ГОДИШНИК НА СОФИЙСКИЯ УНИВЕРСИТЕТ „СВ. КЛИМЕНТ ОХРИДСКИ“
БИОЛОГИЧЕСКИ ФАКУЛТЕТ
Книга 2 – Ботаника
Том 99

ANNUAL OF SOFIA UNIVERSITY “ST. KLIMENT OHRIDSKI”
FACULTY OF BIOLOGY
Book 2 – Botany
Volume 99

CHECKLIST OF MACROMYCETES, OBSERVED DURING THE LAST 20 YEARS (1994–2014) IN THE SOFIA CITY PARK BORISOVA GRADINA (BULGARIA)

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The paper is dedicated to Prof. D. Temnsikova on the occasion of her 80th jubilee

Abstract. A checklist of 115 species of asco- and basidiomycetes, recorded in the south-eastern part of the city park of Sofia Borisova Gradina between 1994 and 2014 is presented and briefly discussed in the paper.

Key words: mycorrhizal fungi, parasitic fungi, park, saprotrophic fungi, threatened species, urban area

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INTRODUCTION

Assessing, understanding, and improving urban biodiversity is of great importance from both conservation and social point of views (Kowarik 2011). Urban green areas are a vital part of the urban landscape, providing contact with wildlife and environmental services with additional socio-ecological benefits to the overall quality of life (Barrico et al. 2012). However, the value of their biota is often underestimated and socio-ecological functions have not been comprehensively studied (EEA 2010). In spite of the fact that, as far as it is known, there are no specifically evolved fungi with adaptation to man-made habitats (Spooner & Roberts 2005), fungi comprise important biological and ecological component in the ecosystems of urban green areas. Additionally there is evidence that land management practices can affect fungal diversity (Moore et al. 2011). Therefore during the last decades they, and especially macromycetes, incl. wood-decay fungi, start to attract the special attention of mycologists and have been discussed from different points of view (*e.g.* Slater 1993; Sede & Lopez 1999; Szczepkowski A. 2007; Terho et al. 2007; Babenko & Tkachenko 2008; Barrico et al. 2012 and citations therein).

Studies of Bulgarian mycota started more than century ago (Drumeva-Dimcheva & Gyosheva-Bogoeva 1993; Denchev et al. 2005) and increase rapidly during the last decade, but data on urban habitats are more than meagre. Barzakow (1926a, b, c) and Barzakoff (1929, 1933, 1936) reported 54 fungal species from the city park Borisova Gradina[1] and from the pine and oak forests situated near the Ecclesiastical school in Sofia[2]. Dimitrov (1926) noted one parasite (*Rhytisma acerinim* (Pers.) Fr.) and Hinkova (1950, 1955, 1961), in a frame of purposive study, published 81 fungal species from the same park. Years later Yurukova (1994) mentioned five edible species from "eastern and southern part" of the city of Sofia, studied for heavy metal contamination and Dimitrova et al. (2007) reported 40 saprotrophic and parasitic fungal species from the central part of the city park Borisova Gradina. Later on, Assyov et al. (2010) added one more species (*Clathrus ruber* P. Micheli ex Pers.) for the same place. Lacheva (2010) found 92 species lignicolous macromycetes in the city of Plovdiv. Nowadays, Alexov et al. (2012) discover *Hericium erinaceus* (Bull.) Pers. in another Sofia city park Zapaden Park.

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[1] Constructed in the late 19th century (ca. 1884–1892) and named after Bulgarian Tsar Boris III, with older names "Razsadnika" (=Nursery-garden), "Pipinierata", "Tsarigradska Gradina" and renamed as "Park na Svobodata" (=Freedom Park) during the socialist period in the development of the country, until its fall in 1989, when it reverted to its most used name "Borisova Gradina" (=Boris Garden), or Knyaz Borisova Gradina (=Prince Boris Garden).

[2] Recently the whole region around this school is implicitly included in the city park Borisova Gradina. Obviously, the author distinguished between the more cultivated part, situated more near to the centre of Sofia and most popular as "Borisova Gradina" and more "wild" part at its edge.

