discarded as burn-in. The maximum likelihood (ML) phylogenetic analyses were performed in PHYML (Guindon et al. 2010) using default settings and 500 bootstrap replicates with the T92+G+I substitution model determined using MEGA 6.06 (Tamura et al. 2013). The tree was rooted with *Caloboletus calopus*, a species related to *Butyriboletus* (Wu et al. 2014).

Herbarium specimens have been deposited at the Mycological Department, National Museum, Prague (PRM). Abbreviations of public herbaria follow Thiers (on-line).

Data on geological conditions were taken from maps and descriptions at www.geologicke-mapy.cz (Bokr on-line). Ponds mentioned in "Material examined" chapter are man-made water bodies, created by intentional damming of streams for fishery purposes (regardless their size).

RESULTS AND DISCUSSION

MOLECULAR STUDY

The rDNA sequence of the *Butyriboletus regius* topotype was identical to various sequences of this species published by Šutara et al. (2014; sequence accession number KJ419920), Arora & Frank (2014; KC184463, KC584789), Li et al. (2014; KC416635) and Zhao et al. (2015; KT002605). Our phylogenetic study included 22 *Butyriboletus* (incl. *Exsudoporus*) species with available DNA data. The two main

clades included the *B. hainanensis* clade and a relatively distant clade of other species. The latter large clade is subdivided into the lineage of *Boletus permagnificus* and *Butyriboletus frostii* (formerly *Exsudoporus*), the lineage of *B. roseopurpureus* and related species, and the lineage of other species including *B. regius*, which forms a well-supported group with *B. querciregius*, *B. primiregius* and *B. autumniregius*. This clustering is concordant with previous studies, showing that *Butyriboletus* species form three well-separated lineages of *B. hainanensis*, *B. frostii* and a lineage comprising other species (Liang et al. 2016, Wu et al. 2016).

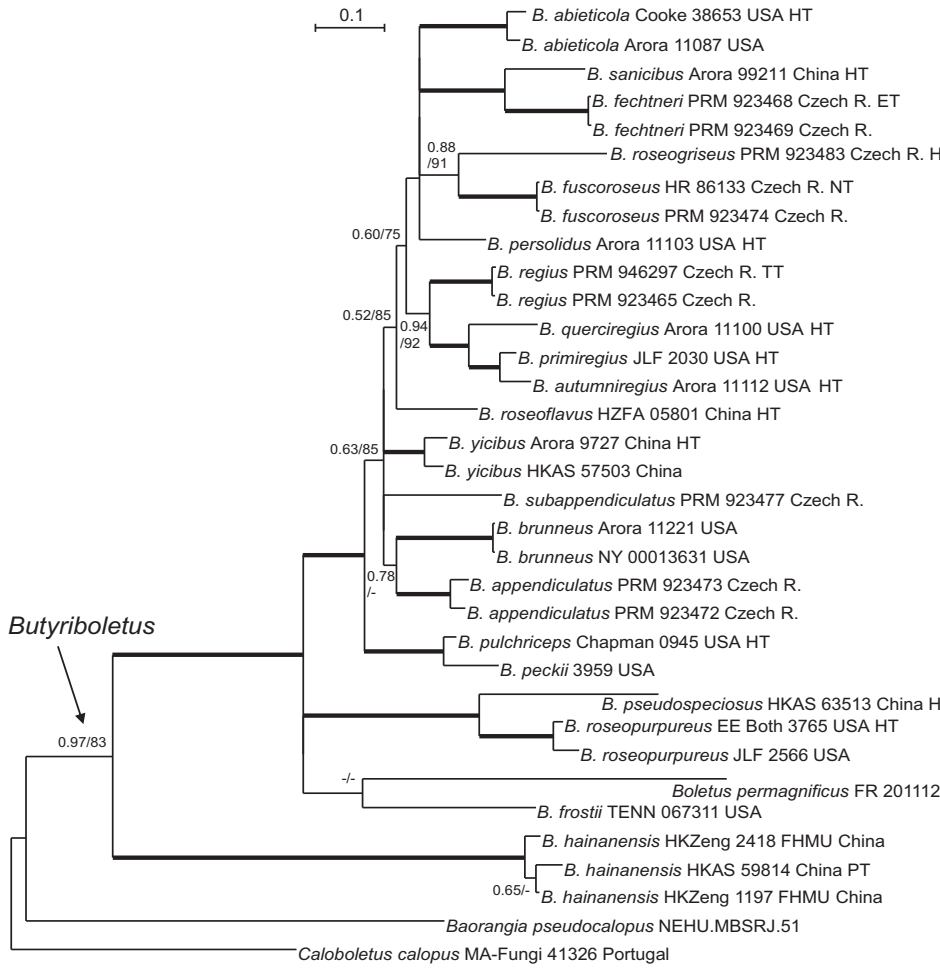

Fig. 1. Phylogeny of ITS-LSU rDNA sequence data for *Butyriboletus*. The tree backbone was constructed using the Bayesian inference method. Numbers beside the internal nodes are Bayesian MCMC posterior probabilities followed by Maximum likelihood bootstraps. Only posterior probabilities ≥0.50% and bootstrap support ≥50% are shown. The thick branches denote full statistical (1.00/100) support. Abbreviations: HT – holotype, NT – neotype, ET – epitype, PT – paratype, TT – topotype.

Tab. 1. List of sequences used in the phylogenetic analyses.

Species	Collection No.	Collector	Date	Location	ITS rDNA	LSU rDNA	Reference
Butyriboletus abieticola (Thiers) D. Arora & J.L. Frank	Arora 11087	D. Arora	07.07.2011	USA, California, Lassen National Forest	KC184412	KC184413	Arora & Frank 2014
Butyriboletus abieticola (Thiers) D. Arora & J.L. Frank (holotype)	Cooke 38653	W.B. Cooke	08.08.1967	USA, California, Mt. Shasta	KC184414	–	Arora & Frank 2014
Butyriboletus appendiculatus (Schaeff.) D. Arora & J.L. Frank	PRM 923472	V. Janda, J. Rejsek	15.08.2009	Czech Republic, Kněžičky, Kněžičky Game Preserve	KJ419922	KJ419922	Šutara et al. 2014
Butyriboletus appendiculatus (Schaeff.) D. Arora & J.L. Frank	PRM 923473	V. Janda	24.08.2013	Czech Republic, Záhornice near Městec Králové, Jakubský pond	KJ419923	–	Šutara et al. 2014
Butyriboletus autumniregius D. Arora & J.L. Frank (holotype)	Arora 11112 / OSC 148243	D. Arora	15.11.2011	USA, California, Mendocino Co.	KC184425	KC184425	Arora & Frank 2014
Butyriboletus brunneus (Peck) D. Arora & J.L. Frank	NY 00013631	R.E. Halling	–	USA, Connecticut	KT002600	KT002611	Zhao et al. 2015
Butyriboletus brunneus (Peck) D. Arora & J.L. Frank	Arora 11221	D. Arora	11.09.2011	USA, New Hampshire, Dublin	KC184471	KC184471	Arora & Frank 2014
Butyriboletus fechtneri (Velen.) D. Arora & J.L. Frank	PRM 923469	J. Rejsek, V. Janda	19.06.2010	Czech Republic, Kněžičky, Kněžičky Game Preserve	KJ419930	KJ419930	Šutara et al. 2014
Butyriboletus fechtneri (Velen.) D. Arora & J.L. Frank (epitype)	PRM 923468	V. Janda	08.08.2010	Czech Republic, Srbsko, Boubová hill	KJ419929	KJ419929	Šutara et al. 2014
Butyriboletus fuscoroseus (Smotl.) Vizzini & Gelardi	PRM 923474	J. Rejsek, N. Melichová, V. Janda	24.09.2011	Czech Republic, Běrunice, Kněžičky Game Preserve	KJ419924	–	Šutara et al. 2014
Butyriboletus fuscoroseus (Smotl.) Vizzini & Gelardi (neotype)	HR 86133	J. Kramoliš	06.08.2010	Czech Republic, Horní Ředice, Žernov forest	KJ419926	KJ419926	Šutara et al. 2014
Butyriboletus hainanensis N.K. Zeng, Zhi Q. Liang & S. Jiang	H.K.Zeng 1197 (FHMU)	–	–	Hainan, southern China	KU961653	–	Liang et al. 2016
Butyriboletus hainanensis N.K. Zeng, Zhi Q. Liang & S. Jiang	H.K.Zeng 2418 (FHMU)	–	–	Hainan, southern China	KU961654	–	Liang et al. 2016
Butyriboletus hainanensis N.K. Zeng, Zhi Q. Liang & S. Jiang (paratype)	HKAS 59814	N.K. Zeng	26.07.2009	Hainan, southern China	KU317762	–	Unpublished
Butyriboletus peckii (Frost) Kuan Zhao & Zhu L. Yang	3959	A.R. Clark, E. Both	04.08.1995	USA, Tennessee	–	JQ326999	Halling et al. 2012
Butyriboletus persolidus D. Arora & J.L. Frank (holotype)	Arora 11103 / OSC 148270	D. Arora	01.11.2011	USA, California, Henry Cowell SP	KC184442	KC184442	Arora & Frank 2014
Butyriboletus primiregius D. Arora & J.L. Frank (holotype)	JLF 2030 / OSC 148279	J.L. Frank	26.06.2011	USA, California, McCloud	KC184455	KC184455	Arora & Frank 2014

