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## The Family Boletaceae s.l. (Excluding Boletus) in the Republic of Macedonia

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**Abstract:** This is the first paper on systematic research into Boletaceae s.l. (excluding *Boletus* L.) in the Republic of Macedonia. A total of 31 species belonging to 8 genera are registered in the Republic of Macedonia. Two genera (*Gyrodon* Opat. and *Phylloporus* Qué.) and 8 species (*Chalciporus amarellus* (Qué.) Bataille, *Gyrodon lividus* (Bull.: Fr.) Opat., *Leccinum variicolor* Watling, *Leccinum vulpinum* Watling, *Phylloporus pelletieri* (Lév.) Qué., *Suillus mediterraneensis* (Jacquet. & J.Blum) Redeuilh, *Xerocomus ferrugineus* (Schaeff.) Bon. and *Xerocomus rubellus* (Krombh.) Qué.) are reported as new for Macedonia.

**Key Words:** Fungi, Boletaceae s.l. (excl. *Boletus* L.), reported species, ecology and distribution, Macedonia

### Introduction

The Republic of Macedonia is situated in the central part of the Balkan Peninsula. The country borders Albania in the west, Greece in the south, Bulgaria in the east, and Serbia in the north (Figure). This relatively small area (25,713 km<sup>2</sup>) is characterised by the most complex geology, diverse and developed relief, different climatic influences, and forest associations that contribute to its rich fungi diversity.

The interest in mycodiversity studies in the Republic of Macedonia has been growing in recent years, and much has been done in this field. There has not been systematic research into *Boletaceae* to date, and there are rather few mycological papers concerned only with individual species of this family. The aim of this study is to compile a complete list of the known species of *Boletaceae* s.l. (excluding *Boletus*). A total of 23 have been published in 17 publications (Pilát & Lindner, 1939; Tortić, 1968, 1975, 1988; Sylejmani, 1980; Karadelev & Popovski, 1995; Karadelev, 2000b; Karadelev & Rusevska, 2000, 2002, 2004; Karadelev et al., 2002a, 2002b, 2002d,

2003a, 2003b, 2004; Rusevska & Karadelev, 2004). Accordingly, we presented a survey of *Boletaceae* s.l. (excluding *Boletus*), including all the published and most of the unpublished source data known to us.

### Materials and Methods

The sources of this list have been papers published, exsiccata deposited in different collections, and research notes of the present authors and other individual collectors, and data from field research trips organised by the Macedonian Mycological Society (MMS) and Biology Students' Research Society (BSRS). Certain specimens have been preserved at the Botanical Department, Faculty of Science in Zagreb (ZA), National History Museum in Belgrade (BEO), and National Museum Prague (PRM). The data from the personal herbarium of Mitko Karadelev and the data cited from the collection SKO are now in the National Collection of Fungi (MAK) at the Institute of Biology, Faculty of Natural Science, Ss Cyril and Methodius University in Skopje. The collections in the herbaria BEO, PRM, SKO, and ZA, have been mostly

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Figure. Map of the studied localities in the Republic of Macedonia.

collected and examined by M. Tortić. This paper includes the data published or collected until November 2006.

The identification of the species has been carried out using Kühner & Romagnesi (1953), Pilát (1959, 1969), Singer (1986), Allesio (1985), Moser (1985), Kreisell (1987), Breitenbach & Kränzlin (1991), Hansen & Knudsen (1992), Fernandez (1997), Krieglsteiner (2000), and Horak (2005). In a few cases, the names of the species have been modified according to Index Fungorum 2005. The species are reported in alphabetical order. Data pertaining to previous publications, geographical distribution, altitude, forest association, and data source are provided under each fungal species.

#### MARKS AND ABBREVIATIONS

- = - synonym
- leg. - legator (collector)
- exs. - collections in which the dried material (exsiccatum) is deposited
- Ref. - references (sources of records of the taxon)
- vill. - village
- Mt. - mountain
- \* - new species for the Republic of Macedonia

#### Results

*\*Chalciporus amarellus* (Quél.) Bataille

Collections: MAK

Shar Planina Mt.: Jelak, 1800 m, under *Picea*, 17.07.1995, exs. MAK 95/4309.

*Chalciporus piperatus* (Bull.: Fr.) Bataille

Ref.: Tortić, 1968, 1988 - published as *Suillus piperatus* (Bull. ex Fr.) O.Kuntze; Karadelev, 2000b; Karadelev et al., 2003a

Collections: MAK, ZA

Bistra Mt.: Dolni Lopushnik, above spring, 1000-1200 m, *Festuco heterophyllae-Fagetum*, 14.10.2006, exs. MAK 06/6106; Kozhuf Mt.: between Dudichki Kolibi and the mine Sumpor, 1400-1370 m, mixed forest (*Fagus, Abies*), 21.07.2005, exs. MAK 05/5189; Shar Planina Mt.: Jelak, 1700-1800 m, *Piceetum subalpinum scardicum*, 16.10.2000, exs. MAK 00/2718.

*\*Gyrodon lividus* (Bull.: Fr.) Opat.

Collections: MAK

Kozjak (between Nidze Mt. and Kozhuf Mt.): toward r. Leshnichka Reka, 1200 m, 22.07.2000, Leg.: BSRS; Strumica: near Koleshino vill., 300 m, *Osmunda regalis* stands and meadow in *Periploco-Alnetum glutinosae*, 2.10.2002, exs. MAK 02/3637; 14.10.2001, exs. MAK 01/567.

*Gyroporus castaneus* (Bull.: Fr.) Quéf.

