Marasmius epidryas at the southern edge of its potential distribution range: discovery of populations in the western Balkan mountains

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Marasmius epidryas is a saprobic fungus specifically associated with dead tissues of *Dryas* spp. It belongs to the group of typical arctic-alpine fungi distributed in the northern (arctic and subarctic) areas and in disjunct high-mountain habitats of the temperate zone. In the framework of extensive studies focused on the fungi of the alpine zone in the Carpathians and the south-east European mountains, we discovered new localities of *M. epidryas* in the western part of the Balkan Peninsula, in the Dinaric mountain system and the Scando-Pindic mountain system. They represent first records of this species (and of arctic-alpine fungi in general) in these mountain ranges as well as new species records for Macedonia and Montenegro. The findings of *M. epidryas* in the western Balkan area bring a significant contribution to the knowledge of distribution of this arctic-alpine fungus in Europe. As they belong to southernmost localities of the species, they confirm the co-occurrence of this saprobic species with its host plant also in disjunct, island populations at the southern edge of the distribution of *Dryas octopetala*. We provide a detailed morphological description of the western Balkan specimens and a map of the southern European distribution of *M. epidryas* on the background of the distribution range of *D. octopetala*.

Keywords: Agaricomycetes, alpine belt, arctic-alpine element, Balkan Peninsula, biogeography, distribution, Macedonia, Montenegro.

Marasmius epidryas Kühner ex A. Ronikier belongs to the section *Chordales* Fr. (= *Alliacei* Kühner) of the genus *Marasmius* (Agaricomycetes, Marasmiaceae). It is characterized by a small, cream to rusty-brownish pileus, rusty brown to black-brown, velvety stipe, and microscopically by smooth, thick-walled elements of the pileipellis, non-dextrinoid hyphae, capitate cheilo- and pleurocystidia and thick-walled caulocystidia (Antonín & Noordeloos 1993; Ronikier 2009). Recently, species belonging to the sect. *Chordales* of the genus *Marasmius*, including *M. epidryas*, have been transferred into the genus *Mycetinis* Earle (Agaricomycetes, Omphalotaceae) (Wilson & Desjardin

2005, Noordeloos & Antonín 2008, Noordeloos 2008; but see Ronikier 2009).

Marasmius epidryas is a typical arctic-alpine fungus specifically associated with dead tissues of *Dryas* spp. (Antonín & Noordeloos 1993; Ronikier 2009). Thus, its distribution is shaped by the distribution range of the host plant. It is known from alpine habitats of mountains of the temperate regions and from the arctic and subarctic areas. From a biogeographical point of view, it is of a particular interest to find out how the species is distributed at the southern edge of its potential distribu-

