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Revision of *Boletus* section *Appendiculati* (Boletaceae) in Bulgaria with a key to the Balkan species

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Abstract: The paper presents the results from the taxonomic revision of *Boletus* section *Appendiculati* in Bulgaria. Descriptions are provided based on Bulgarian specimens for the 5 species of the section: *Boletus appendiculatus*, *B. fechtneri, B. fuscoroseus, B. regius,* and *B. subappendiculatus*. The priority of the name *B. fuscoroseus* against *B. pseudoregius* is briefly discussed. A dichotomous key for the determination of members is also included.

Key words: *Basidiomycetes, Boletales*, boletes, Bulgaria, fungal diversity

Introduction

Section *Appendiculati* Konrad & Maubl. ex Lannoy & Estadès is a well defined entity in the genus *Boletus* L., members of which are found throughout the northern hemisphere (Singer, 1986). It is characterised by the more or less developed reticulum on the stipe and concolourous yellow and often blueing tubes and pores as well as by the flesh, which may be blueing or not, but which is always mild tasting and in many species is somewhat pinkish tinted in the stipe base. The members of this group share some characters with section *Calopodes* Fr. emend. Lannoy & Estadès; the latter, however, are easily distinguished on the basis of their very bitter taste, caused by the presence of calopins and cyclocalopins (Hellwig et al., 2002). Recent molecular research suggests that the genus *Boletus*, even in its current strict sense, is likely a heterogeneous consortium and further studies are likely to lead to major changes in the generic concept of this group in the future (Watling, 2009). Should this happen, it will certainly affect the status of *Appendiculati*; this section is even now sometimes preliminarily paired with *Calopodes* in a separate subgenus with the provisional name *Suillellus* (Watling & Hills, 2005), a disputable decision as the type species of the genus *Suillellus* Murrill is *Boletus luridus* Schaeff. : Fr. (Murrill, 1909).

Most of the European representatives of this grouping have been treated controversially even in the not so distant past but recent molecular research supports the recognition of 5 species: *Boletus appendiculatus* Schaeff., *B. fechtneri* Velen., *B. regius* Krombh., *B. fuscoroseus* Smotl. [= *B. pseudoregius* (Huber) Estadès], and *B. subappendiculatus* Dermek, Lazebnicek & Veselský (Marques & Muñoz, 2006). Further confusion arises from the attempts to apply known European names to North American bolete collections and vice versa, with the application of *Boletus speciosus* Frost for *B. fuscoroseus* being a notable example. The disadvantages of

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this "conservative" approach have recently been demonstrated by molecular studies in another section of the genus (Arora, 2008) and it seems that *Appendiculati* is also in desperate need of a world-wide revision using traditional and molecular techniques.

Although various records of different *Appendiculati* are available throughout Bulgarian mycological literature dating back to the beginning of the 20th century (Assyov & Denchev, 2004; Assyov & Gyosheva, 2010; Denchev & Assyov, 2010), no local taxonomic treatment of this group has been attempted so far, either in Bulgaria or in any of the Balkan countries, where different *Appendiculati* have been found and where intensive research on this genus is going on (Zervakis et al., 1998; Karadelev et al., 2006; Perić & Perić, 2006; Lukić, 2009; Sesli & Denchev, 2009; Demirel et al., 2010; Doğan et al., 2012).

Materials and methods

Bolete samples were collected in different parts of the country between 2002 and 2009. Air dried specimens of the boletes are preserved in the Mycological Collection at the Institute of Biodiversity and Ecosystem Research in the Bulgarian Academy of Sciences (SOMF). Revision was attempted for older findings kept in the same collection and in the mycological section of the Herbarium of the University of Agriculture - Plovdiv (SOA).

The new collections are documented with colour photographs and appropriate field notes. Colour notations in the descriptions below refer to Kornerup and Wanscher (1978) or the British Fungus Flora Colour Chart (HMSO, 1969), the latter abbreviated as "BFF." All colours have been recorded under daylight. The colour terms in the key refer to common colour names rather than colour chart entries. Macroscopic colour reactions were tested on fresh basidiomata with KOH 10%, NH_4OH 10%, and $FeSO_4$ 10%. Microscopic features were observed in 5% KOH and tap water and always measured in water at a magnification of ×1000. All preparations were made from dried samples. Squash slides for observation of basidia and cystidia were made from thin sections of the hymenophore. Sections of pileipellis were prepared as recommended by Ladurner and Simonini (2003). Spore preparations were made by submerging small pieces of hymenophore in mounting medium for approximately 30 s to release the spores. From each specimen, 50 random, normally developed, mature basidiospores were measured. Measurement values for basidiospores are presented below in the following manner: (min-) mean ± s (-max). Spore volume (Vm) was calculated according to the formula $Vm = 4/3\pi.(1/2Sw)^2.1/2Sl$ where Sl refers to spore length, Sw indicates spore width, and the result is estimated to an integer number (Breitenbach & Kränzlin, 1991). Iodine reaction was ascertained by using Melzer's solution (Kirk et al., 2001) on dried samples following the procedure described by Ladurner and Simonini (2003). The results of the reaction are noted in the descriptions in the abbreviated form "MR." In the notations of the macroscopic and microscopic colour reactions, the lack of colour change is noted as "0."

The species concept follows Muñoz (2005) and Marques and Muñoz (2006). Further references to important literature and selected iconography are listed under every species. The distribution in Bulgaria follows the division of the country as accepted in Assyov and Denchev (2004). The general distribution in Europe is summarised as well as possible and is presented with 2-letter abbreviation codes of the countries following the standard ISO-3166 of the International Organization for Standardization.

Abbreviations are used throughout the text for the collectors' names as follows: AT - A. Tosheva; BA - B. Assyov; CB - C. Borisova; CH - C. Hinkova; CS - C. Stefanov; DS - D. Stoykov; GS - G. Stoichev; IA - I. Assyova; MD - M. Drumeva; MG - M. Gyosheva; ML - M. Lacheva; PM - P. Mihov; PP - P. Panov; and VC - V. Chalukov.

Results

Section *Appendiculati* Konrad & Maubl. ex Lannoy & Estadès

Section *Appendiculati* Konrad & Maubl. Icon. Sel. Fungorum, 6: 458 (1935) ex Lannoy & Estadès Doc. Mycol. 31: 121 (2001). — Lectotypus: *Boletus appendiculatus* Schaeff. (cf. Singer, 1947).

