

## THE DISTRIBUTION AND DIVERSITY OF *Amanita* GENUS IN CENTRAL SERBIA

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**ABSTRACT:** Only a few active mycological societies compensate a lack of coordinated activity to establishing of the reliable macrofungi Checklist in Serbia. One of those is Mycological society of Šumadija (MSS-KG). In this paper the distribution and diversity of *Amanita* genus in Central Serbia are shown according to the fungi database of MSS-KG. Especially, the comprehensive database is obtained in wider region of Kragujevac. The results point on the extraordinary diversity of *Amanita* genus on considered territory. One small, explored area as the Park of Šumarice is habitat for numerous *Amanita* species (about 50% of all registered species). Generally, the thermophile species, even the typical Mediterranean species habit in wider region of Kragujevac (some of them exclusively). Serbia has no protected areas due to an extraordinary diversity or a habitat of rare species of macrofungi.

**Keywords:** *Amanita* genus, diversity, thermophile species, region of Kragujevac

### INTRODUCTION

Since seventies fungi have had own kingdom. Permanently, professional and amateur mycologists are discovering fascinate fungal biodiversity. Macrofungi are specific part of this fifth kingdom. Their sporocarps are visible without using a magnifying apparatus. More than 15000 species of macrofungi 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. The ECCF intends to produce a European Red-List of macrofungi by 2010 (GUIDANCE OF ECCF, 2007). Reading the

ECCF reports from Serbia compiled by IVANČEVIĆ (2000) and (2006) it can be founded that the most activities of inventorying, mapping and conservation of macrofungi were carried out by NGOs. There are two the most active NGOs: Mycological Society of Serbia (including professional mycologists, Belgrade, MSS-BG) and Mycological Society of Šumadija (Kragujevac). These two organizations carried out the Serbia inventorying of threatened macrofungi from ECCF list of 33 very rare species prepared for Bern convention (ECCF, 33 threatened fungi in Europe, 2003). The nine species from ECCF list of 33 are detected in Serbia territory. Unfortunately, those activities are not supported and financed by Serbian government without exception. The facts are: Serbia has no an official Red list of macrofungi (the unofficial Red list is prepared by IVANČEVIĆ, 1998) and any following low. Since 2005 the 15 macrofungi species are protected partially from picking and collecting (SL. GLASNIK RS 31/05). Coordination of inventorying and mapping of macrofungi between NGOs does not exist. There is no an organized and strictly defined activity of fungi identifying, exicats keeping and forming of the national fungi database. Despite those facts the Mycological Society of Šumadija (MSS-KG) is carrying out the inventorying of macrofungi in central Serbia, permanently. There are some of the recent results.

## METHODS

The inventorying of macrofungi 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 seven fungi exposures realized on Faculty of Natural Science in Kragujevac. In Serbia up to 1993 only 650 macrofungi species are identified officially (IVANČEVIĆ 2002). There are many taxa that demand revising. The MSS-KG possesses about 700 macrofungi identified species. Unfortunately beside the quality photographs and systematic notation there are no exicats saved (no space and conditions). The fungi exposure in Kragujevac is only one in Serbia where the members of MSS-BG are not the identifiers of fungi samples. Wider region of Kragujevac abounds with quality forest terrains, mainly with *Quercus* spp.

The mushroom samples have been studied using all necessary equipments (microscope, chemical reagents) and literature. *Amanita* genus is the most interested part of Amanitales order and Amanitaceae family. This genus includes the excellent edible species (*A. ceasarea* (Scopoli: Fr.) Persoon) as well as the most poisonous European species (*A. phalloides* (Vaill. ex Fr.) Link, *A. verna* (Bull.: Fr.) Lamarck and *A. virosa* (Lamarck) Bertillon). The disposable literature (COURTECUISE, 1995 and 1999; JORDAN, 2004; MOSER, 1983; and especially GALLI, 2001) has provided a correct identification of the founded samples.

## RESULTS

The fungi samples of *Amanita* genus were collected on numerous locations near to the urban zone of Kragujevac (radius of 15 km), on two locations in the urban zone (City park and Šumarice park) as well as on the mountains Kopaonik, Rudnik, Gledičke planine, Goč and Maljen. Number of visits to the particularly location is smaller with increasing the distance from Kragujevac. In table 1 the number of visits to defined location within last five years of investigation is shown.