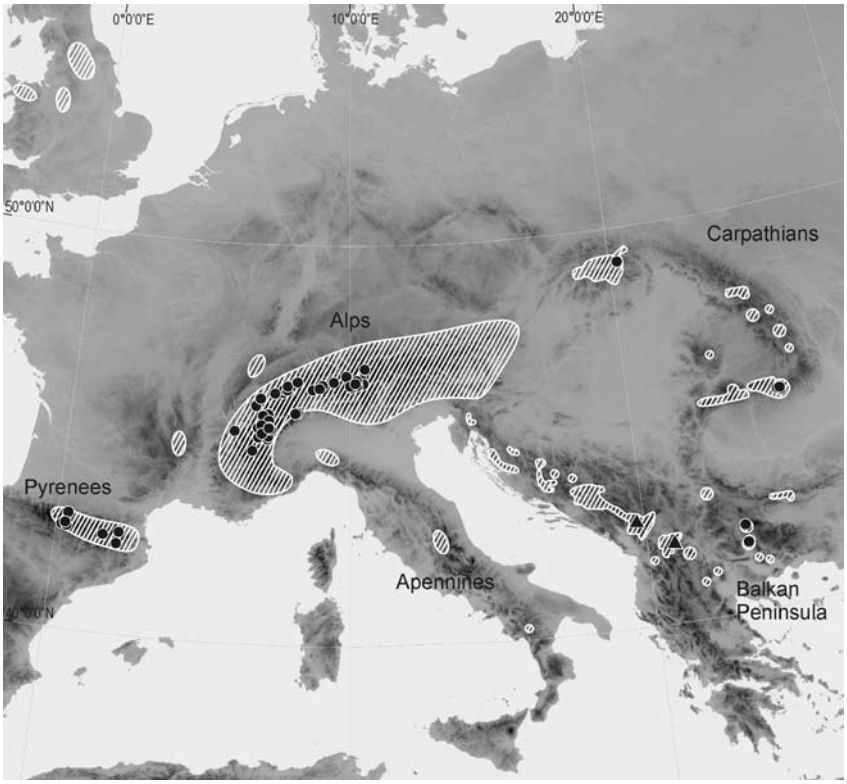


Fig. 1. – Distribution of *Marasmius epidryas* in southern Europe on the background of the distribution range of *Dryas octopetala* (white hatched areas); black circle – localities of *M. epidryas* known from the literature or herbarium collections; black triangle – new localities.

tion range. In central and southern Europe the species is known from the Alps, the Pyrenees, the Carpathians and the Rhodope-Rila Mountains in Bulgaria (Fig. 1), but its known distribution is highly fragmented. It seems to be more common in the Alps, while in other parts of its potential distribution range it has been reported from few localities. No records have been known so far from the large mountain ranges of the Dinaric and Scando-Pindic Mountains in the Balkan Peninsula as

well as from the Italian Apennines. During the extensive research devoted to the fungi of the alpine zone of the Carpathians and south-east European mountains carried out by us for the last six years we discovered new localities of *M. epidryas* in the western part of the Balkan Peninsula. The aim of this paper is to present these new, biogeographically important, localities of *M. epidryas* on the background of the known distribution of this species in southern Europe and to provide detailed morphological description of the collected specimens.

Materials and Methods

The material was collected in August 2009 on several localities in the mountains of the western part of the Balkan Peninsula: the Komovi Mountains (Montenegro) and the Šar Planina Mountains (Macedonia).

The micromorphology of the specimens was examined under light microscope Nikon Eclipse E600 (Nomarski interference contrast; oil immersion objective 100 ×) in 5 % solution of KOH, Congo Red and Melzer's reagent. For all measured elements (except basidia) both ranges and average values from at least 45 measurements are given. Spores were mostly taken from a natural spore deposit on a cap or stem surface, spore size is given without the apiculus. Three dimensions of cheilocystidia, pleurocystidia and caulocystidia are provided in the description in the following order: length × width in a broader place × width at apex. Description of colors is based on field notes of fresh collections with color annotations based on Kornerup & Wanscher (1965). Drawings of microcharacters were made using a camera lucida (Nikon Y-IDT).

The distribution of *Dryas octopetala* in the central and southern European mountains has been based on the maps published by Elkington (1958), Tralau (1963) and Stevanović *et al.* (2009). The distribution of *M. epidryas* in this area has been prepared on a basis of the literature data (Kühner 1936, Favre 1955, 1960; Lamoure 1982, Kühner & Lamoure 1986, Senn-Irlet 1986, 1988, Meyer & Bidaud 1988, Breitenbach & Kränzlin 1991, Antonín & Noordeloos 1993, Bon & Ballarà 1995, Esteve-Raventós *et al.* 1997, Vila et al. 1997, Jamoni 1998, 2006, Vila 1998, Bon 1999, Gyosheva & Denchev 2000, Collin 2003, Corriol 2008, Ronikier 2009), and unpublished localities based on collections borrowed from the following herbaria: DAOM, E, F, KRAM, L, LIP, G, VPI, ZT and kindly provided by Egon Horak, Pierre-Arthur Moreau and Beatrice Senn-Irlet (see "Additional specimens examined").

