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Biogeographical patterns of arctic-alpine fungi: distribution analysis of *Marasmius epidryas*, a typical circumpolar species of cold environments

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Abstract: The existence of an arctic-alpine element is well-known in the biogeography and taxonomy of fungi, however synthetic analyses concerning their global distribution, morphological variation and ecology are largely lacking. Here, we compile all available information including published data and herbarium material concerning *Marasmius epidryas*, a characteristic representative of arctic-alpine macromycetes which grows exclusively on dead woody tissue of *Dryas* species. Our primary aim was to obtain as complete a picture as possible of the known distribution of an arctic-alpine fungus. Additionally, we attempted to analyse the variation of morphological features, phenology and ecology throughout its range. According to our data, the species has been recorded from over 300 localities. Although the records are clearly biased due to an uneven concentration of mycological investigations, the fungus was found in all parts of its presumable circumpolar distribution outlined by presence of the host plant. The localities included main northern and high-mountain areas as well as peripheral, southernmost parts of the *Dryas* distribution in Europe (Balkan Mts.), North America (Rocky Mts. of Colorado) and Asia (Altai Mts.). However, it may be a rare species in some regions. *Marasmius epidryas* appears to occur in most types of

vegetation harbouring its host, an important arctic-alpine dwarf shrub, and is noted as a dominant fungal element for some. No significant differences were found in phenology of *M. epidryas* between the alpine and the arctic sites, with most records in August. Similarly, although there is a significant variation in quantitative morphological characters, no particular geographical trends were detected.

Key words: Agaricomycetes, alpine belt, arctic-alpine element, biogeography, distribution, ecology, *Mycetinis epidryas*, phenology

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Introduction: Arctic-alpine organisms are among the most characteristic and ecologically important biogeographical groups, confined to cold environments of the Northern hemisphere. They occur disjunctly in subarctic and arctic areas in the Northern latitudes and in isolated, island habitats in alpine belt areas of the more southerly high mountain ranges. Their affinity for such areas is determined by a combination of factors, the most important being physiological adaptation to specific life conditions (e.g., short growing season, low temperatures; Körner 2003). The existence of a group of arctic-alpine fungi has been recognized for many years and their regional diversity investigated in various parts of the world (e.g., Favre 1955, Lange 1955, Borgen et al. 2006, Corriol 2008, Cripps and Horak 2008). It is likely that a particularly important element shaping the evolution, biogeographical character and range extension of arctic-alpine fungi are co-evolutionary links with specific plant hosts restricted to cold habitats. Indeed, the obligate specificity of a particular fungus and a particular plant has profound consequences for biogeographical distributions (e.g., Halling 2001). Despite many regional works, there have been no studies so far focused on a detailed reconstruction of the general distribution of arctic-alpine fungi; however such synthetic analyses are an important contribution to our knowledge of biogeographical patterns for this group. According to the best of our knowledge the only map of the global distribution of an arctic-alpine fungus is that for *Arrhenia auriscalpium* (Fr.) Fr. (Cripps and Horak 2006).

Marasmius epidryas Kühner ex A. Ronikier is a typical arctic-alpine fungus specifically associated with dead tissues of *Dryas* spp. (e.g., Redhead et al. 1982, Antonín and Noordeloos 1993, Gulden et al. 1985). It was first described by Kühner (1936) from the French Alps in Europe, however, the original description lacked a Latin diagnosis, so the species remained invalid in the sense of the Code of Botanical Nomenclature for a dozen years and was only recently validated (Ronikier 2009). Transfer of the species to the genus *Mycetinis* has recently been proposed (Noordeloos and Antonín 2008), but it was based on the invalid basionym. Although it seems logical to transfer this fungus to the new genus, we prefer to refrain from proposing a new combination for *Marasmius epidryas* until a DNA sequence confirms this affinity (Ronikier and Ronikier, in preparation).

Soon after its description, the species was found in Asia (Altai Mts, Russia) by Singer (1943, see coll. 7659 in Appendix 1) and was reported for the first time in North America, in Greenland, by Lange (1955). Interestingly, the first date of collection for the species in Greenland dates back to 1930 (Lange 1955). Therefore, the fungus was already known from the three continents of the Northern Hemisphere at the time of its description. The earliest date of the collection of the fungus was Sep 18th 1928 from Svalbard (Skifte 1996). *Marasmius epidryas* is widespread in cold environments and appears to represent a common circumpolar species. As such, it is a useful taxon for an attempt to demonstrate the

global distribution of arctic-alpine fungus based on current knowledge. However, information on its distribution is scattered and has never been summarized. Only two regional maps of distribution of *M. epidryas* in Canada (Redhead 1989) and in Norway including Svalbard (Skifte 1996) are available. Thus, the primary aim of the present paper is to gather together records of published and unpublished (herbarium) data on the occurrence and distribution of *M. epidryas*, as complete as possible, and to prepare a detailed map of its world distribution with the data available. Additionally, general characteristics of the species based on an overview of the data from the entire distribution range are synthesized. The principal micromorphological features were examined for all herbarium collections in order to present intraspecific variation. Information from publications and herbarium labels was used to develop synopses for the frequency of occurrence, ecology and phenology for the species on a global basis.

Materials and Methods: In total 273 specimens determined as *Marasmius* (or *Mycetinis*) *epidryas* deposited in 22 world herbaria (AH, AMNH, BR, C, DAOM, E, F, G, H, IB, K, KRAM, L, LE, LIP, O, S, TROM, UPS, VPI, WTU, ZT, abbreviations follow Index Herbariorum, http://sweetgum.nybg.org/ih/) and private collections of Gilles Corriol (GC), Cathy L. Cripps (CLC) and Beatrice Senn-Irlet (B. Irlet) were examined (see Appendix 1). Each collection was first examined under a stereoscopic microscope (Nikon SMZ1500) and the micromorphology was examined under a light microscope (Nikon Eclipse E600) with Nomarski interference contrast with the oil immersion objective 100x, in 5% KOH, Congo Red and Melzer's reagent. The description of micromorphological features given in results is based on characters for all the examined collections; ranges are based on the following number of total measurements: spores – 713, basidia – 245, hymenial cystidia – 466, caulocystidia – 320, pileipellis elements – 354, pileocystidia – 319. Both ranges and average values are given for all measured elements. Spores were taken, when possible, from a natural spore deposit on the cap or stem surface, otherwise, mature spores floating in the hymenial preparation were measured. 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 the broadest place × width at apex. Macromorphological characters are not described in detail as no fresh material has been examined. Only some of the major macromorphological characters are noted for dried specimens (e.g., maximum and minimum size of pileus, palest and darkest colours of dried basidiomata), while the micromorphological description covers the variability of all collections examined. Symbols of colors used for descriptions of dried basidiomata refer to Kornerup and Wanscher (1965). Drawings of microcharacters were made using a camera lucida (Nikon Y-IDT). All specimens examined are listed in Appendix 1. Additional published localities without herbarium material are listed in Appendix 2.

A map of the world distribution of *Marasmius epidryas* was prepared based on herbarium material as well as information on localities available in the literature. Localities for which no coordinates were given on the herbarium labels were located using printed maps of a given region or those available on the internet. Then, the coordinates for these localities were taken from the geo-referenced satellite images in GoogleEarth (earth.google.com). The map was prepared using GIS software and visualized in the polar stereographic projection. The outline of the world distribution of *Dryas* ssp. (*D. octopetala* L., *D. drummondii* Richardson ex Hook. and *D. integrifolia* Vahl), plant hosts of *Marasmius epidryas*, was based on a map published by Hultén and Fries (1986).

Results and Discussion: Revision of herbarium material resulted in recognition of 265 collections of *Marasmius epidryas* (8 specimens were misidentified and thus excluded from the present study). Additionally, published data is listed for about 90 localities, for which herbarium materials were not available.

DISTRIBUTION: *Marasmius epidryas* is a species characterized by a circumpolar distribution in arctic and alpine regions (Redhead 1989, Antonín and Noordeloos 1993). As a species confined to dead tissue of *Dryas* spp., its distribution presumably follows that of the host plant species. Thus, its potential for occurrence in the Arctic is probably continuous, while in the mountains its distribution range is fragmented. Thus far it has been found in more than 300 localites (Fig. 1). Some localities known only from the literature for which specimens have not been examined either in the present paper or by monographers, should be considered with some caution and for this reason they are marked in the map with a different colour. We found four localities published by Skifte (1996) that are based on misidentified collections. The records are not distributed uniformly due to the clearly uneven concentration of mycological investigations: with very good coverage of some regions (e.g., Iceland, Northern Norway, Western Alps) and a lack of mycological exploration for others (mainly Siberia and mountains of Asia). However, the known localities are distributed across all main parts of the presumable circumpolar distribution of the fungus outlined by the presence of its host plant. It is important to note that the distribution of *M. epidryas* includes the main northern and high-mountain areas as well as peripheral, southernmost parts of the *Dryas* distribution in Europe (Balkan Mts.), North America (Rocky Mts. in Colorado) and Asia (Altai Mts.). Although Ryvarden (1968) suggested that the range of *M. epidryas* is narrower than that of the host plant, the records of the fungus in most peripheral areas appear to confirm a co-occurrence of *M. epidryas* and *Dryas* spp. over the whole plant distribution range. However, there may indeed be significant differences in frequency between regions. In some places the fungus is apparently common, e.g., in Iceland (Hallgrímsson 1981), Northern Norway (Lange and Skifte 1967), regions of Russian Siberia such as the Bargusin Mountains near the Lake Bajkal (Niezdojminogo 1971) or the Altai Mountains (Singer 1943). In some other areas, mainly the peripheral parts of the range, it appears to be rare or very rare. Despite many years of study, the fungus was found only in a single locality in the USA Rocky Mountains (Cripps and Horak 2008). We have also searched for this fungus in the Carpathians (Central Europe) for several years and so far we have only found it in one mountain massif (Bucegi Mts.) in Romania. There is one known locality of the fungus in the Slovak part of the Carpathians (Antonín and Noordeloos 1993); although we visited this locality several times, every year for the last four years, in different periods, we could not find it again. Also an extensive inventory of a dozen isolated high mountain localities with *Dryas octopetala* at the southern edge of the distribution range in southern Europe in 2009 resulted in location of only two new localities (Ronikier and Ronikier, in press). It is noteworthy that the fungus has been reported from numerous localities in the western and central part of the Alps (France, Switzerland, Italy), while it has not been reported so far from the eastern part of this mountain range (Fig. 1). Also, it has not been found in any locality with a large lowland population of *Dryas octopetala* in Ireland (Harrington 2003, see notes on ecology below).

Information on the occurrence of *M. epidryas* in various countries may be found in the following papers: Bulgaria (Antonín and Noordeloos 1993, Gyosheva and Denchev 2000), Canada (Miller 1968, 1982, Redhead et al. 1982, Redhead 1989, 1997, Antonín and Noordeloos 1993), Denmark – Greenland (Lange 1955, Petersen 1977, Lamoure et al. 1982, Borgen 1993, Borgen et al. 2006), Finland (Antonín and Noordeloos 1993, Skifte

1996, Ohenoja 2000, Noordeloos 2008), France (Kühner 1936, Lamoure 1982, Kühner and Lamoure 1986, Meyer and Bidaud 1988, Bon 1999, Antonín and Noordeloos 1993, Corriol 2008, Ronikier 2009), Iceland (Hallgrímsson 1981, Antonín and Noordeloos 1993, Noordeloos 2008), Italy (Antonín and Noordeloos 1993, Jamoni 1998, 2006, Zotti and Orsino 2001), Macedonia (Ronikier and Ronikier, in press), Montenegro (Ronikier and Ronikier, in press), Norway (including Svalbard) (Eckblad 1960, Kallio and Kankainen 1964, Lange and Skifte 1967, Ohenoja 1971, Sivertsen 1978, Gulden et al. 1985, Ryvarden 1968, Antonín and Noordeloos 1993, Jalink and Nauta 1994, Gulden and Torkelsen 1996, Skifte 1996, Robinson et al. 2004, Gulden 2005, Noordeloos 2008), Romania (Antonín and Noordeloos 1993), Russia (Singer 1943, Niezdoiminogo 1971, 1997, 2003, Niezdoiminogo and Zhurbenko 1996, Knudsen and Mukhin 1998, Karatygin et al. 1999), Slovakia (Antonín and Noordeloos 1993), Spain (Bon and Ballarà 1995, Esteve-Raventós et al. 1997, Vila et al. 1997, Vila 1998), Sweden (Lundell and Nannfeldt 1979, Antonín and Noordeloos 1993, Skifte 1996, Ludwig 2001, Tedebrand 2007a, 2007b, Noordeloos 2008), Switzerland (Favre 1955, 1960, Senn-Irlet 1986, 1988, Breitenbach and Kränzlin 1991, Antonín and Noordeloos 1993), USA (Sprague and Lawrence 1960, Miller 1982, Cripps and Horak 2008).

