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Ecology and distribution of *Myriosclerotinia caricis-ampullaceae* (Sclerotiniaceae, Ascomycota) in Central Europe with remarks on its world distribution

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Holec J., Kučera T. & Balner V. (2007) Ecology and distribution of *Myriosclerotinia caricis-ampullaceae* (Sclerotiniaceae, Ascomycota) in Central Europe with remarks on world distribution. Sydowia 59 (1): 57–74.

In 1997–2006, the rare ascomycete *Myriosclerotinia caricis-ampullaceae* was found at several new localities in the Czech Republic – in bogs, mires and fens with *Carex rostrata* in the mountains. The vegetation at the localities was exactly phytosociologically described. The data from Central Europe (this study, published data from Austria) showed that the species grows in fringes of permanently wet ombrotrophic or alluvial sites, in raised bogs formed by terrestrialization, and/or sloping mires formed by paludification. It prefers oligotrophic or mesothrophic stands with rather deep *Sphagnum* peat and a high amount of water. The vegetation can be classified as the associations *Carici rostratae-Sphagnetum apiculati*, *Caricetum rostratae* and *Caricetum lasiocarpae*. The European and world distribution is commented. The species is not a subarctic or boreal-alpine element as previously published but has boreo-montane preferences. Its apothecia appear almost exclusively in June, rarely in May.

Keywords: ascomycetes, mycogeography, vegetation, mountains, raised-bogs

Myriosclerotinia caricis-ampullaceae (Nyberg) N. F. Buchw. is a very interesting ascomycete, remarkable in several aspects – appearance (apothecia with very long stems protruding from long sclerotia), ecology (saproparasite on shoots and rhizomes of several *Carex* species growing in *Sphagnum* stands), fructification (spring and early summer) and distribution pattern (mostly cold localities: mountains or boreal areas of Northern Hemisphere). These aspects were best described by Whetzel & Solheim (1943), Whetzel (1946), Schumacher & Kohn (1985), Palmer (1988) and Krisai-Greilhuber (1996). The phylogeny of *Myriosclerotinia* was studied by Holst-Jensen *et al.* (1998) using ITS DNA sequences based on collections from Canada. The authors showed that the genus *Myriosclerotinia*, as currently conceived, is monophyletic.

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In Central Europe, records of *M. caricis-ampullaceae* were published from the Czech Republic by Pilát (1953), Tondl (1992) and Holec & Pouzar (1998) and from Austria by Krisai-Greilhuber (1996). In the past years, the first and third authors found this rare fungus in other localities in the Czech Republic. The aim of this paper is (i) to summarise all data on its occurrence in the Czech Republic, (ii) exactly characterise the habitats of all recent records from this country, (iii) evaluate the ecology and distribution of *M. caricis-ampullaceae* in Central Europe (with respect to its world distribution) and (iv) discuss the view that the species is a subarctic or boreal-alpine element.

Materials and Methods

Myriosclerotinia caricis-ampullaceae was intensively searched for in several mountain areas of the Czech Republic (Šumava Mts.: 1997–2006, Jizerské hory Mts.: 2006, Hrubý Jeseník Mts.: 2004–2006). All records were documented by voucher specimens, which are deposited in herbaria PRM and OP. If it was found at several sites within one locality, the sites were called microlocalities and were evaluated separately.

The habitat of all localities and microlocalities was characterised by means of phytosociological relevés. The relevés were made directly at the sites where *Myriosclerotinia* was found, mostly the same year, in one case one year later. The relevés were made according to the Braun-Blanquet phytosociological method (Braun-Blanquet 1932). The cover was estimated using the extended Braun-Blanquet scale: r (rare), + (less than 1 % cover), 1 (2 – 4 %), 2m (5 %), 2a (6 – 15 %), 2b (16 – 25 %), 3 (26 – 50 %), 4 (51 – 75 %), 5 (76 – 100 %). Nomenclature of vascular plants follows Kubát et al. (2002). Mire classification and English terminology follows Ellenberg (1988).

Conclusions on habitat preferences of *M. caricis-ampullaceae* are based especially on the results presented here (i. e. on rich data from the Czech Republic supported by a phytosociological analysis) and those published by Krisai-Greilhuber (1996) from Austria which are also supplied with exact phytosociological data. Data on its ecology from other European countries and North America are not so detailed. Consequently, the evaluation of its ecology is focused especially on Central Europe. However, data from other countries are taken into consideration, too.

Abbreviations: all.: phytosociological alliance, alt.: altitude, ass.: phytosociological association, CR: Czech Republic, JH: number of collection by Jan Holec, MTB: grid of Central European mapping system, VB: number of collection by Vít Balner.

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Results

Myriosclerotinia caricis-ampullaceae (Nyberg) N. F. Buchw., Friesia 3: 301, 1947.

≡ *Sclerotinia caricis-ampullaceae* Nyberg, Mem. Soc. Fauna Fl. Fenn. 10: 22, 1933.

Descriptions. – Whetzel & Solheim (1943: 392–396), Whetzel (1946: 407–408), Schumacher & Kohn (1985: 1620–1621), Palmer (1988: 13–15), Krisai-Greilhuber (1996: 266–270), Tondl (1992: 6–7, in Czech).

