

CATATHELASMA

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Ophiocordyceps myrmecophila (Javorníky, Púchov; see p. 19–22)



Cordyceps militaris
(Veľká Fatra, Rajec – Šuja; see p. 8–13)



Cordyceps militaris
(Malé Karpaty, Prašník;
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Elaphocordyceps ohioglossoides (Turzovská vrchovina, Vysoká nad Kysucou;
see p. 22–31)

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Instructions to Authors

Catathelasma publishes contributions to the better knowledge of fungi preferably in Slovakia and central Europe. Papers should be on biodiversity (mycofloristics), distribution of selected taxa, taxonomy and nomenclature, conservation of fungi, and book reviews and notices. We accept also announcements on literature for sale and/or exchange (classified) and on events attractive for mycologists. Manuscripts have to be submitted in English with a Slovak or Czech summary.

Elements of an article submitted to Catathelasma

- title: informative and concise
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- key words: max. 5 words, not repeating words in the title
- text: brief introduction, presented data (design and structure depend on the topic)
- illustrations: line drawings (scanned and "doc" or "tif" formatted)
- list of references
- abstract/summary in Slovak or Czech: max. 10 lines (starting with author's name and the title of the article)

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CORDYCEPS S. L. (ASCOMYCETES, CLAVICIPITACEAE) IN SLOVAKIA

Václav Kautman¹ and Ivona Kautmanová²

Key words: *Elaphocordyceps*, *Ophiocordyceps*, *Elaphomyces*, entomopathogenic fungi, parasitic fungi.

INTRODUCTION

The genus *Cordyceps* s. l. includes over 420 species divided into four genera – *Cordyceps* s. s., *Ophiocordyceps*, *Elaphocordyceps* and *Metacordyceps* (Sung & al. 2007), parasitizing as anamorphs and teleomorphs on many insect and spider species. Only 26 taxa grow on other fungal hosts (*Elaphomyces*, *Claviceps*). New species are described regularly, mostly from subtropical and tropical regions or from the areas investigated by some specialists. Species of *Cordyceps* s. l. are considered to be rare, but they may be overlooked owing to the often small size of their stromata and/or the distribution of their hosts. As is the case with many fungi, specialists find more species than non specialists and regions having more *Cordyceps* s.l. specialists have more species than other geographic regions. Descriptions of many species were based on one or two collections and the species were never recorded again. Southeast Asia is considered to be a center of the *Cordyceps* s.l. diversity, but representatives of the genus are distributed worldwide, especially in tropical regions, where they are often numerous. In Europe they are not so frequently found, around 15 species are commonly mentioned in lists of European species (Dennis, 1968, Koval', 1984, Candoussau 1975, 1976, 1979, Eriksson 1982, a.o.), but detailed study of published data and specimens in various herbaria revealed that around 30 taxa are actually found in this region.

Only a few mycologists have devoted their attention to the genus *Cordyceps* s.l. in Slovakia. Most of the records were accidental and published data were rare and rather scattered. Endlicher (1830) was the first to record a *Cordyceps* from our territory. He briefly noted the presence of *Sphaeria militaris* (*C. militaris*) from Blumenau (now Lamač,

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part of Bratislava city). The next published records of *Cordyceps* for Slovakia only came 62 years later when Hazslinsky (1892) reported finding *E. ophioglossoides* (as *Cordyceps*) in coniferous forests around the town of Prešov in eastern Slovakia. He also found *Cordyceps capitata* in the neighboring village Kojatice; unfortunately no specimens were preserved, making it impossible to know which of the three capitata species he had. In the same year he (Hazlinski 1892) reported a specimen of *Cordyceps alutacea* that had been collected by Kalchbrenner near Spišské Vlachy. This species is now considered to be *Podostroma alutaceum*; it is a lignicolous species with a *Cordyceps*-like stroma but with ascospores typical of *Podostroma*. Moesz (1909, 1910) published on a new collection of *Cordyceps clavulata*, which he found in 1908 at Fenyökosztolanyi (now Jedľové Kostolány in western Slovakia) and issued the specimen in an exsiccate collection (Zahlbruckner, Krypt. Exs. 1817/c, specimens revised at BP, K, M, PRM and PC). Zahlbruckner's exsiccate collections included also specimens collected at the same locality in 1892 and 1908. He published also Filarszky's collection of *C. gracilis* from the Vysoké Tatry Mountains. (under the older name *C. entomorrhiza*), the first record for the species in Slovakia and briefly mentioned Hazslinsky's collection of *C. parasitica* (now *Ophiocordyceps ophioglossoides*) from Spiš region, as did later also Beneš and Melzer (1931). In the years 1910 – 1913 F. Filarszky collected *Elaphocordyceps rouxii* and *E. ophioglossoides* in Iglófüred (now Novoveská Huta) and the collections were issued in Flora Hungaria exsiccata under the names *Cordyceps capitata* and *C. parasitica* (specimens revised at BP, BRA, BRNU, C, K, M, O, PRM, S, SOM, U, W). It took another 40 years till Fassatiová (1954) ignored Moesz's record when he claimed the first finding of *C. gracilis* in Slovakia. His collection came from the Kováčovské kopce Mountains and comprised a single carpohore (without host insect).

Prior to 1996 there were only 20 specimens of *Cordyceps* s. l. preserved in Slovak herbaria, and $\frac{2}{3}$ of them are *O. ophioglossoides*. Before 2002 only six species had been recorded from Slovakia, but only four of them were correctly identified [(*C. militaris*, *C. gracilis* (now *Ophiocordyceps gracilis*), *C. clavulata* (now *Ophiocordyceps clavulata*)]. Specimens filed as *C. capitata* are in fact *Elaphocordyceps rouxii* or *Elaphocordyceps longisegmentis*, and specimens identified as *C. entomorrhiza* are *Ophiocordyceps gracilis*.

In recent years several additional species have been found in Slovakia, and new localities have been uncovered for species already known to

occur in the country. Recent collecting has revealed *O. ophioglossoides* to be common on one locality in Vysoké Tatry. Two collections of *Cordyceps ophioglossoides* were mentioned in the list of specimens collected during the mycological meeting at Záhorie (Lizoň 1977). Lizoň and Bacigálová (1998) included 3 species to the Slovak checklist (*Cordyceps militaris*, *C. ophioglossoides*, *C. sphecocephala*). In the years 1997 – 2002 the present authors published several articles on new records of the genus *Cordyceps* in Slovakia (Kautmanová 1997, Kautmanová 1998, Kautman 2002, Kautman, Kautmanová 2002). In 2006 the authors published an article about *Cordyceps rouxii*, until then a little known species. They described its occurrence in Slovakia as well as in Europe and designed the epitype based on the material from Slovakia (Kautmanová, Kautman 2006).

Concerted recent collecting has resulted in the deposit of more than 470 specimens in Slovak herbaria. Moreover, study of Slovak specimens deposited in European and extra European herbaria has provided for better understanding of the genus.

Currently 12 species of *Cordyceps* are known from Slovakia, and the number will probably increase in future, as there are collections still undetermined, because of uncertain taxonomy or great variability of the species. Many collections of *Acanthomyces*, *Beauveria*, *Gibelulla*, *Isaria*, *Paecilomyces*, *Polycephalomyces*, and other entomopathogenic fungi were made as well and they will be processed in future, too.

MATERIALS AND METHODS

The macromorphological characters were observed in fresh and dried material. The micromorphological structures were observed in fresh and dried material using a light microscope with oil immersion lens. Fragments of material were examined in 5% KOH, lactophenol cotton blue solution or distilled water. Extreme values of micromorphological characters were estimated as average plus and minus standard deviation of 30 measurements. Descriptions were based on our specimens collected in Slovakia (field collections) and revised herbarium material (herbarium collections).

Localities of the species are listed according to orographic regions, at each locality nearest town or village, name of the site, square grid number (Q), altitude and habitat description are given. Records for each locality are listed according to date, followed by the name of collector,

host specification, number of carpophores and some notes. Herbaria abbreviations and numbers are put at the end of the record.

A brief description of each species is presented, together with its known occurrence in Europe, ecology, fruiting season and history of its recording in Slovakia with the number of records and localities.

Abbreviations of public herbaria follow Index Herbariorum (Holmgren & al. 1990). Studied herbarium specimens are from BP, BPI, BRA, BRNM, BRNU, C, CB, CUP, EFCC, K(M), KRA, KRAM, M, MA, O, PC, PRM, S, SAV, SOMF, TNS, U, W, WU.

Other herbaria and private collections: HMIGD – Mycological herbarium of Guangdong institute of microbiology, China; LDM – Forestry and Wood Technology Museum, Zvolen, Slovakia; OP – herbarium of the Orava Museum, Oravský Podzámok, Slovakia; PHD – herbarium H. Deckerová, Ostrava, Czech republic; PJČ – herbarium J. Červenka, Bratislava, Slovakia; PSG – herbarium S. Glejdura, Kováčová, Slovakia; PVDK – herbarium D. Karasinski, Krakow, Poland; PVIK – herbarium V. Kabát, Bratislava, Slovakia, PVK – herbarium V. Kautman, Bratislava, Slovakia.

Abbreviations of the European states: AT – Austria; BA – Bosna and Hercegovina; BE – Belgium; BY – Belarus; BG – Bulgaria; CH – Switzerland; CZ – Czech Republic; DE – Germany; DK – Denmark; EE – Estonia; ES – Spain; FI – Finland; FR – France; GB – Great Britain; HR – Croatia; HU – Hungary; IE – Ireland; IT – Italy; LV – Latvia; LT – Lithuania; MK – Macedonia; NL – Netherland; NO – Norway; PL – Poland; PT – Portugal; RO – Romania; RU – Russia; SE – Sweden; SK – Slovakia; SL – Slovenia; UA – Ukraine; YU – Serbia and Monte Negro.

Countries where the occurrence of the species has been confirmed by authors are marked by an asterix (*).

STUDIED SPECIES

Cordyceps militaris (Fr.) Fr.

SYN.: *Clavaria militaris* L., *Torrubia militaris* (L.) Tul. & C. Tul.

ANAMORPH: *Lecanicilium*

The most common entomopathogenic species in Slovakia. Worldwide distribution, cosmopolitan, recorded in Japan*, Korea*, China, Sri Lanka, Cuba, United States* and other countries. In Europe known from AT*, BE, BY, CH*, CZ*, DE*, DK*, EE*, ES*, FI*, FR*, GB*, HU*, IE*, IT*, LV*, NL, NO*, PL*, PT*, RU, SE*, SK*, UA (Kobayasi 1940, Koval

1974, 1984, 1991, Hlaváček 1994, Sung 1996, Teng 1996, Ghyselinck 2002 a. o.).

The species is extremely variable in size, shape and colour. Parasitises caterpillars and pupae of several species of moths (Lepidoptera) living in various habitats from lowlands to mountains. Rarely recorded also on hymenopterans – *Cimbex similis*, Tenthredinidae, Hymenoptera (Kobayasi, 1940) and on *Tipula paludosa*, Tipulidae, Diptera (Müller-Kögler, 1969). In suitable conditions it occurs year-round, mostly from summer to late autumn. It grows in deciduous as well as coniferous woods, from lowland deciduous to mountain spruce forests. Carpophores emerge on bare ground, in mosses, fallen leaves and needles, but also in grasslands, meadows, along the streams and at open places. Rarely also on branches, stumps and logs, on wood-inhabiting lepidopteran larvae and pupae. Parasitised insects usually lay on ground or buried 1 – 4 cm deep in soil, scarlet-red, orange, pink, yellow and rarely white, albinotic (Kobayashi 1978), clavate stromata rousing from them solitary or in clusters of 2 – 10. Stromata red, orange, pink, yellow and white. *Cordyceps militaris* f. *alba* was described by Yao & al. (1995).

It is strange, that this colourful and striking species has been overlooked in Slovakia for so many years, despite the fact that it was recorded occasionally in neighbouring countries since the beginning of the last century. First record from Slovakia was published in Flora Posoniensis by Endlicher in 1830 from Lamač (Blumenau) near Bratislava city, labeled as *Sphaeria militaris*. Then, after 162 years, Kuthan & al. (2000) published it from Bukovské vrchy Mts. However, voucher the specimen at BRA is not *C. militaris* and we consider this record as dubious. The first reliable record is probably the photo made by Bohdan Ciencala in September 1996 and published online (Ciencala, 1996), but without any voucher specimen (Ciencala, pers. inf.). The first preserved specimen, collected by H. Kautmanová in October 1997, is held at BRA (Kautmanová 1997). Since then the species has been collected more frequently and the number of collections is increasing. Currently 83 collections from 53 localities in Slovakia are known.

RECORDS FROM SLOVAKIA

Known from Borská nížina lowland (6 localities), Malé Karpaty Mts. (6), Biele Karpaty Mts. (8), Považské podolie basin (1), Tríbeč (1), Javorníky Mts. (4), Turzovská vrchovina Mts. (2), Strážovské vrchy Mts. (5), Malá Fatra Mts. (1), Veľká Fatra Mts. (1), Oravská brázda Mts. (1), Hronská pahorkatina Mts. (1), Štiavnické vrchy Mts. (1), Považský Inovec Mts. (2),

Kremnické vrchy Mts. (1), Zvolenská kotlina basin (2), Stolické vrchy Mts. (1), Laborecká vrchovina Mts. (3), Ondavská vrchovina Mts. (2), Beskydské predhorie Mts. (2), and Vihorlatské vrchy Mts. (1).

Malé Karpaty Mts., Lamač (labelled as Blumenau) village, Q 7768; – 1830, S. Endlicher (as *Sphaeria militaris*). ● Sološnica village, loc. Pod Roštúnom, Q 7569, alt. 300 m, in grass in meadow; – 17.1.2004, S. Ripková, one stroma on cocoon of Lepidoptera, PVK 75. ● Bratislava – Dúbravka village, Devínska Kobyla Nature Reserve, NE slope of Hlavica hill, Q 7868, alt. 250 m, meadow with *Crataegus*, *Prunus*, *Rosa*; – 28.10.2008, R. Bednár, 2 stromata on lepidopteran pupa, pers. inf. ● Prašník – Dúbrava village, N slope of Veľká Pec hill, Q 7372, alt. ca 300 m, on submontane meadow; – 17.11.2008, L. Tábi, 2 stromata on pupa, PVK 601; – 17.11.2009, L. Tábi, V. Valo, 30 individuals on caterpillars and pupae of Lepidoptera, PVK 784. ● Dobrá Voda village, SE slope of Hrubé skalky hill, Q 7471, alt. 320 m, in meadow near beech-oak forest; – 25.10.2009, J. Komár, 3 individuals on lepidopteran pupa, PVK 773. ● Častá village, loc. Červený kameň, Q 7670, alt. 360 m, on meadow; – 17.11.2009, B. Kuzmová, 2 individuals on lepidopteran pupa, PVK 786.

Beskydské predhorie Mts., Snina town, Sninské rybníky recreation area, Q 7099, alt. 250 m; – 19.9.1996, B. Ciencala, 2 yellow coloured carpophores on submontane meadow, photo, pers. inf. ● Snina town, Štefkovo hill, Q 7099, alt. 260 m, in forest with *Populus tremula*, *Alnus glutinosa*, *Betula pubescens*; – 14.5.2008, J. Pavlík, one carpophore on pupae in cocoon, 2 cm in soil, PVK 373.

Borská nížina lowland., Tomky village, Šišolákovci settlement, Q 7468, alt. 210 m, in pine forest with admixture of *Quercus*, on caterpillars and pupae of Lepidoptera; – 19.10.1997, H. Kautmanová, BRA CR9118; – 15.10.1999, I. Kautmanová, 6 stromata, BRA CR9119. ● Studienka village, Jasenácke Nature Reserve, Q 7468, alt. 215 m, in mixed forest (*Pinus sylvestris*, *Quercus* sp.); – 10.10.2000, I. Kautmanová, on caterpillars of Lepidoptera, 3 stromata, – 9.9.2001, V. Kautman, 4 stromata on caterpillars and pupa. ● Studienka village, Q 7468, in *Pinus* forest; – 28.10.2004, F. Taragel, one stroma in moss 6 cm deep, photo, pers. inf. ● Sološnica village, loc. Borík, Q 7569, alt. 220 m, in mosses; – 25.11.2008, V. Kučera, one long stroma on lepidopteran caterpillar, PVK 563. ● Tomky village, loc. Šaštínsky les, Q 7468, alt. 230 m, 2 sites in pine forest; – 6.10.2007, L. Tábi & al., 3 parasitised caterpillars of Lepidoptera (2,2,3 stromata), in deep mosses in sandy soil, PVK 317, PVK 318. ● Studienka village, 1 km NW of the village, Q 7468, alt. 220 m, in pine forest, at the edge of the forest road in sandy soil; – 3.11.2007, V. Kabát, on pupa of Lepidoptera (3 stromata), PVK without number.

Biele Karpaty Mts., Nová Bošáca village, Španie settlement, Blažejová Nature Reserve, N slope, Q 7172, alt. 410 m, in meadow surrounded by mixed forest (*Quercus* sp., *Fagus sylvatica*, *Pinus silvestris*, *Carpinus betulus*, *Prunus* sp., *Malus*); – 19.10.2001, V. Kučera, S. Ripková, I. Kautmanová, on pupae of Lepidoptera, 7 stromata; – 16.9.2002, S. Ripková, V. Kautman, on caterpillars and one pupa of Lepidoptera, 7 stromata, PVK 61; – 27.9.2005, V. Kučera, 4 stromata, one thin with a few perithecia, on pupa of Lepidoptera, PVK 83. ● Melčice village, Melčická dolina valley, loc. Pod Zabudíšovou, Q 7172, alt. 410 m, in mowed meadow; – 26.11.2002, K. Devanová, 3 stromata, without host, PVK 65. ● Zubák village, N slope of Zubák hill, Q 6875, alt. 450 m, in mowed meadow near spruce forest; – 28.10.2007, T. Ozimý, 2 pupae of Lepidoptera (2, 4 stromata), PVK 252. ● Adamovské Kochanovce village, Kurinov vrch Natural Monument, Q 7131, alt. 390 m; – 9.10.2008, K. Devanová, 2 stromata without host, PVK 614. ● Chochoľná – Veľčice, Kykuľa hill., Q 7072, alt. 710 m, meadow; – 12.10.2008, E. Pisarčíková, 2

stromata on Lepidoptera pupa, in grass in meadow, PVK 516. ● Mikušovce village, loc. Mikušovský lom, NE exposition, Q 6975, alt. 320 m, xerotherm pasture, in grass; – 9.11.2008, M. Filípek, 2 stromata on lepidopteran pupa, PVK 577. ● Melčice village, Melčická dolina valley, loc. Haluzické kopanice, Q 7172, alt. 280 m, on meadow; – 22.10.2009, 5 parasitised pupae of Lepidoptera, on 3 places, PVK 765. ● Chochoľná – Velčice village, Chochoľanská dolina valley, loc. Pod hájom, S slope, Q 7173, alt. 310 – 320 m, on meadow near old oak forest; – 13.11.2009, F. Šaržík, 5 individuals on lepidopteran pupae, photo, pers. inf.

Vihorlatské vrchy Mts., Nature Reserve Vihorlatský prales, Q 7198, beech forest; – 30.9.2002, J. Terray, on pupa in cocoon 6 small stromata in cluster, PVK 67. ● Snina town, Hrb hill, Q 7099, alt. 360 m, in mosses under the *Pinus*; – 16.10.2008, J. Pavlík, one stroma on caterpillar, PVK 580; – 4.12.2008, J. Pavlík, 2 stromata on 2 old pupae, PVK 611.

Kremnické vrchy Mts., Turovské predhorie, Kováčová village, ESE from the top of Stará Kováčová hill, Q 7480, alt. 350 m, in grass in garden, under *Pinus sylvestris*, on caterpillars and pupae of Lepidoptera; – 15.-20.11.2002, S. Glejdura, ca 70 stromata, LDM 2527, PVK 59; – 15.11.2003, S. Glejdura, 7 individuals, pers. inf.; – 2.11.2008, S. Glejdura, 2 stromata on caterpillars, PSG 9/28.

Hronská pahorkatina upland., Kozárovce town, house no. 899, Q 7677, alt. 190 m, in courtyard, in mossy ground under a maple tree, covered with fallen leaves; – 14.11.2003, V. Kabát, on pupa in cocoon, one stroma, PVIK 103/65.

Oravská brázda basin., Oravice – Peciská village, at the mouth of Suchá and Juráňová valleys, Q 6784, alt. 1050 m, in spruce forest; – 30.7.2004, P. Tomáš, 2 stromata on pupa in cocoon, hidden in rotten, mossy stump, OP 219/2004(B-1765).