MACROMORPHOLOGY (Fig. 2): The examined material was fairly variable in respect to the size and colour of (dried) basidiomes. The smallest mature pileus that possessed mature basidia measured 2 mm in diameter (e.g., coll. F 34279), while the largest was 15 mm in diameter (e.g., coll. O74220). The palest basidiomes were very pale cream, almost white (4A2) (e.g., coll. E 297142) and the darkest were rusty-brown (4EF6, 4EF7, 4EF6, 4EF7) or even blackish brown, especially in the center (e.g., KRAM F-48020). Lamellae in most specimens were broadly adnate, but in a few cases they were slightly but distinctly decurrent (e.g., coll. O 74222). Stipe length ranged from 4 mm (KRAM F-46706) to 75 mm (e.g., AMNH FA-11524). Variation in the color of pileus was stressed by Redhead et al. (1982) and Ronikier and Ronikier (in press) and is explained by several possible factors one of which may be the sensitivity of melanin (likely the pigment present in the pileus) to the sunlight.

Marasmius epidryas is a very distinctive species, easy to identify in the field due to the rusty-brown, velvety stipe entirely covered by thick hairs visible without magnification. According to Gulden et al. (1985), the species is somewhat similar to *Collybia alkalivirens* Singer = *C. obscura* Favre [*Gymnopus fuscopurpureus* (Pers.: Fr.) Antonín, Halling & Noordel.]. Although the latter forms bigger basidiomes with smooth stipes, it may easily be mistaken for large basidiomes of *M. epidryas* as it often occurs in similar vegetation types with *Dryas*. Lange (1955) and Miller (1968) emphasized the similarity of *M. epidryas* to species in the genus *Xeromphalina* Kühner & Maire that are of similar size and overall habit. *Xeromphalina* species may be distinguished by glabrous (or at most tomentose-hairy) stipes and lamellae that are always decurrent. Members of genus *Xeromphalina* occur very rarely in (sub)arctic-alpine regions. One species, *X. caulicinalis* (Fr.) Kühner & Maire, has been reported from Greenland (Lange 1955), Iceland (Hallgrímsson 1981) and the Russian Arctic (Karatygin et al. 1999), but it is likely that none of these records originate from localities with *Dryas* spp., but are rather from vegetation types with higher shrubs or from woodlands, as in the case of the Icelandic site (Hallgrímsson 1981).

Full descriptions of *M. epidryas* that include macromorphology are available in the following papers: Kühner (1936), Miller (1968), Clemençon (1982), Redhead et al. (1982), Gulden et al. (1985), Senn-Irlet (1986), Breitenbach and Kränzlin (1991), Knudsen and Noordeloos (1992), Antonín and Noordeloos (1993), Bon and Ballarà

(1995), Jamoni (1998, 2008), Vila (1998), Ludwig (2001), Collin (2003), Horak (2005), Noordeloos (2008), Ronikier and Ronikier (in press); color illustrations are provided in the following works: Favre (1955), Pl. VIII. Fig. 12; Moser and Jülich (1985-1995), III *Marasmius* 4; Gulden et al. (1985), 21; Breitenbach and Kränzlin (1991), No. 283; Antonín and Noordeloos (1993), Plate 6; Vila (1998), 836; Lamoure (1999), 28; Ludwig (2001), Tafel 102, No. 47.10; Moreau (2002), 18; Jamoni (2008), 455. It should be noted that the illustration of *M. epidryas* provided by Cetto (1984) does not represent this species.

MICROMORPHOLOGY (Fig. 3): *Spores* 8.0–12.0(13.0) × (4.0)5.0–7.0(7.5) µm, av. 9.7 × 6.0 µm, Q= (1.2)1.3–2.0(2.25), Q_{av}=1.6, ellipsoid, amygdaliform, hyaline, thin-walled, non-amyloid (Fig. 3e). *Basidia* (32)33–58(67) × 6.5–11(11.5) µm, narrowly clavate, 4-spored, exceptionally also 2- or 3- spored, and sometimes with more than 4 sterigmata. *Cheilocystidia and pleurocystidia* similar, (30)39–72(91) × 5–10(17) × 2–7(9.5) µm, av. 54.3 × 7.3 × 4.6 µm, fusiform, lageniform, cylindrical, usually with a capitate

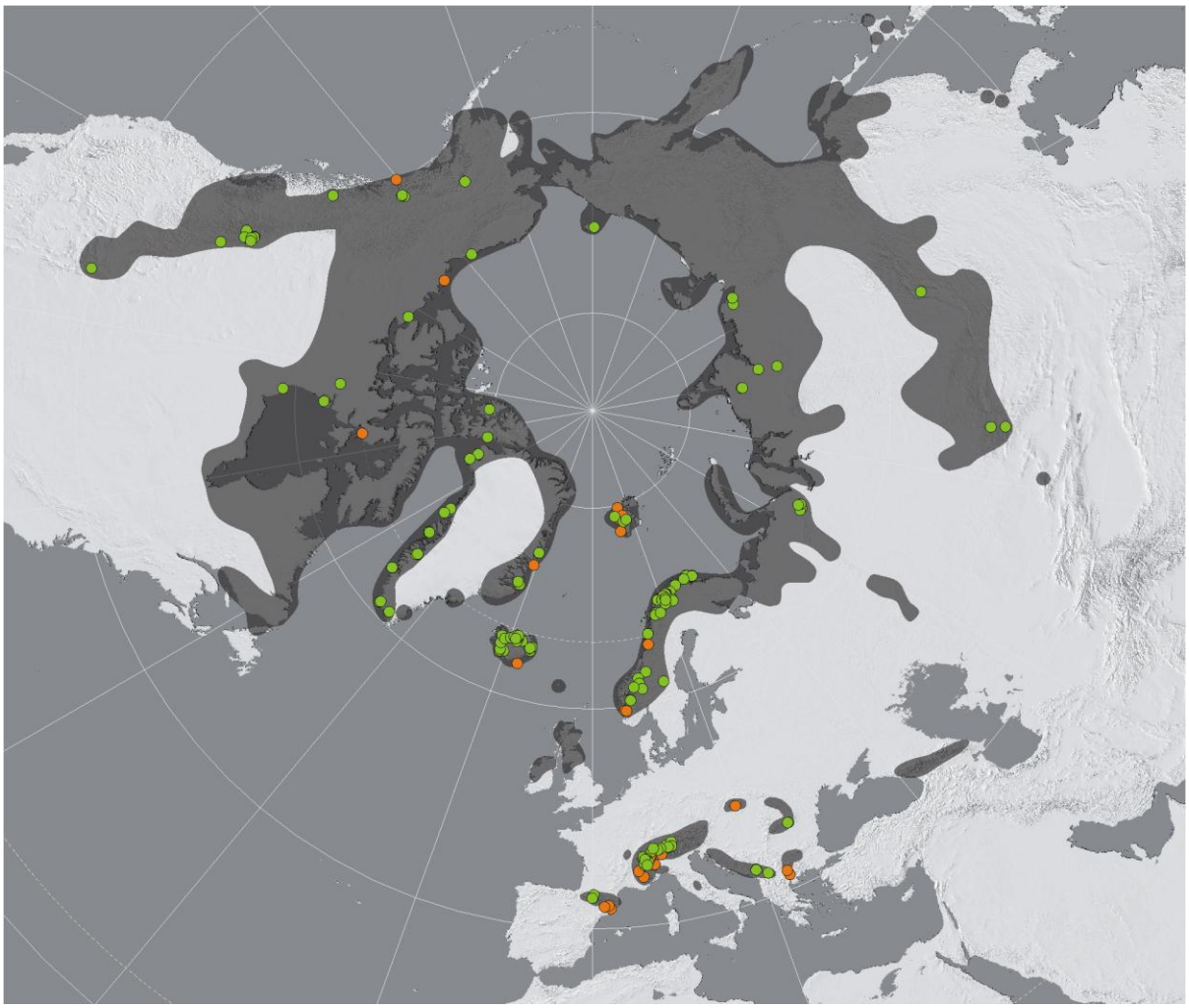

Fig. 1. World distribution of *Marasmius epidryas* based on all herbarium and literature records available. Green dots – herbarium data (revised collections); orange dots – literature data (not revised). Dark grey area – outline of distribution range of *Dryas* spp. according to Hultén and Fries (1986).

Fig. 2. Basidiomes of *Marasmius epidryas* occurring on dead stems of *Dryas octopetala*. A, B – Romania, Carpathians, Bucegi Mts. (coll. KRAM F-46706). C, D, E – Montenegro, Dinaric range, Komovi Mts. (coll. KRAM F-48020). F – Macedonia, Scando-Pindic range, Šar-Planina Mts. (KRAM F-48022). Scale bar equals 1 cm.

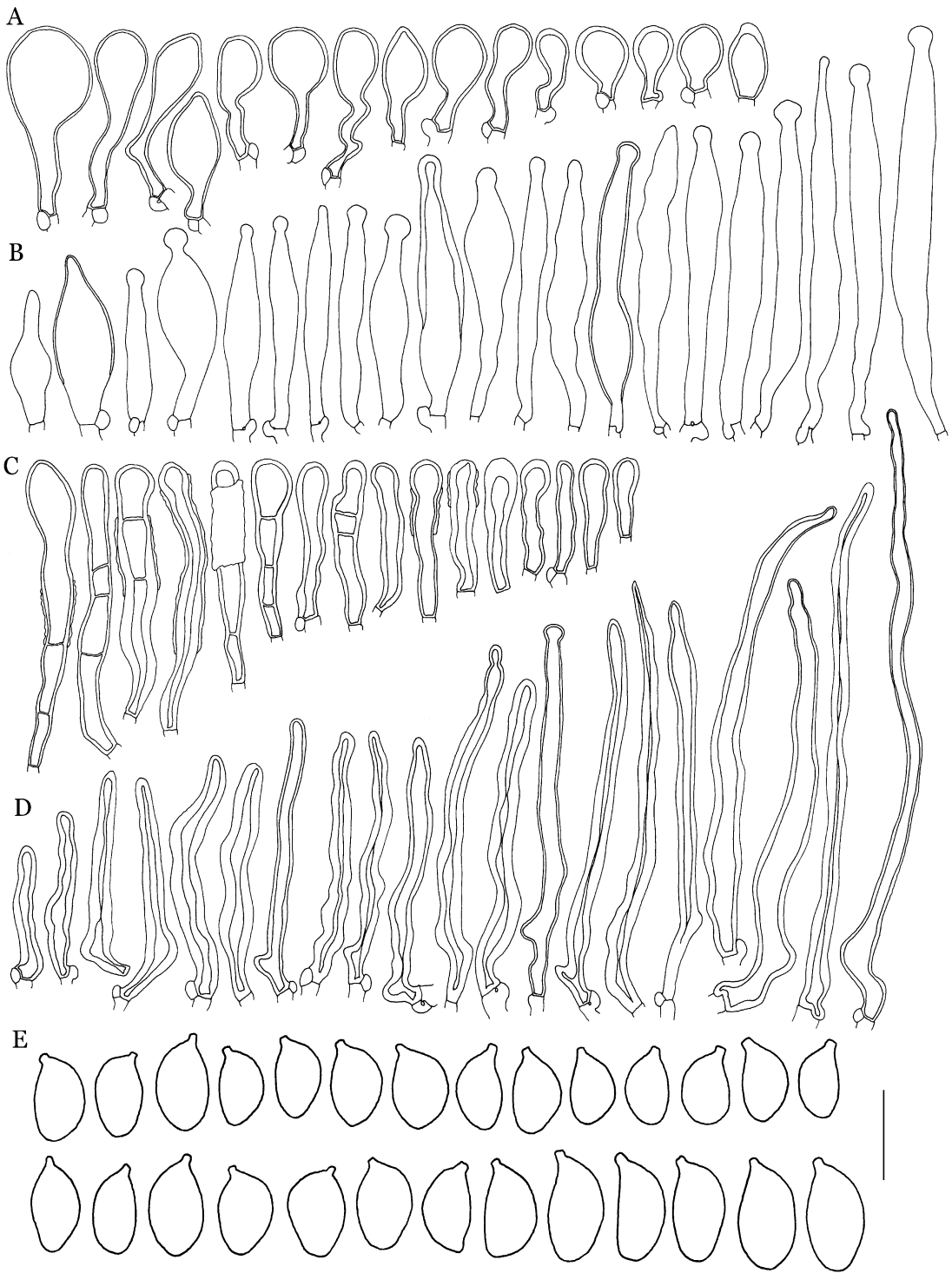

Fig. 3. Range of variation for micromorphological features of *Marasmius epidryas* selected from all collections examined. A. pileipellis elements. B. hymenial cystidia (pleuro- and cheilocystydia). C. pileocystidia. D. caulocystidia from the stipe apex. E. spores. Scale bar equals 20 µm for A–D and 10 µm for E.

apex, thin- or, more rarely, slightly to distinctly thick-walled, clamped, in some collections abundant or numerous, in others rare and scattered and difficult to notice (Fig. 3b). In every collection at least one typical capitate cystidium has been observed, but in some cases fusiform, non-capitate cystidia prevailed (especially cheilocystidia). Differences in the shape of cheilocystidia that were dependent on their location on the lamellae were observed. Cheilocystidia from the part of the lamellae close to the pileus margin were mostly typical and capitate, while those located close to the stipe were often fusiform and slightly to distinctly thick-walled (Fig. 3b – first two cystidia on the left). *Pileipellis* a hymeniderm, dry or slightly gelatinized, made up of broadly clavate, piriform or more rarely slightly fusiform, stipitate or sessile, thick-walled elements, (12)14–35(45) × 7–18(24) µm, av. 24.0 × 11.3 µm, with hyaline or pale to rusty-yellow walls 0.5–3 µm thick (Fig. 3a). *Pileocystidia* narrowly clavate or cylindrical (rarely forked or capitate), 17.5(21)–55(67) × 4–11(12) µm, av. 37.9 × 7.0 µm, with orange brown walls 1–3(6) µm thick, occasionally with 1 to 3 secondary septa, sometimes covered with an amorphous substance (Fig. 3c), in most collections abundant to numerous, more rarely scattered. *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, (30)52–135(177) × (3)4.5–11(15.5) × (1.5)2–6.5(7) µm, av. 86.2 × 7.0 × 3.8 µm (measurements from the stipe apex), cylindrical or more often swollen and curved at base and with an obtuse or slightly pointed apex and with thick, yellow walls (Fig. 3d); some caulocystidia from the very apex of the stipe are more similar in shape to hymenial cystidia, being capitate; caulocystidia in lower parts of a stipe are much longer, darker and usually narrower at the apex. Clamp connections are numerous in all tissues.

