

Diversity of larger fungi in coniferous communities of Shar Mountain National Park (Republic of North Macedonia) with new country records

Hasime Jashari^{1*}, *Slavica Tofilovska*², *Mitko Karadelev*², *Katerina Rusevska*²

¹ - Primary School Simche Nastovski, Tetovo, REPUBLIC OF NORTH MACEDONIA

² - Institute of Biology, Faculty of Natural Sciences and Mathematics, Ss. Cyril and Methodius University, Arhimedova 5, Skopje, REPUBLIC OF NORTH MACEDONIA

*Corresponding author: jasharihasime@gmail.com

Abstract. Shar Mountain is one of the largest mountain ranges in Republic of North Macedonia, distinguished by outstanding biodiversity, first and foremost owing to the presence of various climate and vegetation features. Published data on the mycota of Shar Mt. is scarce; they refer to specific areas, and there are no systematic data available on occurrence of the species in different forest associations. Therefore, we decided to embark on mycodiversity study of the coniferous communities in this mountain. The material was collected in 2021 and 2022, from six localities: Popova Shapka, Jelak, Shipkovica, Leshnica, the Adzhina Reka river - in natural coniferous woods, and in pine plantations from the vicinity of Rogachevo village. The study resulted in recording of 179 species, two lichenized fungi, and one fungus-like organism. The total number of macromycetes from coniferous communities of Shar Mt. is 214. The phylum Basidiomycota comprises 170 species (where of 6 are gasteroid fungi); 6 species are referred to Ascomycota. It is worth noting the finds of *Agaricus altipes*, *Cortinarius flexipes*, *C. triformis*, *Lyophyllum konradianum* and *Pluteus primus*, which are first data for Republic of North Macedonia.

Key words: macrofungi, *Picea* and *Abies* forests, new data records, Shar NP.

Introduction

The first data on fungi research in Macedonia date from early 20th century, and they have been particularly intensified in the last two decades. The first mycological papers related to the area of Macedonia originate from the beginning of last century i.e., by Ranojevic (1909), then by Sydow (1921), and the papers by Pilát & Lindtner, (1938, 1939) are particularly significant. The pioneering more detailed mycological studies in Macedonia were initiated by Dr Milica Tortic, which resulted in the publication of the first mycoflora of Macedonia in 1988, comprising 585 macromycetes species

(Tortic, 1988). In the period until year 2000, lignicolous fungal species were mainly studied in specific regions such as the following: Pelister, Jakupica, Galicica, Golem Grad Island, Kozuf, Shar Mt and Juzno Povardarie (Tortić, 1988; Karadelev, 1993, 1995a,b; Karadelev & Rusevska, 2000; Karadelev et al., 2002a,b,c, 2003).

Systematic research into fungi was especially stepped up after year 2000, which is the reason why in the last two decades a more comprehensible picture of mycodiversity of numerous regions (Vodno, Bistra, Dobra Voda, Jablanica, Mavrovo, Osogovo Mts, Ograzden, Shar Mt., etc) in the country

has been obtained and of certain systematic categories (mostly macromycetes, such as *Amanita*, *Ganoderma*, *Hymenochaete*, *Hyphoderma*, *Peniophora*, *Phellinus*, boletoid, gasteroid, hypogeous and hallucinogenic fungi, morels and so forth). On the basis of these research studies to date, occurrence of 1789 taxa of macromycetes from the phylum Basidiomycota (Karadelev et al., 2018; Tofilovska et al., 2019) and 255 taxa from the phylum Ascomycota (Karadelev et al., 2019) have been established.

Shar Mountain is one of the highest mountains in Republic of North Macedonia, characterized by exceptional species diversity, largely due to the occurrence of a range of climate and vegetation features, and, recently, it was proclaimed a National Park (Shar Mountain National Park). Given that published data on fungi of Shar Mt., concerned with specific areas (Nastov et al., 1996; Karadelev et al., 2002a), are limited,

and given that there is lack of systematic data on their occurrence in different forest associations, we decided to commence studying of mycodiversity of the coniferous communities in this mountain. These communities are developed in the higher alpine sections of Shar Mt., chiefly represented by mixed or pure forest of fir (*Abies alba* Mill.) and spruce (*Picea abies* (L.) H. Karst.).

Materials and Methods

This research was implemented in the coniferous forests on the territory of Shar Mt., at an altitudes ranging between 749 m and 1,805 m. The fungal specimens were collected in autumn of 2021, and spring, summer and autumn of 2022, from the following localities: Popova Shapka, Jelak, Leshnica and the Adzhina Reka river – all with natural coniferous forest, and also from the neighborhood of Rogachevo village – in pine plantations (Fig. 1).

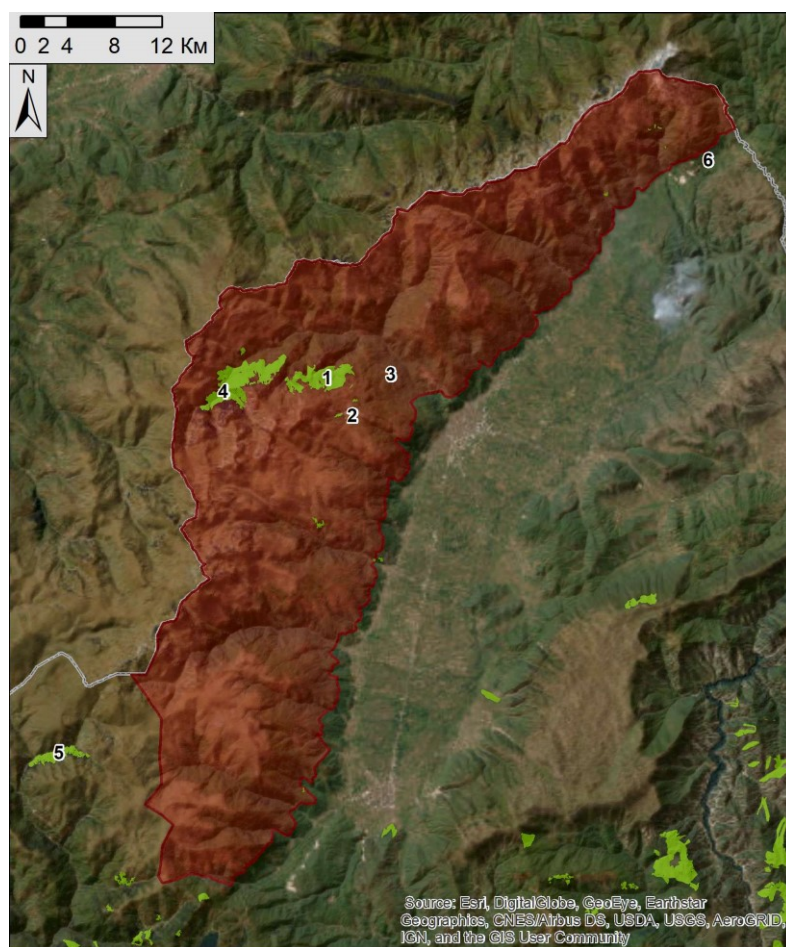


Fig. 1. Map of coniferous communities of Shar Mt. 1 – Jelak, 2 – Popova Shapka, 3 – Shipkovica, 4 – Leshnica, 5 – The Adzhina Reka river, 6 – Rogachevo.

The material was collected from various substrates, such as soil, fallen branches, stumps, old trunks, trees, cones, needles. Some specimens were identified in the field whereas others were determined in the Mycological Laboratory. Identification was done based on morphological and ecological characteristics. Morphological analyses were conducted by means of macro-chemical reactions of sporocarps (with phenol, 30% KOH, ferrous sulphate, NH₄OH, etc.), and by applying a light microscope. Taxonomically relevant microscopic features (spores, basidia, pileipellis, cystidia, asci, ascospores) were visualized in 5%KOH, Melzer's reagent, Methylene blue or Congo red.

For species identification, adequate and contemporary literature was consulted (monographs and identification keys). The majority of the specimens (mushrooms, in particular) were determined while still in fresh condition, while others, such as e.g., crust or other lignicolous fungi, were

identified in dry condition. A portion of the specimens was stored in the Macedonian Collection of Fungi (MCF) and their accession numbers are shown in the resultant list of species, whereas all data were incorporated in the MACFUNGI database. Collection and identification of all specimens were accomplished by the authors of the current paper.

The nomenclatural data-bases from Index Fungorum (<https://www.indexfungorum.org/>) and Mycobank (<https://www.mycobank.org/>) were used to consult the actual species names.

