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First records of two genera and 20 species of fungi (Basidiomycota, Agaricales) in Montenegro

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ABSTRACT:
Two genera (*Chamaemyces* and *Hydropus*) and 20 species of fungi were recorded for the first time for the Montenegrin funga (mycobiota), comprising 27 records from seven municipalities. Basic geographical and ecological data are given for all the records. Each species is shown with a photograph of the basidiomata in the field and is briefly annotated.

Keywords:
basidiomycetes, biodiversity, biogeography

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INTRODUCTION

The fungi of Montenegro are still poorly known. Until 2013, 839 macro-basidiomycetes were reported from Montenegro, 444 of which belong to the order Agaricales (for a detailed list of species see Kasom 2013). The most significant contributions to the knowledge of the Basidiomycota of Montenegro up to this point were made by Tortić (1988), Karadžić (1995), Perić & Perić (1997, 2000, 2002, 2003, 2005), and Moreau *et. al.* (2012). Since then, only a few articles have dealt with the diversity of Montenegrin basidiomycetes (e.g. Hadžić 2018; Ćetković *et. al.* 2020). Hadžić (2018) reported approximately 780 species of Basidiomycota for Montenegro (with photographs). However, due to numerous obvious errors (including inaccuracies in the identifications), the fact that the identifications were largely made without the use of a microscope, the presence of his personal doubts about some identifications, and the inadequate mycological literature used, these records should be approached with caution. Hadžić's personal fungarium with dried samples of 370 fungal species are deposited in the Environmental Protection Agency of Montenegro (Podgorica).

In view of the insufficiently known diversity of fungi in Montenegro, the aim of this study was to expand current knowledge with new fungal findings.

MATERIALS AND METHODS

Studied area. Montenegro is a rather small, mountainous country in south-eastern Europe, located on the coast of the Adriatic Sea and consisting of 25 municipalities. It is located between 41.8° and 43.6° north latitude and between 18.4° and 20.4° east longitude and covers an area of 13,452 km^2. It lies 0–2534 metres above sea level and comprises the Mediterranean and Alpine biogeographical regions with a Mediterranean and continental climate. The complex climatic conditions and diverse habitat types have created the conditions for a high level of biodiversity.

Studied species. The twenty-seven records of 20 species from the order Agaricales (Basidiomycota) presented in this study were collected between 2001 and 2023 in seven municipalities in Montenegro in the following habitats: an old-growth forest of *Fagus sylvatica* L., a managed forest of *F. sylvatica*, a forest of *Picea abies* (L.) H. Karst. (dom-

inant) and *Abies alba* Mill., a deciduous forest of *Quercus cerris* L., *Q. pubescens* Willd., and *Ostrya carpinifolia* Scop., arboretum (botanical garden), a park forest, the marshy edge of a lake, grassland, a yard, and a plant pot in a building. The voucher specimens (basidiomata) for all but one of the records were collected and deposited in the mycological collection of the Natural History Museum of Montenegro (NHMM) in Podgorica (Montenegro) and/or in the Croatian National Fungarium (CNF) in Zagreb (Croatia). The basidiomata were photographed in the field using a Canon PowerShot G11 digital camera in natural light (I. Ćetković) and/or a Canon 6D digital camera in combination with a Canon MR-14EX macro ring flash (Z. Tkalčec and A. Mešić), collected, macromorphologically described, and preserved by drying (at 40–50°C). The collected materials were identified on the basis of macro- and micromorphological characteristics using an Olympus CX41 and/or Olympus BX51 light microscope.

RESULTS AND DISCUSSION

Two genera, *Chamaemyces* Earle and *Hydropus* Singer, and 20 species of fungi (Agaricales, Basidiomycota) were reported as new to Montenegro in this study.

