

## A world-wide key to the genus *Boletinus* Ein Weltschlüssel der Gattung *Boletinus*

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**Abstract:** In the present concept of the order *Boletales* the genus *Boletinus* is integrated, together with some other genera, in the family *Suillaceae*, one of the families in suborder *Suillineae*. The genus is included by some authors into *Suillus*, but can be separated based on anatomical characters and results of molecular studies. A world-wide key of the genus is given and the new combination *Boletinus sinuspaulianus* is proposed.

**Zusammenfassung:** Im gegenwärtigen Konzept der Ordnung *Boletales* ist die Gattung *Boletinus*, zusammen mit einigen anderen Gattungen, in die Familie *Suillaceae* integriert, eine der Familien der Unterordnung *Suillineae*. Die Gattung wird von einigen Autoren unter *Suillus* eingeordnet, kann aber basierend auf anatomischen Merkmalen und Erkenntnissen molekularbiologischer Studien abgetrennt werden. Ein weltweiter Schlüssel wird gegeben und die neue Kombination *Boletinus sinuspaulianus* wird vorgeschlagen.

For a comprehensive synopsis of families in *Suillineae* we refer to BESL & BRESINSKY (1997) and for a key to the genera of *Suillaceae* to KLOFAC (2013).

### 1. Synonym of *Boletinus*

*Erytroporus* QUÉL. 1886, Enchir. fung. (Paris): 163

### 2. The genus *Boletinus* KALCHBR., history and delimitation

#### a) Original diagnosis:

**Diagn. orig.** KALCHBRENNER (1867),

a) in Mohls Bot. Zeit. 25: 181 (as cited in literature): Stiel central, elastisch, zähe, anfangs voll, dann hohl, fast gleichdick oder aufwärts verdünnt, 2–3" lang, 3–4" dick, an der etwas verbreiterten Basis wurzelartig beanhängsel, schuppig -faserig, löwengelb. Schleier häutig, weisslich, nach dem Zerreissen, theils dem Hutrande, theils dem Stiel - als Ring - anhängend. Hut plan-convex, oder niedergedrückt, fleischig, zähe, 1 1/2–3" breit, trocken, löwengelb, mit dunkleren faserigen Schuppen im Centrum dicht, gegen den Rand zu sparsamer bekleidet. Poren lager etwas dunkler als der Hut olivengrün -

bräunlich aus ungleichen zusammengesetzten Zellen bestehend, welche durch fast strahlig verlaufende, vielfach anastomosirende Adern gebildet werden. Der verticale Durchschnitt desselben zeigt ein zeitig ausgehöhltes Hymenophorum, welches zwischen den Zellwänden unverändert herabsteigend die Trama bildet. Das Hutfleisch weich, nicht brüchig, gelblich, Geruch und Geschmack unbedeutend.

b) in KALCHBRENNER & SCHULZER (1877) in Icon. sel. Hymenomyc. Hung. IV: 52 by pointing out the obvious identical type description in „Enum. II p. 286“ [presumably: A szepesi gombák jegyzéke II. in: Mathematikai és természettudományi közlemények, 1867(5. évf.) 2. sz. 207–292]: Hymnonophorum a hymenio celluloso non discretum sed in mucrones porrectum et tramae instar inter cellulas descendens; hinc cellulae in carne pilei immutata nidulantes et nec ab hoc nec a se invicem separabiles. Fungus carnosus, putrescens, stipite centrali annulato. A Boletito ita differt, ut Trametes a Polyporo. Hucusque unam tantum speciem complectitur.

Typus: *Boletus cavipes* KLOTZSCH ex FR. ap. FR. & HÖK 1835

Synonymy: *Boletus cavipes* OPAT. 1836

≡ *Boletinus cavipes* (KLOTZSCH ex FR. 1835) KALCHBR. 1867 sec. REDEUILH 1988:39

Synonymy: *Boletinus cavipes* (OPAT. 1836) KALCHBR. 1867

For information referring to the correct author of the taxon see REDEUILH (1988) and KLOFAC & KRISAI-GREILHUBER (1994). The type species was excellently illustrated by KALCHBRENNER & SCHULZER (1877).

Formerly a much wider concept of the genus was used, including many species with boletinoid pores or fibrillose-squamulose pileus. Most taxa (sections and species) were later transferred to *Suillus*. SINGER (1938) listed four sections in *Boletinus*: sect. *Spectabiles* SINGER, sect. *Solidipedes* SINGER, sect. *Palustres* SINGER and sect. *Cavipedes* (=*Boletinus*) SINGER, with two subsections: subsect. *Rubrini* SINGER and subsect. *Alutaceini* (=*Boletinus*) SINGER. SINGER (1945) treated sections *Palustres* and *Cavipedes* in subgenus *Eu-Boletinus*, the remaining two sections in subgenus *Aporpiellus*. SINGER (1967) transferred sections *Spectabiles* and *Solidipedes* to *Suillus*. So SINGER (1977) lists only three species in his key.

According to molecular biological results by BRUNS & PALMER (1989), KRETZER & al. (1996), WU & al. (2000) and JAROSCH (2001) species of *Boletinus* could be included into *Suillus*, as practiced by them, but form a group standing on the edge of *Suillus* and can thus be interpreted equally well as a separate genus *Boletinus*, as is done by a majority of authors, e.g. GILBERT (1931), SINGER (1938, 1965, 1986), PELLER & YOUNG (1971), WATLING (1970), MOSER (1983), ENGEL & al. (1996), BESL & BRESINSKY (1997), FISCHER & al. (1997), LANNOY & ESTADES (2001), ŠUTARA (1987, 2005), MUÑOZ (2005) and KLOFAC (2007).