The present paper is based on 20-years observations in the south-eastern part of the oldest and best known park of Sofia (Borisova Gradina). The results presented here are mainly qualitative, based on presence–absence of given species, with some minor comments on obvious decrease of abundance of certain species, related with human impact or natural forest aging.

MATERIAL AND METHODS

The observations, presented in this study, were made incessantly by the first author during the last 20 years (1994–2014) in the middle south-eastern part of the Sofia city park Borisova Gradina by tracing the same route twice per day during the obligatory dog walks (Fig. 1). Additional frequent, but occasional zigzag traces in the square, closed by the main route, were followed. Exception was made in the years 2003 and 2004, but since it concerns the non-vegetational period between the end of November and April, we believe that this interruption can be taken as insignificant. The route follows the forest paths through mixed coniferous and deciduous forests (plantations), containing mainly *Quercus rubra* L., *Quercus robur* L., *Pinus sylvestris* L. and *Pinus nigra* Arn., intermittent with *Hedera helix* L., *Crataegus monogyna* Sacq., *Corylus avellana* L., *Sambucus nigra* L., *Sambucus racemosa* L., *Prunus cerasifera* Ehrh., *Cornus sanguinea* L., *Sorbus aucoparia* L., *Acer tataricum* L., *Acer campestre* L., *Acer heldreichii* Orph., *Acer platanoides* L., *Acer pseudoplatanus* L., *Ulmus minor* Mill., *Fagus sylvatica* L., *Carpinus betulus* L., *Fraxinus excelsior* L., *Fraxinus oxycarpa* Willd., *Tilia parvifolia* Ehr., *Amorpha fruticosa* L., *Ailanthus altisima* (Mill.) Swingle, *Gleditsia triacanthos* L., *Periploca graeca* L., *Rubus caesius* L., rarely *Betula pendula* Roth. and *Syringa vulgaris* L., and meadow-like open areas bordered with *Vinca minor* L., *Spiraea douglasii* Hook., *Symphoricarpos albus* (L.) S. F. Blake, *Forsythi*a *intermedia* Zabel, *Rosa canina* L., *etc*. According to Petkov & Antonov (1994), who studied the soil moisture content in 1992–1993 in the same region of the park, especially under *Quercus*-trees, the soils were well supplied and stocked with available moisture.

The observations were focused preliminary on the macromycete community, based on fruiting bodies. Although fruit bodies' production is unlikely to reflect the belowground fungal community (Lilleskov & Bruns 2001), their surveys can be particularly valuable as indicators for assessing the impacts of different land use types on macromycete populations, as observed by Azul et al. (2009). Some parasite species (*e.g*. *Erysiphe alphitoides* (Griffon & Maubl.) U. Braun & S. Takam., *Rhytisma acerinim* (Pers.) Fr.) were included in the list according to description for macromycetes in Kirk et al. (2008).

Identification of fungi was done according to Romagnesi (1970, 1971), Jordanov et al. (1978), Hansen & Knudsen (1992, 1997, 2000) and Bon (2005). Author names for each taxon are abbreviated according to Index Fungorum. Data

on species occurrence and distribution in Bulgaria were compared with the lists in Denchev & Assyov (2013), and conservation status was checked according to Gyosheva et al. (2006) and Peev (2011). Trophic status is provided according to Burova (1986), Pecoraro et al. (2007), Szczepkowski (2007), Babebko & Tkachenko (2008) and authors' observations. The potential uses are after Boa (2004), Bon (2005), Bai et al (2013), Ruthes et al. (2013), Petrovic et al. (2014) and Yoo & Choi (2014).