Key to species

1 - Context blueing considerably when exposed to air; pores blueing when bruised; mean basidiospore length/width ratio <3 2

1 - Context when exposed to air unchanging or almost so (extremely weak and patchy blueing reaction might sometimes occur in parts of the pileus); pores not blueing when bruised, but often darkening instead; mean basidiospore length/width ratio >3 4

2 - Pileus silvery grey, greyish, whitish, beige, or ochraceous, usually not tinted pinkish, or occasionally with pinkish areas towards the margin ..... *B. fechtneri*

2 - Pileus pinkish, dingy pink, or beige to ochraceous with prominent pinkish or reddish tint, or pale to dark brown 3

3 - Pileus pinkish, dingy pink, or beige to ochraceous with pinkish or reddish tint ..... .*B. fuscoroseus*

3 - Pileus pale to dark brown without pinkish tints .. .. *B. appendiculatus*

4 - Pileus pink, pinkish red to reddish; associated with broadleaf trees ..... *B. regius*

4 - Pileus beige, ochraceous to yellowish ochraceous; associated with conifers ..... *B. subappendiculatus*

Boletus appendiculatus Schaeff. (Figure 1).

Boletus appendiculatus Schaeff., Fung. Bav., 4: 86 (1774); *Dictyopus appendiculatus* (Schaeff.) Quél., Enchiridion, p. 160 (1886); *Tubiporus appendiculatus* (Schaeff.) Ricken, Vademecum, p. 215 (1918).

Literature: Kallenbach (1926), Singer (1967), Watling (1970), Pilát and Dermek (1974), Engel et al. (1983), Alessio (1985), Breitenbach and Kränzlin (1991), Knudsen (1992), Galli (1998), Lannoy and Estadès (2001), Muñoz (2005), Watling and Hills (2005), Marques and Muñoz (2006), Knudsen and Taylor (2008), Šutara et al. (2009), Kibby (2011).

Icons: Schaeffer (1774: Table 130; Lectotypus! cf. Singer 1967), Kallenbach (1926: Table 31), Blum (1962: Table 10, Figure 1), Leclair and Essette (1969: Table 39), Pilát and Dermek (1974: Table 50), Engel et al. (1983: Table 14), Alessio (1985: Table 12), Breitenbach and Kränzlin (1991: 53, Figure 4), Galli (1998: 177), Šutara et al. (2009: 121).

Pileus up to 20 cm in diameter, at first hemispherical, then convex or plano-convex, rarely flat or slightly depressed, initially dry and finely felty, later smooth or finely cracked, sometimes in very old specimens and in wet weather slightly viscid, hazel, cognac, cocoa brown, dark brown, agate, fawn brown, reddish brown, mahogany, madeira, liver brown (6-8EF5-7, 7E4); unchanging when bruised. **Stipe** up to 15 × 3.5 cm, at first subspherical or ovoid, later club-shaped, or cylindrical, tapering towards the base, usually rooting, yellowish white, pale yellow

Figure 1. Basidioma of *Boletus appendiculatus* (collection SOMF 27408).

to light yellow (1A2-4, 2A2-3), sometimes gradually discolouring in places or entirely to dingy white or dingy yellowish, sometimes towards the middle with pale red, pastel red, dull red, greyish red, brownish red, deep red, or brownish violet area or band (10-11CD4-8, 9-10AB3-5), at least in the upper half but most often entirely covered with fine concolourous or whitish network; stipe surface blueing when bruised. **Context** lemon or sulphur yellow (BFF 55, 54) or whitish, in the stipe base pinkish, dirty salmon to clay pink (BFF 45, 30); blueing when exposed to air (about BFF 71) predominantly in the cap and in the uppermost part of the stipe. **Tubes** initially lemon yellow (BFF 54), later with gradually developing olive tint; blueing when injured. **Pores** concolourous with the tubes; blueing when bruised. **Odour** not distinctive. **Taste** not distinctive. **Basidiospores** 9-(11.4 ± 0.8)-15.0 × 3.5-(4.4 ± 0.1)-5.5 µm, length/width ratio 2-(2.6 ± 0.2)-3.5, spore volume 63-(114 ± 7.4)-185 µm^3 (n = 250), with 1-3 large oil drops. **Basidia** 4-spored, clavate, 28-42 × 7-12 µm. **Cystidia** 32.5-54 × 9-15 µm. **Pileipellis** a trichodermium of interwoven septate hyphae; cells hyaline or somewhat ochraceous, finely incrusted; terminal cells usually slightly swollen and rounded towards the apex. **Macrochemical reactions:** NH_4OH (pileus - BFF 20, context - BFF 30), KOH (pileus - BFF 19, 20, context - BFF 30), $FeSO_4$ (pileus - 0, context - BFF 65), MR (0). **Microchemical reactions**: MR (0).

Habitat, ecology, phenology: xerothermic or mesophytic broadleaf forests, associated with oaks (*Quercus* spp.), often on limestone, 0-900 m. June-September.

Distribution in Bulgaria: Southern Black Sea coast, Western Forebalkan, Znepole region, Western Sredna Gora Mts. Previously reported also from the Northern Black Sea coast and Tundzha Hilly Region (Denchev & Assyov, 2010), but no voucher specimens have been seen yet to substantiate those records.

General distribution: Europe (AT, BA, BE, BG, CH, CZ, DE, DK, EE, ES, FR, GB, GR, HR, HU, IE, IT, LT, ME, MK, NL, NO, PT, RO, RS, RU, SE, SI, SK, UA; apparently more common in south). Reported also from Asia and North America but extra-European collections might require further study.

Specimens examined: Southern Black Sea coast: along the track between Perla Estate and Maslen Nos Cape, under *Quercus cerris* L., 07.06.2008, *BA* (SOMF 27408); Eastern Forebalkan: in the vicinity of Koman chalet below Terziisko village (Troyan distr.), under *Quercus frainetto* Ten., 07.06.2002, *BA* (SOMF 25371); in the vicinity of Golyama Zhelyazna village (Troyan distr.), under *Quercus* sp., 10.07.2003, *DS* (SOMF 27442); ibid., 30.06.2004, *DS* (SOMF 27437); Eastern Sredna Gora Mts: Zelenikovo village (Plovdiv distr.), in a broadleaf woodland (*Carpinus orientalis* Mill., *Fraxinus* sp.) at the sheep barn at the end of the village, 13.08.2002, *GS & ML* (SOMF 27240).