Results and Discussion

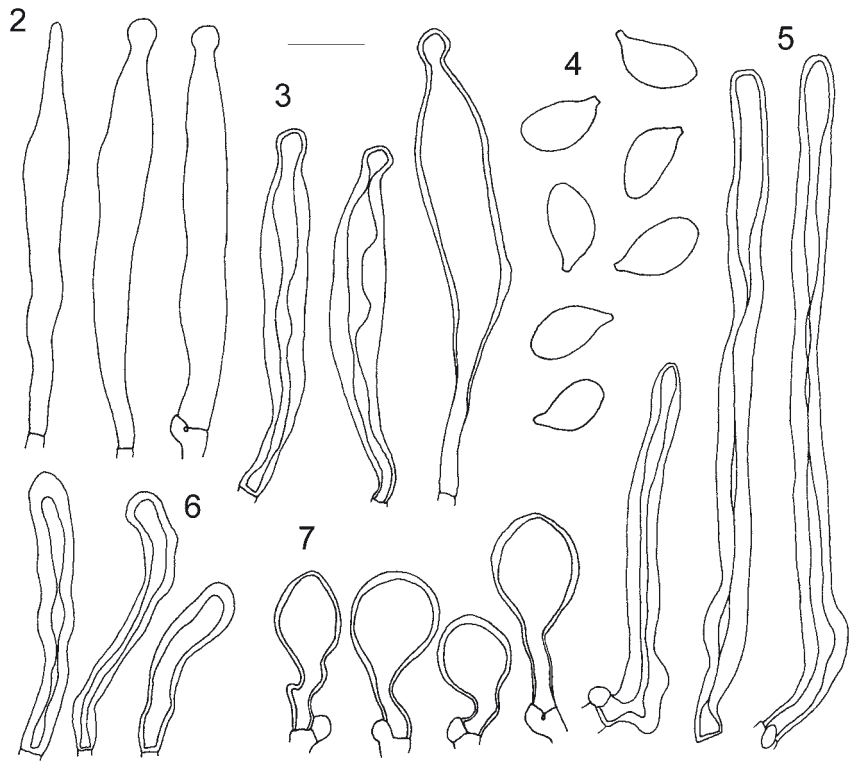
Marasmius epidryas Kühner ex A. Ronikier, Figs. 2–13.

Description – Pileus 4–11 mm in diameter, 3 mm high, first hemispherical, then convex, sometimes with slightly depressed centre,

cream to rusty brown (5C–D6, 6E7, 7E7), margin paler, almost white, centre darker (6F4, 7F4), surface smooth often uneven, wrinkled-nodulose and delicately radially grooved, not translucently striate, not hygrophanous. – Stipe 10–40 × 1–1.5 mm, cream (4A3) at apex, orange-brown, rusty brown to dark brown in lower part (5F5–6), entirely densely covered with hairs causing a velvety appearance. – Lamellae pale cream, distant, up to 1.5 mm broad, broadly adnate. – Flesh rather elastic, not fragile, white in pileus and stipe apex, rusty-brown in lower part of a stipe, smell none, taste mild. – Spores 8.0–10.5 × 5.0–7.0 µm, av. 9.3 × 5.8 µm, Q=1.2–2.0, Q_{av}=1.6, ellipsoid, amygdaliform, hyaline, thin-walled, non-amyloid (Figs. 4, 10). – Basidia 37–48 × 6.5–9 µm, narrowly clavate, 4-spored. – Cheilocystidia and pleurocystidia similar, 35–63 × 5–8.5 × 2–5.5 µm, av. 46.6 × 6.6 × 3.7 µm, fusiform, cylindrical, usually with capitate apex, thin-walled, clamped, numerous (Figs. 2, 8). – Pleurocystidia sometimes thick-walled (Figs. 3, 9). – Pileipellis a hymeniderm, slightly gelatinized, made up of broadly clavate, piriform, thick-walled, hyaline or yellowish elements, 14–34 × 8–15 µm, av. 20.8 × 10.2 µm, walls 0.5–2.5 µm thick, intermixed with narrowly clavate or cylindrical (rarely forked) pileocystidia, 17.5–46 × 4–7.5 µm, av. 29.7 × 5.9 µm, with orange-brown walls 1–3 µm thick, sometimes covered with an amorphous substance (Figs. 6-7, 11-12). – Stipitipellis a cutis made up of long hyphae with thick, slightly incrusted, yellow-brown walls. – Caulocystidia abundant, densely covering the whole length of the stipe, cylindrical or more often swollen and curved at base, 30–146 × 3–10 × 2–5.5 µm, av. 76.2 × 6.6 × 2.3 µm (measurements from the stipe apex), with thick, yellow walls (Figs. 5, 13). – Clamp-connections numerous.