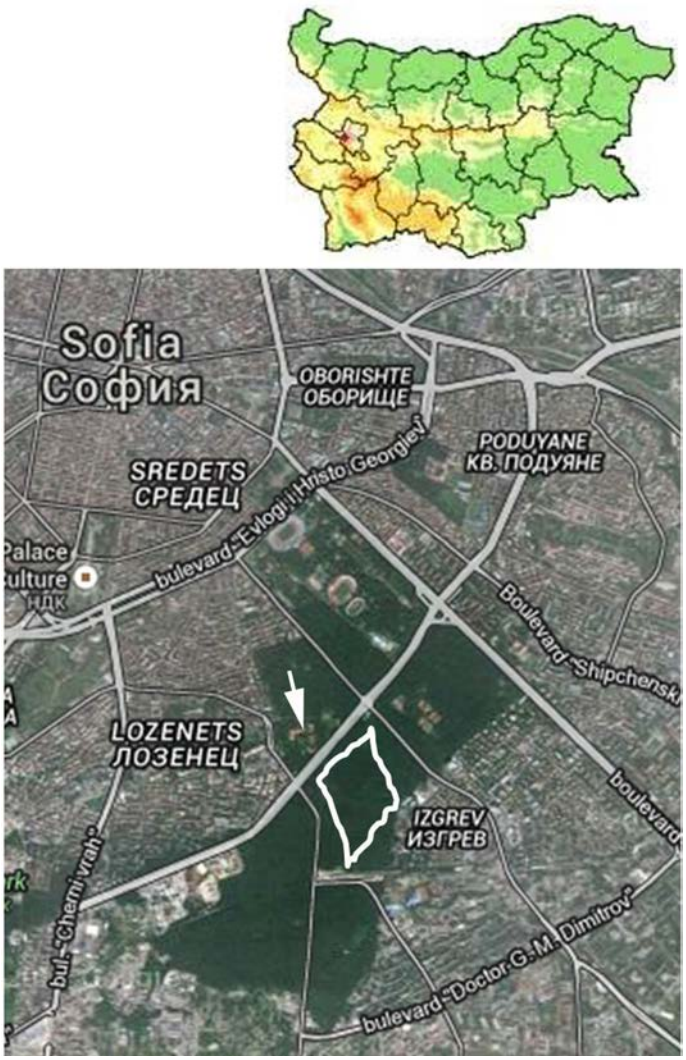

Fig. 1. Map of Bulgaria (red asterisk indicates the capital) and of part of Sofia with the studied park (square line) Borisova Gradina and Ecclesiastical school (arrow). The last map is provided after http://poseti.guide-bulgaria.com/a/807/park_borisova_gradina.htm.

RESULTS AND DISCUSSION

In total, 115 species of ascomycetes and basidiomycetes have been observed in the nearest vicinity of the pathways of the route, shown on Fig. 1. They are enlisted bellow in alphabetical order in the frames of the phyla, in order to facilitate the reader (Table 1).

Table 1. Checklist of macromycetes, found in the city park Borisova Gradina (Sofia) during the last 20 years (1994–2014). The abbreviations are as follows: BG – species reported for the park by Barzakow (1926a,b,c, 1928), Dimitrov (1926), Barsakoff (1929, 1933, 1936), Hinkova (1950, 1955, 1961), Dimitrova et al. (2007); **SR –** species reported for the Sofia region by Denchev & Assyov (2010); and **Ts –** trophic status of the fungal species, where **Ls** = litter saprotroph, **Xy** = xylotroph, **P** = parasite, **Hs** = humic saprotroph and **M** = mycorrhyzal; * – species included in the Red List of fungi in Bulgaria; ** – species included in the Red List and in the Red Data Book of the Republic of Bulgaria.

№	Taxon	BG	SR	Ts	Potential uses
	Ascomycota				
1.	*Aleuria aurantia* (Pers.) Fuckel	+		Ls	Edible
2.	*Ascocoryne cylichnium* (Tul.) Korf.			Xy	Medicinal, non edible
3.	*Erysiphe alphitoides* (Griffon & Maubl.) U. Braun & S. Takam.	+		P	Non edible
4.	*Helvella lacunosa* Afzel.	+		Hs	Non edible
5.	*Nectria cinnabarina* (Tode) Fr.			Xy	Non edible
6.	*Rhytisma acerinim* (Pers.) Fr.	+		P	Non edible
7.	*Sarcoscypha coccinea* (Jacq.) Boud.			Xy	Edible
	Basidiomycota				
8.	*Agaricus arvensis* Schaeff.	+	+	Hs	Medicinal, edible
9.	*Agaricus campestris* L.		+	Hs	Medicinal, edible
10.	*Agaricus comptulus* Fr.		+	Hs	Edible
11.	*Agaricus sylvaticus* Schaeff.	+	+	Hs	Edible
12.	*Agaricus sylvicola* (Vittad.) Peck			Hs	Edible
13.	*Agaricus xanthodermus* Genev.			Hs	Non edible
14.	*Agrocybe praecox* (Pers.) Fayod		+	Hs	Edible
15.	*Amanita citrina* (Schaeff.) Pers.			M	Non edible
16.	*Amanita muscaria* (L.) Lam.		+	M	Medicinal
17.	*Amanita phalloides* (Vaill. ex Fr.) Link	+	+	M	Poisonous
18.	*Amanita rubescens* Pers.			M	Edible
19.	*Amanita virosa* Bertill.			M	Poisonous
20.	*Armillaria mellea* (Vahl) P. Kumm.	+	+	Xy	Medicinal, edible
21.	*Auricularia auricula-judae* (Bull.) Quél.	+	+	Xy	Medicinal, edible
22.	*Boletus calopus* Pers.		+	M	Non edible