Results and Discussion

As a result of the mycological research conducted during 2021 and 2022, 179 fungal species were recorded (Table 1). The number of macromycetes from coniferous communities of Shar Mt. is 214 in total. The phylum Basidiomycota comprises 170 species (whereof 6 are gasteroid fungi), while 8 species belong to Ascomycota (whereof 2 are lichenized fungi), and a single species is fungus-like organism.

Table 1. Names and GPS coordinates of studied localities in Shar Mt.

No	Locality	Number of taxa	Point No	Point no. Latitude	Point no. Longitude	Point no. Altitude (m)	Forest community
1.	Jelak	97	Point 1	1.42.009928	1.20.86105	1.1805	fir, spruce
			Point 2	2.41.967576	2.20.889142	2.1798	
			Point 3	3.41.962704	3.20.877638	3.1790	
			Point 4	4.41.271262	4.20.464655	4.1785	
			Point 5	5.41.987808	5.20.882346	5.1800	
			Point 6	6.42.01593	6.20.514019	6.1802	
2.	Popova Shapka	8	Point 7	7.42.0677	7.21.0094	7.1092	Spruce, fir, pine
3.	Shipkovica	4	Point 8	8.42.150	8.20.5334	8.1635	beech, fir and spruce
			Point 9	9.42.150	9.20.5335	9.1640	
4.	Leshnica	33	Point 10	10.42.133	10.20.4720	10.1568	spruce fir, pine, and mixed deciduous communities
			Point 11	11.42.02550	11.20.8523	11.1478	
5.	The Adzhina Reka river	44	Point 12	12.41.820	12.20.655	12.1438	spruce, fir, pine
6.	Rogachevo	8	Point 13	13.42.944	13.21.926	13.944	pine plantation
			Point 14	14.42.93	14.21.107	14.889	
			Point 15	15.42.92	15.21.107	15.769	
			Point 16	16.42.065	16.20.561	16.950	
			Point 17	17.42.91	17.21.107	17.776	

As far as the substrate is concerned, 165 of the registered species are terricolous, 42 are lignicolous, and one species is a parasite on boletoid fungi (Boletaceae). The majority of fungi and fungus-like organisms were observed in the coniferous communities of Jelak (97). Forty-four species were noted in the fir-spruce association of the Adzhina Reka river whereas 8 species were recorded at Popova Shapka. Eight species were identified in pine plantations of Rogachevo, and 4 species in the mixed beech, fir and spruce association (Shipkovica). Some species are known to be used for human nutrition, such as *Amanita rubescens*, *Boletus edulis*, *Calvatia utriformis*, *Russula cyanoxantha*, *Suillus granulatus*, *S. luteus*. The species *Hericium coralloides* is included in the Macedonian Red List of Fungi, in the category of endangered species. It is important to underscore the identification of *Agaricus altipes* (syn. *A. aestivalis*), *Pluteus primus*, *Cortinarius triformis*, *C. flexipes*, *Lyophyllum konradianum*, which constitute the first records for the country.

List of identified fungi from coniferous forest communities from studied sites in Shar Mt. National Park

The list contains the identified fungi species and the family they are affiliated to, with the following data: the locality, altitude, GPS coordinates, substrate, forest association, collection date.

1. *Agaricus altipes* (F.H. Møller) F.H. Møller (syn. *A. aestivalis* (F.H. Møller) Pilát) (Agaricaceae), the Adzhina Reka river, Point 12, soil, 23.06.2022, note;
2. *Agaricus comtulus* Fr. (Agaricaceae), Jelak, Point 1, soil, 04.09.2022, note;
3. *Agaricus langei* (F.H. Møller) F.H. Møller (Agaricaceae), Jelak, Point 1, soil, 04.09.2022, MCF 2022/19256;
4. *Agrocybe praecox* (Pers.) Fayod (Strophariaceae), Leshnica, Point 10, soil, 25.09.2022, MCF 2022/19273;
5. *Amanita muscaria* (L.) Lam. (Amanitaceae), Jelak, Point 1, soil, 02.10.2021, MCF2021/18897;
6. *Amanita pantherine* (DC.) Krombh. (Amanitaceae), Jelak, Point 3, soil, 31.07.2022, note;
7. *Amanita rubescens* Pers. (Amanitaceae), Jelak, Point 3, soil, 31.07.2022, note;
8. *Apioperdon pyriforme* (Schaeff.) Vizzini (syn. *Lycoperdon pyriforme* Schaeff.) (Lycoperdaceae), Jelak, Point 6, soil, 27.06.2022, note; (gasteroid fungus);
9. *Armillaria mellea* (Vahl) P. Kumm. (Physalacriaceae), Leshnica, Point 10, rotten wood of *Picea-Abies*, 25.09.2022, note;
10. *Armillaria ostoyae* (Romagn.) Herink (Physalacriaceae), Leshnica, Point 10, rotten wood of *Picea-Abies*, 25.09.2022, note;
11. *Boletus aereus* Bull. (Boletaceae), Jelak, Point 2, soil, *Picea-Abies*, 04.09.2022, note;
12. *Boletus edulis* Bull. (Boletaceae), Jelak, Point 2, soil, *Picea-Abies*, 17.07.2022, note;
13. *Boletus reticulatus* Schaeff. (Boletaceae), Jelak, Point 2, soil, *Picea-Abies*, 27.06.2022, note;
14. *Bovistella utriformis* (Bull.) Demoulin & Rebriev (syn. *Calvatia utriformis* (Bull.) Jaap) (Lycoperdaceae), Jelak, Point 2, on soil, 27.06.2022, note; (gasteroid fungus);
15. *Butyriboletus subappendiculatus* (Dermek, Lazebn. & J. Veselský) D. Arora & J. L. Frank (syn. *Boletus subappendiculatus* Dermek, Lazebn. & J. Veselský) (Boletaceae), Popova Shapka, Point 7, soil, *Picea-Abies-Pinus*, 03.07.2022, MCF 2022/19252;
16. *Caloboletu scalopus* (Pers.) Vizzini (syn. *Boletus calopus* Pers.) (Boletaceae), Leshnica, Point 11, soil, *Picea-Abies-Pinus*, 19.06.2022, MCF 2022/19249;
17. *Calocera cornea* (Batsch) Fr. (Dacrymycetaceae), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, note;
18. *Calonarius callochrous* (Pers.) Niskanen & Liimat (syn. *Cortinarius callochrous* (Pers.) Gray) (Cortinariaceae), Jelak, Point 6, soil, *Picea-Abies*, 31.07.2022, note;
19. *Cantharellus cibarius* Fr. (Hydnaceae), Jelak, Point 5, soil, *Picea-Abies*, 04.09.2022, note;
20. *Cerioporus varius* (Pers.) Zmitr. & Kovalenko (syn. *Polyporus varius* (Pers.) Fr.) (Polyporaceae), Leshnica, Point 10, soil, *Picea-Abies*, 19.06.2022, note;
21. *Chalciporus piperatus* (Bull.) Bataille (Boletaceae), Jelak, Point 2, soil, *Picea-Abies*, 02.10.2021, MCF 2021/18901;