Illustrations. – Whetzel & Solheim (1943: 387, 393, 395, black and white photographs), Whetzel (1946: 406, black and white photographs), Kneblová (in Pilát 1953: 116, black and white photograph), Schumacher & Kohn (1985: 1620–1621, line drawings), Ryman & Holmåsen (1992: 653, colour photograph), Tondl (1992: 5, line drawing), Krisai-Greilhuber (1996: 267, line drawing), Holec (in Albrecht *et al.* 2003: 603, colour photograph).

Ecology and distribution in the Czech Republic (Fig. 1)

South-western Bohemia, Šumava Mts. (Czech part of the Bohemian Forest = Böhmerwald in German), Šumava National Park

Mire near Gerlova Hut', E of the road Železná Ruda – Javorná, 0.7 km NE of site called Gerlova Hut', spring area of Slatinný potok stream

Microlocality 1. – alt. 960 m, 49°10.23N, 13°17.71E.

Habitat. – Sloping spring sedge fen formed by paludification, species-rich, with the *Caricion fuscae* species (*Eriphorum angustifolium, Carex nigra, Viola palustris, Dactylorhiza* sp.), and adjacent *Eriophorum vaginatum* community. The stand of *Carex rostrata* is species-poor, overgrown by spruce, and therefore shadowed, with *Calamagrostis villosa, Trientalis europaea,* and *Vaccinium myrtillus*. Phytosociological relevé (Tab. 2) no. 1. (from site of collection PRM 899095, see below).

Number of ascomata. – less than ten (16 Jun 1997), about 30 (8 Jun 2006).

Material examined. – 16 Jun 1997, apothecia on decaying belowground parts of shoots and rhizomes of *Carex rostrata* in deep *Sphagnum* stand, *leg.* J. Holec, no. JH 5/1997 (PRM 890862), published find (Holec and Pouzar 1998). – 8 Jun 2006, idem., *leg.* J. Holec *et* T. Kučera, no. JH 54/2006 (PRM 899095).

Microlocality 2. – alt. 950 m, coordinates not measured.

Habitat. – sedge-sphagnum fen on a gentle slope near the stream with dominant *Carex rostrata* and *Trientalis europaea*.

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Number of ascomata. – less than ten.

Material examined. – 16 Jun 1997, apothecia on decaying belowground parts of shoots and rhizomes of *Carex rostrata* in deep *Sphagnum* stand, *leg.* J. Holec, no. JH 7/1997 (PRM 890891), published find (Holec & Pouzar 1998).

Transitional mire at margin of Hůrecké slatě bog, S part near Drozdí potok stream, 0.3 km NNE of Nová Hůrka between Prášily and Železná Ruda, alt. 880 m, 49°08.84N, 13°19.84E

Habitat. – Small species-poor mire formed by the terrestrialization of a former pool, covered by vegetation typical of the hydroecological zonation of former oligothrophic littoral. The quaking bog with dominant *Sphagnum* sp. and *Carex rostrata* in the central part is surrounded by the poor fen (class *Scheuchzerio-Caricetea fuscae*). Phytosociological relevé (Tab. 2) no. 2.

Number of ascomata. – less than ten.

Material examined. – 13 Jun 2005, apothecia on decaying belowground parts of shoots and rhizomes of *Carex rostrata* in deep *Sphagnum* stand, *leg.* J. Holec, no. JH 42/2005 (PRM 898762). – 8 Jun 2006, idem., *leg.* J. Holec *et* T. Kučera, no. JH 55/2006 (PRM 899096).

Raised bog Rokytecké slatě, open area along N affluent of Rokytka stream, ca. 5.7 km W of Modrava, alt. 1090 m, 49°01.23N, 13°24.98E

Habitat. – sloping wet sedge fen with *Carex rostrata* stand, which is extremely species-poor with only *Calamagrostis villosa* and *Molinia* sp. The sedge stand lies in a microtopographically concave position. The area is affected by the surface outflow from a melting snow bed. The adjacent active raised bog belongs to the alliances *Oxycocco-Empetrion hermaphroditi* and *Sphagnion medii* (class *Oxycocco-Sphagnetea*), with the dominant species *Eriophorum vaginatum, Trichophorum cespitosum, Vaccinium uliginosum, Pinus*pseudopumilio*. Phytosociological relevé (Tab. 2) no. 3.

Number of ascomata. – less than ten.

Material examined. – 14 Jun 2005, apothecia on decaying belowground parts of shoots and rhizomes of *Carex rostrata* in deep *Sphagnum* stand, *leg.* J. Holec, no. JH 53/2005 (PRM 898772).

Sloping sedge meadow near the village of Filipova Hut' in the vicinity of Kvilda, ca. 0.5 km SW of the centre, at left bank of Filipohut'ský potok stream, alt. 1060 m, 49°01.46N, 13°31.00E

Habitat. – species-rich sedge meadow on a slope with a small *Carex rostrata* stand, containing species from the adjacent community belonging to the alliance *Polygono-Trisetion* (class *Molinio-Arrhenatheretea*) with the species *Polygonum bistorta, Caltha palustris, Cirsium palustre, Chaerophyllum hirsutum,* rarely *Ligusticum mutellina*, and some species of *Caricion fuscae* (Scheuchzerio-

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Caricetea fuscae: *Eriophorum angustifolium, Tephroseris crispa, Juncus filiformis, Carex panicea*), in upper part with an *Eriophorum vaginatum* community. The microtopographic depression with *Carex rostrata* and *Sphagnum* sp. is formed by paludification – see phytosociological relevé (Tab. 2) no. 4.