Table 1 Frequency of site visit

Location	Number of visits
Urban zone (City park, and Šumarice park) (KG)	>200
Periphery of Kragujevac (15 km radius) (KGP)	>200
Mountain of Gledič (GP)	>20
Mountain of Rudnik (R)	>20
Mountain of Goč (G)	10
Mountain of Maljen (Divčibare) (M)	5
Mountain of Kopaonik (K)	5

According to the frequency classes of sporocarps appearance, the approach of COURTECUISSE & DUHEM (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 *Amanita* 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. A fungal diversity can be shown as diversity in particular territory for all macrofungi species, for particular fungal life strategy (saprophyte, mycorrhizal or parasite), (HENKEL *et al.*, 2002), for defined family or genus (SIPPOLA *et al.*, 2005) or for defined mycorrhizal host (KRPATA *et al.*, 2007). Other approaches of fungal diversity are also possible. The presented *Amanita* diversity in central Serbia by MSS-KG is very detailed, reliable and comprehensive for wider region of Kragujevac but for the rest territory involved, an additional reserch is needed. The distribution and diversity of *Amanita* 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 *Amanita* species are also shown in Table 2.

Table 2 The distribution and diversity of *Amanita* genus in central Serbia according to the database of MSS-KG

No. of sp.	Species	Subgenus and section	Synonym	Location	Mycorrhiza with	Month of record	Frequency class	Note
1	<i>A. caesarea</i> (Scopoli: Fr.) Persoon	<i>Amanita</i> Singer Caesareae Singer		KG, KGP, GP, R	Quercus	VI-XI	F-S(LA)	
2	<i>A. vaginata</i> (Bull.: Fr.) Lam.	<i>Amanita</i> Singer Vaginatae (Fr.) Quel.		KG, KGP, M, GP, R	Quercus	V-X	F-S	
3	<i>A. vaginata</i> var. <i>alba</i> (De Seynes) Gillet	<i>Amanita</i> Singer Vaginatae (Fr.) Quel.		KG, GP, M	Quercus	VI-IX	R-VR(LA)	
4	<i>A. fulva</i> (Schaeffer) Fr.	<i>Amanita</i> Singer Vaginatae (Fr.) Quel.		KG, KGP, GP	Quercus	VII-IX	S-R(LA)	
5	<i>A. crocea</i> (Quel.) Singer	<i>Amanita</i> Singer Vaginatae (Fr.) Quel.		K	Picea	X	S(HA)	
6	<i>A. crocea</i> var. <i>subnudipes</i> Romagnesi	<i>Amanita</i> Singer Vaginatae (Fr.) Quel.		KG, GP, R	Quercus	VIII-IX	S-VR(LA)	
7	<i>A. battarrae</i> (Boud.) Bon	<i>Amanita</i> Singer Vaginatae (Fr.) Quel.		KGP	Quercus	IX	R-VR(LA)	
8	<i>A. magnivolvata</i> Aalto	<i>Amanita</i> Singer Vaginatae (Fr.) Quel.		KGP	Quercus	VI	R-VR(LA)	
9	<i>A. pachyvolvata</i> (Bon) Krieglsteiner	<i>Amanita</i> Singer Vaginatae (Fr.) Quel.		KGP, R	Quercus	VI-IX	R-VR(LA)	

10	<i>A. lividopallescens</i> (Secr. ex Gillet) Seyot	<i>Amanita</i> Singer Vaginatae (Fr.) Quel.		KGP	Quercus	V	VR-ER(LA)	
11	<i>A. spadicea</i> Persoon	<i>Amanita</i> Singer Vaginatae (Fr.) Quel.		K	Picea	X	S-R(HA)	
12	<i>A. argentea</i> Huijsman	<i>Amanita</i> Singer Vaginatae (Fr.) Quel.		KGP	Quercus	IX-X	R-VR(LA)	
13	<i>A. mairei</i> Foley	<i>Amanita</i> Singer Vaginatae (Fr.) Quel.		KG	Quercus	IX	VR(LA)	Incomplete data
14	<i>A. ceciliae</i> (Berkeley & Broome) Bas	<i>Amanita</i> Singer Inauratae Bon	<i>A.strangulata</i> (Fr.) Quel., <i>A. inaurata</i> Secretan ex Gillet	KG	Quercus	IX	R-VR(LA)	
15	<i>A. submembranacea</i> (Bon) Groger	<i>Amanita</i> Singer Inauratae Bon		K	Picea	X	F-S(HA)	
16	<i>A. beckeri</i> Huijsman	<i>Amanita</i> Singer Inauratae Bon		KG	Quercus	VII-X	S-R(LA)	
17	<i>A. muscaria</i> (L.: Fr.) Persoon	<i>Amanitaria</i> (Gilb.) Gilb. -		K, M, G, R	Fagus, Betula, Picea, Abies	IX-X	CC-F(HA) ER(LA)	
18	<i>A. muscaria</i> var. <i>aureola</i> Boudier	<i>Amanitaria</i> (Gilb.) Gilb. -		G, K	Fagus, Picea, Abies	X	S-R(HA)	
19	<i>A. regalis</i> (Fr.: Fr.) Michael	<i>Amanitaria</i> (Gilb.) Gilb. -		G	Fagus, Abies	X	VR-ER(HA)	
20	<i>A. junquillea</i> Quel.	<i>Amanitaria</i> (Gilb.) Gilb. -	<i>A.gemmata</i> (Fr.) Gillet	K	Picea	X	S-R(HA)	

