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The family Pyronemataceae (Pezizales, Ascomycota) in the Republic of Macedonia

Фамилијата Pyronemataceae (Pezizales, Ascomycota) во Република Македонија

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This is the first attempt of systematic research into Pyronemataceae family (Pezizales, Ascomycota) in the Republic of Macedonia. The aim of this paper was to present all available data (species diversity, brief ecology and distribution) on Pyronemataceae fungi in the country. Compiled species list includes data from existing literature (12 publications), 128 data from the MACFUNGI database, 110 exsiccates from the Macedonian Collection of Fungi (MCF) and our own field research trips, observations and identification. A total of 28 species belonging to 12 genera have been recorded. The highest number of species belongs to the genera *Otidea* (7), *Scutellinia* (4) and *Genea* (3 species). The most frequent species are *Aleuria aurantia, Humaria hemisphaerica* and *Scutellinia scutellata*. The species *Genea fragrans, G. hispidula, G. verrucosa, Geopora arenicola* and *G. sumneriana* are hypogeous fungi. Five genera (*Anthracobia, Cheilymenia, Melastiza, Trichophaea, Trichophaeopsis*) and 14 species are reported as new for the mycobiota of Macedonia.

Keywords: Pyronemataceae, fungi, ecology, distribution, Macedonia.

Ова се податоци од првите систематски истражувања на претставници од фамилијата Pyronemataceae (Pezizales, Ascomycota) во Република Македонија. Целта на ова истражување беше да се соберат сите достапни податоци (диверзитет, краток осврт на екологијата и дистрибуцијата) за видовите од фамилијата Pyronemataceae во земјата. Составена е листа на видови која вклучува податоци од постоечката литература (12 публикации), 128 податоци од базата на податоци MACFUNGI, 110 ексикати од Македонската колекција на габи (MCF) и сопствени податоци од теренски истражувања. Притоа беа регистрирани 29 видови кои припаѓаат на 12 родови од фамилијата Pyronemataceae. Најголем број видови припаѓаат на родовите *Otidea* (7), *Scutellinia* (4) и *Genea* (3 видови). Најчести видови се *Aleuria aurantia, Humaria hemisphaerica* и *Scutellinia scutellata*. Видовите *Genea fragrans, G. hispidula, G. verrucosa, Geopora arenicola* и *G. sumneriana* се подземни габи. Пет родови (*Anthracobia, Cheilymenia, Melastiza, Trichophaea, Trichophaeopsis*) и 14 видови се нови за фунгијата на Република Македонија.

Клучни зборови: Pyronemataceae, габи, екологија, дистрибуција, Македонија.

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Introduction

Pyronemataceae family is the largest in Pezizales, including 78 genera, representing about half of the known species within the order (ca. 500 spp.) (Hansen & Pfister 2006). Ecologically, it includes epigeous, semi – hypogeous to hypogeous taxa that cover an extremely broad range of niches, fruiting on all types of soil, dung and wood plant debris, sand, clay, limestone, burnt ground (Liu & Zhuang 2006a). The majority of species have been considered as saprobes, but their trophic strategies are not well studied (Hansen & Pfister 2006) although recent molecular and isotopic studies contributed and confirmed the trophic strategies for some genera of this family. A species diversity study of Pyronemataceae in Macedonia has not been conducted up till now and most collections represent new records. Also there are rather few mycological papers concerned only with individual species of this family. The aim of this study was to present all available data (list of species with their diversity, brief ecology and distribution) on Pyronemataceae fungi in the country, since no up-to-date list of the species is available. So far, a total of 16 Pyronemataceae species have been published in 12 publications (Tortić & Cekova 1975; Tortić 1988; Karadelev & Nastov 1998; Karadelev et al. 2002a, b, c; Karadelev et al. 2003; Karadelev et al. 2007; Karadelev et al. 2008a, b; Chavdarova et al. 2011).

Materials and methods

The study is based on specimens collected in all parts of Macedonia, exiccates deposed in different collections, 128 data from the MACFUNGI database, field research trips, observations and research notes of the present authors and other individual collectors. The taxa previously described or reported from Macedonia are also listed here and references are given, while most of the unpublished data are from last ten years. Most of the specimens (110) have been preserved in the Macedonian Collection of Fungi (MCF) at the Institute of Biology, Faculty of Natural Science and Mathematics, Ss Cyril and Methodius University in Skopje and few specimens are deposited at the Croatian National Fungarium in Zagreb (CNF). The data from the personal herbarium of Mitko Karadelev and the data cited from the collection SKO are now in the MCF. All other species without any Herbarium Acronym in the text have been collected and determined by the present authors. Several different taxonomic keys were used, depending