Number of ascomata. – tens.

Material examined. – 19 May 2005, apothecia on decaying belowground parts of shoots and rhizomes of *Carex rostrata* in deep *Sphagnum* stand, *leg.* J. Holec, no. JH 26/2005 (PRM 898750). – 8 Jun 2006, idem., *leg.* J. Holec *et* T. Kučera, no. JH 56/2006 (PRM 899097).

Alluvial fen near the village of Kvilda, meadows on left bank of Teplá Vltava stream

Microlocality 1. – 1 km SSW of the church in the village of Kvilda, meadow on left bank of Teplá Vltava stream, alt. 1050 m, 49°00.65N, 13°34.44E.

Habitat. – alluvial site near stream, regularly flooded, maybe former oxbow lake (?). The adjacent communities are represented by mountain meadows and cow pastures with the species-rich fen (alliance *Sphagno recurvi-Caricion canescentis*). The stand of *Carex rostrata* and *Sphagnum* sp. has many acidic fen species, such as *Carex nigra, Eriophorum angustifolium, Potentilla palustris, Viola palustris,* etc. Phytosociological relevé (Tab. 2) no. 5.

Number of ascomata observed: tens.

Material examined: 8 Jun 2006, apothecia on decaying belowground parts of shoots and rhizomes of *Carex rostrata* in deep *Sphagnum* stand, *leg.* J. Holec *et* T. Kučera, no. JH 57/2006 (PRM 899098), digifoto.

Microlocality 2: 1.5 km SW of the centre (church) of the village of Kvilda, meadow on left bank of Teplá Vltava stream, alt. 1065 m.

Habitat. – oligotrophic mountainous sedge meadow with dominant *Sphagnum* sp. and *Carex rostrata*. This microlocality is only about 0.3 km away from the preceding one and is situated at a similar location: species-poor fen in upper alluvium of Teplá Vltava stream (slightly more upstream) at the base of the slope.

Number of ascomata. – hundreds.

Material examined. – 3 Jun 1999, apothecia on decaying belowground parts of shoots and rhizomes of *Carex rostrata* in deep *Sphagnum* stand, *leg.* Ivona Matějková, no. JH 46/1999, *det.* J. Holec (PRM 897925).

Fen meadow near the village of Horská Kvilda, alt. 1050 m, MTB 6947a

This locality was published by Tondl (1992) without an exact location. Therefore, we have not been able to check the occurrence of *Myriosclerotinia* in this locality.

Habitat. – wet fen meadow (alliance *Caricion fuscae*) with dominant *Sphagnum* sp., *Carex rostrata* and *Comarum palustre*,

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along a small stream flowing out from a bog spruce forest (ass. *Sphagno-Piceetum*). The fungus grew at an inundated site near the stream on a gentle slope that was covered by *Sphagnum* sp. and scarce shoots of *Carex rostrata*.

Material examined. – 26 Jun 1991, on *Carex rostrata* in living *Sphagnum* stand, apothecia, *leg. et det.* F. Tondl (CB 6897). – 29 Jun 1991, idem. (PRM 882415). – 10 Sep 1991, idem., sclerotia (CB 6898). – 18 Jun 1992, idem., apothecia and sclerotium (CB 8112). – 14 Sep 1992, idem., microconidial sporodochia and sclerotia on *Carex rostrata* (CB 8113).

Localities in the Sudeten mountains

North-west Bohemia, Krušné hory Mts. (Erzgebirge in German)

Near Rolava, ca. 10 km NE of Kraslice, near border with Germany, alt. 900 m

Habitat. – raised bog on granite bedrock.

Published record (Pilát 1953). – June 1952, on *Carex* rhizome/shoot growing directly in the water pool on the place of former peat digging (partly terrestrialized), *leg.* Vlasta Kneblová, *det.* A. Pilát according to the photograph (Kneblová in Pilát 1953: 116), not documented by voucher specimen.

North-west Moravia, Hrubý Jeseník Mts. (Gesenkes in German), Jeseníky Protected Landscape Area

Submountainous pine bog in central part of the national nature reserve Rejvíz, S of the village of Rejvíz, 6.5 km E of the church in Jeseník town, MTB 5769dd, alt. 750–760 m (for exact data see microlocalities)

Habitat. – submountainous bog (Waldhochmoore) with a central lake (named Velké mechové jezírko) surrounded by a fen and sphagnum-bog communities. This central open part lies among *Pinus rotundata, Pinus sylvestris* and *Picea abies* stands.

Myriosclerotinia caricis-ampullaceae was firstly found there in 2004 during one short visit. In 2005, the fungus was searched for on 26 May and 18 June, in both cases intensively. In spite of this intensive search, ascomata were not found, seemingly due to dry weather and temporary lack of water at the locality. In 2006 the fungus was found most frequently. Five microlocalities of *Myriosclerotinia* were distinguished.