***Asterophora lycoperdoides* (Bull.) Ditmar** (Fig. 1A)
= *Nyctalis asterophora* Fr.
= *Nyctalis agaricoides* (Fr.) Bon & Courtec.
Specimen data: Montenegro, Žabljak Municipality, Durmitor National Park, near the Barno Lake, 1510 m a.s.l., N 43.15392°, E 19.09039°, on the dead basidioma of *Russula* sp. in a forest of *Picea abies* (dominant) and *Abies alba*, leg. Z. Tkalčec, I. Ćetković & A. Mešić, 12 September 2019, NHMM 596/9016, CNF 1/7608.
Notes: The species lives as a parasite on the old basidiomata of *Russula* spp., rarely on those of *Lactarius* spp., in forests. It is widespread in Europe; fairly common to fairly rare (Courtecuisse & Duhem 2000; Kalamees 2012a). Our sample fits well with the morphological concept of the species used by Blanco-Dios (2011) and Kalamees (2012a).

***Calocybe carnea* (Bull.) Donk** (Fig. 1B)
= *Lyophyllum carneum* (Bull.) Kühner & Romagn.
= *Rugosomyces carneus* (Bull.) Bon
Specimen data: Montenegro, Kolašin Municipality, Mt. Komovi, Štavna area, 1774 m a.s.l., N 42.70378°, E 19.67718°, on soil in grassland, leg. I. Ćetković & S. Malidžan, 14 October 2016, NHMM 473/8871.
Notes: The species lives as a soil saprotroph, mostly in grasslands, but also in other open habitats and light deciduous forests. It is widespread in Europe; common to fairly rare (Courtecuisse & Duhem 2000; Kalamees 2012b). The morphological characteristics of our sample correspond well with the concept of the species used by Kalamees (2004, 2012b).

***Chamaemyces fracidus* (Fr.) Donk** (Fig. 1C)
Specimen data: Montenegro, Nikšić Municipality, Grahovo arboretum near Grahovo village, 715 m a.s.l., N 42.65713°, E 18.66291°, on soil in the arboretum (botanical garden), leg. I. Ćetković, 18 November 2023, NHMM 1323/19335.
Notes: The species lives as a soil saprotroph in forests and grasslands. It has been recorded in most parts of Europe; fairly common to rare (Courtecuisse & Duhem 2000; Lange 2012). Our sample aligns with the morphological concept of *C. fracidus* used by Lange (2012).

***Coprinopsis mitrispora* (Bohus) L. Nagy, Vágvölgyi & Papp** (Fig. 1D)
= *Coprinopsis spelaiophila* (Bas & Uljé) Redhead, Vilgalys & Moncalvo
= *Coprinus spelaiophilus* Bas & Uljé
Misappl.: *Coprinus extinctorius* Fr. sensu auct.
Specimen data: Montenegro, Kolašin Municipality, Biogradska Gora National Park, near Lake Biogradsko, 1124 m a.s.l., N 42.89414°, E 19.60494°, in the decayed cavity of an old *Fagus sylvatica* tree in an old-growth beech forest, leg. Z. Tkalčec & I. Ćetković, 14 September 2018, NHMM 994/13763, CNF 1/7622.
Notes: The species lives as a saprotroph on the wood of deciduous trees (often in the wounds of living trees) (Uljé 2005). It has been recorded in about 15 European countries; rare to very rare. The morphological characteristics of our sample correspond to *C. mitrispora*, as used by Uljé (2005) and Nagy *et al.* (2013).

***Crinipellis subtomentosa* (Peck) Singer** (Fig. 1E)
Specimen data: Montenegro, Podgorica Municipality, Podgorica city, Gornja Gorica district, 35 m a.s.l., N 42.43716°, E 19.21417°, on herbaceous debris on the lawn in the yard, leg. I. Ćetković, 10 November 2018, NHMM 744/10603.
Notes: The species lives as a saprotroph on or among herbaceous debris in grasslands, but also in forests. It is widespread in the Mediterranean region of Europe, including Hungary (Antonín & Noordeloos 2010). Morphologically, this sample corresponds to the concept of the species used by Antonín & Noordeloos (2010).

