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THE DISTRIBUTION AND DIVERSITY OF *Boletus* GENUS IN CENTRAL SERBIA

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ABSTRACT: Since *Boletus* genus contains mainly thermophile species, the territory of central Serbia (especially wider region of Kragujevac) is right place to search for boletes. Extraordinary diversity of *Boletus* species proves this claim. Mycological society of Šumadija (MSS-KG) has collected the comprehensive data of *Boletus* genus. Many rare to extremely rare *Boletus* species everywhere in Europe are recorded in defined area. The finding of *B. lupinus* is unique in Serbia. Also one species from *Boletus* genus on ECCF list of 33 very rare species prepared for Bern convention, *B. dupainii* has two different habitats near Kragujevac. The variety of *Boletus* section brings same dilemmas about legal taxons. Certainly, in this field the additional work is needed to more appropriate definition. Higher altitude terrains are habitat for only few *Boletus* species but those are very frequent.

Keywords: *Boletus* genus, diversity, thermophile-xerophile species, region of Kragujevac

INTRODUCTION

Permanently, professional and amateur mycologists are discovering fascinate fungal biodiversity. Macro fungi are specific part of this fifth kingdom. Their sporocarps are visible without using a magnifying apparatus. More than 15000 species of macro fungi are identified in Europe and this work is far away from the finish. In 1985 the European Council for the Conservation of Fungi (ECCF) was established with primary objective to promote conservation of fungi. Almost all European countries have their representatives, mainly professional mycologists in ECCF, including Serbia. According to GUIDANCE OF ECCF (2007), many European countries have a lack of professional mycologist and the important part of ECCF activities depends of non-governmental organization (NGOs), mycological societies and amateur mycologists. One of the based activities of ECCF and local mycological (governmental and non-governmental) organizations is identification of threatened species and their habitats, establishing Checklist and Red-list of fungi. Unfortunately, some organized, coordinated activity of inventorying, mapping and conservation of macro fungi cannot be recognized in Serbia. Mostly, those are activities of separated NGOs or individuals. Mycological Society of Šumadija (MSS-KG) is one of the most active NGO in Serbia. One

small part of macro fungi inventorying activity of MSS-KG is already recorded and published (LUKIĆ, 2008).

Wider region of Kragujevac abounds with quality forest terrains, dominating mainly by *Quercus* spp. Under specific local climate condition and with mentioned mycorrhizal host, the numerous thermophile macrofungi species have found their habitat on defined location. *Boletus* genus is one of the typical thermophile genera of fungi with few exceptions. In regard to the large number of edible species, this genus is probably the most popular among mushroom hunters. However, variability of genus appearance makes it very interesting for the study. Since its founding the MSS-KG has collected the comprehensive data of *Boletus* genus. The selected information from this file will be shown in the following text.

METHODS

The inventorying of macro fungi is capacious work that demands a good organization, a scientific approach, a lot of time and a serious work on terrain. The MSS-KG disposes with the numerous memberships and a good organization. The illustration for this is eight fungi exposures realized on the Faculty of Natural Science in Kragujevac. In Serbia up to 1993 only 650 macro fungi species have been identified officially among which 11 species of *Boletus* genus (IVANČEVIĆ, 2002). In addition, there are many taxons that demand revising. The MSS-KG possesses about 700 macro fungi identified species. Unfortunately, beside the quality photographs and systematic notation there are no exicats saved (no space and conditions). The mushroom samples have been studied using all necessary equipments (microscope, chemical reagents) and literature. Although well known, in recent times (since eighties) the *Boletus* genus has experienced significant changes especially in "*purpureus*" group. The disposable literature (COURTECUISSE, 1995 and 1999; JORDAN, 2004; MOSER, 1983; PHILLIPS, 2006; FOHT 1987; and GALLI, 2000) has provided a correct identification of the founded samples.

RESULTS

The fungi samples of *Boletus* genus were collected on numerous locations near to the urban zone of Kragujevac (radius of 10 kilometres), on two locations in the urban zone (City park and Šumarice park) and on the mountains as Kopaonik, Rudnik, Gledić, Goč, Maljen and Jelica. Number of visits to the particular location is smaller with increasing the distance from Kragujevac. Table 1 presents the number of visits to defined location within last five years of investigation.