Microlocality 1. – ca. 1.5 km SW of the church in the village of Rejvíz, 1.2 km E of Velké mechové jezírko lake, alt. 750 m, 50°13'16"N, 17°17'59"E

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Habitat. – small sedge meadow (ca. 100 × 30 m) with dominant *Sphagnum* sp. and *Carex rostrata*, surrounded by spruce forest and a small stream on the north side. The herb layer is species-poor, with subdominant *Calamagrostis villosa*, *Carex nigra* and *Caltha palustris* subsp. *laeta*. Phytosociological relevé (Tab. 2) nos. 6A, 6B.

Number of ascomata. – less than ten.

Material examined. – 9 Jun 2006, two sites with occurence of apothecia on *Carex rostrata*, in the most humid places of the microlocality, near microdepressions filled with water, *leg.* V. Balner, no. VB 292 (PRM 908433).

Microlocality 2. – ca. 2 km SW of the church in the village of Rejvíz, 0.75 km E of Velké mechové jezírko lake, alt. 750 m, 50°13'12"N, 17; 17'52"E.

Habitat. – large open raised bog (ca. 800 × 100 m) partly passing into a transitional mire with deep peat, saturated by rain- and groundwater, lying on a gentle slope, covered by *Sphagnum* sp., *Carex rostrata*, *Eriophorum angustifolium* and *Oxycoccus palustris*. The area is surrounded by spruce forest, at margin intermixed with *Pinus rotundata*. Ascomata of *Myriosclerotinia* were found in the northern part, 15 m east of the forest margin. Phytosociological relevé (Tab. 2) no. 7.

Number of ascomata. – tens.

Material examined. – 1 June 2006, apothecia with stromata on *Carex rostrata*, *leg.* V. Balner, no. 285. – idem., on decaying shoot of *C. rostrata*, *leg.* I. Nováková, *det.* V. Balner, no. VB 286 (OP 185659). – idem., on shoot of *C. rostrata* submerged in water, *leg.* V. Balner, no. VB 287 (OP 185660). – 9 Jun 2006, on decayins shoot of *C. rostrata* submerged under surface, *leg.* I. Nováková, *det.* V. Balner, no. VB 293 (PRM 908434).

Microlocality 3. – ca. 2 km SW of the church in the village of Rejvíz, 0.65 km E of Velké mechové jezírko lake, alt. 750 m, 50°13'11"N, 17°17'43"E.

Habitat. – see microlocality 2. Besides dominant species (see phytosociological relevé), *Eriophorum vaginatum* and *Drosera rotundifolia* occur in the herb layer. Trees which are present are low and scarce (*Picea abies* and *Pinus rotundata*). *Myriosclerotinia* was found along an indistinct small stream at places where water overflows into the bog. Phytosociological relevé (Tab. 2) no. 8.

Number of ascomata. – tens.

Material examined. – 7 Jun 2004, on shoot of *Carex rostrata* hidden in substrate, *leg.* J. Ševčík, *det.* V. Balner, no. VB 5a (OP 185657). – idem., probably on *Carex rostrata*, sclerotium not found, *leg.* V. Balner, no. VB 5b (OP 185658). – 9 Jun 2006, on shoot of *Carex rostrata* hidden in substrate, *leg.* J. Ševčík, *det.* V. Balner, no. VB 294 (PRM 908435).

Microlocality 4. – ca. 2 km SW of the church in the village of Rejvíz, 0.65 km ESE of Velké mechové jezírko lake, alt. 750 m, 50°13'08"N, 17°17'41É.

Habitat. – see microlocality 2, phytosociological relevé (Tab. 2) no. 9.

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Number of ascomata. – tens.

Material examined. – 9 Jun 2006, on shoot of *Carex rostrata* hidden in substrate, *leg.* V. Balner, no. 295 (PRM 908436).

Microlocality 5. – ca. 2 km SW of the church in the village of Rejvíz, 0.6 km E of Velké mechové jezírko lake, alt. 760 m, 50°13'13"N, 17°17'36"E.

Habitat. – small sedge meadow (ca. 40 × 40 m) on a gentle slope with dominant *Sphagnum* sp. and *Carex rostrata*. It is situated on the lower margin of the neighbouring *Eriophorum vaginatum* bog. The north and east margins are formed by spruce forest. *Myriosclerotinia* was found 12 m from the forest margin at a place enriched by *Calamagrostis villosa*, *Eriophorum vaginatum* and *Oxycoccus palustris*. Phytosociological relevé (Tab. 2) no. 10.

Number of ascomata. – less than ten.

Material examined. – 9 Jun 2006, up to ten apothecia on shoots of *Carex rostrata* submerged in water, *leg.* V. Balner, no. VB 296 (PRM 908437). – idem., *leg.* J. Ševčík, *det.* V. Balner, no. VB 297 (PRM 908438).