Laborecká vrchovina Mts., Osadné village, Q 6898, alt. 400 m, in grass in pasture, – 6.10.2004, V. Kučera, 5 stromata on caterpillar of Lepidoptera, PVK 85; – 7.10.2005, V. Kučera, PVK 58; – 18.9.2006, V. Kučera, S. Adamčík, S. Ripková, 3 stromata (1,2,3 stromata) on pupae of Lepidoptera, PVK 148, PVK 149, PVK 150. ● Snina town, Širkán hill, Q 6998, alt. 315 m, in forest with *Alnus glutinosa*, *Salix caprea*, *Cerasus avium*, *Crataegus laevigata*; – 25.5.2008, J. Pavlík, one carphophore on pupae in leaves in *Alnus* forest, PVK 374; – 25.6.2009, J. Pavlík, alt. 280 m, 2 stromata on lepidopteran pupae, meadow under *Alnus*, *Crataegus*, PVK 621. ● Snina town, park near the factory Vihorlat, Q 7098, alt. 220 m; – 28.9.2008, J. Pavlík, 7 stromata on Lepidoptera caterpillars and pupas in grass with moss, BRA CR12209, PVK 578, PVK 579; – 9.10.2008, J. Pavlík, 3 stromata in grass under *Pinus*, PVK 581.

Javorníky Mts., Dolná Maríková village, Kátlina settlement, Maríkovská dolina valley, in meadow, Q 6775, alt. 550 m; – 5.10.2005, H. Deckerová, 6 stromata on caterpillar of Lepidoptera, PVK 84. ● Púchov town, loc. Špic at the bank of the Váh river, Q 6876, alt. 210 m, in lowland flooded forest (*Populus* sp., *Pinus* sp., *Alnus* sp.); – 2.12.2006, T. Ozimý, 3 stromata on pupa of Lepidoptera, PVK 205; – 23.12.2006, Martin Burian, 2 stromata on pupa of Lepidoptera, PVK 206; – 5.-21.10.2008, M. Burian, 15 stromata solitary or 2 stromata on Lepidoptera caterpillars and pupae, PVK 541; – 3.-17.11.2008, Martin Burian, 14 stromata only on pupae of Lepidoptera, BRA CR12205, PVK 594. ● Púchov town, Lachovec hill, Q 6875, alt. 246 m, in mixed broadleaved forest with pines; – 12.5.2007, Martin Burian, 2 stromata on pupa of Lepidoptera buried 1 cm in soil, PVK 218; – 14. 5. 2007, Martin Burian, one long stroma on pupa of Lepidoptera buried 3 cm in soil, PVK 219; – 3.11.2007, Miroslav Burian, 3 pupae of Lepidoptera with 2 stromata each, PVK 358, PVK 359; – 8.5.2008, T. Ozimý leg., V. Kautman det., 4 stromata on cocoon of Lepidoptera, PVK 372. ● Horné Kočkovce village, Záskanie, N slope of Kozinec hill, Q 6976, alt. 420 m, in

- meadow; – 1.11.2008, T. Ozimý, 2 stromata on lepidopteran pupa, pers. inf.; – 21.10.2009, T. Ozimý, 5 parasitised caterpillars and pupae of Lepidoptera, PVK 764.
- Strážovské vrchy Mts.**, Priedhorie village, recreation area Podskalie, Podskalský Roháč mt., Q 6976, alt. 400 m, in lawn at the recreation area, in soil and mosses; – 6.10.2005, E. Pisarčíková, 6 stromata on caterpillar of Lepidoptera, PVK 84; – 6.10.2005, P. Marstad, on pupa in cocoon of Lepidoptera, one stroma, PVK 82. ● Belušícké slatiny village, Q 6976, alt. 400 m; – 7.6.2008, O. Roučka, one stroma on pupa in mixed forest, PVK 375. ● Čelkova Lehota – Bristenské village, SW slope of Stankov hill, Q 6977, alt. 510 m, pasture; – 19.10.2008, T. Ozimý, O. Roučka, 4 stromata on 2 pupae, PVK 545. ● Nová Dubnica town, loc. Veľký Kolačín, NW slope of Slimáková hill, Q 7074, alt. ca 340 – 360 m, on pasture; – 30.10.2009, R. Galková, M. Zajac, 2 individuals on pupae, 2 places, PVK 780. ● Bojnice town, part Dubnica, loc. Bohátka, N slope, Q 7277, alt. 350 m, in meadow in oak forest with *Carpinus* and young *Picea*, in mosses; – 8.11.2009, L. Majdánová, 2 stromata, photo, pers. inf.
- Ondavská vrchovina Mts.**, Holčíkovec village, house no. 22364, Q 6996, alt. 155 m, in lawn; – 9.10.2005, P. Verdon, one stroma, pers. inf. ● Veľopolie village, S slope of Hill Dúbrava, Q 7097, alt. 238 m, on meadow near forest; – 14.11.2009, M. Hrabovský, ca 10 stromata on caterpillars and pupae, PVK 782.
- Štiavnické vrchy Mts.**, Banská Štiavnica town, in old orchard in Katova street, Q 7579, alt. 700 m; – 1.10.2006, V. Kučera, on pupa of Lepidoptera, one stroma in grass, PVK 170.
- Stolické vrchy Mts.**, Muránska Zdychava village, Karafová valley, near Zdychava stream, Q 7286, alt. 870 m, in mixed forest (*Fagus sylvatica*, *Picea abies*); – 9.8.2007, I. Kautmanová, on 2 pupae of Lepidoptera in cocoons (1 and 2 stromata), buried in beech leaves, PVK 271; – 9.10.2008, S. W. Hansse, 2 stromata on Lepidoptera pupa on pasture - meadow, PVK 503.
- Považský Inovec Mts.**, Piešťany town, Banka village, loc. Nad Bankou, Q 7473, alt. 220 m, in meadow near mixed forest (*Quercus*, *Fagus*, *Acer*, *Pinus*, *Crataegus*, *Prunus*, *Ligustrum*, *Rosa*); – 18.10.2007, L. Tábi, 2 pupae of Lepidoptera ca 10 m apart, PVK 319, PVK 320; – 20.10.2007, L. Tábi, 3 cocoons of Lepidoptera, (2,3,3 stromata), PVK 321, PVK 322, PVK 323; – 26.10.2007, J. Komár; – 27.10.2007, L. Tábi, J. Červenka, V. Kautman, stromata on 5 caterpillars and pupae of Lepidoptera, PVK 327, PVK 328, PVK 329, PVK 330; – 19.9.2008, V. Kautman, one stroma on Lepidoptera pupa in meadow, PVK 483; – 2.10.2008, L. Tábi, one stroma on caterpillar of Lepidoptera, PVK 507; – 25.10.2008, V. Kautman & al., 24 stromata on caterpillars and pupae of Lepidoptera, BRA CR12203, PVK 559; – 24.10.2009, B. Kuzmová, L. Tábi, V. Kautman, 20 parasitised caterpillars and pupae of Lepidoptera, PVK 770, PVK 771. ● Nová Lehota village, loc. Šuhalky, Q 7373, alt. 425 m, on meadow near forest with *Quercus*, *Fagus*; – 17.11.2008, J. Komár, 2 stromata on caterpillar, PVK 584; – 20.11.2008, J. Komár, 2 stromata on caterpillar, PVK 610.
- Malá Fatra Mts.**, Rajec – Šuja town, Q 6977, alt. 480 m, in mowed meadow near spruce forest; – 1.11.2007, L. Faturík, O. Roučka, M. Račko, 7 lepidopteran caterpillars and pupae in silky cocoons, PVK 354, PVK 355; – 3.11.2007, L. Jánošík, 2 lepidopteran caterpillars, PVK 346; – 8.12.2007, L. Jánošík, 6 lepidopteran caterpillars (2 remaining from previous visit), PVK 368; – 28.12.2007, L. Jánošík, one old specimen in snow, photo; – 5.10.2008, L. Jánošík, 5 stromata on caterpillars and pupae of Lepidoptera, PVK 529; – 30.11.2008, L. Jánošík, cluster of 10 stromata on caterpillar, PVK 609.
- Turzovská vrchovina Mts.**, Turzovka village, Q 6577, alt. 550 m, in submontaneous unimproved grassland; – 1.11.2007, T. Ozimý, 3 stromata on pupa of Lepidoptera, PVK 253. ● Vysoká nad

Kysucou village, N slope of Galkovo hill, Q 6577, alt. 620 m, in meadow; – 25.10.2009, M. Zajac, 3 stromata on lepidopteran pupa, PVK 774.

Veľká Fatra Mts., Blatnica village, Dedošova dolina valley, Q 7080, alt. ca 800 m, in debris near stream in forest (*Fagus*, *Picea*); – 13.8.2008, I. Mihál & al., one stroma on lepidopteran pupa, PVK 618.

Zvolenská kotlina basin, Zvolen town, arboretum Borová hora, Q 7480, alt. ca 400 m, on meadow; – 29.-30.9.2009, I. Kautmanová, V. Kautman, 9 parasitised caterpillars and one small pupa in grass, PVK 715, PVK 716; – 27.10.2009, M. Zajac, 11 parasitised caterpillars and pupae, PVK 784. ● Zvolen town, loc. Červený medokýš, N slope of Baba hill, recreation area Červený medokýš, Q 7480, alt. ca 330 m, on meadows near cottages; – 2.10.2009, M. Zajac, 7 parasitised caterpillars and pupa, PVK 752.

Považské podolie basin, Adamovské Kochanovce village, loc. Vinohrady, Q 7173, alt. ca 240 m, on pasture; – 23.10.2009, K. Devanová, one stroma without host, PVK 772.

Tribeč Mts., Zlatno village, 2 km SW from village, W slope of Skalka hill, Q 7575, alt. 315 m, oak forest margin, meadow with mosses; – 13.11.2009, M. Rajtár, 12 stromata on 6 parasitised caterpillars and pupae of Lepidoptera, PVK 789.

***Cordyceps militaris* var. *sphaerocephala* J. C. Schmidt**

Rarely recorded worldwide, known e. g. from Japan and Democratic Republic of Congo (Kobayasi, 1940, Moureau, 1949, 1962, Koval', 1984). In Europe recorded in AT*, BY, CZ*, DE*, EE*, SK*. From typical *C. militaris* this variety differs by small size (up to 1 – 2 cm), slender stromata with small, 1 – 2,5 mm perithecial parts. Stromata grow in clusters (2 – 40) from small, mummified caterpillars or pupae of Lepidoptera.

RECORDS FROM SLOVAKIA

In Slovakia recorded once at Považský Inovec Mts. Probably overlooked due to small size and inconspicuous colour.

Považský Inovec Mts., Piešťany town, Banka village, loc. nad Bankou, Q 7473, alt. 220 m, in old mowed meadow near mixed forest (*Quercus*, *Crataegus*, *Prunus*, *Ligustrum*, *Rosa*); – 25.10.2008, V. Kautman, 5 stromata on small black caterpillar of Lepidoptera, PVK 595.

***Cordyceps tuberculata* (Lebert) Maire em. Petch**

SYN.: *Acrophyton tuberculatum* Lebert, *Torrubia sphignum* Tul. & C.Tul., *Cordyceps sphignum* (Tul. & C.Tul) Berk. & M.A.Curtis,

ANAMORPH: *Akanthomyces pistillariiformis* (Pat.) Samson & H. C.Evans

Rare in the temperate region, known also from North America, South America* (Ecuador*, British Guayana*, Brasil*) Cuba*, St. Domingo, Africa (Madagascar*, Congo, Zair*, Sierra Leone*), New Guinea, New Zealand, Sri Lanka, India, Japan, China, Korea, Tahiti and Phillipines. In

Europe it has been recorded in BY, CZ, DK, EE, LT, LV, RU, SE, SK* UA (Kobayasi 1940, Moureau 1949, 1962, Mains 1958, Koval' 1984, Læssøe 1982, Teng 1996).

It parasitises moths of many families, mostly *Noctuidae* and *Sphingidae* (Lepidoptera), which are not buried in the soil, but stuck to stones, stalks, stems, mosses and branches by white mycelial strands. It occurs in various forms distinguished by the arrangement of stromata and perithecia (Kobayasi 1940). It prefers cold seasons and could be found in winter and in wet caves, mines, cellars and tunnels, parasitising hibernating imagines of moths. Probably overlooked due to specific habitat and time of its occurrence.

RECORDS FROM SLOVAKIA

In Slovakia it was collected by Polish mycologists, twice at the same locality in 2002.

Podtatranská brázda basin., Oravice village, Q 6784, alt. 840 m, in spruce forest, – 5.10.2002, W. Kaminski leg., V. Kautman det., on *Noctuidae* moth, on coniferous wood, half-buried, over 50 stromata, BRA CR9313, PVK 68; – 13.12.2002, P. Chilecki, anamorph on moth, in side branch of living willow, photo, pers. inf.

Ophiocordyceps sphecocephala (Klotzsch ex Berk.) G. H. Sung, J. M. Sung, Hywel-Jones & Spatafora

SYN.: *Cordyceps sphecocephala* (Klotzsch. ex Berk.) Berk. & M. A. Curtis, *Torrubia sphecocephala* (Klotzsch & Berk.) Tul. & C. Tul.

ANAMORPH: *Hymenostilbe sphecocephala* (Ditmar) Petch

Widespread species in northern temperate, as well as in tropical and subtropical regions. Known from Japan, China, Korea, Congo, South America (Jamaica*, Cuba, Guadeloupe, St. Vincent, Brasil) In Europe found sporadically in AT*, CH*, CZ*, DE*, DK*, FR*, GB*, IT*, NL, NO, PL*, RU, SE*, SK* (Kobayasi 1940, Mains 1958, Moureau 1962, Breitenbach 1981, Koval' 1984, Sung 1996, Teng 1996, Eriksson 2005).

This species parasitises *Hymenoptera*, mostly wasps, hornets and ichneumonids, rarely also ants. Sometimes it is misinterpreted as *Ophiocordyceps fourquignoni* which parasitised only flies and is different from *O. sphecocephala* (Stensrud & al. 2005, Sung & al. 2007). Species is often confused also with *Ophiocordyceps oxyccephala*, *O. myrmecophila*, *O. forquignoni* and *O. bicephala*.

In Slovakia recorded most often on wasps *Paravespula vulgaris* (Kabát 2000). Taxonomy of the species is complex and recently it is under revision (Van Vooren, Audibert 2005, 2006). It often occurs in a conidial form and only as such it was known from Slovakia until 2008. In 2008 first

teleomorphs were found. Parasitised insect is usually half-buried or lay on the ground in leaf debris and mosses. Yellow, ochraceous or whitish, capitate stromata, probably overlooked due to their small size and inconspicuousness, occur in summer and autumn. Finds are isolated and random. In Slovakia first recorded by K. Kříž in 1956 in Belianske Tatry Mts., 30 years later, in 1984 Kuthan and in 1988 Antonín found it at Veporské vrchy Mts. and at Malá Fatra Mts. Other records were made in 1999 by Tomáš and Kautmanová at Orava region and Glejdura at Kremnické vrchy Mts. The first records of species first teleomorphs in Slovakia were collected by Fecko in Levočské vrchy Mts. in 2008. The last record (teleomorph) collected by M. Kříž is from Vydrovo in 2009. Until recently 10 records at 9 localities, all of them in mountains.

RECORDS FROM SLOVAKIA

Known from Malá Fatra Mts. (1 locality), Oravská kotlina basin (1), Belianske Tatry Mts. (1), Kremnické vrchy Mts. (1), Veporské vrchy Mts. (3), and Levočské vrchy Mts. (2).

Belianske Tatry Mts., Tatranská kotlina village, dolina Siedmych prameňov valley, Plesnivce lodge, Q 6787, alt. 1300 m, *Picea, Larix, Sorbus*; – 18.7.1956, K. Kříž, infertile, BRNM 224230.

Malá Fatra Mts., Bystrička village, loc. Martinské hole - Lazy, Q 6979, alt. 700 m; – 28.7.1984, J. Kuthan (as *C. sphecophila*), cluster of infertile stromata on destroyed *Vespula* sp., BRA CR9105.

Veporské vrchy Mts., Čierny Balog village, Ramža hill, Q 7283, alt. 900 m; – 9.1988, J. Kuthan, (Škubla 2003). ● Čierny Balog – Dobroč village, Dobročský prales Nature Reserve, Q 7284, alt. 850 m; – 15.9.1988, V. Antonín, 7 infertile stromata on wasp, BRNM 462299. ● Čierny Balog – Vydrovo village, Obrubovanská dolina valley, Q 7283, alt. 630 m, spruce forest with *Alnus incana*, near road and stream; – 11.9.2009, M. Kříž, one teleomorph in mosses and needles with destroyed part of *Vespula* sp., PVK 757.

Oravská kotlina basin, Trstená village, loc. Za Jelešňou, Q 6583, alt. 670 m, spruce forest; – 10.7.1999, P. Tomáš, cluster of conidial stromata on wasp *Vespula vulgaris* laying in spruce needles, OP (PE 17/1999).

Kremnické vrchy Mts., Kováčová village, Kováčovská dolina valley, Ovčiar lodge, Q 7380, alt. 360 m; – 24.6.1999, S. Glejdura, cluster of infertile stromata on wasp, LDM 1311.

Levočské vrchy Mts., Breznica village, Jaškovec valley, ca 3,2 km of the village, Q 6890, alt. 700 m, in mixed forest (*Abies, Picea, Larix, Fagus, Salix, Corylus*); – 13.7.2008, R. Fecko, at the stream, among the roots of spruce stump, on wasp *Vespula vulgaris*, conidial form, PVK 556. ● Nižný Slavkov village, Kunišov valley, Q 6890, alt. ca 720 m, in mixed forest; – 17.7.2008, R. Fecko, one stroma (teleomorph) on wasp *Vespula vulgaris*, PVK 557; – 27.7.2008, R. Fecko, one stroma (teleomorph) on wasp *Vespula vulgaris*, with spherical perithecial part, PVK 558.

***Ophiocordyceps clavulata* (Schwein.) Petsch.**

SYN.: *Cordyceps clavulata* (Schwein.) Ellis & Everh., *C. pistillariformis* Berk. & Broome

ANAMORPH: ? *Hymenostilbe lecaniicola* (Jaap) Mains

Inconspicuous small species, with scattered occurrence in many European countries. Recorded in AT*, CZ*, DE, GB*, LV*, PL*, RO, RU, SE*, SK*, UA, known also from USA* and Canada*. (Moesz, 1909, Stec-Rouppertowa, 1938, Kobayashi 1940, Kovač, 1984, Eriksson, 2005).

It parasitises scale insects – *Lecaniidae* (*Coccinea*) most often females of *Eulecanium* (*Lecanium*) *corni*. Anamorphs and teleomorphs (often together), 2 – 5 mm long, grey or grey-black, grow out of the insect bodies solitary or in clusters of 2 – 8 stromata. Occurrence almost year round, depending on suitable weather conditions. Parasitised scale insects were recorded on *Alnus* sp., *Carpinus betulus*, *Corylus avellana*, *Ilex aquifolium*, *Fraxinus* sp., *Philadelphus coronaria*, *Prunus* sp., *Robinia pseudoacacia*, *Sarothamnus* sp., *Spiraea salicifolia* and *Ulmus* sp. Often recorded once in many years, then in large numbers, and disappearing again for a long period (Stec-Rouppertowa 1938). This species was not known from Slovakia, but in 2006 – 2008 the authors found in various herbaria 9 specimens of the Zahlbruckner's exsiccate collection (Krypt. Exs. 1817/c) from the locality Fenyökosztolanyi (recently Jedľové Kostolány, western Slovakia), collected at the end of 19. and beginning of 20. centuries. These records were also published by Moesz (1909). Until now this is the single known locality in Slovakia.

RECORDS FROM SLOVAKIA

Pohronský Inovec Mts., Jedľové Kostolány village, Q 7576, alt. 500 m; – 7.1892, G. Moesz, on females of *Lecanium corni* on twigs of *Philadelphus coronarium*, BP 71691, K(M)155694, M 0125518, PRM 6721c, SF 35806, W 7126c; – 8.1908, G. Moesz, on *Lecanium* on branches of *Philadelphus coronarium*, BP - without number, M 0125518, PC 1817c, PC 1817c - 2 specimen with one number.

***Ophiocordyceps gracilis* (Grev.) G. H. Sung, J. M. Sung, Hywel-Jones & Spatafora**

SYN.: *Cordyceps gracilis* (Grev.) Durieu & Mont., *C. mawleyi* Westwood.

ANAMORPH: *Paraisaria dubia* (Delacr.) Samson & B. L. Brady

Though the species is rare, it is scattered throughout the whole Europe, recorded in BE, BY, CZ*, DE*, DK*, EE, ES*, FI*, FR*, GB*, HU*, NO*, PL*, RU, SE*, SK*. Known also from North America, South America (Brasil), China, Australia, New Zealand, Sri Lanka, Democratic republic of the Congo and Alger (type locality), (Lloyd, 1915, Cunningham, 1921,

Kobayasi, 1940, Moureau, 1962, Koval', 1984, Teng, 1996, Eriksson, 2005).