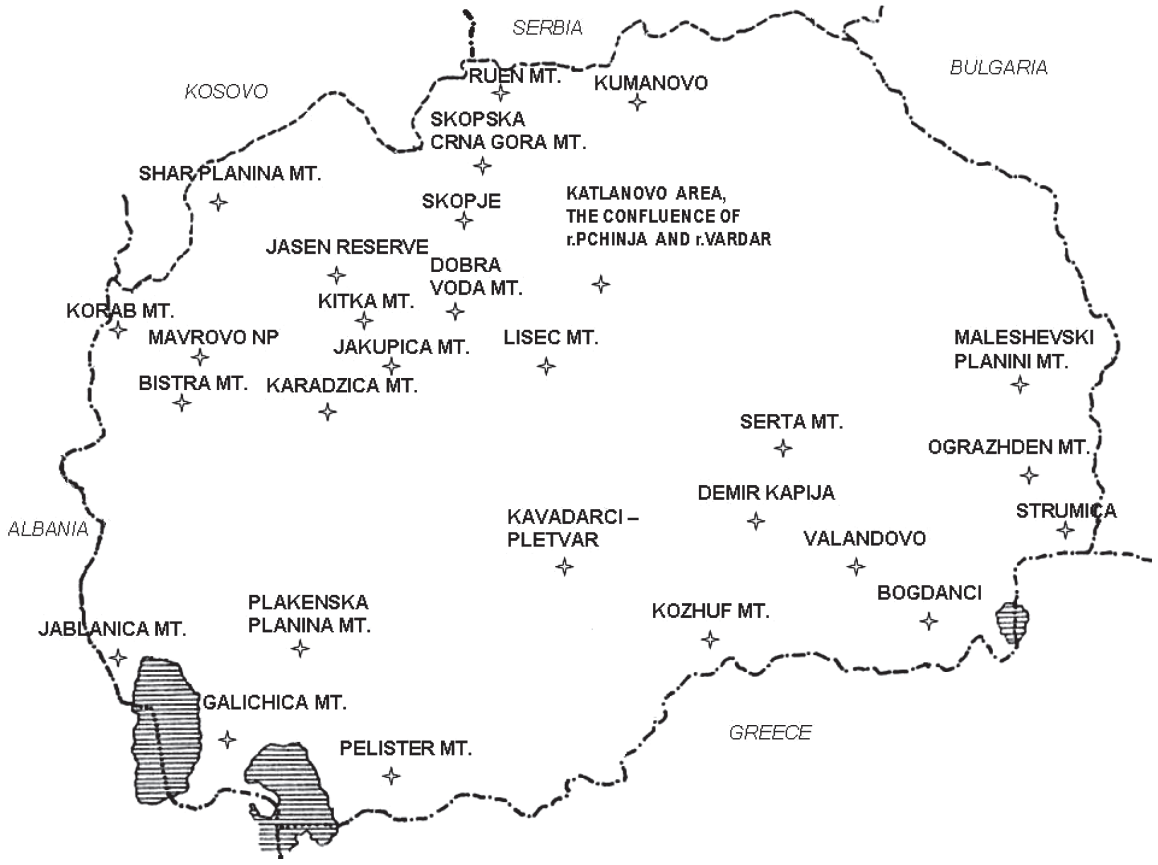

Fig. 1. Map of the studied localities in the Republic of Macedonia

on the genus studied, for identification or revision of the specimens: Dennis (1960); Moser (1963); Breitenbach and Kränzlin (1981); Hansen and Knudsen (eds.) (2000); Montecchi and Sarasini (2000). The trophic groups (**Carb** = Carbotroph, **M** = Mycorrhizal, **Sc** = Coprotrophs, **Sh** = humus saprotrophs, **Sw** = wood saprotrophs) are according to Arnolds et al. (1995) and Dimitrova & Gyosheva (2009). In a few cases, the names of the species have been modified according to Index Fungorum (http://www.indexfungorum.org/names/names.asp) and Mycobank (http://www.mycobank.org/) and all synonyms were also adopted, after author's revision. The genera and species are listed in alphabetical order followed by data of geographical distribution, altitude, substrate, forest association and data source.

Marks and abbreviations

Syn. - synonym
exs. - collection in which the dried material (exsiccatum) is deposited
Ref. - references (sources of records of the taxon)
vill. - village
Mt. - mountain
r. - river
* - new species for the Republic of Macedonia

Results

Aleuria aurantia (Pers.) Fuckel

Ref.: Tortić & Cekova 1975; Tortić 1988; Karadelev & Nastov 1998.