Ref.: Pilát & Lindner, 1939; Tortić, 1988

Collections: BEO, MAK, PRM

**Jakupica Mt.:** Cheples, 12.08.1995, Leg.: Marjan Andreevski; Kitka Mt.: above Gorno Kolichani vill., 700-900 m, *Quercetum frainetto-cerris macedonicum*, 19.10.1998, exs. MAK 98/2221; Shar Planina Mt.: Vratnica vill., 750 m, Leg.: Miroslav Jankovski; near Skopje: Vodno, near Krushopek vill., 800 m, *Castanea* forest, 16.10.2005, exs. MAK 05/5258; Skopska Crna Gora Mt.: above Ljubanci vill., 800 m, oak forest, 18.08.2002, Leg.: K. Rusevska, Rashtak vill., 700 m, oak forest, 29.10.2006, Leg.: Mile Aleksovski & Jasmina Dimitrovska-Shumkova; Veles: Pusta Kula, under *Salix* sp., 20.10.1996, Leg.: Marjan Andreevski.

*Gyroporus cyanescens* (Bull.: Fr.) Quéf.

Ref.: Pilát & Lindner, 1939; Sylejmani, 1980; Tortić, 1988

Collections: BEO, MAK

**Bistra Mt.:** vicinity of Lazaropole vill.: between Koritnik and sheepfold Maskarevec, 1500-1600 m, pasture, 6.08.2002, exs. MAK 02/3338; Zadel, 1300 m, meadow with *Juniperus* (edge of *Fagus* forest) 8.08.2005, exs. MAK 05/5222; footpath between St. Gjorgjija church and Cucul, 8.08.2006, exs. MAK 06/5973; Markova Stopalka, 1300 m, *Festuco heterophyllae-Fagetum*, 10.08.2002, exs. MAK 02/3333, between Lazaropole vill. and Tresonche vill., 1300-1100 m, *Festuco heterophyllae-Fagetum*, 3.08.2002, exs. MAK 02/3334; above Tresonche vill., 1100 m, *Quercetum*, 12.07.2003, exs. MAK 02/3424.

*Leccinum aurantiacum* (Bull.) Gray

Ref.: Sylejmani, 1980; Tortić, 1988; Karadelev & Rusevska, 2002

*Leccinum duriusculum* (Schulzer) Singer

Ref.: Karadelev et al., 2003a

Collection: MAK

Kichevo: Shumnjak, 18.10.2006, oak forest, under *Populus*, exs. MAK 06/6174.

*Leccinum pseudoscabrum* (Kallenb.) Šutara

= *Leccinum griseum* (Quéf.) Singer

Ref.: Sylejmani, 1980; Tortić, 1988; Karadelev et al., 2002b; Karadelev & Rusevska, 2002 - published as *L. griseum*

Collections: MAK

**Bistra Mt.:** Stanoec, 900-1000 m, oak forest (*Quercus cerris*, *Corylus avellana*), under *Quercus cerris*, 15.10.2006, Leg.: MMS, vicinity of Lazaropole vill., footpath to Tresonechki Rid, 1300 m, deciduous forest (*Corylus*, *Fagus*), 31.07.2006, exs. MAK 06/5972, footpath to Sokolica, 1300-1400 m, deciduous forest (*Fagus*, *Corylus*, *Quercus*), 6.08.2006, exs. MAK 06/5951; Bogdanci: Paljurci, 200 m, *Quercus-Carpinetum orientalis macedonicum*, 13.05.2006, Leg.: M. Karadelev; Jakupica Mt.: Cheples, 1400 m, *Calamintho grandiflorae-Fagetum*, 07.1999, Leg.: BSRS; Kitka Mt.: between Gorno Kolichani vill. and Kitka mountain house, 1350 m, deciduous forest (*Fagus*, *Quercus*, *Corylus*), 30.05.1999, exs. MAK 99/3885; Pelister Mt.: above Brajchino vill., Kalojzana, 1400 m, *Fagetum*, under *Betula*, 16.08.2002, exs. MAK 02/3716; Skopska Crna Gora Mt.: Ljubanci vill., around St. Nikola monastery, 800 m, *Quercus-Carpinetum orientalis macedonicum*, 11.9.2005, exs. MAK 05/5154, Rashtak vill., 700 m, oak forest, 29.10.2006, Leg.: Mile Aleksovski & Jasmina Dimitrovska-Shumkova.

*Leccinum quercinum* Pilát ex Pilát

Ref.: Karadelev et al., 2003b; Karadelev & Rusevska, 2004

Collections: MAK

Kichevo: Jagol Dolenci vill., Grosaljca, meadow in oak forest, under *Quercus*, 27.10.2006, exs. MAK 06/6191, Shumnjak, 18.10.2006, oak forest, under *Quercus*, exs. MAK 06/6175; Kozhuf Mt.: between Crvena Zemja and Golubec, 1400-1600 m, mixed forest (*Fagus*, *Quercus*,

*Pinus*), 10.07.2005, exs. MAK 05/5054; vicinity of Skopje: Vodno, near Krushopek vill., 800 m, oak forest, 11.10.2005, exs. MAK 05/5269; vicinity of Krushevo: 1300 m, 15.10.2006, under *Betula*, Leg.: Boris Atanasov.

*Leccinum scabrum* (Bull.: Fr.) Gray

Ref: Tortić, 1988; Karadelev et al., 2003a; Karadelev & Rusevska, 2004

**Deshat Mt.:** above Bitushe vill., 1400 m, meadow in deciduous forest, under *Betula*, 19.08.2006, leg. K. Rusevska; **Kozhuf Mt.:** between Konjsko vill. and Huma vill., 700-750 m, oak forest, 23.09.1995 Leg.: M. Karadelev; vicinity of Krushevo: 1300 m, under *Betula*, 15.10.2006, Leg.: Boris Atanasov; **Pelister Mt.:** above Brajchino vill., 1300 m, *Festuco heterophyllae-Fagetum*, under *Betula*, 20.10.2005, exs. MAK 05/1827; **Nizho Pole vill.:** 1000 m, mixed forest, under *Betula*, 10.10.2004, exs. MAK 04/4968; **Strumica:** Gabrovo vill., 300 m, *Osmunda regalis* stand in *Periploco-Alnetum glutinosae*, under *Betula*, 14.10.2001, exs. MAK 01/706.

\**Leccinum variicolor* Watling

= *Leccinum oxydabile* (Singer) Singer auct pl.