According to results of molecular studies (e.g. KRETZER & al. 1996) the independent status of the genus *Fuscoboletinus*, created by POMERLEAU & SMITH (1962) cannot be maintained. Already SINGER & al. (1963) came to the same conclusion *Fuscoboletinus* taxa should be allocated in *Suillus* respectively *Boletinus*.

## b) Genus characters

The genus characterization follows SINGER (1986), ŠUTARA (1987, 2005) and KLOFAC (2007). Characters of the fungi in this genus in common with members of the family

*Boletaceae* include the presence of a cylindrical stipe, fleshy pileus, soft context and tubular hymenium.

**Pileus**: surface seldom viscid, but then obscurely innately fibrillose, mostly dry and fibrillose to squamulose, the fibrils or scales are not superimposed upon a viscid (gelatinized) layer.

**Context**: white or (pale) yellow, unchanging or seldom turning slightly greenish-blue by autooxidation.

**Tubes**: short, decurrent, often difficult to remove from pileus context.

**Pores**: wide, distinctly boletinoid (formed radially).

**Stipe**: hollow or solid, usually (sub)cylindric, without glandular dots, dry, veil present, often forming an annulus.

**Spore deposit**: from olivebrown to dark purplish or vinaceous-brown.

**Spores**: smooth, elongate, fusoid-ellipsoid or subfusoid, usually pale to darker melleous, seldom exceeding a length of 12 µm.

**Hymenial cystidia**: rather large but not forming such conspicuous, coloured incrustations as in *Suillus*.

**Hymenoporal trama**: bilateral, boletoid.

**Camp connections**: present, mostly numerous, in some cases only scattered present (and then most likely at the basal septum of the basidium and in the mycelium).

**Pileus cuticle**: a trichodermium.

Studies of the most common species, *B. cavipes*, by ŠUTARA (2005) showed an infertile stipe surface, supposed for all species of *Boletinus* by him, but to be checked still at some non-European taxa.

PEGLER & YOUNG (1981) who accepted *Boletinus* as a separate genus placed it even in another family (*Gyrodontaceae*).

The genus is distributed mostly in the northern temperate hemisphere. Species in the genus are associated especially with members of the genus *Larix*, in few cases with other conifers, and are obligatory mycorrhizal.

### c) Further literature on the genus including detailed descriptions and keys

Detailed descriptions of taxa can be found in BOTH (1993), DING & WEN (2003 a, b), ENGEL & al. (1996), ESTADES & LANNOY (2004), HEIKKILÄ (1983), LANNOY & ESTADES (2001), MORON (1987), MURRILL (1910) NOVELLO & MORON (2004), PECK (1872), POMERLEAU (1964), ROBIN (2012), SNELL (1936 a), SLIPP & SNELL (1944), SNELL & DICK (1941), WELLS & KEMPTON (1968).

Keys for American species are included in *Suillus* or *Fuscoboletinus* respectively, and are integrated in a wider *Boletinus* concept (with above cited sections now incorporated in *Suillus*): SNELL (1936 b), SINGER (1945), SMITH & THIERS (1964, 1971), SMITH & al. (1981), ARORA (1986), LAMOUREUX & DESPRES (1997), BESSETTE & al. (2000), KUO (2004).

Taxa in Asia (whereby the occurrence of some of the adventitious species is doubtful) are documented by: CHEN & YEH (2000), CHEN & al. (2003), HUANG (1998), ZANG & al. (2013).

Comments on pigment-chemical studies are cited in SINGER (1986) and JAROSCH (2001).

Cultural studies of some taxa are treated in PANTIDOU (1961), PANTIDOU & GROVES (1966), morphological aspects in GENTILE & SNELL (1953), WATLING & LARENT (1977), and mycorrhizae in SAMSON & FORTIN (1988).

#### d) Main characters used for identification, determinability, edibility

The main macroscopic field characters are: pileus colour, structure and type of ornamentation, nature of the stipe (hollow or solid), veil presence, forming an annulus or not, flesh colour and its discolouring, smell and taste, mycelium colour, configuration and colour of pores and the identity of the associated host (habitat), further colour of spore deposit and macrochemical reactions. Microscopically presence and frequency of clamp connections, spore size, and differences in cystidia are useful.

Some species are reported as edible, but are not recommended or not considered to be choice.

### 3. Genera easily to be confused

These are particularly those genera, where the species mentioned have been included previously.

**a.** Species with a squamulose pileus may be confused with members of *Suillus* (many of them were included formerly in *Boletinus*!), but also species with viscid pileus (*B. sinuspaulianus*) could be confused with *Suillus* spp. with annulate stipe, especially because of the rare clamp connections or lack of mycorrhizal connection to *Larix*.

**b.** Species with a more tomentose pileus surface may be confused with ***Bothia*** (HALLING & al. 2007): “possesses a combination of macro- and microscopic features that has prompted past placement in seven different genera. ...chestnut brown, dry pileus, decurrent, pale brown hymenophore with radially elongated tubes, a short, sometimes eccentric, but exannulate stipe, yellow brown spore deposit and constant association with *Quercus*”. *Bothia castanella* (PECK) HALLING, T. J. BARONI & MANFR. BINDER was before not only combined with *Boletinus* but also with *Suillus*, *Boletinellus*, *Gyrodon*, *Xerocomus* and *Chalciporus*.

**c.** Species with hollow stipe and numerous clamp connections could be confused with members of the genus ***Gyroporus***, but in *Gyroporus* the tubes are depressed to sinuate around the stipe, hardly short, the pores are relatively small, not radially arranged, and the colour of the spore deposit is pale yellow to pale ochre.