ECOLOGY: *Marasmius epidryas* is one of the few species from the genus (in the sense of Antonín and Noordeloos 1993) that is exclusively associated with one type of substrate. In the literature and on herbarium labels, dead stems or branches (sometimes buried in soil), or roots of *Dryas* spp. are cited as the most common substrate of the fungus. Dead leaves are also mentioned (e.g., Singer 1943; Sprague and Lawrence 1960), but we have not found any basidiome in the herbarium material that was attached to a leaf, so in our opinion the fungus grows exclusively on dead woody parts of the plant. *Marasmius epidryas* is considered a saprotroph and based on a majority of observations it is associated with dead (rotting, decaying, necrotic) parts of *Dryas*. However, it was once noted on both dead and living branches of *Dryas* (Eckblad 1960). While it cannot be excluded that the fungus may be a weak parasite which attacks dying parts of the plant and becomes a saprotroph after the plant's death, it may also be that the fungus was found on the dead parts of the living *Dryas'* stems in this particular case.

Although *M. epidryas* is assumed to be exclusively associated with *Dryas*, there are a few reports from sites where *Dryas* was not noted nearby or where it was observed on other substrates. The first to collect *M. epidryas* without the accompanying host plant was R. Kühner, who found the species in the Alps, on litter in a spruce forest (coll. G 110635). The second aberrant collection from the Alps is cited by Bon (1999) who reports it growing among *Salix retusa* L. The species was also noted in Greenland on *Vaccinium uliginosum* L., in a heath bog (Lange 1955), on wooden sticks in damp moss without *Dryas* nearby (coll. C 1453), and in Alaska, on bases of *D. integrifolia* and *Salix* sp. (coll. B. M. Murray 4242, VPI). These abberant records constitute 1.6 % of all collections taken into account in the present paper (herbarium data and literature records) and in our opinion they do not indicate that the fungus is not obligately associated with *Dryas* spp. In sites where the plant was not noticed, it

could have remained only in the form of dead woody material buried in the soil. It should also be noted that small pieces of dead *Dryas* stems containing fungal mycelium can be transported by strong winds for long distances, so the fungus may, at least temporarily, appear far from its original population.

There is little information on specific vegetation types in which the fungus has been found. It was reported in the Swiss Alps from calciphilous grasslands and *Dryas* heath communities. In particular, Senn-Irlet (1986, 1988) reported *M. epidryas* as one of dominant fungi in typical high-mountain plant associations *Salicetum retuso-reticulatae* and *Seslerio-Caricetum sempervirentis* on calcareous bedrock; it was also regularly noted in *Athamantho-Trisetetum distichophylli* subclass *Tortelletosum* vegetation. In the French Pyrenees it was reported from another calciphilous association, *Oxytropido-Elynion* (Corriol 2008).

In alpine/subalpine and arctic/subarctic localities it was reported from various habitats: mostly arctic or alpine tundra with prostrate or shrubby plants such as (apart from *Dryas*) *Salix reticulata* L., *Empetrum nigrum* L., *Juniperus communis* subsp. *nana* Syme., *Vaccinium vitis-idea* L., *V. gaulterioides* Bigelow, *V. uliginosum* L. and others, on open gravelly sites or along river banks. It has been found in polar semi-desert vegetation as well as damp places, such as mires. In the mountains, the fungus follows its host plant and occurs in the alpine belt but also in places where *Dryas* descends from alpine localities into the subalpine belt (Favre 1960, Esteve-Raventós et al. 1997, Bon 1999, see also Appendix 1: coll. e.g., F 16550, S 157013, DAOM 178077). According to Lamoure et al. (1982) *Marasmius epidryas* is a species typical of drier habitats. It was also collected during a 'very dry year' by O. K. Miller Jr. (coll. VPI, OKM 7634). On the other hand, fruitings were also noted after heavy rains (Miller 1968; Sprague and Lawrence 1960). Also Vila et al. (1997) expects more numerous occurrences of the species in the Pyrenees during longer periods of moisture. Our observations from the Southeastern European mountains seem to confirm that the fungus usually appears after periods of heavy rains (A. Ronikier, M. Ronikier, unpublished). However, it is also possible that the frequency and occurrence of the fungus are not the same throughout the entire distribution range and that in some regions it is one of most common species and occurs regardless climatic conditions, while in other (southern peripherical) regions it is rare and more sensitive to the ecological factors (see also notes on distribution above).

Taking into account the wide geographical range of *M. epidryas*, it is probably present in most plant associations in which its host plant occurs, however, with some exceptions. There are places with abundant populations of *Dryas octopetala* where the fungus has not been found so far, i.e. relict lowland locality in Ireland (Harrington 2003). It has also been searched for in lowland localities by Gulden et al. (1985) without any success.

PHENOLOGY: Information on the time of occurrence of *M. epidryas* is very sparse in the literature. According to Antonín and Noordeloos (1993), the fungus occurs from June to September. Gulden et al. (1985) observed that it appears to be most abundant in the later part of the season. In the Finse region (Southern Norway) it occurs from late July to the end of the season (Gulden 2005). The analysis of all studied herbarium materials together with published records of those collections not studied by us demonstrates that the maximum of fruiting of *M. epidryas* is in the second half of August (Fig. 4) and that as much as 64% of all observations were recorded during August. The earliest occurrence noted was May 18th (Axel Heiberg Island, N.W.T,

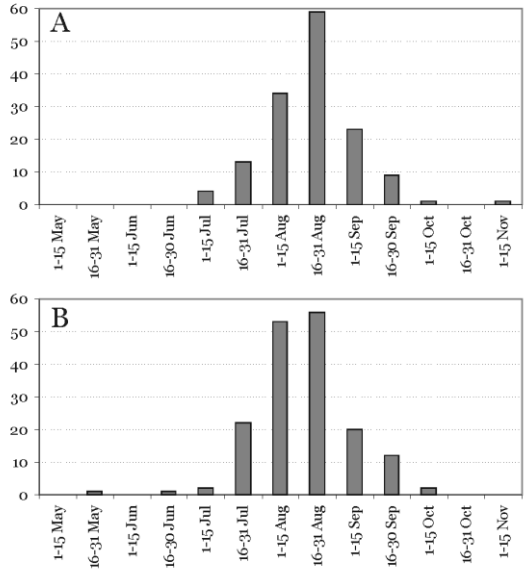

Fig. 4. Diagrams of phenological occurrences of *Marasmius epidryas* in the alpine (A) and arctic (B) regions, based on data synthesized from herbarium labels and publications.

Canada, coll. DAOM 124716), and the latest was November 5th (Swiss Alps, Waadtländer Alpen, Pas de Cheville; Senn-Irlet 1986). An analysis of phenology made separately for arctic versus alpine locations showed no significant differences. In the case of the alpine locations, the peak occurrence was clearly recorded in the second part of August (Fig. 4a), while in the Arctic the number of records for the first and the second part of August were similar (53 and 56, respectively; Fig. 4b).

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Appendix 1. List of herbarium specimens of *Marasmius epidryas* examined and included in the analysis.

CANADA: Alberta, Banff National Park, above Peyto Lake, in subalpine tundra, *Dryas octopetala*, 18 Jul 1977, leg. O. K. Miller Jr., C, DAOM 179737, IB 1977/0305, VPI (OKM 15967) (Miller 1982, Redhead et al. 1982, Antonín and Noordeloos 1993); VPI (OKM 15968) (Miller 1982, Redhead et al. 1982); along Jasper Hwy, just before Colombian Icefields, Banff Prov.(?) Park, on dead *Dryas*, 22 Jul 1989, leg. O. K. Miller Jr. & H.H. Miller, VPI (OKM 24087); Banff National Park, S of Sunwapta Pass, North Sakatchewan River, N of Weeping Wall, on rotting debris of *Dryas drummondii*, alt. 1700 m, 21 Jul 1989, leg. E. Horak, ZT 4400; beside Highway on road to Columbian Icefields, on *Dryas*, 30 Jul 1983, leg. O. K. Miller Jr. & H.H. Miller, VPI (OKM 20647); Columbia, Icefields, Alta, nr. road by the edge of Athabasca Glacier, in an unstable area, on *Dryas*, 10 Sep 1977, leg. R. Watling, E 297142 (Wat. herb. 12207), DAOM 176481 (ex E, herb no. 12207) (Redhead et al. 1982); Kootenay Plain, bank 2 O'clock creek, Rocky Mts., Alta, along rocky creek bank, on *Dryas drummondii*, 31 Jul 1982, leg. H. M. E. Schalkwyk, DAOM 185537 (1826) (Redhead 1989); Livingston Falls, Crowsnest Forest, on *Dryas octopetala*, 23 Jul 1987, leg. H. Miller, VPI (OKM 22890); Parker Ridge, Banff Nat. Park, subalpine tundra, on *Dryas octopetala* branches, 19 Jul 1977, leg. O. K. Miller Jr., VPI (OKM 15982) (Miller 1982, Redhead et al. 1982); Peyto Lake, visitor ctr. (?), Banff PK., on *Dryas* stems, 21 Jul 1981, leg. O. K. Miller Jr., VPI (OKM 19381); **British Columbia**, Bear Glacier, Btwn Mt. Pattullo & Treble Mt. Hwy 37A, on *Dryas*, 28 Sep 1989, leg. S. A. Redhead, DAOM 214687 (SAR 6798); Lower level Beaver R. valley near Hwy. 1, open gravelly sites with *Dryas* patches, *Populus*, *Salix*, *Picea*, *Pseudotsuga* and *Tsuga* saplings, on *Dryas drummondii*, 16 Sep 1980, leg. S. A. Redhead, DAOM 178077 (SAR 3795) (Redhead et al. 1982); Yoho National Park, Yoho Valley, alt. 1600 m, 31 Jul 1990, leg. B. Senn-Irlet (B. Irlet 90/165); **Manitoba**, Northern Manitoba, Churchill Region, Fort Churchill, at SW edge of the town, between the Landing Lake Road and the Churchill Road, near the easternmost junction, lower slope of an esker, gravelly *Dryas*-Carex heath, on *Dryas integrifolia*, 58°45'N, 94°05'W, 25 Aug 1974, leg. E. & M. Ohenoja, F 34273 (1974/11); **North West Territories**, Cape Young, 4 mi. SW Pin 2 Dew Line Site, on decaying stem of *Dryas integrifolia*, 68°58'N, 116°58'W, 3 Aug 1963, leg. J. A. Parmelee, DAOM 96373, L 794227 (3058) (Redhead et al. 1982, Antonín and Noordeloos 1993); District of Keewatin, Baker Lake, between the settlement and the Airplane Lake Stream, about 1 km E of the buildings of the Dept. of Transport, tundra heath with *Dryas integrifolia*, 64°19'N, 95°59'W, 15 Aug 1974, leg. E. & M. Ohenoja, F 34276 (1974/38); District of Keewatin, Baker Lake, Broad promontory, N of the mouth of the Thelon River middle SW slope, about 1 km SW of the rocky ridge, W of airstrip, Tundra heath, , 64°17'N, 96°08'W, 16 Aug 1974, leg. E. & M. Ohenoja, F 34275 (1974/32b); District of Keewatin, Rankin Inlet, about 500 m NW of A.R.T.C., at the base of a rock ridge, tundra heath with *Dryas integrifolia*, 62°49'N, 92°05'W, 19 Aug 1971, leg. E. & M. Ohenoja, F 34283 (1971/75); District of Keewatin, Rankin Inlet, on SW bank of the upper part of the SW side channel of the Meliadine River, ca 1 km NNW of the N end of Sand Crane Lake, Tundra heath on sandy soil, 62°53'N, 92°11'W, 8 Aug 1974, leg. E. & M. Ohenoja, F 34281 (1974/21b); District of Keewatin, Rankin Inlet, SE of Itivia, closed *Dryas* heath, on old stems of *Dryas integrifolia*, 62°48'N, 92°05'W, 13 Aug 1974, leg. E. Ohenoja, DAOM 155398, F 34279 (1974/16) (Redhead et al. 1982); **Nunavut**, Dist. Frank., Axel Heiberg Island, 1 mile W. Jacobson-McGill base camp, on roots of necrotic *Dryas integrifolia*, 7 Jul 1961, leg. J. A. Parmelee, DAOM 87746 (1081) (Redhead et al. 1982); Axel Heiberg Island, to NE of the Base Camp, on the humus soil, among mosses (*Euclelyma* sp.) and