Collection: MAK

**Strumica:** Gabrovo vill., 300 m, *Osmunda regalis* stand in *Periploco-Alnetum glutinosae*, under *Betula*, 30.04.2002, exs. MAK 02/2665.

*Leccinum versipelle* (Fr. & Hök) Snell

= *Leccinum testaceoscabrum* Secr. ex Singer

Ref.: Karadelev et al., 2002b - published as *L. testaceoscabrum*

Collection: MAK

**Korab Mt.:** below Strezimir watch-tower, 1200 m, *Fagus* forest, 9.09.2006, exs. MAK 06/6016.

\**Leccinum vulpinum* Watling

Collection: MAK

**Kichevo:** Krushino vill., 800-900 m, *Pinus* plantation, 18.11.2003, exs. MAK 03/3504.

\**Phylloporus pelletieri* (Lév.) Quél.

Collection: MAK

**Bistra Mt.:** Lazaropole vill., Markova Stopalka, 1300 m, edge of *Fagus* forest, exs. MAK 06/5881; **Jablanica Mt.:** below Gorna Belica vill., Jankov Kamen, 1300 m, *Fagus* forest, 11.07.2006, exs. MAK 06/5749, between Gorna Belica vill. and Vevchani vill., 1400-1200 m, *Fagus* forest, 11.07.2006, exs. MAK 06/5760.

*Suillus bovinus* (L.: Fr.) Kuntze

Ref.: Karadelev & Rusevska, 2002

Collection: MAK

**Kozhuf Mt.:** Konjari vill., 1000 m, *Festuco heterophyllae-Fagetum*, 13.10.2000, exs. MAK 00/4645; **Pelister Mt.:** Palisnopje, 18.07.2001, Leg.: BSRS, Rotino vill., 1000 m, mixed forest, under *Pinus*, 26.10.2004, exs. MAK 04/4964.

*Suillus collinitus* (Fr.) Kuntze

= *Suillus fluryi* Huijsman

Ref.: Tortić, 1988; Rusevska & Karadelev, 2004

Collections: MAK

**Bogdanci:** Paljurci, *Pinus nigra* plantation, under *Pinus*, 11.11.2006, Leg.: M. Karadelev; **Kozjak Mt.:** Alshar, Perun, 1400-1650 m, mixed forest, 12.06.2004, exs. MAK 04/1267; **Pelister Mt.:** Nizho Pole vill., 1000 m, mixed forest, under *Pinus peuce*, 10.10.2004, exs. MAK 04/4972; near Skopje: **Arachinovo vill.:** 250 m, *Pinus* plantation, 28.10.2000, exs. MAK 00/3073; **Rashche vill.:** 700 m, 25.10.2006, *Pinus* plantation, under *Pinus*, Leg.: Redzep Aliu & Bedri Gjureci; **Vodno,** between Sredno Vodno and PTT, edge of planted forest, 500-700 m, 11.10.2006, Leg.: Snezhana Miteva; **Skopje:** Gorno Sonje vill., 21.10.2006, *Pinus nigra* plantation, exs. MAK 06/6190, Gazi Baba, 300 m, 18.10.2006, *Pinus nigra* plantation, exs. MAK 06/6185; **Veles:** Oraovec vill., 21.11.1992, Leg.: Marjan Andreevski.

*Suillus granulatus* (L.) Roussel

Ref.: Tortić, 1988; Karadelev et al., 2002b; Karadelev & Rusevska, 2002; Karadelev et al., 2003a ;

Karadelev & Rusevska, 2004; Rusevska & Karadelev, 2004.

**Collections:** MAK

**Bistra Mt.:** vicinity of Lazaropole vill., *Pinus* plantation in yard, 1300 m, 11.08.2006, footpath to Javorska Voda, 1300-1100 m, *Pinus* plantation, 1.08.2006, leg. K. Rusevska; Bogdanci: Kozarnik, 200 m, 24.10.2006, *Pinus* plantation (*Pinus nigra*, *P. pinea*, *P. halepensis*), Leg.: M. Karadelev; near Bitola: road to Resen, 750 m, coniferous plantations, 25.4.2002, exs. MAK 02/2476; Kavadarci: Sirkovo vill., *Pinus* plantation, 5.11.2000, Leg.: Mile Aleksovski; Kozhuf Mt.: Resa, 700-800 m, *Pinus* plantation, 14.7.2004, under *Pinus* sp., Leg.: BSRS; between Majdan vill. and Tribor, 800-1400 m, *Abieti-Fagetum macedonicum* with *Pinus nigra* and *Pinus sylvestris*, 8.10.1998, Leg.: Mitko Kostadinovski; Konjsko vill., *Pinus* plantings mixed with *Quercus frainetto*, 9.10.1996, Leg.: M. Karadelev; Pelister Mt.: Gjavato, 1100 m, *Pinus sylvestris* plantation, 17.07.1989, Leg.: M. Karadelev; Brajchino vill., 1200 m, *Pinus* plantation, under pine, 15.08.2002; 1300 m, *Pinus* plantation, 20.10.2005, Leg.: MMS; Malovishte vill., St. Ana Monastery, 1200-1400 m, *Fagetum*, 22.07.1989; Probistip: *Pinus* plantation, 20.10.1998, Leg.: M. Karadelev; Skopje and vicinity: Butel, 250 m, *Pinus* plantation, under *Pinus*, 12.10.2006, Leg.: Mile Aleksovski; Katlanovo, 250 m, *Pinus* plantation, 16.10.2002, Leg.: Krune Blazhevski; Matka, 250-300 m, *Pinus* plantation, 22.05.1993, Leg.: Marjan Andreevski; Vodno, *Pinus* plantation, 2004, Leg.: Panche Atanasovski; near Krushopek vill., 800 m, *Pinus* plantation, 11.10.2005, Leg.: Idris Ismailovski and Abdilveap Emine; near a refinery, 250 m, *Pinus* plantation, 13.10.1998, Leg.: M. Karadelev; Veles: Oraovec vill., 21.11.1992, between Pomenovo vill. and Omorani vill., 400-500 m, 14.11.1993, Leg.: Marjan Andreevski; vicinity of Krushevo: 1300 m, 15.10.2006, *Pinus* plantation, under *Betula*, Leg.: Boris Atanasov.