**d.** Regarding the boletoid hymenophore, species with clamp connections could be confused with members of the genus ***Boletinellus*** (*Sclerodermatineae*, earlier linked with *Gyrodon*, see JAROSCH 2001, BINDER & HIBBETT 2006, WATLING 2008) with gyrose-tubulate hymenophore, arcuate-decurrent tubes, dry to tacky pileus and villous margin, rarely central, rather slightly eccentric solid stipe. South and North America.

#### 4. New combination in the genus *Boletinus*

***Boletinus sinuspaulianus* (POMERLEAU & A. H. SM.) KLOFAC & KRISAI, comb. nov.**

Mycobank MB 810997

Basionym: *Fuscoboletinus sinuspaulianus* POMERL. & A. H. SM., Brittonia 14(2): 157 (1962)

#### 5. The key to all known species of *Boletinus*

##### a) How to use the key:

###### Signs used:

- ° material examined by the authors (mostly in the herbarium WU)
- ? at illustrations: not clearly significant image; at distribution report: doubtful
- ! at illustrations: species shown under a different (non-synonymous) name
- \* at illustrations: there are also authentic images available online in the world wide web

###### Abbreviations:

a.	above (icon.)	m.	middle (icon.)
b.	below (icon.)	nom. illeg.	nomen illegitimum, illegitimate
(B/W)	black and white (icon.)		name
cov.	cover (icon.)	r.	right (icon.)
comb. inv.	invalid combination	spec.	species
f.	forma, form	var.	varietas, variety
l.	left (icon.)		

For list of cited illustrations see point 8.

Compare also similar members of the genus *Suillus*, (but only all those without clamp connections): see synoptic key and key of *Suillus* (KLOFAC 2013), but none of the taxa combine the following mentioned characteristics.

##### b) key (mainly made for the determination of fresh basidiomata)

- |    |                         |   |
|----|-------------------------|---|
| 1  | stipe hollow            | 2 |
| 1* | stipe solid, not hollow | 3 |

- 2 pileus purple, wine red scaly on paler ground, up to 12 cm wide, stem and ring with red colours, dry, pores medium-sized, spore print with brown tones, spores  $-12 \times 5 \mu\text{m}$ , clamp connections frequent, associated with *Larix sibirica* (*L. gmelinii*, *L. kaempferi*, *L. dahurica*); introduced from Japan, East Asia via Russia to Finland and recently France.

Selected illustrations: CD1628, Coo55/1:35, DPi15b-c, En: 7, T2/2, FFS:I, FMDS207:22, IOH300, 301al., L13?, Lae, L/E1E, M837?, MJ1b. [= BTR32 (5-6): 30], Mu8, RIV30 (3-4):183, RIV47(2): 119, 120, RM3: pl.IV/2, SIE46(4): cov., Si5/pl.II: 5-6, Tai 45/2):203 (4), TINT1/2007: 48, YS367b.?, 404?!, \*

###### ***B. asiaticus* SINGER**

- 2\* pileus variable coloured, but never purple or wine red scaly, up to 12(-20) cm wide, many variations described:

- pileus ochre yellow: ***B. cavipes f. pallidior* (BRES.) SINGER**
- pileus orange: ***B. cavipes f. aurantiacus* (KREH) SINGER**

Selected illustrations: GS3:49, La6b.?, Rou25!

- pileus russet: ***B. cavipes f. ferrugineus* BECK°**

Selected illustrations : Kb27(7-8, 16-17)?, Lx57/2?, Md202?, MHI142?, Mu6a?, VS83b.?

- pileus golden yellow to chrome yellow: ***B. cavipes f. aureus* (ROLL.) SINGER°**

Selected illustrations : BKIII3, BTR32(5-6): 28, BTR45(1): 64, BSMF IV: pl.21, CP3:1397,

Ct1140 (= CeI: 450), En: 6, T2/3r., FeA96: 698, FLSTp.64, FMDS174: 6b., GS: 51b.,

Hg57, Kr2: 207, La6m., L/E1D, LEC2, MJ1, MT23, Mu7, RIV47(2): 118, SD9a.,

Si5/pl.II: 13-16 [= Kb27 (2,13,18-19,21)], Ve133b., YS368\*

- pileus yellow-brown, golden brown, red-brown, cinnamon-rufous, dark brown, with NH<sub>4</sub>OH wine red, coarsely tomentose to fibrillose-squamulose, tubes yellow, greenish yellow, olivaceous, decurrent, pores radially, angular, radiating from the stipe, stipe coloured like the pileus or paler, with a slight white annulus, spore deposit dark olive-brown, context white to yellowish, guaiac: -, spores  $-10 \times 4$  µm, pileus hyphae  $-15(-25)$  µm wide, clamp connections frequent, near diverse *Larix*; Europe, Asia, North America.

Due to the absence of authentic type material (PALM & STEWART 1986) a neotype was selected by (KLOFAC & KRISAI-GREILHUBER 1994) from the locus classicus (Austria, Styria, Mariazell, Weichselboden near *Larix decidua* 3. Oktober 1992, leg. KLOFAC, WU 11150).