Species	Collection No.	Collector	Date	Location	ITS rDNA	LSU rDNA	Reference
Butyriboletus pseudospeciosus Kuan Zhao & Zhu L. Yang (holotype)	HKAS 63513	G. Wu	08.08.2010	China, Yunnan, Qujing City, Shizong County, Danfeng Town, Shuzu Village	KM388728	–	Wu et al. 2016
Butyriboletus pulchriceps (Both, Bessette & R. Chapm.) Kuan Zhao & Zhu L. Yang (holotype)	R. Chapman 0945 / BUF	R. Chapman	Aug. 1991	USA, Arizona, Cochise County, prope Chiricahua Mountains	KT002604	KT002615	Zhao et al. 2015
Butyriboletus querciregius D. Arora & J.L. Frank (holotype)	Arora 11100 / OSC 148284	F. Menge	31.10.2011	USA, California, Santa Cruz Co.	KC184461	KC184461	Arora & Frank 2014
Butyriboletus regius (Krombh.) D. Arora & J.L. Frank	PRM 923465	V. Janda, L. Opat, T. Pavelka	23.09.2012	Czech Republic, Liteň, Mramor hill	KJ419920	KJ419931	Šutara et al. 2014
Butyriboletus regius (Krombh.) D. Arora & J.L. Frank (topotype)	PRM 946297	T. Pavelka, L. Opat, V. Janda	12.06.2016	Czech Republic, Praha-Točná (near Zbraslav)	LS992174	–	This study
Butyriboletus roseoflavus (Hai B. Li & Hai L. Wei) D. Arora & J.L. Frank (holotype)	HZFA 05801	H.B. Li	11.08.2005	China, Zhejiang Province, Qingyuan County, Jushui village	GU233427	JX290185	Li et al. 2014
Butyriboletus roseogriseus (Šutara, Graca, M. Kolařík, Janda & Kříž) Vizzini & Gelardi (holotype)	PRM 923483	M. Graca	13.08.2010	Czech Republic, Francova Lhota, Tisůvek hill	KJ419927	KJ419927	Šutara et al. 2014
Butyriboletus roseopurpureus (Both, Bessette & Roody) Kuan Zhao, Zhu L. Yang & Halling	JLF 2566	N. Siegel	10.08.2012	USA, West Virginia, Cooper Rock SF	KC184466	KC184467	Zhao et al. 2015
Butyriboletus roseopurpureus (Both, Bessette & Roody) Kuan Zhao, Zhu L. Yang & Halling (holotype)	E.E. Both 3765 (BUF)	E.E. Both	27.07.1995	USA, New York, Town of Orchard Park, Erie County, Chestnut Ridge Park	KT002606	KT002617	Zhao et al. 2015
Butyriboletus sanicibus D. Arora & J.L. Frank (holotype)	Arora 99211 (SFSU)	D. Arora	04.07.1999	China, Yunnan, Shilin	KC184469	KC184470	Arora & Frank 2014
Butyriboletus subappendiculatus (Dermek, Lazebníček & Veselský) D. Arora & J.L. Frank	PRM 923477	M. Graca	24.07.2013	Czech Republic, Bílá, Smradlava stream valley	KJ419921	KJ419921	Šutara et al. 2014
Butyriboletus yicibus D. Arora & J.L. Frank	HKAS 57503	B. Feng	–	China, Yunnan, Yulong	KT002608	KT002620	Zhao et al. 2015
Butyriboletus yicibus D. Arora & J.L. Frank (holotype)	Arora 9727	D. Arora	03.08.1997	China, Yunnan, Lijiang	KC184474	KC184475	Arora & Frank 2014
Butyriboletusus frostii (J.L. Russell) G. Wu, Kuan Zhao & Zhu L. Yang	TENN 067311	SAT	–	USA, Tennessee	KT002601	KT002612	Zhao et al. 2015
Boletus permagnificus Pöder	FR 2011120	–	–	–	KR782301	–	Unpublished

TAXONOMY

Butyriboletus regius (Krombh.) D. Arora & J.L. Frank, Mycologia 106(3): 466, 2014 Figs. 2–10

≡ *Boletus regius* Krombh. in Naturgetreue Abbildungen und Beschreibungen der essbaren, schädlichen und verdächtigen Schwämme 2, p. 3, 1832 [basionym]
≡ *Tubiporus regius* (Krombh.) P. Karst., Bidr. Känn. Finl. Nat. Folk 37: 5, 1882
≡ *Dictyopus appendiculatus* var. *regius* (Krombh.) Quél., Enchiridion Fungorum in Europa media et praesertim in Gallia Vigentium, p. 160, 1886
≡ *Suillus regius* (Krombh.) Kuntze, Revisio Generum Plantarum 3(2), p. 536, 1898

Holotype. None designated.
Other original material. No collection studied by J.V. Krombholz has been preserved. Colour table of several fruitbodies is now chosen as lectotype (see below).
Lectotype (designated here, MycoBank MBT 381726). J.V. Krombholz, Naturgetreue Abbildungen und Beschreibungen der essbaren, schädlichen und verdächtigen Schwämme 2, tab. 7, 1832.

Etymology. The species epithet from the Latin word *regius* refers to the traditionally used name of this bolete in Prague and surroundings – "Königspilz", "Královský Hřib" (Krombholz 1832).

Selected illustrations. Krombholz (1832): tab. 7, figs. 1–11; Kallenbach (1929–1942): tab. 9, tab. 14, figs. 1–2; Pilát & Ušák (1952): tab. 36a; Pilát & Dermek (1974): tab. 53; Engel et al. (1983): p. 75; Lambert & Estadès (1985): p. 16; Galli (1987): p. 117; Dähncke (1993): p. 73; Hagara (1993): p. 137, upper fig.; Antonín & Bieberová (1995): colour supplement; Galli (1998): p. 181; Hagara et al. (1999): p. 342, fig. 12; Gminder (2000): p. 233; Muñoz (2005): p. 699–700, figs. a–d; Marques & Muñoz (2006): p. 359, lower fig.; Domínguez (2007): p. 151–153; Galli (2007): p. 180–181; Tkalčec et al. (2008): p. 204; Šutara et al. (2009): p. 129; Eyssartier & Roux (2011): p. 87; Opat (2011): inner back cover; Assyov (2012): p. 415, fig. 5–6; Holec et al. (2012): p. 573, fig. 1144; Lannoy (2012): fig. 59; Galli (2013): p. 182–183; Hagara (2014): p. 511, lower left fig.; Šutara et al. (2014): p. 27, fig. 21; Janda & Kříž (2016): p. 36, back cover, upper fig.

Original description. *Boletus regius* pileo pulvinato, glabro-purpureo; tubulis adnatis, brevibus, minutis, aureis; stipite bulboso, reticulato, aureo, basi purpurascente: pluribus conglomeratis.

Description

Macroscopic characters. Pileus 60–150 mm, at first hemispherical, then convex to pulvinate, pinkish, purplish pink, yellowish pink or yellow with carmine pinkish red fibrillose or squamulose covering. Surface initially subtomentose, soon becoming adpressed filamentose, finally more or less glabrous, slightly sticky when wet, more reddish but not blueing where touched or bruised.

Tubes 10–25 mm long at maturity, depressed around stipe apex, vivid yellow to golden yellow at first, later with olivaceous tint. Pores small, roundish, "closed" in youth, up to 1 mm large at maturity, concolorous with tubes, usually not blueing when bruised or touched. Spore-print olivaceous brown.

Stipe 50–140 × 20–50(60) mm, fleshy, at first ventricose to subventricose, then almost cylindrical to clavate, vivid yellow, at the base (usually in part hidden in the substrate) rarely faintly reddish or with purplish spots. Surface covered with

a fine, well-developed, yellow reticulum at least in the upper half, but often over the entire length. Stipe base covered with pale yellow tomentum.

Context lemon yellow to vivid yellow, sometimes slightly reddish purplish in stipe base; usually not blueing when cut, but rarely with faintly bluish spots after a long time. Taste mild, pleasant, smell inconspicuous.

Microscopic characters. Basidiospores (10.5)12.0–16.0(17.5) × 4.0–5.0 µm, Q_{av} = 3.1–3.5 (in immature fruitbodies from 2.6), longitudinally fusiform to cylindrical, with suprahilar depression in profile, with distinct hilar appendix, smooth, yellowish, weakly dextrinoid (at least part of the spores becoming brownish) in Melzer's solution.