It parasitises caterpillars and rarely pupae of various Lepidoptera burried 1 – 5 cm deep in soil, mostly among grasses, sometimes in fallen leaves, mosses. Very rarely on beetle larvae (Mains, 1958). Ochraceous-orange stromata with distinct, capitate fertile parts grow out of the similarly coloured insect bodies, solitary, rarely in 2 or 3. They occur early in the season, sometimes as soon as the end of April, latest records are from late summer, rarely in autumn. Parasitised insect is found mostly in old semi-natural grasslands, mowed meadows or pastures, less often in forests and forest margins. In Slovakia rare, but may be overlooked, recently 9 collections from 6 localities. Only 2 records from 20th century are known (Filarszky and Moesz, 1908 – Vysoké Tatry Mts., labelled as *C. entomorrhiza*, Zahradník 1953 – Kováčovské kopce hills). In 2001 Škubla confirmed the historical record of Zahradník from the vicinity of Kováčov village and (Škubla, 2003). In 2003 – 2005 the species was repeatedly collected by Polish mycologists at Oravice in northern Slovakia. In 2003 also E. Röhner found one stroma in Tichá dolina valley. In 2004 authors found *O. gracilis* at Nízke Tatry and in 2007 Kadlec found one individual without host in Orava near Zuberec village, until now the last known locality.

RECORDS FROM SLOVAKIA

Known from Burda Mts.,(1 locality), Skorušinské vrchy Mts.,(1), Vysoké Tatry Mts.,(1), Západné Tatry Mts.,(2) and Nízke Tatry Mts.,(1).

Vysoké Tatry Mts., Kežmarské žľaby, loc. Pri Čiernej vode, Q 6787; – 16. 6. 1908, F. Filarszky (as *C. entomorrhiza*), BP 1724.

Burda Mts., Kováčov village, Q 8178, alt. 220 m, in meadow; – 4.5.1953, J. Zahradník, in mosses, upper part of one young stroma without host; (Fassatiová 1954); – 22.7.2001, P. Škubla, at the edge of oak forest and old meadow, in fallen leaves, many stromata, photo, pers. inf.

Skorušinské vrchy Mts., Oravice village, 2 km N from the village, Q 6684, alt. 810 m, on caterpillars, in grass in meadow; – 22.5.2003, W. Kamiński, KRAM F 54110; – 18.5.2004, W. Kaminski, 3 stromata BRA CR8434, KRAM F 541; – 14.5.2005, D. Karasinski, 1 stroma, BRA CR9309, PVDK 2211.

Západné Tatry Mts., Podbanské village, Tichá dolina valley, at the mouth of the Tomanová dolina valley, Q 6785, alt. 1165 m, near Tichý potok stream, in spruce forest; – 2.10.2003, E. Röhner, one stroma without host in mosses, PVK 95. ● Zuberec village, loc. Úplazíky, Vápenná skala, near Sivý potok stream, Q 6784, alt 850 m, spruce forest, in mosses; – 8.7.2007, S. Kadlec, one individual without host, PVK 255.

Nízke Tatry Mts., Malužiná village, Michalovo valley, loc. Grúň, Q 6984, alt. 780 m, near spruce forest; – 13.-15.6.2004, I. Kautmanová, V. Kautman, 9 stromata, on caterpillars and one pupa of

Lepidoptera burried in soil (3 - 8 cm), in pasture, in short grass, orange coloured caterpillars hidden among the roots of grass, BRA CR3523, PVK 60.

Ophiocordyceps entomorrhiza (Dicks.) G. H. Sung, J. M. Sung, Hywel-Jones & Spatafora

SYN.: *Cordyceps entomorrhiza* (Dicks.) Fr., *C. cinerea* (Tul. & C. Tul.) Sacc., *C. carabi* Quél.

ANAMORPH: *Hirsutella eleutheratorum* (Nees) Petch

Very rare in North America and Africa (Kongo) but widespread in Asia and Europe, where it is known from AT*, BE, BY, CZ*, DE*, DK*, FI*, FR*, GB*, HU*, IT, NO*, PL*, RU, SE*, SK* (Kobayasi, 1940, Koval', 1984, Ghyselinc, 2002, Eriksson, 2005 a. o.).

It parasitises larvae and adults of ground-beetles (*Carabidae*), mostly of the former genus *Carabus*, rarely smaller species, sometimes *Calosoma* and rove beetles (*Staphylinidae*), Kautman and Kautmanová (2002) published *Ocypus* sp. as a new host for the species, later it was recorded also on small ground beetle of the genus *Pterostichus* sp. In Europe recorded on *Carabus* (*Archicarabus*) *nemoralis*, *C. (Chrysocarabus) auronitens*, *C. (Megodontus) violaceus*, *C. (Oreocarabus) hortensis*, *C. (Oreocarabus) glabratus*, *C. (Procrustes) coriaceus* and others. In Japan and south-east Asia on the big species of ground beetles (*Carabidae*), also on genus *Carabus* (*Ohomopterus*), *Damastor* (*Coptolabus*) and others. Parasitised larvae are burried deep in the soil (up to 10 cm) or lay in leaves and mosses, outgrown by white mycelium. Adults usually above the ground in mosses or fallen leaves and debris. Stromata grow solitary or in clusters of 2 – 4(7), sometimes together with anamorphs. Stromata black, black-grey, upper part greyish, white-grey, pink or violaceous on perithecial part. *O. entomorrhiza* occurs from spring to autumn, the first record from 31.5. (Púchov, 2008), the last from 17.10. (Dobročský praes, 2004), mostly in deciduous forests, sometimes on meadows. In Slovakia collected only since 2002. Old record published from Vysoké Tatry Mts. by Moesz (1909) was in fact *Ophiocordyceps gracilis*. In certain localities it has been observed in large numbers year after year (Louny, CZ*). Until recent 14 records from 11 localities in Slovakia.

RECORDS FROM SLOVAKIA

Known from Podunajská rovina lowland (1 locality), Malé Karpaty Mts. (2), Biele Karpaty Mts. (1), Javorníky Mts. (2), Žilinská kotlina basin (1), Malá Fatra Mts. (1), Oravská vrchovina upland (1), Štiavnické vrchy Mts. (1), Veporské vrchy Mts. (1).

Malé Karpaty Mts., Bratislava – Lamač, loc. Plánky, Q 7768, alt. 260 m, in deciduous forest (*Carpinus*, *Quercus*); – 16.6.2002, J. Červenka, on *Ocypus* sp. (*Staphylinidae*), part of the head with mandible (I. Rychlík det.), 3 stromata, PVK 63. ● Mariánka village, loc. Pod vrchom, SE slope, in deciduous forest (*Quercus* sp., *Carpinus betulus*, *Fagus sylvatica*), Q 7768, alt. 270 m; – 31.8.2005, V. Kautman, one individual on *Carabus* sp. larva, buried ca 6 cm in soil, stroma contorted, more than 12 cm long, protruding 5 cm above ground, PVK 79; – 16.6.2006, V. Kautman, I. Kautmanová, one stroma on larva of *Carabus* sp., buried ca 10 cm in soil ca 100 m from the first record, PVK 81.

Biele Karpaty Mts., Drietoma village, part Liešna, loc. Bedové, Q 7073, alt. 720 m; – 22.6.2002, J. Svoboda, 2 stromata on female of *Carabus (Megodontus) violaceus* (V. Kautman det.), PVK 62; – 6.2003, J. Polčák, stromata on *Carabus (Megodontus) violaceus*, pers. inf.

Podunajská rovina lowland, Rusovce village, Dunajské ostrovy Nature Reserve, Horný ostrov, Q 7968, alt. 160 m, in deciduous forest (*Fraxinus* sp., *Ulmus* sp., *Quercus* sp., *Populus* sp.); – 10.6.2004, D. Karasiński, in lowland flooded forest (*Fraxinus* sp., *Populus* sp., *Salix* sp., *Ulmus* sp.), one stroma extremely long and straight, on big larva of *Carabus* sp., slightly buried in soil, PVDK 040610.

Veporské vrchy Mts., Čierny Balog – Dobroč village, Dobročský prales Nature Reserve, Q 7284, alt. 800 m; – 17.10.2004, M. Machálik, on *Carabus (Oreocarabus) glabratus* (V. Kautman det.), PVK 371.

Javorníky Mts., Púchov town, Lachovec hill, Q 6875, alt. 240 m, mixed forest; – 31.5.2008, Miroslav Burian, one stroma, conidial form, on larva of *Carabus* sp., in forest, PVK 451; – 20.9.2008, Martin Burian, 2 stromata, one on *Carabus* sp. larva without perithecial part, second individual with old perithecial part without host but with anamorph, PVK 494. ● Miločov village, Q 6876, alt. 230 m, deciduous forest in shrubs; – 7.6.2008, O. Roučka, one stroma without host, PVK 376.

Žilinská kotlina basin, Žilina city, loc. Žilinský lesopark, Q 6778, alt. 380 m, in mowed meadow with *Salix* sp., *Ainus* sp., *Crataegus* sp., *Prunus* sp., – 25.8.2008, L. Jánošík, one stroma on larva of *Carabus* sp., 8 cm under the ground, with anamorph, PVK 463.

Malá Fatra Mts., Turie village, Turská dolina, Q 6878, in spruce forest mixed with *Fagus sylvatica*; – 28.9.2008, L. Jánošík, 4 destroyed stromata on small carabid beetle (*Pterostichus* sp.), PVK 530.

Štiavnické vrchy Mts., Nová Dedina village, loc. Sovia dolina valley, near stream Podlužianka, Q 7677, alt. ca 350 m; – 4.7.2009, V. Kautman, one stroma without perithecia with anamorph on carabid larva, in leaves under the *Quercus*, PVK 628.

Oravská vrchovina upland, Dolný Kubín town, loc. Kuzmínovo, Q 6881, alt. ca 650 m, on wet place in *Petasites*; – 7.8.2009, M. Švidroň, V. Kautman, on destroyed female imago of *Carabus coriaceus* (V. Kautman det.), 7 stromata without perithecia on all parts of beetle, PVK 670.

Ophiocordyceps myrmecophila (Ces.) G. H. Sung, J. M. Sung, Hywel-Jones & Spatafora

SYN.: *Cordyceps myrmecophila* Ces., *Torrubia myrmecophila* (Ces.) Tul. & C. Tul., *Cordyceps depokensis* Koord.

ANAMORPH: *Hymenostilbe*

Small, inconspicuous and rarely found species recorded worldwide, though not in many collections. Recorded in North America, South America*, (Brasilia*), China, Korea, New Guinea, Sri Lanka, Uganda* and Borneo, but often misinterpreted. In Europe it is known from, BY, DK, EE, FI, FR*, GB, CH, IT* (type locality), PL, RU, SE*, SK* (Krzemieniewski, 1928, Kobayasi, 1940, Mains, 1958, Koval', 1984, Sung, 1996, Teng, 1996).

C. myrmecophila parasitises ants (Myrmicidae, Formicidae, Hymenoptera) in Slovakia mostly *Camponotus piceus*, but we recorded it also on workers of *Formica pratensis* (det. J. Devan), *Formica sanguinea*, *Myrmica laevinodis* (det. T. Kožíšek), one species of *Braconidae* and one species of *Ichneumonidae*. We studied specimens from Brasilia parasitising metallic Hymenoptera, not ants – S (without number), W 3649.

Small white-ochraceous, ochraceous-yellow stromata with yellow cap grow of the insect, solitary or in clusters of 2 – 8, sometimes up to 11 – 13. Very rarely (7 stromata) the stromata branch in two. Length of the stroma depends on the depth in which the host is burried, from 3 to 70 mm, rarely more. Stromata on small workers growing from deeply burried ants are thin, thread-like and contorted, rarely numerous (2,3,4). Fungi parasitising big bodies of queens are comparatively larger, stout and often numerous (2 – 6, up to 13). Some of the parasitised insects were found above the ground with short stromata.

Often confused with *Ophiocordyceps sphecocephala*, *O. forguignoni*, in tropical regions also with *O. bicephala*.

RECORDS FROM SLOVAKIA

Numerous collections of the species in Slovakia from 2007, 2008, 2009, (35 collections from one locality, over 670 stromata) are from the same locality, in old orchard outgrown by various trees and shrubs, mostly broad-leaved, found by Burian and collected by authors and him. Most of the specimens were found in the eroded slope at the old forest road, in bare soil, mosses and grass, especially in shaded places. In 2009 three individuals was found by Zelenay on two localities near Oravské Veselé and one individual Devanová found in Bošáca. We have recorded the species from early June to December. Untill now 38 collections from 4 localities.

Known from Javorníky Mts. (1 locality), Oravské Beskydy (2) and Považské podolie basin (1).

Javorníky Mts., Púchov town, Lachovec hill, Q 6875, alt. 270 m, in old outgrown orchard (*Corylus avellana*, *Ulmus* sp., *Acer campestre*, *Carpinus betulus*, *Juglans regia*, *Prunus spinosa*, *Crataegus* sp. and others); – 10.6.2007, Martin Burian, one stroma on *Camponotus piceus* worker slightly buried in bare soil at the road, PVK 232; – 13.6.2007, Martin Burian, 5 stromata, on workers of *C. piceus*, PVK 233; – 15.6.2007, V. Kautman, I. Kautmanová, V. Kučera, numerous collections along the old forest road. Mostly on workers of *C. piceus*, twice on males of *Formica sanguinea*. Extremely big stromata on queens of *C. piceus* and one big *F. sanguinea*. One parasitised ichneumonid probably of the same species as we observed living among ants. Parasitised insects were found mostly on/in bare soil along the road (from few mm up to 5 cm deep), rarely in mosses, fallen leaves and grass. Stromata solitary, sometimes 2 - 3 rarely more on one host, BRA CR12208, PVK 378; – 17.6.2007, V. Kautman, numerous collections on 3 sites, on *C. piceus*, few of them laying on the ground. Stromata contorted in dry soil, BRA CR12207, PVK 379; – 22.6.2007, V. Kautman, numerous collections after heavy rains (ca 150 stromata) at above mentioned locality. Parasitised ants layed often on the top of the soil, probably washed out by rain, also in slope above the road. Stromata solitary or in 2 - 3, again big stromata on queens. Many dead *Camponotus* ants, probably drowned, one individual on black ichneumonid (Ichneumonidae), BRA CR12213, PVK 380; – 30.6.2007, Martin Burian, one stroma, on *C. piceus* ant, PVK 381; – 14.7.2007, V. Kautman, many (ca 100) parasitised *C. piceus* on the slope above the road, along the road and on the road (probably washed out stromata), 2 queens with big stromata (5 and 6 on each), BRA CR9145, PVK 382; – 12.8.2007, V. Kautman, the first rain after a month drought, 15 stromata, stromata solitary, PVK 383; – 28.8.2007, I. Kautmanová, V. Kautman, dry period, one stromata on worker, PVK 384; – 30.9.2007, V. Kautman, 5 old stromata in slope above the road, PVK 385; – 13.10.2007, Martin Burian, 3 stromata on *C. piceus* workers, one on *Formica sanguinea* worker PVK 335; – 20.10.2007, Martin Burian, 2 stromata on *C. piceus* workers, PVK 338; – 15.12.2007, Martin Burian, one contorted stroma on *C. piceus*, PVK 386; – 14.6.2008, Martin Burian, 3 stromata on 3 parasitized *C. piceus* (2 workers, 1 queen). PVK 387; – 21.6.2008, Martin Burian, 10 stromata on workers *C. piceus*, PVK 388; – 22.6.2008, V. Kautman, 28 stromata on workers of *C. piceus*, one ant bearing 4 stromata, BRA CR12206, PVK 389; – 10.7.2008, Martin Burian, 2 stromata on workers of *Formica sanguinea*, PVK 390; – 17.7.2008, M. Burian, 10 stromata on workers of *C. piceus*, PVK 453; – 10.8.2008, I. Kautmanová, V. Kautman, 25 stromata on workers (1, 2 stromas), and on 2 queens (2,4 big stromata), 4 individuals with stromata branch in 2 perithecial parts from one place, PVK 439, PVK 440; – 12.8.2008, M. Burian, one big stroma on queen of *C. piceus*, PVK 452; – 19.9.2008, V. Kautman, 7 parasitised workers of *C. piceus*, one with 2 stromata, one with stroma branch in 2 perithecial parts, PVK 484; – 20.9.2008, M. Burian, 2 parasitised ants of *C. piceus*, one queen with 2 stromata, PVK 493; – 26.10.2008, M. Burian, one individual, PVK 494; – 15.12.2008, M. Burian, one individual on *C. piceus* worker, PVK 608; – 5.6.2009, M. Burian, 14 individuals on *C. piceus* workers, 9 on queens PVK 620, PVK 696, PVK 697, PVK 698; – 3.7.2009, M. Burian, one individual on queen of *C. piceus*, PVK 696; – 6.7.2009, M. Burian, 8 parasitised queens of *C. piceus*; – 17.7.2009, V. Kautman, ca 90 individuals on *Camponotus piceus* ants, 2 of them on queen, one with 8 stromata, one with 3, PVK 659, PVK 660, PVK 661, PVK 662; – 25.7.2009, V. Kautman, more then 100 individuals, 6 parasitised queens of *C. piceus*, one queen with 13 mature stromata and 5 small imature, another queens with 2,3 stromata, some 6-7 cm long, one branched to 2 perithecial parts, only 2 parasitised workers with 2 stromata, another only with one stroma, one individual on small orange-black braconid (Braconidae), one individual on worker of *Myrmica laevinodis*

(*Myrmicidae*), PVK 663, PVK 664, PVK 665, PVK 666, PVK 667, PVK 668; – 7.8.2009, V. Kautman, 30 individuals on *C. piceus*, 5 on queens with (5,2,2,1,1) stromata, PVK 690, PVK 691, PVK 692; – 19.8.2009, V. Kautman, 4 individuals on workers of *C. piceus*, very dry weather, PVK 693; – 18.9.2009, V. Kautman, 5 individuals on workers, PVK 712.

Oravské Beskydy Mts., Oravské Veselé village, S slope of Hoľa hill, Q 6582, alt. 750 m on meadow with solitary *Picea* and *Populus tremula*; – 31.7.2009, M. Zelenay, 2 individuals on worker of *Formica sanguinea*, in mosses in long grass, PVK 656; – 1.8.2009, M. Zelenay, one individual on head of *Formica* sp. in mosses on meadow, PVK 657. ● Oravské Veselé village, S slope of Magura hill, Q 6582, alt. 670 m, on meadow in grass; – 1.8.2009, M. Zelenay, one long individual in mosses, on worker of *Formica sanguinea*, PVK 658.

Biele Karpaty Mts., Nová Bošáca village, loc. Balážová, Q 7173, alt. ca 450 m, in meadow; – 1.10.2009, K. Devanová, one small individual on worker of *Formica pratensis* (J. Devan det.), PVK 720.

***Elaphocordyceps ophioglossoides* (Ehrh.) G. H. Sung, J. M. Sung, Hywel-Jones & Spatafora**

SYN.: *Cordyceps ophioglossoides* (Ehrh.) Link., *Torrubia ophioglossoides* (Ehrh.) Tul., *Cordyceps parasitica* (Willd.) Henn.

ANAMORPH: verticillium-like

Probably the most common European *Elaphocordyceps* species parasitising hypogeous fungi of the genus *Elaphomyces*. Recorded in AT*, BE*, BY, CH*, CZ*, DE*, DK*, EE*, FI*, FR*, GB*, HU*, IT*, LV, NL*, NO*, PL*, RU*, SE*, SL, SK*, UA. Known also from Asia (Japan*, China) and North America (USA*, Canada*) (Kobayasi, 1940, Mains, 1957, Koval', 1984 a. o.).

Clavate fertile part is brown, in maturity almost black, in young specimens yellow, pale orange to orange-brown, yellow-brown, narrow stipe is pale brown to ochraceous. Size, shape and colour are rather variable. Stromata, solitary or in clusters of 2 – 15 (often branched to several perithecial parts). They are connected with the host by narrow greenish-yellow hyphae of various lengths, outgrowing and overgrowing the host body. In Europe it parasitises *Elaphomyces muricatus* and *E. granulatus*, often on the same localities. Rouppert collected species on *E. asperulus*. In Japan parasites *E. shimizuensis*, *E. titibuensis* and *E. japonicus* (Kobayasi 1960). Parasitised fruit bodies are sometimes buried deep in the soil (up to 20 cm), but more often near the surface. Host fruit bodies are brown to dark brown, outgrown by yellow mycelium of *Elaphocordyceps*. From Japan *E. ophioglossoides* f. *cuboides* and *E. ophioglossoides* f. *alba* was described (Kobayasi, 1960).

In Slovakia this typical forest species grows from lowlands to mountains, mostly in coniferous (spruce) woods, but occurs also in mixed (fir-beech)

and deciduous (oak) ones. It grows in moist, rarely in dry habitats, in fallen leaves, needles, mosses (*Dicranum* sp., *Leucobryum* sp., *Plagiomnium* sp., *Plagiothecium* sp., *Polytrichum* sp., *Pleurozium* sp. and sphagnum (*Lycopodium* sp.), often in great numbers sometimes together with capitate *Elaphocordyceps* species *E. capitata*, *E. longisegmentis* and *E. rouxii*. From summer (Dešná, 7. 7. 2007) to late autumn (Modra, 2. 12. 2008) or beginning of the winter if the weather is mild, 23.2. (Rača, 2007). From 145 m in Jakubov to 1350 m near Popradské pleso.