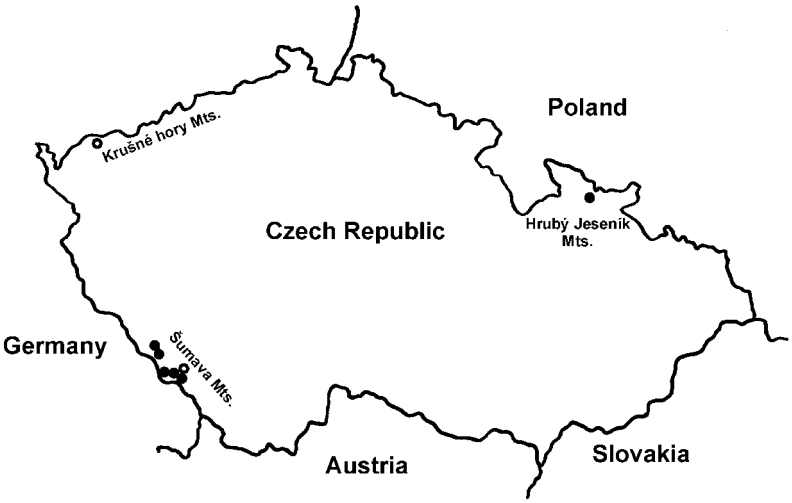

Fig. 1. Distribution of *Myriosclerotinia caricis-ampullaceae* in the Czech Republic. Black dots indicate recent records (1997–2006), dots with white centre indicate older records. Names of mountains with occurrence of *M. caricis-ampullaceae* are added.

Discussion

Distribution in the Czech Republic (Fig. 1)

So far, *Myriosclerotinia caricis-ampullaceae* has been found in mountains only: in the Šumava Mts. (= Böhmerwald, Bohemian For-

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est; influenced by the Alps, both in climate and vascular plants flora, see e. g. Skalický 1975, 1997), Krušné hory Mts. (= Erzgebirge, Ore Mountains; with a summit area deforested as a consequence of air pollution, floristically related to the Atlantic zone) and Hrubý Jeseník Mts. (= Gesenkes; belonging to the Sudeten mountains, differing from the Šumava Mts. in a larger alpine belt area, closely related to the Carpathian region).

Besides the Šumava Mts., the first author searched for *Myriosclerotinia caricis-ampullaceae* also in the Jizerské hory Mts. (= Izergebirge, northern Bohemia, part of Sudeten mountains) on 26 May 2006. The fungus was not found, although it was searched for in the following raised bogs, that look similar to the localities known from the Šumava Mts.: (i) nature reserves Na Čihadle and Rybí loučky; (ii) national nature reserves Rašeliniště Jizery and Rašeliniště Jizerky. However, after the extremely long winter 2005/2006 it was probably too soon for the fructification of *Myriosclerotinia*, because snow melted only 2 weeks before the visit of the localities. We still believe that *Myriosclerotinia* could be found there. The same counts for the neighbouring Krkonoše Mts. (= Giant Mts., Riesengebirge).

The richest area of *M. caricis-ampullaceae* occurrence in the Czech Republic is in the Šumava Mts. This could suggest that the species is common there. However, except for localities published in this paper, about 20 localities with the same habitats in the Šumava Mts. were searched for *M. caricis-ampullaceae* in the period 1997–2006, but without success. This fact shows that the fungus is really rare there. However, it occurs very constantly at its localities. This is illustrated by the fact that apothecia were found at exactly the same place after 9 years (locality Gerlova Hut'), 7 years (near Kvilda) and two-times after 1 year (Hůrecké slatě, Filipova Hut').

European and world distribution (Fig. 2)

According to published data (see also Tab. 1), *Myriosclerotinia caricis-ampullaceae* is known from the following countries: Austria (Krisai-Greilhuber 1996), Belgium (Palmer 1988), Czech Republic (Pilát 1953, Tondl 1992, Holec & Pouzar 1998, this paper), Finland (Nyberg 1934, Whetzel & Solheim 1943, Schumacher & Kohn 1985, Schumacher 2000), Sweden (Whetzel & Solheim 1943, Schumacher & Kohn 1985, Schumacher 2000), Russia (Raitviir & Sirko 1968), Canada (Alberta, Manitoba; see Schumacher & Kohn 1985) and the USA (Wyoming; see Whetzel & Solheim 1943, Whetzel 1946, Schumacher & Kohn 1985, Palmer 1988).

Its records from the Czech Republic and Austria suggest that the species could be present in other countries of Central Europe. Surprisingly, there are no published data on it from Germany (see e. g.

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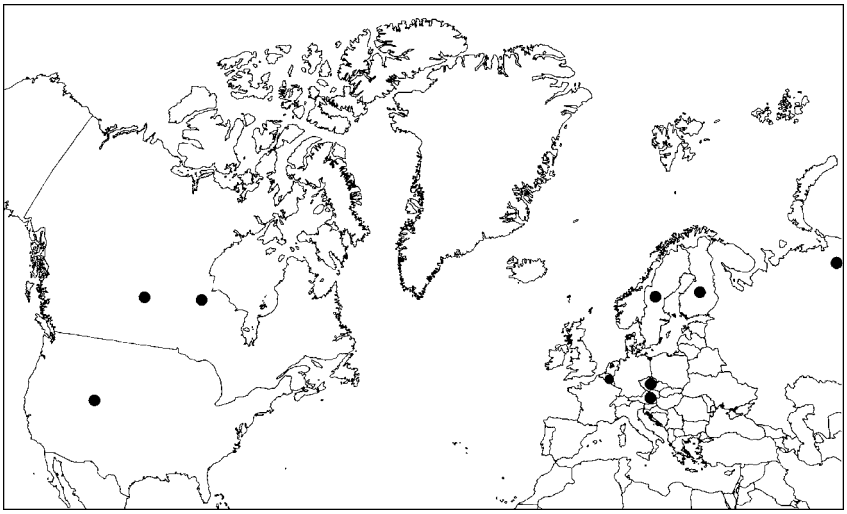

Fig. 2. World distribution of *Myriosclerotinia caricis-ampullaceae* based on published data (see Discussion). In large countries (Canada, USA, Russia), the dots are situated in position showing the area where the species was really found, in small European countries the dots are placed without exact position.