№	Taxon	BG	SR	Ts	Potential uses
23.	*Boletus edulis* Bull.		+	M	Medicinal, edible
24.	*Boletus impolitus* Fr.			M	Edible
25.	*Boletus pinophilus* Pilát & Dermek			M	Edible
26.	*Boletus queletii* Schulzer			M	Edible
27.	*Boletus subtomentosus* L.	+	+	M	Edible
28.	*Bovista plumbea* Pers.		+	Hs	Medicinal, edible
29.	**Caloboletus radicans* (Pers.) Vizzini			M	Non edible
30.	*Calocybe gambosa* (Fr.) Donk	+	+	Hs	Medicinal, edible
31.	*Cantharellus cibarius* Fr.	+	+	M	Medicinal, edible
32.	*Chalciporus piperatus* (Bull.) Bataille			M	Edible
33.	*Chroogomphus rutilus* (Schaeff.) O.K. Mill.			M	Edible
34.	*Clitocybe geotropa* (Bull. ex DC.) Quél.			Ls	Edible
35.	*Clitocybe gibba* (Pers.) P. Kumm.			Ls	Edible
36.	*Clitocybe nebularis* (Batsch) P. Kumm.	+	+	Ls	Edible
37.	*Clitocybe phyllophila* (Pers.) P. Kumm.			Ls	Poisonous
38.	*Clitopillus prunulus* (Scop.)P. Kumm.			Ls	Edible
39.	*Coprinellus congregates* (Bull.) P. Karst.		+	Hs	Medicinal, non edible
40.	*Coprinopsis atramentaria* (Bull.) Redhead, Vilgalys & Moncalvo	+	+	Hs	Medicinal, edible
41.	*Coprinus comatus* (O.F. Müll.) Pers.		+	Hs	Edible
42.	***Cortinarius caperatus* (Pers.) Fr.			M	Edible
43.	***Cortinarius praestans* (Cordier) Gillet			M	Edible
44.	*Cortinarius purpurascens* Fr.			M	Medicinal, edible
45.	*Craterellus cornucopioides* (L.) Pers.			M	Medicinal, edible
46.	*Cyathus striatus* (Huds.) Willd.			Ls	Non edible
47.	*Entoloma clypeatum* (L.)P. Kumm.			M	Edible
48.	*Entoloma rhodopolium* (Fr.) P. Kumm.		+	M	Poisonous
49.	*Exidia glandulosa* (Bull.) Fr.		+	Xy	Non edible
50.	*Fistulina hepatica* (Schaeff.) With.			Xy	Medicinal, edible
51.	*Flammulina velutipes* (Curtis) Singer	+	+	Xy	Medicinal, edible
52.	*Fomes fomentarius* (L.) Fr.			Xy	Medicinal, non edible
53.	*Fomitiporia robusta* (P. Karsten) Fiasson & Niemelä			Xy	Non edible
54.	*Fomitopsis pinicola* (Sw.) P. Karst.	+	+	Xy	Medicinal, non edible
55.	*Ganoderma lucidum* (Curtis) P. Karst.	+	+	Xy	Medicinal, non edible
56.	*Gymnopus fusipes* (Bull.) Gray		+	Ls	Non edible
57.	*Gymnopus perforans* (Hoffm.) Antonín & Noordel.	+	+	Ls	Non edible