Collections: MCF, SKO, CNF

Jasen reserve: r. Ocha, Grnec, soil, 30.10.2009, exs. MCF 09/11418; **Jakupica Mt.**: Gorno Vranovce vill., sandy soil, chestnut forest, 07.2011, exs. MCF 98/1852; 08.2011, exs. MCF 98/1858; Preslap (1000), naked soil, *Quercetum frainetto-cerris*, exs. SKO; **Kitka Mt.**: Gorno Kolichane vill. (900-1200), soil, roadsides, 18.10.2006, exs. MCF 06/6156; above Gorno Kolichani vill. (700-900), soil, *Quercetum frainetto-cerris*, 19.10.1998, exs. MCF 98/2224; **Karadzica Mt.**: Preslap (1000), on naked soil, oak forest; **Kozhuf Mt.**: Konjsko vill., soil, *Pinus* planting mixed with *Quercus frainetto*, 09.10.1996; Smilevo Bachilo (1500), soil, meadow in beech forest, 08.10.1995; (700-1700); naked soil, *Fagetum*, exs. CNF; **Mavrovo NP**: Zhirovnica vill., above Brezna (1143), soil, roadside, *Festuco heterophyllae-Fagetum* (with *Betula pendula*), 03.10.2010, exs. MCF 10/12170; Rostushe vill., *Pinus nigra* planting (1072), 19.09.2010; **Pelister Mt.**: children's resort (1200-1300), *Digitali viridiflorae-Pinetum peuces*, 07.10.1988, **Skopje (vicinity)**: r. Pateshka Reka, soil, 02.06.2007, exs. MCF 07/7037.

****Anthracobia macrocystis*** (Cooke) Boud.

Collections: MCF

Dobra Voda Mt.: Crvivci vill., Chuka, soil, buried *Pinus* planting, 23.10.2007, exs. MCF 07/8181.

****Anthracobia subatra*** (Rehm) M.M. Moser

Syn.: *Lachnea subatra* Rehm

Collections: MCF

Dobra Voda Mt.: Cheloica Mt., above Premka vill. (800-900), soil, under *Pinus* sp., *Pinus* planting, 09.05.2009, exs. MCF 09/10584.

****Cheilymenia stercorea*** (Pers.) Boud.

Collections: MCF

Katlanovo, the confluence of r. Pchinja and r.Vardar: St. Jovan Veterski monastery (150-200), dung, *Pruno webbii-Juniperetum excelsae*, 25.10.2002, exs. MCF 02/2876.

****Cheilymenia vitellina*** (Pers.) Dennis

Syn.: *Humaria vitellina* (Person) Quélet

Collections: MCF

Shar Planina Mt.: Leshnica, rich soil, *Fago-Abietetum meridionale*, 16.07.2009, exs. MCF 09/11010.

Genea fragrans (Wallr.) Paol.

Ref.: Chavdarova et al. 2011.

Collections: MCF

Kavadarci – Pletvar: below Raec vill., close to Mramor monastery (road to Pletvar) (320), in sandy soil, *Quercus frainetto*, *Carpinus orientalis*, *Quercus trojana*, *Quercus pubescens*, 12.12.2009, exs. MCF 09/11365.

Genea hispidula Berk. ex Tul. & C. Tull.

Syn.: *Genea papillosa* Berkeley

Ref.: Chavdarova et al. 2011.

Collections: MCF

Galichica Mt.: road to Leskoec, (800), deep red soil with abundand stones, *Quercus frainetto*, *Quercus cerris*, 16.12.2009, exs. MCF 09/11375.

Genea verrucosa Klotzsch

Ref.: Chavdarova et al. 2011.

Collections: MCF

Valandovo: near St. Georgij monastery, hypogeic, under *Quercus coccifera, Querco cocciferae-Carpinetum orientalis*, 10.12.2008, exs. MCF 08/10631; near St. Georgij monastery (333), hypogeic, under *Quercus coccifera*, *Querco cocciferae-Carpinetum orientalis*, 10.12.2008, exs. MCF 08/10632; Bashiboz, hypogeic, under *Quercus coccifera*, *Querco cocciferae-Carpinetum orientalis*, 10.12.2008, exs. MCF 08/10633; **Katlanovo**: St. Bogorodica Monastery, hypogeic, under *Quercus pubescens*, *Juniperetum excelsae*, 11.12.2008, exs. MCF 08/10646 and 08.12.2008, exs. MCF 08/10647.

Geopora arenicola (Lév.) Kers
Ref.: Chavdarova et al. 2011.
Collections: MCF

Galichica Mt.: above Oteshevo, west from water collection station, soil, *Quercetum frainetto-cerris*, 16.12.2009, exs. MCF 09/11556; **Skopje (vicinity)**: Vodno, below the top (800-900), soil, pathway, 06.12.2009, exs. MCF 09/11352; Matka, near the dam (300), soil, meadow, 26.10.2005, exs. MCF 05/8776; **Valandovo**: Bashiboz vill., hypogeic, under *Quercus coccifera*, *Querco cocciferae-Carpinetum orientalis*, 09.12.2008, exs. MCF 08/10643, MCF 08/10643.