Selected illustrations: AM71, Ar182, Ba172a., BBF369bl., BKIII3, BL33, BM8,9, (B/W), Br943!, BRB334a., BTR32(5-6): 26,27, CC252,253, CD1626, CeI: 448, CO871, CPS353, CQ, Ct300, Dh25, DPi14, En: 5, T2/3, ER59b., FeA96: 697, FBT183, FMDS 147: 33a., GII33, Ga21: 4, GG219a., Gh481b., GH50(B/W), Gli: 35, GS: 51a. = GR: 39, Hg56, HKI142, IOH226, IH 299a., Kalch: t.31, Ki35a., Kib52, KM420, Kr2: 207, L15?, La6a., Læ, LEC2, McK10br. (B/W), Mi288, MiM360r., MS17, MT22, Mu6b-d, PA782, PC76a., ph207bl., PH246rb., PU20, RIV47(2): 117, Ro269A, Rou24, RT199(1), SB29m., SCI57, Si5/pl.II: 7-12 [= Kb27 (1,3-6,9-12,14,15,20-22 p. p.], Sm48(B/W), SPTIII/31, SSW64, ST3,4,(B/W), SW135, TA222b., Wi6.1, \*

### ***B. cavipes* (KLOTZSCH ex FR.) KALCHBR. f. *cavipes*°**

- 3 (stipe solid, not hollow), small species, pileus  $-7$  cm wide, with a deep red tomentose-flocculose cover, becoming fibrillose-squamulose, hymenophore radially arranged, almost lamellate, pores very large, angular, tubes strongly decurrent, stipe with reddish purple partial veil, very rarely leaving an annulus, solid, apex yellow, bright red downward, base with yellow mycelium, context yellowish white to yellowish, odour and taste typically farinaceous, spores  $-10 \times (3,5-4)$  µm, clamp connections frequent, with larch (*Larix laricina*) and balsam fir (*Abies balsamea*), on decaying conifer logs and cedar swamps, at the edge of bogs, often in moss-covered logs; northern North America, Asia

Selected illustrations : Ba172b., BM35(B/W), BMBM12, BRB319m.!, CQ, ESR5(1): 38b., FMDS207:23, GH35(B/W), Hu570, IOH299b., M840?, Mycol56:709(B/W), Pk: pl.6, SD9b., ST46(B/W), YS405?, \*

### ***B. paluster* (PECK) PECK**

3*	larger species	4
4	pileus typically with scales, tomentose-squarrose	5
4*	pileus smooth, $-13(-16)$ cm wide, obscurely innately fibrillose, with ap-	

pressed fibres, viscid, dark rusty brown, ferruginous to chestnut-brown, brownish-red, pores angular, boletinoid, dull yellow brown, stipe dull yellowish brown above and (greyish) red, dry and fibrillose-squamulose below an annulus-like zone left by the not gelatinous, floccose veil; context yellow to orange buff, sometimes reddish, particularly in base of stipe when cut, spores  $10(-13) \times 4.5 \mu\text{m}$ , clamp connections very rare, if present at all, associated with conifers (*Pinus glauca*, *P. mariana*, *Abies balsamea*, *Picea glauca*); North America (Canada)

Selected illustrations: Ba172m.?, Bri14:5 (B/W)!, SB33-2!, \*

***B. sinus-paulianus* (POMERL. & A. H. SM.) KLOFAC & KRISAI**

- 5 pileus –20 cm wide, dry, with first whitish then pink to bright (rosy)red fibrils and scales on reddish ground, veil fragments often on pileus margin, annulus inconspicuous or sometimes absent, tubes decurrent, pores boletinoid, context bright yellow, bluish discolouration of context (often missing), taste acrid, slightly bitter, stipe (venose)reticulate, buff and rose, spores  $9.5 \times 3.2 \mu\text{m}$ , clamp connections very rare, associated with *Larix occidentalis*; western North America, introduced in Europe (Finland), ?China

Selected illustrations: AR123, Ba224a., BM36,37(B/W), BRB319a., Bri14:1(B/W), ESR5(1):38b.?, Li404, LI7(1):21c(B/W), McK12bl., Mi280, MiM360l., MS13, PH252, SB33-3, Sm41(B/W), TA224a., \*

***B. ochraceoroseus* SNELL**

- 5\* pileus –12 cm wide, greyish brown, against margin more brown, in young basidiomata there vivid rufous, tomentose-squamulose, nearly squarrose, against margin depressed, tubes yellow, then darker olivaceous-yellow, decurrent, pores boletinoid, staining violaceous then brownish when handled, stipe solid, darker orange, darker staining when handled, annulus grey, often blackish fibrillose, context in pileus pale orange, sometimes reddish when cut, in stipe pale yellow, often brownish marbled, bluish and/or brownish when cut, taste mild, spores  $11.5 \times 4 \mu\text{m}$ , clamp connections present, near *Larix sibiricus*, *Pinus sibiricus*; Asia, Altai (poorly known species)

***B. oxydabilis* SINGER**

**c) Synoptic key to *Boletinus* and similar species**

The key includes all *Boletinus* spp. and similar *Suillus* spp. with veil or an annulus, but no species with small pores and with glandular dots on stipe; hence see KLOFAC (2013) for *Suillus decipiens* (PECK) KUNTZE, *S. serotinus* (FROST) KRETZER & T. D. BRUNS, as well as members of the remaining genera at point 3. The species included are:

- S. appendiculatus* (PECK) A. H. SM. & THIERS
- S. bresadolae* (QUÉL.) GERHOLD
- S. caerulescens* A. H. SM. & THIERS
- S. glandulosus* (PECK) SINGER
- S. grisellus* (PECK) KRETZER & T. D. BRUNS
- S. lakei* (MURRILL) A. H. SM. & THIERS var. *lakei*
- S. lakei* var. *calabrus* LAVORATO

- S. lakei* var. *landkammeri* (PILÁT & SVRČEK) H. ENGEL & KLOFAC  
*S. lakei* var. *pseudopictus* A. H. SM. & THIERS  
*S. nueschii* var. *nueschii* SINGER  
*S. pictus* (PECK) KUNTZE  
*S. ponderosus* A. H. SM. & THIERS  
*S. spectabilis* (PECK) KUNTZE  
*S. viscidus* var. *viscidus* (L.) ROUSSEL

Details for species and synonymy index for *Suillus* spp. are reported in KLOFAC (2013).