In Slovakia collected for the first time by Hazslinszky near Prešov and published by him in 1892 (Hazslinsky, 1892) and Moesz in 1930 (Moesz, 1930), eighteen years later collected by Roupert in 1909 and 1910 in Vysoké Tatry Mts. In 1910 – 1913 it was recorded by Filarszky in the vicinity of Novoveská Huta, and his exsicata were deposited in various herbaria around the world. Those collections were also published by Beneš and Melzer (1931). After another 40 years, in 1960, it was recorded again by Fábry in Malé Karpaty Mts. In following years it was recorded occasionally by various collectors (Lizoň, 1977, Škubla, 2003), until 1988, when it was found at Spálený vrch in Vysoké Tatry Mts. by Kuthan. For next ten years that was the single known locality of its occurrence, visited by many mycologists. In 1996 a new locality was discovered by Pardovič in Volovské vrchy and by Kautman in Orava region near Zuberec. Since 1999, when the authors focused on *Cordyceps* s. l. species, 101 new sites were recorded in Slovakia. Recently 197 collections from 113 localities are known, but probably the species is far more widespread, especially in the mountainous parts of Slovakia (all records, except the 3 from Borská nížina lowland, were from mountains).

E. ophioglossoides has been often confused with *Xylaria*, *Geoglossum* and *Trichoglossum* species, most often with *Geoglossum ophioglossoides*, *Trichoglossum hirsutum* and *Podostroma alutaceum* (labelled as *Cordyceps alutaceus*).

RECORDS FROM SLOVAKIA

Known from Borská nížina lowland (3 localities), Malé Karpaty Mts., (21), Javorníky Mts., (6), Považský Inovec Mts. (1), Žiar Mts. (1), Strážovské vrchy Mts. (1), Turzovská vrchovina Mts. (5), Moravsko-Sliezske Beskydy Mts. (1), Kysucká vrchovina Mts. (10), Kysucké Beskydy Mts. (1), Oravská Magura Mts. (7), Podbeskydská vrchovina Mts. (2), Oravské Beskydy Mts. (6), Oravská vrchovina (1), Skorušinské vrchy Mts. (4), Malá Fatra Mts. (9), Veľká Fatra Mts. (3), Nízke Tatry Mts. (2), Západné

Tatry Mts. (7), Vysoké Tatry Mts. (5), Belianske Tatry Mts. (1), Kozie chrbty Mts. (1), Slovenský raj Mts. (1), Levočské vrchy Mts. (2), Veporské vrchy Mts. (5), Volovské vrchy Mts. (2), Ľubovnianska vrchovina Mts. (1), Šarišská vrchovina Mts. (1), Laborecká vrchovina Mts. (1).

Šarišská vrchovina Mts., Prešov town vicinity, Q 7093, coniferous forest; – 1830, F. Hazslinsky, on *Elaphomyces*, BP (without number).

Vysoké Tatry Mts., Podbanské village, Kôprová dolina valley, Q 6885; – 8.1909, K. Rouppert, on *Elaphomyces asperulus*, KRAM-F 876; – 8.1910, K. Rouppert, KRAM-F 143. ● Štrbské pleso village, Mengusovská dolina valley, Spálený vrch Nature Reserve, Q 6886, alt. 1230 m, in spruce forest with *Abies*, surrounding peat-bog, undergrowth of *Vaccinium myrtillus*, *Calluna vulgaris*; – 7.9.1988, J. Kuthan, BRA CR9114; – 11.9.1988, J. Sand, L. Hagara, BRA CR9113; – 14.9.1989, P. Škubla, BRA CR9111; – 14.9.1989, L. Hagara, BRA CR9115; – 14.9.1989, J. Kuthan, BRA CR9108; – 15.9.1995, I. Kautmanová, BRA CR9117; – 15.9.1995, L. Varjú, BRA CR9109; – 15.9.1995, V. Antonín, BRNM 603616; 15.9.1996, S. Glejdura, in verb; – 27.8.2005, I. Kautmanová, V. Kautman, more than 100 stromata PVK 69, PVK 70. ● Podbanské village, loc. Kokavský most, Q 6885, alt. 900 m, in spruce forest; – 5.-8.8.2007, S. Husár, PVK 311, PVK 312; – 11.8.2007, L. Tábi, PVK 313; – 4.8.2008, L. Tábi, PVK 508; – 30.8.2009, M. Švidroň, PVK 745. ● Štrbské pleso village, loc. Popradské pleso, near the Poprad river, Q 6886, alt. 1350 m, in spruce forest; – 4.10.2007, L. Jánošík, 20 stromata in first snow, PVK 344. ● Podbanské village, loc. Mláky, Q 6885, alt. 1100 m, in wet spruce forest; – 14.10.2007, L. Jánošík, 70 stromata, PVK 345.

Volovské vrchy Mts., Novoveská Huta (Iglöfűred) village, Q 7089, alt. 830 m, spruce forest; – 8.1910, F. Filarszky (as *Cordiceps ophioglossoides*), BP 1727(75); – 8.1913, F. Filarszky (as *C. parasitica*), in pine forest on *Elaphomyces cervinus* (*E. granulatus*) and *E. asperulus*, BP 1728, BP 1729, BP 71675, BRA CR9106, BRA CR9107, BRNU 119718, BRNU 245430, C (without number), K(M) 155689, M, O (without number), PRM 11785, S (without number), SOMF 284, U (without number), W 474, W 16333, W 18973. ● Opátka village, 4 km N from, Zlatník valley, Q 7292, 650 m, in mixed forest (*Quercus* sp., *Carpinus betulus*, *Fagus sylvatica*, *Pinus silvestris*); – 30.8.1996, J. Pardovič, photo, pers. inf.

Malé Karpaty Mts., Bratislava – Rača city, Q 7768, alt. 320 m; – 17.7.1960, I. Fábry, BRA CR9112; Bratislava - Rača, NW slope on right side of Vajnorský potok creek, Q 7768, alt. 320 m, in mosses *Dicranum scoparium* and *Polytrichum formosum* under *Quercus* and *Fagus*; – 16.2.2007, M. Zelenay, near Vajnorský potok creek, several stromata in mosses under *Quercus* and *Fagus*, PVK 208; – 18.2.2007, I. Kautmanová, V. Kautman, M. Zelenay, near Vajnorský potok creek, ca 20 stromata young and mature, BRA CR9871, PVK 211, PVK 212, PVK 213, PVK 214; – 1.11.2007, V. Kautman, 6 small stromata on very small *Elaphomyces* carpophores, PVK 339. ● Bratislava city, Devínska Kobyla hill, Q 7868, alt. 270 m; – 19.9.1965, J. Kollár, BRA CR9116; – 9.1997, E. Záhorovská, (Škubla 2003) ● Kuchyňa village, Bučková hill, Q 7569, alt. 600 m, in rocky slope, in old oak-beech forest; – 24.9.1999, P. Tlčimuka, few stromata on *Elaphomyces* sp., PVK 80. ● Záhorská Bystrica village, at the foot of Cimbal hill, Q 7768, alt. 280, in oak forest; – 10.11.2002, V. Kabát, on *Elaphomyces granulatus*, pers. inf. ● Modra town, loc. Staré hory, Q 7669, alt. 300 m, in beech forest, near old pine stump; – 14.9.2005, J. Červenka, 3 stromata on one *Elaphomyces*, PVK 86. ● Modra town, Harmónia recreation area, loc. Medvedia skala, Q 7669, alt. 390 m, in oak forest admixed with *Fagus*; – 30.7.2008, R. Bednár, dozens of stromata, in mosses, PVK 401; – 2.8.2008, V. Kautman, many stromata in various stages together with *E.*

longisegmentis, PVK 402, 403; – 5.8.2008, V. Kautman, hundreds of stromata, PVK 413; – 6.8.2008, B. Kuzmová, hundreds individuals, PVK 443; – 18.8.2008, V. Kautman, hundreds stromata in many places with *E. longisegmentis*, PVK 445; – 12.10.2008, V. Kautman, hundreds of old, black individuals on destroyed *Elaphomyces*, PVK 515; – 2.12.2008, B. Kuzmová, hundreds of old and young stromata, pers. inf.; – 22.12.2008, J. Kuriplach, 12 stromata in mosses, PVK 607; – 26.7.2009, B. Kuzmová, J. Kuriplach, many parasitised *Elaphomyces* with very young and also old stromata, only on one small place, in mosses, PVK 744; – 27.7.2009, R. Bednár, 200 stromata only on part of locality, BRA CR 13259; – 30.7.2009, V. Kautman, ca one hundred stromata on many places, PVK 653; – 20.9.2009, R. Bednár, 15 individuals on *Elaphomyces muricatus*, PVK 718. ● Bratislava – Rača city, Knižkova dolina valley, Q 7768, alt. 320 m, in deciduous forest (*Quercus*, *Fagus*); – 1.8.2008, R. Bednár, 2 stromata under *Fagus*, PVK 421. ● Mariánka village, Erika hill, 1000 m W of the Malý Slavín, Q 7768, alt. 370 m, in deciduous forest (*Quercus*, *Fagus*, *Betula*, *Carpinus*); – 2.8.2008, R. Bednár, many stromata in different stages, PVK 405; – 4.8.2008, V. Kautman, ca one hundred stromata on 9 microlocalities, PVK 406, PVK 407. ● Bratislava city, loc. Železná studnička, Q 7768, alt. 290 m, in oak forest with admixture of *Fagus* and *Betula*; – 7.8.2008, I. Kramár, 3 stromata, PVK 419; – 17.9.2008, I. Kramár, 30 young stromata in mosses, PVK 504. ● Bratislava – Rača city, near road to Biely Križ, Piesky hill, Q 7768, alt. 420 m, in beech forest mixed with *Quercus*, *Betula*, *Pinus*, *Carpinus*; – 12.8.2008, M. Kusalová, M. Kusala, 12 stromata in fallen leaves and mosses, PVK 476, PVK 477; – 12.9.2008, V. Kautman, ca 40 stromata on 3 places on small *Elaphomyces*, PVK 479. ● Častá - Papiernička village, Q 7569, alt. 350 m, in deciduous forest (*Fagus*, *Quercus*); – 17.8.2008, M. Kusalová, 2 stromata on small *Elaphomyces*, PVK 442. ● Mariánka village, Malinský vrch hill., Q 7768, alt. 320 m, in beech forest with *Quercus*; – 12.9.2008, J. Červenka, 1 stroma on *Elaphomyces* sp. under the *Fagus*, PVK 480. ● Mariánka village, N slope of Bazgovič hill, Q 7768, alt. 240 m, in beech forest; – 13.9.2008, V. Kautman, 14 stromata on *Elaphomyces granulatus* under the old *Fagus*, PVK 481. ● Kuchyňa village, SE slope of Bučková hill, Q 7569, alt. 450 m, beech forest with *Quercus*, in mosses and leaves; – 8.10.2008, J. Červenka, 1 stroma on *Elaphomyces* sp., PVK 505. ● Limbach village, PR Zlatá Studnička reserve, W and NE slope of Koží chrbát hill, Q 7769, alt 420 – 430 m, on 2 places, beech forest in mosses - *Leucobryum glaucum*; – 23.10.2008, B. Kuzmová, J. Červenka, 4 stromata on small *Elaphomyces* sp., on 2 places, PVK 550; – 7.9.2009, J. Kuriplach, 5 individuals without *Elaphomyces*, PVK 754. ● Pezinok village, NW slope of Piesočný and Červený hill, Q 7669, alt. 380 m, in beech forest with mosses; – 22.12.2008, J. Kuriplach, 30 old individuals, PVK 739. ● Pezinok village, Pezinské hradisko, W slope of Veľká Cajlanská homoľa hill, Q 7669, alt. 480 m, in beech forest with *Quercus*; – 7.8.2009, J. Kuriplach, 20 individuals in mosses, PVK 740. ● Pezinok village, Kučičdorská dolina valley, W slope of Barvienok hill, Q 7669, alt. 340 m, beech forest with *Quercus*; – 23.8.2009, J. Kuriplach, ca 30 individuals in mosses, PVK 741. ● Limbach village, loc. Valchovňa, S slope of Suchý vrch hill, Q 7769, alt. 260 m, oak forest with *Fagus* and *Pinus*, in mosses; – 29.8.2009, J. Kuriplach, 20 individuals on *Elaphomyces muricatus*, PVK 742; – 18.9.2009, J. Kuriplach, 3 individuals, PVK 753. ● Modra – Harmonia town, N slope of Červené hill, Q 7669, alt. 380-470 m; – 31.8.2009, J. Kuriplach, 10 individuals in mosses on *Elaphomyces granulatus*, PVK 743. ● Pezinok village, Hrubá dolina valley, loc. Rybníček, NE slope of Čmelok hill, Q 7669, alt. 380 m, old beech forest with mosses; – 24.10.2009, J. Kuriplach, 25 individuals on *Elaphomyces muricatus*, on 3 places, PVK 769.

Borská nížina lowland., Gbely village, Kútska alej alley, Q 7268, alt. 160 m, in mixed forest (*Quercus* sp., *Pinus silvestris*, *Betula* sp.); – 17.9.1975, (Lizoň 1977). ● Jakubov village, loc. Dúbrava, Q 7567, alt. 145 m, in oak forest; – 19.9.1975, (Lizoň 1977). ● Mikulášov village, military area Bežnisko, Q 7469, alt. 205 m, in oak forest mixed with *Pinus*, on sandy soil; – 5.8.2008, V. Kautman, ca 70 stromata under the *Quercus*, on place digged by warthogs, PVK 414, PVK 415, PVK 417.

Levočské vrchy Mts., Iľhany – Majerka village, Q 6889, alt. 710 m; – 10.1979, J. Lazebníček, (Škubla 2003). ● Dlhé Stráže village, Kráľovec valley, Q 6890, alt. ca.700m, beech forest; – 24.8.2008, R. Fecko, 2 young stromata on *Elaphomyces* sp., PVK 555.

Nízke Tatry Mts., Važec village, loc. Múry - Krieslo, Q 6985, alt. 870 m; – 9.1988, P. Škubla, (Škubla 2003). ● Dúbrava village, Križska dolina valley, loc. Preddechtárka, Q 7083, alt. 1000 m, in spruce forest around peatbog; – 3.8.2007, V. Kautman, ca 50 stromata, PVK 266, PVK 267, PVK 268, PVK 269.

Západné Tatry Mts., Zuberec village, Brestová, Mačie diery Nature Reserve, Q 6784, alt. 950-1100 m, in mossy spruce forest with admixture of fir, undergrowth of *Vaccinium myrtillus*, in needles and in mosses *Plagiothecium undulatum* and sphagnum *Lycopodium clavatum*; – 27.9.1996, V. Kautman, without *Elaphomyces*, photo; – 18.9.2004, I. Kautmanová, V. Kautman, several hundreds of stromata on *Elaphomyces* sp., buried 3-20 cm deep, together with numerous *E. rouxii*, PVK 88, PVK 89, PVK 91, BP(PVK 92); – 22.7.2005, I. Kautmanová, V. Kautman, ca 20 young stromata, together with *E. rouxii* and *Chamonixia caespitosa*, PVK 98; – 10.8.2005, I. Kautmanová, V. Kautman, hundreds of stromata, young and mature, together with *E. rouxii*, PVK 97; – 16.8.2006, I. Kautmanová, V. Kautman, ca 50 stromata small mostly young carpophores, PVK 132; – 24.8.2006, V. Kautman, ca 70 stromata, mostly young (one *Elaphomyces* with 12 stromata), PVK 64; – 10.9.2006, V. Kautman, ca 500 stromata, KRAM F 56621, PVK 135, SOMF 26714; – 14.7.2007, V. Kautman, often together with *E. rouxii*, young and mature, PVK 246, PVK 247; – 16.7.2007, V. Kautman, many stromata, PVK 66; – 29.8.2007, V. Kautman, hundreds of stromata, young and old, *E. rouxii* unusually rare (2 stromata), BRA CR9312, HMIGD (PVK 282), PVK 283; – 10.8.2008, V. Kautman, hundreds of young, brown stromata on many places, with *C. rouxii*, BRA CR12212 - DNA, PVK 429; – 11.7.2009, V. Kautman, young yellow-brown stromata on *Elaphomyces muricatus*, PVK 627. ● Huty village, along the main road to Zuberec, Q 6783, alt. 840 m, in spruce forest; – 16.9.2006, I. Godál, J. Šuvada, 1 stroma without host, PVK 152; – 24.9.2007, I. Godál, 20 stromata, PVK 763. ● Zuberec - Brestová, W from the open-air museum, Q 6784, alt. 860 m, in cultivated spruce forest; – 12.8.2007, L. Tábi, PVK 314; – 31.8.2008, D. Karasová leg., hundreds stromata in mosses, PVK 475. ● Zuberec village, Nature Reserve Úplazíky, Q 6783, alt. 950 m, in spruce forest; – 25.8.2007, V. Kučera, 3 stromata, PVK 564; – 29.8.2007, I. Kautmanová, V. Kautman, BRA CR9310, PVK 280; – 25.7.2009, M. Zajac, 5 individuals, PVK 736. ● ridge between Oravice and Habovka villages, Q 6784, alt. 890 m, in spruce forest with *Lonicera nigra*; – 29.8.2007, I. Kautmanová, V. Kautman, PVK 284. ● Zuberec village, SW slope of Javorina hill, Q 6784, alt 1020 m, in spruce forest with *Vaccinium myrtillus*, near small lake; – 20.8.2009, L. Jánošík, 20 individual on *Elaphomyces muricatus*, PVK 737. ● Zuberec village, Látaná dolina valley, W slope of Lysec hill, Q 6784, alt. 1060 m, in spruce forest in mosses; – 16.8.2009, L. Jánošík, 30 individuals with *E. rouxii*, PVK 738.

Oravské Beskydy Mts., Mútne village, Spálený grúnik Nature Reserve, Q 6481, alt. 950 m, in peatbog with spruce; – 9.2000, P. Škubla, OP 375/2000 (B-709). ● Oravská Polhora village, Slaná Voda recreation area, loc. Hviezdoslavova alej, Q 6482, alt. 740 m, in spruce forest; – 1.9.2003, D. Ďuriška, 8 stromata without host, BRA CR2935, BRA CR3332. ● Oravská Polhora

village, loc. Vonžovec, SW slope of the Turňa hill, Q 6482, alt. 750 m, in spruce forest; – 19.8.2007, K. Kozáková, many old stromata, PVK 349. ● Beňadovo village, NW slope between Havrika hill and Poľany hill, Q 6581, alt. 850 m, spruce forest with *Fagus*, *Betula*, *Sorbus*, *Salix*, on wet springs; – 27.7.2008, P. Tomáš, 10 stromata on *Elaphomyces* sp., OP 83/2008. ● Oravské Veselé village, NE slope of Dudová hill, Q 6582, alt. 889 m, spruce forest; – 1.8.2009, Ryszard Zietkiewicz, one small individual in mosses without *Elaphomyces*, PVK 654; – 2.8.2009, I. Stach, 2 young individuals without *Elaphomyces*, PVK 655. ● Oravská Polhora village, Vonžovec, SW slope of Babia hora hill, Q 6483, alt. 770 m, spruce forest, – 10.8.2009, P. Tomáš, OP (PE 23/2009).

Veľká Fatra Mts., Rojkov village, Rojkovské rašelinisko Nature Reserve, Q 6881, alt. 460 m, in peatbog; – 26.7.2002, M. Beran, on *Elaphomyces granulatus*, pers. inf. ● Podsuchá village, Q 7081, alt. 1000 m, in spruce forest; – 26.7.2008, I. Hlavatý, 50 stromata in small plot, PVK 392; – 21.8.2008, I. Hlavatý, 50 stromata on *Elaphomyces muricatus*, on another places under the *Fagus* and *Picea*, PVK 591. ● Lubochňa village, loc. Lubochnianska dolina valley, 100 m SE from TS Lipová, Q 6980, alt. 620 m; – 1.9.2008, T. Hulík, 2 stromata on one *Elaphomyces*, PVK 450.

Skorušinské vrchy Mts., between Oravice and Habovka villages, Blatná dolina valley, Q 6784, alt. 850 m, in spruce forest, along the road; – 18.9.2004, V. Kautman, 4 stromata, PVK 90. ● Habovka village, Blatná valley, Q 6784, alt. 900 m, near stream, in spruce forest with admixture of *Pinus silvestris*, *Abies alba*, *Fagus sylvaticus*; – 16.7.2007, V. Kautman, V. Kučera, ca 30 stromata, PVK 262, PVK 263. ● Veľké Borové village, S slope of Mlynová hill, Q 6882, alt. 1004 m in spruce forest on places diging by warthogs; – 27.7.2009, J. Šuvada, M. Švidroň, 3 individuals on *Elaphomyces muricatus*, PVK 672. ● Veľké Borové village, on SW slope of Diel hill, Q 6882, alt. 1030 m, in spruce forest with *Pinus* in mosses, *Sphagnum* and *Lycopodium*; – 15.8.2009, I. Kautmanová, V. Kautman, ca 250 young individuals with *E. rouxii*, only on one place, PVK 683, PVK 684.

Liptovská kotlina basin, Lazisko village, loc. Svätý križ, Q 6983, alt. 680 m, in dense, mossy spruce forest; – 28.7.2005, V. Kautman, 2 young stromata, PVK 96; – 24.8.2008, V. Kautman, 20 stromata on 3 places, PVK 448.