Dryas, alt. 250 m, 18 May 1967, leg. M. Kuc, DAOM 124716 (Redhead et al. 1982); Ellesmere Islands, Alexandra Fjord, lowland, on *Dryas integrifolia*, 78°53'N, 75°55'W, 20 Jul 1984, leg. H. Dissing, C 56610 (E.I. 84.22); **Yukon Territory**, along old log road up the Slims River mile 1059, Alcan Highway, common on only dead *Dryas dummondii*, 18 Jul 1967, leg. O. K. Miller Jr., DAOM 179736, K 165409 VPI-VTMH 7544 (OKM 5638) (Miller 1968, 1982, Redhead et al. 1982); Base camp mi 1054, Alaska Hwy, on *Dryas* clump, 17 Jul 1968, leg. A.H. Tinker, VPI (OKM 7160) (Miller 1982, Redhead et al. 1982); Kluane Lake, on dead *Dryas alaskensis*, 26 Jul 1967, leg. A. H. Tinker, VPI (OKM 5809) (Miller 1968, 1982, Redhead et al. 1982); road up Slims River from Mile 1056, Kluane Lake, on dead *Dryas* stems (very dry year), 20 Jul 1969, leg. O. K. Miller Jr., VPI (OKM 7634); **DENMARK: Greenland**, Disko, Godhavn, Lyngmarksfjeld, *Dryas integrifolia*, 69°16'N, 53°33'W, alt. 200 m, 15 Aug 1967, leg. M. Lange, C, 515 (ML.G.67-210) (Lamoure et al. 1982); Disko, Godhavn, Lyngmarksfjeld, 69°16'N, 53°33'W, alt. 200 m, 15 Aug 1967, leg. M. Lange, C 516 (ML.G.67-211) (Lamoure et al. 1982); Disko, Godhavn, SW-slope of Skarvefjeld, in *Dryas*-cushion, wet ground, 69°17'N, 53°27'W, alt. 500-600 m, 23 Jul 1986, leg. S. A. Elborne, C 86 (SAE-86, 15-GR); Disko, Godhavn, Sydskrænten, *Dryas*, 69°16'N, 53°33'W, 22 Aug 1970, leg. P. M. Petersen, C 519 (PMP 70.187) (Petersen 1977, Lamoure et al. 1982); Disko, Godhavn, ved Røde Elv, på *Dryas*-pude, 69°15'N, 53°30'W, 24 Aug 1955, leg. F. Terkelsen, C 518 (FT 78); Dundas, N side of Akinarssuaq, deep in wet moss near *Dryas* cushion, apparently on dead *Dryas*, 76°31'N, 68°44'W, alt. 50-100 m, 2 Aug 1988, leg. S. A. Elborne, C 1398 (SAE-88, 78-GR); Dundas, Thule Air Base, *Dryas* association, 76°32'N, 68°45'W, 14 Aug 1987, leg. H. Dissing, C 523 (HD 87.105); Grønnedal, Kangilinnguit, på visne dele af levende tuer af *Dryas integrifolia*, på hede, 61°14'N, 48°05'W, alt. 50 m, 4 Aug 1984, leg. T. Borgen, C 514 (TB 84.49); Imartuneq, 70°41'N, 54°35'W, 11 Aug 1972, leg. P. M. Petersen, C 520 (PMP 72.210); Ivigtut, Webers Havn, on *Dryas*, 61°10'N, 48°10'W, alt. 300 m, 15 Sep 1946, leg. M. Lange, C 4101 (ML 46.570) (Lange 1955); Jameson Land, camp at "Vindelv", river WNW of pt. 330, on rotten leaves of *Dryas*, 71°00'N, 23°28'W, 27 Jul 1989, leg. H. Knudsen, C 2273 (HK,SE & JP 324); Jameson Land, copse N of Gåseelv, W of large moraine, in withered leaves of *Dryas*, 70°48'N, 22°51'W, 9 Aug 1989, leg. H. Knudsen, C 2962 (HK, SE & JP 584); Jameson Land, copse N of Gåseelv, W of large moraine, on *Dryas*, 70°48'N, 22°51'W, 19 Jul 1989, leg. H. Knudsen, C 2139 (HK, SE & JP 63); Jameson Land, S-exposed mire & copses N of Gåseelv, E of large moraine, on leaves of *Dryas*, 70°47'N, 22°45'W, 6 Aug 1989?, leg. J. H. Petersen, C 2634 (HK, SAE, JHP - 540); Jameson Land, side river to "Vindelv", W of pt. 330, N of pt. 270, *Dryas*-heath, in tufts of *Dryas*, 71°00'N, 23°37'W, alt. 200-300 m, 28 Jul 1989?, leg. S. A. Elborne, C 2393 (HK, SAE, JHP - 196); Kangerlussuaq SE, Qaarsorsuaq, by store Saltsø, *Dryas* hummock on tundra heath, On stems of *Dryas* inegrifolia, 66°59'N, 50°38'W, 15 Aug 2000, leg. E. Ohenoja, F 50664 (2000/1); Kangerlussuaq, near Store Saltsö, in niedrigen, offenen *Dryas octopetala*, 67°00'N, 50°38'W, 15 Aug 2000, leg. B. Senn-Irlet, (B. Irlet 00/100); Narssarssuaq, in *Dryas*, , 61°10'N, 45°25'W, 25 Aug 1991, leg. H. Knudsen, C 5621 (HK 91.161); Narssarssuaq, on *Dryas*-clone, 61°10'N, 45°25'W, 18 Jul 1984, leg. H. Knudsen & T. Læssøe, C 513 (HK & TL-103); Narssarssuaq mellemlandet, scattered in clones of *Dryas*, 61°10'N, 45°25'W, alt. c. 200 m, 6 Aug 1984, leg. H. Knudsen & T. Læssøe, C 512 (HK & TL 456); Prøven, 72°23'N, 55°35'W, 1 Aug 1971, leg. M. Lange, C 517 (ML.P.71-5); Qaanaaq mires NW of town, in mire, on dead parts of *Dryas*, 77°28'N, 69°17'W, alt. 0-100 m, 4 Aug 1988, leg. S. A. Elborne, C 1417 (SAE-88, 98-GR); Qaanaaq mires SE of town, in damp moss attached to buried woody sticks, apparently no *Dryas* nearby, in mire, 77°28'N, 69°12'W, alt. 10 m, 8 Aug 1988, leg. S. A. Elborne, C 1453 (SAE-88, 142-GR); Qaanaaq, Thule på *Dryas*, 77°28'N, 69°14'W, 7 Aug 1987, leg. H. Dissing, C 522 (HD 87.50);

Søndre Strømfjord, Hassell Fjeld, on *Dryas*, 67°01'N, 50°45'W, 22 Aug 1946, leg. M. Lange, C 4097 (ML 46.358) (Lange 1955); Søndre Strømfjord, Hassell Fjeld, on *Vaccinium uliginosum* in heath bog, 67°01'N, 50°45'W, 4 Aug 1946, leg. M. Lange, C 4098 (ML 46.217) (Lange 1955); Søndre Strømfjord, Nakajanga Umivit, on *Dryas*, 66°54'N, 50°57'W, 21 Aug 1946, leg. T. W. Böcher, C 4100 (ML 46.342a) (Lange 1955); Søndre Strømfjord, Store Saltsø, , on dead *Dryas*, 66°59'N, 50°36'W, 15 Aug 1946, leg. M. Lange, C 4099 (ML 46.296) (Lange 1955); Svartenhavn, 70°40'N, 55°35'W, 14 Aug 1972, leg. P. M. Petersen, C 521 (PMP 72.302); Zackenberg, Aucella Mountain, on rotting *Dryas* in moist *Vaccinium* heath, on *Dryas*, 74°30'N, alt. 100-200 m, 20 Aug 2006, leg. T. Borgen, KRAM F-48437 (TB 06.239); **FINLAND: Enontekiön Lappi**, Enontekiö, Kilpisjärvi, Saanan, SW-rinteellä pahdan alla *Dryas*-patjoissa monin paikoin, *Dryas*, 69°02'N, 20°50'E, alt. ca. 800 m, 24 Sep 1966, leg. T. Ulvinen, F 16565, F 16564, L 794228 (Ex herb. Univ. Oulensis), H 6007665 (Ex herb. Univ. Oulensis) (Antonín and Noordeloos 1993); Enontekiö, Kilpisjärvi, Saana, SW slope above tree line, between Retkeilykeskus (Camping centre) and Biological Station, *Dryas* heath, on old stems of *Dryas octopetala*, 69°02'N, 20°49'E, alt. about 650 m, 22 Aug 1984, leg. K. Metsänheimo, F 16562; Enontekiö, Kilpisjärvi, Saanan, SW-pahdan juurella, Dryaksen varella, 69°02'N, 20°49'E, alt. 700 m, 19 Aug 1987, leg. R. Virtanen, F 16561; Kilpisjärvi, Pikku-Malla, NE-slope, limestone cliff, on old *Dryas* stems, 69°03'N, 20°45'E, 7 Aug 1985, leg. O. Skifte, F 16563; **FRANCE: Hautes-Pyrénées**, Bagnères-de-Bigorre, Coume du Pic du Midi de Bigore, *Oxytropido-Elynion*, on *Dryas octopetala*, alt. 2330 m, 16 Aug 2006, leg. G. Corriol, C. Hannoire, F. Trouillard (GC 06081613) (Corriol 2008); **Haute-Savoie**, La Clusaz, Fr. - 74, alt. 1400 m, 29 Aug 1999, leg. O. Röllin, G, 119685 (OR99-62); mt. Saxonnex, on slope of Le Bargy above Morsulaz, on old stems of *Dryas octopetala*, alt. ca. 1400 m, 2 Sep 1986, leg. E. C. Vellinga, L 54179 (ECV961) (Antonín and Noordeloos 1993); **Savoie**, Beaufort, Col du Joly, *Dryas* sur dolomite, alt. 1950 m, 27 Aug 2008, leg. P.-A. Moreau, KRAM F-47117; Bellecombe de Permignon à Leisse, alt. 2300 m, 23 Aug 1970, leg. R. Kühner, G 110633 (G-K19931) (Antonín and Noordeloos 1993); Col du Joly, 28 Aug 1986, leg. M. Bon, LIP; environs de Bozel, Au-dessus de Premeruet, près de Moutiers-Salins, dans les touffes de *Dryas octopetala*, 1 Sep 19??, leg. R. Kühner, G 110628 (8-70) – HOLOTYPE (Kühner 1936, Ronikier 2009); Petit Mont-Cenis, Dryades, 31 Aug 1986, leg. M. Bon, LIP; Pralognan, Bois de la Rossa, Un exeplaire 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, Entre Arcellin et Assiettes, 22 Aug 1961, leg. R. Kühner, G 110637 (Pralo 61; G-K19935) (Antonín and Noordeloos 1993); Région de Pralognan, Juste sous le Pas d l'Âne, sur les couches de *Dryas*, 26 Aug 1965, leg. R. Kühner, G 110632 (Pralo 65, G-K19930); Région de Pralognan, Pas d l'Âne, 26 Aug 1965, leg. R. Kühner, G 110629 (Pralo 65; G-K19927) (Antonín and Noordeloos 1993); Région de Pralognan, Sentier forestier pour Mont Blanc, 25 Aug 1965, leg. R. Kühner, G 110636 (Pralo 65; G-K19934) (Antonín and Noordeloos 1993); South of Lanslebourg, 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, alt. 1850 m, Aug 1959, leg. P. Heinemann, BR (2780) (Antonín and Noordeloos 1993); Val d'Isere, from Pont St. Charles at foot of Galise glacier, on *Dryas octopetala*, 31 Aug 1992, leg. M. Moser, VPI-VTMH 3652 (OKM 25425); Val d'Isère, Sentier de Malpasset, un exemplaire sur *Dryas*, alt. 2250 m, 15 Aug 1970, leg. R. Kühner, G 110631 (G-K19929) (Antonín and Noordeloos 1993); **ICELAND: Árnessýsla**, Hlíð Hrunamannahreppi mólendi á dauðu rjúpnalaufi, *Dryas*, rjúpnalauf, dautt, 64.261° N, 20.166°W, alt. 130-150 m, 30 Aug 1981, leg. G. Guðríður Eyjólfsdóttir, AMNH–44760, FA-15173; Hveragerði, *Dryas*, 63.999°N, 21.189°W, alt. 80-