**Comments:** When using this key, note that missing data (i. e. not yet available in literature) cause a special handling: select all characters which best match your fungus and note down the appropriate letters. Should you have more letters as cited here, check where in the code list you find the sequence matching best.

- A. pileus surface smooth to viscid (possibly over a fibrillose ground)
- B. pileus surface with scales, squamulose or fibrillose (sometimes viscid)
- C. stipe hollow
- D. stipe not hollow
- E. pileus wider than 8 cm
- F. pileus not wider than 8 cm
- G. context staining greenish or bluish when injured (often seldom, try also excluding this variant)
- H. pores, when older, radially arranged, boletinoid
- I. veil forming a significant annulus
- J. veil not forming a significant annulus
- K. annulus (veil) not gelatinous
- L. annulus (veil) gelatinous
- M. clamp connections present (often seldom, try also alternative)
- N. clamp connections absent
- O. largest spores not longer than 10 µm
- P. largest spores longer than 10 µm
- Q. largest spores not wider than 4 µm
- R. largest spores wider than 4 µm
- S. only near *Larix*
- T. near *Pinus*

A D E G H I K N P R	<i>Suillus ponderosus</i>
A D E G H I L N O R	<i>Suillus caerulescens</i>
A D E G H I L N P R	<i>Suillus caerulescens</i>
A D E G H I L N P R S	<i>Suillus bresadolae</i>
A D E G I K N P Q S	<i>Suillus nueschii</i>
A D E G I K N P R S	<i>Suillus viscidus</i>
A D E G I L N P R S	<i>Suillus bresadolae</i>
A D E H I K N P R	<i>Suillus glandulosus</i>
A D E H I L M P R	<i>Boletinus sinuspaulianus</i>

A D E H I L N P R	<i>Boletinus sinuspaulianus</i>
A D E H I L N P R S	<i>Suillus bresadolae</i>
A D E H J N O Q	<i>Suillus appendiculatus</i>
A D E I L N P R S	<i>Suillus bresadolae</i>
A D E J N O Q	<i>Suillus appendiculatus</i>
B C E H I L M P Q S	<i>Boletinus cavipes</i>
B C E H I L M P R S	<i>Boletinus asiaticus</i>
B D E G H I L M O Q S	<i>Boletinus ochraceoroseus</i>
B D E G H I L M P Q	<i>Boletinus oxydabilis</i>
B D E G H I L N O Q	<i>Suillus lakei</i> var. <i>calabrus</i>
B D E G H I L N O Q	<i>Suillus lakei</i> var. <i>pseudopictus</i>
B D E G H I L N O Q S	<i>Boletinus ochraceoroseus</i>
B D E G H I L N P Q	<i>Suillus lakei</i>
B D E G H I L N P R T	<i>Suillus pictus</i>
B D E G H J L M O Q S	<i>Boletinus ochraceoroseus</i>
B D E G H J L N O Q S	<i>Boletinus ochraceoroseus</i>
B D E H I K N P R S	<i>Suillus spectabilis</i>
B D E H I L M O Q S	<i>Boletinus ochraceoroseus</i>
B D E H I L M P Q	<i>Boletinus oxydabilis</i>
B D E H I L N O Q	<i>Suillus lakei</i> var. <i>calabrus</i>
B D E H I L N O Q S	<i>Boletinus ochraceoroseus</i>
B D E H I L N P Q	<i>Suillus lakei</i>
B D E H I L N P R	<i>Suillus lakei</i> var. <i>landkammeri</i>
B D E H I L N P R T	<i>Suillus pictus</i>
B D E H J L M O Q S	<i>Boletinus ochraceoroseus</i>
B D E H J L N O Q S	<i>Boletinus ochraceoroseus</i>
B D F G H J N P R S	<i>Suillus grisellus</i>
B D F H J M O Q S	<i>Boletinus paluster</i>
B D F H J N P R S	<i>Suillus grisellus</i>

## 6. Excluded and critical species

### a) Species named *Boletinus* but not belonging to this genus

	Current name (in bold)
<i>Boletinus amabilis</i> (PECK) SNELL 1944	<i>Suill. lakei</i> v. <i>landkammeri</i> p. p.
<i>B. appendiculatus</i> PECK 1896	<i>Suillus appendiculatus</i>
<i>B. berkeleyi</i> MURRILL 1909, nom. illeg.	<i>Suillus decipiens</i>
<i>B. castanellus</i> PECK 1900	<i>Bothia castanella</i>
<i>B. cavipoides</i> C. S. BI & G.Y. ZHENG 1982	<i>Suillus cavipoides</i>
<i>B. decipiens</i> PECK 1889	<i>Suillus decipiens</i>
<i>B. flavoluteus</i> SNELL 1941	<i>Suillus flavoluteus</i>
<i>B. floridanus</i> MURRILL 1944 [1943]	<i>Suillus decipiens?</i>
<i>B. glandulosus</i> PECK 1909[1907]	<i>Suillus glandulosus</i>
<i>B. grevillei</i> (KLOTZSCH) POMERL. 1980	<i>Suillus grevillei</i> var. <i>grevillei</i>
<i>B. grevillei</i> var. <i>clintonianus</i> (PECK) POMERLEAU 1980, comb. inv.	<i>Suillus clintonianus</i>
<i>B. grisellus</i> PECK 1900	<i>Suillus grisellus</i>