Geopora sumneriana (Cooke) M. Torre
Syn.: *Sepultaria sumneriana* (Cooke) Masse
Ref.: Karadelev & Nastov 1998; Chavdarova et al. 2011.
Collections: MCF

Demir Kapija: (150), grass, *Juniperus excelsa* forest with *Quercus coccifera*, 19.11.2003, exs. MCF 03/10344; **Kitka Mt.**: above the vill. Gorno Kolichani (700-900), soil, *Quercetum frainetto-cerris*, 19.10.1998, exs. MCF 98/2231; **Skopje**: Botanical garden (250), soil, under *Cedrus* sp., park, 14.04.2002, exs. MCF 02/2459; Institute of Agriculture (250), soil, under *Cedrus* sp., park, 10.04.2002, exs. MCF 02/2458.

Humaria hemisphaerica (Hoffm.) Fuckel
Ref.: Sylejmani 1980; Tortić, 1988; Karadelev & Nastov 1998; Karadelev et al. 2002b; Karadelev et al. 2003; Karadelev et al. 2008a, b.
Collections: MCF

Bistra Mt.: Lazaropole vill., between St. Tanasije and Chulavec (1400-1500), fallen twigs of *Fagus*, *Calamintho grandiflorae-Fagetum*, 07.08.2003, exs. MCF 03/3502; Mavrovo, soil, *Fago-Abietetum meridionale*, 29.10.2009, exs. MCF 09/11480; **Bogdanci**: Bolovan (150), soil, azonal vegetation, 25.10.2007, exs. MCF 07/8254; Paljurci (150), rotten wood of *Pyrus amygdaliformis*, *Coccifero-Carpinetum orientalis* with planted *Pinus* sp. and *Cupressus* sp., 26.12.2009, exs. MCF 09/11530; **Dobra Voda Mt.**: soil, *Quercetum frainetto-cerris*; **Galichica Mt.**: Prchno Brdo, soil, *Quercetum frainetto-cerris*, 11.2008, exs. MCF 08/10789; **Jablanica Mt.**: Vishni vill., St. Spas church (1000), deciduous wood used in construction, 10.07.2006; **Jakupica Mt.**: Cheples (1200-1300), trunk of *Fagus*, *Festuco heterophyllae-Fagetum*, 11.07.1999; Preslap (1000), soil, *Quercetum frainetto-cerris*; **Kitka Mt.**: above the vill. Gorno Kolichani, (700-800), in oak forest, 10.1998; **Korab Mt.**: above Strezimir watchtower (1350-1500), stump of *Fagus*, with moss, beech forest, 04.09.2005; **Kozhuf Mt.**: Mihajlovo summer resort, rotten wood of *Quercus* sp., mixed forest (*Fagus*, *Quercus* sp., *Pinus* sp.), 12.07.2005, exs. MCF 05/5003; Chvrstec (1400), rotten wood, beech forest, 13.07.2005, exs. MCF 05/5029; Mihajlovo summer resort (1250-1400), rotten wood of *Fagus*, beech forest, 17.07.2005, exs. MCF 05/5096; near r. Stara Reka, rotten wood, beech forest, 18.07.2005, exs. MCF 05/5126; soil, 20.10.1983, exs. MCF 83/6508; **Mavrovo NP**: Vrben vill., soil, *Abies* forest, 22.10.2010, **Ograzhden Mt.**: Shumanov Chukar (1300), rotten branches of *Corylus avellana*, mixed forest (*Fagus*, *Pinus sylvestris* and *P. nigra*), 14.07.2000, exs. MCF 00/1568; **Pelister Mt.**: around Palisnopje (1500), soil, *Digitali viridiflorae-Pinetum peuces* with *Fagus*, 07.10.2001, exs. MCF 01/186 and 06.10.2001, exs. MCF 01/24; above the vill. Brajchino (1400), soil, among moss, *Fagus* forest with *Abies* trees, 19.09.2006, exs. MCF 06/9632; **Serta Mt.**: Lipa vill. (500), rotten wood, oak forest, 11.10.2002, exs. MCF 02/2847; **Shar Planina Mt.**: Gorno Jelovce vill. (1400), rotten wood of *Fagus*, *Festuco heterophyllae-Fagetum*, 09.07.1998, exs. MCF 98/1933; **Skopje (vicinity)**: Vodno (800), *Querco-Carpinetum orientalis*, 20.10.2002; **Skopska Crna Gora Mt.**: Ljubanci vill. (800), stump of deciduous tree, *Querco-Carpinetum orientalis macedonicum*, 09.10.2005, exs. MCF 05/5449; **Strumica**: near Koleshino vill. (300), soil, *Periploco-Alnetum glutinosae*, 14.10.2001, exs. MCF 01/563 and 02.10.2002, exs. MCF 02/3638.