№	Taxon	BG	SR	Ts	Potential uses
58.	*Hygrophorus russula* (Schaeff.) Kauffman			M	Edible
59.	*Hypholoma capnoides* (Fr.) P. Kumm.			Xy	Edible
60.	*Hypholoma fasciculare* (Huds.) P. Kumm.	+	+	Xy	Poisonous
61.	*Imleria badia* (Fr.) Vizzini		+	M	Edible
62.	*Inocybe erubescens* A. Blytt			M	Poisonous
63.	*Kuehneromyces mutabilis* (Schaeff.) Singer & A.H. Sm.		+	Xy	Edible
64.	*Laccaria laccata* (Scop.) Cooke	+	+	Hs	Edible
65.	*Lactarius deliciosus* (L.) Gray	+	+	M	Edible
66.	*Lactarius piperatus* (L.) Pers.		+	M	Edible
67.	*Lactarius rufus* (Scop.) Fr.			M	Medicinal, non edible
68.	*Lactarius vellereus* (Fr.) Fr.			M	Edible
69.	*Laetiporus sulphureus* (Bull.) Murrill		+	Xy	Edible
70.	*Lepiota cristata* (Bolton) P. Kumm.			Hs	Non edible
71.	*Lepista nuda* (Bull.) Cooke	+	+	Hs	Medicinal, edible
72.	*Leucoagaricus leucothites* (Vittad.)Wasser		+	Hs	Non edible
73.	*Leucopaxillus giganteus* (Sowerby) Singer			Hs	Edible
74.	*Lycoperdon echinatum* Pers.			Ls	Edible
75.	*Lycoperdon perlatum* Pers.	+	+	Ls	Medicinal, edible
76.	*Lycoperdon pyriforme* Schaeff.			Xy	Medicinal, edible
77.	*Macrolepiota procera* (Scop.) Singer		+	Hs	Edible
78.	*Marasmius alliatus* (Schaeff.) J. Schröt.		+	Ls	Non edible
79.	*Megacollybia platyphylla* (Pers.) Kotl. & Pouzar			Xy	Non edible
80.	*Melanoleuca grammopodia* (Bull.) Murrill			Hs	Edible
81.	*Meripilus giganteus* (Pers.) P. Karst.			Xy	Medicinal, non edible
82.	*Mycena galericulata* (Scop.) Gray			Xy	Non edible
83.	*Omphalotus olearius* (DC.) Singer			Xy	Poisonous
84.	*Paxillus involutus* (Batsch) Fr.	+	+	M	Poisonous
85.	*Peniophora quercina* (Pers.) Cooke			Xy	Non edible
86.	*Pleurotus cornucopiae* (Paulet) Rolland	+		Xy	Edible
87.	*Pluteus cervinus* (Schaeff.) P. Kumm.	+	+	Xy	Edible
88.	*Polyporus squamosus* (Huds.) Fr.	+	+	Xy	Edible
89.	*Psathyrella spadicea* (P. Kumm.) Singer		+	Xy	Edible
90.	*Russula aeruginea* Lindbl. ex Fr.		+	M	Edible
91.	*Russula alutacea* (Fr.) Fr.			M	Non edible
92.	*Russula cyanoxantha* (Schaeff.) Fr.	+	+	M	Edible
93.	*Russula delica* Fr.			M	Edible
94.	*Russula emetica* (Schaeff.) Pers.	+	+	M	Poisonous?
95.	*Russula nigricans* Fr.		+	M	Edible