Krieglsteiner 1993). However, we suppose that *M. caricis-ampullaceae* could be found in bogs on the German side of the Bohemian Forest (named Šumava on the Czech side and Böhmerwald or Bayerischer Wald on the German side) or in some bogs in the Alps (similarly as in Austria). There are no published data from Poland. Polish mycologists (A. Chlebicki, A. Bujakiewicz, M. Chmiel, personal communication) confirmed that it is not known from Poland, neither from the lowlands nor the mountains (High Tatra Mts., Babia Gora). In Slovakia, another Central European country with high mountains, *M. caricis-ampullaceae* is also not known. There is a lower probability of the species growing in Poland and Slovakia, because the appropriate mires occurring at the relevant altitudes are relatively rare or absent.

Geographical pattern

Myriosclerotinia caricis-ampullaceae is strictly associated with *Carex* species, preferentially with *C. rostrata*, but also with *C. lasiocarpa* and *C. aquatilis* (see Tab. 1). *Carex rostrata* is aboreal-circumpolar floroelement. It is a common species widely distributed in northern Eurasia (northern limit in Scandinavia, Iceland), and northern America, from Alaska to Greenland southward to New Mexico, Arizona, and California (Hultén 1971). In North America it is most common in wet meadows, marshes, edges of lakes, ponds,

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Tab. 1. – Ecology of *Myriosclerotinia caricis-ampullaceae* based on published data outside the Czech Republic. Only published records with detailed information on the locality and habitat are listed. (n. d. – no data)

Country + location	Reference	Fructification	Host plant	Habitat	Altitude
Belgium: Liège province, Hautes-Fagnes region, Fagne Wallonne	Palmer (1988)	24 May 1983	*Carex rostrata*	sphagnum-filled second world war bomb crater	620 m
Finland: Borgå parish	Nyberg (1934)	mostly June, a few times in July	*Carex rostrata (as C. ampullacea)*	bog in the vicinity of a summer house, with dead *Carex* stand surrounded by white moss	n. d.
Finland (north to Inarin Lappi province)	Schumacher (2000)	n. d.	*Carex rostrata, C. aquatilis*	hemiboreal and boreal zone, occasionally	n. d.
Sweden (north to Västerbotten province)	Schumacher (2000)	n. d.	*Carex rostrata, C. aquatilis*	hemiboreal and boreal zone, occasionally	n. d.
Austria: Salzburg, Lungau, Niedere Tauern (the Alps), near Tamsweg, bog Wirtsalmmoor	Krisai-Greilhuber (1996)	1 Jul 1985	*Carex lasiocarpa*	raised bog with ass. *Caricetum lasiocarpae* (dominated by *C. lasiocarpa*, partly intermingled with *C. rostrata* and *Carex* species), over silicate rock, area with suboceanic climate	1514 m
Austria: Lower Austria, Waldviertel, near Pertenschlag-Melon, bog Altmeloner Au	Krisai-Greilhuber (1996)	2 Jun 1994 19 Jun 1995	*Carex rostrata*	acidic-mesotrophic „Durchströmungsmoor“ *Caricetum rostratae* (poor in plant species, the most characteristic one being *C. rostrata* together with *Sphagnum fallax*), in fact regenerated peat-extraction site, on granitic soil, climate suboceanic but subcontinentally influenced	860 m

Tab. 1. – continued.

Country + location	Reference	Fructification	Host plant	Habitat	Altitude
Russia: Polyarnyj Ural Mts., E slopes (foothills), Yamalo-Neneckyij region	Raitviir and Sirko (1968)	28 Jun 1960	*Carex* sp.	peat bog in forest tundra ecosystem (without trees in studied area)	n. d.
USA: Wyoming, Medicine Bow Mts., below Nash Fork Bridge	Whetzel and Solheim (1943)	apothecia: between 18–27 Jun; young sclerotia: 6 Sep; mature sclerotia: 14 Oct	*Carex aquatilis* var. *altior*, *C. rostrata* (as *C. inflata*)	typical mountain swamp with an abundance of *Carex* and scattered willows, without *Sphagnum* but with aquatic or semi-aquatic mosses growing in abundance among *Carex* plants	ca. 3000 m
USA: Wyoming, Fremont County, Dickinson Park, Trout Creek	Palmer (1988)	4 Jul 1980	*Carex* sp.	beaver ponds, in an overspill slough from a beaver dam	ca. 2430 m