<i>B. kunmingensis</i> W. F. CHIU 1948	<i>Suillus kunmingensis</i>
<i>B. lakei</i> (MURRILL) SINGER 1945	<i>Suillus lakei</i> var. <i>lakei</i>
<i>B. lakei</i> subsp. <i>landkammeri</i> (PILÁT & SVRČEK) PILÁT & DER-MEK 1974	<i>Suillus lakei</i> var. <i>landkammeri</i>
<i>B. landkammeri</i> (PILÁT & SVRČEK) BON 1986	<i>Suillus lakei</i> var. <i>landkammeri</i>
<i>B. lignicola</i> M. ZANG 1980	<i>Boletinus lignicola</i> (?= <i>Suillus</i> )
<i>B. meruliooides</i> (SCHWEIN.) COKER & BEERS 1943	<i>Boletinellus meruliooides</i>
<i>B. mitis</i> (MOUG.) v. HÖHNEL 1905	<i>Suillus bovinus</i> var. <i>mitis</i>
<i>B. oxydabilis</i> f. <i>aberrans</i> SINGER 1938	<i>Suillus pictus</i> ss. <i>auct. asiat.</i> ?
<i>B. pictus</i> PECK 1889	<i>Suillus pictus</i>
<i>B. pinetorum</i> (W. F. CHIU) TENG 1962	<i>Suillus pinetorum</i>
<i>B. porosus</i> (BERK.) PECK 1889	<i>Boletinellus meruliooides</i>
<i>B. proximus</i> (SINGER) MURRILL 1946	<i>Boletinellus proximus</i>
<i>B. punctatipes</i> SNELL & E. A. DICK 1941	<i>Suillus punctatipes</i>
<i>B. punctatipes</i> var. <i>pinetorum</i> W. F. CHIU 1948	<i>Suillus pinetorum</i>
<i>B. solidipes</i> PECK 1913	<i>Suillus solidipes</i>
<i>B. squarrosoides</i> SNELL & E. A. DICK, 1936	<i>Bothia castanella</i>
<i>B. spectabilis</i> (PECK) MURRILL 1909	<i>Suillus spectabilis</i>
<i>B. subspectabilis</i> VASSILKOV 1952	<i>Suillus viscidus</i> var. <i>viscidus</i>
<i>B. tridentinus</i> (BRES.) BIG. & GUILLEM. 1913	<i>Suillus tridentinus</i>

## b) Critical species

*Boletinus benoisii* SINGER, nom. ill., Revue Mycol. 3(4–5): 159, 1938, Siberia  
*Boletinus birkenhoffii* LEBEDEVA, Opredelitel' shlyaprochykh gribov (key to cap Fungi-Agaricales): 497, 1949, Jakutsk  
*Boletinus borealis* PECK, Bull. Torrey Bot. Club 22: 206, 1895, North America, Labrador, spec.dub.  
*Boletinus clavipes* KALCHBR. 1867, an orthographic error by SACCARDO (1888)  
*Boletinus griseopallidus* VASSILKOV, Not. Syst. Sect. Crypt. Inst. Bot. Acad. Sci. U.S.S.R.: 209, 1955  
 Siberia

## 7. Species and synonymy index (without excluded and critical species)

### Current name (in bold)

*Boletinellus paluster* (PECK) MURRILL, Mycologia 1(1): 8, 1909 = ***Boletinus paluster***  
*Boletinus asiaticus* SINGER, Rev. Mycol. 3(4–5): 164, 1938 = ***Boletinus asiaticus***  
*Boletinus cavipes* f. *aurantiacus* (KREH) SINGER, Rev. Mycol. 3(4–5): 167, 1938  
*Boletinus cavipes* var. *aureus* ROLLAND, Bull. Soc. Mycol. France 4(2): 139, 1888  
*Boletinus cavipes* f. *aureus* (ROLLAND) SINGER, Rev. Mycol. 3(4–5): 167, 1938  
*Boletinus cavipes* f. *pallidior* (BRES.) SINGER, Rev. Mycol. 3(4–5): 167, 1938  
*Boletinus cavipes* f. *ferrugineus* BECK  
*Boletinus cavipes* f. *rubrotinctus* SNELL & DICK, Mycologia 33: 26 (1941), nom. inv. = ***Boletinus ochraceoroseus***  
*Boletinus cavipes* (OPAT.) KALCHBR. Mohls Bot. Z. 25: 182, 1867 = ***Boletinus cavipes*** (KLOTZSCH ex FR.) KALCHBR. sec. REDEUILH, Doc. Mycol. 18(72): 39, 1988  
*Boletinus ochraceoroseus* SNELL, Mycologia 33(1): 35, 1941 = ***Boletinus ochraceoroseus***  
*Boletinus oxydabilis* SINGER, Rev. Mycol. 3(4–5): 160, 1938 = ***Boletinus oxydabilis***  
*Boletinus paluster* (PECK) PECK, Ann. Rep. New York State Mus. 42: 78, 1889 = ***Boletinus paluster***  
*Boletinus sinuspaulianus* (POMERL. & A. H. SM.) KLOFAC & KRISAI