Basidia 29–55 × 8.0–12.0 µm, clavate to narrowly clavate, mostly 4-spored. Pleurocystidia 30–52 × 5.5–9.0 µm, scattered to rare, smooth and thin-walled, fusiform, but in immature fruitbodies often not very differentiated from basidiolae (only those with fusiform apex were measured), then more distinct and with a long neck. Cheilocystidia of mature fruitbodies similar to pleurocystidia, up to 68 × 4–10 µm, but when young (when the pileus is not yet sufficiently opened) forming a dense layer of hyphoid terminal elements of the hymenophoral trama – this layer covers the pores entirely (giving the impression of "closed" pores, see Šutara 2014). Hymenophoral trama gelatinised. Caulohymenium present.

Pileipellis composed of a trichoderm of smooth hyphae (not incrusted under a light microscope) which later often cluster into small tufts well visible with the naked eye as minute squamulae, the trichoderm finally more or less collapses and changes into an adpressed fibrillose layer. Hyphal elements of pileipellis long and 2.5–8.0 (mostly 4.0–5.0) µm wide. Clamps absent.

Ecology and distribution

Ecology. In deciduous, mainly sparse oak forests, on dikes and banks of ponds, especially in warm sunny places – in Central Europe on e.g. steep, south-facing slopes, but also in more or less flat landscapes in thermophytic regions (colline vegetation zone). In the Czech Republic, *Butyriboletus regius* forms ectomycorrhiza with *Quercus*, more rarely with *Fagus*, preferably on basic soils, but frequently with acidified upper soil horizon. Further, predominantly in the Mediterranean region, it also grows under *Castanea* (e.g. Roux 2006, Galli 2007, 2013). It was included in the lists of indicator species of animals and fungi for natural habitats defined in the Habitat Catalogue of the Czech Republic (Hofmeister & Hošek 2016) as a representative of *Galio-Carpinetum* oak-hornbeam forests and Euro-Siberian steppic woods with *Quercus* spp. *Butyriboletus regius* fruitbodies grows usually solitary or in small groups from the first half of May to early October.

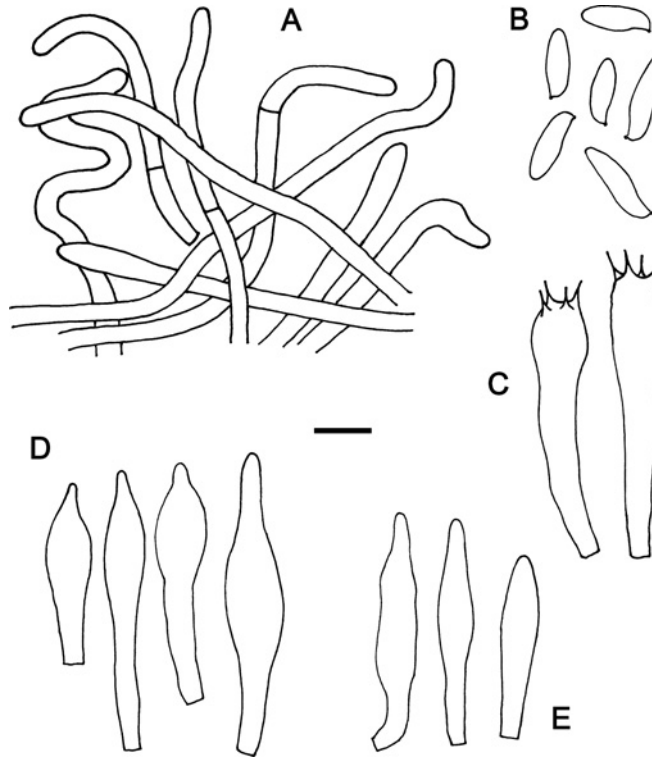

Fig. 2. *Butyriboletus regius* (PRM 946297). **A** – pileipellis, **B** – basidiospores, **C** – basidia, **D** – cheilocystidia, **E** – pleurocystidia. Scale bar = 10 µm. Del. M. Kříž.

Distribution. *Butyriboletus regius* is known from many European countries. Although widespread, it is reported by most authors as rare and is red-listed or even legally protected in many countries including the Czech Republic (Antonín & Bieberová 1995, Šutara & Janda 2006), where its occurrence markedly decreased during the 20th century. In the 19th century, *B. regius* was rather common in Bohemia, including the surrounding of Prague; Krombholz mentioned this species as popular and often sold at Prague's marketplaces. Probably the main cause of its decrease was a general change in the soil chemistry due to acidification as a result of extensive deterioration of the environment in the second half of the 20th century, but also other factors had a negative influence: felling and vanishing of suitable habitats, increase in some nutrients (especially nitrogen) in the soil, and recently also increasingly frequent long dry periods which do generally not allow fungi to fructify. On the other hand, the gradual return of the soil chemistry to its original state together with current global warming may be favourable factors for its occurrence (this has been observable over the last ca. 20 years).

History and nomenclature

Butyriboletus regius is the second described species of boletes belonging to this genus. Krombholz's species concept was followed by many Czech and Slovak mycologists (e.g. Smotlacha 1912, Velenovský 1922, Pilát 1951, 1969, Pilát & Ušák 1952, Veselý et al. 1972, Dermek 1973, Pilát & Dermek 1974, Hagara 1993, Hlaváček 1993, Antonín & Bieberová 1995, Hagara et al. 1999, Šutara et al. 2009, 2014, Janda & Kříž 2016), but also by many other European authors (e.g. Kallenbach 1929–1942, Singer 1967, Engel et al. 1983, Moser 1983, Lambert & Estadès 1985, Galli 1998, 2007, 2013, Gminder 2000, Lannoy & Estadès 2001, Estadès & Lannoy 2004, Watling & Hills 2005, Muñoz 2005, Marques & Muñoz 2006). On the other hand, Lambert & Estadès (1985) and Redeuilh & Simonini (2002, 2005) pointed out that the species had been poorly or not at all known to some authors for a long time. The epithet '*regius*' was used by them many times in different ranks, however, often for other species, *Butyriboletus fuscoroseus* (Smotl.) Vizzini & Gelardi = *Boletus pseudoregius* Huber ex Estadès (e.g. Konrad 1925, Peltereau 1926, Konrad & Maublanc 1935, Leclair & Essette 1969, Romagnesi 1962a, 1962b, 1970) or *Rubroboletus legaliae* (Pilát & Dermek) Della Maggiora & Trassin. (Blum 1965, 1970). The name *Boletus regius* was also used for some similar, but different species occurring in North America (e.g. Snell & Dick 1970, Bessette et al. 2000) and Asia (e.g. Chiu 1948, Zang 2006). Therefore this European species was incorrectly considered widely distributed in the temperate northern hemisphere.

The protologue of *Boletus regius* includes a short original description in Latin together with a detailed description in German, information on its ecology supplemented with several names of sites of occurrence, on possible confusions with other species, and an excellent illustration (Fig. 3). According to our investigation, no other element of original material is known, except for the colour table published together with the original description. As the drawings of species in this table well agree with our collections, we have decided to designate it as a lectotype (see also Redeuilh & Simonini 2002, 2005). Based on localities of *B. regius* mentioned by Krombholz, we consider Prague and its southern surroundings as the area of its type locality. We also molecularly analysed a topotypic specimen collected near Zbraslav, one of Prague's neighbourhoods (now part of Prague), in the protologue cited under the German name of Königsaal (PRM 946297, see LS992174 in Tab. 1).

Concerning the macromorphology and colour of the fruitbodies, *Butyriboletus regius* is not a very variable species according to our observations in the past twenty years. Only one infraspecific taxon has been described to date – the xanthoid form *B. regius* f. *aureus* (Lambert & Estadès) Klofac, characterised by a yellow pileus. The taxonomic value of this form is uncertain, as this taxon may

represent only an extreme case within the species colour range. We have seen some pinkish or reddish traces on the pilei of almost all fruitbodies with a predominantly yellow pileus (see Fig. 10 or Janda & Kříž 2016, p. 36, lower fig.). Yellow (uncoloured) parts of the pileus sometimes remain when covered by leaves, as was already described by Krombholz (1832).

Assyov (2012) described the colour of the pileus among other as „greyish rose", „greyish red" or even „reddish grey". However, we have never observed greyish or grey tints, which are absolutely uncharacteristic of *B. regius*. On the contrary, these tints are typical of some similar species, particularly *Butyriboletus roseogriseus* and *Rubroboletus legaliae* (see below). Assyov's characteristics were later adopted by Li et al. (2014) for morphological comparison of *B. regius* with *B. roseoflavus* (M. Zang & H.B. Li) D. Arora & J.L. Frank and some other congeneric species.

Distinguishing characters

Butyriboletus regius could be confused with species which may have a similarly coloured pileus: *B. fuscoroseus*, *Caloboletus kluzakii* (Šutara & Špinar) Vizzini, *Rubroboletus legaliae* and *R. pulchrotinctus* (Alessio) Kuan Zhao & Zhu L. Yang.