160 m, 7 Aug 1959, leg. M. Lange, AMNH-45598, FA-16023 (ML425); Þingvellir, *Dryas*, 64.258°N, 21.106°W, alt. 120-140 m, 12 Aug 1959, leg. M. Lange, AMNH-45603, FA-16028 (ML640); Tindar við Hveragerði, Í mólendi, 64.0226°N, 21.1944°W, alt. 60-260 m, 30 Aug 1959, leg. M. Lange, AMNH-45600, FA-16025 (ML684); **Austur-Barðastrandarsýsla**, Króksfjarðarnes, Á *Dryas*mó, 65.4539°N, 21.9279°W, alt. 50-70 m, 1 Sep 1969, leg. H. Hallgímsson, AMNH-39051, FA-05917; **Austur-Húnavatnssýsla**, Gautsdalur Laxárdal, Á rjúpnalaufi, rjúpnalaufi, 65.5759°N, 19.878°W, alt. 200-300 m, 21 Jul 1969, leg. H. Hallgímsson, AMNH-38904, FA-05725; **Eyjafjarðarsýsla**, Glerárdalur, við vatnsbólin, Í *Dryas* mó og á mosa, 65.638°N, 18.228°W, alt. 400-450 m, 11 Sep 1968, leg. H. Hallgímsson, AMNH-38617, FA-05255; Glerárdalur, við vatnsbólin, Í *Dryas* mó auk fleiri tegunda, í mosa, 65.638°N, 18.228°W, alt. 400 m, 11 Sep 1968, leg. H. Hallgímsson, AMNH-38618, FA-05256; alt. 500-550 m, 11 Sep 1968, leg. H. Hallgímsson, AMNH-38636, FA-05297; Gnúpufell, skógræktarreitur mólendi í skógarreit með rjúpnalaufi, rjúpnalauf, 65.4308°N, 18.2029°W, alt. 70-80 m, 18 Sep 1999, leg. G. Guðríður Eyjólfsdóttir, AMNH-44959, FA-15379; Grund Svarfaðardal, Í mosa á *Dryas*, rjúpnalauf, 65.907°N, 18.5909°W, alt. 200-300 m, 3 Oct 1971, leg. H. Hallgímsson, AMNH-40331, FA-07682; Hlíðarfjall við Akureyri melur, 65.658°N, 18.201°W, alt. 650 m, 21 Aug 1962, leg. H. Hallgímsson, AMNH-470, FA-01516; Hlíðarfjall við Akureyri, Í mosa á *Dryas* mó, 65.658°N, 18.201°W, alt. 500-650 m, 24 Aug 1983, leg. H. Hallgímsson, AMNH-41563, FA-09253; Hóll Upsaströnd, Í *Dryas* og krækilyngs mó í graslendi, 65.987°N, 18.534°W, alt. 50 m, 20 Sep 1968, leg. H. Hallgímsson, AMNH-38749, FA-05434; Kjarnaskógur, SA-hluti lerkilundur, Í lerkilundi á dauðu rjúpnalaufi undir barrnálabreiðu, rjúpnalauf, dautt, 65.6435°N, 18.0811°W, alt. 30-35 m, 15 Aug 2006, leg. G. Guðríður Eyjólfsdóttir, AMNH-180759, FA-18716; Kotárborgir Akureyri, Í *Dryas* mó og á mosa, 65.683°N, 18.11°W, alt. 40-60 m, 29 Sep 1984, leg. H. Hallgímsson, AMNH-41850, FA-09581; möðruvallafjall Eyjarðarsveit, Í mólendi, 65.472°N, 18.1°W, alt. 100-600 m, 9 Aug 1961, leg. H. Hallgímsson, AMNH-36947, FA-00027; myrkárdalur Hörgárdal, Í mólendi, 65.63°N, 18.613°W, alt. 500 m, 8 Sep 1966, leg. H. Hallgímsson, AMNH-38340, FA-04001; Vaglaskógur Þelamörk mólendi í blandskógi, rjúpnalauf, 65.721°N, 18.3029°W, alt. 90-100 m, 27 Aug 1994, leg. G. Guðríður Eyjólfsdóttir, AMNH-47414, FA-13624; Vík Árskógsströnd, Í mólendi á *Dryas*, holtasóley, jarðstönglar, 65.91°N, 18.2889°W, alt. 10-40 m, 26 Sep 1969, leg. H. Hallgímsson, AMNH-43831, FA-14233; Víkurbakki Árskógsströnd, Í *Dryas* og krækilyngs mó, stönglar, 65.905°N, 18.28°W, alt. 50 m, 20 Sep 1968, leg. H. Hallgímsson, AMNH-38751, FA-05436; **Mýrasýsla**, Hredavatn, alt. m, 17 Aug 1984, leg. S. A. Elborne, C 24787 (SAE-118-ISL); **Norður-Múlasýsla**, Droplaugarstaðir Fljótsdal, Í rjúpnalaufsmóa, rjúpnalauf, 65.146°N, 14.7329°W, alt. 200-400 m, 3 Sep 1961, leg. H. Hallgímsson, AMNH-37279, FA-00713; Droplaugarstaðir Fljótsdal, Í *Dryas* mó, 65.146°N, 14.7329°W, alt. 150-200 m, 3 Sep 1985, leg. H. Hallgímsson, AMNH-42336, FA-10109; Droplaugarstaðir Fljótsdal, Í djúpum mosa í lerkilundi með strjálu grasi, 65.146°N, 14.7329°W, alt. 70 m, 08 Sep 1987, leg. H. Hallgímsson, AMNH-43220, FA-11524; Droplaugarstaðir Fljótsdal, Gilið, Á *Dryas*, stönglar, 65.146°N, 14.7329°W, alt. 80-200 m, 12 Sep 1970, leg. H. Hallgímsson, AMNH-39859, FA-06952; Í grámosa, alt. 80-200 m, 12 Sep 1970, leg. H. Hallgímsson, AMNH-46174, FA-16602, 6956; Hengifossá, Í *Dryas*-móa, holtasóley, 65.0759°N, 14.8789°W, alt. 140 m, 6 Aug 1993, leg. G. Guðríður Eyjólfsdóttir, AMNH-44536, FA-14941; Hrafnsgerði Fellum Héraði, Í árgili, 65.153°N, 14.7189°W, alt. 80-120 m, 14 Sep 1985, leg. H. Hallgímsson, AMNH-42441, FA-10240; Setberg Fellum Héraði, Á *Dryas* jarðstönglum, *Dryas* jarðstönglar, 65.258°N, 14.5019°W, alt. 50-100 m, 27 Sep 1987, leg. H. Hallgímsson, AMNH-43309, FA-11631; **Skagafjarðarsýsla**, Víðines Hjaltadal, Áreyrar,

65.743°N, 19.1369°W, alt. 120 m, 20 Jul 1972, leg. H. Hallgímsson, AMNH-40681, FA-08124; **Suður-Múlasýsla**, Egilsstaðaklettar Egilsstöðum, Á *Dryas* þúfu með mosa og fleiru, 65.267°N, 14.416°W, alt. 20-50 m, 29 Jul 1987, leg. H. Hallgímsson, AMNH-42882, FA-11120; Hallormsstadir, 8 Aug 1984, leg. S. A. Elborne, C 24747 (SAE-037-ISL); Hengifossargil, basaltformasjon, fjellhei med. *Dryas*, på *Dryas*, 6 Aug 1993, leg. G. Gulden, O 71748 (202/93); Hesthals Breiðdal, Á mel, 64.895°N, 14.5539°W, alt. 150-200 m, 4 Sep 1970, leg. H. Hallgímsson, AMNH-39613, FA-06635; **Suður-Þingeyjarsýsla**, Skútustaður in Mývatnsveit, on *Dryas octopetala*, 25 Aug 1980, leg. K. Høiland, O 370303; Svínárnes Látraströnd, Á *Dryas*, 65.997°N, 18.2549°W, alt. 600 m, 29 Jun 1963, leg. H. Hallgímsson, AMNH-38339, FA-04000; Vaðlaheiði, Radarstöðin mólendi, 65.66°N, 18.0009°W, alt. 600 m, 26 Aug 1962, leg. H. Hallgímsson, AMNH-37451, FA-10605; **Vestur-Húnavatnssýsla**, Tannstaðir Hrútafirði, Á *Dryas*, 65.285°N, 21.0839°W, alt. 100 m, 31 Aug 1969, leg. H. Hallgímsson, AMNH-39488, FA-06423; **ITALY: Piemonte**, Vallée d'Aoste, Col du Petit St. Bernard, versant italien, pelouse pâturée, dans *Dryas*, 20 Aug 1970, leg. R. Kühner, G 110634 (G-K19932) (Antonín and Noordeloos 1993); **MACEDONIA: Tetovo,** Šar-Planina Mts., N-E slopes of Ceripašina Mt., high mountain shrubland with *Dryas octopetala*, *Juniperus nana*, *Vaccinium* vitis-idea and *V. gaultherioides*, on dead stems of *Dryas octopetala*, 42°01'26"N, 20°51'47"E, alt. 2020 m, 17 Aug 2009, leg. A. Ronikier, M. Ronikier, KRAM F-48022 (Ronikier and Ronikier, in press); **MONTENEGRO: Andrijevica**, Komovi Mts., N slopes of Kom Vasojevički, high mountain meadow with *Dryas octopetala*, on dead stems of *Dryas octopetala*, 42°41'50"N, 19°40'27"E, alt. 1900 m, 12 Aug 2009, leg. A. Ronikier, M. Ronikier, KRAM F-48020 (Ronikier and Ronikier, in press); Komovi Mts., N-E slopes of Kom Kučki, high mountain meadow with *Dryas octopetala*, on dead stems of *Dryas octopetala*, 42°40'34"N, 19°38'57"E, alt. 2130 m, 13 Aug 2009, leg. A. Ronikier, M. Ronikier, KRAM F-48023 (Ronikier and Ronikier, in press); Komovi Mts., summit area of Kom Vasojevički, high mountain meadow with *Dryas octopetala*, on dead stems of *Dryas octopetala*, 42°41'15,8"N, 19°40'01"E, alt. 2460 m, 12 Aug 2009, leg. A. Ronikier, M. Ronikier, KRAM F-48021 (Ronikier and Ronikier, in press); **NORWAY: Finnmark**, Alta, 19 Aug 1982, leg. O. Skifte, TROM 9174; Alta, N for utløpet av Mazeniasjokka, kalkberg ovenf. utløpet, på *Dryas*,alt. 307 m, 23 Aug 1982, leg. O. Skifte, TROM 9946 (139/82); Båtsfjord, Båtsfjord, 25 Aug 1961, leg. F.-E. Eckblad, TROM 33380, TROM 33381 (Skifte 1996); Båtsfjord, Båtsfjord, Y Allosjokka, 28 Jul 1961, leg. F.-E. Eckblad, TROM 33379 (Skifte 1996); Båtsfjord, Syltefjord, Skogdalen, UTM: PU 00,26, på *Dryas*, 18 Aug 1981, leg. L. Mølster, O. Skifte, V. Wader, TROM 2804 (Skifte 1996); Kautokeino mazeniilasjåkka, 2-300 m frå utløpet Vir'dnejav'ri, UTM FC 007,202, på *Dryas* i trong kalksteinskløft, alt. 270-275 m, 24 Aug 1982, leg. O. Skifte, A. Elvebakk, TROM 33382 (83:1966) (Skifte 1996); Kautokeino, Virdegvoi'ka S-side av elveutløpet, kalkholdig grunn, alt. 262 m, 24 Aug 1982, leg. O. Skifte, TROM 8192, TROM 8193; Porsanger, Hestnes, bortenfor neset, i tett *Dryas*-samfunn, 3 Sep 1969, leg. H. Mehus, TROM 33383 (Skifte 1996); Tana herred, Austertana, Sörlia, NE sidde of Klokkefjellet, S of the Danerelven, half-open schist gravel field among trees in subalpine birch forest, on fjeldslope, in tussock of *Dryas octopetala*, ok. 70°29'N, ok. 28°25'E, 13 Sep 1972, leg. M. Ohenoja, F 16550 (1972/29); Vardø, Persfjord, like E for Vesterelva, 1 km fra stranda, N-skråning av høyde 78 m i *Dryas*, *Dryas*, 08 Aug 1967, leg. O. Skifte, O. Stellander, TROM 33384 (OS 313/67) (Skifte 1996); Vardø, Persfjorden UTM VD 15,15, *Dryas octopetala*, 23 Aug 2002, leg. L. Ryvarden, O 290025 (44985), Vardø hd, Krognes, *Dryas octopetala*, wood, 27 Aug 1986, leg. K. Holm, L. Holm, UPS (F-180178) 505897; **Hedmark**, Grimsdalen, near "Verkensseter", in large tussock of *Dryas*s *octopetala* along footpath through subalpine