- Boletopsis cavipes* (OPAT.) HENN., in ENGLER & PRANTL, Nat. Pflanzenfam., Teil. I (Leipzig) 1\*\*:  
195, 1898 [1900] = *Boletinus cavipes*
- Boletus ampliporus* PECK, Bull. Buffalo Soc. Nat. Sci. 1: 60, 1873 = *Boletinus cavipes*
- Boletus cavipes* KLOTZSCH ex FR., FR. & HÖK, Boleti, fungorum generis, illustratio: 7, 1835 = *Boletinus cavipes*
- Boletus cavipes* OPAT., Commentation Historico-Naturalis de Familia Fungorum Boletoideorum (Berolini) 2(1): 11, 1836 = *Boletinus cavipes*
- Boletus paluster* PECK, Ann. Rep. Reg. New York State Mus. 23: 132, 1872 [1870] = *Boletinus paluster*
- Euryporus cavipes* (OPAT.) QUÉL., Enchir. fung. (Paris): 163, 1886 = *Boletinus cavipes*
- Fuscoboletinus ochraceoroseus* (SNELL) POMERL. & A. H. SM., Brittonia 14: 158, 1962 = *Boletinus ochraceoroseus*
- Fuscoboletinus paluster* (PECK) POMERL. & A. H. SM., Mycologia 56: 708, 1964 = *Boletinus paluster*
- Fuscoboletinus sinuspaulianus* POMERL. & A. H. SM., Brittonia 14(2): 157, 1962 = *Boletinus sinuspaulianus*
- Suillus ampliporus* (PECK) KUNTZE, Revis. gen. pl. (Leipzig) 3(2): 535, 1898 = *Boletinus cavipes*
- Suillus asiaticus* (SINGER) KRETZER & T. D. BRUNS, in KRETZER, LI, SZARO & BRUNS, Mycologia 88(5): 784, 1996 = *Boletinus asiaticus*
- Suillus cavipes* (OPAT.) A. H. SM. & THIERS, Monogr. North Amer. Species of *Suillus*: 30, 1964 = *Boletinus cavipes*
- Suillus ochraceoroseus* (SNELL) SINGER, Persoonia 7(2): 319, 1973 = *Boletinus ochraceoroseus*
- Suillus paluster* (PECK) KRETZER & T. D. BRUNS, Mycologia 88(5): 784, 1996 = *Boletinus paluster*
- Suillus sinuspaulianus* (POMERL. & A. H. SM.) E.A. DICK & SNELL, Mycologia 57: 457, 1965 = *Boletinus sinuspaulianus*

## 8. List of illustrations cited:

AM	ALESSIO, C. L.	Fungi Europaei 2 <i>Boletus</i> 1985 + 2A Suppl. <i>Boletus</i> 1991
AR	ARORA, D.	Mushrooms demystified 2 <sup>nd</sup> edn 1986
Ar	ARORA, D.	All that the rain promises, and more 1990
Ba	BARRON, G.	Mushrooms Northeast North America 1999
BBF	BESSETTE, A. E., BESSETTE, A. R., FISCHER, M.	Mushrooms of Northeastern North America 1997
BKIII(PS)	BREITENBACH, J., KRÄNZLIN, F.	Pilze der Schweiz 3, 1991
BL	BON, M.	Pareys Buch der Pilze 1988/Mushrooms & Toadstools
BM	SMITH, A. H., THIERS, H. D.,	The <i>Boletes</i> of Michigan 1971 plate No.
BMBM	BESSETTE, A. E., MILLER, O. K., BESSETTE, A. R., H.H.MILLER	Mushrooms of North America in color a field guide companion to seldom-illustrated fungi
Br	BRESADOLA, G.	Iconographia Mycologica 1927-1933
BRB	BESSETTE, A. E., BESSETTE, A. R. ROODY, W.	North American <i>Boletes</i> , 2000
BRBD	BESSETTE, A. E., ROODY, W. C., BESSETTE, A. R., DUNAWAY, D.	Mushrooms of the Southeastern United States, 2007
Bri		Brittonia, plate no.
BSMF		Bulletin semestriel de la Soc. Mycol. de France
BTR		Bollettino del Gruppo Micologico Bresadola
CC	CLEMENCION, H., & al.	Pilze im Wandel der Jahreszeiten, 1981
CD	COURTECUISSE, R., DUHEM, B.	Guide des Champ. de France et d'Europe, 1994
Cei	CETTO, B.	Enzyklopädie der Pilze 1, 1987
CO	COURTECUISSE, R.	Photo-guide des Champignons d'Europe, 2000
Coo		Coolia
CPS	PAPETTI, C., CONSIGLIO, G., SIMONINI, G.	Atlante fotografico de Funghi d'Italia 1, 2000/2 <sup>nd</sup> edn
CQ		Mille et un champignons du Quebec