Strážovské vrchy Mts., Pružina – Priedhorie village, Podskalský Roháč hill, Q 6976, alt. 400 m, in mixed forest; – 6.9.2005, P. Tomáš, 3 young stromata on 3 *Elaphomyces* buried 10 cm in soil, PVK 78.

Kysucká vrchovina Mts., Horná Tižiná village, Nogovci settlement, loc. Vojenné, Q 6780, alt. 1000 m, in mixed forest (*Pinus silvestris*, *Picea abies*, *Abies alba*, *Fagus sylvaticus*, *Acer* sp., *Corylus avellana*), with species rich mossy undergrowth in *Dicranum scoparium*, *Hylocomium splendens*, *Lycopodium clavatum* with *Vaccinium myrtillus*; – 7.10.2005, B. Skolozdrová, one individual, photo, pers. inf.; – 6.10.2006, V. Kautman & al., ca 150 stromata, together with *E. capitata*, on *Elaphomyces* sp. growing under *Corylus*, *Picea*, BRA CR8487, K(M)158314, PJČ 917, PVK 165, PVK 167, PVK 168; – 13.10.2006, V. Kautman, J. Červenka, PVK 179; – 21.10.2006, I. Kautmanová, V. Kautman, PVK 193; – 18.8.2007, B. Kuzmová, M. Zelenaj, numerous collections, PVK 273, PVK 274. ● Zázrivá village, N slope of the Čapica hill, Q 6780, alt. 650 m, in cultivated spruce forest with *Acer* sp., *Fagus sylvaticus* and *Corylus avellana* in mosses *Dicranum scoparium*, *Leucobryum glaucum*, *Polytrichum formosum* and sphagnum *Lycopodium clavatum*; – 6.10.2006, V. Kautman & al., ca 10 stromata, together with *E. capitata*, BRA CR8487, PVK 156; – 13.10.2006, V. Kautman, J. Červenka, numerous stromata, PVK 189; – 21.10.2006, I. Kautmanová, V. Kautman, numerous stromata, BRA CR8495; – 14.7.2007, V. Kautman, together

with *E. rouxii*, many young stromata, PVK 245; – 12.8.2007, V. Kautman, after dry period at the sites of former occurrence of *E. rouxii*, PVK 275; – 28.8.2007, I. Kautmanová, V. Kautman, young specimens after long dry period, no *E. rouxii* or *E. capitata* recorded, BRA CR9311, PVK 279; – 30.9.2007, V. Kautman, several stromata together with young *E. capitata*, PVK 306; – 10.8.2008, I. Kautmanová, V. Kautman, hundreds of young stromata together with old *E. rouxii* and young *E. capitata*, first locality where we collected this 3 species in one day, PVK 422, PVK 423, PVK 424; – 19.9.2008, I. Kautmanová, V. Kautman, 50 stromata, PVK 488; – 3.10.2008, M. Burian, 10 individuals with *E. capitata*, HMIGD (PVK 537), PVK 538; – 17.7.2009, V. Kautman, 4 young stromata on *Elaphomyces granulatus*, with *E. rouxii*, PVK 632; – 7.8.2009, V. Kautman, 5 individuals on *Elaphomyces granulatus*, PVK 671. ● Horná Tižiná village, Q 6780, alt. 800 m, mixed forest; – 18.8.2007, T. Ozimý, 2 stromata without host, PVK 272. ● Nová Bystrica village, loc. Riečnica, on S slope of Prípor hill, Q 6680, alt. 650 m, in old spruce forest; – 28.8.2007, L. Jánošík, few stromata, PVK 760; – 29.9.2007, L. Jánošík, PVK 288; – 30.9.2007, V. Kautman, numerous stromata, locality on which is together with *E. capitata* and *E. rouxii*, PVK 295; – 26.7.2008, L. Jánošík, one stroma in soil, PVK 461; – 30.7.2008, L. Jánošík, ca 40 stromata, PVK 458, PVK 459, PVK 460; – 1.9.2008, L. Jánošík, ca 400 stromata, PVK 470. ● Lutiše village, 2 km E from the village, on steep slope under the Lutiša stream on Vřšky hill, Q 6779, alt. 590 m, in spruce forest mixed with *Larix*, *Fagus*, *Quercus*, *Ligustrum* in mosses; – 26.8.2008, J. Komár, 8 stromata on 3 *Elaphomyces*, photo, pers. inf.; – 10.9.2008, J. Komár, few stromata in mosses, photo, pers. inf. ● Vychylovka village, W slope of Starý diel hill, Q 6680, alt. 700 m, spruce forest with *Vaccinium* and mosses; – 12.10.2008, L. Jánošík, 15 stromata on *Elaphomyces muricatus*, PVK 525. ● Lutiše – Lutiška, Kováčovci settlement, N slope of Okružlica hill, Q 6780, alt. 650 m, spruce forest; – 25.10.2008, L. Jánošík, 3 individuals, PVK 551. ● Kubíková village, 700 m E from the village, Q 6779, alt. 700 m, in spruce forest without mosses; – 25.10.2008, L. Jánošík, 2 individuals, PVK 606. ● Zázrivá village, loc Kozinská, under protection area Dubovské lúky, Q 6781, alt. ca 750 m, in mixed forest with *Abies*, *Picea*, *Fagus*; – 18.7.2009, M. Švidroň, 2 young stromata on *Elaphomyces granulatus*, OP (PE 16/2009), PVK 642. ● Zástranie village, W slope of Hôrka hill, Q 6778, alt. 540 m, spruce forest with mosses; – 9.10.2009, L. Racko, 6 individuals on *Elaphomyces muricatus* on place digging by warthogs, PVK 758.

Malá Fatra Mts., Krasňany village, in the valley of Kúr stream, under Bielková hill, Q 6879, alt. 740 m, in mixed forest (*Picea abies*, *Fagus sylvatica*); – 3.9.2007, L. Jánošík, few stromata without host, PVK 286. ● Višňové village, NE slope of the Dolná Roveň hill, Q 6878, alt. 650 m, in steep slope in old spruce forest; – 21.10.2007, L. Jánošík, ca 30 stromata, PVK 342, PVK 343; – 17.8.2008, L. Jánošík, 2 stromata, in moist spruce forest, near stream, on another place, PVK 462; – 19.10.2008, L. Jánošík, 1 small stroma on small *Elaphomyces muricatus*, PVK 567. ● Kunerád village, Domčica hill, Q 6978, alt. 569 m, in spruce forest; – 31.7.2008, L. Račko, 15 stromata, PVK 420. ● Turie village, loc. Turská dolina valley, 0,5 km from village, Q 6878, alt. 560 m, in spruce forest mixed with *Fagus*, with *Vaccinium* and mosses; – 24.8.2008, L. Jánošík, ca 200 stromata, PVK 455; – 28.9.2008, L. Jánošík, ca 200 stromata, PVK 524. ● Nezbudská Lúčka village, 300 m N from Starý hrad castle, on NW slope of Gabrišová hill, Q 6879, alt. 460 m, in forest under the *Fagus* and *Carpinus*; – 6.12.2008, L. Jánošík, 4 stromata, PVK 605. ● Vrútky village, loc. Javorná valley, S-SE slope of Dialňa hill, Q 6979, alt. 710 m, in spruce forest; – 15.2.2009, M. Zajac, numerous old stromata, pers. inf. ● Trusalová village, loc. Gol'ove mláky, 200 m N from camp, Q 6880, alt. ca 500m, spruce forest; – 11.7.2009, J. Švidroň, J. Šuvada, 2 young stromata on 2 very small *E. muricatus*, PVK 646. ● Stráňavy village, NE slope of Hoblík hill, Q 6878, alt. 650 m, in spruce forest with mosses and *Vaccinium myrtillus*; – 8.8.2009, I.

Kramár, ca 100 individuals on places diging by warthogs, PVK 746; – 30.8.2009, I. Kramár, hundreds of individuals, PVK 747. ● Višňové village, Višňovská dolina valley, SW slope of Hoblík hill, Q 6878, alt. ca 450 m, spruce forest near stream; – 22.9.2009, J. Komár, many individuals from young to old, on *Elaphomyces muricatus*, PSG 9/187.

Oravská Magura Mts., Beňova Lehota village, Kubínska hoľa Mt., loc. Bucľov, E slope of Pikula hill, Q 6781, alt. 800 m, in spruce forest, in needles and mosses; – 14.10.2006, J. Šuvada, PVK 202; – 21.10.2006, J. Šuvada, I. Kautmanová, V. Kautman, numerous stromata, BRA CR8492, PVK 201; – 30.9.2007, J. Šuvada, numerous stromata together with *E. capitata*, PVK 308; – 24.8.2008, E. Bohunická, J. Šuvada, many stromata, PVK 587; – 6.11.2008, M. Švidroň, J. Šuvada, PVK 588. ● Oravská Lesná village, Q 6681, alt. 650 m, in dense spruce forest; – 26.8.2007, T. Ozimý, several stromata, some very young, PVK 287. ● Lomná village, Q 6681, alt. 750 m, in spruce forest with admixture of *Fagus*; – 30.9.2007, L. Jánošík, V. Kautman, ca 10 stromata, together with *E. capitata*, PVK 298. ● Oravská Lesná village, loc. Predné podžľaby, Zimná voda stream, Q 6681, alt. 780 m, in wet spruce forest, on elevated sites; – 30.9.2007, L. Jánošík, M. Zelenaj, V. Kautman, numerous stromata, PVK 300, PVK 357. ● Beňova Lehota village, Kubínska hoľa Mt., S slope of Kamenný závož hill, Q 6781, alt. 910 m, in mixed forest (*Abies*, *Fagus*, *Picea*); – 5.8.2009, M. Švidroň, J. Šuvada, 4 individuals with *E. rouxii*, on *Elaphomyces muricatus*, PVK 675. ● Oravská Lesná village, Zimná valley, W slope of Čerchľa hill, Q 6681, alt. 900-950 m, in spruce forest; – 21.8.2009, P. Tomáš, 5 parasitised *Elaphomyces*, OP (PE 19/2009), OP (PE 20/2009), PVK 09/43. ● Beňova Lehota village, SE slope of Kubínska hoľa hill, Q 6781, alt 1120 – 1200 m, spruce forest with *Abies*, *Fagus*; – 31.8. 2009, P. Tomáš, OP (PE 8/2009), OP (PE 9/2009). ● Beňova Lehota village, S slope of Kubínska hoľa hill, loc. Koliesko, on right side of ski slope, Q 6781, alt. 900 m, spruce forest with *Pinus*, *Betula*, – 22.11.2009, M. Švidroň, 16 individuals, PVK 790.

Javorníky Mts., Dešná village, loc. Paseky, N slope of Dubkovská jama, Q 6775, alt. 510 m, mixed forest (*Fagus*, *Abies*, *Picea*) in leaves and mosses; – 7.7.2007, L. Faturík, 2 young stromata, together with one *E. rouxii*, PVK 235. ● Horná Mariková village, Ráztoka settlement, NE slope of Čovia hill, Q 6775, alt. 650 m, in cultivated spruce forest with *Fagus*; – 25.8.2007, J. Kianička, 1 old specimen without host, photo, pers. inf.; – 13.10.2007, J. Kianička, numerous stromata, together with *E. capitata*, PVK 326; – 8.9.2009, J. Kianička, 50 individuals, PVK 725. ● Rudinská village, Krchovci settlement, 3 km NW from village on SW slope of Žiar hill, Q 6678, alt. 600 m, spruce forest with *Vaccinium*, mosses; – 27.9.2008, M. Žikavský, ca 70 stromata in mosses, PVK 532. ● Marček village, S slope of Diel hill, Q 6777, alt. 440 m, spruce forest with *Abies*, *Vaccinium*, mosses; – 26.10.2008, L. Jánošík, 100 stromata with *E. capitata*, PVK 570; – 8.11.2008, L. Jánošík, 12 stromata in cluster, PVK 571, PVK 572; – 26.8.2009, L. Jánošík, 5 individuals in mosses, PVK 750. ● Krásno nad Kysucou village, E slope of Kykuľa hill, Q 7966, alt. 550 m, in spruce forest with *Pinus* and *Fagus*; – 13.9.2009, J. Komár, many individuals around the anthill, PVK 751. ● Horná Mariková village, Stolečné settlement, W slope of Čovia hill, Q 6575, alt. ca 600 m, in spruce forest with *Fagus*; – 19.9.2009, J. Kianička, hundreds of individuals in mosses, with *E. capitata*, PVK 726.

Belianske Tatry Mts., Ždiar village, Q 6787, alt. 850 m, in spruce forest with *Vaccinium*; – 29.8.2007, V. Ridzoň, several stromata, PVK 369; – 1.9.2008, V. Ridzoň, O. Liška, 5 stromata on *Elaphomyces*, PVK 604.

Turzovská vrchovina Mts., Makov village, Q 6676, alt. 600 m, in spruce forest; – 11.10.2007, L. Racko, numerous, PVK 251. ● Olešany village, Klokočov, Q 6577, alt. 570 m, in open spruce

- forest, in *Vaccinium* and mosses near peatbog; – 21.8.2008, L. Hederová, 15 stromata, PVK 467.
- Vysoká nad Kysucou village, on steep northern slope, near forest road to Vrchrieka settlement, Q 6677, alt. 750 m, in spruce forest with *Abies*, *Larix*, *Corylus*, in mosses in herbs undergrowth with *Rubus*; – 29.8.2008, M. Zajac, 6 stromata on 2 *Elaphomyces*, PVK 566; – 25.10.2009, M. Zajac, another place, 5 parasitised *Elaphomyces*, PVK 778. ● Vysoká nad Kysucou village, 1 km N from the village, E slope of Klinkovský vrch hill under the stream, Q 6677, alt. 600 m, spruce forest, in mosses; – 25.9.2008, M. Zajac, 20 stromata in 2 places, PVK 546; – 28.9.2008, M. Zajac, 9 stromata in 2 places on ca 0,5 km, PVK 547. ● Korňa village, part Žilovci, N slope of Kvačkov vršok hill, Q 6577, alt. 565 m, spruce forest with *Vaccinium*, on wet place in mosses; – 6.9.2009 L. Mikovčáková, 9 individuals with one *Elaphomyces muricatus*, PVK 721; – 19.9.2009., L. Mikovčáková, ca 40 individuals with one *Elaphomyces granulatus*, on 4 places with, PVK 721; – 27.9.2009, L. Mikovčáková, 27 individuals on *Elaphomyces granulatus*, second place, PVK 724.
- Žiar Mts.**, Jasenovó village, 200 m S from the village, Q 7178, alt. 570 m, in moist spruce forest; – 14.8.2008, L. Hederová, 9 stromata in mosses, PVK 444.
- Kysucké Beskydy Mts.**, Zborov nad Bystricou village, N from the village, Q 6679, alt. 580 m, in steep slope near stream in spruce forest; – 23.8.2008, L. Jánošík, 12 stromata, PVK 456.
- Veporské vrchy Mts.**, Čierny Balog – Vydrovo village, W slope of Korytársky grúň hill, Q 7283, alt. 650 m, in spruce forest mixed with *Fagus*, in mosses *Pleurozium schreberi*; – 5.9.2008, A. Mócik, 50 stromata on *Elaphomyces granulatus*, PVK 474, PSG 9/24, PSG 9/23, and *E. muricatus*, PSG 9/26, PSG 9/27; – 20.9.2008, I. Kautmanová, V. Kautman, many stromata on *Elaphomyces granulatus* and *E. muricatus*, on many places, PVK 490, PVK 491; – 4.10.2008, V. Kautman, several stromata in some places on *E. muricatus* and *E. granulatus*, PVK 500; – 10.10.2009, V. Kautman & al. on *Elaphomyces muricatus*, PVK 756. ● Ľubietová – Podlipa village, W slope of Lósy hill, Q 7282, alt. 630 m, in spruce forest with mosses; – 26.9.2008, V. Kautman, 25 stromata in mosses on *Elaphomyces*, PVK 495. ● Čierny Balog – Dobroč village, Dobročský prales Nature Reserve, Q 7284, alt. 750 - 800 m, mixed forest with *Fagus*, *Abies*, *Picea*, *Sorbus*, *Vaccinium*, mosses; – 7.10.2008, B. Wasstorp, V. Kautman, ca 60 stromata on *Elaphomyces muricatus*, PVK 501. ● Hriňová – Biele vody village, N slope of Skalka hill, Q 7383, alt. ca 900 m, spruce forest; – 28.9.2009, V. Kautman, 3 parasitised *Elaphomyces*, PVK 714. ● Čierny Balog – Vydrovo village, Vydrovská dolina valley, SE slope of Urbanov vrch hill, Q 7283, alt. 650-700 m, old spruce forest; – 26.10.2009, A. Mócik, many individuals on many places, PVK 776.
- Slovenský Raj Mts.**, Telgárt village, Besník saddle, NE slope of Kozovec hill, Q 7187, alt. 1100 m, open spruce forest with *Rubus*, *Vaccinium* and mosses; – 11.9.2008, R. Krč, 20 stromata, photo, pers. inf.
- Laborecká vrchovina Mts.**, Čukalovce village, NW slope of Horbok hill, Q 6899, alt. 375 m, beech forest mixed with *Carpinus*; – 18.9.2008, M. Hrabovský, 6 stromata (3,2,1) on 3 very small *Elaphomyces muricatus*, in 3 places, PVK 497, PVK 498.
- Ľubovnianska vrchovina Mts.**, Orlov village, 2 km N from village, south slope of Koščulné hill, Q 6791, alt. 550 m, in spruce forest mixed with *Abies*, *Fagus*, near stream; – 18.9.2008, V. Harčarik, 20 stromata on *Elaphomyces muricatus*, PVK 496.
- Moravsko-sliezske Beskydy Mts.**, Maslovenka village, Zajacovci settlement, 1 km SE from village, loc. under the Klokočovské skálie Reserve, Q 6577, alt. 650 m, in wet spruce forest with mosses (*Leucobryum* sp., *Polytrichum* sp.); – 30.9.2008, M. Zajac, ca 30 stromata in 2 places, PVK 548.

Oravská vrchovina Mts., Srňacie village, Q 6781, alt. ca 700m, in spruce forest admixed with *Abies*, *Fagus*; – 6.7.2009, J. Šuvadá, M. Švidroň, young stromata on *Elaphomyces muricatus*, PVK 648; – 17.7.2009, V. Kautman, J. Šuvadá 2 stromata on *E. muricatus*, PVK 637.

Povážsky Inovec Mts., Selec village, E slope of Lazový vrch hill, Q 7372, alt. ca 450 m, in young oak forest; – 11.9.2009, M. Margetín, 15 individuals, PVK 728.

Kozie chrbtý Mts., Vikartovce village, Čierny Váh river valley, steep W slope of Jedlinská hill, old spruce forest with *Vaccinium*; – 6.9.2009, E. Bohunická, 8 individuals, PVK 727.

Podbeskydská vrchovina Mts., Zákamenné village, S slope of Strakov vrch hill, Q 6681, alt. 800-850 m, spruce forest, – 24.8.2009, P. Tomáš, OP (PE 21/2009), OP (PE 22/2009). ● Rabča village, Kopanica hill, Q 6582, alt. ca 500-700 m, spruce forest with *Abies*, *Pinus*; – 23.9.2009, I. Janotová, tens of individuals on many places, PVK 762.

Elaphocordyceps capitata (Holmsk.) G. H. Sung, J. M. Sung, Hywel-Jones & Spatafora

SYN.: *Cordyceps capitata* (Holmsk.) Link., *Torrubia capitata* (Holms.) Tul. & C. Tul., *Cordyceps nigriceps* Peck, *C. agariciformis* (Bolt.) Seaver, *C. canadensis* Ellis & Everh.

ANAMORPH: unknown

Probably the most frequently published capitata *Elaphocordyceps* species, parasitising *Elaphomyces* worldwide. However, published data do not reflect the real occurrence of the species. Revisions of the specimens in herbaria (more than 900) revealed, that it is rather rare and not only in Europe. Almost two thirds of the revised specimens were in fact *E. longisegmentis* and *E. rouxii* (Kautmanová & Kautman, 2006) or some other species.

It is known from Asia*(Japan*) and North America*, and in following European countries: AT*, BE, CZ*, DE*, DK*, ES*, FI, FR*, GB*, CH*, IT*, LUX*, NL, NO*, PL*, RU, SE*, SL, SK*. (Kobayasi, 1940, Koval', 1984). White form of the species has been published recently from France under the name *C. capitata* var. *axantha* (Moingeon, 2006). All specimens of capitata *Cordyceps* species preserved in herbaria worldwide are in need of revision, to reveal the real distribution of the species.

Kobayasi (1940) placed this species to the section Directae, meaning that the stromata grow straight upwards directly from the carpophores of *Elaphomyces*, solitary or in cluster up to 9 stromata. Stromata with yellow to ochraceous stem and brown fertile part are stout, only rarely they are thin and contorted branching to sides. Mycelium outrowing *Elaphomyces* is pink-brown to black in old specimens. Mostly on *Elaphomyces granulatus*, rarely on *E. muricatus*. In Japan also on *E. japonicus*. (Kobayasi, 1960). It is autumn species fructifying until the first frosts.

