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Dedicated to Professor Alina Skirgiełło on the occasion of her ninety-fifth birthday

Remarks to the ecology of the boreo-montane polypore *Amylocystis lapponica* based on data from the Czech Republic and Poland

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In the Czech Republic, the rare polypore *Amylocystis lapponica* (Romell) Singer continuously occurs in the Boubínský prales virgin forest (southern Bohemia: Šumava Mts) where it has been documented for more than 60 years. Similarly, in Poland it has been known only from the Puszcza Białowieska virgin forest (northeastern Poland) for more than 50 years. Generally, it is considered a species of boreal coniferous forests of northern Europe (taiga) and montane coniferous forests in Central and Southern Europe. However, the data from the Czech Republic, Slovakia and western Ukraine show that it also grows in mixed montane forests composed mainly of *Fagus sylvatica*, *Picea abies* and *Abies alba*. In Poland, the locality is situated in a lowland forest consisting mostly of *Carpinus betulus, Quercus robur* and *Tilia cordata*. In Central Europe, *A. lapponica* occurs only in virgin forest refuges with the following habitat conditions: vegetation continuity (never cut), natural tree species composition, multi-aged structure, rich presence of dead wood in various stages of decay, relatively large area of the virgin forest surrounded by near-natural forests, stable, cold and humid meso- and microclimate. Consequently, *A. lapponica* may be considered an indicator of long-term vegetation continuity and stable habitat conditions.

Key words: fungi, Central Europe, habitats, virgin forests, vegetation continuity

INTRODUCTION

Amylocystis lapponica (Romell) Singer (Basidiomycetes, Polyporales, *Fomitopsidaceae*) is a polypore typical of northern boreal forests (taiga) (Ryvarden, Gilbertson 1993; Dahlberg, Croneborg 2003). In Europe, the species has a boreo-montane distribution and is extremely rare outside boreal forests. This also relates to its occurrence in the Czech Republic (CR) and Poland (PL). In each of these countries, *A. lapponica* occurs only at one large locality, representing the best-preserved virgin (primeval) forest of the country: Boubínský prales (National Nature Reserve) and its vicinity in the Mt. Boubín complex (CR) and Puszcza Białowieska

virgin forest (Białowieża National Park, PL). The occurrence in the Czech Republic was summarised by Kotlaba (1984) and Kotlaba et al. (1995), who used data from older publications by Kotlaba and Pouzar (1963) and Pilát (1965), labels of herbarium collections and field notes. More recent collections from the Boubín area were published on-line by Vlasák (2005). In Poland, the occurrence of *A. lapponica* was recently evaluated by Piątek (2005).

From the conservational viewpoint, *Amylocystis lapponica* is considered a critically endangered species, included both in the Red Book (Kotlaba et al. 1995) and Red List of fungi of the Czech Republic (Holec, Beran 2006). Consequently, it is protected by law in the country (Antonín, Bieberová 1995). In Poland, the species is also included in the national Red List as a critically endangered species (Wojewoda, Ławrynowicz 2006) and also protected by law (Ławrynowicz 2004; also see Karasiński 2007: http://grzyby.strefa.pl/chronione.html).

Recently, Dahlberg and Croneborg (2003) summarised data on habitats of *Amylocystis lapponica* in Europe. Unfortunately, the habitats present in the Boubínský prales and Puszcza Białowieska virgin forests are not mentioned.

The aims of this paper are (1) to summarise older data and publish new data on the occurrence of *Amylocystis lapponica* in the Boubínský prales virgin forest, (2) to compare the habitats of *A. lapponica* in the Czech Republic and Poland, and (3) to add data on habitat preferences of *A. lapponica* in these countries to the incomplete habitat characteristics published by Dahlberg and Croneborg (2003).

MATERIAL AND METHODS

The search for *Amylocystis lapponica* in the Boubínský prales virgin forest by J. Holec was not intensive and not focused only on this species. It was carried out as part of a study of mycobiota in the Šumava Mts in the years 1996-2006 (see e.g. Holec 2000; Holec, Beran 2007). Consequently, his find of *A. lapponica* is rather accidental. However, when combined with published and herbarium data and provided with a phytosociological analysis, it can be used for an ecological synthesis. This paper is a reply to a request from the Agency for Nature Conservation and Landscape Protection of the Czech Republic for monitoring protected species of fungi.

The habitat of the recent stand of *Amylocystis lapponica* is characterised by a phytosociological relevé. The relevé was made according to the Braun-Blanquet phytosociological approach with the cover being estimated by using the extended Braun-Blanquet scale: r (rare), + (less then 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).

Voucher specimens are deposited in PRM (National Museum, Prague, Czech Republic) and BRNU (Masaryk University, Brno, Czech Republic).