22. *Clavulina cinerea* (Bull.) J. Schröt. (*Hydnaceae*), Jelak, 1,795 m, Point 5, soil, *Picea-Abies*, 02.10.2021, MCF 2021/18911;
23. *Clitocybe costata* Kühner & Romagn. (*Tricholomataceae*), Jelak, Point 6, soil, *Picea-Abies*, 04.09.2022, MCF 2022/19276;
24. *Clitocybe fragrans* (With.) P. Kumm. (*Tricholomataceae*), the Adzhina Reka river, Point 12, *Picea-Abies*, 18.09.2022, note;
25. *Clitocybe nebularis* (Batsch) P. Kumm. (*Tricholomataceae*), Rogachevo, Point 13, soil, *Pinus* Plantation, 31.10.2021, note;
26. *Clitocybe odora* (Bull.) P. Kumm. (*Tricholomataceae*), Rogachevo, Point 17, soil, *Pinus* Plantation, 31.10.2021, note;
27. *Clitocybe odora* var. *alba* J.E. Lange (*Tricholomataceae*), Popova Shapka, Point 7, soil, *Picea-Abies-Pinus*, 03.07.2022, note;
28. *Clitocybe vibecina* (Fr.) Quél. (*Tricholomataceae*), Leshnica, Point 10, soil, *Picea-Abies*, 25.09.2022, MCF 2022/19346;
29. *Collybiopsis confluens* (Pers.) R.H. Petersen (syn. *Collybia confluens* (Pers.) P. Kumm.) (*Omphalotaceae*), Leshnica, Point 10, soil, *Picea-Abies*, 25.09.2022, MCF 2022/19345;
30. *Coprinus comatus* (O.F. Müll.) Pers. (*Agaricaceae*), Jelak, Point 6, soil, *Picea-Abies*, 04.09.2022, note;
31. *Cortinarius anomalus* (Fr.) Fr. (*Cortinariaceae*), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, MCF 2022/19336;
32. *Cortinarius cinnamomeus* (L.) Gray (*Cortinariaceae*), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 04.09.2022, MCF 2022/19293;
33. *Cortinarius croceus* (Schaeff.) Gray (*Cortinariaceae*), Jelak, Point 6, soil, *Picea-Abies*, 04.09.2022, MCF 2022/19294;
34. *Cortinarius duracinus* Fr. (*Cortinariaceae*), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 23.06.2022, note;
35. *Cortinarius flexipes* (Pers.) Fr. (*Cortinariaceae*), Jelak, Point 6, soil, *Picea-Abies*, 02.10.2022, note;
36. *Cortinarius infractus* (Pers.) Fr. (*Cortinariaceae*), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, MCF 2022/19333;
37. *Cortinarius laetus* M.M. Moser (*Cortinariaceae*), Jelak, Point 6, soil, *Picea-Abies*, 31.07.2022, note;
38. *Cortinarius semisanguineus* (Fr.) Gillet (*Cortinariaceae*), Jelak, Point 6, soil, *Picea-Abies*, 04.09.2022, note;
39. *Cortinarius subferrugineus* (Batsch) Fr. (*Cortinariaceae*), Jelak, Point 6, soil, *Picea-Abies*, 31.09.2022, MCF 2022/19279;
40. *Cortinarius triformis* Fr. (*Cortinariaceae*), Jelak, Point 6, soil, *Picea-Abies*, 02.10.2022, MCF 2022/19354;
41. *Crepidotu sluteolus* Sacc. (*Crepidotaceae*), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 22.06.2022, note;
42. *Cystoderma amianthinum* (Scop.) Fayod (*Agaricaceae*), Rogachevo, Point 15, soil, *Pinus* plantation, 31.10.2021, note;
43. *Cystoderma carcharias*(Pers.) Fayod (*Agaricaceae*), Jelak, Point 6, soil, *Picea-Abies*, 07.11.2021, note;
44. *Cystodermella granulosa* (Batsch) Harmaja (syn. *Cystoderma granulorum* (Batsch) Harmaja (*Agaricaceae*), Shipkovica, Point 9, soil, *Picea-Fagus*, 07.11.2021, MCF 2021/18920; Leshnica, Point 11, soil, *Picea-Abies*, 18.09.2022, note;
45. *Cystolepio tasistrata* (Fr.) Singer ex Bon & Bellù (*Agaricaceae*), Leshnica, Point 11, soil, *Picea-Abies*, 18.09.2022, note;
46. *Daedaleopsis confragosa* (Bolton) J. Schröt. (*Polyporaceae*), Leshnica, Point 11, tree, *Picea-Abies*, 18.09.2022, note;
47. *Deconica montana* (Pers.) P.D. Orton (*Strophariaceae*), Leshnica, Point 11, tree, *Picea-Abies*, 18.09.2022, note;
48. *Discina ancilis* (Pers.) Sacc. (syn. *Discina perlata* (Fr.) Fr.) (*Discinaceae*, *Ascomycota*), Jelak, Point 2, tree, *Picea-Abies*, 25.05.2021, note;
49. *Entoloma rhodopolium* (Fr.) P. Kumm. (*Entolomataceae*), Jelak, Point 6, soil, *Picea-Abies*, 27.06.2022, note;
50. *Entoloma sodale* Kühner & Romagn. ex Noordel. (*Entolomataceae*), Jelak, Point 6, soil, *Picea-Abies*, 04.09.2022, MCF 2022/19284;
51. *Exidia nigricans* (With.) P. Roberts (syn. *Exidia pithya* (Alb. & Schwein.) Fr.) (*Auriculariaceae*), the Adzhina Reka river, Point 12, *Picea-Abies*, 23.06.2022, note;

52. *Fomes fomentarius* (L.) Fr. (Polyporaceae), Shipkovic, Point 8, tree, *Picea-Fagus*, 02.11.2021, note;
53. *Fomitopsis pinicola* (Sw.) P. Karst. (Fomitopsidaceae), the Adzhina Reka river, Point 12, tree, *Picea-Abies*, 23.06.2022; Jelak, Point 6, tree, *Picea-Abies*, 02.11.2021, note;
54. *Galerina marginata* (Batsch) Kühner (Hymenogastraceae), the Adzhina Reka river, Point 12, tree, *Picea-Abies*, 23.06.2022, note;
55. *Galerina sideroides* (Bull.) Kühner (Hymenogastraceae), Jelak, Point 2, rotten wood, *Picea-Abies*, 04.09.2021, MCF 2022/19258;
56. *Galerina stylifera* (G.F. Atk.) A.H. Sm. & Singer (Hymenogastraceae), Jelak, Point 2, rotten wood, *Picea-Abies*, 02.10.2021, MCF 2021/18508;
57. *Gerronema xanthophyllum* (Bres.) Norvell, Redhead & Ammirati (Marasmiaceae), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, MCF 2022/19339;
58. *Gloeophyllum abietinum* (Bull.) P. Karst. (Gloeophyllaceae), Jelak, Point 6, rotten wood, *Picea-Abies*, 26.07.2021, note;
59. *Gloeophyllum sepiarium* (Wulfen) P. Karst. (Gloeophyllaceae), Jelak, Point 6, rotten wood, *Picea-Abies*, 26.09.2021, note;
60. *Gomphidius glutinosus* (Schaeff.) Fr. (Gomphidiaceae), Popova Shapka, Point 7, soil, *Picea-Abies-Pinus*, 03.07.2022, MCF 2022/19250;
61. *Guepinia helvelloides* (DC.) Fr. (syn. *Tremiscus helvelloides* (DC.) Donk). (Auriculariomycetidae), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, note;
62. *Gymnopilus penetrans* (Fr.) Murrill (Hymenogastraceae), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, note;
63. *Gymnopilus sapineus* (Fr.) Murrill (Hymenogastraceae), Jelak, Point 6, rotten wood, *Picea-Abies*, 02.10.2021, MCF 2021/18899;
64. *Gymnopus androsaceus* (L.) Della Magg. & Trassin (syn. *Marasmius androsaceus* (L.) Fr.) (Omphalotaceae), the Adzhina Reka river, Point 12, fallen needles, *Picea-Abies*, 23.06.2022, note;
65. *Gymnopus aquosus* (Bull.) Antonín & Noordel. (Omphalotaceae), Jelak, Point 6, soil, *Picea-Abies*, 19.07.2022, MCF 2022/19315;
66. *Gymnopus dryophilus* (Bull.) Murrill (Omphalotaceae), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 23.06.2022, note; Leshnica, Point 10, soil, *Picea-Abies*, 18.09.2022, note;
67. *Hebeloma crustuliniforme* (Bull.) Quél. (Hymenogastraceae), Leshnica, Point 11, soil, *Picea-Abies*, 18.09.2022, note;
68. *Hebeloma circinans* (Quél.) Sacc. (Hymenogastraceae), Jelak, Point 6, soil, *Picea-Abies*, 04.09.2022, note;
69. *Helvella lacunose* Afzel. (Helvellaceae, Ascomycota), Leshnica, Point 11, soil, *Picea-Abies*, 18.09.2022, MCF 2022/19283;
70. *Hericium coralloides* (Scop.) Pers. (Hericiaceae), Jelak, Point 2, rotten wood, *Picea-Abies*, 02.10.2021, MCF 2021/18904;
71. *Heterobasidion annosum* (Fr.) Bref. (Bondarzewiaceae), the Adzhina Reka river, Point 12, rotten wood, *Picea-Abies*, 23.06.2022, note;
72. *Hyaloscypha leuconica* (Cooke ex Stev.) Nannf. (Hyaloscyphaceae, Ascomycota), the Adzhina Reka river, Point 12, rotten wood, *Picea-Abies*, 23.06.2022, note;
73. *Hydnellum peckii* Banker (Bankeraceae), Jelak, Point 6, soil, *Picea-Abies*, 04.09.2022, MCF 2022/19265;
74. *Hygrocybe citrina* (Rea) J.E. Lange (Hygrophoraceae), Point 2, rotten wood, *Picea-Abies*, 04.09.2022, MCF 2022/19263;
75. *Hygrocybe conica* (Schaeff.) P. Kumm. (Hygrophoraceae), Popova Shapka, Point 7, soil, *Picea-Abies-Pinus*, 03.07.2022, note;
76. *Hygrophoropsis aurantiaca* (Wulfen) Maire (Hygrophoropsidaceae), Jelak, 1,800 m, Point 6, soil, *Picea-Abies*, 02.10.2021, MCF 2021/18921;
77. *Hygrophorus agathosmus* (Fr.) Fr. 1838 (Hygrophoraceae), Jelak, Point 2, soil, *Picea-Abies*, 07.11.2021, MCF 2021/18925;
78. *Hygrophorus camarophyllus* (Alb. & Schwein.) Dumée, Grandjean & Maire (Hygrophoraceae), Shipkovic, Point 8, soil, *Picea-Fagus*, 02.11.2021, MCF 2021/18919;
79. *Hygrophorus chrysodon* (Batsch) Fr. (Hygrophoraceae), Leshnica, Point 11, soil, *Picea-Abies*, 25.09.2022, note;
80. *Hygrophorus pudorinus* (Fr.) Fr. (Hygrophoraceae), Leshnica, Point 11, soil, *Picea-Abies*, 25.09.2022, note;