Table 1. Frequency of site visit

Location	Number of visits
Urban zone (City park, and Šumarice park) (KG)	>200
Suburb of Kragujevac (10 km radius) (KGP)	>200
Mountain of Gledić (GP)	>20
Mountain of Rudnik (R)	>20
Mountain of Goč (G)	10
Mountain of Maljen (Divčibare) (M)	5
Mountain of Kopaonik (K)	5
Mountain of Jelica (J)	2

According to the frequency classes of sporocarps appearance, the approach of COURTECUISSE (1995) has been accepted. This approach considers eight frequency classes:

EC-extremely common; VC-very common; C-common; F-frequent; S-scarce; R-rare; VR-very rare and ER-extremely rare. In literature, similar methods can be found with seven frequency classes (MARRIOTT, 2005). According to the total number of reliable finding of *Boletus* species, the every particular frequency class has been adopted. In addition, the frequency classes are different depending of a terrain altitude. Two altitude classes have been considered: LA-lower altitude and HA-higher altitude.

The presented *Boletus* diversity in central Serbia by MSS-KG is very detailed, reliable and comprehensive for wider region of Kragujevac but for the rest territory included, an additional research is needed. Since *Boletus* genus contains mainly thermophile species, the lack of HA data is not so significant. The distribution and diversity of *Boletus* genus in central Serbia according to the database of MSS-KG are shown in Table 2. The recognised mycorrhizal host and month of record for any *Boletus* species are also shown in Table 2.

DISCUSSION

The diversity of *Boletus* genus in central Serbia, especially in wide region of Kragujevac is extraordinary. Only a few valid European *Boletus* species are not recorded in explored area. Mycorrhizal host of *Boletus* species in central Serbia is mainly *Quercus sp*. Despite the conservation low (SLUŽBENI GLASNIK RS 31/05, 2005), every season true boletes as export goods have been cleaned systematically on territory of Serbia.

Figure 1. *B. pinophilus* Pilat et Dermek

Figure 2. *B. quercicola* (Vassilkov) Singer !?

According to recent literature, Boletus section in *Boletus* genus (true boletes) contains four main taxons: *B. edulis, B. pinophilus* (Fig. 1)*, B. aestivalis* and *B. aereus*. The first two are typical criophile and hygrophile species (especially *B. pinophilus*). On the other hand, *B. aestivalis* and *B. aereus* as typical termophile and xerophile species are very frequent in region of Kragujevac. Although this topic does not permit the detailed analysis, some dilemmas must be emphasized.

The very frequent taxon (Fig. 2) in explored region cannot be recognized as *B. aestivalis*. Unlike *B. aestivalis* this taxon has never cracked cap and has very short net on the stem like *B. aereus*. The nearest taxon to described species is *B. quercicola* (invalid name according to recent literature) but it has long net on the stem. Other question mark is examined taxon, the nearest to the forgotten taxon (Fries, 1818), *B. rubiginosus*. Taxon (Fig. 3) has reddish brown never cracked cap, long net on the slender stem and corrugated cap margin in ripe age. Appearance of young mushroom reminds on *Leccinum aurantiacum* (Bull.) Gray. Certainly, in this field the additional work is needed to better definition of the new taxa.

Table 2. Distribution and diversity of *Boletus* Dillenius: Fries genus in central Serbia according to the database of MSS-KG

No. of sp.	**Species**	**Section**	**Synonym**	**Location**	**Mycorrhiza with**	**Month of record**	**Frequency class**	**Note**
1	*B. pulverulentus* Opatowskyi			KG, GP	*Quercus*	VIII-IX	VR(LA)	
2	*B. edulis* Bulliard: Fr.	Boletus		G, M, K	*Fagus, Picea, Abies*	IX-X	VC-C(HA)	
3	*B. persoonii* Bon	Boletus		GP	*Quercus*	VIII	ER(LA)	
4	*B. pinophilus* Pilat et Dermek	Boletus	*B .pinicola* (Vitt.) Vent. non Swartz, *Boletus edulis* var. *pinicola* Vitt.	J	*Pinus*	IX	F-R(HA)	
5	*B. aestivalis* (Quel.) Singer	Boletus	*B. reticulatus* Schaeffer ss. Boudier	KG, KGP, GP, R	*Quercus, Carpinus*	VI-X	C-F(LA)	
6	*B. quercicola* (Vassilkov) Singer	Boletus		KG, KGP, GP, R	*Quercus*	V-XI	VC-C(LA)	Invalid name
7	*B. rubiginosus* Schrad.: Fr.	Boletus		KG	*Quercus*	VI-IX	ER(LA)	Invalid name
8	*B. aereus* Bulliard: Fr.	Boletus		KG, KGP, GP, R	*Quercus*	V-X	C-F(LA)	
9	*B. appendiculatus* Schaeffer	Appendiculati Konr. et Maub.		KG, KGP, R	*Quercus, Fagus*	VIII-X	R-VR(LA)	
10	*B. subappendiculatus* Dermek, Lazebnicek et Veselsky	Appendiculati Konr. et Maub.		K	*Picea*	VIII, X	R(HA)	
11	*B. regius* Krombholz	Appendiculati Konr. et Maub.		KG, KGP, GP, R	*Quercus*	V, VII-X	S-R(LA)	
12	*B. fechtneri* Velenovsky	Appendiculati Konr. et Maub.	*B. appendiculatus* subsp. *pallescens* Konrad	KGP	*Quercus*	VI-VII	R-VR(LA)	
13	*B. pseudoregius* Hubert ex Estades	Appendiculati Konr. et Maub.		KG, KGP, GP, R	*Quercus*	VI-X	S-R(LA)	