Abbreviations: BPVF: Boubínský prales virgin forest, CR: Czech Republic, PL: Poland.

RESULTS

Amylocystis lapponica, occurrence and ecology in the Czech Republic

Geographic position of the locality. Czech Republic, southern Bohemia, former Prachatice District, Šumava Mts (=Bohemian Forest, Böhmerwald), Šumava Protected Landscape Area, 9 km NW of the town of Volary, Mt. Boubín complex: Boubínský prales virgin forest (BPVF) and adjacent slopes of Basumský hřbet ridge and Mt. Červený vrch.

Habitat of Boubínský prales. Mixed montane forest composed of *Fagus sylvatica, Picea abies* and *Abies alba*, with admixed *Acer pseudoplatanus* and *Ulmus glabra*, phytosociologically a mosaic of herb-rich beech forests, montane sycamore beech forests, acidophilous beech forests and montane spruce forests with *Calamagrostis villosa* (Albrecht et al. 2003), with some trees aged 400-500 years. The core area (46.67 ha) has never been cut nor managed by foresters. It represents a remnant of original natural vegetation, with a high amount of dead and fallen decaying trunks. It has been protected as a nature reserve since 1858. Forest surrounding the core area is also natural. The total area of the reserve is 677 ha, its altitude ranges from 874 to 1362 m, the core area (enclosed by a palisade) from 930 to 1100 m. Coordinates of the centre of the core area are 48° 58´ 39´´ N, 13° 48´ 41´´ E.

Mycological characteristics of Boubínský prales. See Kubička (1960, 1973), partial data are present in dozens of publications on taxonomy, biodiversity and ecology of fungi both in Czech and foreign literature.

Records of *Amylocystis lapponica* in the Boubínský prales. For details see Table 1. On Mt. Boubín, the species is known from several microlocalities. Most of them are situated in the core area (enclosed by a palisade, see below) of the Boubínský prales National Nature Reserve.

The exact geographic position of older finds by J. Herink and J. Kubička is not known, but it is highly probable that they originate from the core area of BPVF which was traditionally visited by mycologists at that time. However, finds of *A. lapponica* are known from more microlocalities in the Mt. Boubín complex. The exact location of finds by Vlasák (2005) is not clear from data published by him but it is probable that those indicated by a question mark in Table 1 are from BPVF (core area enclosed by a palisade plus surrounding parts of the National Nature Reserve). However, Vlasák mentions also two finds from Mt. Červený vrch which is situated in the Mt. Boubín complex but approximately 3.5 km S of the summit of Mt. Boubín and outside of the Boubínský prales National Nature Reserve. There are also near-natural forests on slopes of Mt. Červený vrch which resemble those in the BPVF. The well-documented find by Holec published here (see below) is situated in the National Nature Reserve but outside the core area. Good colour photographs of *A. lapponica* from Boubínský prales were published by Papoušek (2004: no. 237).

Habitat conditions of the recent find by J. Holec. Boubínský prales National Nature Reserve, approximately 100 m WSW of the Boubínské (Kaplické) jezírko water reservoir, 10 m S of the palisade enclosing the core area close to the forest path (nature trail) around the core area, ENE slope (for details on location and substrate, see Table 1).

Table 1
Summary of records of *Amylocystis lapponica* in Mt. Boubín complex (Šumava Mts, Czech Republic)

voucher specimen	locality	microlocality	substrate	part	altitude	day	month	year	leg.
PRM 807430, PRM 930470	BPVF	?	?	?	?	12	9	1946	J. Herink
PRM 618504	Mt. Boubín	?	*Picea? Abies?*	decayed trunk	?	4	7	1954	J. Kubička
PRM 870783	BPVF	core area (enclosed by palisade)	*Picea abies*	fallen trunk	?	28	9	1967	Z. Pouzar
PRM 684420	BPVF	core area (enclosed by palisade)	*Picea abies*	fallen trunk	?	28	9	1967	Z. Pouzar
?	BPVF	?	*Picea abies*	?	?	19	9	1981	J. Vlasák
herb. Vlasák	Mt. Boubín	Mt. Červený vrch in Mt. Boubín complex	*Picea abies*			?	9	1981	J. Vlasák
herb. Vlasák	BPVF	?	*Picea abies*			?	9	1982	J. Vlasák
herb. Vlasák	BPVF	?	*Picea abies*			?	9	1983	J. Vlasák
? (photograph)		?	*Picea abies*	log of a fallen decaying trunk	1050	9	10	1988	J. Vlasák
absent	BPVF	core area (enclosed by palisade)	?	?	?	25	10	1990	found by F. Kotlaba, seen in the field by J. Holec
herb. Vlasák	Mt. Boubín	Mt. Červený vrch in Mt. Boubín complex	conifer				10	1994	J. Vlasák
herb. Vlasák	BPVF	?	*Picea abies*				9	2001	J. Vlasák
BRNU: Dvořák 170/03	BPVF	core area (enclosed by palisade); N 48°58´28.2´´ E 13°49´00.6´´	*Picea abies*	fallen trunk, without bark but with rather hard wood	?	27	9	2003	D. Dvořák
PRM 898867 (JH 235/2004)	BPVF	S of core area, close to palisade; N 48°58´22.44´´ E 13°49´03.44´´	*Picea abies*	fallen decaying trunk (diameter 40 cm), felled at base, without bark, with soft wood	950	9	10	2004	J. Holec