****Melastiza chateri*** (W.G. Sm.) Boud.
Syn.: *Humaria chateri* (W.G. Smith) Saccardo
Collections: MCF

Shar Planina Mt.: r. Studena Reka (1700), sandy soil, at roadsides, 14.06.2007, exs. MCF 07/7223.

****Melastiza flavorubens*** (Rehm) Pfister & Korf
Syn.: *Aleuria flavorubens* (Rehm) J. Moravec
Collections: MCF

Lisec Mt.: soil, edge of beech forest (*Festuco heterophyllae-Fagetum*), 16.05.2007, exs. MCF 07/6753.

Otidea abietina (Pers.) Fuckel
Ref.: Karadelev et al. 2003; Karadelev et al. 2007.
Collections: MCF

Bistra Mt.: Dolni Lopushnik, above spring (1000-1200), soil, *Festuco heteroprhyllae-Fagetum*, 14.10.2006, exs. MCF 06/6103; Mavrovo, soil, *Fago-Abietetum meridionale*, 29.10.2009, exs. MCF 09/11485; **Mavrovo NP**: Volkovija vill. (above), soil, *Abies* forest, 11.10.2010, exs. MCF 10/12162; **Pelister Mt.**: Palisnopje (1500), soil, *Digitali viridiflorae-Pinetum peuces* with *Fagus*, 06.10.2001, exs. MCF 01/53 and 19.10.2005, exs. MCF 05/5580; Kopanki (1650), soil, *Digitali viridiflorae-Pinetum peuces*, 21.09.2002, exs. MCF 02/3169; Ko-

panki (1700), soil, *Gentiano luteae-Pinetum peuces*, 25.09.2002, exs. MCF 02/3222.

****Otidea alutacea*** (Pers.) Massee
Collections: MCF
Pelister Mt.: Malovishte vill., above St Ana monastery (1200-1300), fallen branches of *Fagus*, *Festuco heterophyllae-Fagetum*, 18.09.2006, exs. MCF 06/9626.

****Otidea auricula*** (Schaeff.) Sacc.
Collections: MCF
Shar Planina Mt.: Popova Shapka, soil, edge of *Picea* forest, 15.07.2009, exs. MCF 09/10972; Leshnica, soil, *Fago-Abietetum meridionale*, 16.07.2009, exs. MCF 09/11015.

****Otidea bufonia*** (Pers.) Boud.
Syn.: *Peziza bufonia* Persoon
Collections: MCF
Kumanovo (vicinity): Dobroshane vill., soil, *Pinus* plantings, 10.2006, exs. MCF 06/9071.

Otidea cantharella (Fr.) Quél.
Syn.: *Flavoscypha cantharella* (Fries) Harmaja
Ref.: Karadelev et al. 2008a
Collections: MCF
Jablanica Mt.: Belichko Brdo (1850), leaves litter, *Fagus* forest, 15.07.2006.

****Otidea cochleata*** (L.) Fuckel
Syn.: *Helvella cochleata* (Linnaeus) J.F. Gmelin
Collections: MCF
Bistra Mt.: near the dam (1300), soil, *Abieti-Fagetum*, 18.10.2005, exs. MCF 05/8916; **Kozhuf Mt.**: Smrdliva Voda (800), soil, beech forest, 24.10.2005, exs. MCF 05/5614.

Otidea concinna (Pers.) Sacc.
Ref.: Karadelev et al. 2007a
Collections: MCF
Pelister Mt.: around Trnovo vill. (1200), soil, *Festuco heterophyllae-Fagetum*, 26.05.2002;

Otidea onotica (Pers.) Fuckel
Ref.: Tortić 1988; Karadelev & Nastov 1998.
Collections: MCF, CNF
Bogdanci: Bolovan (200), soil, *Coccifero-Carpinetum orientalis*, 24.11.2007, exs. MCF 07/8404; **Kozhuf Mt.**: Konjsko vill. (500), *Pinus* planting, 10.1996; Smrdliva Voda (800), rotten wood of *Fagus*, beech forest, 24.10.2005, exs. MCF 05/5613; **Pelister Mt.**: around Kopanki (1500-1700), soil, *Digitali viridiflorae-Pinetum peuces*, 19.10.2005, exs. MCF 05/5582 and *Gentiano luteae-Pinetum peuces abietetosum*, 06.10.1998, exs. CNF; **Skopska Crna Gora Mt.**: Brodec vill. (1000), soil, oak forest, 12.10.1998; Brodec vill. (1000), soil, *Querco-Carpinetum*, 06.10.1998, exs. MCF 98/4334.