81. *Hygrophorus pustulatus* (Pers.) Fr. (*Hygrophoraceae*), Leshnica, Point 11, soil, *Picea-Abies*, 25.09.2022., MCF 2022/19264;
82. *Hymenopellis radicata* (Relhan) R.H. Petersen (syn. *Oudemansiella radicata* (Relhan) Singer) (*Physalacriaceae*), Leshnica, Point 10, soil, *Picea-Abies*, 19.06.2022, note;
83. *Hyphodontia alutaria* (Burt) J. Erikss. (*Hyphodontiaceae*), the Adzhina Reka river, Point 12, rotten wood, *Picea-Abies*, 23.06.2022, note;
84. *Hypholoma fasciculare* (Huds.) Fr. P. Kumm. (*Strophariaceae*), Jelak, Point 5, rotten wood, *Picea-Abies*, 02.10.2021, MCF 2021/18917; Jelak, Point 5, rotten wood, *Picea-Abies*, 25.05.2021, note;
85. *Imleria badia* (Fr.) Vizzini (syn. *Xerocomus badius* (Fr.) E.-J. Gilbert (*Boletaceae*), Jelak, Point 4, soil, *Picea-Abies*, 17.07.2022, note;
86. *Infundibulicybe gibba* (Pers.) Harmaja (syn. *Clitocybe gibba* (Pers.) P. Kumm.) (*Tricholomataceae*), Jelak, Point 5, soil, *Picea-Abies*, 02.10.2021, MCF 2021/18907;
87. *Inocybe catalaunica* Singer (syn. *Inocybe leiocephala* (D.E. Stuntz) (*Inocybaceae*), Jelak, Point 2, soil, *Picea-Abies*, 31.07.2022, note;
88. *Inocybe flocculosa* Sacc. (*Inocybaceae*), Jelak, Point 2, soil, *Picea-Abies*, 17.07.2022, MCF 2022/19318;
89. *Inocybe geophylla* P. Kumm. (*Inocybaceae*), the Adzhina Reka river, Point 12, rotten wood, *Picea-Abies*, 23.06.2022, note;
90. *Laccaria amethystine* Cooke (*Hydnangiaceae*), Jelak, Point 2, soil, *Picea-Abies*, 07.11.2021, MCF 2021/18926;
91. *Laccaria laccata* (Scop.) Cooke (*Hydnangiaceae*), Leshnica, Point 11, soil, *Picea-Abies*, 25.09.2022, note;
92. *Laccaria proxima* (Boud.) Pat. (*Hydnangiaceae*), Jelak, Point 6, soil, *Picea-Abies*, 27.06.2022, note;
93. *Lactarius deliciosus* (L.) Gray (*Russulaceae*), Rogachevo, Point 13, soil, *Pinus* Plantation, 31.10.2021, note;
94. *Lactarius deterrimus* Gröger (*Russula-ceae*), Jelak, Point 6, soil, *Picea-Abies*, 17.07.2022, MCF 2022/19255; the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 23.06.2022, note;
95. *Lactarius fulvissimus* Romagn. (*Russulaceae*), Jelak, Point 2, soil, *Picea-Abies*, 04.09.2022, note;
96. *Lactarius salmonicolor* R. Heim & Leclair (*Russulaceae*), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 23.06.2022, note;
97. *Lactarius sanguifluus* (Paulet) Fr. (*Russulaceae*), Popova Shapka, Point 7, soil, *Picea-Abies- Pinus*, 02.10.2022, note;
98. *Lactarius scrobiculatus* (Scop.) Fr. (*Russulaceae*), Jelak, Point 2, soil, *Picea-Abies*, 31.07.2022, note;
99. *Lactarius zonarioides* Kühner & Romagn. (*Russulaceae*), Jelak, Point 2, soil, *Picea-Abies*, 04.09.2022, MCF 2022/19272;
100. *Legaliana badia* (Pers.) Van Vooren (syn. *Peziza badia* Pers.) (*Pezizaceae*, *Ascomycota*), Jelak, 1,798 m, Point 2, soil, *Picea-Abies*, 31.07.2022, note;
101. *Lentinellus cochleatus* (Pers.) P. Karst. (*Auriscalpiaceae*), Jelak, Point 6, rotten wood, *Picea-Abies*, 27.06.2022, note;
102. *Lepiota cristata* (Bolton) P. Kumm. (*Agaricaceae*), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, note;
103. *Lepiota magnispora* Murrill (syn. *Lepiota ventriosospora* (D.A. Reid) (*Agaricaceae*), Jelak, Point 6, soil, *Picea-Abies*, 04.09.2022, MCF 2022/19292;
104. *Lepista nuda* (Bull.) Cooke (*Tricholomataceae*), Shipkovica, Point 8, soil, *Picea-Fagus*, 07.11.2021, note;
105. *Lepista sordida* (Schumach.) Singer (*Tricholomataceae*), Jelak, Point 6, soil, *Picea-Abies*, 04.09.2022, MCF 2022/19277;
106. *Leratiomyces squamosus* (Pers.) Bridge & Spooner (syn. *Stropharia squamosa* (Pers.) Quél.) (*Strophariaceae*), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, note;
107. *Leucopaxillus nauseosodulcis* (P. Karst.) Singer & A.H. Sm (*Tricholomataceae*), Jelak, Point 2, soil, *Picea-Abies*, 04.09.2022, MCF 2022/19257;
108. *Lycoperdon atropurpureum* Vittad. (*Lycoperdaceae*), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 23.06.2022, MCF 2022/19253; (gasteroid fungus);
109. *Lycoperdon mole* Pers. (*Lycoperdaceae*), Rogachevo, Point 16, soil, *Picea-Abies*, 31.10.2021, note; (gasteroid fungus);