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and streams, and other riparian areas. The surface may be hummocky or mounded laying in trough-shaped or flat flooded valleys. The species grows best on gentle slopes. Sometimes it is a dominant species in floating mats. *Carex rostrata* is well adapted to a variety of mineral and organic soils – many soils have large amounts of peat. Other common soils where it can be found may be sandy, silty, clayey, loamy, clayey loam, alluvial, or granitic. Soil pH tolerance is from 3.0 up to 7.9 (Cope 1992). In Central Europe it grows in wetlands from the lowlands up to the mountains (altitudinal maximum in the Krkonoše Mts.: 1450 m a.s.l.). *Carex lasiocarpa* has a temperate-circumboreal distribution and mostly prefers similar habitats as *C. rostrata*, sometimes with better nutrition and lower acidity. *C. aquatilis* has a temperate to arctic subcontinental-circumboreal distribution. It occurs in northern regions like arctic Canada, Greenland, northern and eastern Russia. This species does not occur in Central Europe.

When the ecological limits of these *Carex* species are compared with the vertical distribution of *M. caricis-ampullacea* (620 – 3000 m, see Tab. 1), it is clear that the fungus requires not only the presence of *Carex* species as a host, but also sites at higher altitude having humid and cold climate. At such sites, winter snow accumulation protects the fungus against deep freezing. Only mires and raised bogs possess these conditions in Central Europe.

In the literature, *M. caricis-ampullacea* is considered a subarctic element (Whetzel & Solheim 1943: "remarkable subarctic species") or boreal-alpine element (Pilát 1953). When the definition of the terms "arctic or subarctic" and "alpine" are taken into consideration (Holub & Jirásek 1968), it is evident that most of such species should grow above and north of the timberline. In vascular plants, where these terms are widely used, arctic elements are generally distributed in Siberia, Novaya Zemlya, Svalbard, northern Greenland, and arctic Canada. Alpine elements occur in mountain regions in subalpine to nival altitudinal belts (Dahl 1998).

All presently known localities of *M. caricis-ampullacea* in Central Europe lie under the climatic timberline, in hydrologically conditioned treeless in the mountains. In North Europe, the species grows in the boreal and hemiboreal zone (Schumacher 2000). Therefore, the species should be considered to have a disjunctive distribution with boreo-montane preferences. Boreo-montane species are able to tolerate higher summer temperatures, as shown by their occurrence in eastern and Central Europe (Dahl 1988).

Habitats of *Myriosclerotinia caricis-ampullaceae* in Central Europe

The species is strongly associated with *Carex rostrata*, rarely with *Carex lasiocarpa*. The species prefers oligotrophic to meso-

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trophic stands with rather deep *Sphagnum* peat, when compared to stands of *Carex rostrata* where *M. caricis-ampullaceae* is absent. The species is not strictly linked to natural communities; it grows also at sites under negative anthropogenic impact. Examples are a former pool, bog damaged by peat digging and later regenerated (this paper, Krisai-Greilhuber 1996: 268), an occasional cow pasture (this paper) or a bomb crater filled with *Sphagnum* (Palmer 1988). We can assume preference for middle-age successional stadia in transitional mires. In the Czech Republic the species grows in the fringes of permanently wet ombrotrophic or alluvial sites, in raised bogs formed by terrestrialization, and/or sloping mires formed by paludification (Soukupová 1996). The gently sloping sites are influenced by surface and subsurface water outflow.

The classification of the *Carex rostrata* stands has not appointed definitely to the concrete plant community (according to Rybníček in Moravec 1995), because the localities lie in the transitional mires (from the historical point of view) neighbouring to fens and bogs, respectively. The microtopographic position in depressions can change the main mire hydrological gradient from ombrotrophic to minerotrophic. The plant community could be associated with the association *Carici rostratae-Sphagnetum apiculati* Osvald 1923 (alliance *Sphagno recurvi-Caricion canescentis* Passarge 1978), *Caricetum rostratae* Rübel 1912 and *Caricetum lasiocarpae* Koch 1926 (all. *Caricion rostratae* Balátová-Tuláčková 1963). According to the Austrian mire classification by Steiner (1992, 1993), *M. caricis-ampullaceae* grows in the „Niedermoortorf“, preferentially in „topogene Moore“ (Verlandungsmoore, Überflutungsmoore, Kesselmoore) and „soligenne Moore“ (Quellemoore or Durchströmungsmoore).

In the Šumava Mts. the vegetation is associated with the widely defined ass. *Caricetum rostratae* Osvald 1923 em. Dierssen 1982 (all. *Caricion lasiocarpae* vanden Berghen in Lebrun et al. 1949). In the Jeseníky Mts. and Krušné hory Mts. the vegetation cover is closely related to the all. *Sphagnion medii* Kästner et Flössner 1933 (class *Oxycocco-Sphagnetea*).

Fructification

In the Czech Republic, apothecia of *Myriosclerotinia caricis-ampullaceae* – appear mostly in June, rarely in May (see Results). The sites (mostly stands of *Sphagnum* with *Carex rostrata*) must be well saturated by water. This fact was confirmed by observations at the Rejvíz locality where the fungus did not produce ascomata in the dry spring of the year 2005, whereas in 2004 and 2006 (normal humid springs) there were tens of ascomata. The second condition is rather

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developed vegetation (presence of at least some individuals of *Carex rostrata*) because 1–2 weeks after snow melting (when only young leaves of *C. rostrata* were developed) apothecia were not found (e.g. in Rokytecké slatě in 2006).