Material examined. – MACEDONIA, Šar-Planina Mountains, NE slopes of Ceripašina Mt., 42° 01' 26'' N, 20° 51' 47'' E, alt. 2020 m, high mountain shrubland with *Dryas octopetala*, *Juniperus nana*, *Vaccinium vitis-idaea* and *V. gaultherioides*, on dead stems of *Dryas octopetala*,17 Aug 2009, *leg.* A. Ronikier, M. Ronikier (KRAM F-48022); MONTENEGRO, Komovi Mountains, N-E slopes of Kom Kučki, 42° 40' 34'' N, 19°38'57'' E, alt. 2130 m, high mountain meadow with *Dryas octopetala*, on dead stems of *Dryas octopetala*, 13 Aug 2009, *leg.* A. Ronikier, M. Ronikier (KRAM F-48023); N slopes of Kom Vasojevički, 42° 41' 50'' N, 19°40'27'' E, alt. 1900 m, high mountain meadow with *Dryas octopetala*, on dead stems of *Dryas octopetala*, 12 Aug 2009, *leg.* A. Ronikier, M. Ronikier (KRAM F-48020); summit area of Kom Vasojevički, 42° 41' 15,8'' N, 19° 40' 01'' E, alt. 2460 m, high mountain meadow with *Dryas octopetala*, on dead stems of *Dryas octopetala*, 12 Aug 2009, *leg.* A. Ronikier, M. Ronikier (KRAM F-48021).

Additional specimens examined. – FRANCE, Haute-Savoie, La Clusaz, Fr. - 74, alt. 1400 m, 29 Aug 1999, *leg.* O. Röllin (G 119685; OR99-62); Savoie, Beaufort, Col du Joly, *Dryas* sur dolomite, alt. 1950 m, 27 Aug 2008, *leg.* P.-A. Moreau (KRAM F-47117); Petit Mont-Cenis, Dryades, 31 Aug 1986, *leg.* M. Bon (LIP); Pralognan, Bois de la Rossa, Un exemplaire dans la forêt de *Picea*, dans un compost complexe, pas vu de *Dryas*!, 14 Aug 1968, *leg.* R. Kühner (G 110635 ; Pr 68; G-K19933); Région de Pralognan, Juste sous le Pas de l'Âne, sur les couches de *Dryas*, 26 Aug 1965, *leg.* R. Kühner (G 110632 ; Pralo 65, G-K19930); South of Lansle-



Figs. – 2–7. Micromorphological characters of *Marasmius epidryas* from the localities in the Komovi Mountains: **2.** Cheilocystidia. **3.** Pleurocystidia. **4.** Spores. **5.** Caulocystidia (from the stipe apex). **6.** Pileocystidia. **7.** Pileipellis elements. **2–4.** (KRAM F-48021), **5–7.** (KRAM F-48020). Bar = 10 µm.