The most similar species *B. fuscoroseus* differs from *B. regius* by its duller coloured pileus (i.e. brownish pink to reddish brown or purplish brown), the frequent presence of a pinkish, orange-reddish or red to purplish red zone in the lower third of the stipe, blueing context, which is usually pinkish to light carmine-rose in the stipe base, as well as blueing of the tubes, pores and surface of the stipe when touched or bruised (see e.g. Šutara et al. 2014).

Caloboletus kluzakii differs from *B. regius* in the following characters: whitish to slightly greyish pileus when young, bitter taste of context, blueing context and hymenophore when cut or bruised and distinctly wider spores, measuring (4.5)4.8–6.0(6.5) µm (see Šutara & Špinar 2006, Šutara et al. 2009).

Rubroboletus legaliae, which usually has a pinkish to purplish red pileus when mature, is well distinguished from *B. regius* by its pileus completely covered by a greyish tomentum when young (later glabrescent), red stipe and red or orange-red pores in younger stages (but the pores can sometimes be almost yellow, especially when mature), blueing context with a smell of lovage or Maggi seasoning when drying, and distinctly wider spores, measuring (4.5)5.0–6.0(7.0) µm (Šutara et al. 2009, Janda et al. 2017).

Rubroboletus pulchrotinctus usually has a whitish to pale greyish pileus with a pink tint in the marginal zone, but sometimes the pileus is uniform pink all over. It differs from *B. regius* by the colour of pores and stipe, which are often not purely yellow, but frequently have yellow-orange to orange-pinkish shades, and

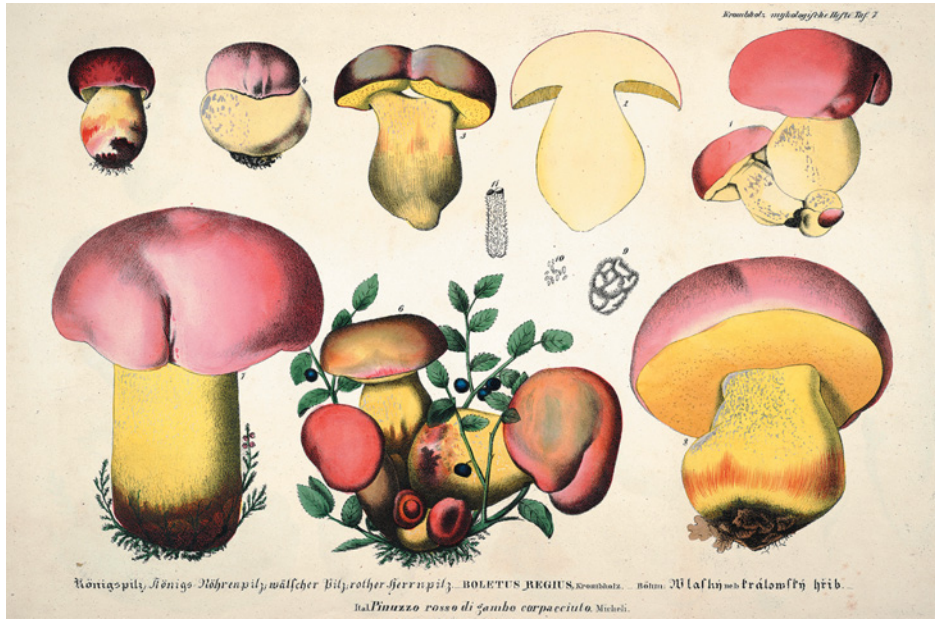

Fig. 3. *Butyriboletus regius*, J.V. Krombholz – Naturgetreue Abbildungen und Beschreibungen der essbaren, schädlichen und verdächtigen Schwämme 2, tab. 7, 1832 (lectotype).

Fig. 4. *Butyriboletus regius*, Praha-Točná, Czech Republic, under *Quercus* and *Tilia*, 12 June 2016 (PRM 946297, topotype). Photo V. Janda.

Fig. 5. *Butyriboletus regius*, Praha-Točná, Czech Republic, under *Quercus*, 10 Sept. 2010 (PRM 923466). Photo V. Janda.

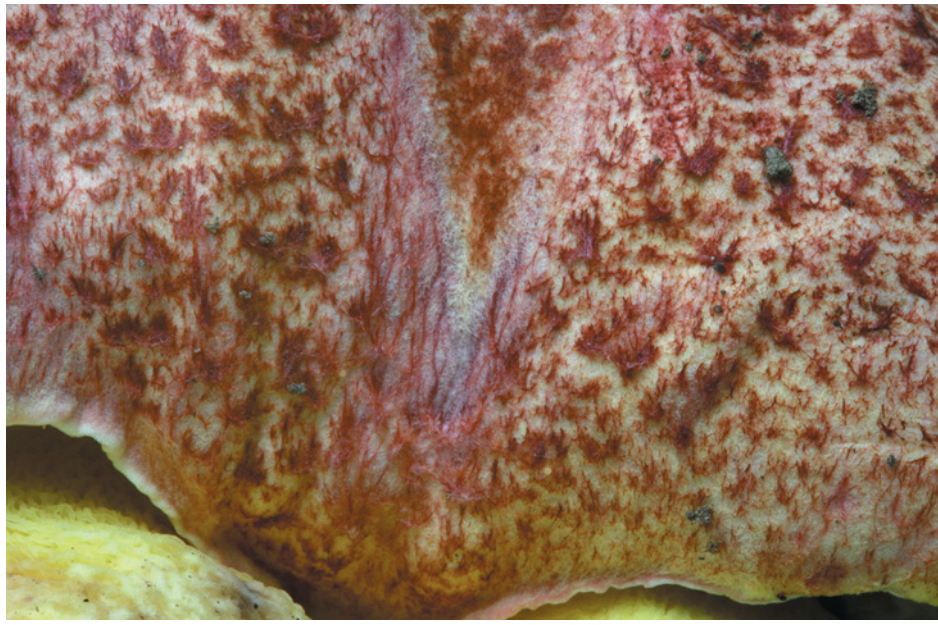

Fig. 6. *Butyriboletus regius*, detail of cap, Měňany, Bohemian Karst, Czech Republic, under *Quercus*, 12 June 2016 (PRM 944117). Photo V. Janda.

Fig. 7. *Butyriboletus regius*, Měňany, Bohemian Karst, Czech Republic, under *Quercus*, 26 July 2011 (herb. J. Šutara). Photo M. Kříž.

Fig. 8. *Butyriboletus regius*, Jinačovice, Czech Republic, under *Quercus*, 25 Aug. 2006 (PRM 944099). Photo M. Kříž.

Fig. 9. *Butyriboletus regius*, Měňany, Bohemian Karst, Czech Republic, under *Quercus*, 12 June 2016 (PRM 944117). Photo V. Janda.

Fig. 10. *Butyriboletus regius*, Měňany, Bohemian Karst, Czech Republic, under *Quercus*, 23 Sept. 2012 (PRM 944111). Photo V. Janda.

by a blueing context. The occurrence of *R. pulchrotinctus* is restricted to the Mediterranean region.

The xanthoid form *Butyriboletus regius* f. *aureus* could be confused with some xanthoid forms of boletes belonging to the genera *Rubroboletus*, *Suillellus*, *Neoboletus* or *Imperator*. These boletes, however, turn instantly strongly blue when cut or only slightly touched.

Butyriboletus fechtneri (Velen.) D. Arora & J.L. Frank, Mycologia 106(3): 466, 2014 Figs. 11–24

≡ *Boletus fechtneri* Velen., České houby 4–5: 704, 1922 [basionym]
= *Boletus appendiculatus* subsp. *pallescens* Konrad, Bull. Soc. mycol. Fr. 44: 73, 1929

Holotype. None designated.
Other original material. Czech Republic, Central Bohemia, Bohemian Karst, Roblín, 1921, leg. F. Fechtner, det. J. Velenovský, preserved in the Department of Botany of Charles University, Prague (PRC 3981). One young fruitbody stored in a glass cylinder filled with preserving liquid (Figs. 12–13), the note "p. 704" refers directly to this page in Velenovský's České houby.
Lectotype (designated here, MycoBank MBT 381727). Czech Republic, Central Bohemia, Bohemian Karst, Roblín, 1921, leg. F. Fechtner, det. J. Velenovský (PRC 3981) – see above.
Epitype (designated here, MycoBank MBT 381728). Czech Republic, Central Bohemia, Bohemian Karst, Srbsko, Karlštejn National Nature Reserve, Boubová hill, 340 m a.s.l., under *Quercus*, *Carpinus* and *Tilia*, 8 Aug. 2010, leg. & det. V. Janda. Epitype deposited in Mycological Department of the National Museum, Prague (PRM 923468), sequence KJ419929 (ITS rDNA, LSU rDNA) deposited in NCBI GenBank (for more details, see Šutara et al. 2014). Isoepitype deposited in the Moravian Museum, Brno (BRNM 805388). Colour photos: Fig. 14 and in Šutara et al. (2014), p. 27, fig. 22. We selected as an epitype herbarium material collected in a characteristic habitat of the Bohemian Karst, thermophilic deciduous forest on calcareous bedrock, which was cited by Velenovský in his original description (see below). Both the site of the collection and the morphological characters of the selected material fit the protologue.