*Suillus grevillei* (Klotzsch: Fr.) Singer

Ref.: Sylejmani, 1980; Tortić, 1988

**Collections:** MAK

**Bistra Mt.:** Lazaropole vill., 1300 m, yard, under planted *Larix* sp., 25.08.2006, exs. MAK 06/5933; Pelister Mt.: Kazhani vill., 900 m, plantation of *Larix decidua*, 17.07.1989, exs. MAK 89/4293.

*\*Suillus mediterraneensis* (Jacquet. & J.Blum) Redeuilh

=*Suillus granulatus* (L.) Roussel var. *mediterraneensis* (Jacquet. & J.Blum)

**Collections:** MAK

**Pelister Mt.:** Kazhani vill., 1000 m, *Pinus nigra* plantings with *Quercus cerris* and *Q. frainetto*, under *Pinus nigra*, 19.04.2002, exs. MAK 02/2628.

*Suillus luteus* (L.: Fr.) Roussel

Ref.: Sylejmani, 1980; Tortić, 1988; Karadelev & Rusevska, 2000; Karadelev et al., 2003a; Karadelev & Rusevska, 2004; Karadelev et al., 2004

**Collections:** MAK, SKO, ZA

**Belasica Mt.:** above Bansko vill., *Pinus sylvestris* plantation, 20.10.1996, Leg.: M. Karadelev; Jablanica Mt.: Gorna Belica vill., 1400 m, *Pinus sylvestris* plantation, 10.10.2005, exs. MAK 05/5320, *Pinus* plantation, 20.11.2000, exs. MAK 00/3842; Kichevo: Krushino vill., 800-900 m, *Pinus* plantation, 18.11.2003, exs. MAK 03/3506; Kozhuf Mt.: above Majdan vill., 900 m, pine forest, 16.05.2004, exs. MAK 04/4005; Osogovski Planini Mt.: Konopnica vill., 1100 m, *Pinus* plantation, 3.09.2002, Leg.: Daniela Mitovska; Pelister Mt.: Brajchino vill., 1200 m, *Pinus* plantation, under *Pinus*, 15.08.2002; Gjavato, 1100 m, *Pinus sylvestris* plantation, 9.10.2001; Nizho Pole vill., 1000 m, mixed forest, under *Pinus peuce*, 10.10.2004, exs. MAK 04/4971; near Skopje: Matka 250-300 m, *Pinus* plantation, 22.05.1993, Leg.: Marjan Andreevski; Vodno, near Krushopek vill., 800 m, *Pinus* plantation, 11.10.2005, Leg.: Idris Ismailovski and Abdilveap Emine; Veles: Oraovec vill., *Pinus* plantation, 8.05.1994, Leg.: Marjan Andreevski.

*Suillus plorans* (Roll.) Kuntze

Ref.: Karadelev et al., 2003a

**Collections:** MAK

*Suillus sibiricus* (Sing.) Sing. subsp. *helveticus* Sing.

Ref.: Tortić, 1968, 1988; Karadelev & Rusevska, 2000; Karadelev et al., 2002d (as *S. sibiricus*), Karadelev et al., 2003a (published as *S. sibiricus* subsp. *helveticus*)

**Collections:** MAK

**Pelister Mt.:** between hotel Molika and Kopanki, 1400-1500 m, *Digitali viridiflorae-Pinetum peuces*, 19.10.2005, Leg.: MMS; around Palisnopje, 1500 m, *Digitali viridiflorae-Pinetum peuces* with *Fagus*, 6.10.2001; around Kopanki, 1500-1700 m, *Digitali viridiflorae-Pinetum peuces* with *Fagus*, 19.10.2005, Leg.: MMS; around mountain house Kopanki, 1640-1700m, *Digitali viridiflorae-Pinetum peuces*, 3.10.2001.

*Suillus variegatus* (Sw.: Fr.) Richon & Roze

Ref.: Tortić, 1988

**Collections:** MAK

**Osogovski Planini Mt.:** Konopnica vill., 1100 m, 3.09.2002, *Pinus* plantation, Leg.: Daniela Mitovska.

*Tylopilus felleus* (Bull.: Fr.) P.Karst.

Ref: Karadelev & Popovski, 1995; Karadelev et al., 2003a

**Collections:** MAK

**Kichevo:** Krushino vill., 800-900 m, mixed pine forest with *Quercus* and *Castanea*, 18.11.2003, exs. MAK 03/3519; Kozhuf Mt.: Visoka Chuka, 1000 m, *Festuco heterophyllae-Fagetum*, 07.1998, Leg.: M. Karadelev; Ograzhden Mt.: Suvi Laki, 1200 m, mixed forest (*Pinus*, *Quercus*, *Fagus*), 23.10.2005, exs. MAK 05/4242.

*Xerocomus armeniacus* (Quél.) Quél.

Ref.: Karadelev et al., 2003a

**Collections:** MAK

*Xerocomus badius* (Fr.: Fr.) E.J.Gilbert

Ref.: Karadelev, 2000b; Karadelev & Rusevska, 2004; Karadelev et al., 2004

**Collections:** MAK

**Bogdanci:** under Komoren, 150 m, 22.10.1996, Leg.: M. Karadelev; Jablanica Mt.: between Gorna Belica vill. and Vevchani vill., 1400-1200 m, 11.07.2006, exs. MAK 06/5709, below Gorna Belica vill., Jankov Kamen, 1300 m, *Fagus* forest, 11.7.2006; Skopska Crna Gora Mt.: above Chucher – Sandevo vill., 600 m, degraded oak

forest (*Quercus-Carpinetum orientalis macedonicum*), 6.10.1998, exs. MAK 98/1839.

*Xerocomus chrysenteron* (Bull.) Quél.