Boletus fechtneri Velen. (Figure 2).

Boletus fechtneri Velen., Českе houby, 4/5: 704 (1922). — *B. appendiculatus* ssp. *pallescens* Konrad, Bull. Soc. Mycol. France, 45: 73 (1929); *B. pallescens* (Konrad) Singer, Ann. Mycol., 34: 416 (1937); *Tubiporus appendiculatus* var. *pallescens* (Konrad) Imler, Bull. Soc. Mycol. France, 66: 201 (1950); *Boletus appendiculatus* var. *pallescens* (Konrad) Kühner & Romagn., Fl. Anal. Champ. Super., p. 38 (1953). — *B. romellii* Kallenb., Röhrlings-Best., p. 13 (1931).

B. aestivalis sensu Kallenb., Die Röhrlinge, p. 139 (1926) non Fr., Epicr. Syst. Mycol., p. 422 (1838), nec *Tubiporus aestivalis* Paulet, Traité Champ., p. 371 (1835).

Literature: Velenovský (1922), Kallenbach (1926), Singer (1967), Leclair and Essette (1969), Pilát and Dermek (1974), Engel et al. (1983), Alessio (1985), Breitenbach and Kränzlin (1991), Knudsen (1992), Galli (1998), Lannoy and Estadès (2001), Muñoz (2005), Marques and Muñoz (2006), Knudsen and Taylor (2008), Šutara et al. (2009), Kibby (2011).

Figure 2. Basidiomata of *Boletus fechtneri* (collection SOMF 25384).

Icons: Kallenbach (1926: Table 14, Figures 5, 6, Table 43; sub *B. aestivalis*), Leclair and Essette (1969: Table 42; sub *B. aestivalis*), Pilát and Dermek (1974: Table 51), Engel et al. (1983: Table 15), Alessio (1985: Table 13), Breitenbach and Kränzlin (1991: 57, Figure 10), Galli (1998: 183-185), Muñoz (2005: 701-703, Figure 53a-e), Šutara et al. (2009: 131).

Pileus up to 20 cm in diameter, at first hemispherical, later convex to flat-convex, rarely flat or slightly depressed, dry, smooth, occasionally slightly viscid in very old basidiomata, pale grey, grey, ash grey to yellowish grey (1-2B1-2, 4-5B1-2); surface not blueing when bruised. **Stipe** up to 15 × 3.5 cm, initially subspherical or ovoid, later club-shaped, sometimes cylindrical or tapering towards the base, sometimes rooting, yellowish white, pale yellow to light yellow (1A2-4, 2A2-3), rarely discolouring in places or entirely to dirty whitish, usually towards the middle with pale red, pastel red, dull red, brownish orange, or copper red band or area (10AB3-4, 8C7-8), at least in the upper half but most often entirely covered with fine, concolourous or whitish network; surface blueing when bruised or handled. **Context** lemon yellow, lemon chrome (BFF 54, 53), or yellowish white, in the stipe base pale dingy rose, dirty salmon, or clay pink (BFF 45, 39, 30); blueing (BFF 71) mostly in the cap and in the upper part of the stipe, when exposed to air. **Tubes** at first lemon yellow (BFF 54), later with olive tint; blueing when injured. **Pores** concolourous with the tubes, blueing when bruised. **Odour** indistinctive. **Taste** slightly acid. **Basidiospores** 9-(11 ± 1)-15 × 3.5-(4.3 ± 0.3)-5.5 µm, length/width 2-(2.6 ± 0.2)-3.4, spore volume 54-(115 ± 20.7)-201 µm^3, (n = 250). **Basidia** 4-spored, clavate, 27-48 × 9-13 µm. **Cystidia** 46.5-58 × 9-15 µm. **Pileipellis** trichodermium of interwoven septate, yellowish or hyaline, finely incrusted hyphae. Terminal cells mostly rounded or sometimes tapering towards the apex. **Macrochemical reactions:** NH_4OH (pileus - BFF 20, context - BFF 12), KOH (pileus - BFF 19, context - BFF 12), $FeSO_4$ (pileus - 0, context - BFF 63), MR (0). **Microchemical reactions**: MR (0).

Habitat, ecology, phenology: xerothermic or xeromesothermic broadleaf forests, associated with oaks (*Quercus* spp.) or sweet chestnut (*Castanea sativa* Mill.), often on limestone, 0-900 m. June-September.

Distribution in Bulgaria: Western Forebalkan, Belasitsa Mt, Western Sredna Gora Mts, Central Rhodopi Mts, and the Thracian Plain. Older records are available also from the Southern Black Sea coast, Znepole Region, and Western Rodopi Mts (Denchev & Assyov, 2010); these are however not substantiated by voucher specimens in public mycological collections.

General distribution: Europe (AT, BE, BG, CH, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IT, LT, LU, ME, MK, NL, PL, RO, RS, RU, SE, SI, SK, UA; apparently more common in south), North Africa (MA). Reported also from Asia - IL (Binyamini, 1975) but, as evident from the illustration published in this work, at least part of the Israeli records will appear to belong to *B. pulchrotinctus* Alessio.

Specimens examined: Eastern Forebalkan: Koman locality (Troyan distr.), under *Quercus frainetto*, 07.06.2002, *BA* (SOMF 25269, 25270, 25384, 27042); Vlaskovska Mahala at Golyama Zhelyazna village (Troyan distr.), 01.09.2002, *DS* (SOMF 27427, 27428); ibid., 08.09.2002, *DS* (SOMF 27429, 27430); Belasitsa Mt: along the road between Belasitsa chalet and Kongur chalet, under *Castanea sativa*, 22.09.2009, *BA & IA* (SOMF 27892); Western Sredna Gora Mts: in the vicinity of Drangovo village (Plovdiv distr.), in a mixed oak forest, 10.08.2002, *GS & ML* (SOMF 27043); Central Rhodopi Mts: in a mixed forest (pine and beech) at Studenets Resort, 04.06.1975, *GS* (SOA, s.n.); Thracian Plain: between Nadezhden and Ostar Kamak villages (Harmanli distr.), under *Quercus* sp., 21.06.2005, *DS* (SOMF 27425, 27426).