***Entoloma euchroum* (Pers.) Donk** (Fig. 1F)
Specimen data: Montenegro, Kolašin Municipality, Biogradska Gora National Park, near Lake Biogradsko, ca. 1130 m a.s.l., N 42.90072°, E 19.59963°, on dead wood, in an old-growth beech forest, leg. Z. Tkalčec & A. Mešić, 29 September 2001, CNF 1/2351; 1135 m a.s.l., N 42.89881°, E 19.60153°, on a fallen trunk of *Fagus sylvatica*, leg. I. Ćetković & S. Malidžan, 23 October 2020, NHMM 952/13125.
Notes: The species lives as a saprotroph on the wood of deciduous trees (very rarely of conifers) in forests. It

Fig. 1. Basidiomata in the field. **A**. *Asterophora lycoperdoides*; **B**. *Calocybe carnea*; **C**. *Chamaemyces fracidus*; **D**. *Coprinopsis mitrispora*; **E**. *Crinipellis subtomentosa*; **F**. *Entoloma euchroum*; **G**. *Flammulaster limulatus*; **H**. *Galerina vittiformis*. Photos: **B**, **C**, **E**–**G** I. Ćetković; **A**, **D**, **H** Z. Tkalčec & A. Mešić.

is widespread in Europe; fairly common to fairly rare (Courtecuisse & Duhem 2000; Noordeloos *et al.* 2022). Our collections align with the morphological concept of *E. euchroum* used by Noordeloos *et al.* (2022).

***Flammulaster limulatus* (Fr.) Watling** (Fig. 1G)
Specimen data: Montenegro, Kolašin Municipality, Biogradska Gora National Park, near Lake Biogradsko, ca. 1130 m a.s.l., N 42.90072°, E 19.59963°, on dead wood, in an old-growth beech forest, leg. Z. Tkalčec & A. Mešić, 29 September 2001, CNF 1/2350; 1125 m a.s.l., N 42.89411°, E 19.60501°, on a fallen trunk of *Fagus sylvatica*, leg. I. Ćetković, Z. Tkalčec & A. Mešić, 14 September 2018, NHMM 739/10598.
Notes: The species lives as a saprotroph on the wood and sawdust of deciduous or coniferous trees in forests. It has been recorded in most parts of Europe, but in the north, it is only known from Sweden; quite rare to very rare (Vellinga 1986; Gminder *et al.* 2003; Vesterholt & Rald 2012). Morphologically, these samples correspond to the concept used by Vellinga (1986) and Vesterholt & Rald (2012). According to the basidiospores, most of which are clearly phaseoliform in lateral view, our collections belong to *F. limulatus* var. *limulatus*.

***Galerina vittiformis* (Fr.) Singer** (Fig. 1H)
Specimen data: Montenegro, Žabljak Municipality, Durmitor National Park, by Lake Barno, 1496 a.s.l., N 43.15678°, E 19.09175°, among moss on the marshy edge of the lake, leg. Z. Tkalčec, I. Ćetković & A. Mešić, 12 September 2018, NHMM 662/9230, CNF 1/7614.
Notes: The species lives on mosses in grasslands, forests, dunes, and fens. It is widespread in Europe; very common to quite rare (Courtecuisse & Duhem 2000; Gulden 2012). Our collection corresponds well with the morphological concept of the species used by de Haan & Walleyn (2009) and Gulden (2012). The predominance of two-spored basidia identifies this specimen as *G. vittiformis* var. *vittiformis* f. *bispora* A.H. Sm. & Singer.

***Gymnopus aquosus* (Bull.) Antonín & Noordel.** (Fig. 2A)
= *Collybia aquosa* (Bull.) P. Kumm.
Specimen data: Montenegro, Kotor Municipality, Crkvice area, 945 m a.s.l., N 42.55633°, E 18.64296°, on litter in a *Fagus sylvatica* forest, leg. I. Ćetković & S. Malidžan, 1 June 2022, NHMM 1166/15677.
Notes: The species lives as a saprotroph on soil, humus or litter in deciduous (rarely coniferous) forests, also in grassy places. It is widespread in Europe; very common to rare (Antonín & Noordeloos 2010; Noordeloos 2012a). The collected sample morphologically aligns with the concept of *G. aquosus* used by Antonín & Noordeloos (2010).