Ref.: Tortić, 1968, 1988; Sylejmani, 1980; Karadelev, 2000b; Karadelev & Rusevska, 2000; Karadelev et al., 2002 a, 2002b; Karadelev & Rusevska, 2002; Karadelev et al., 2003a; Karadelev & Rusevska, 2004; Rusevska & Karadelev, 2004

**Collections:** MAK, ZA

**Belasica Mt.:** above Bansko vill., Fagetum, 20.09.1996, Leg.: M. Karadelev; Bistra Mt.: Dolni Lopushnik, above spring, 1000-1200 m, 14.10.2006, *Abies* plantings, under *Abies*, exs. MAK 06/6135; Lopushnik, beneath the monument of Kocho Racin, 1500-1600 m, *Fagus* forest, 3.08.2006, Leg.: K. Rusevska; 6.08.2006, Leg.: Katerina Aleksovska; Bogdanci: Karabalija Mt., 200-500 m, 23.09.1995, Leg.: M. Karadelev; Buchne: around Vratnica vill., 750-800 m, deciduous forest (*Castanea*, *Fagus*, *Carpinus*), 20.10.2003, Leg.: Vojno Stojcheski; Demir Hisar: Zhurche vill., 750 m, oak forest, 29.05.2003, Leg.: Biljana Risteska; Galichica Mt.: between Oteshevo and Kale, 900-1000 m, meadow, 8.10.1988, Leg.: M. Karadelev; Jablanica Mt.: above Vishni vill., 900-1200 m, 28.10.2006, *Ostrya* and *Quercus* forest, Leg.: M. Karadelev; around Gorna Belica vill. 1500 m, *Fagus* forest, 12.7.2006, below Piskupshtina vill., 700-850 m, oak forest, 21.07.2006, Leg.: BSRS, between Gorna Belica vill. and Vevchani vill., *Fagus* forest, 1400-1200, 11.7.2006, Vishenski Pat (between Gorna Belica vill. and Vishni vill.), *Fagus* and *Quercus cerris* forest, 17.07.2006; Jakupica Mt.: below Begovo Pole, 1900 m, 27.07.1997, *Pinetum mugo macedonicum*, Cheples, 1300-1400 m, 10.07.1999, *Calamintho grandiflorae-Fagetum*, Leg.: BSRS; Karadzica Mt.: Demirovi Livadi, 1500 m, 25.07.1997, *Fagus* forest, exs. MAK 97/4413; Aldinska Planina – Mumdzica, 1500 m, 24.07.1997, Leg.: BSRS; Kichevo: Jagol Dolenci vill., 14.10.2006, Grosaljca, oak forest, 30.10.2006, Leg.: Emri Murati; Kitka Mt.: above Gorno Kolichani vill., 700-900 m, *Quercetum frainetto-cerris macedonicum*, 19.10.1998, Leg.: M. Karadelev; between Gorno Kolichani vill. and mountain house Kitka, 1350 m, deciduous forest (*Fagus*, *Quercus*, *Corylus*), 30.05.1999, Leg.: BSRS, between Dolno Kolichani vill. and Gorno Kolichani vill., 900-1200 m, deciduous forest, 18.10.2006, exs. MAK 06/6169;

Kozhuf Mt.: below Asan Cheshma, 750-900 m, beech forest, 10.07.2004, between Asan Cheshma and Kichikaja, 1350-1700 m, *Fagetum*, 11.07.2004, Mala Rupa, 1200-1500 m, mixed forest (*Fagetum*, *Pinus*, *Abies*), 16.07.2004, around Mihajlovo summer resort, 1200 m, beech forest, 9.07.2005, Leg.: BSRS; Visoka Chuka, 1000 m, *Festuco heterophyllae-Fagetum*, 13.07.1996, Leg.: M. Karadelev; Kozjak (between Nidze Mt. and Kozhuf Mt.), Baltova Chuka, 1620 m, 07.2000, Leg.: BSRS; Mariovo (Prilep): road to Vitolishte vill., oak forest (*Quercus trojana*), 11.10.2005, exs. MAK 05/5427; Osogovski Planini Mt.: Konopnica vill., 1100-1300 m, *Orno-Quercetum petraeae*; *Festuco heterophyllae-Fagetum*, 3.06.2002, 5.06.2003, Leg.: Daniela Mitovska; Pelister Mt.: around Kopanki, 1500-1700 m, *Digitali viridiflorae-Pinetum peuces* with *Fagus*, 19.10.2005, Leg.: MMS; Shar Planina Mt.: Jelak, 1700 m, ?mixed forest (*Fagus* and *Picea*), 10.07.1995, exs. MAK 95/1381; footpath to Leshnica, *Abieti-Fagetum macedonicum*, 4.07.1993, Leg.: M. Karadelev; around Staro Selo vill., 1000 m, 17.07.1997, Leg.: BSRS; Kobilica, Kobilichka Shuma (Brodec vill.), cut *Fagus* forest, 1.10.2006, Leg.: Ljupcho Melovski & Marina Janchevska; between Lavci vill. and Selce vill., 700-800 m, edge of deciduous forest, 11.10.2006, Leg.: K. Rusevska; vicinity of Skopje: Matka, 250-300 m, *Quercus-Carpinetum orientalis macedonicum*, 25.10.1998, Leg.: M. Karadelev, Matka, Osoj, 300 m, deciduous forest, 25.10.2006, Leg.: Redzep Aliu & Bedri Gjureski; Vodno, near Krushopek vill., 800 m, *Quercus-Carpinetum orientalis macedonicum*, 16.10.2005, exs. MAK 05/5265; Skopska Crna Gora Mt.: Ljubanci vill., above St. Nikola monastery, 800-900m, 15.10.2006, edge of oak forest with *Castanea* plantings, 29.10.2006, *Quercus* and *Carpinus* forest, Leg.: K. Rusevska; Rashtak vill., 700 m, oak forest, 29.10.2006, Leg.: Mile Aleksovski & Jasmina Dimitrovska-Shumkova, vicinity of Ljubanci vill., 800 m, oak forest, 18.8.2002, around monastery St. Nikola, 800 m, *Quercus-Carpinetum orientalis macedonicum*, 11.09.2005, Leg.: K. Rusevska; Tetovo: below Kale, 450-500 m, deciduous forest, 11.10.2006, Leg.: K. Rusevska.