Boletus fuscoroseus Smotl. (Figures 3-4).

Boletus fuscoroseus Smotl. Vestn. Král. České Společ. Nauk 8: 47 (1912); — *B. pseudoregius* (Huber) Estadès, Bull. Trimestriel Féd. Mycol. Dauphiné-Savoie, 27: 7 (1988); *B. appendiculatus* var. *pseudoregius* Huber, Z. Pilzk., 6: 40 (1927); *B. appendiculatus* ssp. *pseudoregius* (Huber) Huber, Z. Pilzk., 17(3-4): 86 (1938) (nom. inval.).

B. speciosus sensu Singer, Die Röhrlinge, 2: 38 (1967), et auct. eur. post. plur., non Frost, Bull. Buffalo Soc. Nat. Sci., 2: 101 (1874); *B. regius* sensu Leclair & Essette, Les Bolets, p. 38 (1969) (ex ic. et descr.), et auct. nonnul. Brit., non Krombh., Naturgetr. Abbild. Schwämme, 2: 3 (1831).

Figure 3. Basidiomata of *Boletus fuscoroseus* (collection SOMF 25277). Here and in Figure 4, note the colour variability of the species.

Figure 4. Basidioma of *Boletus fuscoroseus* (collection SOMF 25262).

Literature: Smotlacha (1912), Singer (1967), Pilát and Dermek (1974), Engel et al. (1983), Alessio (1985, 1991), Estadès (1988), Breitenbach and Kränzlin (1991), Galli (1998), Lannoy and Estadès (2001), Muñoz (2005), Watling and Hills (2005), Marques and Muñoz (2006), Šutara et al. (2009), Kibby (2011).

Icons: Leclair and Essette (1969: Table 40, sub *B. regius*), Pilát and Dermek (1974: Table 52; sub *B. speciosus*), Engel et al. (1983: Table 17; sub *B. speciosus*), Alessio (1985: Table 15, sub *B. speciosus*), Alessio (1991: Table 14, sub *B. pseudoregius*), Breitenbach and Kränzlin (1991: 63, Figure 21; sub *B. speciosus*), Galli (1998: 187-189), Muñoz (2005: 695-698, Figure 51a-h, sub *B. pseudoregius*), Šutara et al. (2009: 125-127).

Pileus up to 20 cm in diameter, at first hemispherical, later convex to flat-convex, violet brown, greyish red, brownish red, or dull red (10E6-7, 10F6, 10D4-6, 10-11C4, 10B3-4), sometimes discolouring to beige (4C3), but at least partly with somewhat pinkish tint; surface dry, sometimes cracked, not blueing when bruised or handled; margin appendiculate. **Stipe** up to 10 × 3 cm, cylindrical or club-shaped, sometimes tapering towards the base, at least in the upper part yellowish white, pale yellow to light yellow (1A2-4, 2A2-3), in the lower 1/2 or 1/3 pink, pale red, pastel red, or dull red (11A4-5, 9-10AB3-5), rarely high red, madder red, or cherry (11AB7-8) or occasionally pinkish brown, or with similarly coloured band, at least in the upper half with well developed concolourous or reddish or rusty network; surface blueing when handled. **Context** whitish in the pileus, lemon yellow in the stipe (BFF 54, 53), dirty salmon to clay pink (BFF 45, 30) in the stipe base, blueing (BFF 71) mostly above the tubes when exposed to air. **Tubes** up to 1.5 cm long, lemon yellow (BFF 54), later with olivaceous tint, blueing when injured. **Pores** concolourous with the tubes, blueing when bruised. **Odour** in young fruit bodies not distinctive, later medicinal, of tempera paints, or resembling smoked meat, and of chicory when dried. **Taste** not distinctive to slightly acid. **Basidiospores** 10-(12.6 ± 0.6)-14.5 × 4-(4.6 ± 0.2)-5.5 µm, length/width ratio 2.2-(2.7 ± 0.1)-3.2, spore volume 86-(142 ± 19)-214 µm^3 (n = 400), with 1-3 large oil drops. **Basidia** 4-spored, clavate, 26-34 × 9-15 µm. **Cystidia** 36.5-52 × 9-14.5 µm. **Pileipellis** trichodermium of interwoven septate yellowish slightly incrusted hyphae; terminal cells rounded towards the apex. **Macrochemical reactions**: NH_4OH (pileus - BFF 13, context - 9H), KOH (pileus - BFF 11, 13, context - BFF 47), $FeSO_4$ (pileus - 0, context - 0), MR(0). **Microchemical reactions**: MR(0).

Habitat, ecology, phenology: xerothermic or mesothermic broadleaf forests, associated with oaks (*Quercus* spp.), 0-800 m. June-September.

Distribution in Bulgaria: Southern Black Sea coast, Eastern Forebalkan, Western and Eastern Stara Planina Mts, Sofia Region, and Eastern Rhodopi Mts.

General distribution: Europe (AT, BE, BG, CH, CZ, ES, FR, GB, GR, HR, HU, IT, ME, MK, RO, RS, SI, SK; more or less widespread but apparently absent in north and probably under-recorded), Asia Minor (TR).

Specimens examined: Southern Black Sea coast: in a mixed oak forest (*Quercus frainetto*, *Q. cerris*) along the track between Perla Estate and Maslen Nos Cape, under *Q. cerris*, 15.06.2004, *BA* (SOMF 25262); ibid., 17.06.2005, *BA* (SOMF 27432-27434); Eastern Forebalkan: in Gradyuvitsa locality in the vicinity of Golyama Zhelyazna village, in a mixed oak forest, 10.07.2004, *DS* (SOMF 25503, 25504); above Golyama Zhelyazna village, in a mixed oak forest, 18.07.2004, *DS* (SOMF 27435, 27436); Western Stara Planina Mts: in the vicinity of Voynyagovtsi village (Sofia distr.), under *Quercus* sp., 24.07.2005, *DS* (SOMF 25473); Eastern Stara Planina Mts: in a broadleaf woodland, Kaynika locality above Omurtag town, 14.08.1975, *GS & MD* (SOMF 12401); Sofia Region: Lyulin Mt, between Manastirski Livadi locality and the chapel, 26.07.2005, *BA* (SOMF 25276); ibid., 30.07.2005, *BA* (SOMF 25277, 25278); ibid., 04.09.2005, *BA* (SOMF 27431); Eastern Rhodopi Mts: in an oak forest, Glumovski Kanton locality along the road between Ivaylovgrad and Krumovgrad towns, 08.07.1977, *CH & MD* (SOMF 13032); in an oak forest in Kara Yolu locality in the vicinity of Knizhovnik village, 08.07.1977, *CH & MD* (SOMF 13056).