Slovak records were from 30.7. (Riečnica, 2008) to 30.12. (Vrátna, 2007, 2008). Mostly in coniferous forests sometimes with admixture of deciduous trees (*Fagus*, *Acer*, *Corylus*), often numerous. Often growing together with *E. ophioglossoides*, rarely with *E. rouxii* (Riečnica, 2007, Zázrivá, 2006, 2007, 2008, 2009). Typical forest species growing from soil, needles, mosses and sphagnum.

Until October 2006 the species was not recorded at the Slovak territory, though it has been incorrectly published several times (Škubla, 2003, Kautmanová, 1998). All herbaria specimens labelled as *Cordyceps capitata* were in fact *E. longisegmentis* and *E. rouxii*. The first preserved record of the species from Slovakia is from October 2006 from Horná Tižiná village. Šuvada (2005) published 2 photos of *E. capitata* from the same locality a year sooner, but no voucher specimen existed. In 2006 two other localities were discovered at Orava region (Zázrivá, Kubínska hoľa), in 2007 six and in 2008 another six and in 2009 another six new localities for Slovakia were recorded. Sites at the Veporské vrchy Mts. were situated outside the known area of the species occurrence and confirmed its supposed wider distribution. Field research in the last 3 years brought 50 collections from 21 localities until now, all in mountain forests. It is interesting that this relatively large and conspicuous species, hardly overlooked, has not been recorded for such a long time.

In Czech Republic six specimens of this species have been recorded (BRNM 130 261, BRNM 224 238 (Kautmanová & Kautman, 2006), BPI 634 738, PVK 561, PVK 582 and PVK 583).

RECORDS FROM SLOVAKIA

Known from Biele Karpaty Mts. (1 locality), Javorníky Mts. (3), Turzovská vrchovina Mts. (2), Kysucká vrchovina Mts. (7), Kysucké Beskydy Mts. (1), Oravská Magura Mts. (3), Malá Fatra Mts. (1) and Veporské vrchy Mts. (2).

Kysucká vrchovina Mts., Terchová – Horná Tižiná village, Nogovci settlement, loc. Vojenné, Q 6780, alt. 1000 m, in mixed forest (*Pinus*, *Picea*, *Abies*, *Fagus*, *Acer*, *Coryllus*), rich mossy undergrowth with *Dicranum scoparium*, *Hylocomium splendens* and sphagnum *Lycopodium clavatum*; – 6.10.2005, J. Šuvada, together with *E. ophioglossoides*; – 6.10.2006, J. Šuvada, Miro Burian, V. Kautman, ca 30 stromata, together with *E. ophioglossoides*, on *Elaphomyces granulatus*, probably associated with *Coryllus*, BRA CR8485, BRA CR8486, PVK 157, PVK 158, PVK 159, PVK 160, PVK 161, PVK 162, PVK 163; – 8.10.2006, J. Šuvada, B. Kuzmová, J. Richmanová, numerous, PVK 169, PVK 170; – 13.10.2006, V. Kautman, numerous stromata, BRA CR8488, BRA CR8490, PVK 171, PVK 172, PVK 173, PVK 174, PVK 175, PVK 178, BPI (PVK 176); – 21.10.2006, I. Kautmanová, V. Kautman, 1 stroma after frost, PVK 192; – 18.10.2008, M. Bachleda, 3 stromata on *Elaphomyces muricatus*, PVK 586. ● Zázrivá village, N slope of the Čapica hill, Q 6780, alt. 650 m, in spruce forest with *Acer*, *Fagus* and *Corylus*,

mosses *Dicranum scoparium*, *Leucobryum glaucum*, *Polytrichum formosum* and sphagnum *Lycopodium clavatum*; – 16.9.2006, Miro Burian, 3 stromata; – 6.10.2006, M. Burian, J. Šuvada, V. Kautman, 4 stromata together with *E. ophioglossoides*, BRA CR8484, PVK 153, PVK 155; – 13.10.2006, V. Kautman, numerous collections, together with *E. ophioglossoides*, 16 *Elaphomyces granulatus* parasitised with 1 – 4 stromata, BRA CR8489, BRA CR8491, PVK 182, PVK 183, PVK 184, PVK 187, PVK 188, EFCC (PVK 186); – 21.10.2006, I. Kautmanová, V. Kautman, numerous, BRA CR8493, BRA CR8494, PVK 195, PVK 197, SOMF 26715, TNS (PVK 194); – 30. 9. 2007, V. Kautman, several young stromata, 8 stromata from one *Elaphomyces*, PVK 301, PVK 302, PVK 303, PVK 304, PVK 305; – 10.8.2008, I. Kautmanová, V. Kautman, 2 parasitised *Elaphomyces granulatus* with 3 and 3 young stromata, with *E. rouxii* and *E. ophioglossoides* in one day, PVK 425; – 19.9.2008, I. Kautmanová, V. Kautman, 7 stromata on *Elaphomyces granulatus*, in 3 places, BRA CR 12225 – DNA, PVK 486; – 3.10.2008, M. Burian , great number of stromata parasitising *Elaphomyces granulatus*, in mosses, PVK 533, PVK 534, PVK 535, PVK 536, PVK 539; – 21.8.2009, L. Jánošík, 2 parasitised *Elaphomyces granulatus* with 2 stromata, PVK 748; – 18.9.2009, V. Kautman, 2 parasitised *Elaphomyces granulatus* with one stromata, PVK 719. ● Nová Bystrica village, Riečnica, Prípor hill, Q 6680, alt. 650 m, old spruce forest in needles and mosses *Dicranum scoparium*; – 28.8.2007, H. Jánošíková, 1 young specimen, photo, pers. inf.; – 29.9.2007, L. Jánošík, numerous, in places where *E. rouxii* was collected in summer, PVK 289; – 30.9.2007, V. Kautman, numerous young and old stromata up to 12 cm, K(M)158313, PVK 290, PVK 291, HMIGD (PVK 292), PVK 294; – 30.7.2008, L. Jánošík, 1 young stroma on *Elaphomyces granulatus*, PVK 418; – 1.9.2008, L. Jánošík, ca 50 stromata, PVK 468, PVK 469. ● Lutiše village, 2 km E from village, on steep slope under Lutiša stream on Vřísky hill, Q 6779, alt 600 m, in spruce forest mixed with *Larix*, *Fagus*, *Quercus*, in mosses; – 11.9.2008, J. Komár, 2 stromata without *Elaphomyces*, PVK 509; – 9.9.2009, J. Komár, 2 individuals, photo, pers. inf., PVK 729. ● Vychylovka village, in S slope of Starý diel hill, Q 6680, alt. 730 m, spruce forest with mosses; – 12.10.2008, L. Jánošík, 5 parasitised *Elaphomyces granulatus*, PVK 523. ● Vychylovka village, S slope of Sajdovia hill, Q 6680, alt. 810 m, spruce forest with mosses; – 12.10.2008, L. Jánošík, one parasitised *Elaphomyces granulatus*, PVK 522. ● Lutiše village, Meliškovci settlement, S slope of Vrchrybník hill, Q 6779, alt. 660 m, spruce forest with *Vaccinium* and mosses; – 25.10.2008, L. Jánošík, 2 stromata on *Elaphomyces granulatus*, PVK 552, PVK 553.

Malá Fatra Mts., Terchová village, Stará dolina valley, loc. Starý dvor, Q 6780, alt. 750 m, in spruce forest mixed with *Fagus*; – 30.12.2007, L. Jánošík, ca 20 – 30 stromata in snow, most old, one young immature, PVK 364, PVK 365, PVK 366, PVK 367; – 30.12.2008, L. Jánošík, 20 old stromata in snow, PVK 603.

Oravská Magura Mts., Beňova Lehota village, Kubínska Hoľa mt., loc. Bucľov, Q 6781, alt. 800 m, in spruce forest; – 14.10.2006, J. Šuvada, PVK 190; – 30.9.2007, J. Šuvada, 5 young stromata together with *E. ophioglossoides*, PVK 307; – 24.8.2008, E. Bohunická, J. Šuvada, 1 stroma, together with hundreds of *E. ophioglossoides*, PVK 585. ● Lomná village, in spruce forest admixed with *Fagus*, Q 6681, alt. 750 m; – 23.9.2007, P. Hrubjak, 2 stromata, PVK 296; – 30.9.2007, V. Kautman, 3 stromata at the edge of forest, young and very old, PVK 297. ● Oravská Lesná village, loc. Predné Podžľaby, at the bank of Zimná Voda creek, Q 6681, alt. 780 m, moist spruce forest; – 30.9.2007, L. Jánošík, V. Kautman, 1 young stroma on *Elaphomyces granulatus*, numerous *E. ophioglossoides*, PVK 299.

Javorníky Mts., Horná Maríková – Ráztoka village, NE slope of Čovia hill, Q 6775, alt. 650 m, in spruce forest; – 13.10.2007, J. Kianička, site where *E. ophioglossoides* was collected in august the same year, 1 stroma without host, PVK 325. ● Marček village, S slope of Diel hill, Q 6777, alt. 440 – 510 m, spruce forest with *Abies*, *Vaccinium* and mosses; – 26.10.2008, L. Jánošík, 30 parasitised *Elaphomyces granulatus*, stromata young, old, solitary, in clusters, PVK 570; – 8.11.2008, L. Jánošík, several stromata, PVK 571, PVK 572. ● Horná Maríková – Stolečné village, W slope of Čovia hill, Q 6775, alt. ca 600 m, spruce forest with *Fagus*; – 19.9.2009, J. Kianička, 2 parasitised *Elaphomyces granulatus* with 2 and 5 stromata, in mosses, PVK 730.

Turzovská vrchovina Mts., Vysoká nad Kysucou village, Vrchrieka settlement, loc. Javorníky, Q 6677, alt. 600 m, spruce forest; – 5.- 6.11.2007, M. Zajac, 4 and 7 stromata on *Elaphomyces granulatus* in wet, mossy place, PVK 347, PVK 348; – 21.8.2008, M. Zajac, L. Hederová, 1 destroyed stroma, photo, pers. inf.; – 8.11.2008, M. Zajac, one *Elaphomyces granulatus* with 3 stromata, PVK 589; – 29.12.2008, M. Zajac, 7 stromata in snow, PVK 602; – 12.10.2009, M. Zajac, another place, 3 parasitised *Elaphomyces* with young individuals, PVK 785; – 31.10.2009, 3 parasitised *Elaphomyces granulatus*, PVK 779. ● Korňa village, part Žilovci, N slope of Kvačkov vršok hill, Q 6577, alt. 560 m, young spruce forest with mosses; – 4.10.2009, L. Mikovčáková, 9 individuals on *Elaphomyces granulatus*, PVK 731.

Veporské vrchy Mts., Čierny Balog – Vydrovo village, W slope of Korytársky grúň hill., Q 7283, alt. 650 m, in spruce forest mixed with young *Fagus*; – 5.9.2008, I. Kramár, 1 stroma on *Elaphomyces granulatus*, PSG 9/25; – 20.9.2008, I. Kautmanová, V. Kautman, 1 stroma on *Elaphomyces granulatus*, PVK 485; – 10.10.2009, R. Bednár, one individual on *Elaphomyces granulatus*, PVK 755. ● Čierny Balog – Dobroč village, Dobročský prales Nature Reserve, on NW slope, Q 7284, alt. 780 m, in mixed forest (*Fagus*, *Abies*, *Picea*, *Sorbus*), in mosses and needles; – 7.10.2008, B. Wastorp, V. Kautman, 5 parasitised *E. granulatus* and *Elaphomyces muricatus* with 4,2,2,1 stromata, in places digged by warthogs, with *E. ophioglossoides*, PVK 502. ● Čierny Balog – Vydrovo village, Vydrovská dolina valley, SE slope of Urbanov vrch hill, Q 7283, alt. ca 650 m, old spruce forest with mosses, near open air museum; – 26.10.2009, A. Mócik, 2 individuals on *Elaphomyces granulatus*, on 2 places, PVK 775.

Biele Karpaty Mts., Zubák village, Majere settlement, in SE slope of Nad Suchým potokem hill, Q 6875, alt. 515 m, in mixed forest (*Picea*, *Abies*, *Fagus*, *Betula*, *Populus tremula*); – 12.10.2008, T. Ozimý, 4 and 2 stromata on *Elaphomyces granulatus*, in mosses, PVK 549.

Kysucké Beskydy Mts., Zborov nad Bystricou village, on N foot of Jaseň hill, near Foštkov potok stream, Q 6679, alt. 550 m, in spruce forest with *Corylus* and *Fagus*, in gravel; – 12.10.2008, L. Jánošík, 20 parasitised *Elaphomyces granulatus*, PVK 526, PVK 527, PVK 528.

***Elaphocordyceps longisegmentis* (Ginns) G. H. Sung, J. M. Sung, Hywel-Jones & Spatafora**

SYN.: *Cordyceps longisegmentis* Ginns

ANAMORPH: unknown

This capitata species parasitising *Elaphomyces* is macroscopically similar to *Elaphocordyceps capitata*, but the significant difference is in length and shape of ascospore segments. It is widespread in northern temperate region from North America* to Japan*, in Europe it has been recorded and confirmed by authors in, BE, CZ*, DE*, DK*, FI*, FR*, GB*, LT*, LUX*, NL, NO*, PL*, SE*, SK*. (Beneš 1939, Holec 2002). Described in

1988 (Ginns 1988). As in the case of *E. rouxii*, specimens of *E. longisegmentis* in herbaria are often labelled as *Cordyceps capitata* or *C. canadensis*. Carefull revision of all capitata *Elaphocordyceps* specimens may improve our knowledge about the distribution and ecology of the species.

E. longisegmentis occurs from lowlands to mountains in deciduos or mixed forests, probably prefering deciduous trees. We collected it under the *Quercus*, *Pinus*, *Fagus* and *Corylus*, on *Elaphomyces muricatus* and *E. granulatus*. Stromata can be small (rarely) but mostly they are robust, up to 14 cm high, with orange (young) or brown to black (old) fertile part and yellow stipe, often with greenish scales on upper part. Cap moist, shiny, involuted, often wider than high), not hooded like in *E. capitata*. Solitary or in clusters of 2 – 6 stromata, from late summer to autumn, usually sooner than *E. capitata*. Mycelium outrowing *Elaphomyces* from brown to black coloured. We have found it from 2. 8. (Modra, 2008) to 8. 11. (Modra, 2009). One late record from 2. 12. (Modra, 2008). In Slovakia it was first published in 1998 from Borská nížina lowland (Kautmanová 1998 as *Cordyceps capitata*), the second known locality was recorded in 2006 at Liptovská kotlina basin. The last collection is from Malé Karpaty Mts. from 2008. In Slovakia much more rare than the former two capitata species. From Slovakia 17 collections from 3 localities.

RECORDS FROM SLOVAKIA

Known from Borská nížina lowland (1 locality), Malé Karpaty Mts. (1), and Vysoké Tatry Mts. (1).

Borská nížina lowland, Studienka village, Jasenácke Nature Reserve, Q 7468, alt. 220 m, in mixed forest (*Pinus silvestris*, *Quercus* sp. *Salix* sp.); – 10.9.1998, I. Kautmanová (as *Cordyceps capitata*; Holec, 2001: *C. longisegmentis*), on *Elaphomyces granulatus*, 3 stromata, BRA CR3124; – 23.9.2000, H. Kautmanová, one old specimen without host, PVK 99.

Liptovská kotlina basin, Hybe village, loc. Hybské lúky, ca 8 km NE from Hybe, Q 6885, alt. 800 m, steep slope at the bank of Hybica river, old pasture outgrown by *Picea abies*, *Pinus silvestris*, *Corylus avellana*, *Juniperus communis*, *Salix caprea*, allways under *Corylus avellana*; – 12.9.2006, V. Kučera, I. Kautmanová, V. Kautman, 4 *Elaphomyces muricatus* with 4,1,1,1 stromata, BRA CR8520, K(M)158316, PVK 137; – 12.9.2006, I. Kautmanová, V. Kautman, ca 1 km from the first locality, 18 stromata, one up to 15 cm high, BRA CR8521, BRA CR8522, KRAM F45056, PVK 140, PVK 144 to TNS, PVK 145, PVK 146, EFCC (PVK 142), BPI (PVK 141); – 6.8.2007, V. Kautman, 1 young stroma, PVK 270; – 2.9.2007, I. Kautmanová, V. Kautman, 2 *Elaphomyces* with 3 stromata each, PVK 285; – 13.8.2008, I. Kautmanová, V. Kautman, on 2 places 7 parasitised *Elaphomyces muricatus* and *E. granulatus* with 1,2,2,3,5,5,5 stromata, young, orange-brown under *Corylus* with *Clavariadelphus pistillar*, BRA CR12211 – DNA, PVK 436, HMIGD (PVK 438); – 31.8.2008, V. Kautman, 6 stromata on *Elaphomyces muricatus* very

deep in the ground, PVK 471, PVK 472, PVK 473; – 9.8.2009, V. Kautman, 3 *Elaphomyces muricatus* parasitised with 3,2,2 young stromata, PVK 674; – 19.9.2009, V. Kautman, 3 old individuals on a new place, under the *Corylus*, PVK 710.

Malé Karpaty Mts., Modra – Harmónia village, NW slope of Medvedia skala hill, Q 7669, alt. 370 m, in oak forest admixed by *Fagus*, with mosses *Dicranum scoparium*, *Leucobryum glaucum* and *Polytrichum formosum*; – 2.8.2008, I. Kautmanová, V. Kautman, 16 stromata on *Elaphomyces muricatus*, solitary or 2 and 6 stromata on one, with many stromata of *E. ophioglossoides*, PVK 408, PVK 409, PVK 410; – 5.8.2008, V. Kautman, 6 stromata, solitary, one *Elaphomyces muricatus* with 2 stromata, PVK 411; – 18.8.2008, V. Kautman, 11 stromata, many of them small, short, parasitised on very small *Elaphomyces*, on 5 places, with *E. ophioglossoides*, BRA CR12591, PVK 446, PVK 447; – 12.10.2008, V. Kautman, 1 destroyed stroma on destroyed *Elaphomyces*, only perithecial part with perithecia in really good condition, PVK 514; – 2.12.2008, B. Kuzmová, one 11 cm long stroma on small old *Elaphomyces muricatus*, PVK 592; – 27.7.2009, R. Bednár, 2 young short stromata on *Elaphomyces*, PVK 652, – 8.11.2009, J. Kuriplach, one stroma, photo.

Elaphocordyceps rouxii (Cand.) G. H. Sung, J. M. Sung, Hywel-Jones & Spatafora

SYN.: *Cordyceps rouxii* Cand.

ANAMORPH: unknown

Though this species is macroscopically easily recognizable from other capitate *Elaphocordyceps* species, it remained unknown until 1976, when it was described (Candoussau, 1976). However, the description was based on immature, atypical carpophores (holotype, 2 paratypes from CUP, isotype from S) and that might be one of the reasons why, also many years after the description, it has been still collected and determined as *Cordyceps capitata*. After the numerous collections of the species, authors proposed an epitype based on the material from Slovakia (Kautmanová & Kautman, 2006).

In Europe it is known from AT*, CZ*, DE*, DK*, FR* (type locality), ES, IT, NO*, PL*, SE* SK* (Kautmanová & Kautman, 2006, Stensrud, 2006, Karasiňski, 2004, Ghyselinck, 2002, Hertzog, 2001). Worldwide distribution is not known, future revision of the material held in the herbaria outside the Europe is necessary. Until recently authors found only a single specimen from North America (Canada*) held at BPI 634 546.

E. rouxii parasitises *Elaphomyces muricatus*, growing directly, straight upwards, or contorted underground in many directions. Stromata solitary or in clusters of 2 – 12, capitate fertile part pale brown to almost black with involuted margin. Stipe grey, pale brown, sometimes with olivaceous tinge, lower underground part pure white and often contorted. Also the mycelium outrowing *Elaphomyces* is white and the host carpophores

obtain typical orange colouring. No part of *Elaphocordyceps. rouxii* is coloured yellow as in related species. It is also more delicate and fragile than *E. capitata* and *E. longisegmentis*, though some solitary carphophores are robust (rare), up to 10 cm tall.

It grows in mountains most often in spruce forests, also in cultivated ones, in wet sites and their vicinity, in mosses (*Dicranum* sp., *Leucobryum* sp., *Plagiomnium* sp., *Plagiothecium* sp., *Polytrichum* sp.) or sphagnum (*Lycopodium* sp.). It occurs often together with *Elaphocordyceps ophioglossoides*, sometimes also with *E. capitata* (Riečnica, 2007, Zázrivá, 2007, 2008). Often it was recorded also in beech or mixed deciduous forests. Authors found it often under the *Picea*, *Fagus*, rarely under the *Corylus* and *Quercus*. It is summer species occurring from the beginning of summer – 9. 6. (Púchov, 2007) until autumn – 19. 9. (Hybská tiesňava, 2009). Altitude: from 460 m at Cérov, to 1460 m at Rakúska poľana mt. In France collected by P. A. Moreau in Landry (Savoie) Barmont at 1600 m (S, without number). Often on calcareous soil.

