

## Overview of mycological literature, research and herbaria collections on macro fungi of Serbia with reference list

The field guides in south Slavic languages with descriptions taken from foreign mycological literature appeared in the second part of the 20<sup>th</sup> Century and are still used for mushroom determination in the entire region. First field guides for mushroom species determination in southern Slavic languages were written by the very dedicated hobbyists mainly from Slovenia and Croatia, where the culture of collecting and consuming mushrooms was well established (Božac 1989, Focht 1979, 1987, 1988). The keys for determining fungal sporocarps compiled by philosopher Ivan Focht (1979, 1987, 1988) have been the most professional taxonomic literature ever published in the ex Yugoslavia region with the original descriptions from the local findings. Even though he was the only person from ex Yugoslavia listed on the Wikipedia List of mycologists ([https://en.wikipedia.org/wiki/List\\_of\\_mycologists](https://en.wikipedia.org/wiki/List_of_mycologists)), Focht himself has never pretended to address to the scientific community - he dedicated his work to the mushroom gatherers (Focht 1987). Hobbyist field books with very basic descriptions, but claimed to be based on findings in Serbia and in Serbian language were published recently (Davidović 2007, Uzelac 2009). The species nomenclature in all these field guides is long outdated, which makes any kind of literature on fungi survey and analysis in Serbia very difficult.

The investigations on epigeic fungal diversity in Serbia could be divided in three phases. First published data originate from the late 19<sup>th</sup> and early 20<sup>th</sup> centuries, the time of kingdoms of Serbia and Yugoslavia, were the lists of species from the defined territory produced by few foreign and domestic authors (Schröter 1890, Simić 1895, 1900, Ranojević 1900, 1902, 1904, 1905a,b, 1910, 1938, Lindtner 1935, Pilat, 1937, Pilat and Lindtner 1938, Litschawer 1939). This trend have continued 15 years later, through the second phase of intense publishing in the time of socialist Yugoslavia (Ranković 1955\*, Jelić 1961, 1966, 1967\*, Marinković and Šmit 1965, Čolić 1967<sup>x</sup>, Lisiewska and Jelić 1971\*, Tortić 1981\*, Randelović and Ilić 1984\*, Krivošej and Randelović 1984\*, Ilić et al. 1985\*, Gajić 1989\*, Gajić and Karadžić 1991a,b\*, Gajić et al. 1992a,b\*, Matavulj 1995\*, Matavulj at al. 1995\*, **Ivančević and Marjanović 1987,1988, 1990<sup>x</sup>, Marjanović 2000<sup>x</sup>**, \*Points in Figure 2, <sup>x</sup> cross in Figure 2). Though this phase the number of authors and publications significantly grew and all the authors were professional mycologists. However, all the data appeared in monographs, thesis or articles in national journals, in Serbian

language and thus were not available to the international scientific community. Third phase has begun a decade ago, when the stabilization in political and social life of nowadays Serbia started and continued to present lists of species in national journals in Serbian, but also in English (Lukić 2008, 2009, Cvijanović et al. 2009, Ivančević and Davidović 2011, Karaman et al. 2012, Sadiković et al. 2012, Sadiković and Kuštera 2013, Vukojević et al. 2016, all points on Figure 2). However, it is noticeable that majority of these contributions were written or coauthored by highly dedicated hobbyists whose enthusiastic research was privately organized and financed. At present, there are at least 8 active professional mycologists in the country with traceable publication records in macro fungal diversity (Gajić and Karadžić 1991a,b, Matavulj 1995, Matavulj et al. 1995, Ivančević and Marjanović 1987,1988,1990, Marjanović 2000, Glamočlija et al. 1997, Ivančević 2007, Ivančević and Davidović 2011, Karaman, Savić et al. 2012, Vukojević et al. 2016), but we are not aware of any publically financed past or ongoing project on the topic.