Note. In the past this bolete was erroneously referred to in the European mycological literature as *B. speciosus*, a confusion that was apparently introduced by Singer (1967) and then followed by the European authorities since (see references above). *B. speciosus* is a North American species and as far as known to the author there is currently no firm evidence that it occurs in Europe. The name *B. pseudoregius* is used for this fungus in most of the recent European treatments (e.g., Muñoz, 2005; Watling & Hills, 2005; Marques & Muñoz, 2006). Having studied the original description of *B. fuscoroseus*, the author of this paper finds that it corresponds well to the above described entity, except for the spore dimensions, which are similar but not exactly the same as those presented above. However, this discrepancy might derive from many factors, e.g., the number of the spores measured, the choice of spores to be measured, differences of the optics used, etc. An English translation of the original description and Smotlacha's remarks is provided below.

As indicated by Šutara and Špinar (2006) and later also by Šutara et al. (2009), it appears that *B. fuscoroseus* is an older name for the same species which has priority over *B. pseudoregius*. *B. fuscoroseus* is effectively published and Smotlacha (1912) provided in his publication a Czech description of the new species, satisfying the requirements of ICBN (McNeill et al., 2007) for valid publication. There is one more matter that needs to be mentioned with regard to this name: When introducing his *B. fuscoroseus*, Smotlacha added immediately after it the statement "Smotlacha 1910." The author is not aware of the existence of any earlier publication of Smotlacha where this name appears. The notation of "1910" might be possibly explained by the fact that Smotlacha's manuscript was prepared for publication in 1910, as inferred from the dating in its introduction, although the lecture was presented on the session held on 13.01.1911, as can be seen from the notice on the second title of the journal and as apparent from the dating below the title on page 1 of the paper ["Submitted on 13.01.1911"]. In addition, there are different considerations about the actual date of Smotlacha's publication. On the title page of separata it is explicitly noted "Vydáno dne 30. Června 1911" (Printed on 30.06.1911). On the title page of the journal itself (issue 1911), however, the dating is "1912." Therefore, the year of publication is to be considered as 1912.

The English translation of the original description is as follows: "Pileus at first hemispherical, later expanded, 10-20 cm wide, coloured brownish with pinkish tint. Tubes at first short, later elongating, 1-1½ cm long, at first decurrent, later connected with the stipe [adnate], yellow with small rounded pores, [the latter] coloured as the tubes, blue-green when bruised. Spores pale brownish, 10 µ[m] long, 3-4 µ[m] wide. Stipe 8-16 cm long, solid, initially ovoid, ventricose swollen at the base, tapering towards the apex, entirely [covered] with well-defined network, in the upper part blue-green, when bruised, later darkening. Context compact, yellow-white, blueing when damaged. — *B. fuscoroseus* shows similarity with the preceding species [*Boletus regius* and

Boletus aereus in group "Duri"]. It is distinguished [from both of these] by its swollen stipe, tubes at first decurrent, also from *B. regius* by the blueing context and tubes, [and] from *B. aereus* by the colour of the pileus. By the taste and the character of the context it is similar to those 2 species; it is edible and valuable. I have collected it for the first time in August 1909 in the forest Žernově u Holic under oaks. I sent 2 fruit bodies to Prof. Velenovský for specimen. Locals call it růžovník" (Smotlacha, 1912: 47-48).

Boletus regius Krombh. (Figures 5-6).

Boletus regius Krombh., Naturgetr. Abbild. Schwämme, 2: 3 (1831); *Dictyopus appendiculatus* var. *regius* (Krombh.) Quél., Enchiridion, p. 160 (1886); *Suillus regius* (Krombh.) Kuntze, Revis. Gen. Pl., 3(2): 536 (1898); *Tubiporus regius* (Krombh.) Ricken, Vademecum, p. 206 (1918); *Boletus appendiculatus* ssp. *regius* (Krombh.) Konrad, Bull. Soc. Mycol. France, 41: 63 (1925); *Tubiporus appendiculatus* var. *regius* (Krombh.) Imler, Bull. Soc. Mycol. France, 66: 201 (1950).

Literature: Krombholz (1831), Kallenbach (1926), Singer (1967), Watling (1970), Pilát and Dermek (1974), Engel et al. (1983), Alessio (1985), Knudsen (1992), Galli (1998), Lannoy and Estadès (2001), Estadés and Lannoy (2004), Muñoz (2005), Marques and Muñoz (2006), Šutara et al. (2009), Kibby (2011).

Icons: Krombholz (1831: Fasc. 2, Table 7; Lectotypus! cf. Singer, 1967), Kallenbach (1926: Table 9, Table 14, Figures 1-2), Bresadola (1931: Table 922), Pilát and Dermek (1974: Table 53), Engel et al. (1983: Table 16), Alessio (1985: Table 14), Galli (1998: 181), Muñoz (2005: 699-701, Figure 52a-e; Table 49), Šutara et al. (2009: 129).

Pileus up to 17 cm in diameter, at first hemispherical, later convex, flat-convex, or rarely almost flat, initially dry, somewhat felty, later smooth, sometimes slightly viscid in very old basidiomata, greyish rose, geranium, aurora, greyish red, or medium madder red (10-11BC4-7), sometimes with darker spots (10D6-7), towards the margin paler, pink, pinkish white, reddish grey, or pale red (10-11AB2-3), occasionally somewhat yellowish; not blueing when bruised. **Stipe** up to 9 × 3.5 cm, initially ovoid, later club-shaped, cylindrical or tapering towards the base, pale yellow, pastel yellow, sulphur yellow, or sun yellow (1-2A3-5), after drying or in places where eaten by animals often with irregular red to blood red (BFF 41, 42) or purple (BFF 40) spots, entirely or at least in the upper part with fine concolourous or whitish network; surface not blueing when bruised. **Context** lemon yellow (BFF 54) to lemon chrome (BFF 53), sometimes in the base of the stipe dingy salmon (BFF 45) to clay pink (BFF 30); not blueing when exposed to air, when dried in places often with scarlet red spots (BFF 43). **Tubes** at first lemon yellow (BFF 54), later with somewhat olive tint, not blueing when injured. **Pores** concolourous, not blueing when bruised. **Odour** not distinctive. **Taste** not distinctive.