****Scutellinia cejpii*** (Velen.) Svrcek
Syn.: *Hyaloscypha cejpii* Velenovský
Collections: MCF
Kozhuf Mt.: to Mala Rupa (1200-1500), beech remnants, 16.07.2004, exs. MCF 04/1596.

Scutellinia kerguelensis (Berk.) Le Gal
Syn.: *Lachnea kerguelensis* (Berkeley) Saccardo
Ref.: Karadelev et al. 2002c.
Collections: MCF
Malesevski Mt.: along the stream r. Dvoriska Reka (1000), unknown substrate, *Festruco heterophyllae-Fagetum*, 15.07.2000, exs. MCF 00/1595.

Scutellinia scutellata (L.) Lambotte
Ref.: Karadelev & Nastov, 1998; Karadelev et al., 2002a, b; Karadelev et al. 2008a.
Collections: MCF
Bistra Mt.: Galichnik vill. (1300), by spring, beech forest, 29.08.2009, Leg.: Kristina Zimbakova; Lazaropole vill., footpath to St. Gjorgija church (1300), rotten wood of *Fagus*, beech forest, 08.08.2005, **Galichica Mt.**: Volko Legalo (1700), fallen branches of *Fagus*, 19.07.1987, exs. MCF 87/4343; **Jablanica Mt.**: (1300), soil, beech forest, 10.10.2005, exs. MCF 05/5373; below Gorna Belica vill., Jankov Kamen (1300), rotten wood of *Fagus*, *Fagus* forest, 11.07.2006; **Jakupica Mt.**: Babina Rupa (1900-2000), fallen branch of *Fagus*, 12.07.1999; Cheples (1400-1500), rotten wood of *Fagus*, *Calamintho grandiflorae-Fagetum*, 11.07.1999, exs. MCF 99/2446; **Kitka Mt.**: r. Kadina Reka, 24.05.2002; **Korab Mt.**: below Mala Korabska Vrata (2500), soil, moss, wet place, high-mountain pasture, 09.09.2006, exs. MCF 06/5995; **Kozhuf Mt.**: Mihajlovo summer resort, rotten wood, mixed forest (*Fagus*, *Quercus* sp., *Pinus* sp.), 12.07.2005, exs. MCF 05/5002; Dudichki Kolibi (1400-1370), rotten wood of *Fagus*, mixed forest (*Fagus*, *Abies*), 21.07.2005, exs. MCF 05/5185; mine Sumpor (r. Stara Reka) (1370), rotten wood of *Fagus*, beech forest, by the river, 21.07.2005, exs. MCF 05/5194; Stara Karaula, soil, mountain pasture, near stream, 20.07.2005, exs. MCF 05/5167; to Mala Rupa (1200-1500), rotten wood, beech forest, 16.07.2004, exs. MCF 04/4175; **Plakenska Planina Mt.**: Golemo Ilino vill., St. Ilija monastery (1479), plant reminants, wet meadow, 21.07.2008, exs. MCF 08/9863; **Ruen Mt.**: Staro Nagorichane vill., rotten wood, mixed forest (*Populus* sp., *Salix* sp.), 16.05.2005, exs. MCF 05/4924; **Shar Planina Mt.**: around Sharski Vodi mountain house (1300), bark of *Fagus*, *Calamintho grandiflorae-Fagetum*, 07.07.1998, exs. MCF 98/1774; r. Ljubotenska Re-

ka (1400-1600), *Fagus*, *Calamintho grandiflorae-Fagetum*, 13.07.1997, exs. MCF 97/2975; Tri Vodi, *Fagus*, 12-24.07.1996; Zendelbeg (Gorno Jelovce vill.) (1500-1600), rotten wood of *Fagus*, beech forest, 11.07.1998, exs. MCF 98/8616; **Skopska Crna Gora Mt.**: Ljubanci vill., above monastery St. Nikola, (800-900), moss, *Querco-Carpinetum orientalis*, 01.05.2006, exs. MCF 06/2944; **Skopje (vicinity)**: Matka, soil, 07.02.1999, exs. MCF 99/3890.

Scutelinia umbrarum (Fr.) Lambotte
Ref.: Karadelev & Nastov 1998.
Collections: MCF
Karadzica Mt.: between mountain house Karadzica and r. Kadina Reka (1270-1500), soil, beech forest, 25.07.1997.