Phytosociological relevé (made by T. Kučera 13 June 2007):

Total area 400 m^2 (20 x 20 m), alt. 950 m, ENE slope, inclination 15 °.

Tree layer (E_3) – total cover 50 %: *Picea abies* 3+. Shrub layer (E_2) – total cover 10 %: *Fagus sylvatica* 1+, *Sorbus aucuparia* +, *Picea abies* 1. Herb layer (E_1) – total cover 15 %: *Vaccinium myrtillus* 1+, *Prenanthes purpurea* 1, *Dryopteris dilatata* 1, *Oxalis acetosella* +, *Luzula luzuloides* +, *Carex pilulifera* +, *Polygonatum verticillatum* +, *Athyrium filix-femina* +, *Rubus idaeus* +, *Senecio ovatus* +, *Lycopodium annotinum* +, *Gymnocarpium dryopteris* r, *Abies alba* juv. r. Moss layer (E_0) – total cover 5 %: *Polytrichum commune* 1, *Dicranum scoparium* +, *D. undulatum* +.

Species outside the relevé: *Actaea spicata, Cardamine impatiens, Carex sylvatica, Chaerophyllum hirsutum, Circaea alpina, Dentaria enneaphyllos, Galeobdolon montanum, Galium odoratum, Impatiens noli-tangere, Myosotis nemorosa, Petasites albus, Stellaria nemorosa.*

The plant community belongs to the association *Dentario enneaphylli-Fagetum* Oberdorfer ex W. et A. Matuszkiewicz 1960, the neighbouring stands to the subassociation *impatientetosum* (Hartmann, Jahn 1967) Moravec 1974. It falls under Natura 2000 habitat 9130, *Asperulo-Fagetum* beech forests (Chytrý et al. 2001). This is a potential natural vegetation type, which would be present if the site were free of human influence. In fact, the site is a high-grown (approximately 100 years old) man-influenced forest with dominance of *Picea abies* and admixed *Fagus sylvatica*. It is not a virgin forest (trees are of the same age, dominance of *Picea* instead of *Fagus*, low amount of dead wood). However, natural forest almost untouched by man (virgin forest) is situated at 10 m distance (behind the palisade enclosing the core area of the Nature Reserve).

DISCUSSION

Occurrence in the Czech Republic. To the present date, Boubínský prales virgin forest is the only locality of *Amylocystis lapponica* in the Czech Republic. The species has not been found in other virgin forests of the country (e.g. Žofínský prales in south-eastern Bohemia, Mionší, Salajka and Razula in north-eastern Moravia) in spite of a long and intensive study of polypores in the Czech Republic (e.g., Pilát 1936-1942; Kotlaba 1984; Kotlaba, Pouzar, Vampola in Holec, Beran 2006).

The data document continuous occurrence of *Amylocystis lapponica* on Mt. Boubín for more than 60 years. The vitality of the local population is illustrated by the fact that the species is known from several microlocalities. The following habitat conditions (which are unique in the Central European landscape) seem to be decisive: vegetation continuity (never cut), natural tree species composition, multi-aged structure, rich presence of dead wood in various stages of decay, relatively large area of the virgin forest surrounded by near-natural forest (the importance of larger reserves for maintaining sensitive species was stressed by Siitonen et al. 2005), and a stable, cold and humid meso- and microclimate. As it was illustrated in another paper (Holec, Beran 2007), these "virgin forest conditions" of BPVF enable the occurrence of other fungi preferring natural forests (e.g., *Phellinus pouzarii* Kotlaba, *Phellinus ferrugineofuscus* (P. Karst.) Bourdot et Galzin, *Pseudoplectania melaena* (Fr.) Sacc., *Baeospora myriadophylla* (Peck) Singer, *Rigidoporus crocatus* (Pat.) Ry-

varden, *Multiclavula mucida* (Pers.) R.H. Petersen; see Holec 2003, Holec, Beran 2006). Some rare species occurring in BPVF have a boreo-montane distribution (e.g., *Laurilia sulcata* (Burt) Pouzar, *Phellinus ferrugineofuscus* (P. Karst.) Bourdot et Galzin, *Perenniporia subacida* (Peck) Donk). All these data show the uniqueness of the habitat conditions of BPVF, which is the best-preserved montane virgin forest of the Czech Republic.

