

## ***Tricholoma borgsjoeëense* found in the Czech Republic and *Tricholoma luridum* documented in Slovakia**

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For the first time, the rare species *Tricholoma borgsjoeëense* and *T. luridum* are reported from the Czech Republic and Slovakia, respectively. *Tricholoma borgsjoeëense*, a species of the *T. terreum* group, is unique for its thick, distant and grey lamellae with a lilaceous tinge, dark grey pileus with a tomentose-squamulose surface, yellowing stipe base, and unusually large basidiospores and basidia. It was found in a man-made forest composed of *Picea abies* with admixed *Pinus sylvestris*. *Tricholoma luridum*, recognisable by its olive yellow-green tinges on the pileus, distinctly grey lamellae, uniformly ellipsoid, unusually large spores, and 4-spored basidia, was found in a *Picea abies*–*Corylus avellana* forest on calcareous soil. It is compared with *T. guldeniae*, its North European sibling. Notes on taxonomy, ecology and distribution of both species are added.

**Key words:** Fungi, *Agaricales*, taxonomy, ecology, distribution.

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V článku jsou publikovány nálezy dvou vzácných druhů čirůvek: *Tricholoma borgsjoeëense* z České republiky a *T. luridum* ze Slovenska. *Tricholoma borgsjoeëense*, patříci do okruhu kolem *T. terreum*, je nápadná řídkými a šedými lupeny s nafialovělým nádechem, tmavě šedým kloboukem s šupinkatě vláknitým povrchem, žloutnoucí bází třeně a především neobvykle velkými výtrusy a bazidii. Byla nalezena v kulturní smrčíně s příměsí borovice. *Tricholoma luridum* je poznatelná podle olivově žlutozeleného klobouku, nápadně šedých lupenů, konstantně elipsoidních, neobvykle velkých výtrusů a čtyřvýtrusých bazidií. Rostla v lese tvořeném smrkem a lískou na vápnitém podloží. Je srovnávána se svým severoevropským dvojníkem *T. guldeniae*. U obou druhů je diskutována taxonomie, ekologie a rozšíření.

### INTRODUCTION

During field research, the authors found the rare species *Tricholoma borgsjoeëense* Jacobsson et Muskos in the Czech Republic in 2011 and *T. luridum* (Schaeff.: Fr.) P. Kumm. in Slovakia in 2012. Both of them had not been published from these countries and there are no voucher specimens of them in the main Czech and Slovak mycological herbaria (PRM, BRNM, CB, BRNU, BRA). Consequently, descriptions, localities and habitats of both species are published with notes on their taxonomy, ecology and distribution in Europe.

## MATERIALS AND METHODS

The descriptions of macrocharacters are based on fresh collections. Colour codes refer to Kornerup & Wanscher (1981). Microcharacters were studied on dried material. Microscopic mounts were made in a 5% KOH solution and studied under an Olympus BH-2 light microscope. Spore sizes of 20 spores measured (extremely large spores were omitted) are presented in the form of the main range (c. 10–90 percentile values), complemented with extreme values in parentheses. The spores were measured directly under the microscope using an eyepiece micrometer. Illustrations of microcharacters were drawn at a magnification of 1250 $\times$  using a drawing tube. Voucher specimens are deposited in the Mycological Department, National Museum, Prague (herbarium PRM). For herbarium acronyms, see Thiers (2012). Data on geological conditions of the Czech locality were taken from maps and descriptions at [www.geologicke-mapy.cz](http://www.geologicke-mapy.cz), of the Slovak locality at [mapserver.geology.sk](http://mapserver.geology.sk). Coordinates were not measured in the field but taken from maps at [www.mapy.cz](http://www.mapy.cz).

Abbreviations. a.s.l. – altitude (metres above sea level), L – number of lamellae reaching up to the stipe, l – number of lamellulae between each pair of lamellae, Q – quotient of length and width of the spores, Q<sub>av</sub> – mean value of Q of the 20 spores studied.

## RESULTS

***Tricholoma borgsjoeëns*** Jacobsson et Muskos

Figs. 1, 2

*Tricholoma borgsjoeëns* Jacobsson et Muskos in Jacobsson, Muskos & Larsson, Mycotaxon 95: 197, 2006.