*\*Xerocomus ferrugineus* (Schaeff.) Bon

Collections: MAK

Kichevo: Jagol Dolenci vill., 14.10.2006, oak forest, exs. MAK 06/6173; Kitka Mt.: Gorno Kolichani vill., 800

m, deciduous forest (*Quercus*, *Carpinus*), 18.05.2004, exs. MAK 04/4002; Kozhuf Mt.: Asan Cheshma, 1200-1300 m, *Fagetum*, 13.07.2004, exs. MAK 04/4180.

*Xerocomus porosporus* (Imler ex G. Moreno & Bon) Contù

Collections: MAK, PRM

Misappl.: *Xerocomus truncatus* Sing., Snell & E.A. Dick sensu auct. Europ. Non Singer, Snell & E.A. Dick

Ref.: Tortić, 1988 (published also as *X. truncatus* Sing., Snell & Dick)

Pelister Mt.: Brajchino vill., 1300 m, *Festuco heterophyllae-Fagetum*, under *Fagus*, 15.08.2002, exs. MAK 02/3704; near Skopje: Matka, Osoj, 300 m, 25.10.2006, deciduous forest, exs. MAK 06/6193; Vodno, near Krushopek vill., 800 m, meadow, 16.10.2005, exs. MAK 05/5266.

*\*Xerocomus rubellus* (Krombh.) Quéf.

Collections: MAK

Kavadarci: Vitachevo vill., near the lake, *Pinus* and *Quercus* forest, 17.10.1998, Leg.: M. Karadelev; Kozhuf Mt.: Visoka Chuka, 1000 m, *Festuco heterophyllae-Fagetum*, 07.1998, Leg.: M. Karadelev; Pelister Mt.: around Kopanki, 1500-1700 m, *Digitali viridiflorae-Pinetum peuces* with *Fagus*, 19.10.2005, Leg.: MMS; Prespa: Pretor, Mite Bogoevski children's resort, park, under *Betula*, 09.2006, Leg.: MMS; Shar Planina Mt.: Popova Shapka, 1600 m, meadow in *Calamintho grandiflorae-Fagetum*, 5.07.1993; exs. MAK 93/1601.

*Xerocomus subtomentosus* (L.: Fr.) Quéf.

Ref.: Pilát & Lindtner, 1939 (published as *Boletus subtomentosus* (L.) Fr.); Tortić, 1975, 1988; Karadelev & Rusevska, 2002; Karadelev et al., 2003a

Collections: MAK, PRM, ZA

Bigla Mt.: Kaljkoec, 1100-1500 m, *Quercus* and *Fagus* forest, 15.08.2002, Leg.: I. Golovodovski; Bistra Mt.: Lazaropole vill., footpath to Javorska Voda, 1300-1100 m, *Fagus* and *Quercus* forest with *Pinus* plantings, 1.08.2006, exs. MAK 06/5877; Demir Hisar: Smilevo vill., 6.11.2004, exs. MAK 04/4774; Galichica Mt.: Oteshevo vill., 900 m, oak forest, 9.11.2002, Leg.:



Tanja Tasevska; Kozhuf Mt.: Nancheva Chesma, 350 m, oak forest, 29.04.2002, exs. MAK 02/2698; Pelister Mt.: above Brajchino vill., Pae, 1300 m, *Quercus cerris* forest, 15.08.2002, exs. MAK 02/3700; Skopje and vicinity: Gazi Baba, Botanical Garden (Faculty of Natural Science and Mathematics), 250 m, park, 10.2005, Leg.: M. Karadelev; Vodno, Krushopek vill., oak forest, 15.06.2005, exs. MAK 05/5486; Skopska Crna Gora Mt.: above Rashtak vill., Peshter, 800 m, deciduous forest with *Castanea* plantings, under *Fagus*, 2.09.2001, exs. MAK 01/611.

## Discussion and Conclusions

### *Chalciporus* Bat. (1908)

Of a total of 4 species known for Europe (Horak, 2005), 2 species have been recorded in the Republic of Macedonia: *Chalciporus amarellus* and *Ch. piperatus*.

*Chalciporus amarellus* grows in coniferous forests or alpine pastures under *Picea* or *Pinus sylvestris*. According to Krieglsteiner (2000), this species is ectomycorrhizal with coniferous trees (*Picea*, *Abies*). In the Republic of Macedonia, it has been observed at 1 locality, Shar Planina Mt., in a spruce forest. It is a new species for the mycobiota of the Republic of Macedonia.

*Chalciporus piperatus* is a widespread species, growing in coniferous forests, among mosses, along pathways, etc., principally at mountain elevations, rarely in hardwood forests, on both acid and calcareous soils (Breitenbach & Kränzlin, 1991). As indicated by Horak (2005), this species is ectomycorrhizal with different deciduous and coniferous trees. In the Republic of Macedonia, it has been registered at 5 localities and the data from Kozhuf Mt. and Shar Planina Mt. are new for this species. It has been found between 1370 and 1800 m altitude, in molika pine (*Pinus peuce*), spruce, and mixed fir-beech forests.

### *Gyrodon* Opat. (1836)

As maintained by Horak (2005), *Gyrodon lividus* is ectomycorrhizal only with *Alnus*. This widespread distributed but uncommon species (Breitenbach & Kränzlin, 1991) has been found in 2 localities in the Republic of Macedonia; therefore, a conclusion on its distribution cannot be drawn. According to Breitenbach & Kränzlin (1991), it is a colline to subalpine species and

our data are from 300 and 1200 m altitude. This is a new genus for the Republic of Macedonia.

### *Gyroporus* Quél. (1886)

According to Horak (2005), 2 species from the genus *Gyroporus* are known in Europe. Both of them have been recorded in the Republic of Macedonia.