Occurrence in Poland. In Poland, *Amylocystis lapponica* is known only from the Puszcza Białowieska virgin forest in north-eastern Poland (Piątek 2005) where it is rather common. Although Piątek (2005) wrote that the last find was made in 1973, photographs of *A. lapponica* were taken in 2005 and 2006 (Karasiński 2007, Snowarski 2007), which document its continuous occurrence since its first find in 1956 (Domański 1959). Similarly like in Boubínský prales virgin forest in the Czech Republic, Puszcza Białowieska in Poland is an important remnant of natural vegetation which is unique not only from the Polish but also the European point of view.

Comparison of Czech and Polish habitats. The following habitats of *Amylocystis lapponica* in the Puszcza Białowieska virgin forest are given by Piątek (2005): *Vaccinio uliginosi-Pinetum* Kleist 1929, *Tilio cordatae-Carpinetum betuli* Tracz. 1962, and the grouping association *Querco-Carpinetum medioeuropaeum* Tüxen 1936. In all cases, the species was found on fallen trunks or branches of *Picea abies*. Puszcza Białowieska virgin forest is a lowland forest (mean altitude 170 m), where spruce grows in wet depressions, the microclimatological conditions are colder than in the surrounding.

In the Czech Republic, the locality is surrounded by the natural montane spruce-fir beech forests of the very large coniferous complex of the Šumava Mts (montane spruce forests in upper, and spruce cultural forests in lower position, dozens of square kilometres). In contrast, the Polish locality is situated in a lowland deciduous forest complex with a higher proportion of pine and spruce forests in wet depressions near the bog. Therefore both localities are especially similar in their historical management (minimal influence by man) rather than habitat.

Remarks to habitats and occurrence in Europe. Dahlberg and Croneborg (2003) compiled the following data on habitats of *Amylocystis lapponica* in Europe: western taiga (Natura 2000 priority habitat 9010) and Fennoscandian herb-rich forests with *Picea abies* (9050) in Nordic countries and Estonia, acidophilous *Picea* forest of the montane to the alpine levels (9410) in Slovenia and alpine *Larix decidua* and/or *Pinus cembra* forests (9420) in Italy. It is clear that habitats known from the Czech Republic and Poland are not included. These differ e.g. by a high percentage of broad-leaved trees (esp. *Fagus sylvatica, Carpinus betulus, Quercus robur,* and *Tilia cordata*) forming the habitats *Asperulo-Fagetum* beech forests (9130, Boubínský prales) and *Galio-Carpinetum* oak hornbeam forests (9170, Puszcza Białowieska), respectively.

The number of localities in various European countries is very different. While hundreds of localities in Sweden and Finland and dozens in Norway (Dahlberg, Croneborg 2003) are known, in countries of Central and Southern Europe the species is extremely rare and mostly occupies only one locality per country. It clearly shows that localities in Central and Southern Europe represent refuges of *A. lap-*

ponica outside the zone of boreal forests of northern Europe. These refuges are formed by azonal soil or topoclimatic conditions in the temperate forest zone.

In northern Europe, *Amylocystis lapponica* is considered as a good indicator of old-growth and species-rich spruce forests which are in special need of conservation (Norway: Bredesen et al. 1997; Røsok 1998; Finland: Siitonen et al. 2005). However, Jonsson and Jonsell (1999) showed in Swedish spruce forests that if indicator species are to be used for evaluation of their biodiversity, these should be chosen from several groups of organisms (e.g. vascular plants, bryophytes, epiphytic lichens and wood-inhabiting fungi). This is certainly true but at least in Central Europe, *A. lapponica* indicates high continuity of forest vegetation which has never been cut. Supporting data from the Czech Republic and Poland are summarised here. Data from Slovakia (Kotlaba, Pouzar 1963; Pilát 1965; Kotlaba 1984; Varjú 1994; Škubla 2003) and eastern Carpathians in western Ukraine (Pilát 1936-1942, 1940; for current names of his localities, see Holec 2002) are almost identical. *Amylocystis lapponica* occurs there exclusively in virgin forests (central Slovakia: Dobročský prales, voucher specimens in PRM and herb. Vlasák; Eastern Carpathians: altogether 19 collections from several localities, voucher specimens in PRM). These forests are composed mainly of *Fagus sylvatica*, *Abies alba* and *Picea abies* and have the same „virgin forest character" as was specified in the first chapter of the Discussion.

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