21	<i>A. eliae</i> Quel.	<i>Amanitaria</i> (Gilb.) Gilb. -		GP, KGP	Quercus	V,VI,IX	R-VR(LA)	
22	<i>A. pantherina</i> (De Candolle: Fr.) Krombholz	<i>Amanitaria</i> (Gilb.) Gilb. -		KG, KGP, GP, R, G, K	Quercus, Picea, Fagus, Abies	V-X	F(LA)	
23	<i>A. rubescens</i> Persoon	<i>Lepidella</i> (Gilb.) Vesely Validae (Fr.) Quel.		KG, KGP, R, GP, M	Quercus, Fagus, Pinus	VI-X	C-F(LA)	
24	<i>A. spissa</i> (Fr.) Kummer	<i>Lepidella</i> (Gilb.) Vesely Validae (Fr.) Quel.		KG, M, G, K	Pinus, Picea, Abies, Fagus	VII-X	F-R	
25	<i>A. spissa</i> var. <i>exelsa</i> (Fr.: Fr.) Dorfelt & Roth	<i>Lepidella</i> (Gilb.) Vesely Validae (Fr.) Quel.		KG, M	Pinus	X	VR(LA)	
26	<i>A. spissa</i> var. <i>valida</i> (Fr.) Dorfelt & Roth	<i>Lepidella</i> (Gilb.) Vesely Validae (Fr.) Quel.		K	Picea	IX	VR(HA)	
27	<i>A. franchetii</i> (Boudier) Fayod	<i>Lepidella</i> (Gilb.) Vesely Validae (Fr.) Quel.	<i>A.aspera</i> auct. pl. non Pers., <i>A.queletii</i> Bon & Dennis	KG, KGP, GP, R	Quercus	VIII-X	S-VR(LA)	
28	<i>A. franchetii</i> fo. <i>lactella</i> (Gilb. ex Bertault) Bon & Contu	<i>Lepidella</i> (Gilb.) Vesely Validae (Fr.) Quel.		KG	Quercus	VII	ER(LA)	
29	<i>A. vittadini</i> (Moretti) Vittadini	<i>Lepidella</i> (Gilb.) Vesely <i>Lepidella</i> Bas		KG, GP	Saprophyte species	IX-X	VR-ER(LA)	
30	<i>A. strobiliformis</i> (Paulet ex Vittadini) Bertillon	<i>Lepidella</i> (Gilb.) Vesely <i>Lepidella</i> Bas	<i>A.solitaria</i> ss auct.	KG, R	Quercus	IX-X	VR-ER(LA)	

31	<i>A. echinocephala</i> (Vittadini) Quel.	<i>Lepidella</i> (Gilb.) Vesely <i>Lepidella</i> Bas		KGP, R	Quercus	IX	R-VR(LA)	
32	<i>A. ovoidea</i> (Bulliard: Fr.) Link	<i>Amidella</i> (Gilb.) Konrad&Maublanc -		KGP, GP	Quercus	X	VR-ER(LA)	
33	<i>A. phalloides</i> (Vaill. ex Fr.) Link	<i>Amanitina</i> (Gilb.) Gilb. Phalloideae (Fr.) Quel.		KG, KGP, GP, R, M, G	Quercus, Fagus	VII-XI	C-S(LA)	
34	<i>A. phalloides</i> var. <i>alba</i> (Vittadini) Vesely	<i>Amanitina</i> (Gilb.) Gilb. Phalloideae (Fr.) Quel.		GP, M	Quercus	VIII-IX	R(LA)	
35	<i>A. verna</i> (Bull.: Fr.) Lamarck	<i>Amanitina</i> (Gilb.) Gilb. Phalloideae (Fr.) Quel.		GP	Quercus	V, VIII, IX	VR(LA)	
36	<i>A. virosa</i> (Lamarck) Bertillon	<i>Amanitina</i> (Gilb.) Gilb. Phalloideae (Fr.) Quel.		KGP	Pinus	VII	ER(LA)	Incomplete data
37	<i>A. citrina</i> (Schaeffer) Persoon	<i>Amanitina</i> (Gilb.) Gilb. Mappae Gilb.		KG, KGP, GP, R, G, M	Quercus, Fagus, Abies, Pinus	VIII-XI	CC-F	