**Macrocharacters.** The description is based on one younger basidioma collected in a period of dry weather. Pileus 35 mm, broadly convex-conical, dry, mat, covered with densely arranged, fine, adpressed to slightly upraised fibrillose squamules with silvery grey apices on a dark grey (1F1) to blackish grey background. Lamellae distant, L = 30, l = 1–3, 3–5 mm high, emarginate, individual lamellae considerably differing in height, edge even, colour greyish with a slight lilaceous buff tinge (the exact colour is missing from Kornerup & Wanscher 1981). Stipe 60  $\times$  8–10 mm, cylindrical, slightly broadened towards base, mat, fibrillose-tomentose to slightly squamulose in upper part, greyish to grey (1B–C1), paler towards base, at the very base with white tomentum and becoming yellowish, especially after drying. Context solid, colour not recorded. Smell and taste mild, farinaceous.

**Microcharacters.** Basidiospores (7.5)8.0–9.8  $\times$  (5.5)5.8–6.8(7)  $\mu\text{m}$ , Q = 1.30–1.54, Q<sub>av</sub> = 1.42, ellipsoid to broadly ellipsoid with small but distinct hilar ap-

pendix, thin-walled, hyaline. Basidia 40–48 × 10–11 µm, narrowly clavate, 4-spored. Basidiolae up to 44 × 6–10 µm. Cystidia absent. Hyphidia present both on edge and lamellae surface. Lamellar trama regular, consisting of thin-walled to slightly thick-walled, up to 8 µm broad hyphae. Pileipellis a transition between cutis and trichoderm, consisting of short cylindrical cells 8–12 µm broad, with brown membranous pigment, below with a layer of cylindrical to inflated cells, sometimes appearing subcellular, with strongly brown-pigmented wall, inflated cells up to 30 × 15 µm, other cells up to 110 × 25 µm. Clamp connections absent.

Collection studied. Czech Republic, Bohemia, Českomoravská vrchovina (Bohemian-Moravian Highlands), W of Pelhřimov, 1.7 km WSW of the village of Chmelná, 49°23'36.010" N, 15°5'24.653" E (accuracy about 50 m), alt. 600 m, gentle W slopes facing the valley of the Brúdek stream, 2 Oct 2011, leg. M. Kříž et J. Burel, det. M. Kříž (PRM 860663).

Habitat. The geological bedrock is paragneiss, which is an acidic rock. The vegetation cover is formed by man-made forest composed of *Picea abies* with admixed *Pinus sylvestris*. The fungus was found among mosses and fallen needles at the margin of a full-grown stand, neighbouring with a young stand of about 5 m high trees.

Notes. Unfortunately, only one basidioma was found. It was unique by its dark pileus and sparse lamellae with a lilaceous tinge. A detailed study showed that the collection possesses the key distinguishing characters of *T. borgsjoeëns* (Jacobsson et al. 2006, Christensen & Heilmann-Clausen 2012): thick, distant and grey lamellae with a lilaceous tinge, a dark grey pileus with a tomentose-squamulose surface, a yellowing stipe base, and unusually large basidiospores and basidia. In the Czech collection the basidiospore size was even larger than in the Nordic ones (Tab. 1). On the other hand, the rooting stipe base mentioned by the Nordic authors was not observed.

The size of the basidiospores (larger than 7 µm and broader than 5 µm) clearly distinguish *T. borgsjoeëns* from the similar species *T. terreum* and *T. orirubens*, the spores of which are distinctly smaller (Tab. 1). Moreover, they differ in several other characters – e.g. a paler stipe and more crowded lamellae in *T. terreum* and reddening parts of basidiomata when old and growth under deciduous trees in *T. orirubens*.

The Nordic authors stress the occurrence of *T. borgsjoeëns* in old-growth *Picea* forests (in other words: „boreal forests of virgin character“, Jacobsson et al. 2006: 199). On the contrary, the Czech locality is a cultural forest, extensively managed by farmers from the neighbouring villages. Fallen trees and logs are removed and the whole forest area is intertwined by a net of narrow non-asphalted forest roads and paths. On the other hand, the local habitat conditions seem to be extremely favourable for rare to endangered mycorrhizal fungi, such as representatives of the hydroid genera *Sarcodon*, *Bankera*, *Hydnellum*, and *Phellodon* (more than 15 species altogether, which makes it the richest locality of hydroid

fungi in the Czech Republic) and species like *Boletopsis grisea*, *Cortinarius cumatilis*, *Tricholoma fucatum*, *T. apium* etc. (Burel 2010). Such a cumulation of rarities is hard to explain, however, the southern regions of Bohemia along the border with Austria are well-known for their unpolluted environment, a factor suitable for sensitive representatives of ectomycorrhizal fungi.