#### *The special case of truffles in Serbia*

Even though the truffles have been first time mentioned from the territory of Serbia by Taube (1777), later on appreciated by the King of Serbia, Milan Obrenović (Jakšić 1896) and first time officially detected by Lindtner (1935), the tradition of their consumption in local cuisine has never been established (**Marjanović 2008**). In the recent history, they have probably been rediscovered accidentally during 60ties last Century by Italian hunt tourists (Ivan Ratoša, Paolo Urbani †, personal communications). The hunting guides from Slovenia would bring the tourists and their dogs to Serbia, while some local guides would bring them around. In time, stimulated by Italian visitors, these local guides became first truffle hunters, while Slovenian guides became first truffle smugglers to Italy (Ivan Ratoša, personal communication). Dimensions of such business are not known. The wars in ex Yugoslavia at the beginning of the 90ties interrupted the business, but then hunter and mammal biologist Miroljub Milenković learns through his hunting connections how to train dogs and where to search for truffles, and begins the truffle hunt on his own (Milenković, M. personal communication). Being a biologist, he understood the importance of saving the exemplars of collections and noting the data, and created a new era in the truffle science of Serbia. Milenković collaborated with different mycologists that worked on the determination and description of his collections of truffles and other accidentally found hypogeous

fungi, (Milenković et al. 1992, Glamočlija et al. 1997, Ławrynovic et al. 1997, Milenković and Marjanović 2001).

#### *Ecology and habitats investigations on macro fungi in Serbia*

Existing ecosystem research, including investigation of connections between climate, soil, vegetation and fungal communities in Serbia, is minimal. The first serious sinecological investigation was located in the mountain of Tara (reservation of *Picea omorica* Panc., the tree species endemic for Serbia) was done by Čolić (1967). The similar investigation of macro fungal communities in the mountain (National park) Kopaonik was done in a period 1986-1989 (Ivančević and Marjanović 1987, 1988, 1990). Investigations of connections between communities of macromycetes, plant communities, climatic factors and soil characteristics in refugial regions of West Serbia (gorges of the Rivers Gradac and Trešnjica, both Protected regions) were done in the period 1993-1998 (Marjanović 1996, 2000, Marjanović and Karadžić 1998, 1999, Marjanović et al. 2009). Forestry monographs in Serbian language that included some mushrooms lists have been published for mountains Golija, Javor, Tara, Jastrebac and part of Vojvodina province Srem (Gajić 1989, Gajić and Karadžić 1991a,b, Gajić et al. 1992a,b). Even though most of these publications were written in Serbian or not yet published in peer reviewed journals and therefore unavailable to international scientific community, they could serve as a starting point for National plan for monitoring diversity and habitats of macro fungi.

#### *National collection of macro fungi in Serbia*

The single official national collection of fungal dry exsiccates in Natural Museum in Belgrade was founded by custodian Vojteh Lindtner in the period 1935-1965 (Lindtner and Ivančević 2014). Many of the species from this time were described by Lindtner himself (Lindtner 1935, Pilat and Lindtner 1938), while some exemplars were examined by Tortić (1975, 1979). Even though the current mycologist custodian has been working in Natural Museum in Belgrade since 25 years, no compiled publication or publically available database on this collection has ever been produced. This makes the work on fungal diversity for anyone in Serbia extremely difficult, assuming that the existence of official public national database on the preserved exsiccates with data, in an official institution, is obligate for any further serious biodiversity work. Also, such

public database should enable formation of the basic national check list of the species, which is further the useful precondition for formation of the basic national Red list.

The collection of dry sporocarps of hypogeic macrofungi that have been assembled by Mirosljub Milenković and other truffle hunters since 1991 was in custody of Ž. Marjanović 2005-2010 and was used for publishing check list of truffles (**Marjanović et al. 2010a**). Additionally, 42 species of other hypogeic fungi were determined based on morphological features (Marjanović Ž, unpublished). Milenković decided to transfer his part of this collection to Natural museum in 2011, and the mycologist custodian re-analyzed it in his PhD thesis describing 16 species and 1 subspecies of truffles (including the newly described species, **Milenković et al. 2016**) and 51 species of other hypogeic fungi, all based on descriptions of morphological features only (Ivančević 2016).