Etymology. Named after František Fechtner (1883–1967), taxidermist and official at the Institute of Botany of the Charles University (Pilát 1967).

Selected illustrations. Kallenbach (1929–1942): tab. 14, figs. 5–6, tab. 43 (as *Boletus aestivalis* Fr.); Pilát (1949): p. 97, 100; Pilát & Ušák (1952): tab. 36b; Pilát & Ušák (1959, 1961): tab. 2; Leclair & Essette (1969): tab. 42 (as *Boletus aestivalis* Fr.); Pilát & Dermek (1974): tab. 51; Engel et al. (1983): p. 71; Estadès (1985): p. 16; Galli (1987): p. 114; Breitenbach & Kränzlin (1991): p. 57, fig. 10; Antonín & Bieberová (1995): colour supplement; Galli (1998, 2007): p. 183–185; Hagara et al. (1999): p. 341, fig. 9; Gminder (2000): p. 239; Ložek et al. (2005): p. 628, fig. 6; Muñoz (2005): p. 701–703, figs. a–d; Marques & Muñoz (2006): p. 365; Domínguez (2007): p. 103; Šutara et al. (2009): p. 131; Assyov (2012): p. 411, fig. 2; Holec et al. (2012): p. 573, fig. 1145; Galli (2013): p. 185–187; Šutara et al. (2014): p. 27, fig. 22; Janda & Kříž (2016): p. 40–41.

Original description (in Czech). Kompaktně, tvrdě mas. Kl. 6–14 cm v pr., pravid. sklen., tlustě mas., úplně hladký a lysý (nesametový), světle okrově našedlý, bílou jinovatkou nadechlý a radiálně tmavými žilkami přejemně žíhaný. Rour. od tř. odsedlé, přehusté a jako drobounká ústí krásně žluté, ale pomačkáním okamžitě zelenomodré. Tř. krátký, silně hlízovitě napuchlý, pevný, solidní, od dola do poloviny růžově nadechlý, nahoře zlatožlutý, až do poloviny ostrou, hustou sítí zdobený. Duž. kl. i tř. zlatožlutá, na řezu okamžitě intensivně modrá (jako u *B. erythropus* a *luridus*), ale za chvilku znova žlutá, sladká, v tř. na basi červeně mramorovaná. Výtr. ellipt., k basi šikmo staž., žlutavé, 7–10 µ.

V teplých hájích (vápno) u Roblína co rok přináší p. Fr. Fechtner, pilný můj sběratel hub. Jest nejvíce příbuz. a podob. *B. aereus* a *B. calopus*. Od prvého se liší barvou kl., silným modráním, od druhého barvou kl., silným modráním a nikoliv rudým tř. Fries praví o *B. calopus*: »*pileo impolito, subtomentoso, olivaceo, stipite undique apiceve coccineo*«.

Description

Macroscopic characters. Pileus 50–90(180) mm wide, at first hemispherical, then convex, finally plano-convex to pulvinate or even flat, with a regular or slightly undulate margin, surface dry, mat, sometimes slightly shiny, initially subtomentose, soon becoming adpressed filamentose, whitish, whitish grey, greyish, silvery grey when young or middle-aged, then grey-buff to brownish, rarely with very slight pinkish tint (mostly in the marginal zone), slowly darkening when bruised. Subcuticular layer brown or brownish pink (observable in a scalp or section of the pileus), this coloration becomes gradually visible on the surface of the pileus at maturity, sometimes in the form of a brownish line at margin.

Tubes 5–10(25) mm long, somewhat depressed around stipe apex when young, at first pale yellow to lemon yellow, finally with a more or less distinct olivaceous tinge, blueing or blue-greening when cut. Pores small, roundish, at first closed, up to 1 mm large at maturity, concolorous with tubes, ochre-yellow in dry weather, quickly blueing or blue-greening when bruised. Spore-print olivaceous brown.

Stipe 50–90(150) × 25–40(60) mm, initially ventricose-fusiform, then clavate to subcylindrical, usually rounded at base, with small, up to 15 mm long appendix, pale yellow to bright yellow at least in the upper part, often with a pinkish, carmine-pinkish or reddish zone in the lower half or less often in the lower two thirds, sometimes even over almost the entire length of the stipe (Fig. 19), but occasionally partially or completely absent (Fig. 18). Surface covered with a fine, pale yellowish to yellow reticulum initially formed by small roundish meshes in the apical part of the stipe, later with larger, elongated meshes developed over almost the entire length of the stipe except for the basal part. Bruised spots on the stipe surface turn more or less blue. Places bitten by slugs slowly become carmine-red to purple-reddish. Stipe base covered with whitish, at times partly yellowish or pale ochraceous tomentum.

Context light yellow in pileus and upper half of the stipe when young, more vividly coloured above the tubes and near the surface of the stipe, becoming partly whitish with age, usually pinkish to light carmine-rose in the stipe base (but sometimes over almost the entire length of the stipe). This pinkish or light carmine-rose shade is particularly distinct in younger fresh fruitbodies, but gradually disappears in older or insufficiently fresh ones. Context in pileus and stipe apex blueing when cut. The blueing (like the pink colour in the stipe base) is less intensive in old or drying fruitbodies and, in such cases, it is usually only present above the tubes. Taste mild, pleasant, smell inconspicuous.

Microscopic characters. Basidiospores (10)11–15(16) × (4.8)5.0–6.0(6.6) µm, Q_{av} = 2.3–2.5 (in immature fruitbodies from 2.0), fusiform to fusiform-ellipsoid, with suprahilar depression in profile, with distinct hilar appendix, smooth, yellowish, very weakly dextrinoid (a few spores becoming pale brownish) in Melzer's solution.

Basidia 26–52(56) × 10–14 µm (long when young, shorter when old), clavate, mostly 4-spored. Pleurocystidia 36–51 × 6–12 µm, scattered, smooth and thin-walled, fusiform. Cheilocystidia of mature fruitbodies similar to pleurocystidia but often more conspicuous and clavate, up to 71 × 6–15 µm, when young (before the opening of the pileus) forming a dense layer of hyphoid terminal elements of the hymenophoral trama, sparsely branched in the basal part – this layer covers the pores entirely (giving the impression of "closed" pores, see Šutara 2014). Hymenophoral trama gelatinised. Caulohymenium present.

Pileipellis composed of a trichoderm of finely incrusted to smooth hyphae. The incrustation is more easily observable on the surface of narrow hyphae as a minute asperulation, rarely some more distinct granules are present. The trichoderm later more or less collapses and changes into an adpressed fibrillose layer. Hyphae of pileipellis 2–7(9) (mostly about 4) µm wide, with narrower terminal elements. Clamps absent.

Ecology and distribution

Ecology. Mainly in oak, oak-hornbeam and thermophilous beech forests, only exceptionally outside forests (in gardens) under deciduous trees or in coniferous forests. In the Czech Republic, *Butyriboletus fechtneri* forms ectomycorrhiza most often with *Quercus*, *Fagus* and *Tilia*, typically on calcareous soils in thermophytic regions (colline vegetation zone), but occasionally also in the Mesophyticum. It was included in the lists of indicator species of animals and fungi for natural habitats defined in the Habitat Catalogue of the Czech Republic (Hofmeister & Hošek 2016) as a representative of Central European limestone beech forests of the *Cephalanthero-Fagion* alliance, oak-hornbeam forests of the *Galio-Carpinetum* association, and Euro-Siberian steppic woods with *Quercus* spp. Some other thermophilous boletes frequently found together with *B. fechtneri* are *Rubroboletus satanas* (Lenz) Kuan Zhao & Zhu L. Yang, *R. rhodoxanthus* (Krombh.) Kuan Zhao & Zhu L. Yang, and *Hemileccinum depilatum* (Redeuilh) Šutara. According to our observations, *B. fechtneri* fructifies from the second half of June to September, rarely up to the early October.