№	Taxon	BG	SR	Ts	Potential uses
96.	*Russula olivacea* (Schaeff.) Fr.			M	Non edible
97.	*Russula rosea* Pers.		+	M	Edible
98.	*Russula vesca* Fr.			M	Edible
99.	*Russula xerampelina* (Schaeff.) Fr.		+	M	Edible
100.	*Schizophyllum commune* Fr.	+	+	Xy	Medicinal, non edible
101	*Scleroderma citrinum* Pers.		+	M	Poisonous
102.	*Stereum hirsutum* (Willd.) Pers.	+	+	Xy	Medicinal, non edible
103.	*Stropharia hornemanni* (Fr.) S. Lundell & Nannf.			Hs	Poisonous
104.	*Suillus granulatus* (L.) Roussel	+	+	M	Edible
105.	*Suillus luteus* (L.) Roussel		+	M	Medicinal, edible
106.	*Tapinella atrotomentosa* (Batsch) Šutara	+	+	Xy	Non edible
107.	*Trametes hirsuta* (Wulfen) Lloyd		+	Xy	Medicinal, non edible
108.	*Trametes versicolor* (L.) Lloyd	+	+	Xy	Medicinal, non edible
109.	*Tremella mesenterica* Retz.		+	Xy	Medicinal, edible
110.	*Tricholoma imbricatum* (Fr.) P. Kumm.			M	Non edible
111.	*Tricholoma portentosum* (Fr.) Quél.		+	M	Edible
112.	*Tricholoma saponaceum* (Fr.) P. Kumm.			M	Poisonous
113.	*Tricholoma virgatum* (Fr.) P. Kumm.			M	Non edible
114.	*Xerocomellus chrysenteron* (Bull.) Šutara	+	+	M	Edible
115.	*Xerocomellus rubellus* (Krombh.) Šutara			M	Edible

In spite of the fact that comparisons with older data are practically impossible due to lack of detailed descriptions of the visited localities, it is possible to outline that only 35 species from our list coincide with the species, published by Barzakow (1926a, b, c, 1928), Dimitrov (1926), Barzakoff (1929, 1933, 1936), Hinkova (1950, 1955, 1961) and Dimitrova et al. (2007), and 59 of them have already been reported for Sofia region by Denchev & Assyov (2013).

As it could be seen from Table 1, the fungi observed by us, belong mostly to the major ecological groups of saprotrophs (65), mycorrhizal species (48) and parasites (2). Xylotrophs predominated (32) in the first group and were followed by humic saprotrophs (21) and litter saprotrophs (12). Three of the found species are known to be of conservational importance with different threat status in the Red List of fungi in Bulgaria (Gyosheva et al. 2006) – *Caloboletus radicans* VU, *Cortinarius caperatus* EN and *Cortinarius praestans* CR. Two of them (*Cortinarius praestans* CR and *Cortinarius caperatus* EN) are included also in the Red Data Book of the Republic of Bulgaria (Gyosheva 2011).

In spite of the fact that the abundance was not estimated, it could be noted that the most numerous (except trunk inhabitants like *Collybia fusipes, Flammulina velutipes, etc*. and xyllophyllous *Trametes, Fomes, ets*.) in almost all years were different representatives of the genus *Russula,* while abundant development of *Macrolepiota procera, Clitocybe geotropa, Amanita rubescens, Laetiporus sulphureus* and representatives of *Boletus-Xerocomus* group, was detected only periodically, with interruptions of 2–4(5) years. Macromycetes like *Ascocoryne cylichnium, Amanita muscaria, Amanita phalloides, Boletus queletii, Chroogomphus rutilus, Cortinarius praestans, Cortinarius purpurascens, Craterellus cornucopioides* and *Leucoagaricus leucothites* were rarely found, in singular specimens or groups/ clumps. The abundance of *Auricularia auricula* decreased obviously with falling down and taking out of the old decayning *Sambucus* stems. The abundance, and even the occurrence, of *Ganoderma lucidum* decreased strongly due to its intensive uncontrolled collection for decorative and medicinal purposes.

CONCLUSION

The results obtained in this work provide pilot data on the recent mycota in urban park area of Sofia and, most probably, are the first data published from the south-eastern part of the city park Borisova Gradina. Nevertheless of their preliminary character, they reveal the presence of considerable fungal biodiversity with the 115 species of asco – and basidiomycetes recorded non-purposively, only during dog walks. Therefore we claim that they could serve as a good contemporary basis for future studies of biodiversity in Sofia and other Bulgarian towns. Moreover, 70% of the macromycetes observed are of multiple potential interest (e.g. food, medicinal properties, wood status, soil protection), which, according to Barrica et al. (2012), demonstrates that we should take into account not only the biological and ecological perspectives of the landscapes but also their potential products and environmental services with regard to future land use and urban life.

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Accepted 26 November 2014