References cited in this file (bolded ones were listed in the main text Reference list):

- 1) Božac R (1989) The mushrooms of our lands. Grafički zavod Hrvatske, Zagreb. (in Croatian)
- 2) Cvijanović MS, Stanković MN, Matavulj MN, Lolić S B, Pjanić BM (2009). Macrofungi of the Zasavica Special Nature Reserve [Serbia]. Zbornik Matice srpske za prirodne nauke 116: 235-243
- 3) Davidović M (2007) Fungi - treasure of our lands. Field guide. Metaphysica, Belgrade. (in Serbian)
- 4) Focht I (1979) The mushrooms of Yugoslavia. Nolit, Beograd. (In Serbian)
- 5) Focht I (1987) Our bolets. Nakladni zavod Znanje, Zagreb. (in Croatian)
- 6) Focht I (1988) Key for mushrooms, Naprijed, Zagreb. (In Croatian)
- 7) Gajić M, (1989) Flora and vegetation of Golija and Javor. Forestry faculty in Belgrade and Forestry Golija, Ivanjica, Serbia. (in Serbian)
- 8) Gajić M, Karadžić D (1991a) Wild mushrooms in forest communities of Serbia. Agriculture, XXXX, 360-361, 39-46. (In Serbian)
- 9) Gajić M, Karadžić D (1991b) Flora of the plane Srem with special emphasis on Obedska pond. Forestry faculty in Belgrade and Forestry economy Sremska Mitrovica, Sremska Mitrovica, Serbia. (in Serbian)

- 10) Gajić M, Tucović A, Karadžić D (1992a) Flora of the northern part of Big Jastrebac. Forestry faculty in Belgrade and Public company for forest management Rasina, Kruševac, Serbia. (in Serbian)
- 11) Gajić M, Kojić M, Karadžić D, Vasiljević M, Stanić M (1992b) Vegetation of National Park Tara. Forestry faculty in Belgrade and National park Tara, Bajina Bašta, Serbia. (in Serbian)
- 12) Glamočlija J, Vujičić R, Vukojević J (1997) Evidence of truffles in Serbia. *Mycotaxon* LXV: 211–22.
- 13) Ilić S, Randelović V, Randelović N (1985) The mushrooms of Vlasina and Krajište. In Proceedings of symposium: "Centenary of flora of Niš county", Niš, Serbia (in Serbian)
- 14) Ivančević B (2016) Spatial distribution and ecological variation of habitats of hypogeous macromycetes (*Mycota*) in Serbia. PhD Thesis. University of Belgrade, Belgrade.
- 15) Ivančević B, Davidović M (2011). Macromycetes from Bojčinska forest with conservation framework. *Nature Protection*, 61(2): 21-33. (in Serbian)
- 16) Jakšić S (1896) Trifle in Serbia. *Trgovinski glasnik, Beograd* 6(149). (in Serbian)
- 17) Jelić BM (1961) Contribution a la connaissance de la mycoflore des Sables. *Glasnik Botaničkog zavoda i bašte Univerziteta u Beogradu*, 1 (3): 257-64.
- 18) Jelić BM (1966) Someecological characteristics of wood degrading macro fungi in beech forests of Đerdap county. *Glasnik Prirodnjačkog muzeja, B*: 21. (in Serbian)
- 19) Jelić BM (1967) Contribution a la connaissance de la flora des Champignons macroscopiques des forets mixtes de hetre et de sapin (*Abieto-Fagetum serbicum* Jov. 1959) dans la montagne Goč (RS de Serbie). *Glasnik Botaničkog zavoda i bašte Univerziteta u Beogradu*, 2 (1-4): 197-203.
- 20) Karaman MA, Novaković MS, Savić D, Matavulj MN (2012). Preliminary checklist of Myxomycota and Ascomycota from Fruška Gora Mountain. *Zbornik Matice srpske za prirodne nauke*, 123: 37-49.
- 21) Krivošej Z, Randelović N (1984) Contribution to the knowledge of fungi from mountain Goljak. *Glasnik Prirodnjačkog muzeja u Beogradu, seria B*, 39: 5-9. (in Serbian)
- 22) Ławrynowicz M, Marković M, Milenković M, Ivančević B (1997) *Terfezia terfezioides*-a new hypogeous fungus for Balkan Peninsula. *Acta Mycologica*, 32(2): 233-238.
- 23) Lindtner V (1935) Hypogeous fungi in Serbia. *Šumarski list* 1935(1): 15-18. (in Serbian)