grass-heath, 12 Aug 1985, leg. E. Arnolds, L 794232 (5476); **Hordaland**, Finse, below Sanddalsnuten, in dying bed of *Dryas octopetala*, 13 Aug 1985, leg. R. Watling, E 297144 (Wat. herb. 18229); Finse, between Jomfrunuten and Sanddalsnuten, on *Dryas octopetala*, 13 Aug 1985, leg. R. Watling, E 297145 (Wat. herb. 18264); Hardanger Vidda, Finse, 08-1985, leg. M. E. Noordeloos, L 794230; Finse Sandalsnut montaan i groeiend op *Dryas octopetala*, 13 Aug 1985, leg. A. E. Jansen, L 794233 (AEJ 935); Ulvik, Finse, Jomfrunut, , *Dryas octopetala*, 20 Aug 1962, leg. F.-E. Eckblad, O 74217 (Gulden 2005); Ulvik, Finse, on slope of Sanddalsnut, on stems of *Dryas octopetala*, alt. 1500 m, 12 Aug 2005, leg. A. Ronikier, G. Gulden, KRAM F-48470; Ulvik, Finse, on slope of Sanddalsnut, on dead stems of *Dryas octopetala*,alt. ca. 1450 m, 13 Aug 1985, leg. E. C. Vellinga, L 794231 (ECV770) (Antonín and Noordeloos 1993); Ulvik, Finse, Sandalsnut, 13 Aug 1985, leg. K. M. Jenssen, O 74222; Ulvik, Finse, Sandalsnut, Dryadion, 5 Sep 1978, leg. G. Gulden, O 74218 (220/78) (Gulden et al. 1985, Gulden 2005); Ulvik, Finse, Sandalsnut, plot GG1 UTM_{ED50} MN 190, 209, *Dryadion*, *Dryas octopetala*, alt. 1460 m, 10 Aug 1979, leg. G. Gulden, O 74219 (65/79) (Gulden 2005); Ulvik, Finse, Sandalsnut, plot GG1 UTM_{ED50} MN 190, 209, *Dryadion*, *Dryas octopetala*, alt. 1460 m, 7 Sep 1980, leg. G. Gulden, O 74220 (508/80) (Gulden 2005); Ulvik, Finse, Sandalsnut, S-side, UTM_{WGS84} (MN 190-198, 207-212), *Dryas octopetala*,alt. 1350 m, 16 Sep 1972, leg. R. Elven, O 74221; Ulvik, Finse, S-slope of Sandalsnuten, *Dryas octopetala*-heath, 60°40'N, 07°30'E, 13 Aug 1985, leg. E. Bendiksen, K. Metsänheimo, F 16558; Ulvik, N-Finse, kalkreiche gneisschiefer, dryasreiche flechtenheide, *Dryas octopetala*, 60°35'N, 07°30'W, alt. 1450 m, 13 Aug 1985, leg. B. Senn-Irlet (B. Irlet 85/87) (Antonín and Noordeloos 1993); **Nordland**, Ballangen, Bukkevatn, Langvatn, gammel *Dryas*, sammen m. Festuca alp. & Carex rup.,alt. 820 m, 13 Aug 1975, leg. O. Skifte, Ø. Normann, TROM 33400 (OS 57/75) (Skifte 1996); Ballangen, Langvatn, NW-bukta, kalkrabb, på gammel *Dryas*, 24 Aug 1970, leg. O. Skifte, H. Mehus, B. M., TROM 33401 (OS 155/70) (Skifte 1996); Narvik, NW-helling av Gautesfjellet, SE for Kjørrisvatn, kalkrabb, på gamle Dryas-greiner, S for vatn 903, alt. 903 m, 16 Aug 1972, leg. O. Skifte, D.-O. Øvstedal, TROM 33399 (OS 71/72) (Skifte 1996); Rana, Dunderlandsdalen, SE of Ørtfjellmoen and Ranenelven, *Dryas octopetala* heath above tree limit, ok. 66°40'N, ok. 14°E, 11 Sep 1976, leg. E. Ohenoja, F 16557 (Sivertsen 1978, Skifte 1996); **Oppland**, Dovre dh.: 1519 III 32V NP 3385, Tverråi i Grimsdalen, på *Dryas*, 13 Aug 1985, leg. J. Stordal, O 504 (24154) (Skifte 1996); Dovre, Grimsdalen ved Tverråa, *Dryas*-mark, noe ovenfor vegen nær Tverråa, UTM_{ED50} NP 34,84, 13 Aug 1985, leg. O. Skifte, TROM 8583 (74/85); Dovre, Grimsdalen, near Grimsa and Grimsdalshytta, *Dryas octopetala*, 11 Jul 1972, leg. G. Gulden, O 74223 (318/72); Lom, Ved Bøvertun, i *Dryas*hei, alt. ca 950 m, 25 Sep 1969, leg. S. Løkken, O 370316 (Skifte 1996); Lom, ved Høyrokampen, i *Dryas*hei, på *Dryas octopetala*, alt. 950 m, 8 Sep 1974, leg. L. Borgen, B. Eidissen, A. Elven, R. Elven, O 370315 (Skifte 1996); mts Jotunheimen, Pente nord du lace de Bovertun,, 05 Aug 1967, leg. R. Kühner, G 110630 (SC 67; G-K19928); Ringebu hd.: mellom Ramshytta og Flåtjömglupm[?] 32V NP 58-60/44-45, på *Dryas octopetala*, alt. 1100 m, 16 Aug 1980, leg. J. Stordal, O 4554 (20837); Ringebu hd.: Ramshytta 1818 III NP 602 451, alt. 1150 m, 17 Sep 1978, leg. J. Stordal, O 18982 (19476) (Skifte 1996); **Sør-Trøndelag**, Oppdal hd.: Hemre Gjevilvasskam midt mellom ovu og rudu Rensbektjern, 1520 III NQ 1456, på *Dryas octopetala*, alt. 1420 m, 13 Aug 1951, leg. J. Stordal, O 19023 (6132); Tydal hd.: 1721 II 33V UK 5489, Sylene, vestsiden av Bandaklumpen, i *Dryas*-område, alt. 1100-1200 m, 21 Aug 1986, leg. J. Stordal, O 298 (25040) (Skifte 1996); **Svalbard**, Isfjorden, Longyearbyen, on *Dryas octopetala*, 78°13'N, 15°40'E, 22 Aug 1966, leg. P. Kallio, E. Kankainen, F 16559 (Ohenoja 1971, Skifte 1996); Kongsfjord district: Blomstrandhalvøya, above "London" in

Peirsonharna, 5 Aug 1986, leg. G. Gulden & K. M. Jenssen, O 370305 (GG/86) (Gulden and Torkelsen 1996, Skifte 1996); Sassenfjorden, Gjelhallet - Gjelrabbane, under W-slope of Coloradofjella, on *Dryas*, 78°N, 20'E, 22 Jul 1981, leg. G. Gulden, O 370306 (157/81) (Gulden and Torkelsen 1996, Skifte 1996); Svalbard and Jan Mayen Islands, Madan, Nanette No. 1 LNP, Record no. 179775, in polar semi-desert vegetation, on dead *Dryas*, 17 Aug 2001, E 159350; Svalbard and Jan Mayen Islands, Madan, Nanette No. 2 HNP, Record no. 179776, in polar semi-desert vegetation in *Dryas*, 17 Aug 2001, E 159349; Svalbard and Jan Mayen Islands, Madan, Nanette No. 21 HNP, Record no. 179782, in polar semi-desert vegetation, on dead *Dryas* stem, 17 Aug 2001, E 159358, Vest-Spitsbergen, Adventsdalen, *Dryas*, 9 Jul 1967, leg. S. Woldmar, UPS (F-180177) 505896; **Troms**, Lyngen heard, Lyngspollen, E-rinne Pollelvan, N-puolella, Jyrkkä sorainen rinneketo keskirinteellä, *Dryas octopetala*, 69°29.5'N, 20°10'44E, 3 Aug 1981, leg. E. Ohenoja, F 16560; Tromsø, Tromsdalen, Dalheim, E-helling av Fløyfjellet, tørr *Dryas*-mark, alt. 500 m, 25 Aug 1965, leg. O. Skifte, M. Lange, TROM 33397 (Lange and Skifte 1967, Skifte 1996); Troms, Guolasjav'ri, Sinaivarri, Kalfjord Herad, N-Norwegen, Äste und Rhizome von *Dryas octopetala*, 13 Aug 1984, leg. M. Moser, IB 1984/0112 (84/112) (Antonín and Noordeloos 1993); Kåfjord, Cearpmotjokka, på *Dryas*-vegetasjon, alt. 200 m, 13 Aug 1994, leg. O. Skifte, TROM 4737 (Skifte 1996); Kåfjord, Guolasjav'ri-omr. ved veg på W-siden av vatnet, UTM_{ED50} EB 0,9, på *Dryas*, 13 Aug 1984, leg. O. Skifte, TROM 8446 (51/84); Kvænangen, Cæbetcærro S, *Dryas*hei like over skoggrensa, 31 Jul 1967, leg. S. Sivertsen, TROM 33387 (Skifte 1996); Kvænangen, Nøklan myrvoll, S-helling av Brennberget, på *Dryas*, 18 Aug 1968, leg. Kurs-Deltaker, TROM 33385 (Skifte 1996); Kvænangen, Skorpa, 3 Aug 1963, leg. O. Skifte, TROM 33386 (2567) (Skifte 1996); Nordreisa, Javreoaivve ved Sappen, on *Dryas octopetala*, 14 Aug 1968, leg. L. Ryvarden, O 370320 (Skifte 1996); Nordreisa, Reisadalen, Sappen, Javreoaive Bhika Hihtama, noe ovenf. skoggrensa, på *Dryas*, 3 Sep 1954, leg. O. Skifte, J. Stordal, TROM 33389 (OS 957) (Skifte 1996); Nordreisa, Reisadalen, Sappen, Javreoaivit Bhika Hihtama, gamle *Dryas*-greiner, åpen sandig rasmark, alt. 520 m, 15 Sep 1968, leg. O. Skifte, M. Elvestad, H. Mehus, H. Sætra, TROM 33390 (OS 294/68) (Skifte 1996); Nordreisa, Reisadalen, Sappen, Javreoaivit Bhika Hihtama, NE-helling mot dalen, skifrig grunn, 15 Sep 1968, leg. O. Skifte, M. Elvestad, H. Mehus, H. Sætra, TROM 33391 (OS 292/68) (Skifte 1996); Nordreisa, Reisadalen, Sappen, Javreoaivit Bhika Hihtama, spredt over høydeintervall,alt. 550-700 m, 15 Sep 1968, leg. O. Skifte, M. Elvestad, H. Mehus, H. Sætra, TROM 33393 (OS 293/68), TROM 33392 (OS 293/68) (Skifte 1996); Nordreisa, Storslett-Sørkjosen, N for Sagelva, Sagåsen, skifrig grunn m. *Rhododendron* lapp. på *Dryas*-grein, 14 Sep 1968, leg. O. Skifte, H. Mehus, H. Sætra, TROM 33388 (OS 291/68) (Skifte 1996); Tromsø, Breivikeidet, Blånova, S mot Russevankskaret, *Dryas*-hei, 16 Sep 1964, leg. S. Sivertsen, TROM 33477 (Skifte 1996); Tromsø, Breivikeidet, Sandeggen, Solli, 1.5 km S for Skittenelvvatn, SW helling, *Dryas*-hei, 21 Sep 1965, leg. O. Skifte, S. Sivertsen, TROM 33394 (OS 331/65) (Skifte 1996); Tromsø, Russevankskaret, Blånova, på fuktig, skifrig berghylle *Dryas*grein, fuktig og gammel, 21 Sep 1965, leg. O. Skifte, S. Sivertsen, TROM 33395 (OS 341/65) (Skifte 1996); Tromsø, Russevankskaret, Blånova, *Dryas*vegetatsjon, noe fuktig, 2 Oct 1963, leg. O. Skifte, S. Sivertsen, TROM 33396 (OS 3213) (Skifte 1996); Tromsø, Tromsdalen, Fløyfjellet, på *Dryas*, alt. 525 m, 31 Aug 1969, leg. O. Skifte, T. Gjeldsen, Jevningen, TROM 33398 (OS 113/69) (Skifte 1996); **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; **RUSSIA: Chukotsky avtonomny okrug**, О-в Врангеля, район бух. Сомнительной, на мертвых веточках *Dryas*, 29 Jul 1966, leg. В. Ф. Шамурин, LE 7656 (Karatygin et al. 1999); **Respublika Altay**, Aktash, Ulagan-road, 22 km N of the town and S of the pass, 50°30'N, 87°39'E, alt. 2060 m, 23 Aug 2001, leg. H. Knudsen, C 60005 (HK 01.80); Чуйские Альпу (северо-вост. часть передней цели), in regione subalpina et in tundra alpina, ad folia *Dryadis octopetalae*, alt. 2250-2500 m, 10 Aug 1937, leg. R. Singer, LE 7659 (695) (Singer 1943); **Respublika Sakha (Yakutiya)**, Sakha, Bulunskiy Ulus, Tiksi, SE of the town mossy tundra heath on middle NW slope, on *Dryas octopetala*, 71°38'N, 128°52'E, 10 Aug 1999, leg. E. Ohenoja, F 50457 (1999/31); Устье р. Лены, Остров Тит-Ары, на сухом *Dryas punctata*,03 Aug 1955, В. В. Василькова, LE 7655 (Karatygin et al. 1999); **Respublika Buryatiya**, Баргузинский Хребей, в исроке р. Таркулик, на склоне кара, ивово-дриадовая тундра, на веточках и листьях *Dryas*, 25 Aug 1969, leg. Э. Л. Нездойминого, LE 7660 (Niezdoiminogo 1971); **Taymyrsky (Dolgano-Nenetsky) avtonomny okrug**, Lukunskij forest reserve, NE Khatanga, 72°30'N, 104°E, 23 Aug 1993 leg. M. Nissen, C 60412 (HK 93.129); Taimyr, river Kotuykan, where it joins river Kotuy, 70°37'N, 103°28'E, 19 Aug 1993, leg. S.-Å. Hansson, C 60337 (HK 93.054); Taimyr, river Kotuykan, where it joins river Kotuy, 70°37'N, 103°28'E, 19 Aug 1993, leg. H. Knudsen, C 60319 (HK 93.036); С. Таймыр, оз. Левинсон-Лессинга, долина ручья Врезанного, разнотравно-мохово-лишайниково-кустарничковая бугорковатая тундра, 74°30'N, 98°33'E, 22 Aug 1994, leg. М. П. Журбенко, LE 199817, LE 199820 (Karatygin et al. 1999, Niezoimonogo and Zhurbenko 1996); С. Таймыр, Таймырский зап-к, оз. Левинсон-Лессинга, усте р. Красной, разнотравно-мохово-лишайниково-кустарничковая бугорковатая тундра, 74°33'N, 27 Aug 1994, leg. М. П. Журбенко, LE 199818 (Karatygin et al. 1999, Niezoimonogo and Zhurbenko 1996); С. Таймыр, Таймырский зап-к, оз. Левинсон-Лессинга, усте р. Красной, разнотравно-мохово-лишайниково-кустарничковая бугорковатая тундра, 74°35'N, alt. 200 m, 10 Aug 1994, leg. М. П. Журбенко, LE 199819 (Karatygin et al. 1999, Niezoimonogo and Zhurbenko 1996); **Yamalo-Nenetsky Avtonomny Okrug**, N-Urals, Tjumenskaja oblast, Jangana, in calcareous tundra with *Dryas*, 26 Aug 1996, leg. H. Knudsen, C 36032 (HK 96.59) (Knudsen and Mukhin 1998); Polar Ural Mts., 104 km railway station, on stem of *Dryas octopetala*, 25 Aug 1996, leg. A. Chlebicki, KRAM F-47360; Polar Ural Mts. mt. Raiz, near meteorological station, on stem of *Dryas octopetala*, 12 Aug 1996, leg. A. Chlebicki, KRAM F-47359; , Polar Ural, Slantsevaya Mtn., Western Sibiria, Russia, *Dryas octopetala*, 24 Aug 1996, leg. U. Peintner, IB 1996/0744 (96/744); Tjumenskaja, northern Urals, Krasnij Chanmei, c. 40 km NW of Labytnangi, in tundra above timberline, 66°33'N, 65°00'E, alt. 3-500 m, 16 Aug 1990, leg. H. Knudsen, C 16615 (HK 90.396) (Knudsen and Mukhin 1998); Tumen Region, Yamalo-Nenetsia, Polar Ural mountains, E of the railroad stop Krasni Kamen, W slope of Slantzevaya, forest limit with Tofieldia, Salix reticulata, on *Dryas octopetala*, ok. 66°59'N, ok. 65°30'E, 18 Aug 1996, leg. E. Ohenoja, F 31453; Yamal Peninsula, Yangane-Pe, near calcareous rock, on stem of *Dryas octopetala*, 25 Aug 1996, leg. A. Chlebicki, KRAM F-47361; Полярный Урал, долина р. Собь, горная каменистая тундра, среди мхов и *Dryas*, 12 Aug 1962, leg. Э. Л. Нездойминого, LE 7658 (Karatygin et al. 1999); Полярный Урал, долина р. Собь, вершина горы у Краеного камня, 13 Aug 1962, leg. Э. Л. Нездойминого, LE 7657 (Karatygin et al. 1999); **SPAIN: Huesca**, Bielsa, Pala de Montinier, sobre *Dryas octopetala*, 28 Aug 1996, leg. F. Arenal, F. Esteve-Raventós, E. Horak, AH 21608 (Esteve-Raventós et al. 1997); Bielsa, Sierra del