Figure 5. Basidiomata of *Boletus regius* (collection SOMF 27419).

Figure 6. Basidiomata of *Boletus regius* (collection SOMF 25469). The unusual colours of the pileus in this collection are notable.

Basidiospores 10.5-(12.8 ± 1.4)-16 × 3-(4.1 ± 0.2)-5 µm, length/width ratio 2.7-(3.3 ± 0.1)-4.3, spore volume 63-(121 ± 14.6)-181 µm^3 (n = 250). **Basidia** 4-spored, clavate, 29-42 × 8-15 µm. **Cystidia** 34-52.5 × 7-14.5 µm. **Pileipellis** trichodermium of interwoven septate, hyaline or ochraceous yellow, not incrusted cells; terminal cells rounded at the apex. **Macrochemical reactions**: NH_4OH (pileus - BFF 11, context - 8G), KOH (pileus - BFF 11, context - BFF 49), $FeSO_4$ (pileus - 0, context - BFF 68), MR(0). **Microchemical reactions:** MR (0).

Habitat, ecology, phenology: xerothermic and mesothermic broadleaf forests, associated with oaks (*Quercus* spp.) or sweet chestnut (*Castanea sativa*), possibly also with beech (*Fagus* spp.), 0-1000 m. May-September.

Distribution in Bulgaria: Stara Planina Mts, Znepole Region, Sofia Region, Belasitsa Mt, Western Sredna Gora Mts, Central and Eastern Rhodopi Mts. Recorded also from the Southern Black Sea coast and Vitosha Region (Assyov & Denchev, 2004), but no voucher specimens have been seen that support those records.

General distribution: Europe (more common in south, absent in the far north - AT, BA, BE, BG, CH, CZ, DE, ES, FR, GB, GR, HR, HU, IT, ME, MK, PO, PT, RO, RS, RU, ?SE, SI, SK, TR, UA, NL), Asia. Reported from North America (US, MX) but molecular research is desperately needed to resolve the status of the American collections.

Specimens examined: Western Stara Planina Mts: in an oak forest in the vicinity of Barzia village, 06.2002 (s.d.), *CB* (SOMF 25398); Central Stara Planina Mts: in a mixed deciduous forest (beech and hornbeam) above H.G. Danovo village, 14.08.1976, *GS* (SOA, s.n.); Eastern Stara Planina Mts: Mokrenski Prohod pass between Mokren and Gradets villages (Sliven distr.), in an oak forest, under *Quercus cerris*, 28.08.2004, *BA* (SOMF 27929); in the vicinity of Kotel town, 11.08.2004, *MZ*; in the vicinity of Sliven town, 01.08.2004, *MZ*; Znepole region: Konyavska Mt, in an oak forest above Zhedna village, 15.06.1993, *MG* (SOMF 21804); Sofia Region: Lyulin Mt, along the track in Derivol locality, under *Quercus* sp., 19.07.2005, *BA & IA* (SOMF 25469, 25470); ibid., 09.09.2005, *BA & IA* (SOMF 25501); Belasitsa Mt: above Belasitsa village (Petrich distr.), under *Castanea sativa*, 18.05.2004, *BA* (SOMF 25258); Western Sredna Gora Mts: Verinsko village, at the margins of an oak forest, 10.06.1992, *PM* (SOMF 27409); in the vicinity of Gabra village, under Gabra village, under *Quercus cerris*, 24.06.2004, *BA* (SOMF 25259, 27419-27421); at Krushovitsa village, under *Quercus cerris*, 24.06.2004, *BA* (SOMF 27424, 27930); broadleaf forest in vicinity of Vakarel town, 10 June 1972, *PP* (SOMF 10464); mixed oak forest, Lozenska Mt, *CS* (SOMF 88); Central Rhodopi Mts: at Dedevo village, s. d., *GS* (SOA, s.n.); Eastern Rhodopi Mts: in an oak forest in Genchov Zavoy locality between Ivaylovgrad and Krumovgrad villages, 28.05.1977, *CH, VC & MD* (SOMF 13044).

Note. Weak and patchy blueing reaction of the context is said to occur sometimes in this species, which generally has unchanging flesh, clearly separating it from the slightly similar *B. fuscoroseus*. It has not been evidenced yet in Bulgarian collections.

Boletus subappendiculatus Dermek, Lazebnicek & Veselský (Figures 7-8).

Boletus subappendiculatus Dermek, Lazebnicek & Veselský, in Dermek, Fungorum Rar. Icon. Color. 9: 13 (1979).

Literature: Engel et al. (1983), Alessio (1985), Breitenbach and Kränzlin (1991), Galli (1998), Lannoy and Estadès (2001), Muñoz (2005), Marques and Muñoz (2006), Knudsen and Taylor (2008), Šutara et al. (2009), Assyov and Gyosheva (2010), Kibby (2011).

Figure 7. Basidiomata of *Boletus subappendiculatus* (collection SOMF 27673) (photo I. Assyova).

Figure 8. Basidiomata of *Boletus subappendiculatus* (collection ca SOMF 27673) (photo I. Assyova). Rusty tinges of the hymenophore are often developed in aging fruit bodies.

Icons: Engel et al. (1983: Tab. 18), Breitenbach and Kränzlin (1991: 65, Figure 24), Galli (1998: 179), Šutara et al. (2009: 123), Assyov and Gyosheva (2010: 324).