***Gymnopus fuscopurpureus* (Pers.) Antonín, Halling & Noordel.** (Fig. 2B)
= *Collybia fuscopurpurea* (Pers.) P. Kumm.
Specimen data: Montenegro, Kolašin Municipality, Mt. Sinjajevina, Semolj saddle, 1576 m a.s.l., N 42.90756°, E 19.27640°, on litter in a *Fagus sylvatica* forest, leg. I. Ćetković & S. Malidžan, 27 September 2019, NHMM 814/10721.
Notes: The species lives as a saprotroph on humus or coarse litter, mostly of *Fagus*, also in subalpine and subarctic dwarf shrub heaths. It has been recorded in most parts of Europe; occasional to very rare (Courtecuisse & Duhem 2000; Antonín & Noordeloos 2010; Noordeloos 2012a). The sample corresponds well with the morphological species concept used by Antonín & Noordeloos (2010).

***Hydropus subalpinus* (Höhn.) Singer** (Fig. 2C)
Specimen data: Montenegro, Plužine Municipality, on soil in a *Fagus sylvatica* forest, leg. I. Ćetković & S. Malidžan, 18 May 2017, near Lake Malo Stabansko, 1252 m a.s.l., N 43.18977°, E 18.72533°, NHMM 365/6983; near Lake Veliko Stabansko, 1370 m a.s.l., N 43.19818°, E 18.72243°, NHMM 369/6987.
Notes: The species lives as a saprotroph on ± buried pieces of wood (often small) or old litter of *Fagus sylvatica*, rarely of other deciduous trees. Its distribution in Europe corresponds to the distribution of *F. sylvatica* (sensu lato); locally very common to very rare (Courtecuisse & Duhem 2000; Gminder *et al.* 2001; Læssøe 2012). The morphological characteristics of these samples correspond to *H. subalpinus* as used by Ludwig (2001), Horak (2005), and Læssøe (2012).

***Hygrocybe acutoconica* (Clem.) Singer** (Fig. 2D)
= *Hygrocybe konradii* R. Haller Aar.
= *Hygrocybe persistens* (Britzelm.) Singer
Specimen data: Montenegro, Cetinje Municipality, Mt. Lovćen, N of Bjeloši village, on soil in a deciduous forest of *Quercus cerris, Q. pubescens*, and *Ostrya carpinifolia*, leg. I. Ćetković & S. Malidžan, 6 October 2022, 845 m a.s.l., N 42.38106°, E 18.89867°, NHMM 1204/15835; 856 m a.s.l., N 42.38092°, E 18.89846°, NHMM 1205/15837.
Notes: The species lives in unimproved grasslands, on roadsides, in solid dunes, on lawns, and in deciduous forests. It is widespread in Europe; rather common to occasional in most countries (Boertmann 2010). Our collections align with the morphological concept of the species used by Boertmann (2010). The shape of the basidiospores identifies the collected samples as *H. acutoconica* var. *acutoconica*.

***Hygrophorus discoxanthus* (Fr.) Rea** (Fig. 2E)
= *Hygrophorus eburneus* var. *discoxanthus* (Fr.) Krieglst.
Specimen data: Montenegro, Cetinje Municipality, Lovćen National Park, Ivanova korita area, 1306 m a.s.l., N 42.37781°, E 18.83320°, on soil in a *Fagus sylvatica*

Fig. 2. Basidiomata in the field. **A**. *Gymnopus aquosus*; **B**. *Gymnopus fuscopurpureus*; **C**. *Hydropus subalpinus*; **D**. *Hygrocybe acutoconica*; **E**. *Hygrophorus discoxanthus*; **F**. *Inocybe haemacta*; **G**. *Lepista glaucocana*; **H**. *Leucocoprinus birnbaumii*. Photos: **A**–**H** I. Ćetković.

forest, leg. I. Ćetković & S. Malidžan, 4 October 2019, NHMM 833/10771.
Notes: The species lives in forests as a symbiont (mutualist), in an ectomycorrhizal association with *Fagus sylvatica*. Its distribution in Europe corresponds to that of *F. sylvatica* (sensu lato); fairly common to rare (Courtecuisse & Duhem 2000; Gminder *et al.* 2001; Kovalenko 2012). The sample morphologically matches that of *H. discoxanthus* as used by Kovalenko (2012) and Ludwig (2012).