14	*B. fragrans* Vittadini	Fragrantes		KG, GP	*Quercus*	VIII-IX	VR-ER(LA)	
15	*B. impolitus* Fr.	Fragrantes		KG, KGP, GP, R	*Quercus*	V-X	S(LA)	
16	*B. depilatus* Redeuilh	Fragrantes		KG, R	*Carpinus, Qercus*	VIII	ER(LA)	
17	*B. calopus* Persoon: Fr.	Calopodes Fr.		KG, R, G, K	*Quercus, Fagus, Picea, Abies*	VII, IX, X	F-S	
18	*B. pachypus* Fr.: Fr.	Calopodes Fr.		KG	*Quercus, Tilia*	IX	ER(LA)	
19	*B. radicans* (Fr.: Fr.) Michael	Calopodes Fr.	*B. albidus* Roques	KG, KGP, GP, R	*Quercus*	VIII, IX	S-R(LA)	
20	*B. luridus* Schaeffer: Fr.	Luridi Fr.		KG, KGP, GP, R	*Quercus*	VI-X	S-R(LA)	
21	*B. satanas* Lenz	Luridi Fr.		KGP, GP, R	*Quercus*	VIII-X	R-VR(LA)	
22	*B. pulchrotinctus* Alessio	Luridi Fr.	*B. cicognanii* Ubaldi	KGP	*Quercus*	IX	ER(LA)	Incomplete data
23	*B. rhodopurpureus* Smotlacha	Luridi Fr.	*B. purpureus* ss. auct.	KGP, GP	*Quercus*	VI-VIII	R(LA)	
24	*B. luteocupreus* Bertea et Estades	Luridi Fr.		KG, KGP, GP	*Quercus*	VI-IX	S-R(LA)	
25	*B. rhodopurpureus* var. *gallicus* (Romagnesi) Redeuilh	Luridi Fr.		KG	*Quercus*	VIII-IX	VR(LA)	
26	*B. rhodoxanthus* (Krombholz) Kallenbach	Luridi Fr.		KGP, GP, R	*Quercus*	VI, VIII	S-R(LA)	
27	*B. legaliae* Pilat et Usak	Luridi Fr.	*B. splendidus* Martin ss. Sing. B. *satanoides* Smotlacha	KG, R	*Quercus*	VI-IX	R-VR(LA)	

28	*B.lupinus* Fr.	Erythropodes		KGP	*Quercus*	VIII	ER(LA)	
29	*B. dupainii* Boudier	Erythropodes		KGP, GP	*Quercus*	VIII-IX	VR(LA)	
30	*B. erythropus* Persoon	Erythropodes		KG, KGP, GP, R, G, K	*Quercus, Fagus, Picea, Abies, Pinus*	VII-X	C-F	
31	*B. erythropus* var. *discolor* (Quelet) Krieglstein et Gerhold	Erythropodes		KG, KGP	*Quercus*	VI-VIII	R(LA)	
32	*B. junquilleus* (Quelet) Boudier	Erythropodes		KG	*Carpinus*	VIII	ER(LA)	
33	*B. queletii* Schulzer	Erythropodes		KG, KGP, GP, R	*Quercus, Tilia*	V-X	C-S(LA)	
34	*B. queletii* var. *discolor* (Quelet) Alessio ss. Alessio	Erythropodes		KG, KGP	*Quercus*	VI-X	R(LA)	
35	*B. queletii* var. *zugazae* Moreno	Erythropodes		KGP	*Quercus*	VIII	ER(LA)	

Figure 3. *B. rubiginosus* Schrad.: Fr. !?

Figure 4. *B. regius* Krombholz

In section Appendiculati, all European known species are presented in central Serbia. Some of them are very rare as *B. appendiculatus*; others are even scarce as *B. pseudoregius* (Fig. 5). The species, *B. regius* (Fig. 4), placed in many European Red-lists of fungi, has numerous habitats in explored region.

Figure 5. *B. pseudoregius* Hubert ex Estades

Figure 6. *B. impolitus* Fr.