Pileus up to 8 cm in diameter, at first hemispherical, later convex to flat-convex, rarely flat or slightly depressed, dry or sometimes slightly viscid when old, smooth, fibrillose or finely cracked, brownish orange, sunburn, cinnamon, light brown (5C3-4, 6D4-5, 7D4-6), buff, or clay buff (BFF 32, 52); surface unchanging when bruised; margin appendiculate. **Stipe** up 13 × 5.5 cm, at first subspherical or ovoid, later club-shaped or sometimes cylindrical, sometimes rooting, yellowish white, pale yellow, or pastel yellow (1A2-4, 2A2-3), rarely discolouring in places or entirely to whitish or brownish, sometimes in the middle or in the upper 1/3 with reddish white, pale red, or brownish orange zone (9-10A2-3, 7C7-8), at least in the upper half or most often entirely covered with fine, concolourous, white, yellowish, rusty orange, orange, or orange-red reticulum; stipe surface unchanging when bruised. **Context** lemon yellow (BFF 54), straw, or whitish (BFF 50, 78), but then under the pileipellis, above the tubes and under the stipe surface sulphur yellow, lemon yellow, or lemon chrome (BFF 53-55), in the stipe base often dirty salmon (BFF 45) to clay pink, vinaceous buff, or clay buff (BFF 30-32); not blueing when exposed to air. **Tubes** at first lemon yellow (BFF 54), later yellow with olivaceous tint, unchanging when damaged. **Pores** at first lemon yellow (BFF 54), later yellow with olivaceous tint, sometimes in old basidiomata rusty spotted, darkening and not blueing when bruised. **Odour** not distinctive. **Taste** not distinctive. **Basidiospores** 9.5-(12.2 ± 1.2)-15 × 3-(3.8 ± 0.2)-4.5 µm, length/width ratio 2.4-(3.3 ± 0.1)-4.3, spore volume 50-(92 ± 18)-149 µm^3 (n = 200). **Basidia** 4-spored, clavate, 30-39.5 × 7-10 µm. **Cystidia** 35.5-45 × 8-10.5 µm. **Pileipellis** trichodermium of interwoven, septate, sometimes branched, yellowish, finely incrusted hyphae; most terminal cells cylindrical with rounded apex. **Macrochemical reactions:** NH_4OH (pileus - BFF 41, context - BFF 30), KOH (pileus - BFF 41, context - BFF 30), $FeSO_4$ (pileus - 0, context - BFF 65), MR (0). **Microchemical reactions:** MR (0).

Habitat, ecology, phenology: coniferous or mixed forests in the upper mountain belt, associated with spruce (*Picea abies* (L.) Karst.) or fir (*Abies alba* Mill.), 1200-1700 m. July-August.

Distribution in Bulgaria: Northern Pirin Mts, Rila Mts.

General distribution: Europe (in areas where the associated trees are present, but needs further clarification - AT, BG, CH, CZ, DE, ES, GB, GR, FR, IT, ME, NO, PO, RS, SI, SK) and Asia Minor (TR); see Assyov and Gyosheva (2010) for further comments.

Specimens examined: Northern Pirin Mts: ca. 1 km below Banderishka Polyana locality above Bansko town, ca 1770 m, under *Abies alba*, 26.08.2009, *BA* (SOMF 27904); Rila Mts: Kirilova Polyana locality, along the track to Suhoto Ezero lake, ca. 1460 m, under *Abies alba*, 28.07.2002, *BA* (SOMF 27913); ibid., under *Picea abies*, 15.07.2008, *AT* (SOMF 27044); ibid., under *Picea abies*, 24.07.2009, *BA & IA* (SOMF 27673, 27674); Preslapa locality above Mechit chalet above Govedartsi village, 1647 m, under *Picea abies*, 01.08.2008, *MG* (SOMF 27045); Generalska Pusiya locality above the village of Raduil, 1355 m, under *Picea abies* and *Fagus sylvatica* L., 04.07.2009, *MG* (SOMF 27671).

Note. Some literature sources suggest that the context of the pileus of *B. subappendiculatus* might occasionally show some very light and patchy blueing. Such a peculiarity has not been seen yet in any of the studied Bulgarian collections, although some of the

known localities offered the possibility to examine a great number of fresh basidiomata. This event is not impossible but is most probably very rare.

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References

Alessio CL (1985). *Boletus* Dill. ex L. (sensu lato). In: *Fungi Europaei* 2: 1-705. Saronno: Libreria editrice Biella Giovanna.

Alessio CL (1991). Supplemento a *Boletus* Dill. ex L. (sensu lato). In: *Fungi Europaei* 2A: 1-126. Saronno: Libreria editrice Biella Giovanna.

Arora D (2008). California porcini: three new taxa, observations on their harvest, and the tragedy of no commons. *Economic Botany* 62: 356-375.

Assyov B & Denchev CM (2004). Preliminary checklist of *Boletales* in Bulgaria. *Mycologia Balcanica* 1: 195-208.

Assyov B & Gyosheva M (2010). First encounters of *Boletus subappendiculatus* (*Boletaceae*) in Bulgaria. *Phytologia Balcanica* 16: 323-327.

Binyamini N (1975). [*Fleshy Fungi of Israel (Agaricales)*]. Tel Aviv: Hakibutz Hameuchad. (In Hebrew)

Blum J (1962). Les Bolets. Descriptions, déterminations, classifications, comestibilité. In: *Etudes Mycologiques* 1, pp. 1-168. Paris: Editions Paul Chevalier.

Breitenbach J & Kränzlin F (1991). *Pilze der Schweiz*. Vol. 3(1). Röhrlinge und Blätterpilze. Luzern: Verlag Mykologia.

Bresadola J (1931). *Iconographia Mycologica*. Vol. 19. Milano: Societa Botanica Italiana.

Demirel K, Erdem Ö, Uzun Y & Kaya A (2010). Macrofungi in Hatila Valley National Park (Artvin, Turkey). *Turkish Journal of Botany* 34: 457-465.

Denchev CM & Assyov B (2010). Checklist of the larger basidiomycetes in Bulgaria. *Mycotaxon* 111: 279-282.

Doğan HH, Aktaş S, Öztürk C & Kaşık, G (2012). Macrofungi distribution of Cocakdere valley (Arslanköy, Mersin). *Turkish Journal of Botany* 36: 83-94.

Engel H, Krieglsteiner G, Dermek A & Watling R (1983). *Dickröhrlinge. Die Gattung Boletus in Europa*. Weidhausen bei Coburg: Verlag Heinz Engel.

Estadès A (1988). *Boletus pseudoregius* (Huber) comb. nova. *Bulletin Mycologique et Botanique Dauphiné-Savoie* 108: 6-8.

Estadès A & Lannoy G (2004). Les bolets européens. *Bulletin Mycologique et Botanique Dauphiné-Savoie* 44(3): 3-79.