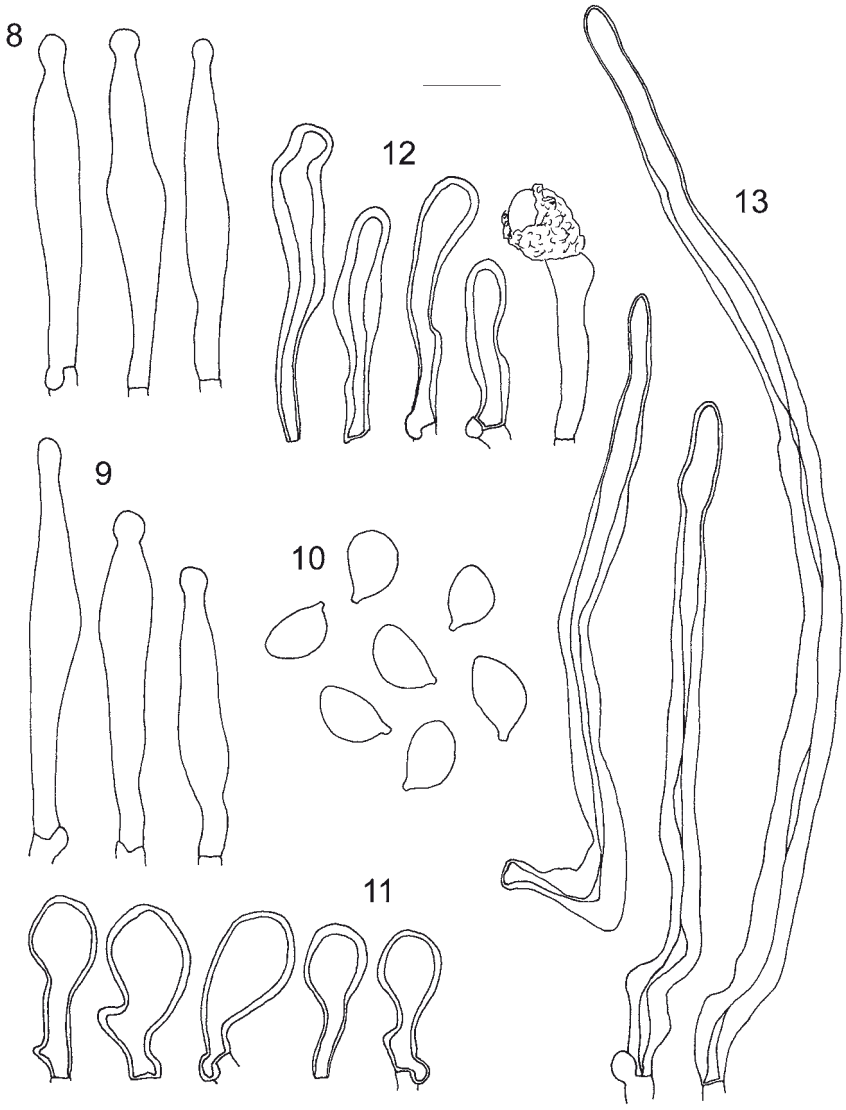
bourg, on road to Lac du Mont Cenis, in subalpine tundra, on *Dryas*, alt. 2300 m, 30 Aug 1992, *leg*. O. K. Miller Jr. & H.H. Miller (VPI–VTMH 3683; OKM 25400); Val d'Isère, from Pont St. Charles at foot of Galise glacier, on *Dryas octopetala*, 31 Aug 1992, *leg*. M. Moser (VPI-VTMH 3652; OKM 25425); ROMANIA: Dâmboviţa, Southern Carpathians, Munţii Bucegi, at the refuge Cabana Babele, alpine meadow with *Dryas octopetala*, on dead stems of *Dryas octopetala*, 45° 24' 22" N, 25° 28' 21" E, alt. 2200 m, 31 Jul 2006, *leg*. A. Ronikier, M. Ronikier, H. Knudsen (KRAM F-46706); Prahova, Southern Carpathians, Munţii Bucegi, Muntele Caraiman, vicinity of the summit of the Vf. Caraiman, alpine meadow with *Dryas octopetala*, on dead stems of *Dryas octopetala*, 45° 24' 53" N, 25° 29' 34" E, alt. 2330 m, 1 Aug 2006, *leg*. A. Ronikier, M. Ronikier, H. Knudsen (KRAM F-46707); SWITZERLAND, Bern, Schynige Platte, Oberberghorn, alt. 1990 m, 9 Jul 1992, *leg*. B. Senn-Irlet (B. Irlet 92/66); Graubünden, Albula Pass, on rocky rubble […]?, in cushion vegetation, with *Dryas octopetala*, 30 Aug 1984, leg. R. Watling (E 297143; Wat. herb. 17856); Albula Pass, alpine tundra, on *Dryas*, alt. 8000 ft., 30 Aug 1984, *leg*. O. K. Miller Jr. & H.H. Miller (VPI; OKM 21342); Albula Pass, snow bed on N slope, in *Dryas* cushion, on old stems of *Dryas*, 46° 33' N, 09° 52' E, alt. 2400 m, 30 Aug 1984, *leg*. K. Metsänheimo (F 16555); Alp Trida, alpine slope, on ?*Dryas*, alt. 2270 m, 28 Aug 1984, *leg*. S. A. Redhead (DAOM 198485; SAR 5072); E of Swiss N.P., Val Plavna, Alpe Plavna mots da Nossa Donne, on rotting debris of *Dryas octopetala*, alt. 2060–2360 m, 3 Sep

1981, *leg*. E. Horak (ZT 1304); Ramosch, Val Sinestra - Praschan, Saumgesellschaften, *Dryas*, alt. 1800 m, 14 Aug 2006, *leg*. B. Senn-Irlet (B. Irlet 06/114); Ticino, just S of Passo del Lucomagno, in subalpine grassland on calcareous soil, on dead stems and roots of *Dryas octopetala*, alt. ca. 1800 m, 31 Aug 2000, leg. E. Arnolds (L 794229; 00-70).

The collection of *Marasmius epidryas* found in the Komovi Mountains in the lower parts of the northern slopes of Kom Vasojevički (KRAM F-48020) was abundant. It was represented by several dozens basidiomes, sometimes growing in groups, on a steep, calcareous slope dominated by a shrub cover of *Dryas octopetala* along a distance of about 200 m. In other localities the fungus was less abundant growing as dispersed, solitary basidiomes on distant shrubs of *D. octopetala*. A few to a dozen specimens were found at each of these localities.