The first records from Slovakia made by Filarszky in 1910 in Novoveská Huta village at Spiš territory, determined as *Cordyceps capitata*, are probably one of the first records of the species worldwide (Kautman & Kautmanová, 2006). Specimens from this exicate collection are in many herbaria of the world. Next record was made after 72 years by Hagara at Malá Fatra Mts. In 2004 it has been recorded at one locality in Nízke Tatry Mts. and 2 localities at the Orava region. Tomáš (2004a, 2004b) published it as *Cordyceps* cf. *rouxii*, incorrectly as the first record for the Slovak territory. After observing its bionomy at the rich locality at Mačie diery and at other sites, authors recorded it more frequently in the last years. Since 2005 known from 29 localities. In Slovakia 65 collections from 33 localities.

RECORDS FROM SLOVAKIA

Known from Javorníky Mts. (3 localities), Žiar Mts. (1), Malá Fatra Mts. (1), Veľká Fatra Mts. (1), Kysucká vrchovina Mts. (5), Oravská Magura Mts. (3), Oravská vrchovina Mts. (1), Chočské vrchy Mts. (1), Skorušinské vrchy Mts. (3), Západné Tatry Mts. (4), Belianske Tatry Mts. (1), Podtatranská kotlina (1), Nízke Tatry Mts. (5), Volovské vrchy Mts. (1), Levočské vrchy Mts. (1), Stolické vrchy Mts. (1).

Volovské vrchy Mts., Novoveská Huta village (labelled as Iglófüred), Q 7089, alt. ca 800 m, coniferous forest; – 1910, (some specimens labelled from 8. 1910), N. Filarszky (as *Cordyceps*

capitata), on *Elaphomyces cervinus* (*E. granulatus*), BP 1720, BP 71665, BPI 634750, BRA CR4858, BRA CR4859, BRA CR4860, C (without herbarium number), K(M)156683 (2 specimens with the same number), M 0125511, O (without number), PC 0090839, PRM 11702, PRM 169288, S (two specimens without number), SOMF 2427, U (without number), W 9870, W 12844, W 18967, WU 2618.

Malá Fatra Mts., Bystrička village, loc. Hôrky, Q 6979, alt. 700 m; – 15.7.1982, in beech forest at the Bystrička stream, 3 km W of the village, L. Hagara (as *Tulostoma fimbriatum*, rev. by V. Zíta as *Cordyceps capitata*), 3 stromata without host, BRA CR8042.

Skorušinské vrchy Mts., Zuberec village, Blatná dolina valley, loc. Pod Skorušinou, Q 6784, alt. 900 m, in mixed forest (*Picea abies*, *Abies alba*, *Fagus sylvatica*), in mosses, *Sphagnum Lycopodium clavatum* and *Vaccinium myrtillus*; – 30.7.2004, H. Deckerová, J. Červenka, 6 young stromata, stromata with no mature spores, 2 stromata, unusually big, OP 219, PVK 761; – 16.7.2007, V. Kučera, V. Kautman, one stroma, PVK 264. ● Veľké Borové village, S slope of Mlynová hill, Q 6882, alt. 1007 m, in spruce forest; – 27.7.2009, J. Šuvada, M. Švidroň, one stroma on *Elaphomyces muricatus*, PVK 673. ● Veľké Borové village, SW slope of Diel hill, in spruce forest with *Pinus*, in mosses, *Sphagnum* and *Lycopodium*; – 15.8.2009, I. Kautmanová, V. Kautman, ca 40 individuals on *Elaphomyces muricatus*, only on one place with *E. ophioglossoides*, PVK 685, PVK 686, PVK 687, PVK 688, PVK 694.

Nízke Tatry Mts., Malužiná village, Michalovo valley, Q 6984, alt. 760 m, in spruce forest with *Vaccinium*; – 9.8.2004, J. Ripka, 3 stromata growing from decayed *Elaphomyces muricatus* buried in soil, BRA CR8030; – 20.8.2005, V. Kautman, 2 stromata on one *Elaphomyces muricatus* in *Plagiomnium* sp., PVK 109; – 15.7.2007, V. Kautman, 1 stroma in young spruce forest with *Vaccinium*, PVK 256; – 13.8.2008, V. Kautman, 2 stromata on one *Elaphomyces muricatus* in leaves under *Fagus*, in mixed forest (*Picea*, *Pinus*, *Abies*, *Acer*, *Sorbus*, *Salix*), 1 km from another localities, PVK 435; – 16.8.2009, V. Kautman, 2 parasitised *Elaphomyces muricatus* with 2 small individuals in mosses with *Vaccinium*, spruce forest, PVK 689. ● Lazisko village, loc. Svätý Kríž, spruce forest, Q 6983, alt. 650 m; – 7.2005, Ondrej Liška, 7 stromata, 5 in cluster, photo, pers. inf. ● Liptovská Teplička village, Kráľova Hoľa hill, loc. Podšútová, Q 7086, alt. 1150 m, at the edge of the peat-bog in spruce forest; – 8.9.2006, H. Deckerová, 1 stroma, BRA CR9915. ● Dúbrava village, loc. Preddechtárka, Q 7083, alt. 1100 m, spruce forest, in steep slope; – 7.7.2007, S. Bednárová, 2 stromata on *Elaphomyces muricatus*, PVK 238. ● Ludrová village, Ludrovská dolina valley, Q 6981, alt. 630 m, SW slope, spruce forest; – 15.7.2007, I. Hlavatý, one stroma without *Elaphomyces*, PVK 277.

Západné Tatry Mts., Zuberec village, loc. Brestová, Mačie diery Nature Reserve, Q 6784, alt. 950 – 1100 m, in cultivated spruce forest with admixture of *Abies alba*, together with *E. ophioglossoides*, in mosses *Plagiothecium undulatum* and sphagnum *Lycopodium clavatum*, in needles; – 8.9.2004, I. Kautmanová, V. Kautman, ca 60 stromata, in mossy places with *Vaccinium myrtillus*, growing solitary or in clusters of 4 to 10 from each *Elaphomyces muricatus*, BRA CR8031, PVK 100, PVK 101, PVK 102, PVK 103; – 22.7.2005, I. Kautmanová, V. Kautman, ca 20 stromata, all young except one cluster of 9 stromata, together with *E. ophioglossoides*, *Chamonixia caespitosa*, in *Plagiothecium undulatum* and spruce needles, BRA CR8028 (EPITYPE), PVK 104, PVK 105, PVK 106, PVK 107, PVK 108; – 19.8.2005, I. Kaumanová, V. Kautman, ca 50 – 60 stromata, dry weather, most of the specimens mature, BRA CR8027, PVK 110, PVK 111, PVK 112, PVK 113, PVK 114, PVK 115; – 16.8.2006, I. Kautmanová, V. Kautman, one *Elaphomyces muricatus* with 5 young stromata, dry weather conditions, PVK 124; – 24.8.2006, V. Kautman, 5 *Elaphomyces muricatus* with 9,2,2,2 and 5 stromata, most of the

underground only in moist places, PVK 126, PVK 127, PVK 129, PVK 130, PVK 131; – 10.9.2006, V. Kautman, 4 *Elaphomyces muricatus* with 4,1,4,2 stromata in moist sites in mosses, KRAM F 56622, PVK 133, PVK 134; – 14.7.2007, V. Kautman, several stromata in different stages of maturity, on *Elaphomyces muricatus* some of them rather big, one *Elaphomyces* with 12 stromata, PVK 250, PVK 251, PVK 252, PVK 253, BPI (PVK 254), EFCC (PVK 248), TNS (PVK 249); – 16.7.2007, V. Kautman, V. Kučera, PVK 257, PVK 258, PVK 259, PVK 260, PVK 261; – 29.8.2007, V. Kautman, 3 stromata on 2 *Elaphomyces muricatus*, together with hundreds of *E. ophioglossoides*, extremely dry conditions, PVK 281; – 10.8.2008, V. Kautman, 12 *Elaphomyces muricatus* parasitised with many stromata (1-11), most of them old, PVK 430, PVK 431, PVK 433, BRA CR12210 – DNA, HMIGD (PVK 432); – 11.7.2009, V. Kautman, 7 parasitised *Elaphomyces muricatus* with 3,3,3,2,1,1,1 stromata only from one place, with *Chamonixia caespitosa*, PVK 623, PVK 624, PVK 625, PVK 626; – 22.7.2009, V. Kautman, 3 stromata on 2 *Elaphomyces muricatus*, dry weather, PVK 645. ● Zuberec – Brestová, 0,5 km W from open – air museum, Q 6783, alt. 900 m, cultivated spruce forest; – 14.7.2007, S. Husár, 3 stromata on *Elaphomyces muricatus*, PVK 309; – 12.8.2007, L. Tábi, on *Elaphomyces*, PVK 310; – 13.7.2008, L. Tábi, 1 stroma, PVK 396; – 21.8.2009, L. Jánošík, 7 individuals on destroyed *Elaphomyces muricatus*, PVK 749. ● Zuberec village, Roháčska dolina valley, near recreation cottage Šindlovec, Q 6784, alt. 1150 m, in spruce forest with *Vaccinum myrtillus*; – 16.8.2009, L. Jánošík, 2 individuals on *Elaphomyces muricatus*, PVK 732. ● Zuberec village, Látná dolina valley, Q 6784, alt. 1060 m, in spruce forest with mosses; – 16.8.2009, L. Jánošík, one individual on *Elaphomyces muricatus*, with *E. ophioglossoides*, PVK 733.

Oravská Magura Mts., Hruštín village, loc. Zábava, 3 km W of the village, Q 6781, alt. 760 m, in young cultivated spruce forest, on NE slope, in *Plagiomnium rostratum*, *Dicranum undulatum*, *Pleurozium schreberi* and *Equisetum* sp; – 16.7.2006, V. Kautman, 7 *Elaphomyces muricatus* with small young stromata, half buried in soil, BRA CR8179, PVK 116, PVK 117, PVK 118; – 16.8.2006, V. Kautman, 5 *Elaphomyces muricatus* in different stages of maturity, PVK 119, PVK 120, PVK 121, PVK 122, PVK 123; – 24.8.2006, V. Kautman, 2 *Elaphomyces muricatus* with 3 and 4 stromata, PVK 125. ● Babin, NW slope of Pripor hill, 1 km from village, Q 6682, alt. 860 m, in spruce forest admixed with *Sorbus aucuparia* and *Sorbus aria*, in mosses; – 3.8.2008, V. Struhárová, 2 stromata on *Elaphomyces muricatus*, PVK 404. ● Beňova Lehota village, Kubínska hoľa mt., S slope of Kamenný závoz hill, Q 6781, alt. 910 m, in mixed forest (*Fagus*, *Abies*), under the *Fagus*; – 5.8.2009, M. Švidroň, one individual with atypical perithecial part, on *Elaphomyces muricatus*, PVK 676.

Javorníky Mts., Púchov – Lachovec, Q 6875, alt. 466 m, young beech and oak forest with larch; – 9.6.2007, Martin Burian, 2 stromata on one *Elaphomyces muricatus*, PVK 221; – 11.6.2007, Martin Burian, V. Kautman, 2 stromata on one *Elaphomyces muricatus*, unusually dry locality, PVK 222. ● Dešná village, loc. Paseky, N slope of Dubkovská jama, Q 6775, alt. 490 m, in mixed forest (*Fagus*, *Picea*, *Abies*, *Pinus*), in mosses *Polytrichum formosum* and *Plagiomnium* sp; – 19.6.2007, T. Ozimý, O. Roučka, L. Faturík., ca 10 stromata growing solitary from small *Elaphomyces* carpophores, in fallen leaves and mosses, PVK 224; – 22.6.2007, T. Ozimý, O. Roučka, V. Kautman, 20 small, gracile stromata of different age, greenish coloured stems, PVK 225, PVK 226, PVK 227, PVK 228; – 7.7.2007, V. Kautman & al., ca 10 stromata on small *Elaphomyces muricatus* carpophore, together with *E. ophioglossoides*, PVK 236, PVK 237; – 20.7.2008, T. Ozimý, 10 stromata, PVK 395. ● Cérov village, Brekovec hill, Q 6876, alt. 460 m, in beech forest in leaves and mosses under the old *Fagus*; – 19.7.2008, Martin Burian, 3 stromata

on 3 small *Elaphomyces muricatus*, PVK 393; – 20.7.2008, Martin Burian, 5 stromata on one *Elaphomyces*, PVK 394.

Kysucká vrchovina Mts., Zázrivá village, at the foot of the Čapica hill, Q 6780, alt. 650 m, in spruce forest with *Fagus*, *Acer*, *Corylus*, with mosses *Dicranum scoparium*, *Leucobryum glaucum* and sphagnum *Lycopodium clavatum*; – 2.7.2007, Martin Burian and Miro Burian, at the sites of occurrence of *E. capitata*, parasitised *Elaphomyces muricatus* with 1,2 and 4 stromata, PVK 336, PVK 337; – 14.7.2007, V. Kautman, ca 20 stromata, K(M)158315, PVK 239, PVK 240, PVK 241, PVK 242, PVK 243; – 10.8.2008, I. Kautmanová, V. Kautman, 10 old stromata on destroyed *Elaphomyces*, with *E. capitata* and *E. ophioglossoides* in one day, PVK 427, PVK 428; – 17.7.2009, 10 parasitised *Elaphomyces muricatus* with 1,2,3,4 stromata, on 3 places, PVK 633, PVK 634, PVK 635; – 7.8.2009, V. Kautman, 3 individuals on destroyed *Elaphomyces muricatus*, PVK 669; – 8.8.2009, M. Burian, 11 individuals on *E. muricatus*, PVK 734. ● Zázrivá – Havrania village, loc Velká Havrania valley on NW slope of Hořa hill, Q 6681, alt. 730 m, spruce forest with *Abies*, in mosses with *Vaccinium*; – 17.7.2009, V. Kabát, P. Tomáš, 10 stromata on *Elaphomyces granulatus*, OP (PE 14/2009), PVK 636. ● Zázrivá – Kozinská village, loc. Kozinská valley, N slope of Hlásna skala hill, near protection area Dubovské lúky, Q 6781, alt. ca 750 m, mixed forest (*Abies*, *Picea*, *Fagus*, *Acer*) under the *Fagus*; – 18.7.2009, V. Kautman, M. Švidroň, many young stromata under the fallen beech leaves, on *Elaphomyces muricatus*, OP (PE 15/2009), PVK 643. ● Zázrivá – Malá Havrania village, NE slope of Havranský vrch hill, Q 6781, alt. ca 700 m, in mixed forest under the *Fagus*; – 18.7.2009, V. Kautman, one small stroma on small *Elaphomyces muricatus*, PVK 644. ● Nová Bystrica village, Přípor hill, Q 6680, alt. 620 m, at the edge of spruce forest; – 16.7.2007, L. Jánošík, ca 15 stromata on *Elaphomyces muricatus*, PVK 759.

Levočské vrchy Mts., Brezovica village, 2,8 km NW of the village, Jaškovec valley, Q 6890, alt. 660 m, in coniferous forest (*Abies alba*, *Picea abies*), near the stream; – 13.7.2008, R. Fecko, 4 stromata on *Elaphomyces muricatus*, PVK 397.

Žiar Mts., Budiš village – Žiar village, loc. Za hájom, Q 7178, alt. 550 m, in dark beech forest, in mosses, – 24.7.2008, L. Hederová, 9 stromata on small place, PVK 399.

Oravská vrchovina Mts., Srňacie village, Q 6781, alt. 700 m, in spruce forest admixed with *Abies*, *Fagus*, 2 places in 1 km; – 26.7.2008, J. Šuvada jun., 7 stromata on *Elaphomyces muricatus*, PVK 398; – 3.7.2009, J. Šuvada, one stroma on *Elaphomyces muricatus*, PVK 650; – 6.7.2009, M. Švidroň, J. Šuvada, 5 stromata on 2 *E. muricatus* on dry place on top of hill, PVK 647, PVK 649; – 17.7.2009, V. Kautman, J. Šuvada, J. Šuvada jun., 7 parasitised *Elaphomyces muricatus*, on 3 places, near stream, PVK 638, PVK 639, PVK 640, PVK 641.

Veľká Fatra Mts., Podsuchá village, S slope of Podsuchá hill, Q 7081, alt. 750 m, spruce forest with *Betula* and *Acer*, in mosses in very steep, moist slope; – 28.7.2008, I. Hlavatý, 1 small stroma without *Elaphomyces*, PVK 400.

Stolické vrchy Mts., Predná hora village, near recreation area Predná hora, on north slope, Q 7286, alt. ca 800 m, in forest with *Fagus*, *Picea*, *Betula*; – 8.7.2009, V. Kautman, one young stroma without *Elaphomyces* under the *Fagus* in fallen leaves, PVK 622.

Chočské vrchy Mts., Osádka vilage, NE slope of Holica hill, Q 6882, alt. ca 750 m; – 7.8.2009, V. Kautman, 3 very small young individuals on *Elaphomyces muricatus*, PVK 735.

Belianske Tatry Mts., Tatranská kotlina village, S slope of Rakúška poľana hill, Q 8767, alt. ca 1460 m, in spruce forest; – 16.9.2009, S. Adamčík, V. Kučera, 40 individuals on forest road on *Elaphomyces muricatus*, in needles, many of them very old, PVK 709.

Podtatranská kotlina, Hybe village, Hybská tiesňava, Q 8568, alt. 900 m, in spruce forest mixed with *Pinus*, *Corylus*, *Populus tremula*, *Salix*, *Juniperus*; – 19.9.2009, V. Kautman one small individual on *Elaphomyces muricatus* under the *Corylus*, PVK 711.

KEY TO SPECIES OF CORDYCEPS S. L. KNOWN FROM EUROPE

- | | | |
|----|---|--|
| 1 | Growing of bodies of insects or spiders | 2 |
| | Growing of fruitbodies of hypogeous fungi <i>Elaphomyces</i> | 18 |
| 2 | On caterpillars, cocoons or adults of Lepidoptera. | 3 |
| | On other insects | 8 |
| 3 | On adult outgrown by mycelium and stuck to substrate by it | 4 |
| | On caterpillars and cocoons | 5 |
| 4 | Stromata small 2 – 4 mm, with a few scattered perithecia, on moths of the genus <i>Triphosa</i> (Noctuidae) in caves, mines and underground sites | <i>Cordyceps riverae</i> |
| | Stromata up to 20 – 30 mm, with more perithecia, scattered on the top of mycelium, on moths | <i>Cordyceps tuberculata</i> |
| 5 | Fertile part spatulate, clavate, cylindrical or oblong, not delimited from the stem, with red, pink, orange, yellow or brown perithecia | 6 |
| | Fertile part globular or ovoid, sharply delimited from the stem of pale brown to ochraceous colour. Solitary, rarely in clusters of 2 – 3, on caterpillars, rarely on pupae | <i>Ophiocordyceps gracilis</i> |
| 6 | Stromata slender, up to 15 – 20 mm, in clusters, perithecial part small, 2 – 3 mm | <i>Cordyceps militaris</i> var. <i>sphaerocephala</i> |
| | Stromata spatulate, clavate or cylindrical | 7 |
| 7 | Stromata solitary, sometimes in clusters, cylindrical, ascospores bifusiform | <i>Cordyceps bifusispora</i> |
| | Stromata solitary, often in clusters, clavate to cylindrical, ascospores breaking to segments | <i>Cordyceps militaris</i> |
| 8 | On <i>Hymenoptera</i> | 9 |
| | On other insects | 10 |
| 9 | On ants | <i>Ophiocordyceps myrmecophila</i> |
| | On wasps, hornets, ichneumonids | <i>Ophiocordyceps sphecocephala</i> |
| 10 | On scale insects (Coccinea), stromata small, grey up to 4 – 5 mm, mostly on females of <i>Lecanium corni</i> | <i>Ophiocordyceps clavulata</i> |
| | On other insects. | 11 |
| 11 | On flies (Diptera) | 12 |
| | On beetles (<i>Coleoptera</i>). | 13 |

- 12 On larvae of march flies (Bibionidae, Diptera) and Coleoptera, small species up to 4 – 5 mm, red coloured, apex of stroma sterile
Ophiocordyceps variabilis
 On adults of flies, solitary, stromata pale brown, to 20 mm, perithecial part globular or ovoid
Ophiocordyceps forquignoni
- 13 Stromata slender with scattered perithecia 14
 Stromata with well defined perithecial part 15
- 14 Stromata very slender, grey, often in clusters of 2 – 3, dark perithecia free but not scattered, on larvae of Coleoptera
Ophiocordyceps superficialis
 Stromata slender, often in clusters, ochraceous-orange, perithecia scattered, on larvae of Scarabaeidae beetles
Ophiocordyceps michiganensis
- 15 On larvae and adults of ground beetles (Carabidae), rarely on rove beetles (Staphylinidae), stromata slender up to 10 cm, perithecial part well defined, globular
Ophiocordyceps entomorrhiza
 On other families of Coleoptera perithecial part ovoid, cylindrical, not globular 16
- 16 Perithecial part with sterile apex 17
 Perithecial part ovoid, without sterile apex, collar-shaped at the base, ascospore segments globular
Cordyceps larvicola
- 17 On Scarabaeidae beetles, stromata big and stout, whitish, yellow, ochraceous to pale brown, solitary or in clusters
Ophiocordyceps melolonthae
 On larvae of Elateridae beetles, stromata delicate, slender, brown to dark brown, solitary
Ophiocordyceps stylophora
- 18 Perithecial part clavate, cylindrical or spatulate, not sharply delimited from the stem 19
 Perithecial part capitate, globular, sharply delimited from the stem 20
- 19 Stromata in clusters, growing directly of the *Elaphomyces*, whitish grey, ascospore segments 9–13 µm
Elaphocordyceps japonica
 Stromata in clusters, connected to *Elaphomyces* indirectly by yellow-green hyphae, outgrowing also the host fruitbody, ascospore segments 2–4 µm
Elaphocordyceps ophioglossoides
- 20 Stromata yellow, yellow-orange or greenish, lacking white colour, perithecial part brown to black, *Elaphomyces* outgrown by brown mycelial hyphae, blackening with age 21
 Stromata greyish white to almost white, perithecial part pale brown, greyish almost black, orange coloured parasitised *Elaphomyces* outgrown by white mycelial hyphae
Elaphocordyceps rouxii

- 21 Stromata small, slender, up to 40 mm long, protruding perithecial apices of different colour, perithecial part small, globular, solitary, ascospore segments 3–7,5 µm ***Elaphocordyceps intermedia***
 Stromata robust, often more than 10 cm, perithecial apices of the same colour as the head 22
- 22 Perithecial part often prolonged, hooded, matt, brown to black, stem yellow, rarely greenish, ascospore segments thin walled, cylindrical, 15–23 µm ***Elaphocordyceps capitata***
 Perithecial part often flattened, undulated, shiny, brown to black, stem of the young carpophores yellow, soon turning to greenish or green-gray, covered with squamules of the same colour, ascospore segments thick walled, spindle shaped, 30–70 µm
Elaphocordyceps longisegmentis

SPECIES EXPECTED TO BE COLLECTED IN SLOVAKIA

Cordyceps bifusispora Eriksson

Described from Sweden in 1982 (Ericksson 1982). Parasitizes caterpillars and pupae of Lepidoptera. Stromata orange or yellow-orange, growing solitary or more often in clusters from the infected host bodies. In Europe recorded in AT*, FI*, NO*, PL, (1 km from the Slovak border, (Bujakiewicz & al. 2005)), SE*, often near streams under the *Alnus incana*. Known also from SE Asia, from Korea.