110. *Lycoperdon perlatum* Pers. (*Lycoperdaceae*), Jelak, Point 6, soil, *Picea-Abies*, 27.06.2022, note; (gasteroid fungus);
111. *Lycoperdon pratense* Pers. (syn. *Vascellum pratense* Pers.) (*Lycoperdaceae*), Jelak, Point 6, soil, *Picea-Abies*, 02.10.2021, MCF 2021/18905; (gasteroid fungus);
112. *Lyophyllum decastes* (Fr.) Singer (syn. *Lyophyllum fumosum* (Pers.) P.D. Orton) (*Lyophyllaceae*), Leshnica, Point 11, soil, *Picea-Abies*, 25.09.2022, note;
113. *Lyophyllum konradianum* (Maire) Kühner & Romagn. (*Lyophyllaceae*), Popova Shapka, Point 7, soil, *Picea-Abies-Pinus*, 11.09.2022, MCF 2022/19308;
114. *Macrolepiota procera* (Scop.) Singer (*Agaricaceae*), Jelak, Point 6, soil, *Picea-Abies*, 04.09.2022, note;
115. *Marasmius rotula* (Scop.) Fr. (*Marasmiaceae*), Jelak, Point 6, soil, *Picea-Abies*, 02.10.2021, MCF 2021/18906;
116. *Melanoleuca humilis* (Pers.) Pat. (*Tricholomataceae*), Jelak, Point 6, soil, *Picea-Abies*, 04.09.2022, note;
117. *Melanoleuca turrata* (Sacc.) Singer (*Tricholomataceae*), Leshnica, Point 11, soil, *Picea-Abies*, 18.09.2022, note;
118. *Mycena galericulata* (Scop.) Gray (*Mycenaceae*), the Adzhina Reka river, Point 12, rotten wood, *Picea-Abies*, 18.09.2022, note;
119. *Mycena galopus* (Pers.) P. Kumm. (*Mycenaceae*), the Adzhina Reka river, Point 12, rotten wood, *Picea-Abies*, 23.06.2022, note;
120. *Mycena metata* (Fr.) P. Kumm. (*Mycenaceae*), Leshnica, Point 11, soil, *Picea-Abies*, 25.09.2022, note;
121. *Mycena pura* (Pers.) P. Kumm. (*Mycenaceae*), the Adzhina Reka river, Point 12, rotten wood, *Picea-Abies*, 23.06.2022;
122. *Mycena renati* Quél. (*Mycenaceae*), Leshnica, Point 11, rotten wood, *Picea-Abies*, 19.06.2022, note;
123. *Neoboletus luridiformis* (Rostk.) Gelardi, Simonini & Vizzini (syn. *Boletus luridiformis* subsp. *luridiformis* Rostk.) (*Boletaceae*), Jelak, Point 2, soil, *Picea-Abies*, 27.06.2022, note; the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, note;
124. *Otidea brunneoparva* Harmaja ex K. Hansen, M. Carbone, Olariaga & Van Vooren (*Otideaceae*, *Ascomycota*), Jelak, Point 2, soil, *Picea-Abies*, 04.09.2022, note;
125. *Otidea onotica* (Pers.) Fuckel (syn. *Otidea abietina* (Pers.) Fuckel) (*Otideaceae*, *Ascomycota*), Leshnica, Point 10, soil, *Picea-Abies*, 25.09.2022, note;
126. *Panaeolus semiovatus* (Sowerby) S. Lundell & Nannf. (*Bolbitiaceae*), Jelak, Point 2, horse manure, *Picea-Abies*, 31.07.2022, note;
127. *Paralepista flaccida* (Sowerby) Vizzini (syn. *Lepista inversa* (Scop.) Pat.) (*Tricholomataceae*), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, note;
128. *Phaeoclavulina flaccida* (Fr.) Giachini (syn. *Ramaria flaccida* (Fr.) Bourdot) (*Gomphaceae*), Leshnica, Point 10, soil, *Picea-Abies*, 25.09.2022, note;
129. *Phellinus hartigii* (Allesch. & Schnabl) Pat. (*Hymenochaetaceae*), Leshnica, Point 10, tree, *Picea-Abies*, 19.06.2022, note; the Adzhina Reka river, Point 12, tree, *Picea-Abies*, 23.06.2022, note;
130. *Phlebia segregata* (Bourdot & Galzin) Parmasto (*Meruliaceae*), the Adzhina Reka river, Point 12, rotten wood, *Picea-Abies*, 23.06.2022, note;
131. *Phlegmacium glaucopus* (Schaeff.) Wünsche (syn. *Cortinarius glaucopus* var. *acyaneus* (M. M. Moser) Nezdobjm.) (*Cortinariaceae*), Jelak, Point 6, soil, *Picea-Abies*, 04.09.2022, MCF 2022/19261;
132. *Pholiota squarrosa* (Vahl) P. Kumm. (*Strophariaceae*), Jelak, Point 1, rotten wood, *Picea-Abies*, 02.10.2021, MCF 2021/18900;
133. *Pluteus cervinus* (Schaeff.) P. Kumm. (*Pluteaceae*), Jelak, Point 6, soil, 02.10.2021, MCF 2021/18903;
134. *Pluteus primus* Bonnard (*Pluteaceae*), Leshnica, Point 10, soil, *Picea-Abies*, 19.06.2022, MCF 2022/19250;
135. *Pluteus roseipes* Höhn. (*Pluteaceae*), Jelak, Point 2, soil, *Picea-Abies*, 27.06.2022, note;
136. *Protostropharia semiglobata* (Batsch) Redhead, Moncalvo & Vilgalys (syn. *Stropharia semiglobata* (Batsch) Quél.) (*Strophariaceae*), Jelak, Point 2, soil, *Picea-Abies*, 31.07.2022, note;

137. *Psathyrella ochracea* (Romagn.) M. M. Moser (*Psathyrellaceae*), Leshnica, Point 10, soil, *Picea-Abies*, 25.09.2022, note;
138. *Psathyrella piluliformis* (Bull.) P.D. Orton (*Psathyrellaceae*), Jelak, Point 2, rotten wood, *Picea-Abies*, 07.11.2021, MCF 2021/18922;
139. *Psilocybe coronilla* (Bull.) Noordel. (syn. *Stropharia coronilla* (Bull.) Quél.) (*Hymenogastraceae*), Jelak, Point 2, soil, *Picea-Abies*, 07.11.2021, note;
140. *Ramaria flava* (Schaeff.) Quél. (*Gomphaceae*), Jelak, Point 2, soil, *Picea-Abies*, 04.09.2022, note;
141. *Ramaria formosa* (Pers.) Quél. (*Gomphaceae*), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, note;
142. *Rhizocybe pruinose* (P. Kumm.) Vizzini, P. Alvarado & G. Moreno (syn. *Clitocybe pruinosa* P. Kumm.) (*Tricholomataceae*), Jelak, Point 5, soil, *Picea-Abies*, 04.09.2022, MCF 2022/19270;
143. *Rhodocollybia butyracea* (Bull.) Lennox (syn. *Collybia butyracea* (Bull.) P. Kumm.) (*Omphalotaceae*), Jelak, Point 2, soil, *Picea-Abies*, 04.09.2022, MCF 2021/18924;
144. *Rhodocollybia proluxa* (Fr.) Antonín & Noordel. (syn. *Collybia distorta* (Fr.) Quél.) (*Omphalotaceae*), Jelak, Point 6, soil, *Picea-Abies*, 04.09.2022, MCF 2022/19290;
145. *Russula aeruginea* Lindblad ex Fr. (*Russulaceae*), Jelak, Point 2, soil, *Picea-Abies*, 31.07.2022, note;
146. *Russula cyanoxantha* (Schaeff.) Fr. (*Russulaceae*), Jelak, Point 2, soil, *Picea-Abies*, 17.10.2022, note;
147. *Russula deliciosa* J. Schröt. (*Russulaceae*), Jelak, Point 2, soil, *Picea-Abies*, 04.09.2022, note;
148. *Russula firmula* Jul. Schäff. (*Russulaceae*), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, note;
149. *Russula grisea* Fr. (*Russulaceae*), Jelak, Point 2, soil, *Picea-Abies*, 31.07.2022, note;
150. *Russula integra* (L.) Fr. (*Russulaceae*), Jelak, Point 2, soil, *Picea-Abies*, 04.09.2022, MCF 2022/19272;
151. *Russula mustelina* Fr. (*Russulaceae*), Jelak, Point 2, soil, *Picea-Abies*, 02.10.2021, MCF 2021/18909;
152. *Russula nauseosa* (Pers.) Fr. (*Russulaceae*), Popova Shapka, Point 7, soil, *Picea-Abies-Pinus*, 11.09.2022, MCF 2022/19317;
153. *Russula queletii* Fr. (*Russulaceae*), Jelak, Point 2, soil, *Picea-Abies*, 04.09.2022, note; Leshnica, Point 10, soil, *Picea-Abies*, 25.09.2022, note;
154. *Russula turci* Bres. (*Russulaceae*), Jelak, Point 2, soil, *Picea-Abies*, 17.07.2022, MCF 2022/19317;
155. *Russula xerampelina* (Schaeff.) Fr. (*Russulaceae*), Jelak, Point 2, soil, *Picea-Abies*, 02.10.2021, MCF 2021/18910;
156. *Sagaranelia tylicolor* (Fr.) V. Hofst., Cléménçon, Moncalvo & Redhead (syn. *Lyophyllum tylicolor* (Fr.) M. Lange & Sivertsen) (*Lyophyllaceae*), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, note;
157. *Sarcodon imbricatus* (L.) P. Karst. (*Strophariaceae*), Jelak, Point 2, soil, *Picea-Abies*, 17.10.2022, MCF 2022/19289; the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, MCF 2022/19325;
158. *Stropharia aeruginosa* (Curtis) Quél. (*Strophariaceae*), Jelak, Point 2, soil, *Picea-Abies*, 04.09.2022, note;
159. *Stropharia caerulea* Kreisel (*Strophariaceae*), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, note;
160. *Suillus bovinus* (L.) Roussel (*Suillaceae*), Jelak, Point 2, soil, *Picea-Abies*, 04.09.2022, note;
161. *Suillus granulatus* (L.) Roussel (*Suillaceae*), Rogachevo, Point 14, soil, *Pinus* plantation, 31.10.2021, note;
162. *Suillus luteus* (L.) Roussel (*Suillaceae*), Rogachevo, Point 14, soil, *Pinus* plantation, 31.10.2021, note;
163. *Suillellus queletii* (Schulzer) Vizzini, Simonini & Gelardi (syn. *Boletus queletii* Schulzer) (*Boletaceae*), Jelak, Point 2, soil, *Picea-Abies*, 17.07.2022, MCF 2022/19320;
164. *Thaxterogaster turmalis* (Fr.) Niskanen & Liimat (syn. *Cortinarius turmalis* Fr.) (*Cortinariaceae*), Jelak, Point 6, soil, *Picea-Abies*, 04.09.2022, note;
165. *Thelephora palmata* (Scop.) Fr. (*Thelephoraceae*), Jelak, Point 2, soil, *Picea-Abies*, 04.09.2022, MCF 2022/19271;