Figure 7. *B. fragrans* Vittadini

Figure 8. *B. luteocupreus* Bertea et Estades

All European species of section Fragrantes are termophile and xerophile (distribution of *B. depilatus* is not fully understood). Also, species of section Fragrantes are rare to extremely rare everywhere in Europe (especially on North). Species *B. fragrans* (Fig. 7) is typical example for this. According to FOHT (1987), south of river Sava *B. impolitus* (Fig. 6) has not been found. Obviously, this data turned to be invalid due to numerous findings of *B. impolitus* in central Serbia.

Section Calopodes contains widespread *B. calopus*, termophile-xerophile *B. radicans* and specific taxon, *B. pachypus* with red ringlike zone on the stem apex.

Section Luridi is the largest in the genus. It contains acidophile, neutrophile and alcalophile groups. All species in the section are mostly thermophile and xerophile. Significant number of species has become from old taxon *B. purpureus* Fr. Thermophile and xerophile *B. luteocupreus* (Fig. 8) is one of them. In recent literature the typical southern species *B. satanas* (Fig. 10) is indicated as highly poisonous (PHILLIPS, 2006) and even edible species (GALLI, 2000). In any case, edibility of *B. satanas* is very similar to other species from section Luridi. Species *B. rhodoxanthus* (Fig. 9) as unripe can be very similar to *B. satanas* but on first view only. Another example of the lack of terrain work is habitat of *B. rhodoxanthus*. At GALLI (2000) *B. rhodoxanthus* grows on acid soils, but at COURTECUISSE (1995) the same species grows on calcareous soils. Our experience points on first conclusion.

Finally, with exception of *B. erythropus*, all species in section Erithropodes are typical thermophile and xerophile. Some of them are Mediterranean species as *B. lupinus* (Fig. 12). In Serbia only one finding of this remarkably species was found near village of Drača. Many mycologists consider extremely rare species, *B. junquilleus* as "forma xanthoide" of *B. erythropus*. Some transitional form (with orange-yellow pores) was found in park Šumarice. One species from Boletus genus on ECCF list of 33 very rare species prepared for Bern convention (ECCF, 33 threatened fungi in Europe, 2003) is *B. dupainii* (Fig. 11). Mentioned species has two different habitats near Kragujevac.

Figure 9. *B. rhodoxanthus* (Krombholz) Kallenbach

Figure 10. *B. satanas* Lenz

CONCLUSION

The distribution and diversity of *Boletus* genus in central Serbia is extraordinary. With exception of few species (*B. aemilli* Barbier, *B. permagnificus* Poder, *B. poikilochromus* Poder, Cetto et Zuccher, etc.), all European *Boletus* species are recorded in central Serbia. Wide region

of Kragujevac can be recognized as habitat of thermophile and xerophile *Boletus* species. Mycorrhizal host of those species is mainly *Quercus sp*. Some very rare species everywhere in Europe have habitats in defined region (*B. dupainii*, *B. fragrans*, *B. lupinus*, *B. depilatus*, …). Higher altitude terrains are habitat for only few *Boletus* species but those are very frequent (for example, *B. edulis* or *B. erythropus*).

Figure 11. *B. dupainii* Boudier

Figure 12. *B. lupinus* Fr.

* Mycological Society of Šumadija has authority on all shown pictures.

References:

[1] COURTECUISSE, R. & DUHEM, B. (1995). *Mushrooms and tead-stools of Britain and Europe*. Harper Collins, London.

[2] COURTECUISSE, R. (1999). *Mushrooms of Britain and Europe*. Harper Collins, London.

[3] ECCF (2003). 33 threatened fungi in Europe – Complementary and revised information on candidates for listing in Appendix I of the Bern Convention. *T-PVS (2001) 34 REV* 2.

[4] ECCF. (2007). *Guidance for Conservation of Macrofungi in Europe*.

[5] FOHT, I. (1987). *Naši vrganji*. Nakladni zavod Znanje, Zagreb.

[6] GALLI, R. (2000). *I Boleti*. Edinatura, Milano.

[7] IVANČEVIĆ, B. (2002). Zabeležene vrste makromiceta u Srbiji i Crnoj Gori do 1993. godine. *Svet gljiva* 14: 7-10.

[8] JORDAN, M. (2004). *The encyclopedia of fungi of Britain and Europe*. Frances Lincoln, London.

[9] LUKIĆ, N. (2008). The distribution and diversity of *Amanita* genus in central Serbia. *J.Sci.*30: 105-115.

[10] MARRIOTT, J.V.R. (2005). A tool for the assessment of agaric site diversity, *Mycologist* 19: 168-174.

[11] MOSER, M. (1983). *Keys to Agarics and Boleti*. Roger Phillips, London.

[12] PHILLIPS, R. (2006). *Mushrooms*. Macmillan, London.

[13] SLUŽBENI GLASNIK RS 31/05 (2005) *Uredba o stavljanju pod kontrolu korišćenja i prometa divlje flore i faune*.