*Gyroporus castaneus* is a rare species, growing in hardwood and coniferous forests, especially under *Quercus* (Breitenbach & Kränzlin, 1991). In the Republic of Macedonia, it has been observed at 7 localities, between 700 and 900 m altitude. The data are from oak and chestnut forests, and according to Krieglsteiner (2000), its mycorrhizal partners are broadleaved trees (*Quercus* spp., *Fagus sylvatica*, *Coryllus avellana*).

*Gyroporus cyanescens* grows in forests and parks, on sandy soil. Several localities have been published (Tortiç, 1988); Bistra Mt. is a new site for the Republic of Macedonia. According to Hansen & Knudsen (1992), it grows with *Betula* or *Picea*, and Krieglsteiner (2000) also cited *Fagus* as a mycorrhizal partner. Our data are from oak and beech forests at 600-1500 m altitude.

### *Leccinum* Gray (1821)

According to Horak (2005), 16 species are known for Europe. Thus far in the Republic of Macedonia the following 8 species have been registered: *Leccinum aurantiacum*, *L. duriusculum*, *L. pseudoscabrum*, *L. quercinum*, *L. scabrum*, *L. variicolor*, *L. versipelle*, and *L. vulpinum*.

*Leccinum aurantiacum* is known from 4 localities in the Republic of Macedonia, (Tortiç, 1988; Karadelev & Rusevska, 2002). It is associated with *Populus tremula*; our data are mainly from under *Populus*, but also under *Betula*.

*Leccinum duriusculum* is known from 2 localities, under *Populus* on Pelister Mt. (Karadelev et al., 2003a) and Kichevo, and according to Krieglsteiner (2000), it is mycorrhizal mainly with *Populus*. This is not a common species, and so the distribution on the existing data cannot be finalised.

*Leccinum pseudoscabrum* grows primarily under *Carpinus*, *Corylus* but also *Populus*, *Quercus*, and rarely *Fagus* (Breitenbach & Kränzlin, 1991). In the Republic of

Macedonia, it was previously known from 2 localities (Tortić, 1988; Karadelev et al., 2002b; Karadelev & Rusevska, 2002) to which 6 new localities can be added (Bistra, Bogdanci, Kitka, Nidzhe, Pelister, and Skopska Crna Gora mountains). The data are mainly from beech, oak, or deciduous forests with *Quercus* or *Corylus*, but it has also been found under *Betula*.

*Leccinum quercinum* is associated with *Quercus*, and occasionally with *Fagus*, (Horak, 2005). There are 3 localities in the Republic of Macedonia: Bistra Mt. (Karadelev & Rusevska, 2004), Kozhuf Mt. and Vodno Mt., between 800 and 1600 m altitude, all associated with *Quercus*.

*Leccinum scabrum* is always mycorrhizal with *Betula* (Breitenbach & Kränzlin, 1991). It is known from 5 localities (Tortić, 1988; Karadelev et al., 2003a; Karadelev & Rusevska, 2004), 2 of which are new (Deshat Mt., Strumica and vicinity of Krushevo). The data are from different associations but always under *Betula*, at 300-1550 m.

*Leccinum variicolor* is another species associated with *Betula*. There is only 1 unpublished record for the Republic of Macedonia, registered in *Osmunda regalis* stands in *Periploco-Alnetum glutinosae*, under *Betula*.

*Leccinum versipelle*, mycorrhizal with *Betula*, has been recorded at 2 localities: Jakupica Mt. (Karadelev et al., 2002b) and Korab Mt. (a new site).

*Leccinum vulpinum* is mycorrhizal with *Pinus sylvestris*. As indicated by the current data, it has been found at 1 locality in the Republic of Macedonia, in a pine plantation.

#### *Phylloporus* Qué. (1888)

According to Horak (2005), 1 species - *Phylloporus pelletieri* - from this genus is known for Europe, which has also been found in our country. The data are from Bistra Mt. and Jablanica Mt., in beech forests. This is a new genus for the Republic of Macedonia.

#### *Suillus* Adans (1763)

According to Horak (2005), 13 species are known for Europe. Until the present, in the Republic of Macedonia the following 9 species with 1 variety have been observed: *Suillus bovinus*, *S. collinitus*, *S. granulatus*, *S.*

*mediterraneensis*, *S. grevillei*, *S. luteus*, *S. plorans*, *S. sibiricus* subsp. *helveticus*, and *S. variegatus*.

According to Breitenbach & Kränzlin (1991), *Suillus bovinus* is a widespread species; it grows under 2-needle species of *Pinus*. In the Republic of Macedonia, it has been recorded from Nidzhe Mt. (Karadelev & Rusevska, 2002); the mountains of Kozhuf and Pelister are new localities for this species. It has been found at 1000 m altitude, under *Pinus nigra* or *P. sylvestris*.

*Suillus collinitus* is mycorrhizal with *Pinus* (Horak, 2005). It has been recorded from Vodno Mt. (Tortić, 1988; Rusevska & Karadelev, 2004); a further 5 localities are new for the Republic of Macedonia (the mountains Kozjak and Pelister and the surroundings of Skopje, Veles and Bogdanci), associated with 2-needle pines, but it has also been found under *Pinus peuce*.

*Suillus granulatus* is a common species, grows in coniferous or mixed conifer-hardwood forests, associated with 2-needle pines. In the Republic of Macedonia, it has been found in 14 localities (5 are new), between 250 and 1550 m altitude, always associated with *Pinus*.

*Suillus grevillei* is a common species, mycorrhizal with *Larix*, lowland to subalpine, it is also found in artificial plantations (Breitenbach & Kränzlin, 1991). In the Republic of Macedonia, it is known from 3 localities, 1 published (Tortić, 1988), while the mountains Bistra and Pelister are new sites. The data come from 900 and 1300-1400 m altitude, in *Larix* plantations.

*Suillus mediterraneensis* in the Republic of Macedonia has been recorded in Pelister Mt. only, at 1000 m altitude, in pine plantation, under *Pinus nigra*, and this is the first record for our country. Horak (2005) cited this species for South Europe, and according to Tkalcec & Mesic (2003) this species has also been registered in Croatia.