166. *Trametes hirsuta* (Wulfen) Lloyd (Polyporaceae), Leshnica, Point 10, soil, *Picea-Abies*, 19.06.2022, note;

167. *Trichaptum abietinum* (Pers. ex J.F. Gmel.) Ryvarden (Polyporaceae), Jelak, Point 2, tree, *Picea-Abies*, 04.09.2022, note;

168. *Tricholoma bufonium* (Pers.) Gillet (Tricholomataceae), Leshnica, Point 10, soil, *Picea-Abies*, 25.09.2022, note;

169. *Tricholoma cingulatum* (Almfelt ex Fr.) Jacobashch (Tricholomataceae), Leshnica, Point 10, soil, *Picea-Abies*, 18.09.2022, note;

170. *Tricholoma imbricatum* (Fr.) P. Kumm. (Tricholomataceae), Jelak, Point 2, soil, *Picea-Abies*, 02.10.2022, MCF 2022/10426;

171. *Tricholoma saponaceum* (Fr.) P. Kumm. (Tricholomataceae), Leshnica, Point 10, soil, *Picea-Abies*, 25.09.2022, MCF 2022/19324; the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, note;

172. *Tricholoma sulphureum* (Bull.) P. Kumm. (Tricholomataceae), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, MCF 2022/19338; Popova Shapka, Point 7, soil, *Picea-Abies-Pinus*, 11.09.2022, note;

173. *Tricholoma terreum* (Schaeff.) P. Kumm. (Tricholomataceae), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, note; Rogachevo, Point 16, soil, *Pinus* Plantation, 31.10.2021, note; Jelak, Point 4, soil, *Picea-Abies*, 04.09.2022, note;

174. *Tricholoma vaccinum* (Schaeff.) P. Kumm. (Tricholomataceae), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, MCF 2022/19291;

175. *Xerocomellus chrysenteron* (Bull.) Šutara (*Xerocomus chrysenteron* (Bull.) Quél.) (Boletaceae), Jelak, Point 4, soil, *Picea-Abies*, 27.06.2022, note;

176. *Xeromphalina caudicinalis* (Fr.) Kühner & Maire (syn. *Xeromphalina fellea* Maire & Malençon) (Mycenaceae), the Adzhina Reka river, Point 12, soil, *Picea-Abies*, 18.09.2022, note;

Lichenized fungi

177. *Peltigera canina* (L.) Wild. (Peltigeraceae, Ascomycota), Jelak, Point 2, tree, 02.10.2021, MCF 2021/18890;

178. *Pseudevernia furfuracea* (L.) Zopf (Parmeliaceae, Ascomycota), Jelak, Point 2, rotten wood of conifer tree, 07.11.2021, note;

Fungus-like organism

179. *Lycogala epidendrum* (J.C. Buxb. ex L.) Fr. (Reticulariaceae, Myxomycota), the Adzhina Reka river, Point 12, rotten wood, 23.06.2022; Jelak, Point 6, rotten wood, 27.06.2022, note.

As a result of mycological research into coniferous communities at different sites in Shar Mt. during 2021 and 2022, the number of larger fungi, lichenized fungi and fungus-like organisms has increased, and it now amounts to 214, compared to the previously published data from where 50 species are known.

In addition, data has been recorded about five species, found for the first time on the territory of Republic of North Macedonia.

Agaricus altipes

Peculiar features of the species are its early emergence i.e., late spring or early summer in communities of *Picea* (Breitenbach & Kränzlin, 1995). In Poland, it is cited on debris of deciduous trees (Halama & Panek, 2000). It occurs in a number of Euro-pean countries, such as Denmark, Norway and Sweden (Knudsen & Vesterholt, 2012), Turkey (Doğan et al., 2003; Şen et al., 2012; Tirpan & Alli, 2019), Great Britain, Belorussia, France, Italy, Russia, Spain, the Ukraine. In Germany, it is a rare species, and in the Netherlands it is known as vulnerable (Davies & Nichol, 2016). It is also known from Bulgaria (Lacheva, 2012), and it is on the Red List of Fungi, categorised as an endangered species (Gyosheva et al., 2006 and in the Red Data Book of Republic of Bulgaria (Gyosheva, 2015). In Macedonia, a single specimen was spotted in spruce-fir forest near the Adzhina Reka river, at approximately 1,400 m altitude, in June.

Cortinarius flexipes

The species is part of the group *Telamonia*, and it is distinguished by the cap surface, covered with white scales and the *Pelargonium odour* (Fig. 2). It occurs in Europe, in coniferous associations of *Picea* and *Pinus*, or deciduous

trees, such as *Betula*, *Fagus* and *Quercus* (Breitenbach & Kränzlin, 2000; Horak, 2005). In Bulgaria, it is cited as a rare species, identified in *Sphagnum* or under *Picea abies* (Gyosheva & Ganeva, 2004). It is known from India, where it grows in coniferous communities (Ito et al., 2015). The species is new to Macedonia, found in a community of *Picea* and *Abies*, at the site Jelak, at approximately 1,800 m altitude.



Fig. 2. *Cortinarius flexipes* – a macroscopic image.

Cortinarius triformis

As claimed by Breitenbach & Kränzlin (2000), the distinctive attributes of this species are the moist and undulating pileus, dark-red in colour, which turns ochre yellow when dried (Fig. 3); the edges are white, so when dried, the pileus exudes three nuances of colour, which is the reason for the species name, and the quality that differentiates it from other similar species. Another attribute, as argued by Manic (2020), is that the stem is bare and without a ring, but sometimes there may be remnants of a veil shaped as silky straps (Fig. 3). An ectomycorrhizal species with coniferous trees, particularly *Picea*, but also *Pinus* and *Larix*, and for California there is also data from *Quercus* (Kernaghan & Currah, 1998). Arnold (1993)

has recommended separating of the species dependent on their mycorrhizal partners, coniferous or deciduous trees (*C. fusco-pallens* and *C. triformis* Fr., respectively), while Soop (2002) has cited *C. triformis* Fr. var. *fuscopallens*, whereas Horak (2005) has quoted solely the species *C. triformis* both for deciduous and coniferous trees. In our country, it has been recorded in a community of *Picea* and *Abies*, at the site Jelak, at an altitude of 1,800 m, in October.



Fig. 3. *Cortinarius triformis* – a macroscopic image.

Lyophyllum konradianum

The species sporocarp is light-cream in colour, and its key feature is that the fruit body turns black; it has an indistinct or acid odour and taste (Knudsen & Vesterholt, 2012), and according to Bellanger et al. (2015), there is a presence of hymenial cystidia. Cléménçon (1986) has quoted the species for France and Switzerland, where it occurs on fallen needles of *Abies* and *Picea*. It is known from several northern-European countries such as Norway, Sweden (Knudsen & Vesterholt, 2012) and Finland, where, since 2019, it has been on the Red List of Fungi, in the category of vulnerable species, known from two sites (<https://laji.fi/>). It is part of the Red List of Fungi in the region Bayern in Germany, where it is cited as extinct

(Karasch & Hahn, 2009). It is the first time that the species has been observed in Macedonia, in a community of *Picea*, *Abies* and *Pinus* (Popova Shapka), in autumn (September), and it is easy to distinguish as it turns in black when touched (Fig. 4).

Pluteus primus

Consistent with Bonnard (1991), who described it, as well as the other publications providing data on the current species (Bonnard, 2001; Justo et al., 2014; Kaygusuz et al., 2021), the key morphological characteristics that differentiate it are the long cheilocystidia (Fig.