- 24) Lindtner V, Ivančević, B. (2014) Journey Across Fungal Conservation in Serbia. *Fungal Conservation*, 21. [http://www.fungal-conservation.org/newsletter/issue\\_4\\_2014\\_02\\_28\\_low\\_resolution.pdf#page=22](http://www.fungal-conservation.org/newsletter/issue_4_2014_02_28_low_resolution.pdf#page=22)
- 25) Lisiewska M, Jelić M (1971) Mycological investigations in the beech forests of some reservations in Serbia (Yugoslavia). *Fragmenta Floristica et Geobotanica*, 17
- 26) Litschawer V (1939) Ein Beitrag zur Kenntnis der resupinaten Phylacteriaceen von Südserbien. *Glasnik Skopskog naučnog društva*, 20: 13-22.
- 27) Lukić N (2008) The distribution and diversity of *Amanita* genus in central Serbia. *Kragujevac Journal of Science*, 30: 105-115.
- 28) Lukić N (2009) The distribution and diversity of *Boletus* genus in central Serbia. *Kragujevac Journal of Science*, 31: 59-68.
- 29) Marinković P, Šmit S (1965) Beech wood degrading fungi in forests and warehouses in Serbia. *Zbornik Instituta za šumarstvo i drvenu industriju, Beograd*, 5 (in Serbian)
- 30) Marjanović Ž (1996) Effects of some climatic factors on macromycetes sporocarp production in community *Quercus-Carpinetum moesiicum Rudski*. 5<sup>th</sup> Yugoslavian Congress of Ecologists, Belgrade Yugoslavia
- 31) Marjanović Ž, Karadžić B (1998) Comparative quantitative analysis of macromycetes communities in two refugial regions in Western Serbia. Second International Conference of Mycorrhiza, Uppsala, Sweden
- 32) Marjanović Ž, Karadžić B (1999) Influence of abiotic factors on differentiation of forest and macrofungal communities in central-Balkan canyon conditions – first report. 4<sup>th</sup> EUROSILVA Workshop on *Plant-Microbe interactions in trees*, Gozd Martuljek, Slovenia
- 33) Marjanović Ž, Smiljanić M, Sabovljević, Karadžić B (2009) Factorial differentiation of plant and macrofungal communities in the canyon of Gornja Trešnjica river (West Serbia) Book of Abstracts, 5<sup>th</sup> Balkan Botanical Congress, 7.-11. September, Belgrade, Serbia: 15.
- 34) Matavulj M (1995) Lignicolous macrofungi of some plant associations of the Vršacke planine mountains, *Zbornik Matice srpske za prirodne nauke*, 88: 59-64.
- 35) Matavulj M, Bokorov M, Stojić V (1995) Contribution to the study of wood degrading macromycetes of Vršacke mountains, *Nature Protection* 46-47:173-76 (in Serbian)