## DISCUSSION

The diversity of *Amanita* genus in central Serbia, especially in wider region of Kragujevac is extraordinary. Excluding *Amanita* species from specific habitats such as a very high altitude (*A. nivalis* Greville) or a costal sand (*A. boudieri* Barla, *A. gilbertii* Beauseigneur, *A. curtipes* Gilbert), the territory of central Serbia is home of the most European *Amanita* species.



Figure 1. *Amanita beckeri* Huijsman



Figure 2. *Amanita franchetii* fo. *Lactella* (Gilb. ex Bertault) Bon & Contu

According to the other reliable sources in Serbia (mainly MSS-BG), only a few *Amanita* taxa can be added to Table 2. (*A. pantherina* var. *abietum* (Gilbert) Vesely, *A. porphyria* Albertini & Schweinitz: Fr., *A. umbrinolutea* (Secr. ex Gillet) Bataille) and the *Amanita* genus diversity in Serbia would be completed (in this moment).



Figure 3 *Amanita ovoidea* (Bulliard: Fr.) Link



Figure 4 *Amanita strobiliformis* (Paulet ex Vittadini) Bertillon

Unfortunately, the foreign mycologists and amateurs, reading the comprehensive literature as COURTECUISSÉ & DUHEM (1995) get wrong information that more than half of *Amanita* species defined in Table 2 are not present in Serbia. Within the *Amanita*



genus database of central Serbia, wider region of Kragujevac, especially park of Šumarice takes the special place with its *Amanita* diversity.



Figure 5 *Amanita lividopallescens* (Secr. ex Gillet) Seyot



Figure 6 *Amanita eliae* Quel.

Regarding Table 2 it can be noted that 18 of 37 identified *Amanita* species (48.6%) have been found in small area of Šumarice Park. Four *Amanita* species have a habitat in this park, exclusively (e.g. *Amanita beckeri* Huijsman or *A. franchetii* fo. *lactella* (Gilb. ex Bertault) Bon & Contu, Fig.1 and 2)\*. The typical Mediterranean species, *A. ovoidea* (Bulliard: Fr.) Link exclusively habits in region of Kragujevac (Figure 3). In addition, many very rare thermophile species as *A. echinocephala* (Vittadini) Quel., *A. strobiliformis* (Paulet ex Vittadini) Bertillon (Figure 4), *A. lividopallescens* (Secr. ex Gillet) Seyot (Figure 5), *A. eliae* Quel. (Figure 6) and only one saprophyte in genus, *A. vittadini* (Moretti) Vittadini\*\* (Figure 7) have habitats in region of Kragujevac, also. On the other side, the mountain species, *A. regalis* (Fr.: Fr.) Michael, very rare in Italy and south Europe habits in mountain of Goč (Figure 8).

## CONCLUSION

The distribution and diversity of *Amanita* genus in Serbia is extraordinary. With fascinate *Amanita* genus diversity, some small areas, as Šumarice Park of Kragujevac needs protection by local or national law. The wider region of Kragujevac can be considered as very valuable area for thermophile and even characteristic Mediterranean *Amanita* species. Mycorrhizal host of those species are mainly *Quercus* spp.

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

\*\* Very similar species *A. codinae* (Maire) Singer is saprophyte species too.

Figure 7 *Amanita vittadini* (Moretti) VittadiniFigure 8 *Amanita regalis* (Fr.: Fr.) Michael

In condition of a lack of the official Checklist and Red List of macrofungi, a lack of plan and coordination between mycological societies in Serbia, a deficiency of any financial support to defined activities, an effort of the local active and good organized mycological societies could be very useful to moderate the reported situation.

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