Ct	CETTO, B.	Der große Pilzführer 1-4, 1979-1984, I fungi dal vero 5-7, 1977-1993
Dh	DÄHNCKE, R. M.	1200 Pilze in Farbfotos, 1993
Dpi	DERMEK, A., PILÁT, A.	Poznavajme huby 1974/illustr. no. corresponds PD +10
En	ENGEL, H., & al.	Schmier- und Filzröhrlinge, 1996, illustr. no.
ER	EYSSARTIER, G., ROUX, P.	Le guide des champignons France et Europe, 2011
ESR		Endemic Species Research
FBT	AUGUADRI, A., LUCCHINI, G., RIVA, A., TESTA, E.	Funghi e boschi del Cantone Ticino 1-4, 1984-1987
FeA		Funghi e Ambiente
FFS	ZANG M.	Flora Fungorum Sinicorum 44, Boletaceae II, 2013 pl.
FLST	FOIERA, F. & al.	Funghi Boleti, 1993, no.
FMDS		Bull. de la Fed. Mycol. du Dauphiné-Savoie
GII	GERHARDT, E.	Pilze 2. BLV Intensivführer, 1984-1985
Ga	GARNWEIDNER, E.	GU Naturführer Pilze, 1985
GG	GRÜNERT, H., GRÜNERT, R.	Pilze, Steinbachs Naturführer, 1984
Gh	GERHARDT, E.	Der große BLV Pilzführer für unterwegs, 1997
GH	GRUND, D. W., HARRISON, A. K.	Nova Scotian Boletes, 1976, pl. no.
Gli	GALLI, R.	I Boleti delle nostre Regioni, 1980
GR	GALLI, R.	I Boleti delle nostre Regioni, 1987 (only new illustration cited!)
GS GS3	GALLI, R.	I Boleti 1998, + 3rd edn (only new illustr. cited!)
Hg	HAGARA, L.	Atlas hub, 1987, illustr. no.
HKI,II	MICHAEL, HENNIG, KREISEL	Handbuch für Pilzfreunde, 1983-1988
Hu	HUANG, N.	Colored illustrations of macrofungi (mushrooms) of China, 1998 fig. no.
IH	IMAZEKI, R., HONGO, T.	Coloured Illustrations of Fungi of Japan I, 1980, no.
IOH	IMAZEKI, R., OTANI, Y., HONGO, T.,	Fungi of Japan, 1988
Kalch.	KALCHBRENNER,K., SCHULZER S.	Icones selectae Hymenomycetum Hungariae IV, 1877
Kb	KALLENBACH, F. J.	Die Pilze Mitteleuropas 1 Die Röhrlinge, 1926-1943
Ki	KIBBY, G.	The Pocket Guide to Mushrooms a. other Fungi, 1991
Kib	KIBBY, G.	British Boletes, 2011, fig. no.
KM	KONRAD & MAUBLANC	Icones Selectae Fungorum, 1924-1937
Kr2	KRIEGLSTEINER, G.	Die Großpilze Baden-Württembergs 2, 2000
L	LIU, X.	Coloratlas Wild Macrofungi China 2, 2004
La	LANNOY, G.	Iconographie des Bolets d'Europe, 2013, fig. no.
Læ	LÆSSOE, T., PETERSEN J.H.	MycoKey2.1, 2006
L/E	LANNOY, G., ESTADÈS, A.	Les Bolets Flore Myc. d'Europe 6, 2001
LEC	LECLAIR, A., ESSETTE, H.	Les Bolets, 1969
Li	LINCOFF, G. H.	The Audubon Soc. Field Guide to North American Mushrooms, 1981
Lx	LAUX, H.	Der große Kosmos Pilzführer, 2001
M	MAO, X. L., (Ed.)	The Macrofungi in China, 2000 fig. no.
Md	MARCHAND, A.	Champ. du Nord et du Midi, 1971-1986, icon. no.
MH	MICHAEL, HENNIG	Handbuch für Pilzfreunde, 1958-1975
Mi	MILLER, O. K. Jr.	Mushrooms of North America 5th edn, 1981, no.
MiM	MILLER, O. K. Jr., MILLER, H. H.	North American Mushrooms, 2006
MJ	MOSER, M., JÜLICH, W.	Farbatlas der Basidiomyceten, 1985-2007, no.
MS	MCKENNY, M., STUNTZ, D. E.	The New Savory Wild Mushroom, 1987
MT	MERLO, E. G., ROSSO, M., TRAVERSO, M.	I nostri funghi I Boleti, 1980
Mu	MUÑOZ, J. A.	Fungi Europaei2 Boletus s. l., 2005
Mycol		Mycologia
PA	PAPOUSEK, T.	Velky Fotoatlas Hub z Jiznich Cech

PC	POELT, J., JAHN, H., CASPARI, C.	Champignons d'Europe S.F.L/Mitteleuropäische Pilze, 1963/1965
PD	PILÁT, A., DERMEK, A.	Hribovite houby, 1974
Ph	PHILLIPS, R.	Les champignons 1981, Das Kosmosbuch der Pilze 1982, Mushrooms, 1981
PH	PHILLIPS, R.	Mushrooms of North America, 1991
Pk		Ann. Rep. Reg. New York State Mus. 23, 1972
PU	PILÁT, A., USAK, A.	Mushrooms Nase Houby I, 1952
RIV		Rivista di Micologia, Assoc. Micol. Bres.
RM		Revue de Mycologie
Ro	ROMAGNESI, H.	Nouvel Atlas des Champ. de France 1956-1970, I-IV
Rou	ROUX, P.	Mille et un champignons, 2006
RT	RINALDO, A., TYNDALO, V.	Pilzatlas 1974, Atlante dei funghi, 1972
SB	SCHALKWIJK-BARENSEN, H.	Mushrooms of western Canada, 1991
SCI		Scientifica Nr.1. Brillouet: Princes des Champignons, no.
SD	SNELL, W., DICK, E.	Boleti of northeastern North America, 1970, pl. no.
Si5	SINGER, R.	Die Röhrlinge I. Die Pilze Mitteleuropas V, 1965
SIE		Sienilehti
Sm	SMITH, A. H.	Mushroom Hunter's field guide, 1963
SPT	WALTY, H.	Schweizer Pilztafeln
SSW	SMITH, A. H., SMITH-WEBER, N.	The Mushroom Hunter's Field Guide, edn 1996
ST	SMITH, A. H., THIERS, H. D.	A Contrib. tow. a Monogr. of North Amer. spec. of <i>Suillus</i> 1964, plate no.
SW	SCHLITTLER, J., WALDVOGEL, F.	Das große Buch der Pilze, 1975
TA	TRUDELL S., AMMIRATI, J.	Mushrooms Pacific Northwest, 2009
Tai		Taiwania
TINT		Der Tintling
Ve	VESTERHOLT, J.	Danmarks Svampe
VS	VIOLA, S.	Die Pilze, 1972
Wi	WINKLER, R.	2000 Pilze einfach bestimmen, 1996
YS	YUAN, M., SUN, P.	Pictorial book of mushrooms in China, 2007

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