Galli R (1998). *I Boleti. Atlante pratico-monographico per la determinazione dei boleti.* Milano: Edinatura.

Hellwig V, Dasenbrock J, Gräf C, Kahner L, Schumann S & Steglich W (2002). Calopins and Cyclocalopins - bitter principles from *Boletus calopus* and related mushrooms. *European Journal of Organic Chemistry* 17: 2895-2904.

HMSO (1969). *Flora of British Fungi. Colour Identification Chart.* Edinburgh: Her Majesty's Stationery Office.

Kallenbach F (1926). Die Röhrlinge (*Boletaceae*). In: *Die Pilze Mitteleuropas* 1: 1-158 + Tabs 1-55. Leipzig: W. Klinkhardt.

Karadelev M, Rusevska K & Spasikova S (2006). Ecology and distribution of the genus *Boletus* (*Boletaceae*) in the Republic of Macedonia. *Mycologia Montenegrina* 9: 7-23.

Kibby G (2011). *British Boletes with Keys to Species.* London: published by the author.

Kirk PM, Canon PF, David JC & Stalpers JA (2001). *Dictionary of the Fungi.* edn. 9. Oxon: CAB International.

Kornerup A & Wanscher JH (1978). *Methuen Handbook of Colour.* edn. 3. London: Methuen.

Knudsen H (1992). *Boletus* Dill. ex L.: Fr. In: Hansen L & Knudsen H (eds). *Nordic Macromycetes*. Vol. 2. *Polyporales, Boletales, Agaricales, Russulales*, pp. 56-63. Copenhagen: Nordsvamp.

Knudsen H & Taylor A (2008). *Boletus* L.: Fr. In: Knudsen H & Vesterholt J (eds.). *Funga Nordica*, pp. 163-168. Kopenhagen: Nordsvamp.

Krombholz JV (1831). *Naturgetreue Abbildungen und Beschreibungen der essbaren, schädlichen und verdächtigen Schwämme.* Vol. 2. Prag: J. G. Calve Buchhandlung.

Ladurner H & Simonini G (2003). *Xerocomus* s.l. In: *Fungi Europaei* 8: 1-527. Alassio: Edizioni Candusso.

Lannoy G & Estadès A (2001). Les Bolets. Flore mycologique d'Europe. *Documents Mycologique Mémoire Hors série* 6: 1-163. Lille: Association d'Écologie et de Mycologie.

Leclair A & Essette H (1969). Les Bolets. In: *Atlas Mycologiques* 2: 1-86. Paris: Editions Paul Chevalier.

Lukić N (2009). The distribution and diversity of *Boletus* Genus in Central Serbia. *Kragujevac Journal of Science* 31: 59-68.

Marques G & Muñoz JA (2006). Révision des espèces européennes du genre *Boletus* section *Appendiculati*. Étude sur la base de caractères morphologique et d'analyse des polymorphismes des fragments de restriction (PCR-RFLP). *Bulletin Trimestriel de la Société Mycologique de France* 122: 353-366.

McNeill J, Barrie FR, Burdet HM, Demoulin V, Hawkswort DL, Marhold K, Nicolson DH, Prado J, Silva PC, Skog JE, Wiersema JH & Turland NJ (eds) (2007). International Code of Botanical Nomenclature (Vienna Code) adopted by the 17th International Botanical Congress Vienna, Austria, July 2005. *Regnum Vegetabile* 146: 1-568.

Muñoz JA (2005). *Boletus* s. l. In: *Fungi Europaei* 1: 1-951. Alassio: Edizioni Candusso.

Murrill WA (1909). The *Boletaceae* of North America - I. *Mycologia* 1: 4-18.

Perić B & Perić O (2006). Contribution to the study of the genus *Boletus* s. l. in Montenegro. *Mycologia Montenegrina* 9: 35-54.

Pilát A & Dermek A (1974). *Hríbovité huby. Československé hríbovité a sliziakovité huby (Boletaceae - Gomphidiaceae).* Bratislava: Veda.

Schaeffer JC (1774). *Fungorum qui in Bavaria et Palatinatu circa Ratisbonam nascuntur icones nativis coloribus expressae.* Erlangae: Johannem Jacobum Palmium.

Sesli E & Denchev CM (2009). Checklists of the myxomycetes, larger ascomycetes and larger basidiomycetes in Turkey. *Mycotaxon* 106: 65-68.

Singer R (1947). The *Boletoideae* of Florida with notes on extralimital species. *American Midland Naturalist* 37: 1-135.

Singer R (1967). Die Röhrlinge. II. Die *Boletoideae* und *Strobilomycetaceae*. In: *Die Pilze Mitteleuropas* 6: 1-151. Bad Heilbrunn: Julius Klinkhardt Verlag.

Singer R (1986). *The Agaricales in the Modern Taxonomy.* edn. 4. Koenigstein: Koeltz Scientific Books.

Smotlacha F (1912). Monografie českých hub hřibovitých. *Věstník Královské české společnosti náuk, Třída mathematicko-přírodovědecká* 8[1911]: 1-73.

Šutara J & Špinar P (2006). *Boletus kluzakii*, a new species related to *B. radicans*. *Czech Mycology* 58: 31-42.

Šutara J, Mikšík M & Janda V (2009). *Hřibovité houby. Čeleď Boletaceae a rody Gyrodon, Gyroporus, Boletinus a Suillus.* Praha: Academia.

Velenovský J (1922). *České houby.* Vol. 4/5. Praha: Nákladem České botanické společnosti.

Watling R (1970). *Boletaceae, Gomphidiaceae, Paxillaceae.* In: Henderson DM, Orton PD & Watling R (eds). *British Fungus Flora. Agarics and Boleti.* Vol. 1. Edinburgh: Royal Botanic Garden.

Watling R (2009). A manual and source book on the boletes and their allies. In: *Synopsis Fungorum* 24: 1-248. Oslo: Fungiflora.

Watling R & Hills AE (2005). Boletes and their allies (revised and enlarged edition). In: Henderson DM, Orton PD & Watling R (eds). *British Fungus Flora. Agarics and Boleti.* Vol. 1. Edinburgh: Royal Botanic Garden.

Zervakis G, Dimou D & Balis C (1998). A checklist of the Greek macrofungi including hosts and biogeographic distribution: I. *Basidiomycotina. Mycotaxon* 66: 273-336.