- 36) Milenković M, Glamočlija J, Veljković V, Vukojević J (1992) Record of two Tuber (*T. aestivum* and *T. melanosporum*) species in Serbia. Archives of Biological Sciences, 44: 223-28
- 37) Milenković M, Marjanović Ž (2001) Current results on *Tuber spp.* research in Yugoslavia. Proceedings of the 5th international congress on the science and cultivation of truffle and other edible hypogeous mushrooms 1999. Aix-en-Provence, France, 3-7 March 1999.) Paris, Federation Française des trufficulteurs. Section Ecology: 4.218 – 4.225.
- 38) Pilat A (1937) Contribution a la connaissance des Basidiomycetes de la peninsule des Balkans. Bulletin Societe Mykologie de France 53: 81-104
- 39) Pilat A, Lindtner V (1938-1939) Ein Beitrag zum Kenntnis der Basidiomyceten von Südserbien I und II. Glasnik Skopskog naučnog društva, 18:173-192, 20:1-11.
- 40) Ranđelović N, Ilić S (1984) Contribution to the study of fungi of south-east Serbia. 4. Most, 84:49-60. (in Serbian)
- 41) Ranković B (1955) Contribution to the knowledge of fungi from our reservations. Fungi of Fruška Gora. Nature Protection 36: 2-12 (in Serbian)
- 42) Ranojević N (1900) Contribution to the fungi flora of Kingdom of Serbia. Spomenik, I razred, XXXV (5) (in Serbian)
- 43) Ranojević N (1902) Beitrag zur Pilzflora Serbiens. Hedwigia, 41: 89-103.
- 44) Ranojević N (1904) Herbar estate of dr Velislav Vojnović. Prosvetni glasnik 25, Beograd (in Serbian)
- 45) Ranojević N (1905) Talofita in Serbia. Prvi kongres srpskih lekara i prirodnjaka pod najvišom zaštitom Njegovog veličanstva kralja Petra I u Beogradu, Knjiga druga:79-85. (in Serbian)
- 46) Ranojević N (1905) Contribution to the fungi flora of Kingdom of Serbia. Nastavnik XVI, sveska 7-8: 289-98 (in Serbian)
- 47) Ranojević N (1910) Zweiter Beitrag zur Pilzflora Serbiens. Annales Mycologici, Volume VIII: 347-402
- 48) Ranojević N (1938) Fourth Contribution to the knowledge of fungi in Serbia Glas Srpske kraljevske akademije, I razred CLXXVII, 87:205-23 (in Serbian)

- 49) Sadiković D, Čapelja, E., & Dašić, M. (2012). Basidiomycetes of Temska village area (Eastern Serbia, Mt Stara Planina). *Biologica Nyssana*, 3(2): 91-96.  
<http://journal.pmf.ni.ac.rs/bionys/index.php/bionys/article/view/38>
- 50) Sadiković D, Kuštera M (2013). Fungal conservation: Protected species of fungi in South Serbia region. *Biologica Nyssana*, 4(1-2): 35-40.  
<http://journal.pmf.ni.ac.rs/bionys/index.php/bionys/article/view/15>
- 51) Schröter J (1890) Pilze Serbiens. *Hedwigia, Organ für Kryptogramenkunde*, No 2
- 52) Simić M (1895) Material for fungal flora of Kingdom of Serbia. *Nastavnik, poseban otisak* (in Serbian)
- 53) Simić M (1900) Contribution of fungal flora of Kragujevac county. *Izveštaj gimnazije Kneza Miloša Velikog za školsku 1899-1900. godinu* (in Serbian)
- 54) Taube FW (1777) *Historische Und Geographische Beschreibung Des Königreiches Slavonien Und Des Herzogthums Syrmien*. Leipzig.
- 55) Tortić M (1975) First records for Yugoslavia of several macromycetes from the collection of V. Lindner. *Glasnik Prirodnjačkog muzeja u Beogradu*, 30: 159-65.
- 56) Tortić M (1979) Larger fungi from Kopaonik mountain (Serbia, Yugoslavia) collected by Lindner. *Acta Botanica Croatica*, 38
- 57) Tortić M (1981) Aphylophorales and some other wood inhabiting macromycetes from mountain Tara (Serbia, Yugoslavia). *Glasnik Prirodnjačkog muzeja u Beogradu, ser. B*, 36: 31-42.
- 58) Uzelac B (2009): *Mushrooms of Serbia and west Balkans*. BGV. Logik, Beograd (in Serbian)
- 59) Vukojević J, Hadžić I, Knežević A, Stajić M, Milovanović I, Čilerdžić J (2016) Diversity of macromycetes in the Botanical Garden "Jevremovac" in Belgrade. *Botanica Serbica*, 40(2): 249-259  
[http://botanicaserbica.bio.bg.ac.rs/arhiva/pdf/2016\\_40\\_2\\_671\\_full.pdf](http://botanicaserbica.bio.bg.ac.rs/arhiva/pdf/2016_40_2_671_full.pdf)