Tarzetta catinus (Holmsk.) Korf & J.K. Rogers
Ref.: Karadelev & Nastov 1998
Collections: MCF
Galichica Mt.: Trpejca vill. (800), oak forest, 22.10.2005, exs. MCF 05/8772; **Kitka Mt.**: between Gorno Kolichani vill. and Preslap (950), soil, *Fagus* forest, 03.05.2007, exs. MCF 07/6785; above the vill. Gorno Kolichani (700-900), soil, *Quercetum frainetto-cerris*, 19.10.1998, exs. MCF 98/2237; **Shar Planina Mt.**: Leshnica, soil, *Fago-Abietetum*, 16.07.2009, exs. MCF 09/11020; **Skopje (vicinity)**: Matka, footpath to St. Nikola monastery (400), soil, mixed deciduous forest, 29.05.2004, exs. MCF 04/4125.

****Tarzetta cupularis*** (L.) Svrcek
Syn. : *Aleuria cupularis* (Linnaeus) Gillet
Collections: MCF
Kumanovo (vicinity): Staro Nagorichane vill., soil, mixed deciduous forest (*Populus* sp., *Betula pendula*, *Alnus glutinosa*, *Salix* sp.), 25.10.2005, exs. MCF 05/8947.

****Trichophaea hemisphaerioides*** (Mouton) Graddon
Syn.: *Humaria hemisphaerioides* (Mouton) Eckblad
Collections: MCF
Bogdanci: Pogana (300), 26.07.1983, exs. MCF 87/7748; **Bogdanci (vicinity)**: confluent of r. Gabrovska Reka, humic soil, near water, near stream, 03.09.1983, exs. MCF 83/9552.

****Trichophaeopsis bicuspis*** (Boud.) Korf & Erb
Syn.: *Trichophaea bicuspis* (Boudier) Boudier
Collections: MCF
Kitka Mt.: mountain house Kitka, fallen branch of deciduous tree, 24.05.2002, exs. MCF 02/9148; **Kozhuf Mt.**: Nancheva Cheshma (350), on rotten deciduous wood, oak forest, 29.04.2002, exs. MCF 02/2697.

Discusion

Aleuria Fuckel

Species of the genus *Aleuria* are characterized by sessile or short stipitate apothecia, disc-shaped to deeply cup-shaped, usually grows in clusters and has irregular outline; himenium is brightly-colored (orange to apricot); ascospores are elliptical, hyaline containing two oil-drops. Only one species - *Aleuria aurantia* - has been recorded in Macedonia. It is a cosmopolitan species which develops on land devoid of vegetation (Calonge & Menezes de Sequeira 2011). According to Tortić & Cekova (1975), Tortić (1988), Karadelev & Nastov (1998), it is registered in eight localities and the following four localities are new: Jasen reserve, mountains Kitka and Pelister, and surrounding area of Skopje. According to the current data it is frequent and widespread species in Macedonia. Although it is known as saprotrophic fungus, Hobbie et al. (2001), based on isotopic analyses of ascocarps, indicate that *A. aurantia* may be mycorrhizal species. The data from Macedonia come from deciduous forests (chestnut, beech, oak) and from pine forests.

Anthracobia Boud.

Anthracobia species have often densely gregarious apothecia, disk-shaped with yellow-brown, ochraceous, orange or red hymenium; on the outside and the margin arise short, appressed, brownish hairs; spores are narrowly elliptical, smooth and hyaline with two oil-drops. Common ecological feature of *Anthracobia* is that sporocarps occur always on burnt ground or charred wood during the whole year (Dennis 1960; Breitenbach & Kränzlin 1984; Hansen & Knudsen 2000; Medardi 2006). Two species of the genus have been recorded in Macedonia: *Anthracobia macrocystis* and *A. subatra*. This genus is new for the mycobiota of the country and both species have been registered from one locality (Dobra Voda Mountain) in buried *Pinus* plantings.

Cheilymenia Boud.

Cheilymenia species have small, sessile apothecia, disc-shaped or cup-shaped with brightly - cloured hymenium (yellow, yellow-orange to reddish); outside are concolorous or darker with yellowish, light-brown, pointed and septate hairs; spores are elliptical, smooth, without guttules, sometimes with de Bary bubbles as mentioned by Hansen & Knudsen (2000). *Cheilymenia* shows no marked seasonal preference, fruiting whenever the temperature remains above freezing and there is adequate moisture (Denison 1964). *Cheilymenia* species occur on dung, manured or soil with high humus content and on degraded plant debris. In Macedonia two species have been found: *Cheilymenia stercorea* and *Ch. vitellina*. Collections from Macedonia comprised of

a single record for each species: *Ch. stercorea* has been found on dung in Katlanovo area (at the confluence of r. Pchinja and r. Vardar) and *Ch. vitellina* has been found on rich soil on Shar Planina Mountain. The data have not been published yet, and this is a new genus for Macedonia.

Genea Vittad.