5a) and the presence of clamp connections in the hyphae of the pileipellis (Fig. 5b). As maintained by Justo et al. (2014), it is rare species, known from Europe (Switzerland, Germany), Asia (Russia) and North America (the USA and Canada), where it grows on decayed or rotten wood, stumps, wood shavings or fallen needles of conifers (*Abies*, *Picea*, *Pseudotsuga*). Kaygusuz et al. (2021) have cited it for Turkey, on rotten wood or branches of *Fagus orientalis*. In our country, a single specimen was sighted in spruce-fir forest at Leshnica, at 1,600 m altitude, on decayed conifer tree (*Abies* or *Picea*), in June.



Fig. 4. *Lyophyllum konradianum* – a macroscopic image, where colour change into black is discernible.

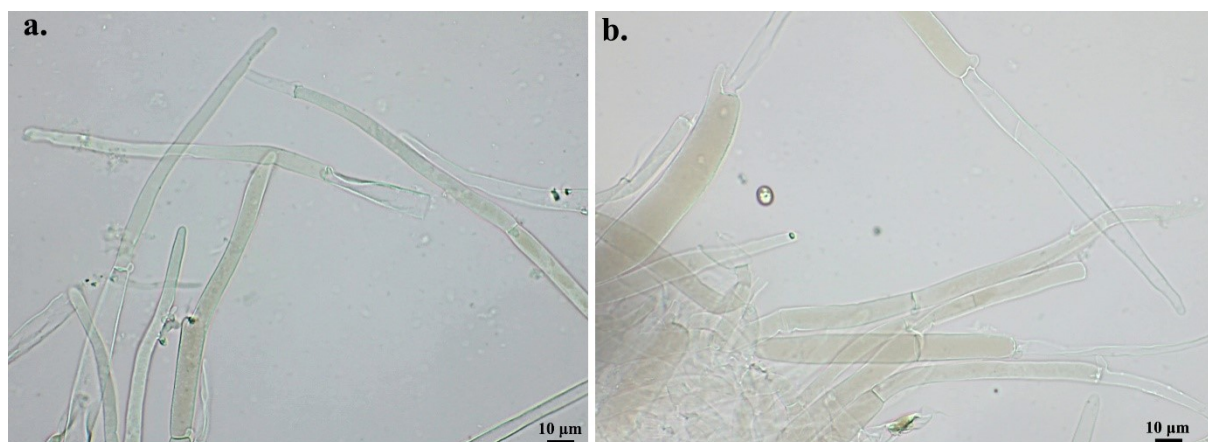


Fig. 5. *Pluteus primus* – a light microscopic image of: a) hyphae with clamp connections in the pileipellis. b) long cheilocystidia and spore.

Two of the registered species are part of the Macedonian Red List of Fungi, as follows:

Hericium coralloides

The species is easily recognizable due to the coral-like appearance of its fruiting body with a spiny hymenophore. It is on the red lists of many countries in Europe (Boddy et al., 2011) and the world, and, according to the IUCN, it is in the category of least-concern species (The Global Fungal Red List Initiative on-line, http://iucn.ekoo.se/iucn/species_view/120231/). Besides, it is listed on the Macedonian Red List of Fungi, in the category of endangered species – EN (Karadelev et al., 2021).

Hydnellum peckii

The bright red liquid droplets on the surface of sporocarps of young specimens, and the hydroid hymenophore are distinctive features of this species, which is most commonly found in spruce woods. It is known from Europe and North America, and, as of recently, from Asia: Iran (Asef, 2008), Korea (Han et al., 2010) and China (Mu et al., 2021). It is on the red lists of many countries, Australia inclusively, and it has been proposed to be part of the IUCN (http://iucn.ekoo.se/iucn/species_view/414442/). On the Macedonian Red List of Fungi, it is listed in the category of endangered – EN, and it is known only from a single locality i.e., Shar Mt. (Karadelev et al., 2018). With the present research, the species *Hydnellum peckii* has been confirmed from the same locality, found in a spruce community.

Conclusions

With the current study, the total number of recorded species in the coniferous communities is 214, and 50 of the species are derived from prior studies. Most of the recorded species originate from spring, summer and autumn seasons of 2022, compared to 2021, which was a very arid season and only 27 fungal species were spotted in the coniferous associations.

Apart from the new data about coniferous communities of Shar Mt., 5 species - *Agaricus aestivalis*, *Cortinarius flexipes*, *Cortinarius triformis*, *Lyophyllum konradianum*, and *Pluteus primus* are presented with first records for the country.

Acknowledgements

We are thankful to Vasko Avukatov from the Macedonian Ecological Society for compiling the map of the studied area and to the reviewers for improving the manuscript.

References

- Arnold, N. (1993). Morphologisch-anatomische und chemische Untersuchungen und der Untergattung *Telamonia* (*Cortinarius*, *Agaricales*). *Libri Botanici*, 7, IHW-Verlag.
- Asef, M.R. (2008). *Hydnellum peckii*, a new ectomycorrhize for Iran. *Rostaniha*, 9(2), 115.
- Bellanger, J.M., Moreau, P.A., Corriol, G., Bidaud, A., Chalange, R., Dudova, Z., & Richard, F. (2015). Plunging hands into the mushroom jar: a phylogenetic framework for *Lyophyllaceae* (Agaricales, Basidiomycota). *Genetica*, 143, 169–194. doi: [10.1007/s10709-015-9823-8](https://doi.org/10.1007/s10709-015-9823-8)
- Boddy, L., Crockatt, M.E., & Ainsworth, A.M. (2011). Ecology of *Hericium cirrhatum*, *H. coralloides* and *H. erinaceus* in the UK. *Fungal Ecology*, 4(2), 163–173. doi: [10.1016/j.funeco.2010.10.001](https://doi.org/10.1016/j.funeco.2010.10.001).
- Bonnard, J. (1991). *Pluteus primus* spec. nov. (Agaricales, Basidiomycetes). *Mycologia Helvetica*, 4, 169–178.
- Bonnard, J. (2001). *Pluteus albineus* sp. nov.: (Agaricales, Basidiomycetes). *Mycologia Helvetica*, 11, 131–136.
- Breitenbach, J., & Kränzlin, K. (2000). *Fungi of Switzerland*, 5. Lucerne, Switzerland: Edition Mycologia.
- Breitenbach, J., & Kränzlin, K. (1995). *Fungi of Switzerland*, 4. Lucerne, Switzerland: Edition Mycologia.
- Cléménçon, H. (1986). Staining *Lyophyllum* species of Europe. *Zeitschrift Für Mykologie*, 52(1), 61–84.
- Davies, V., & Nichol, P. (2016). *The Fungus Conservation Trust*. 2. Red Data conservation assessment of selected genera of fungi, based on national and local database records, fruit body morphology, and microscopic anatomy. Retrieved from <https://www.fungustrust.org.uk/page/red-lists/51/redlist2.html>
- Doğan, H.H., Öztürk, C., & Kaşık, G. (2003). New records for the mycoflora of Turkey from Mut environ. *Ot Sistematik Botanik Dergisi (Science)*, 10(2), 197–211.