Revilla, Valle de Pineta, Pass between Mayo Gran and Mayo Pequeño, dolomit, on rotting roots of *Dryas octopetala*, alt. 2050 m, 28 Aug 1996, leg. E. Horak, ZT 5867; Torla, P. N. Ordesa, Bajada de Punta Acuta a Calcilarruego, UTM: 307-0741 4725, sobre *Dryas octopetala*, 29 Aug 1996, leg. F. Arenal, F. Esteve-Raventós, V. Gonzales, AH 21609 (Esteve-Raventós et al. 1997); **SWEDEN: Härjedalen**, Tännäs par., Hamrafjället, Grid: 694384:131814, Dryashed, 18 Aug 2006, leg. S. Jacobsson, UPS (F-124545) 393691 (Tedebrand 2007a, 2007b); Hamra, *Dryas octopetala*, 18 Aug 2006, leg. P.-A. Moreau (no voucher specimen preserved, ITS sequence obtained; A. Ronikier & M. Ronikier, unpubl. data); **Torne Lappmark**, Abisko-Björkliden, unterhalb Rakaslako Norrbotten, Schweden, an moderigen *Dryas*-Resten, alt. 900 m, 24 Aug 1981, leg. M. Moser, IB 1981/0275 (81/275) (Antonín and Noordeloos 1993); Kiruna (formerly Jukkasjärvi parish), Abisko, towards "Marmorbrottet", in *Dryas*-heath on dolomite, on *Dryas*, 30 Aug 1959 & Aug 1962, leg. R. Rydberg, C, K 165410, S 31486 (2863. Fungi exiccati Suecici) (Lundell and Nannfeldt 1979, Antonín and Noordeloos 1993, Skifte 1996); Lappland, Jukkasjärvi s:n, Abisko, i *Dryas*hed, 04 Sep 1953, leg. G. Haglund, S 44216; **SWITZERLAND: Bern**, Gemmi-Spittelmatten, kalkschut, *Dryas* heide, *Dryas octopetala*, 615/144, alt. 1880 m, 5 Sep 1984, leg. B. Senn-Irlet, G 110848 (G-K 18290) (Senn-Irlet 1986); Schynige Platte, Obesberghorn, 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; Albula pass, *Dryas octopetala*, alt. 2300 m, 2 Sep 2006, leg. P.-A. Moreau (no voucher specimen preserved, ITS sequence obtained; A. Ronikier & M. Ronikier, unpubl. data); Alp Murter, Parc National,alt. 2200 m, 26 Aug 1942, leg. J. Favre, G 110850 (24-b; G-K 14021) (Antonín and Noordeloos 1993); Alp Trida, alpine slope, on ? *Dryas*, alt. 2270 m, 28 Aug 1984, leg. S. A. Redhead, DAOM 198485 (SAR 5072); Astras Dadaint, Val Scarl, alt. 2160 m, 20 Aug 1948, leg. J. Favre, G 110850 (24-1; G-K 14022) (Antonín and Noordeloos 1993); Boren Arosa, op *Dryas*, alt. ca. 2400 m, 11 Sep 1968, leg. H. S. C. Huijsman, L 794234 (Antonín and Noordeloos 1993); E of Swis 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; from Ofenpass towards Murtaröl, alt. 2400 m, 3 Sep 1979, leg. H. Dissing, C (Sch 79.108) (Antonín and Noordeloos 1993); Mount la Schera, pr. du Fuorn, Parc National, alt. 2550 m, 21 Aug 1941, leg. J. Favre, G 110850 (24-a; G-K 14020) (Favre 1955, Antonín and Noordeloos 1993); Sous le Piz del Geier, Val Scarl, sur *Dryas*, alt. 2400 m, 15 Aug 1951, leg. J. Favre, G 110850 (24-3; G-K 14024) (Antonín and Noordeloos 1993); Val Nüglia, region du Fuorn, Parc National, sur *Dryas*, alt. 2200-2500 m, 31 Aug 1949, leg. J. Favre, G 110850 (24-2; G-K 14023) (Antonín and Noordeloos 1993); Pass dal Fuorn, the northern slope of Il Jalet, in an open *Pinus mugo* stand with *Dryas octopetala*, alt. 2250 m, 3 Sep 1979, leg. Å. Strid, S 157013 (16141) (Antonín and Noordeloos 1993); Ramosch, Val Sinestra - Praschan, Saumgesellschaften, *Dryas*, alt. 1800 m, 14 Aug 2006, leg. B. Senn-Irlet (B. Irlet 06/114); **Ticino**, Bedretto, Nordhang ob Alpe di Cruina zur Cap. Corno Gries, in grossem Polster von *Dryas octopetala*, alt. 2200 m, 28 Aug 1988, leg. B. Senn-Irlet, G 110847 (Inventar-nr. 12765-12766; G-K18275) (Antonín and Noordeloos 1993); 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); **USA: Alaska**, Demarcation point Quad.: Beaufort Lagoon, Nuvagapak Pt., in disturbed area, on bases of *Dryas integrifolia* and Salix, 69°53'N, 142°18'W, 30 Jul to 1 Aug 1971, B. M.

Murray, VPI (4242) (Miller 1982); Mt McKinley National Park, Wonder Lake, on rotting roots and debris of *Dryas* sp., 25 Aug 1980, leg. E. Horak, ZT 34; Mt. McKinley Nat. Park, in *Dryas*, 25 Aug 1980 m., leg. M. Lange, C 34716; **Colorado**, Southern Rocky Mts., Loveland Pass, alpine, 16 Aug 2001, leg. C. L. Cripps (CLC 1774) (Cripps and Horak 2008); W of Loveland Pass, on rotting stems and among debris of *Dryas octopetala*, alt. 3660 m, 7 Aug 1999, leg. E. Horak, ZT 8066 (Cripps and Horak 2008); **COUNTRY NOT SPECIFIED;** Conches, s/branches de dryas, alt. 1980 m, 19 Aug 1994, G 110849; leg. P. Heinemann, BR (A6683, p[?] 388); WTU F-2810 (Sprague 254), WTU F-2809 (Sprague 260).

Appendix 2. List of published localities of *Marasmius epidryas* which could not be revised based on herbarium materials.

BULGARIA: **Blagoevgrad,** Vihren, 1983, leg. J. Klán, herb. J. Klán (Antonín and Noordeloos 1993); Blagoevgrad**,** Kutelo, 13 Jul 1985, leg. J. Klán, herb. J. Klán (Antonín and Noordeloos 1993); **Kyustendil,** The Seven Rila Lakes area (Gyosheva and Denchev 2000); **CANADA**: **Manitoba,** Fort Churchill, 23 Aug 1974, leg. E. & M. Ohenoja, OULU (1974/32) (Redhead et al. 1982); **North West Territories,** Repulse Bay, W shore of Nauja Fiord, 4 Aug 1974, leg. E. & M. Ohenoja, OULU (1974/144) (Redhead et al. 1982); Dist. Keewatin, Baker L., 14 Aug 1974, leg. E. & M. Ohenoja, OULU (1974/11) (Redhead et al. 1982); N of Black Ice L., Tuktoyaktuk Pen., 21 Jul 1980, leg. D. Lahaie, TRTC (80020H) (Redhead et al. 1982); **DENMARK**, **Greenland,** Loch Fine Fjord (E. Gr. 74°0'N), 74°0'N, 25 Jul 1930, leg. Scholander, (Lange 1955); **FINLAND: Enontekiön Lappi**, Enontekiö, Porojärvi reinbeitedistrikt, ved Somasjärvi finske ødestue, sandskrent ved Valtijoki, nær elva, i *Dryas*-hei, 22 Aug. 1961, leg. S. Sivertsen, nr. 184 (O, TRH) (Skifte 1996); **FRANCE**, **Ariège**, Orlu, Col de Terrès, *Oxytropido-Elynion*, on *Dryas octopetala*, alt. 2450 m, 19 Sep 2003, leg. N. de Munnik (not preserved) (Corriol 2008); **Hautes-Alpes/Isère,** Parc National des Écrins, 1978, leg. D. Lamoure (L. 78-70, L. 78-111) (Lamoure 1982); **Hautes-Pyrénées**, Bagnères-de-Bigorre, Coume du Pic du Midi de Bigore, *Oxytropido-Elynion*, on *Dryas octopetala*, alt. 2300-2350 m, 28 Aug 2003, leg. G. Corriol (not preserved) (Corriol 2008); **Haute-Savoie**, massif des Aravis, La Clusaz, Crêt du Loup et Combe des Juments, au nord du col des Aravis, sous l'Aiguille des Calvaires, entre les combes de Fernuy et Borderan (Alt. 2000-2200 – MEN 3431-B22). Pelouse alpine calcicole à hélianthèmes avec dryades, surtout du côté Borderas (Est) et *Salix retusa*, plus rarement *S. reticulata*, côté Fernuy (Ouest) (Bon 1999); La Balme, sous la gare supérieure du télécabine (Alt. 1600-1800 m = MEN 3430-D44) et au niveau de la dite gare ou un peu au dessus (Alt. 1800-2000 = MEN 3530-C33) + 3531-A11). Dryades et pelouses sur lapiaz (avec quelques pessières de zone subalpine) dans les parties inférieures, combes à *Salix retusa-reticulata* dans la partie supérieure (Bon 1999); Au sud du col des Aravis, nord-ouest de la pointe de Merdassier, au dessus de la gare supérieure du téléphérique de l'Etale (Alt. 2000-2300 m, MEN 3431-B24). Le calcaire y est dominant, comme partout ailleurs (dryadaie et saulaie réticulée), mais il existe quand même quelques combes à neige à *Salix herbacea* (Bon 1999); Du côté opposé du col des Aravis, vers le versant est, la combe de la Croix de Fer, au dessus du «chalet du Curé», fait partie de la commune le La Giettaz (Savoie). Il s'agit d'une petie vallée (1660-1800 m = MRN 3431-B24) avec à la base, ou sur ses versants, plusieurs zones ± subalpines, à aulnes verts, rhododendrons, adénostyles ou pétasites, etc. mais le talweg est vite occupé par un éboulis calcaire avec des plages herbeuses à dryades et *Salix retusa*; plus rarement *Salix reticulata* (Bon 1999); **Savoie,** Tignes, 29 Jul 1968, leg. P. Heinemann, BR 4388 (Antonín and Noordeloos 1993); Entremont-le-Vieux, La Plagne (la carrière), longitude 3,97 gr, latitude 50,495 gr, sur racine affleurante de *Dryas octopetala*, 20 Aug 2002, leg. J.-P. Collin (JPC200802-01); Pralognan, Aug 1987 (Meyer and Bidaud 1988); Pralognan, Aue, 26 Aug 1968, leg. R. Kühner, G – 'Neotype' (Antonín and Noordeloos 1993); Région de Pralognan: Le Moriond, près de la Glière, alt. 2150 m, 20 Aug 1960 (Kühner and Lamoure 1986); Région de Pralognan: Arcellin supérieur, alt. 2300 m, 16 Aug 1963 (Kühner and Lamoure 1986), 23 Aug 1965 (K. 65-103) (Kühner and Lamoure 1986), alt. 2300 à 2400 m, 27 Aug 1983 (Kühner and Lamoure 1986); Région de Pralognan: montée au Cirque du Dard, alt. 2200 m, 9 Sep 1961 (Kühner and Lamoure 1986), alt. 2300 m, 24 Aug 1961 (Kühner and Lamoure 1986); Région de Pralognan: Cirque du Génépy, pierrier sous la moraine, alt. 2300 m, 14 Sep 1969 (Kühner and Lamoure 1986); Région de