Distribution. *Butyriboletus fechtneri* is known from many European countries. Although widely distributed, it is mostly reported as rare outside the Mediterranean region, where it can be rather common (e.g. Galli 1998). Regarding the Czech Republic, it is included both in the Red list of macromycetes

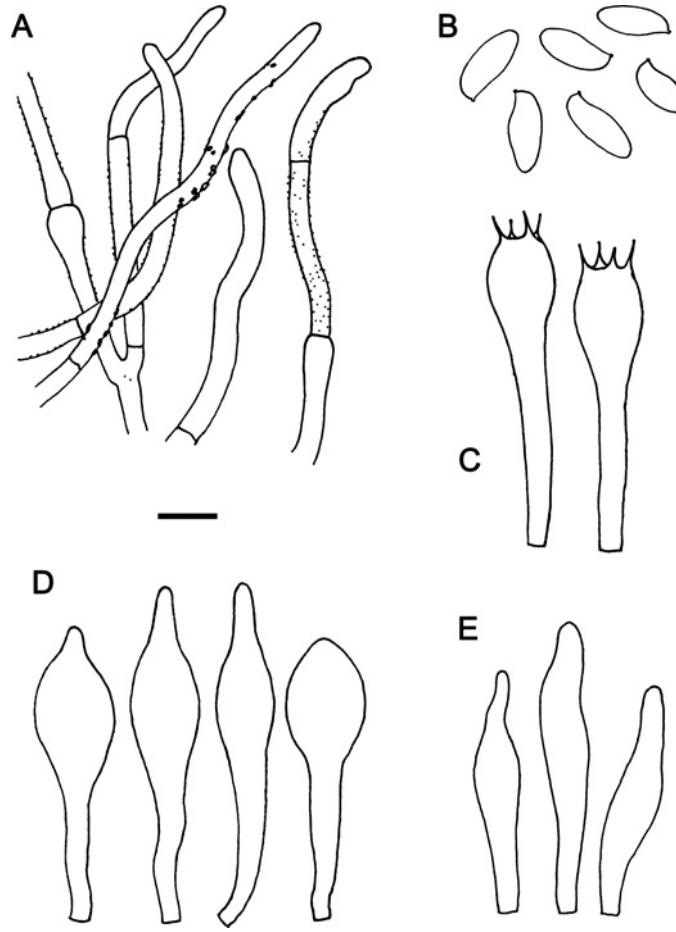

Fig. 11. *Butyriboletus fechtneri* (PRM 923468). **A** – pileipellis, **B** – basidiospores, **C** – basidia, **D** – cheilocystidia, **E** – pleurocystidia. Scale bar = 10 µm. Del. M. Kříž.

(Šutara & Janda 2006) and in the List of protected species (Antonín & Bieberová 1995).

History and nomenclature

Boletus fechtneri was described as the last representative of European butter boletes occurring in thermophilous deciduous forests (*B. appendiculatus* Schaeff. 1774, *B. regius* Krombh. 1832, *B. fuscoroseus* Smotl. 1912, *B. fechtneri* Velen. 1922). In the past, some authors considered butter boletes, including *B. fechtneri*, only as an infraspecific taxa of *B. appendiculatus*, usually in the

rank of subspecies or varieties (e.g. Konrad 1929, Konrad & Maublanc 1935, Imler 1950, Kühner & Romagnesi 1953, Romagnesi 1962a, 1962b, 1970). Currently, the species rank of these taxa has been confirmed as correct in molecular studies by Marques & Muñoz (2006), Arora & Frank (2014), and Šutara et al. (2014).

Velenovský (1922) described this species based on finds of František Fechtner, who collected this fungus every year near the small village of Roblín in a thermophilous forest on calcareous bedrock (i.e. somewhere in the central part of Karlické údolí valley, where oak-hornbeam forests on Devonian limestone occur). Later, Velenovský (1939) stated that the species grows frequently in the surroundings of the villages of Roblín and Karlštejn annually. Some other records and documented collections of this species from the same area, the central part of the Bohemian Karst, were published in e.g. Pilát (1949, 1951, 1969), Svrček (1960), and Pilát & Dermek (1974). Field research by the first two authors of this paper in the past twenty years has shown that *B. fechtneri* occurs in several ecologically similar sites over the entire area of the Bohemian Karst (including Karlické údolí valley). The fungal community of these localities is generally in accordance with its description given by Svrček (1960, fungi of *Querceto-Carpineta*). Therefore the Bohemian Karst can be considered as the type locality of the species in general terms.

Redeuilh & Simonini (2002, 2005) mentioned that no original material of *B. fechtneri* is known. We have thoroughly investigated all relevant resources. Although Velenovský did not directly cite a holotype, one collection by Fechtner, from 1921, has been preserved to date (PRC 3981). As this collection represents the only discovered original material, we designate it as a lectotype. Our examination of this collection has provided the following findings: the material contains one young fruitbody devoid of the typical colour of the species (due to both age of the collection and preservation method) (Figs. 12–13). The hymenophore almost lacks spores; we discovered a few immature spores of smaller size in comparison with those from mature fruitbodies. Unfortunately, molecular study of this material is not feasible because the preserving liquid contains formaldehyde. For these reasons we selected a representative collection from 2010 from Boubová hill (Karlštejn NNR), one of the best localities of *B. fechtneri* in the Bohemian Karst, as an epitype (Fig. 14 in this paper, fig. 22 in Šutara et al. 2014, PRM 923468).

Distinguishing characters

Butyriboletus fechtneri could be particularly confused with *B. appendiculatus*, *B. fuscoroseus*, *B. roseogriseus*, *Caloboletus radicans* (Pers.) Vizzini, *Hemileccinum impolitum* (Fr.) Šutara, *Rubroboletus pulchrotinctus*, or *R. satanas* f. *crataegi* (Smotl. ex Antonín & Janda) Janda & Kříž.

Butyriboletus appendiculatus can be easily distinguished from *B. fechtneri* by its darker, brown pileus without greyish or pinkish tints, the yellow stipe sometimes having brownish, but never reddish tints, the colour of the context in the stipe base, which can be brownish but never pink or carmine-rose, and its somewhat narrower spores.

Butyriboletus fuscoroseus is sometimes very similar, but it differs from *B. fechtneri* in the following characters: the pileus colour is mostly brownish pink or purplish brown, the spores are narrower, and the pileus cuticle is composed of hyphae with conspicuous incrustation (see Šutara et al. 2014, fig. 20a).

Butyriboletus roseogriseus differs from *B. fechtneri* by its yellow stipe without pinkish or reddish tints, the brownish colour of the context in the stipe base without pink or carmine-rose zone, and growth only in submontane regions (mostly under conifers, rarely under *Fagus*). Morphologically problematic collections from such localities should be molecularly tested.

Caloboletus radicans clearly differs from *B. fechtneri* by its bitter context, which is more whitish and in the stipe base brownish.

Hemileccinum impolitum, which sometimes has a reddish zone in the upper part of the stipe, clearly differs from *B. fechtneri* by its stipe without a reticulum (but with fine concolorous floccules), total absence of blueing, and unpleasant smell of iodoform, especially in the stipe base.

Rubroboletus pulchrotinctus differs from *B. fechtneri* by the colour of the pores, which are often not purely yellow but frequently has yellow-orange to orange-pinkish shades. Its pileus is usually pink-tinged in the marginal zone (sometimes even uniformly pink). The occurrence of *R. pulchrotinctus* is restricted to the Mediterranean region.

Rubroboletus satanas f. *crataegi* is a xanthoid form of *R. satanas*; it shares the same characters with the typical form except for the colour of the fruitbody. It differs from *B. fechtneri* by stouter fruitbodies, the absence of a pink or carmine-rose zone in the context of the lower part of the stipe, and in addition by its pores mostly more or less red-tinged.

Material examined

Abbreviations. Names of the collectors are abbreviated as follows (in alphabetical order): VJ (Václav Janda), MK (Martin Kříž), LO (Lubomír Opat), TP (Tomáš Pavelka), JR (Jiří Rejsek), JŠ (Josef Šutara).

Butyriboletus regius

Czech Republic. Bohemia. Trnobrany (North Bohemia, České středohoří Mts.), deciduous forest, under *Quercus*, 13 June 2016, leg. J. Anderková, det D. Marounek (PRM 945435); ibid., 23 July 2016, leg. & det. D. Marounek (PRM 944531). – Nepomyšl (North Bohemia, Doupovské hory Mts.), Chlum hill (outside Dětaňský chlum Nature Reserve), under *Quercus*, 15 Aug. 2011, leg. K. Jakšová, det. VJ, TP & K. Jakšová (PRM 944107). – Jesenice (Central Bohemia, Rakovnická pahorkatina hills), on dike between Horní Fikač and Dolní Fikač Ponds, under *Quercus* and *Betula*, 30 Sept. 2017, leg. &

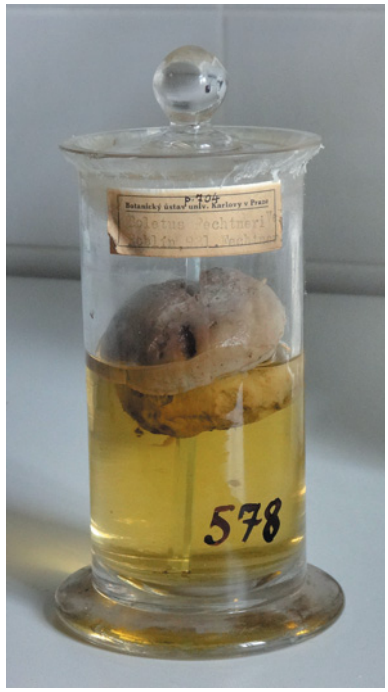

Fig. 12, 13. *Butyriboletus fechtneri*, Roblín, Bohemian Karst, Czech Republic, 1921 (PRC 3981, lectotype). Photo V. Janda.