- Gyosheva, M. (2015). *Agaricus altipes*. In: Peev, D. & al. (eds). *Red Data Book of the Republic of Bulgaria*. Vol. 1. Plants and Fungi. IBER, BAS & MOEW, Sofia.
- Gyosheva, M., & Ganeva, A. (2004). New and rare macromycetes and bryophytes from montane peat habitats in Bulgaria. *Mycologia Balcanica*, 1, 9–13.
- Gyosheva, M., Denchev, C., Dimitrova, E., Assyov, B., Petrova, R., & Stoichev, G. (2006). Red List of fungi in Bulgaria. *Mycologia Balcanica*, 3, 81–87.
- Halama, M., & Panek, E. (2000). Macromycetes of various habitats of the nature reserve "Łęczok" near Racibórz (SW Poland). *Acta Mycologica*, 35(2), 217–241.
- Han, S. K., Oh, S. H., & Kim, H. J. (2010). Eight unrecorded fungi identified at the Korea National Arboretum. *Mycobiology*, 38(2), 81–88. doi: [10.4489/2FMYCO.2010.38.2.081](https://doi.org/10.4489/2FMYCO.2010.38.2.081)
- Horak, E. (2005). *Röhrlinge und Blätterpilze in Europa*. Spektrum Akademischer Verlag. 6. Edition. Germany.
- Index fungorum. Retrieved from <https://www.indexfungorum.org/>
- Ito, Z. A., Reshi, A. Z., Basharat, Q., Majeed, T. S. H., & Andrabi, I. K. (2015). Identification and Characterization of Ectomycorrhizal *Cortinarius* Species (Agaricales, Basidiomycetes) from Temperate Kashmir Himalaya, India, by ITS Barcoding. *Advances in Molecular Biology*, 1–9. Article ID 507684. doi: [10.1155/2015/507684](https://doi.org/10.1155/2015/507684)
- Justo, A., Malysheva, E., Bulyonkova, T., Vellinga, E. C., Cobian, G., Nguyen, N., Minnis, A. M., & Hibbett, S. (2014). Molecular phylogeny and phylogeography of Holarctic species of *Pluteus* section *Pluteus* (Agaricales: Pluteaceae), with description of twelve new species. *Phytotaxa*, 180(1), 001–085. doi: [10.11646/phytotaxa.180.1.1](https://doi.org/10.11646/phytotaxa.180.1.1)
- Karadelev, M., & Rusevska, K. (2000). Makromicete u molikovim šumama planinae Pelister. Beograd. *Svet gljiva*, 12, 25–30. (In Serbian).
- Karadelev, M. (1993). *Contribution to the knowledge of wood – destroying fungi in the Republic of Macedonia*. Young explorers of Macedonia, *Fungi Macedonici I*, 1–78.
- Karadelev, M. (1995a). Qualitative and Quantitative Investigations of Lignicolous Macromycetes in Different Forest Associations on Pelister Mountain. *Ekologija I zaštita na životnata sredina*, 2(1), 3–16. (In Macedonian, English abstract).
- Karadelev, M. (1995b). *Lignicolous Fungi on Kozhuf Mountain*. School Centar "Josif Josifovski", Gevgelija, Macedonia (In Macedonian).
- Karadelev, M., Nastov, Z., & Rusevska, K. (2002a). Qualitative and Quantitative Researches of Macro-mycetes on Sar Planina, *Bulletin of Biology Students' Research Society*, 2, 71–78. Skopje (In Macedonian, English abstract).
- Karadelev, M., Nastov, Z., & Rusevska, K. (2002b). Qualitative and Quantitative Researches of Macromycetes on Jakupica Mountain. *Bulletin of Biology Students' Research Society*, 2, 79–87 (in Macedonian, English abstract).
- Karadelev, M., Nastov, Z., & Rusevska, K. (2002c). Qualitative and Quantitative Researches of Macromycetes on Pelister Mountain. *Bulletin of Biological Students' Research Society*, 2, 93–96 (in Macedonian, English abstract).
- Karadelev, M., Kost, G., & Rexer, K.H. (2003). Macromycetes diversity in *Pinus peuce* Forest in the Republic of Macedonia. *Atti del III Convegno Nazionale di Studi Micologici, "I Funghi del Monte Amiata"*. Piancastagnaio (SI) 14–19 Ottobre 2003, Italy, pp. 32–47.
- Karadelev, M., Rusevska, K., & Cicimov, V. (2011). Distribution and ecology of genus *Amanita* (*Amanitaceae*) in the Republic of Macedonia. *Glas. Rep. Zavoda Zašt. Prir. Podgorica*, 31–32, 63–84.
- Karadelev, M., Rusevska, K., Kajevska, I., & Mitic-Kopanja, D. (2019). Checklist of larger ascomycetes in the Republic of Macedonia. *Contributions, Section of Natural, Mathematical and Biotechnical Sciences, MASA*, 40(2), 239–253.
- Karadelev, M., Rusevska, K., Kost, G., & Kopanja, D. M. (2018). Checklist of macrofungal species from the phylum Basidiomycota of the Republic of Macedonia. *Acta Musei Macedonici Scientiarum Naturalium*, 21, 23–112.
- Karadelev, M., Rusevska, K., Tofilovska, S., Jovanovski, T., & Zimbakova, K. (2021). National Red List Assessment, Final Report, Fungi, Retrieved from <https://c-cluster-110.uploads.documents.cimpress.io/v1/uploads/>
- Karasch, P., & Hahn, Ch. (2009). *Rote Liste gefährdeter Großpilze Bayerns*. Bayerisches Landesamt für Umwelt, Augsburg, Germany. p. 50.
- Kaygusuz, O., Türkecul, I., & Knudsen, H. (2021). *Volvopluteus* and *Pluteus* section *Pluteus* (Agaricales: Pluteaceae) in Turkey based on morphological and molecular data. *Turkish Journal of Botany*, 45(3), 224–242. doi: [10.3906/bot-2012-7](https://doi.org/10.3906/bot-2012-7)

- Kernaghan, G., & Currah, R.S. (1998). Ectomycorrhizal fungus at tree line in the Canadian Rockies. *Myxotaxon*, 69(1), 39-80. doi: [10.7939/R31005](https://doi.org/10.7939/R31005)
- Knudsen, H., & Vesterholt, J. (Eds.) (2012). *Funga Nordica: Agaricoid, boletoid and cyphelloid genera*. (Firsted.) Nordsvamp-Copenhagen.
- Lacheva, M. (2012). New data of some rare larger fungi of Agaricaceae (Agaricales) in Bulgaria. *Ecologia Balkanica*, 5 (Special Edition), 107-114.
- Manic, Ş. (2020). Contributions to the research on the genus *Cortinarius* Fr. in the mycobiota of Bessarabia. *Journal of Botany*, 12, Nr. 1(20), 53-60.
- Mu, Y.-H., Yu, J.-R., Cao, T., Wang, X.-H., & Yuan, H.-S. (2021). Multi-Gene Phylogeny and Taxonomy of *Hydnellum* (Bankeraceae, Basidiomycota) from China. *Journal of Fungi*, 7, 818. doi: [10.3390/jof7100818](https://doi.org/10.3390/jof7100818).
- Nastov, Z., Cilkovska, M., Skandeva, M., & Karadelev, M. (1996). Contribution to the knowledge of macromycetes on Shar Mountain. *Bulletin of Biology Students' Research Society*, 1, 39-43. (In Macedonian).
- Pilát, A., & Lindtner, V. (1938). Ein Beitrag zur Kenntnis der Basidiomyceten von Südserbien I. *Glasnik Skopskog naučnog društva*, 18, 173-192 (In German).
- Pilát, A., & Lindtner, V. (1939). Ein Beitrag zur Kenntnis der Basidiomyceten von Südserbien II. *Glasnik Skopskog naučnog društva*, 20, 1-11 (In German).
- Ranojević, N. (1909). Prilog flori stare Srbije i Makedonije. *Muzej Srpske zemlje*, 7, 3-7 (In Serbian).
- Sar Mountain National Park. Retrieved from <https://www.sarmountain.org.mk/en/general-information>
- Şen, I., Alli, H., Çöl, B., Çelikkollu, M., & Balci, A. (2012). Trace metal contents of some wild-growing mushrooms in Bigadiç (Balıkesir), Turkey. *Turkish Journal of Botany*, 36, 519-528. doi: [10.3906/bot-1103-14](https://doi.org/10.3906/bot-1103-14)
- Soop, K. (1988). A review of the *Cortinarius suberi* complex. *Bollettino del Gruppo Micologico Giacomo Bresadola*, 44(3), 5-30.
- Stalpers, J., & Cock, A. (2013). Onward (Continuously updated). *MycoBank*. Retrieved from <http://www.mycobank.org>
- Sydow, H. (1921). Bornmüller: Plantae Macedoniae. Pilze. *Annales Mycologici*, 19(3-4), 243-254.
- The Global Fungal Red List Initiative. Retrieved from http://iucn.ekoo.se/iucn/species_view/414442/
- The Global Fungal Red List Initiative. Retrieved from http://iucn.ekoo.se/iucn/species_view/120231/
- The Web Service of the Red List of Finnish Species. Retrieved from <https://laji.fi/en/taxon/MX.72965>
- Tirpan, E., & Alli, H. (2019). *Agaricus* species biodiversity of Manisa. *2nd international Eurasian Mycology Congress (EMC' 19), Book of Proceedings and Abstracts*, September 04-06, 2019, Konya-Türkiye, pp. 14-16.
- Tofilovska, S., Rusevska, K., Grebenc, T., Kost, G., & Karadelev, M. (2019). Contribution to the Checklist of Basidiomycota for the Republic of North Macedonia. *Acta Musei Macedonici Scientiarum Naturalium*, 22, 27-33.
- Tortić, M. (1988). *Materials for the mycoflora of Macedonia*. Macedonian Academy of Sciences and Arts, Skopje, Macedonia.

Received: 09.03.2023
Accepted: 18.07.2023