Jacobsson et al. (2006) write that *T. borgsjoeëense* grows „on rather moist and mossy ground with nutrient-rich soil“. The Czech locality is different. Its soil is oligotrophic and of an average moisture.

**Distribution.** Until recently, *T. borgsjoeëense* had only been known from Sweden, Norway and Finland (Jacobsson et al. 2006, Christensen & Heilmann-Clausen 2012). The Czech find seems to be the first one outside Scandinavia. In Central Europe, *T. borgsjoeëense* is either extremely rare or not distinguished from *T. terreum*.

In conclusion, *Tricholoma terreum*-like *Tricholomas* growing under *Picea* and having a dark grey pileus and sparse lamellae should be carefully studied, as they could represent *T. borgsjoeëense*. The unusually large spores, tomentose-squamulose pileus surface and yellowing stipe base are further distinguishing characters.

**Tab. 1.** Basidiospore size of *T. borgsjoeëense* and similar species.

species	data source	length (µm)	width (µm)
<i>T. borgsjoeëense</i>	Jacobsson et al. (2006)	(7)7.5–9.0	5–6
	Christensen & Heilmann-Clausen (2012)	7.5–9(9.5)	5–6(6.5)
	this paper	(7.5)8.0–9.8	(5.5)5.8–6.8(7)
<i>T. terreum</i>	Christensen & Heilmann-Clausen (2012)	(4.5)5–7.5(8)	3–5(5.5)
<i>T. orirubens</i>	Christensen & Heilmann-Clausen (2012)	4–6(7)	3–4.5(5)

***Tricholoma luridum*** (Schaeff.: Fr.) P. Kumm.

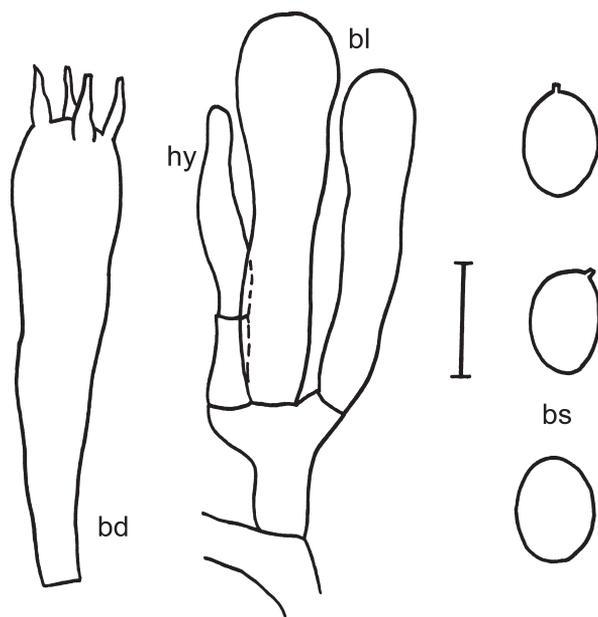
Figs. 3, 4

Basionym. *Agaricus luridus* Schaeff., Fung. Bavar. Palat. 4: 30, 1774.

**Macrocharacters.** Basidiomata growing in groups. Pileus 40–80 mm, plano-convex with appanate centre, margin inflexed and lobed, surface mat, smooth, finely innately fibrillose, olive yellow-green (1B–D7–8) to dark olive (1E–F8) with dark brown centre (4F8) and indistinct brown spots (5E8), silver grey (1B–C1) pruinose-fibrillose at centre and margin. Lamellae moderately crowded, L = 70–90, l = 1–3, 4–7 mm high, emarginate with a decurrent tooth, at first whitish with lemon yellow tinge, then distinctly grey (1B1), finally with a slight lilaceous tinge (15B2), edge unevenly flexuose. Stipe 50–100 × 8–13 mm, cylindrical or slightly thickened at base, mat, finely pruinose at apex and fibrillose-tomentose downwards, whitish with greyish and lemon tinges when young, then pale greyish-greenish (30B3). Context solid, colour not recorded. Smell and taste mild, farinaceous.