Cordyceps formicivora Schröt.

Known from Europe – PL, Zabkowice, DE – Silesia, Frankenstein, SE* – Uppsala (Obenberger, 1924, Eriksson, 2005) and North America (USA, Michigan, Main), (Kobayasi, 1940). Rare species similar to *Ophiocordyceps unilateralis* parasitizing wood ants. Black-brown perithecial part with short 2 – 3 mm stroma, without sterile apical part.

Cordyceps larvicola Quél.

Rare species recorded in Europe from DE, FR (Jura) – type material and IT, in several localities in mountains. (Kobayasi, 1940, Mornard, 1994, Hertzog, 2005). Moureau found it in Congo (Moureau, 1949, 1962). It parasitizes larvae of beetles (Coleoptera). Small species, stromata growing on the host bodies solitary, perithecial part ovoid to cylindrical, at the base collar shaped and free. Pale brown to brown, fresh carpophores with violet tinge at the paler stem. Rounded ascospore segments are typical for this species.

Cordyceps riverae Pacioni

Small species described from Italy (Pacioni, 1978), growing on hibernating *Triphosa* moths, similar to *Cordyceps tuberculata*. Until recently known on *Triphosa dubitata* and *T. sabaudiata* (Matošec, 2001). Known from HR, IT, BE?, CZ?, SK? Specimens found in Czech Republic were without mature spores (Kubátová, Dvořák 2005), similar records of immature specimens we found also in Slovakia. Stromata 2 – 4 mm growing on the white mycelium covering the

moth body, with 2 – 4 yellowish perithecia with darker apices. Host bodies found in wet underground spaces, such as mines, caves, cellars and tunnels.

Ophiocordyceps forguignoni Quéf.

The species is known mostly from Europe, recorded in DK*, ES*, FR (type material), GB* IR, PL. (Kobayasi, 1940, Læssøe, 1982, Mornard, 1994). It parasitizes adult flies (Diptera). Pale brown stromata are solitary and small, up to 2 cm. Perithecial parts are globular to ovoid, basal part collar shaped. Rather inconspicuous species recently recorded in several European countries.

Ophiocordyceps melolonthae (Tul.) Sacc.

Described from Pennsylvania in USA. Widespread mostly in North*, Central* and South America*(Costa Rica*). Published also from East India and Russia – Primorsko (Koval', 1984). In Europe recorded twice at Bialowieza virgin forest at Belarus (Koval', 1984). Robust species growing solitary or in clusters of the larvae of the *Scarabaeidae* (Coleoptera) beetles. Known 2 varieties, *O. melolonthae* var. *melolonthae* and *O. melolonthae* var. *rickii*. Yellow, yellow–orange, yellow–brown stromata, sometimes more than 10 cm grow from the front part of the host body. Cylindrical perithecial part with longitudinal groove is sometimes ended by sterile apex.

Ophiocordyceps michiganensis Mains

Described from Michigan, recorded mostly in USA.* and Canada. (Kobayasi, 1940, Mains, 1958). In Europe found in Switzerland on larvae of Coleoptera (Roth & Clerc, 1997). Small species parasitizing larvae of *Scarabaeidae* (Coleoptera) living in decaying wood. Yellow and yellow-ochraceous stromata up to 2,5 cm long, covered at upper part by scattered or clustered perithecia.

Ophiocordyceps stylophora Berk. & Br.

Known from Japan, China and North America. (Kobayasi, 1940, Koval', 1984). In Europe recorded once at SE (Nordén, 2002, Eriksson, 2005). Parasitizes larvae of the click beetles, Swedish record was on *Denticollis lineare* (Elateridae, Coleoptera), common also in Slovakia. Brown to black-brown stromata, 2 – 4,5 cm long grow of the host body solitary. Cylindrical perithecial part usually ended by long sterile apical part.

Ophiocordyceps superficialis (Peck) Sacc.

Small and slender species described from North America* (USA,) and reported from Japan and Russia – Primorsko (Kobayasi, 1940, Mains, 1958). In Europe recorded at Bialowieza virgin forest in Belarus (Koval', 1984). Parasitizes larvae and pupae of beetles (Coleoptera), growing solitary or in clusters of grey stromata 1 – 5 cm long. Darker perithecia are arranged regularly and are free.

Ophiocordyceps variabilis Petch

Described from Ithaca in USA. Known from North America and Africa. In Europe recorded once in France on larvae of Diptera. Other records on larvae of Coleoptera (Kobayasi, 1940, Mains, 1958, Moureau, 1962, Koval', 1984). Small species, stromata 4 – 17 mm long, rusty brown, orange to red growing solitary from the host bodies. Perithecia embedded in lateral cushions partly surrounding the cylindrical stromata with sterile apex above. Inconspicuous.

Elaphocordyceps intermedia Imai

Rare, small, up to 4 cm big species recorded mostly in SE Asia (Japan*, Korea), where it parasitizes local species of *Elaphomyces*. *Cordyceps intermedia* f. *michinokuensis* was described from Japan (Kobayasi, 1982). The species is known also from North America (Imai, 1934, Kobayasi, 1940, Imazeki, 1988, Ghyselinck, 2002). From Europe it is known from a single record, in 1976 it was collected by F. Candoussau in France. (Candoussau, 1979). European record is unique. Stromata slender, pale brown, with small globular perithecial part. surface spotted with darker perithecial apices.

Elaphocordyceps japonica Lloyd

Described from USA* (type TNS 720447*). From Japan*described as *Cordyceps umemurai*. Widespread in SE Asia and recorded occasionally also in North America. (Mains, 1957) and also Ghyselinck (2002) published one record of the species from Feldkirch in Austria from Farlow herbarium. In 1974 it was published from France (Candoussau, 1974), but later it was identified as *Cordyceps rouxii* (Candoussau, 1975). Clavate grey and grey-black stromata, without yellow colours, grow in clusters directly from the carpophores of *Elaphomyces*.

ANOTHER SPECIES PUBLISHED AND COLLECTED FROM EUROPE

Cordyceps clavicipitis Örtengren – SE

Cordyceps coccinea Penz. & Sacc. – BY, EE

Cordyceps deflectens Penz. & Sacc. – BY

C. doassansi Pat. – BY, FR

Cordyceps erotyli Petch – BY

Cordyceps martialis Speg.– ES

Cordyceps memorabilis (Cesati) Sacc. – IT

Cordyceps thaxteri Mains – EE, UA

Cordyceps variegata Moureau – BY, RU

Ophiocordyceps dipterigena (Berk. & Broome) – NL

Ophiocordyceps elongata (Petch) – BY

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Václav Kautman a Ivona Kautmanová: Rod žezlovka, *Cordyceps* s. l. (Ascomycetes, Clavicipitaceae) na Slovensku. *Catathelasma* (11): 5-48, 2009.

Štúdiom vlastných nálezov a dokladov v slovenských a svetových zbierkach sa potvrdil výskyt 12 taxónov žezloviek na Slovensku: *Cordyceps militaris*, *C. militaris* var. *sphaerocephala*, *C. tuberculata*, *Elaphocordyceps capitata*, *E. longisegmentis*, *E. ophioglossoides*, *E. rouxii*, *Ophiocordyceps clavulata*, *O. entomorrhiza*, *O. gracilis*, *O. myrmecophila*, *O. sphecocephala*. V článku je uvedený súpis zistených lokalít, ako aj údaje o taxonómii a ekológii jednotlivých druhov.

PLUTEUS EXIGUUS – A THREATENED OR OVERLOOKED SPECIES?

SOŇA RIPKOVÁ³

Key words: Slovakia, Basidiomycota, occurrence

Pluteus exiguus (Pat.) Sacc. is a small fungus, with pileus up to 20 mm diam. and stipe 10–20 × 1.5–2 mm. Pileus is hemispherical with low umbo, later convex to plano-convex, at centre slightly depressed with or without obtuse umbo, covered with characteristic brown-grey to blackish brown scales. Stipe is cylindrical or slightly broadened towards the base, white to greyish white, glabrous or faintly fibrillose, sometimes white tomentose at base. Microscopically, the species is characterised by a trichoderm pileipellis, absence of pleurocystidia, and cheilocystidia with ventricose base and abruptly narrowing at the apex in appendix; the appendix is not filiform, but weakly clavate (Vellinga, 1990, Citérin & Eyssartier, 1998).

During the research of non-forest habitats in Slovakia, I have collected *P. exiguus* in the Miroľská slatina Nature Reserve. Pileus 6 mm, plano-convex with central depression, dark brown to brown-black squamulose (at centre densely covered with erect scales, towards margin with more appressed scales and underlying whitish context showing in between), slightly hygrophanous and not striate at margin. Lamellae 1 mm wide, free, L = 32, l = 1, white, later pink, with slightly flocculose white edge. Stipe 15 × 1 mm, cylindrical, glabrous, whitish to greyish and faintly pruinose on upper half of stipe and brownish towards the base. Spores (5–)5.1–5.6(–6) × (6–)6.4–7.6(–8.2) μm, Q = (1.1–)1.2–1.4(–1.5), broadly ellipsoid to ellipsoid, slightly amygdaliform, smooth, hyaline. Basidia 4-spored, (23–)24.7–29.1(–32) × (6–)7.1–8.9(–10) μm, clavate, hyaline. Cheilocystidia (33–)38.7–57.2(–63) × (10–)11.3–15.1(–17) μm, narrowly utriform, clavate or narrowly clavate, with subcapitate or mucronate appendix up to 18 μm long and (2–)2.8–5.2(–7) μm wide, hyaline, thin-walled [according to Citérin & Eyssartier (1998) the width of the appendix is 3–4.5 μm]. Pileipellis a trichoderm consisting of 1–4 elements; terminal elements (38–)53.1–95.1(–112) × (11–)11.9–19.4(–24) μm, simply or narrowly clavate, fusiform or cylindrical, brown coloured. Stipitipellis a cutis made up of cylindrical, hyaline, up to 14 μm wide hyphae.

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The find of this species gave me the inspiration to look for more information on its occurrence in Slovakia as well as on its ecology and threat.

OTHER DESCRIPTION AND/OR ILLUSTRATIONS: Vellinga (1990), Musumeci (2006).

MATERIAL AND METHODS

Specimens of *Pluteus exiguus* kept in BRA and SLO were studied. The micromorphological characters were observed in dried material under the light microscope in oil immersion lens. Fragments of lamellae, stipe and pileipellis were examined in 5% KOH, Melzer's reagent and a solution of Congo Red in ammonia (1 ml of 25% ammonia dissolved in filtrated solution of 1.5 g of Congo Red and 50 ml of distilled water). For the measurements (30 per collection) of microscopical characters (spores, cheilocystidia, basidia and terminal elements of pileipellis) min, max (in the parenthesis) and average +/- standard deviation values are presented. Q is ratio of length and width of spores. Morphological terms follow Vellinga (1988). Data on specimens are updated, but the original text is kept in the square brackets, too. The ecology and distribution of the species is based on the material studied and quoted literary data.

OCCURRENCE IN SLOVAKIA

There are three known localities in Slovakia: one in the Podunajská nížina Lowland (1 specimen), one in the Poľana Mts. (1 specimen) and one in the Nízke Beskydy Mts. (1 specimen).

MATERIAL STUDIED⁴: Nízke Beskydy Mts., the village of Miroľa, Miroľská slatina Nature Reserve, fen peat, 410–415 m a. s. l., coord. N 49°20'00" E 21°43'45", on peaty moist soil (for associated plants see ecology below), 19 Sep 2006, leg. S. Ripková (SLO).

LITERARY DATA: Poľana Mts., the town of Zvolen, Arborétum Borová hora Protected Site, 300 m a. s. l., on branch of deciduous tree [Zvol. pah., Zvolen, Arborétum Borová hora, na listnatej haluzi], 6 Jun 1995, leg. S. Glejdura (Škubla, 1996). — Podunajská nížina Lowland:

⁴ Another five specimens originally labeled as *P. exiguus* in BRA represent different *Pluteus* taxa. One of them from the Poľana Mts. [Slovakia centralis, Poľana, Pod Dudášom, na zanorenom dreve, 28.IX.1993, leg. S. Adamčík] published by Adamčík (1994) represents *P. hispidulus* (Fr.) Gillet; another one from the Podunajská nížina Lowland [in horto arboreo Starý háj in urbe Bratislava (pars. Petržalka), 140 m n. m., in codice Quercus sp., 6.VIII.1987, leg. L. Hagara] published by Hagara (1992) is probably *P. semibulbosus* (Lasch) Quéf. Three other specimens of *Pluteus* have not being identified.

2 km E of the village of Močenok, the forest between the villages of Močenok and Pereš, [2 km V od obce Močenok, les medzi Močenkom a osadou Pereš], Oct 1993 (Škubla, 2003).

ECOLOGY

Pluteus exiguus seems to be a saprotroph producing fruitbodies from June to October. In Slovakia, Škubla (1996) presents *P. exiguus* from branch of deciduous tree. I have found this species in fen peat (pH H₂O cca. 7), on soil among *Angelica sylvestris*, *Carex flava*, *C. panicea*, *C. echinata*, *Cirsium rivulare*, *Deschampsia caespitosa*, *Equisetum palustre*, *Eriophorum latifolium*, *Galium palustre*, *Juncus articulatus*, *Linum catharticum*, *Lycopus europaeus*, *Lythrum salicaria*, *Potentilla erecta* and *Ranunculus repens*. It is treated as terrestrial fungus also by Vellinga (1990), who gives its growth on soil in woods or on chalk grasslands, as well as by Citérin & Eyssartier (1998). Antonín (2006) presents it as a wood-inhabiting fungus fructifying on decaying wood of deciduous trees, mostly of *Fagus sylvatica*, *Quercus* sp. div. and *Carpinus betulus*.

THREAT

In Europe, *Pluteus exiguus* is classified as threatened in the Czech Republic (Holec & Beran, 2006), Denmark (Stoltze & Pihl, 1998), Germany (Benkert & al., 1996) and the Netherlands (Arnolds & Kuyper, 1996).

In Slovakia, two species of the genus *Pluteus* are redlisted: *P. aurantiorugosus* (Trog) Sacc. and *P. favrei* Antonín & Škubla. Based on the database of the available published data on occurrence and distribution of macrofungi in Slovakia (Adamčík et al., 2003) and unpublished data (Hagara in verb.) only 2 collections of *P. favrei* and about 20 collections of *P. aurantiorugosus* are recently known in Slovakia. Low number of the collections of *P. exiguus* might be caused by its rarity or the species is just overlooked. If its rarity is confirmed *P. exiguus* should be included to the Red List of fungi of Slovakia.

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Soňa Ripková: Štítovka hlúžkatá – ohrozený alebo prehlíadaný druh? *Catathelasma* (11): 49–52, 2009.

Štítovka hlúžkatá (*Pluteus exiguus*) je na Slovensku dosiaľ známa z troch lokalít. Uvedený je opis plodníc, lokality výskytu, ako aj poznatky o ekológii a ohrozenosti.

BOOK NOTICES

PAVEL LIZOŇ

Alexandra Šimonovičová. 2008. **Soil microscopic fungi of Slovakia I.** Letter of alphabet from A to N. [1]–[128]. Dept. of Soil Sciences, Faculty of Natural Sciences, Comenius University, Bratislava. ISBN 978-80-969678-5-8 (softbound). Price not indicated.

From 1954 till 2008 331 species (in 97 genera) of microscopic fungi have been isolated from soils in Slovakia. First part of the checklist has 97 species (in 49 genera), each with basic synonymies and distributional and ecological data.

Kent Loeffler and Kathie Hodge. 2009. **Beneath notice. Adventures with a borescope.** [1]-90, incl. 88 color photographs. Lulu Press (for Cornell University), Ithaca. Price: \$33.50 (order from www.lulu.com).

Do you know what is a borescope? It is an optical device used both in industries and medicine. It consists of a tube with an eyepiece on one end, an objective lens on the other linked together by a relay optical system in between. Those with a rigid tube are used for examining the inside of engines, rifle barrels, those with flexible tube for inspecting the human body (referred to as an endoscope).

Kent Loeffler, the photographer of the Cornell Department of Plant Pathology and Plant-Microbe Biology using a borescope, captured numerous mushrooms and slime molds. Selection of the “borescope” pictures were on display in the Cornell Albert L. Mann Library in January – March 2009. Some of them commented by Kathie Hodge, Associate Professor of Mycology, are in the present book published as a catalogue for the exhibition.

For details about this project go to www.ppath.cornell.edu/PhotoLab.

Carol Kaesuk Yoon. 2009. **Naming nature. The clash between instinct and science.** [i-vi], [1]-344, W. W. Norton & Co., New York. ISBN-10: 0393061973, ISBN-13: 978-0393061970. Price for hardcover at books.wwnorton.com: \$27.95 (at amazon.com: \$18.45); paperback should be released in 2010.

Carol Kaesuk Yoon (www.carolyoon.com) is a science writer for the New York Times (www.nytimes.com). She received her BS in biology from Yale and her PhD in ecology and evolutionary biology from the Cornell University. Carol is one of those people who are important for science even they are not involved in research: they are telling the general public how scientists create a science, how the progress of science is changing our lives.

Her latest book takes us on a guided tour on science's attempts to order and name all living creatures on the earth. It explains how new methodologies helped to the progress of the taxonomy and the understanding of the evolution of organisms.

My friend Richard P. Korf, emeritus professor of mycology (Cornell University, Ithaca) when he drew my attention to this book noted: „I strongly recommend the book, and if I were still teaching I would make it the second required reading for all taxonomy students (the first being the Van Steenis paper in *Flora Malesiana* that you probably remember)“. I bought the book, enjoyed reading it and agreed with him.

References:

Steenis, C. G. G. J. van. 1957. Specific and subspecific delimitation. *Flora Malesiana* 1(5): clxxvii-ccxxiv.

Thomas Læssøe and Jens H. Petersen. 2008. **MycoKey 3.1.** DVD (Funga Nordica edition). Code: 2008721646FN.

We have already referred about MycoKey 2.1 (Catathelasma 9: 33, 2007). Version 3.1 was attached and distributed with Funga Nordica and has not only identification software but also the species keys from the book. MycoKey web-site (www.mycokey.com) offers now an upgraded edition 3.2 that has more species, more illustrations and more references to literature.

References:

Knudsen, H. & J. Vesterholt (eds.). 2008. *Funga Nordica*. [1]-965. Nordsvamp, Copenhagen.



Elaphocordyceps capitata
(Kysucká vrchovina, Horná Tižiná;
see p. 31–34)



Elaphocordyceps rouxii
(Javorníky, Dešná; see p. 36–41)



Elaphocordyceps longisegmentis
(Malé Karpaty, Modra – Harmónia; see p. 34–36)



Ophiocordyceps gracilis
(Západné Tatry, Zuberec;
see p. 16–18)



Ophiocordyceps entomorrhiza
(Javorníky, Miločov;
see p. 18–19)



Ophiocordyceps sphecocephala
(Levočské vrchy, Breznica;
see p. 14–16)



Ophiocordyceps sphecocephala
(Levočské vrchy, NIžný Slavkov;
see p. 14–16)