***Inocybe haemacta* (Berk. & Cooke) Sacc.** (Fig. 2F)
Specimen data: Montenegro, Nikšić Municipality, Grahovo arboretum near Grahovo village, 715 m a.s.l., N 42.65715°, E 18.66252°, on soil in the arboretum (botanical garden), leg. I. Ćetković, 18 November 2023, NHMM 1324/19336.
Notes: The species lives in forests and parks as a symbiont (mutualist), in an ectomycorrhizal association with *Fagus sylvatica* and *Quercus* spp. It is widespread in Europe; quite rare to rare (Kuyper 1986; Courtecuisse & Duhem 2000; Jacobsson & Larsson 2012). The sample corresponds well with the morphological concept of species used by Kuyper (1986), Stangl (1989), and Jacobsson & Larsson (2012).

***Lepista glaucocana* (Bres.) Singer** (Fig. 2G)
= *Lepista nuda* var. *glaucocana* (Bres.) Krieglst.
Specimen data: Montenegro, Kolašin Municipality, Biogradska Gora National Park, near Lake Biogradsko, ca. 1130 m a.s.l., N 42.90072°, E 19.59963°, on soil in an old-growth beech forest, not. Z. Tkalčec & A. Mešić, 29 September 2001; 1139 m a.s.l., N 42.89457°, E 19.60627°, leg. I. Ćetković & S. Malidžan, 23 October 2020, NHMM 959/13133; 1137 m a.s.l., N 42.89399°, E 19.60648°, 4 November 2020, NHMM 964/13138; Žabljak Municipality, ca. 3 km N-NW of Žabljak town, 1525 m a.s.l., N 43.17926°, E 19.11029°, on soil in a forest of *Picea abies* (dominant) and *Abies alba*, leg. I. Ćetković & S. Malidžan, 17 July 2020, NHMM 887/13057.
Notes: The species lives as a soil saprotroph in deciduous and coniferous forests and parks (Christensen & Gulden 2012). It has been recorded in most parts of Europe; occasional to rare. The morphological characteristics of these samples correspond to the concept used by Christensen & Gulden (2012).

***Leucocoprinus birnbaumii* (Corda) Singer** (Fig. 2H)
= *Leucocoprinus flos-sulfuris* (Schnizlein) Cejp
Specimen data: Montenegro, Podgorica Municipality, Podgorica city, Natural History Museum, 38 m a.s.l., N 42.43589°, E 19.25989°, in a plant pot, leg. V. Biberdžić, 27 August 2018, NHMM 730/10578.
Notes: The species lives as a soil saprotroph in houseplant pots indoors, as well as in greenhouses (as it is of tropical origin). It is widespread in Europe; common to occasional (Vellinga 2001). Morphologically, the collected sample corresponds to *L. birnbaumii*, as used by Vellinga (2001) and Ludwig (2012).

***Pholiota tuberculosa* (Schaeff.) P. Kumm.** (Fig. 3A)
Specimen data: Montenegro, Plužine Municipality, ca. 15 km S of Plužine town, 1126 m a.s.l., N 43.02101°, E 18.86230°, on a stump of *Fagus sylvatica* in a mixed forest dominated by *F. sylvatica*, leg. I. Ćetković & S. Malidžan, 5 October 2021, NHMM 1096/15491.
Notes: The species lives as a saprotroph on the wood (logs, branches, stumps, etc.) of deciduous trees. It is widespread in Europe; uncommon (Noordeloos 2011). The morphological features of the sample correspond well with the concept used by Noordeloos (2011).

***Pluteus chrysophaeus* (Schaeff.) Quél.** (Fig. 3B)
Specimen data: Montenegro, Kolašin Municipality, Biogradska Gora National Park, near Lake Biogradsko, 1136 m a.s.l., N 42.89887°, E 19.60142°, on a fallen trunk of *Fagus sylvatica* in an old-growth beech forest, leg. I. Ćetković & S. Malidžan, 23 October 2020, NHMM 948/13121.
Notes: The species lives as a saprotroph on wood in deciduous forests. It is widespread in Europe; rare (Vellinga 1990). Our sample aligns with the morphological concept of the species used by Vellinga (1990) and Heilmann-Clausen (2012).