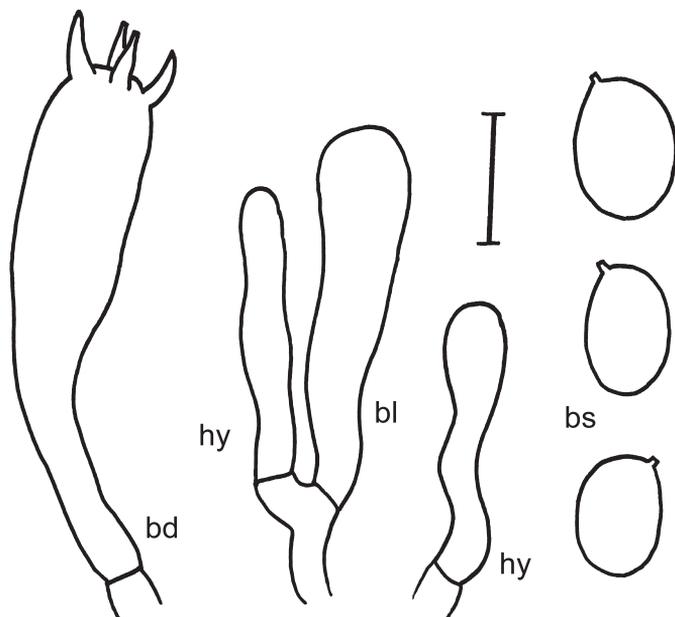
**Fig. 1.** *Tricholoma borgsjoeëense*, Czech Republic, 1.7 km WSW of the village of Chmelná (PRM 860663). Photo by M. Kríž.



**Fig. 2.** *Tricholoma borgsjoeëense*, Czech Republic, 1.7 km WSW of the village of Chmelná (PRM 860663). Line drawings of microcharacters. **bd** – basidium, **bl** – basidiolae, **bs** – basidiospores, **hy** – hyphidium. Scale bar = 10 µm. Del. J. Holec.



**Fig. 3.** *Tricholoma luridum*, Slovakia, Hybica stream valley (PRM 860639). Photo by J. Holec.



**Fig. 4.** *Tricholoma luridum*, Slovakia, Hybica stream valley (PRM 860639). Line drawings of microcharacters. **bd** – basidium, **bl** – basidiole, **bs** – basidiospores, **hy** – hyphidia. Scale bar = 10  $\mu$ m. Del. J. Holec.

**Microcharacters.** Basidiospores  $8.8\text{--}10.4 \times (6.0)6.4\text{--}6.8 \mu\text{m}$ ,  $Q = 1.29\text{--}1.63$ ,  $Q_{\text{av}} = 1.42$ , ellipsoid with a small but distinct hilar appendix, thin-walled, hyaline, mostly containing one large droplet. Basidia  $40\text{--}50 \times 8\text{--}10 \mu\text{m}$ , clavate, 4-spored. Basidiolae  $32\text{--}40 \times 8\text{--}9.5 \mu\text{m}$ , narrowly clavate. True cystidia absent. Hyphidia present both on edge and lamellae surface,  $22\text{--}38 \times 3\text{--}6 \mu\text{m}$ , distinctly smaller than basidia and basidiolae, cylindrical to narrowly clavate, often flexuose. Lamellar trama regular, of densely arranged parallel hyphae  $3\text{--}8 \mu\text{m}$  broad, cells cylindrical. Pileipellis a cutis of hyphae  $3\text{--}6 \mu\text{m}$  broad, cells cylindrical, with brown membranal pigment and incrustations. Clamp connections absent.

**Collection studied.** Slovakia, Podtatranská kotlina basin (subunit Liptovská kotlina), Hybianska pahorkatina highlands, c. 3 km N of the village of Východná, alt. 800 m,  $49^{\circ}5'17.560''$  N,  $19^{\circ}53'49.196''$  E (accuracy about 50 m), Hybica stream valley, 18 Aug. 2012, leg. et det. J. Holec, JH 31/2012 (PRM 860639).

**Habitat.** The geological bedrock is built by Palaeogene organodetritic limestones, at places protruding as stones and small rocks. The fungus was found at the south margin of the Hybická tiesňava Nature Reserve, comprising a canyon-like valley which is unique in the gently rolling landscape of the surrounding highlands. The vegetation is a sparse forest stand of *Picea abies* and *Corylus avellana* with admixed *Salix caprea*. There are large pastures in the vicinity. The occasional presence of *Juniperus communis* in the forest stand shows that the slopes of the valley were formerly used as pastures.