Apothecia of *Genea* species is hypogeous or semi-hypogeous, developed in organic layer, always hollow, subglobose to highly irregular, knotty or lobed, with an apical opening, interior hollow; surface brownish or black, verrucore, glabrous or tomentose, often with basal mycelial tuft; gleba with one or several chambers and tramal walls (Pegler et al. 1993); spores are ellipsoid or subglobose, hyaline or pale yellowish, ornamented at maturity with evident rounded or conical to crested warts (Montecchi & Sarasini 2000). Smith et al. (2006) cited variety of host plants as ectomycorhizal simbionts with *Genea* taxa. Three species of this genus are known in Macedonia: *Genea fragrans*, *G. hispidula* and *G. verrucosa*. As noted in Chavdarova et al. (2011) *G. fragrans* is known from one locality, Kavadarci – Pletvar area, found in sandy soil in oak and/or hornbeam strands. One record of *G. hispidula* still remains for Macedonia, found in red soil with abundant stones, under *Quercus frainetto* and *Q. cerris*. Data of *G. verrucosa* coming from two localities: Katlanovo, found under *Q. pubescens* and Valandovo, under *Q. coccifera*. According to the existing data this is not a common species, but for detailed conclusion about its distribution further researches are needed.

Geopora Harkn.

Geopora species are also hypogeous or semi-hypogeous; hymenium is whitish or yellowish grey; surface hairy–tomentose, yellowish, brownish; spores are ellipsoid to subglobose, smooth, hyaline, with one or more large oil-drops. Two species are known from Macedonia: *Geopora arenicola* and *G. sumneriana. G. arenicola* has been recorded from three new localities (Galichica Mountain, Vodno Mountain and canyon Matka). Records of *G. sumneriana* for Macedonia also coming from three localities, Kitka Mountain, Demir Kapija and Skopje (Chavdarova et al. 2011). *G. sumneriana* is abundant in town parks and gardens, closely related to *Cedrus* trees (Montecchi & Sarasini 2000).

Humaria Fuckel

Species of the genus *Humaria* have sessile, cup-shaped apothecia clothed with long, pointed, brown, multiseptate hairs; hymenium is usually light colored (grayish or yellowish); spores are ellipsoid, hyaline, ornamented and usually with two oil-drops. Only the species *Humaria hemisphaerica* has been noted in Macedonia. This common and widespread species is growing on rich soil or very rotten wood (Jacson 2004) with fruiting from late summer to autumn. Within the investigations in Hungary, Erös-Honti et al. (2008) notes that *H. hemisphaerica* frequently forms ectomycorrhiza in xeric oak forests and in more humid beech forests. In Macedonia it is known from 17 localities and the following nine are new for the country: surrounding area of the towns Bogdanci, Skopje and Strumica, the mountains of Galichica, Korab, Kozhuf, Ograzhden and Serta, and Mavrovo NP. The species were registered in deciduous forests with highest records in beech and oak forests, and with only one record in fir forest. According to the current data it is very common and widespread species in Macedonia.

Melastiza Boud.

Apothecia of *Melastiza* species are sessile, terestrial, solitary or gregarious, irregularly cup-shaped with orange or red hymenium; outside is darker with short dark appressed hairs; spores are ellipsoid, hyaline, with reticulate or warted-reticulate ornamentation. Species of the genus are usually found on damp soil (Zhuang 2005). Two species - *Melastiza chateri* and *M. flavorubens*, have been found in Macedonia and represent new records for the country. As indicated by the current data, *M. chateri* has been found at one locality in Macedonia, in Shar Planina Mountain at 1700 m altitude, on sandy soil. *M. flavorubens* is also a species with only one locality in the country - Lisec Mountain.

Otidea (Pers.) Bonord.

Species of the genus are characterized with mostly eccentric, sessile or stipitate, ear-shaped apothecia, split down on one side or sometimes elongated vertically, always terrestrial; hymenium is yellow, orange, brownish, sometimes with olivaceous, pink or reddish gray tinge; spores are elliptical, elliptic-fusiform, smooth with two oil-drops. The species are separated largely by colour and hence are difficult to recognize when not in prime condition (Dennis 1960). According to Van Vooren et al. (2011) the species delimitation of the genus is not yet straightforward. *Otidea* species are known as saprotrophs but recently are also detected as ectomycorrhizal symbionts of diverse host plants (Hobbie et al. 2001; Smith & Healy 2009). Thus far in Macedonia, the following eight species have been registered (including *Flavoscypha*): *Otidea abietina, O. alutacea, O. auricula, O. bufonia, O. catharella, O. cochleata, O. concinna, O. onotica*. The species *O. abietina* grows on needles or ground with moss in coniferous forests (Breitenbach & Kranzlin 1981). In Macedonia it is found in three localities (Bistra Mt., Mavrovo NP and Pelister Mt.), Mavrovo NP is new locality for this species. It is found in the following associations: *Digitali viridiflorae-Pinetum peuces* with *Fa-*

gus, