BIOLOGICA NYSSANA
4 (1-2) • December 2013: 35-40 11th SFSES • 13-16 June 2013, Vlasina lake

Original Article

Fungal conservation: Protected species of fungi in South Serbia region

Dušan Sadiković , Marjan Kuštera

Mycological socety of Niš, Somborska 81 A/9, 18000 Niš, Serbia

** E-mail: dusan.sadikovic@gmail.com*

***Abstract*:**
Sadiković, D., Kuštera, M.: ***Fungal conservation: Protected species of fungi in South Serbia region. Biologica Nyssana, 4 (1-2), December 2013: 35-40.***

Protection and conservation of fungi has only recently became an issue of concern. Main motives for increased attention are uncontrolled, mass collecting of edible wild mushrooms and environmental pollution which leads to the rapid decline of their natural habitats, some of which are rich with rare and endangered species. By Serbian Nature Conservation Law 2010. there are 38 strictly protected fungal species of which 17 species are recorded in this paper. 11 of those recorded species are on European and/or National Red List of endangered fungal species. All investigated territories were in South Serbia region. This study is a contribution to conservation of protected and threatened fungi and their respective habitats in Serbia.

Key words: Red list, protected species, South Serbia, macrofungi.

Introduction

Fungi play vital roles in most of the ecosystems on the biosphere. As they are the dominant decomposers of the lignocellulose plant debris and knowing that cellulose is the most abundant organic polymer on the Earth (Klemm, 2005), it is obvious that fungi are integral factors in processes of recycling carbon and reprocessing of nutrients in general. They have established mutualistic symbioses with a wide range of organisms: cyanobacteria and green algae (in Lichens), Bryophytes, Pteridophytes, Gymnosperms and Angiosperms (in mycorrhizae), and coleopteran, dipteran, homopteran, and isopteran insects (Kendrick, 2011) . Also with some hymenopterian insects like Fungus-growing ants (Attini: Formicidae) engage in an obligate mutualism with fungi they cultivate for food (Caldera et al., 2009).

In Europe more than 15000 species of macroscopic fungi had been identified. This is a conservative estimate because many morphological species concepts are proving to be species complexes. Also identifying species of concern has been hampered by the sporadic occurrence of the sexual fruit bodies (sporocarps) of the fungi, the cryptic nature and the lack of morphological characters of the vegetative state, and the difficulty in culturing most species for lab work (Lilleskov et al., 2010).

In Serbia the official number of recorded species, presented by Institute for Nature Conservation of Serbia, is 1300 but it's estimated that it's closer to 3000, a figure which would represent about 20% of total European mycodiversity. Biogeographical studies on fungi are relatively scarce, due mainly to methodological problems (Arnolds, 1997).

The awareness that fungi can be threatened came recently, in the early 1980s, when it was noticed that heavy acidification of soil due to acid rains has a receding effect, both qualitatively and quantitatively. Acid rain results into acidification of soil, which increases the exchange between

hydrogen ion and nutrient cations like potassium (K), magnesium (Mg) and calcium (Ca) in the soil. These cations are liberated into soil and can be rapidly leached out in soil solution along with sulphate from acid input. Acid induced leaching leads to nutrient deficiency in the affected soils and thus negatively affecting microbial processes (Sigh & Agrawall, 2008). Also higher levels of nitrogen caused by anthropogenic activities has a reducing effect on mycofloral diversity as it was proven that with increasing the N deposition, ectomycorrhizal root tip abundance and mycelial production can be decreased five and 10-fold. In addition, fungal community can be changed and the species richness decreased (Kjøller et al., 2012).

Recognizing this problem, national red lists started to emerge, first being in Germany in 1982. Today more than 35 countries have some form of Red List for fungi. Evaluations of those Red Lists in almost every European country, together with many studies regarding fungal conservation, indicate that a large portion, probably in the range of 2000 –3000 species of macrofungi throughout Europe are declining and their future is uncertain. European mycologists, through the European Council for Conservation of Fungi (ECCF), have prepared list of fungi for possible inclusion in the Bern Convention. These 33 species represent only a small fraction of all threatened fungal species, but by including them in the Convention Appendix, the need for conservation of fungi and their habitats would be officially recognized (Kjøller et al., 2012).

In Serbian legislation, first species of fungi were put under protection in 1991, as "natural rarities threatened by exploitation and trade", under the Decision on amending the decision on putting plant species under protection as natural rarities (1991) but it had inadequate protection measures as well as cardinal taxonomic mistakes. Because Yugoslavia was in the first half of the last decade the largest exporter of Bolets in the, of which the largest quantities were from Serbia, the protection only included a few edible species world (for example in 1993. 5 186 100kg of *Boletus edulis* was purchased in Serbia) (Ivancevic et al., 2012). Currently by the Nature Conservation Law (2009) and Regulation on the proclamation and protection of strictly protected and protected wild species of plants, animals and fungi (2010), 38 species of macroscopic fungi are treated as strictly protected. Serbian Preliminary National Red List of endangered species was comprised in 1998 (Ivancevic, 1998) and it contained 96 species. In 2004 the List was corrected and amended to IUCN standards. The NPRL of endangered species was not fully or not at all considered when making the list of strictly protected species and methods used in comprising this list were unclear.

Material and methods

The areas were investigated between 2011. and 2013. All mycological investigations were conducted in South Serbia region (Fig. 1**.**).

The fungal specimens were identified on the basis of macroscopic and microscopic morphological characteristics and specific chemical reactions of fruiting bodies according to specific identification keys: (Božac 1978; Foht 1986; Breitenbach & Kränzlin 1995; Maca et al., 1995; McKnight et al., 1998; Jordan 2004; Uzelac 2009). Author citations for each taxon are abbreviated according to the Index Fungorum(2013). For the analysis of the legal protection of fungi in Serbia and Europe, following material was used:

Guidance for the Conservation of Mushrooms in Europe. Convention on the Conservation of European Wildlife and Natural Habitats. Document prepared by Beatrice Senn-Irlet, Jacob Heilmann-Clausen and Anders Dahlberg for the European Council for Conservation of Fungi (ECCF) within the European Mycological Association (EMA). Strasbourg, 17 October 2007.

Одлука о изменама и допунама одлуке о стављању под заштиту биљних врста као природних реткости. Службени гласник СРС 49, 15. 08. 1991; [Decision on amending the decision on putting plant species under protection as natural rarities, 1991]

Закон о заштити природе. Службени гласник Републике Србије 36, 12.05.2009. і 88/2010; [Nature Conservation Law, 2009 – Actual]

Правилник о проглашењу и заштити строго заштићених и заштићених дивљих врста биљака, животиња и гљива. Службени гласник Републике Србије 5, 05. 02. 2010; [Regulation on the proclamation and protection of strictly protected and protected wild species of plants, animals and fungi, 2010 – Actual].

The purpose of this study is presenting to the scientific community precise bio geographical data on rare and endangered species of macromycetes in Serbia and thus helping in process of making more accurate National Red List and National Checklist. This is the beginning of more extensive investigations which will revel yet unexplored South Serbian mycodiversity.

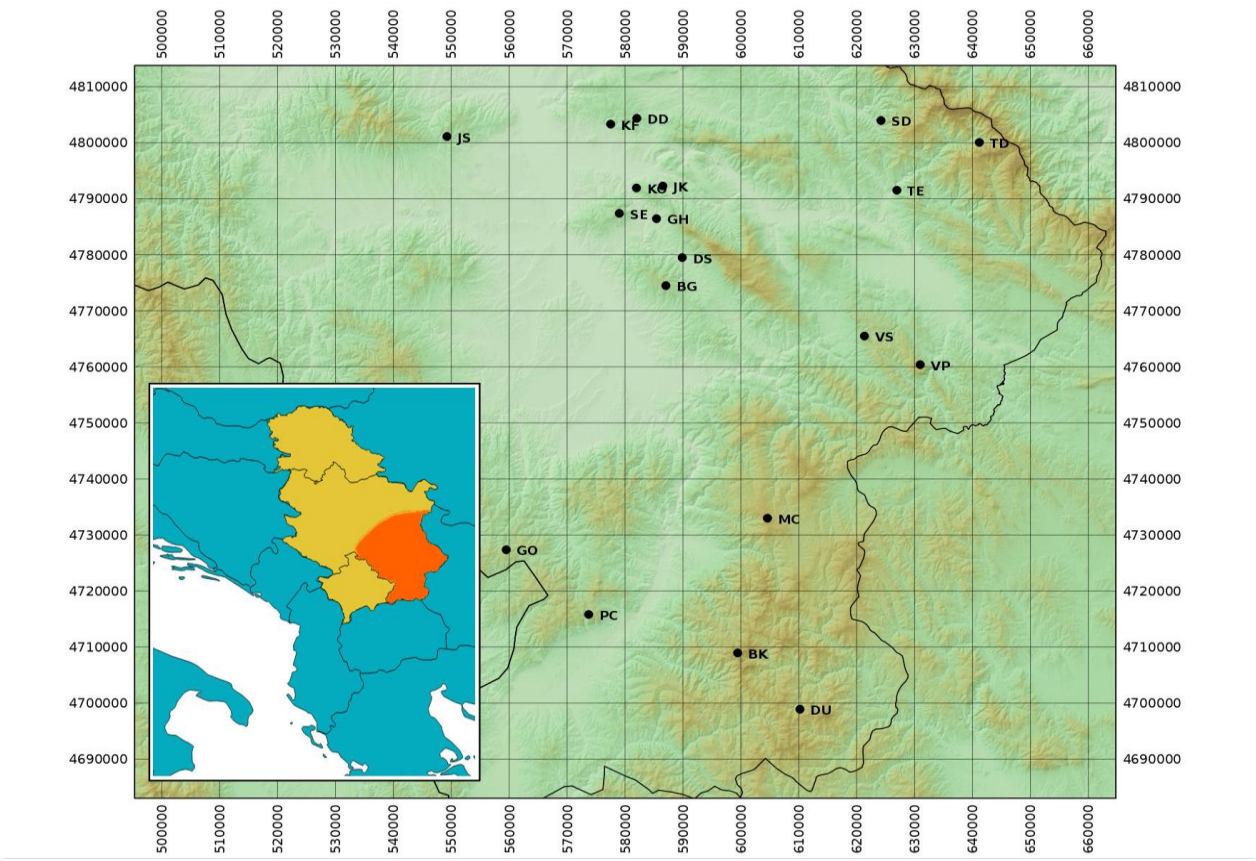

Figure 1. Map of invastigated area JS- Mt.Mali Jastrabac, DD-Debeli Del hill, KF-Mt.Kalafat, KO-Mt.Koritnik, JK-Jelašnica gorge, SE-Mt.Seličevica, BG-Mt.Babička Gora, GH-Mt.Suva Planina(SW foothill), DS-Mt.Suva Planina, SD-Mt.Stara Planina(Sedlar), TD- Mt.Stara Planina(Arbinje), TE- Mt.Stara Planina(Temska area), VS-Mt.Veliki Stol, VP-Mt.Vlaške Planine, MC-Mt.Mali Čemernik, GO-Mt.Goljak, PC-Mt.Pljačkovica, BK-Mt.Besna Kobila, DU-Mt.Dukat

Results and discussion

Of 38 species of macromicetes protected by Nature Conservation Law we located and indentified 17 species, belonging to 13 genera, 7 families and 5 orders. The list of species with number of sightings, location and status is presented in the Table (Table 1**.** List of species found with number and localities of findings and status).

Phylloporus pelletieri (Lév.) Quél., *Sarcosphaera coronaria* (Jacq.) J. Schröt. and *Hericium erinaceus* (Bull.) Pers. are listed on European Preliminary Red List and are regarded as highly endangered species.

P.pelletieri is widespread in Europe (very rare in European Russia, also in Ukraine and Moldova), from the lowland up to the montane zone, sometimes subalpine. It is rare in most regions, very local and in low numbers, but more widespread in the Alps, e.g. in Switzerland. The species is spreading into Asia. It is in national lists of endangered fungi in Austria, Denmark, Germany, Hungary, Moldova, Norway, Poland, Sweden, and The Netherlands. In total it has 926 localities in Europe and to our knowledge, other than founding in this paper, it has only few unofficial locations in Serbia. *S.coronaria* (syn. *S.crassa*) is distributed in North Europe and mountains of Central and South Europe up to 1700 m altitude. It is rare in most regions but in some regions more widespread and even numerous in places, for instance in the Swiss Alps and Central Italy. It is in national lists of endangered fungi in Austria, Bulgaria, Denmark, Estonia (also protected by law), Finland, Germany, Great Britain, Hungary, Norway, Poland, and Sweden. It has 691 localities in Europe with official 2 localities in Serbia according to (Dahlberg et al., 2006). *H.erinaceus* is widespread in Europe, from the lowland up to the montane zone, north to southern Scandinavia; generally rare, for instance in Switzerland (5 records between 220 and 930 m) and Austria (4 records from the Vienna region, altitude 150m). It is locally more common, e.g. in southern England and the central part of the Netherlands. It is found on national lists of endangered fungi in Armenia, Austria, Bulgaria, Denmark, Germany, Great Britain, Greece, Macedonia, Poland, Sweden (also protected by law), Switzerland, The

Netherlands (ECCF, 2001). It has 435 localities in Europe with 3 official in Serbia.

The rest of the fungal species recorded in this research are also all on other European countries Red Lists and/or leagaly protected, but because of many lists are still in proces of forming and their data deficiency, we are unable to produce the precise data on the number of their localities and state of populations fully yet.

Table 1. List of species found with number and localities of findings and status (PNRL-Preliminary National Red List)

	Taxa	Total number of recorded localities	Listed in	Location
PEZIZALES				
Pezizaceae	***Sarcosphaera coronaria* (Jacq.) J. Schröt**	**1**	**PERL**	**Mt. Stara Planina**
AGARICALES				
Hygrophoraceae	***Hygrocybe punicea* (Fr.) P. Kumm**	**1**	**PNRL**	**Dukat Mountain**
	***Hygropophrous Marzuolus* (Fr.) Bres.**	**6**	**PNRL**	**Mt. Suva Planina Mt.Suva Planina SW foothill Mt.Babicka Gora Mt. Seličevica Mt. Mali Jastrebac Debeli Del hill Mt.Golemi stol**
Tricholomataceae	***Leucopaxillus giganteus* (Quel.) Singer**	**1**	**PNRL**	**Mt. Stara Planina**
BOLETALES				
Boletaceae	***Boletus impolitus* Fr.**	**4**	**PNRL**	**Mt.Kalafat Mt.Seličevica Mt.Suva Planina Mt.Babicka Gora**
	***Boletus regius* Kromb.**	**8**	**PNRL**	**Mt.Besna Kobila Mt. Pljackovica Mt.Selicevica Mt.Selicevica (Gabrovac) Mt.Mali Jastrebac Mt.Suva Planina Mt. Golemi Stol Mt.Koritnik**
	***Boletus rhodoxanthus* (Krombh.) Kallenb**	**2**	**PNRL**	**Mt.Vlaška Planina Debeli Del hill**
	***Boletus satanas* Lenz**		**PNRL**	**Mt. Stara Planina**
	***Leccinum crocipodium* (Letell.) Watling 1961**	**3**		**Mt.Seličevica Mt.Besna Kobila Jelašnica gorge**
	***Phylloporus pelletieri* (Lév.) Quél.**	**1**	**PERL**	**Mt.Mali Čemernik**
	***Strobilomyces strobilaceus* (Scop.) Berk.**	**1**	**PNRL**	**Mt.Goljak**
GEASTRALES				
Geastraceae	***Geastrum fornicatum* (Huds.) Hook.**	**1**		**Mt.Dukat**
	***Geastrum melanocephalum* (Czern.) V.J. Staněk**	**2**		**Mt.Veliki Stol Debeli Del hill**
PHALLALES				
Phallaceae	***Mutinus caninus* (Huds.) Fr.**	**1**	**PNRL**	**Mt.Veliki Stol**
	***Phallus hadriani* Vent.**	**1**	**PNRL**	**Mt. Stara Planina**
RUSSULALES				
Hericiaceae	***Hericium coralloides* (Scop.) Pers.**	**1**		**Mt.Veliki Stol**
	***Hericium erinaceus* (Bull.) Pers.**	**1**	**PNRL PERL**	**Mt.Stara Planina (Arbinje)**

Only 20 species from the Red List one found on the strictly protected list and knowing that on the Preliminary Red List also contained some internationally significant and protected wild species which Serbian Government had promise to protect (Biodiversity Strategy of the Republic of Serbia for the period 2011 – 2018) it is evident that forming of the list of protected species was not based on the Preliminary Red List data, rather in superficial, subjective and unscientific manner. The fact that in 2007 the author of NPRL has presented to Ministry of Environment and Spatial Planning project proposition for making the Red Book of fungi in Serbia, which was highly acclaimed by the Ministry, was not yet accepted furthermore shows the gap between Serbian mycological experts and the government (personal email communication with author).

Conclusion

If a species is rare or endangered in one region or in whole country it doesn't mean that its state is homogeneous throughout Europe and vice versa so biogeographical information on fungi is crucial for understanding biodiversity patterns, evolutionary processes and monitoring. Unfortunately these kinds of publications are scarce in Serbia, especially for South Serbian region due to lack of experts and it's vastly unexplored, but rich terrains. Deficient number of this sort of research may also be contributed to the annual fluctuations of fungal fruiting bodies due to micro and macro climate conditions, uncontrolled wild mushrooms picking, stochastic events and effemeral properties of fungal fruiting bodies.

In order to better protect natures rearities, Serbia must adopt less anthropocentric and more ecocentric laws. Wild mushroom picking itself does not effect the numbers of emerging fruiting bodies but soil trampeling of the mushroom pickers can destroy pre-fruit body primordia formed at the soil surface and thus reduce the frequency of occurrence and reduce their quantity (Egli et al., 2006). Beside the prevention of picking young and immature specimens and specimens less in size then size allowed for respective species, the state should specify time annually and daily when picking of certain species is allowed. Also instead of allowing only picking 2/3 of total number of sporocarps found at the picking site, which is very difficult to assess, government should restrict maximum allowed quantity of collected sporocarps per person and for groups like in some European countries legislations (e.g. in Luxembourg one person can pick up to 1kg of sporocarps per day and for a group, the allowed maximum is 3kg). With these measures the disturbance made by trampling of forest floor would be significantly reduced and mushroom picking for sale purposes would be significantly decreased at the same time.

In order to bring better nature protecting laws, actual state of Serbian mycodiversity must be evaluated. This is only possible trough national and regional checklists, red lists and more extensive biogeographical research. For this to be possible, far better State cooperation with scientific community and experts is imperative.

Acknowledgments

The authors would like to express gratitude to all members of the Mycological Society of Niš for helping in research for this paper.

References

Arnolds, E. 1997: Biogeography and conservation. In: Wicklow, D., Soderstrom, B. (ed.), *The Mycota IV: Environmental and Microbial Relationships*: (2): 115-131, Springer-Verlag, Berlin.

Biodiversity Strategy of the Republic of Serbia for the period 2011 – 2018. Ministry of Environment and Spatial Planning, Belgrade 2011.

Božac, Romano. 1978: Gljive Naših Krajeva. Grafički zavod Hrvatske.

Breitenbach, J., Kränzlin, F. 1995: Pilze Der Schweiz. Band 4. Verlag Mykologia, Luzern. 371p.

Cladera, E., Poulsen, E., Suen, G., Currie, C., 2009: Insect Symbioses: A Case Study of Past, Present, and Future Fungus-growing Ant Research. *Environmental Entomology*, 38(1):78-92.

Dahlber, A., Croneborg, H., 2006: The 33 Threatened Fungi in Europe. Council of Europe Publishing, Belgium.

Egli, S., Peter, M., Buser, C., Stahel, W., Ayer, F., 2006: Mushroom picking does not impair future harvests – results of a long-term study in Switzerland. *Biological conservation*, 129: 271-276.

Focht, I., 1986: Ključ Za Gljive: Ilustrirani Uvod u Gljivarstvo. Naprijed, Zagreb.

Index Fungorum. http://www.indexfungorum.org/names/names.asp

Ivančević, B., 1998: A preliminary Red List of the macromycetes of Yugoslavia. In: Perini, C. (ed.), *Conservation of fungi in Europe*: 57-61, Università degli Studi, Siena.

Ivančević, B., Matavulj, M., Vukojević, J., Karaman, M., 2012: Fungi in the Legislation of

the Republic of Serbia. *Zbornik Matice Srpske Za Prirodne Nauke*, 123: 51–64

Jordan, M., 2004: The Encyclopedia Of Fungi: Of Britain And Europe. Frances Fincoln ltd., London.

Kendrick. B. (2011). Fungi: Ecological Importance and Impact on Humans. *Wiley Online Library*.

Kjøller, R ., Nilsson, L., Hansen, K., Schmidt, I., Vesterdal, L., Gundersen, P., 2012: Dramatic changes in ectomycorrhizal community composition, root tip abundance and mycelial production along a stand-scale nitrogen deposition gradient. New Phytologist , vol 194(1): 278-286.

Klemm, D., 2005: Cellulose: Fascinating Biopolymer and Sustainable Raw Material. *Chemlnform*. Vol. 36(Issue 36),

Lilleskov, E., Hobbie, E., Horton, T., 2011: Conservation of ectomycorrhizal fungi: exploring the linkages between functional and taxonomic responses to anthropogenic N deposition. *Fungal Ecology*, 4: 174-183.

McKnight, K., McKnight V., 1998: A Field Guide to Mushrooms: North America. Houghton Mifflin Harcourt, Boston.

Rikardo, M., Ileš, M., Unković, S., 1995: Kako Da Raspoznate Pečurke: Jestive Gljive i Njihovi Otrovni Dvojnici. Evro, Beograd.

Sigh, A., Agrawal, M., 2008: Acid rain and its ecological consequences. *Journal of Environmental Biology*, 29 (1): 15-24.

The European Council for Conservation of Fungi (ECCF). 2001: Datasheets of threatened mushrooms of Europe, candidates for listing in Appendix I of the Convention. Strasbourg, 13 June 2001.

Uzelac, B., 2009: Gljive Srbije i Zapadnog Balkana. BGV logik, Beograd.