***Rhodocybe gemina* (Paulet) Kuyper & Noordel.** (Fig. 3C)
= *Clitopilus geminus* (Paulet) Noordel. & Co-David
Misappl.: *Rhodocybe truncata* (Schaeff.) Singer sensu auct.
Specimen data: Montenegro, Nikšić Municipality, Nikšić town, under Trebjesa Hill (city park), 636 m a.s.l., N 42.76807°, E 18.95502°, on soil under *Pinus nigra* J.F. Arnold in a park forest, leg. I. Ćetković, 15 November 2023, NHMM 1322/19334.
Notes: The species lives as a soil saprotroph in deciduous and coniferous forests and parks. It is widespread in Europe; occasional to rare (Noordeloos 1988, 2012b). Our collection corresponds with the morphological concept of the species used by Noordeloos (1988, 2012b). The revision of the material collected in 2011 by I. Ćetković (NHMM 65/3070), which was originally identified as *R. gemina* (the only record of this species for Montenegro to date), revealed that the specimen actually belongs to the genus *Hebeloma* (Fr.) P. Kumm.

***Tricholoma filamentosum* (Alessio) Alessio** (Fig. 3D)
= *Tricholoma pardinum* var. *filamentosum* Alessio
Specimen data: Montenegro, Žabljak Municipality, Durmitor National Park, near Barno Lake, 1516 m a.s.l., N 43.15419°, E 19.09031°, on soil in a forest of *Picea abies* (dominant) and *Abies alba*, leg. I. Ćetković, Z. Tkalčec & A. Mešić, 12 September 2018, NHMM 595/9015, CNF 1/7609.