When collected, pilei of *M. epidryas* were mostly pale, cream-colored with slightly darker centre. Only few of them were darker, orange- to rusty-brown. The collection was kept in a transparent plastic box and the next day the color change of some of the pale basidiomes into rusty-brown was observed. Redhead *et al.* (1982) observed color variability in *M. epidryas* and they explained it by two factors: (1) pale basidiomes of overwintered collections can be bleached of melanin and (2) the number of pileocystidia (that usually have yellow-brown walls) may influence the pileus color. Based on our observations the exposition to the sun light may be another factor. Basidiomes that are covered by litter or plant shoots are paler, while those exposed to the sun light are darker.

The new localities of *M. epidryas* reported here are situated in the western part of the Balkan Peninsula (Fig. 1): the Komovi Mountains and the Šar-Planina Mountains. The two massifs, although localized in a relatively short distance from each other, belong to the two different mountain systems and biogeographical areas. The Komovi massif belongs to the Dinaric Mountains (Dinaric mountain system) beginning from the Mt. Snežnik in Slovenia in the north-west and running southwards to the Prokletije Mountains in Albania in south-east, while the Šar-Planina Mountains form the north-western edge of the neighboring Scando-Pindic mountain system spreading south-eastwards from the Dinaric Mountains to S Peloponnese (Stevanović *et al*. 2009). These Balkan mountain systems, together with the Apennines and the Pyrenees, are the southernmost European mountains where the host plant species of *M. epidryas* (*Dryas octopetala*) occurs. In the Pyrenees, where *D. octopetala* is common in places, *M. epidryas* has been reported from several localities, both at the French and Spanish sides of the mountain range (Bon & Ballarà 1995, Esteve-Raventós *et al*. 1997, Vila *et al*. 1997, Vila 1998, Corriol 2008). The species has earlier also been found in the eastern part of the Balkans in the Bulgarian mountains Rila and Pirin (Antonín & Noordeloos 1993; Gyosheva & Denchev 2000) belonging to the Rhodope-Rila mountain system (Stevanović et



Figs. 8–13. – Micromorphological characters of *Marasmius epidryas* from the localities in the Šar-Planina Mountains. (KRAM F-48022): **8.** Cheilocystidia. **9.** Pleurocystidia. **10.** Spores. **11.** Pileipellis elements. **12.** Pileocystidia. **13.** Caulocystidia (from the stipe apex). Bar = 10 µm.

al. 2009). In this part of its distribution range *D. octopetala* forms smaller or bigger patches in the alpine belt, but the area of its occurrence is highly fragmented. Our new records from the southern part of the Dinaric Mountains and from the Scando-Pindic mountain system circumstantiate the presence of *M. epidryas* in another important bio-

geographical mountain region of southern Europe where the distribution range of *D. octopetala* is dispersed. There is also another isolated locality of *D. octopetala* in the Apennines, on the other side of the Adriatic Sea, from where the fungus has not been reported so far; so it remains unknown if the fungus exists in the disjunct stations of *D. octopetala* in this area. The records from the Balkans, however, confirm that *M. epidryas* indeed regularly accompanies its host plant also in the disjunct island populations at the southern edge of its distribution. From the ecological point of view it is interesting that all south-European localities of *M. epidryas* are located in high vegetation belts: the alpine belt or, more rarely, subalpine belt – in places where *D. octopetala* descends downwards from higher level localities. The fungus has not been found so far in populations of this plant occurring in lower mountains without the alpine belt. Similarly, it has never been found in relict lowland temperate localities of *D. octopetala* in northern Europe (Gulden *et al*. 1985, Harrington 2003). It is possible that the fungus follows the distribution range of its host plant, but has slightly more stenotypic ecological requirements, so in some parts of the *D. octopetala* distribution area the fungus may be absent.

It is also interesting to note that, to our best knowledge, the new records of *M. epidryas* are the first records of arctic-alpine fungi in general from the western mountains of the Balkan Peninsula. Despite their southerly location, the high mountain areas of this region harboring populations of the ectomycorrhizal *Dryas octopetala* at the edge of its distribution range seem to provide appropriate habitats for arctic-alpine fungi and will constitute promising sites for mycological explorations.

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