These data are in accordance with those from the world literature (see Tab. 1 and many fructification data published in the following works: Whetzel & Solheim 1943, Whetzel 1946, Schumacher & Kohn 1985). It is very interesting that all over the world and in various habitats and altitudes, *M. caricis-ampullaceae* produces apothecia almost exclusively in June and rarely in May. There is only one exception published – on 7 April 1980, Wyoming, USA (Schumacher & Kohn 1985: 1620). However, anamorphs like sporodochia, microconidia and sclerotia are found later in the year in September and October.

Conservation aspects

These aspects were firstly discussed by Krisai-Greilhuber (1996). As a rare species growing in rare and endangered habitats (bogs, mires, fens), *Myriosclerotinia caricis-ampullaceae* shoud be at least monitored by nature conservation bodies and institutions. In the Czech Republic, all known localities are situated in nature reserves, which means that the species is not immediately endangered and its survival should be ensured when habitat conditions remain unchanged. However, there is still a danger of drying up of some localities (e.g. due to forest decline in their vicinity, which is now very relevant in the Šumava Mts.).

M. caricis-ampullaceae is included in the Red Lists of Austria (Krisai-Greilhuber 1999: in category 4 – potentially endangered for being very rare). It is also placed on the Red List of the Czech Republic, which is now in print preparation.

Acknowledgements

We thank M. Beran (Czech Republic) for data on *Myriosclerotinia caricis-ampullaceae* from the herbarium CB, I. Matějková (Czech Republic) for information on the locality of *Myriosclerotinia* near Kvilda, Z. Prymusová (Czech Republic) for phytosociological relevés from the Hrubý Jeseník Mts., A. Raitviir (Estonia) and I. Krisai-Greilhuber (Austria) for reprints of their publications. The first author was financially supported by the Grant Agency of the Czech Republic (project no. GA 206/04/0356) and the Ministry of Culture of the Czech Republic (institutional research project no. MK00002327201). The second author was supported by the Institutional research plan AV0Z60870520.

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Tab. 2. – Phytosociological relevés of the vegetation growing on *Myriosclerotinia caricis-ampullaceae* stands by T. Kučera and J. Holec (no. 1–5, 8 Jun 2006) and Z. Prymusová (no. 6–10, 23 Jun 2006).

Relevé No.	**1**	**2**	**3**	**4**	**5**	**6A**	**6B**	**7**	**8**	**9**	**10**
Altitude (m a.s.l.)	960	880	1090	1060	1050	750	750	750	750	750	760
Exposition (orientation)	SE	0	SSW	NW	NE	0	0	NE	NE	NE	NE
Inclination (degrees)	3		5	4	3			2	2	2	2
Area (m^2)	16	16	16	25	16	1	1	4	4	4	4
Cover of shrub layer (E_2)	2									5	
Cover of herb layer (E_1)	30	25	30	65	50	30	40	25	30	45	40
Cover of moss layer (E_0)	65	75	80	30	65	100	100	100	100	100	100
E_2+E_1											
Picea abies	1									1	
Pinus rotundata										1	
Carex rostrata	2b	2a	3	2b	2b	2b	2m	2a	2b	2m	3
Calamagrostis villosa	2a	1	(+)			1	3				1
Vaccinium myrtillus	1			+							
Vaccinium vitis-idaea	+										
Trientalis europaea	2m	2m		+							
Viola palustris	(+)	2m		+	+						
Epilobium palustre		r		+							
Polygonum bistorta				2b	2m						
Caltha palustris		(+)		1	+	+					
Eriophorum angustifolium	(+)			+	1			1	+	2a	+
Potentilla erecta	(+)			+	+						
Tephroseris crispa		(+)		+							
Carex nigra	(+)	(+)		2a	2a	+		1			
Cirsium palustre	(+)	(+)		+	+						
Equisetum fluviatile		(+)		+							
Juncus filiformis				+							
Molinia sp.			(+)	+	+						
Galium palustre		(+)		+							
Carex panicea				r							
Angelica palustris		(+)			+						
Potentilla palustris					2m						
Aconitum plicatum					+						
Rumex arifolius					+						
Valeriana dioica		(+)		(+)							
Oxycoccus palustris								2a	2a	2b	
Dactylorhiza fuchsii								+			
Eriophorum vaginatum									1		1
Drosera rotundifolia										+	
E0											
Sphagnum sp.	4	4	5	3	4	5	5	5	5	5	5
Polytrichum formosum	1								+	2a	1

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(Manuscript accepted 12 Apr 2007; Corresponding Editor: M. Kirchmair)

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Digitale Literatur/Digital Literature

Zeitschrift/Journal: Sydowia

Jahr/Year: 2007

Band/Volume: 59

Autor(en)/Author(s): Holec Jan, Kucera Tomás, Balner Vit

Artikel/Article: Ecology and distribution of Myriosclerotinia caricis-ampullaceae (Sklerotiniaceae, Ascomycota) in Central Europe with remarks on its world distribution. 57-74