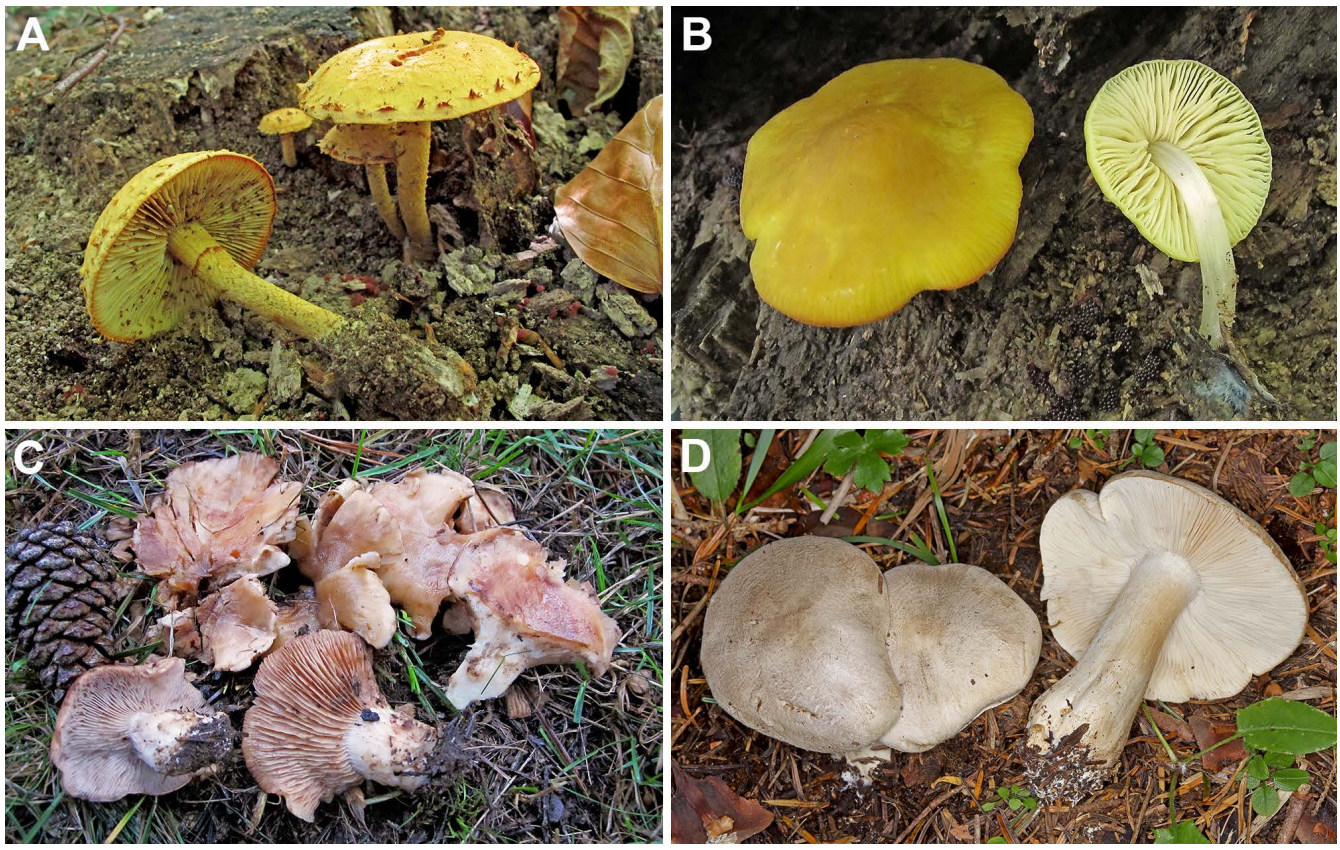

Fig. 3. Basidiomata in the field. **A**. *Pholiota tuberculosa*; **B**. *Pluteus chrysophaeus*; **C**. *Rhodocybe gemina*; **D**. *Tricholoma filamentosum*. Photos: **A–C** I. Ćetković; **D** Z. Tkalčec & A. Mešić.

Notes: The species inhabits forests as a symbiont (mutualist), in an ectomycorrhizal association with mainly deciduous trees (e.g. *Castanea sativa* Mill., *Fagus sylvatica*, and *Quercus* spp.), rarely with conifers (*Picea abies*). It has a more southern distribution in Europe, while in the northern part of its distribution range (in the southernmost part of Norway and Sweden) it is restricted to warm microsites; occasional to very rare, but locally can be more frequent (Christensen & Heilmann-Clausen 2012, 2013). This species was discovered relatively recently (1988), so data on its distribution and ecology remain insufficient. Morphologically, our sample corresponds to the concept of the species used by Christensen & Heilmann-Clausen (2013).

Additionally, the revision of the specimen NHMM 87/3092, which was collected by I. Ćetković in 2011 and incorrectly identified as *Tricholoma apium* Jul. Schäff., revealed that it actually belongs to the genus *Leucopaxillus* Boursier. Therefore, *T. apium* should currently not be considered a member of the Montenegrin funga.

CONCLUSIONS

The results presented in this study, with two genera and 20 species of fungi which are new to Montenegro, are a noteworthy contribution to the knowledge of Montenegrin funga and national biodiversity in general. However, considering the poor degree of mycological exploration on the one hand, and diverse habitat conditions suitable for rich fungal diversity on the other, much remains to be discovered, and research on Montenegrin fungi needs to be intensified.

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REZIME

Botanica SERBICA

Prvi nalazi dva roda i 20 vrsta gljiva (Basidiomycota, Agaricales) u Crnoj Gori

Ilinka Ćetković, Zdenko Tkalčec, Suzana Malidžan, Ivana Kušan i Armin Mešić

Dva roda (*Chamaemyces* i *Hydropus*) i 20 vrsta gljiva prvi put su registrovani za crnogorsku fungu (mikobiotu), obuhvatajući 27 nalaza iz sedam opština. Za sve nalaze dati su osnovni geografski i ekološki podaci. Svaka vrsta je prikazana fotografijom sa plodonosnim telima na staništu i kratko je komentarisana.

Ključne reči: bazidiomicete, biodiverzitet, biogeografija