Pralognan: La Motte, pierrier sous le Roc de la Pêche, alt. 2100 m, 24 Aug 1961 (Kühner and Lamoure 1986); Région de Pralognan: Pont de la Pêche, alt. 1800 m, 20 Aug 1961 (Kühner and Lamoure 1986); Haute Vallée de Champagny: Moraine de l'Épéna, alt. 2100 m, 16 Aug 1969 (Kühner and Lamoure 1986), 27 Aug 1983 (Kühner and Lamoure 1986), alt. 2200 m, 11 Sep 1975 (Kühner and Lamoure 1986); Haute-Tarentaise: sous les Sources de l'Isère, Prariond, alt. 2300 m, 23 Aug 1982 (L.82-22) (Kühner and Lamoure 1986); Plan de Bellecombe: Lapiaz du Plan, alt. 2400 m, 29 Aug 1982 (Kühner and Lamoure 1986); **ICELAND**: **Vestur-Skaftafellssýsla,** Skaftafell, Sjonarsker, 21 Jul 1988, leg. B. Senn-Irlet, BERN (88.93) (Antonín and Noordeloos 1993); **ITALY**, **Piemonte,** Val d'Olen, verso il Passo Foric, *Dryas, Salix retusa, S. reticulata* (Jamoni 1998, 2006); Conca delle Pisse, *Dryas, Salix reticulata*, 5 Sep 1991, exicc. no 2347 GMFN (969) (Jamoni 1998, 2006); Alpe Zube, (Jamoni 2006); **Valle d'Aosta,** Gabiet (Jamoni 2006); **NORWAY**: **Buskerud,** Hol hd., Ustaoset, Hallingskarvet opp mot Eimeskard, på *Dryas* , ved bekk, 18 Aug 1960, leg. S. Sivertsen, nr. 6 (B, O, TRH) (Skifte 1996) ; Eimeskardal, nær bekk, *Dryas*-matte, 18 Aug 1960, leg. S. Sivertsen (O) (Skifte 1996); **Finmark,** Tanadalen, nord for Leavvjokka, Rastegaissa (Rástigáissa), alpine region, on a dry twig of *Dryas octopetala*, 24 Aug 1964 (Kallio and Kankainen 1964, Skifte 1996); Vassbotndalen, nordhellig av Moal'keluok'ka, knapt 500 m o.h., UTM: EC 62,61, høsten 1995, S. Sivertsen (notat) (Skifte 1996); **Hordaland,** Ulvik, Finse, NE of Kvannjolsnut, on dead and living branches of *Dryas*, 4 Sep 1959, leg. F.-E. Eckblad, O (Eckblad 1960); Ulvik, Finse, Sandalsnutten, on dead branches of *Dryas*, 6 Sep 1959, leg. F.-E. Eckblad, O (Eckblad 1960, Skifte 1996); 1460 m o.h., 5 Aug 1960, leg. F.-E. Eckblad (O) (Skifte 1996); Ulvik, Nordøst for Kvannjolnut, på døde (og levende) *Dryas*-kvister, 9 Sep 1959, leg. F.-E. Eckblad (O) (Skifte 1996); Eidfjord hd., Dyraheiene, Gjerånut, høyde 1351 m o.h., nær toppen i Dryas-hei, 14 Aug 1960, leg. F.-E. Eckblad, S. Sivertsen (TRH) (Skifte 1996); sørlige Gjerånut, på døde *Dryas*-greiner, 13 Aug 1960, leg. F.-E. Eckblad (O) (Skifte 1996); Dyranut, 13 Aug 1960, leg. F.-E. Eckblad (O) (Skifte 1996); **Nordland**, Grane hd., Børgefjell nasjonalpark, nordøst av Jangelvatnet, nær Store Kjukkelen, på *Dryas*, 8 Aug 1970, leg. S. Sivertsen (TRH) (Skifte 1996); Rana hd., Plurdalen, Kalfjellet, like ovanfor skoggrensa, 23 Sep 1979, leg. S. Sivertsen, B.K.P. Sveum, nr. 79-197 (TRH) (Skifte 1996); **Rogaland**, Suldal hd., Grønfjell sør for Krossvatnet, 28 Jul 1969, leg. L. Ryvarden (O) (Skifte 1996); Stranddalsvatn, ca. 1000 m o.h., 21 Jul 1969, leg. L. Ryvarden (Skifte 1996); **Sør-Trøndelag**, Oppdal, vestsida av heimre Gjevilvasskam, 1100-1300 m o.h., 1962, leg. I. Egeland, G. Gulden (O) (Skifte 1996); **Svalbard,** Isfjorden, Kongressdalen, 19 Aug 1966, leg. H. Heikkilä (Ohenoja 1971, Skifte 1996); Braganzatoppen, 19 Aug 1966, leg. E. Kankainen (Ohenoja 1971, Skifte 1996); Kongsfjorden, southeast of NY Ålesund, 24 Aug 1966, leg. H. Heikkilä (Ohenoja 1971, Skifte 1996); Adventfjorden, Hotellneset by Vogts, 18 Sep 1928, Spitsbergenexpedition 1928 (O) (Gulden and Torkelsen 1996, Skifte 1996); Isfjorden, Vestsiden av halvøya mellom Dicksonfjorden og Billefjorden, Kapp Wijk, på *Dryas*, 1960, leg. J. Stordal, nr. 11792 (O) (Skifte 1996); Kapp Wijk (Gulden and Torkelsen 1996); Kapp Wijk, på *Dryas* like ved hytte, 12 Aug 1960, leg. J. Stordal, nr. 11805 (O) (Skifte 1996); St. Jonsfjorden, Nordsiden av den ytre dalen av St. Jonsfjorden, vest for Ankerbreen, 29 Jul 1960, leg. J. Stordal, nr. 11632 (O) (Gulden and Torkelsen 1996, Skifte 1996); Gluudneset (Gulden and Torkelsen 1996); Reinsdyrflya (Gulden and Torkelsen 1996); Bockfjorden (Gulden and Torkelsen 1996) Bockfjorden: vestsiden av fjorden, under Sverrefjellet, 7 Aug 1960, leg. O. Skifte, nr. SB 931 (TROM) (Skifte 1996); botn av Bockfjorden – Trollkildene, 7 Aug 1960, nr. SB 958 (TROM); Woodfjorden, Liefdefjorden: Worsleyhamn, 10 Aug 1960, leg. O. Skifte, nr. SB 977, nr. SB 984 (TROM) (Skifte 1996); mellom Longyearbyen og kullkaia, på

Dryas, 15 Aug 1960, leg. S. stordal, nr. 11831 (O) (Skifte 1996); mellom Longyearbyen og Adventpynten, på *Dryas*, ble sett flere steder, 15 Aug 1960, leg. J. Stordal, O. Skifte, nr. SB 1012 (TROM) (Skifte 1996); Longyearbyen, skifrig grunn ovenfor kaia, 3 Sep 1958, leg. O. Skifte, nr. SB 709, SB 910 (TROM), nr. SB 710 noe lenger ned enn SB 709 (Skifte 1996); Kongsfjorden, 3 km W of Ny-Ålesund, 78°56'00"N, 11°50'00"E, alt. 22 m (Robinson et al. 2001); **Troms,** Kåfjord hd., Kåfjorddalen – Guolasjavri: nord for nedre Ahkkejavrit, forholdsvis fuktig hei, 22 Aug 1961, leg. S. Sivertsen, nr. 180 (TRH, O) (Skifte 1996); Nordeisa hd., Nordeisadalen, Puntadalen, Geatkkutjavri, nord for nerenden av vatnet, *Dryas*-hei, 16 Aug 1961, leg. S. Sivertsen, nr. 292 (TROM) (Skifte 1996); **ROMANIA**: **Dâmboviţa**, Bucegi, La Cerdac, 6 Jul 1987, leg. J. Klán, herb. J. Klán (Antonín and Noordeloos 1993); **SLOVAKIA**: **Spiš**, Belanské Tatry, 1985, leg. J. Klán, herb. J. Klán (Antonín and Noordeloos 1993); **SPAIN**: **Girona**, Queralbs (Ripollès), Vall de Núria, UTM 31T 4304694, alt. 2220, sobre restes vegetals de *Dryas octopetala*, 8 and 16 Aug 1996, leg. J. Vila (JVG960808-3 and JVG960816-12) (Vila et al. 1997, Corriol 2008), 12 Aug 1997, sobre parts mortes de la rosàcia alpina *Dryas octopetala*, que forma gespes baixes (Vila 1998); **Lerida,** Alt Urgell, Coll de Conflent, *Dryas octopetala*, alt. 2150 m, 9 Oct 1994 (JB-1121/94) (Bon and Ballarà 1995); **SWEDEN**: **Torne Lappmark,** Schwedish-Lappland, Abisko, den Wurzekstöcken lebender Dryaspflanzen aufsitzend, 21 Aug 1988 (Ludwig 2001); **SWITZERLAND: Bern,** Berner Oberland, Schynige Platte, Daube, Malmkalk, Blaugrashlade (*Seslerio-Caricetum sempervirentis*), alt. 2060 m, 24 Aug 1984, leg. B. Senn-Irlet, BERN (84.600) (Senn-Irlet 1986, 1988, Antonín and Noordeloos 1993), 12 Aug 1981, 18 Aug 1981, leg. B. Senn-Irlet (Senn-Irlet 1986), 3 Sep 1981, 26 Jul 1982, leg. Senn-Irlet (Senn-Irlet 1986, 1988); Berner Oberland, Kandersteg, 5 Aug 1982, leg. B. Senn-Irlet, BERN (82.101) (Antonín and Noordeloos 1993); Berner Oberland, Adelboden-Engstligenalp, 21 Sep 1986, leg. B. Senn-Irlet, BERN (86.139) (Antonín and Noordeloos 1993); Berner Alpen, Gemmi, Schwarzgrätli, alt. 2380 m, Kalkfelsblock mit *Dryas*-Polster, 14 Sep 1980, leg. B. Senn-Irlet (Senn-Irlet 1986); au bord de la Simme, alt. 1100 m (Favre 1955); aux environs de la Lenk, alt. 1100 m (Favre 1955); **Graubünden,** Flims, Crap Grisch, 17 Aug 1987, leg. B. Senn-Irlet, BERN (87.97) (Antonín and Noordeloos 1993); S-chanf/GR (Val Trupchun), quad. 1679, on dead stems of *Dryas octopetala*, alt. 1700 m, 13 Aug 1989, leg. F. Kränzlin (1308-89 K 1) (Breitenbach and Kränzlin 1991); Fuorn, Munt da la Bescha, alt. up to 2550 m (Favre 1955); val Trupchun, alt. 1700 m, (Favre 1955, 1960); val Torta, alt. 1620 m (Favre 1955, 1960); val Flin, alt. 1600 m (Favre 1955, 1960); Tarasp, alt. 1450 m (Favre 1955, 1960); Gorge de la Clemgia, alt. 1650 m (Favre 1960); **Ticino,** Quinto, 26 Aug 1988, leg. B. Senn-Irlet, BERN (Antonín and Noordeloos 1993); Lepontinishe Alpen, Quinto, Val Piora, Pian Murinasca, Dryasheide, alt. 2040 m, 17 Aug 1982, leg. B. Senn-Irlet (Senn-Irlet 1986); **Waadt/Wallis,** Waadtländer Alpen, Pas de Cheville, Dryasheide, alt. 2050 m, 5 Nov 1982, leg. B. senn-Irlet (Senn-Irlet 1986); **USA: Alaska**, Glacier Bay (Sprague and Lawrence 1960, Redhead 1989).

Erratum: this version of this article was posted February 21, 2011 to correct an error in Figure 1 in the original version published December 22, 2010.