*Suillus luteus* is a widespread species growing under *Pinus*, principally *Pinus sylvestris*. It is known from 5 localities (Tortić, 1988; Karadelev & Rusevska, 2000; Karadelev et al., 2003; Karadelev & Rusevska, 2004; Karadelev et al., 2004), 7 being new. It has been observed in pine plantations, conifer-deciduous, and molika pine associations.

According to Horak (2005), *Suillus plorans* grows under 5-needle pines, and Breitenbach & Kränzlin (1991) also cited it as widely distributed in mixed stands of *Larix*

and *Pinus cembra*. According to Karadelev et al. (2003), in the Republic of Macedonia, it is known from 1 locality (Pelister Mt.), in *Digitali viridiflorae-Pinetum peuces*.

*Suillus sibiricus* subsp. *helveticus* is another species associated with 5-needle species of pine. This rare species is known from Pelister Mt., in molika pine associations (Tortić, 1988; Karadelev et al., 2002d; Karadelev et al., 2003a) and is mycorrhizal with *Pinus peuce*. Assyov & Denchev (2004) cited this species for Bulgaria. According to Karadelev (2000a), this species is included in the Preliminary Red List of Macromycetes in the Republic of Macedonia, as a species found in endangered or rare habitats.

*Suillus variegatus* is a widespread species; it grows under 2-needle species of *Pinus* (Breitenbach & Kränzlin, 1991). Until now 1 locality was known, Jakupica Mt. (Tortić, 1988); Ograzhden Mt. is a new site.

#### *Tylophilus* P.Karst. (1881)

According to Horak (2005), 1 species of *Tylophilus*, *T. felleus*, is known for Europe, which has been found in our country. There are 3 localities for the Republic of Macedonia (Karadelev, 1995; Karadelev et al., 2003a), and 3 additional sites are new (mountains of Kozhuf and Ograzhden, and Kichevo). The data are from deciduous and coniferous forests, between 800 and 1200 m altitude.

#### *Xerocomus* Quél. in Mougeot & Ferry (1887)

According to Horak (2005), 13 species are known for Europe. In the Republic of Macedonia, thus far, the following 8 species have been noted: *Xerocomus armeniacus*, *X. badius*, *X. chrysenteron*, *X. ferrugineus*, *X. porosporus*, *X. rubellus*, and *X. subtomentosus*.

As maintained by Karadelev et al. (2003a), *Xerocomus armeniacus* has been registered at 1 locality (Pelister Mt.), in *Digitali viridiflorae-Pinetum peuces*. Horak (2005) cited broadleaved trees (*Quercus*, *Fagus*, *Castanea*, *Corylus*, and *Tilia*) and *Pinus* and *Abies* as mycorrhizal partners. The distribution of this species in the Republic of Macedonia has not been sufficiently investigated, but most likely it forms mycorrhiza with *Pinus peuce*.

*Xerocomus badius* is a common species; it grows in coniferous forests, rarely in hardwood. There are 4

localities known for the Republic of Macedonia (Karadelev & Rusevska, 2004; Karadelev et al., 2004) with 2 new sites (the surroundings of Bogdanci and Jablanica Mt.), in oak, beech, and pine forests, between 150 and 1700 m altitude.

*Xerocomus chrysenteron* is a common species growing in hardwood and coniferous forests. In the Republic of Macedonia it is a widespread species and known from many localities. Thirteen sites are new, ranging between 150 and 1900 m altitude. It has been noted in different associations: beech, oak, molika pine forests, in pine plantations, etc.

*Xerocomus ferrugineus* is associated with coniferous trees (Horak, 2005). In the Republic of Macedonia it has been observed at 3 localities, (Kichevo, Kitka and Kozhuf Mt.), in hornbeam-oak and beech forests and is a new species for the country.

*Xerocomus porosporus*, according to Hansen & Knudsen (1992), grows in hardwood forests. In the Republic of Macedonia this species is known from Shar Planina Mt. (Tortić, 1988, published as *X. truncatus*, after the revision by Pouzar). Two more localities (Pelister Mt. and the vicinity of Skopje) are new. It has been found between 800 and 1300 m altitude, in beech forests and meadows.

*Xerocomus rubellus* grows in mixed hardwood forests, parks, and gardens. It is a new species for the Republic of Macedonia, recorded at 5 localities (mountains of Kozhuf, Pelister, Shar Planina, and the surrounding area of Kavadarci and Prespa), between 1000 and 1700 m altitude, in pine-oak, beech forests, *Digitali viridiflorae-Pinetum peuces* with *Fagus*, and in parks.

*Xerocomus subtomentosus* is a widespread species; it grows in hardwood and coniferous forests. In the Republic of Macedonia it has been noted in 12 localities (Tortić, 1988; Karadelev & Rusevska, 2002; Karadelev et al., 2003a), 7 of which are new. It has been found between 250 and 1500 m altitude, in hornbeam-oak and molika pine associations.

A total of 31 species of *Boletaceae* s.l. (excluding *Boletus*), belonging to 8 genera are recorded from the Republic of Macedonia. There are 2 genera (*Gyrodon* and *Phylloporus*) and 8 species (*Chalciporus amarellus*, *Gyrodon lividus*, *Leccinum variicolor*, *Leccinum vulpinum*, *Phylloporus pelletieri*, *Suillus mediterraneensis*,

*Xerocomus ferrugineus*, and *Xerocomus rubellus*) reported as new for Macedonia. According to available data, *Gyroporus castaneus*, *Suillus granulatus*, *S. luteus*, *Xerocomus chrysenteron*, and *X. subtomentosus* are widespread species in the Republic of Macedonia, while the species *Suillus bovinus* and *Xerocomus badius* are rare. According to Karadelev (2000a), *Suillus sibiricus* subsp. *helveticus* is included in the Preliminary Red List of Macromycetes in the Republic of Macedonia, as species found in endangered or rare habitats. Species that do not occur frequently (known from only 1 locality), whose

distribution is not well researched, and which are still assumed to be rare are the following: *Chalciporus amarellus*, *Leccinum duriusculum*, *L. vulpinum*, *Suillus plorans*, and *Xerocomus armeniacus*.

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