**Notes.** The basidiomata perfectly fit the photographs of *T. luridum* by Galli (1999). They agree also well with the original illustration by Schaeffer (1762: tab. 69). These publications show *T. luridum* as a fungus with a grey-green pileus and distinctly grey lamellae. Another important character is the spore size, which is much larger ( $8\text{--}11 \times 5\text{--}7 \mu\text{m}$ , Tab. 2) than in other *Tricholomas* with greenish tinges on the pileus surface. Species like *T. sejunctum*, *T. viridilutescens* or *T. fucatum* have spores shorter than  $8(8.5) \mu\text{m}$ . Other good photographs and/or descriptions of *T. luridum* have been published by Breitenbach & Kränzlin (1991: fig. 424), Riva (1998: tab. 5), Moser & Jülich (Farbatlas der Basidiomyceten: 3 *Tricholoma* 26) and Cooke (Cooke 1881–1891: tab. 214). The illustration by Dermek (in Riva 1988: tab. 44) shows a fungus with a brown pileus. In our opinion, this illustration does not represent *T. luridum*.

According to Christensen & Heilmann-Clausen (2009, 2012), the Nordic interpretation of *T. luridum* (Gulden 1969, 1992) does not represent the original *T. luridum* but a separate species *T. guldeniae* Mort. Chr. Its key characters are the following: pileus with grey-brown or greyish yellow fibrils or squamules on a pale yellowish or whitish ground (without greenish tinges), lamellae whitish or with a slight greyish or yellowish tinge (not distinctly grey), spores on average  $7.4\text{--}9.3 \times 5.9\text{--}7.4 \mu\text{m}$ , very heterogeneous in size and shape, some large and subglobose, others ellipsoid, with  $Q = 1.0\text{--}1.6$  (in *T. luridum*, they are uniformly

ellipsoid and on average larger), basidia 1-, 2-, 3- or 4-spored (4-spored in *T. luridum*). So far, *T. guldeniae* has been reported from Norway, Sweden, Finland and Scotland (Christensen & Heilmann-Clausen 2009, 2012). It grows mostly in *Picea* forests, preferably on calcareous soils, but also in more acidic habitats and in forests with deciduous trees and other conifers (*Pinus*).

**Distribution.** There are no published data nor herbarium specimens from the Czech Republic. Five collections labelled *T. luridum* are kept in PRM, but their revision showed that they represent other species. In Slovakia, the species is not included in check-lists (Marhold & Hindák 2012, Šklubla 2003) nor present in the BRA herbarium. A photograph not documented by voucher specimen was published by Roučka (2006: Horná Mariková, distr. Považská Bystrica, Javorníky Mts.) The record published here is the first well-documented find from Slovakia.

*Tricholoma luridum* is rare to scattered in Europe. It is considered rare in Germany (e.g. Krieglsteiner 2001, Besl & Bresinski 2009), the Netherlands (Noordeloos et Christensen 1999), near-threatened in Croatia (Tkalčec et al. 2008), and extinct in Poland (Wojewoda 2003). There are 12 records in the database of Austrian fungi (Austrian Mycological Society 2009), which suggests that it is not so rare in that part of Europe. The records are distributed at altitudes of about 300–1200 (1700–1800) m a.s.l. It is also known from e.g. Slovenia (Jurc et al. 2005), Italy (e.g. Galli 1999; Riva 1988, 1998), France (e.g. Roux 2006), Switzerland (Breitenbach & Kränzlin 1991), and Great Britain (Cooke 1881–1891, Legon & Henrici 2005). It is not reported from Scandinavia. In most publications *T. luridum* is characterised as a species preferring forests with *Picea abies* on calcareous soils. Such habitats are rare in the Czech Republic and this is probably the reason why it is not known here. In Slovakia, coniferous forests on calcareous bedrock are more common and *T. luridum* is probably overlooked (compare its numerous records in the neighbouring Austria).

**Tab. 2.** Basidiospore size of *T. luridum*.

data source	length (µm)	width (µm)
Riva (1988)	8.5–10(10.5)	5.5–7
Bon (1995)	(8)9–10(11)	5.5–6.5(7)
Noordeloos & Christensen (1999)	8–10(11)	5–7
Christensen & Heilmann-Clausen (2009)	8–10	5–7
this paper	8.8–10.4	(6.0)6.4–6.8

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