Fig. 14. *Butyriboletus fechtneri*, Boubová hill, Karlštejn NNR, Srbsko, Bohemian Karst, Czech Republic, under *Quercus*, *Carpinus* and *Tilia*, 8 Aug. 2010 (PRM 923468, epitype). Photo V. Janda.

Fig. 15. *Butyriboletus fechtneri*, Boubová hill, Karlštejn National Nature Reserve, Srbsko, Bohemian Karst, Czech Republic, under *Quercus*, *Carpinus* and *Tilia* (epitype locality), 6 Aug. 2014 (PRM 946296). Photo V. Janda.

Fig. 16. *Butyriboletus fechtneri*, Boubová hill, Karlštejn National Nature Reserve, Srbsko, Bohemian Karst, Czech Republic, under *Quercus*, *Carpinus* and *Tilia*, 11 Aug. 2010 (not documented by a voucher). Photo V. Janda.

Fig. 17. *Butyriboletus fechtneri*, Bechov, Czech Republic, under *Tilia*, *Ulmus* and *Betula*, 15 July 2006 (not documented by a voucher). Photo M. Kříž.

Fig. 18. *Butyriboletus fechtneri*, Bažantnice forest, Choťovice, Czech Republic, under *Quercus*, *Populus tremula*, *Carpinus*, *Corylus*, *Acer campestre* and *Betula*, 12 Aug. 2014 (PRM 932932). Photo M. Kříž.

Fig. 19. *Butyriboletus fechtneri*, Kněžičky National Nature Reserve, Kněžičky, Czech Republic, under *Quercus*, 17 June 2010 (PRM 944151). Photo V. Janda.

Fig. 20. *Butyriboletus fechtneri*, Na Voskopě Nature Reserve, Suchomasty, Bohemian Karst, Czech Republic, under *Quercus*, *Carpinus* and *Tilia*, 22 Aug. 2013 (PRM 923470). Photo V. Janda.

Fig. 21. *Butyriboletus fechtneri*, Čtvrtě National Nature Reserve, Mcely, Czech Republic, under *Tilia* and *Quercus*, 21 Aug. 2006 (PRM 944131). Photo M. Kříž.

Fig. 22. *Butyriboletus fechtneri*, stipe reticulum, Mramor hill, Liteň, Bohemian Karst, Czech Republic, under *Quercus* and *Carpinus*, 9 Aug. 2014 (PRM 944167). Photo V. Janda.

Fig. 23. *Butyriboletus fechtneri*, stipe reticulum, Na Voskopě Nature Reserve, Suchomasty, Bohemian Karst, Czech Republic, under *Quercus*, *Carpinus* and *Tilia*, 22 Aug. 2013 (PRM 923470). Photo V. Janda.

Fig. 24. *Butyriboletus fechtneri*, Kněžičky National Nature Reserve, Kněžičky, Czech Republic, under *Quercus*, 19 June 2010 (PRM 923469). Photo V. Janda.

det. A. Šprinc, MK, O. Jindřich et al. (PRM 946206). – Nezabudice (Central Bohemia, Plaská pahorkatina hills), forest road, under *Quercus*, *Fagus* and *Pinus*, 7 June 2006, leg. J. Anýž, det. VJ & V. Bazika (PRM 944098). – Křivoklát (Central Bohemia, Křivoklátská vrchovina upland), under *Quercus*, 28 May 2009, leg. Z. Šafář & Slomčík, det. VJ (PRM 944103). – Loděnice (Central Bohemia, Křivoklátská vrchovina upland), Kolo hill, under *Quercus*, 24 Aug. 2002, leg. anonymous, det. VJ & P. Šťastný (PRM 944093). – Měňany (Central Bohemia, Hořovická pahorkatina hills), Bohemian Karst, between the villages of Měňany and Korno, under *Quercus*, 14 May 2009, leg. & det. T. Wagner, VJ, JŠ & TP (PRM 944101); ibid., 26 July 2011, leg. & det. MK (herb. JŠ); ibid., 23 Sept. 2012, leg. & det. TP, LO & VJ (PRM 944110, PRM 944111); ibid., 2 Aug. 2014, leg. & det. VJ & LO (PRM 944112, PRM 944113); ibid., 12 June 2016, leg. & det. TP, LO & VJ (PRM 944117). – Liteň (Central Bohemia, Hořovická pahorkatina hills), Bohemian Karst, Mramor hill, under *Quercus* and *Carpinus*, 18 Aug. 2011, leg. LO, det. LO & VJ (PRM 944108); ibid., 23 Sept. 2012, leg. & det. VJ, LO & TP (PRM 923465, PRM 944109); ibid., 9 Aug. 2014, leg. VJ & LO, det. VJ (PRM 944114, PRM 944115); ibid., 16 Sept. 2014, leg. & det. VJ (PRM 924810); ibid., 19 Sept. 2014, leg. & det. VJ (PRM 924838). – Karlík (Central Bohemia, Pražská plošina plateau), Bohemian Karst, Karlické údolí Nature Reserve, under *Quercus*, 9 Sept. 2005, leg. anonymous, det. VJ (PRM 944096). – Karlík (Central Bohemia, Pražská plošina plateau), Bohemian Karst, Krásná stráň Nature Monument, under *Quercus*, 21 May 2006, leg. & det. T. Wagner (PRM 944097); ibid., 14 May 2009, leg. & det. T. Wagner, VJ, JŠ & TP (PRM 944100). – Praha-Točná (Central Bohemia, Pražská plošina plateau), Šance Nature Reserve, under *Quercus* and *Tilia*, 10 Sept. 2010, leg. LO, det. LO & VJ (PRM 923466); ibid., 13 Aug. 2014, leg. LO, det. LO & VJ (PRM 944116); ibid., 12 June 2016, leg. TP, LO & VJ, det. VJ (PRM 946297 – topotype); ibid., 16 Aug. 2016, leg. LO, det. LO & VJ (PRM 944091). – Slapy (Central Bohemia, Benešovská pahorkatina hills), under *Quercus*, *Fagus* and *Pinus*, 27 May 2009, leg. & det. Z. Šafář & VJ (PRM 944102). – Nouzov near Dymokury (Central Bohemia, Středolabská tabule lowland), southern bank of Komárovský Pond, under *Quercus* and *Tilia*, 12 June 2009, leg. JR, det. VJ & JR (PRM 944104); ibid., 17 June 2009, leg. & det. JR (PRM 944105); ibid., 21 Aug. 2010, leg. & det. VJ & JR (PRM 923467); ibid., 9 Aug. 2016, leg. & det. JR & TP (PRM 944092). – Pěčice (Central Bohemia, Jizerská tabule lowland), on dike of Malopěčický Pond, under *Quercus*, 21 July 2011, leg. & det. TP (PRM 944106). – Žďár near Mnichovo Hradiště (Central Bohemia, Jičínská pahorkatina hills), on dike of Hájenský (Zezulák) Pond, under *Quercus* and *Alnus*, 19 July 2003, leg. & det. O. Jindřich & J. Sedláček (PRM 944094); ibid., 31 Aug. 2005, leg. & det. MK (PRM 944095). – Moravia. Opatov, Třebíč District (Vysočina Region, Křižanovská vrchovina upland), on dike of Zlatomlýn Pond, under *Quercus*, 16 June 2016, leg. & det. MK & LO (PRM 945556). – Jinačovice (South Moravia, Bobravská vrchovina upland), Sychrov hill, under *Quercus*, 25 Aug. 2006, leg. L. Straka et al., det. L. Straka, MK & VJ (PRM 944099).

Slovakia. Ladzany (Central Slovakia, Štiavnické vrchy Mts.), Háj hill, under *Quercus*, 6 Sept. 2015, leg. & det. MK, P. Špinar, J. Hlásek & L. Hagara (PRM 934528).

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Czech Republic. Bohemia. Suchomasty (Central Bohemia, Hořovická pahorkatina hills), Bohemian Karst, Na Voskopě Nature Reserve, under *Quercus*, *Carpinus* and *Fagus*, 30 July 2005, leg. VJ & B. Bušek, det. VJ (PRM 944126, PRM 944127, PRM 944128, PRM 944129, PRM 944130 – photo in Šutara et al. 2009, p. 131, upper fig.); ibid., 8 June 2007, leg. & det. VJ (PRM 944136); ibid., under *Quercus* and *Carpinus*, 12 July 2009, leg. P. Janda & VJ, det. VJ (PRM 944148); ibid., under *Quercus*, 22 Aug. 2013, leg. VJ & LO, det. VJ (PRM 923470, PRM 944162); ibid., under *Quercus* and *Fagus*, 14 Sept. 2013, leg. VJ & LO, det. VJ (PRM 924181, PRM 924183); ibid., 2 Aug. 2014, leg. LO & VJ, det. VJ (PRM 944163); ibid., under *Populus*, *Pinus* and *Quercus*, 17 Aug. 2014, leg. LO, TP & VJ, det. VJ (PRM 924804). – Liteň (Central Bohemia, Hořovická pahorkatina hills), Bohemian Karst, Mramor hill, under *Quercus* and *Carpinus*, 18 Aug. 2011, leg. LO, det. VJ (PRM 944161); ibid., 9 Aug. 2014, leg. VJ & LO, det. VJ (PRM 944167). – Srbsko, Beroun District (Central Bohemia, Hořovická pahorkatina hills), Bohemian Karst, Karlštejn National Nature Reserve, north-western slope of Boubová hill, under *Quercus* and *Carpinus*, 12 July 2001, leg. VJ, A. Vít & H. Hamerská, det. VJ (PRM 944118); ibid., under

Quercus, *Carpinus* and *Tilia*, 5 Aug. 2001, leg. & det. VJ (PRM 944121); ibid., 5 Aug. 2007, leg. & det. VJ (PRM 944142); ibid., under *Quercus*, *Carpinus*, *Fagus* and *Tilia*, 2 Sept. 2007, leg. VJ & TP, det. VJ (PRM 944139, PRM 944140); ibid., 8 Aug. 2010, leg. & det. VJ (PRM 923468 – epitype); ibid., 6 Aug. 2014, leg. VJ & LO, det. VJ (PRM 944164, PRM 944165, PRM 944166, PRM 946296). – Karlštejn (Central Bohemia, Hořovická pahorkatina hills), Bohemian Karst, Karlštejn National Nature Reserve, area of Dřínová hora hill, under *Quercus*, *Carpinus* and *Fagus*, 21 July 2001, leg. & det. VJ (PRM 944119); ibid., 16 July 2005, leg. & det. VJ (PRM 944122); ibid., under *Quercus* and *Fagus*, 23 July 2005, leg. & det. VJ (PRM 944123); ibid., under *Quercus*, *Carpinus* and *Fagus*, 30 July 2005, leg. VJ & B. Bušek, det. VJ (PRM 944125); ibid., under *Quercus* and *Fagus*, 26 Aug. 2007, leg. & det. VJ (PRM 944138); ibid., under *Quercus*, *Fagus* and *Tilia*, 8 Aug. 2010, leg. & det. VJ (PRM 944153); ibid., under *Quercus*, *Carpinus* and *Tilia*, 11 Aug. 2010, leg. & det. TP & VJ (PRM 944155). – Karlštejn (Central Bohemia, Hořovická pahorkatina hills), Bohemian Karst, Karlštejn National Nature Reserve, western slope of Haknovec hill, under *Quercus* and *Fagus*, 3 Sept. 2007, leg. & det. VJ (PRM 944141). – Roblín (Central Bohemia, Pražská plošina plateau), Bohemian Karst, Karlické údolí valley, 1921, leg. F. Fechtner, det. J. Velenovský (PRC 3981 – lectotype); ibid., under *Quercus*, *Acer* and *Fagus*, 19 Aug. 2006, leg. & det. MK, J. Burel & O. Jindřich (PRM 945577). – Praha - Velká Chuchle (Central Bohemia, Pražská plošina plateau), Homolka Nature Reserve, under *Quercus*, 11 Aug. 2011, leg. TP & LO, det. TP, LO & VJ (PRM 944160). – Semice (Central Bohemia, Středolabská tabule lowland), Semická hůra hill, under *Quercus*, *Carpinus* and *Crataegus*, 4 Aug. 2001, leg. J. Burel, det. VJ & J. Burel (PRM 944120); ibid., under *Quercus*, 24 July 2005, leg. Báča, det. VJ (PRM 944124). – Nepřevázka (Central Bohemia, Jičínská pahorkatina hills), western part of Chlum Nature Park, under *Quercus*, 16 July 2016, leg. & det. LO & VJ (PRM 944080). – Mcely (Central Bohemia, Jizerská tabule lowland), Čtvrtě National Nature Reserve, under *Tilia* and *Quercus*, 21 Aug. 2006, leg. & det. MK (PRM 944131); ibid., 24 June 2009, leg. JR, det. JR & VJ (PRM 944150). – Svídnice near Dymokury (Central Bohemia, Středolabská tabule lowland), site named Lichovky, under *Quercus*, *Carpinus* and *Tilia*, 11 Aug. 2010, leg. JR, det. VJ (PRM 944154). – Břístev (Central Bohemia, Středolabská tabule lowland), northern bank of Komárovský Pond, under *Quercus*, 22 June 2007, leg. VJ & JR, det. VJ (PRM 944137); ibid., 26 July 2013, leg. & det. JR (PRM 924191). – Nouzov near Dymokury (Central Bohemia, Středolabská tabule lowland), southern bank of Komárovský Pond, under *Quercus*, *Tilia* and *Carpinus*, 25 June 2007, leg. & det. MK (PRM 934045); ibid., under *Quercus* and *Tilia*, 27 June 2008, leg. JR & Z. Kučera, det. VJ (PRM 944143); ibid., 10 July 2008, leg. JR, VJ & JŠ, det. VJ & JŠ (PRM 944144); ibid., 14 July 2008, leg. JR & VJ, det. VJ (PRM 944145); ibid., under *Quercus*, *Tilia* and *Carpinus*, 27 June 2009, leg. & det. JR & VJ (PRM 944147); ibid., under *Quercus*, *Tilia* and *Betula*, 12 Aug. 2010, leg. JR & VJ, det. VJ (PRM 944156); ibid., 20 Aug. 2010, leg. & det. JR (PRM 944159); ibid., under *Quercus* and *Tilia*, 6 Aug. 2013, leg. & det. JR (PRM 924194); ibid., under *Quercus* and *Carpinus*, 5 Sept. 2015, leg. VJ & TP, det. VJ (PRM 944168). – Dymokury (Central Bohemia, Středolabská tabule lowland), deciduous forest on bank of Pustý Pond, under *Quercus*, *Tilia* and *Corylus*, 16 July 2008, leg. JR, Z. Kučera & VJ, det. VJ (PRM 944146); ibid., under *Quercus* and *Corylus*, 24 Aug. 2013, leg. JR, det. VJ (PRM 924119); ibid., under *Quercus*, 25 Sept. 2013, leg. LO & JŠ, det. VJ & JŠ (herb. JŠ 6206–6207); ibid., under *Corylus*, *Fraxinus*, *Picea* and *Quercus*, 16 July 2014, leg. & det. MK & P. Mikuš (PRM 924320); ibid., under *Quercus*, *Corylus* and *Picea*, 29 July 2016, leg. VJ, JR & LO, det VJ (PRM 944170). – Záhornice (Central Bohemia, Středolabská tabule lowland), northern bank of Jakubský Pond, under *Quercus* and *Corylus*, 28 July 2013, leg. & det. MK & P. Mikuš (PRM 922664). – Kněžičky (Central Bohemia, Středolabská tabule lowland), Kněžičky Game Preserve, Kněžičky National Nature Reserve, under *Quercus* and *Crataegus*, 17 June 2010, leg. JR, det. VJ (PRM 944151); ibid., 19 June 2010, leg. JR, det. VJ (PRM 923469); ibid., 26 June 2010, leg. VJ & JR, det. VJ (PRM 944152); ibid., 14 Aug. 2010, leg. VJ & JR, det. VJ (PRM 944157, PRM 944158); ibid., under *Quercus*, 20 Aug. 2011, leg. & det. VJ (herb. JŠ 5837). – Choťovice (Central Bohemia, Východolabská tabule lowland), Bažantnice forest NE of the village of Dománovice, under *Quercus*, *Carpinus* and *Betula*, 28 July 2013, leg. MK & P. Mikuš, det. MK (PRM 922665); ibid., under *Quercus*, *Populus tremula*, *Carpinus*, *Corylus*, *Acer campestre* and *Betula*, 12 Aug. 2014, leg. & det. J. Holec & MK (PRM 932932). – Dětenice (East Bohemia, Středolabská

tabule lowland), U rybníčka forest, under *Quercus* and *Carpinus*, 12 Sept. 2015, leg. VJ & LO, det. VJ (PRM 944169). – Újezd pod Troskami (East Bohemia, Jičínská pahorkatina hills), under *Tilia*, *Populus* and *Betula*, 28 Aug. 2006, leg. D. Friedlanderová, det. P. Šťastný & VJ (PRM 944133); ibid., 2 Sept. 2006, leg. D. Friedlanderová & VJ, det. VJ (PRM 944135); ibid., under *Tilia*, *Populus*, *Quercus* and *Betula*, 29 July 2009, leg. & det. VJ (PRM 944149). – Choceň (East Bohemia, Orlická tabule lowland), Homole hill, under *Tilia*, *Carpinus* and *Quercus*, 5 July 2012, leg. & det. M. Mička, P. Brůžek, MK & O. Jindřich (PRM 860499 – photo in Kříž 2018, p. 15). – Moravia. Kněždub (South Moravia, Bílé Karpaty Mts.), SE of the village, former orchard, under *Tilia*, 28 Aug. 2006, leg. V. Chudíček, det. P. Šťastný & VJ (PRM 944132); ibid., 31 Aug. 2006, leg. V. Chudíček, det. VJ (PRM 944134).

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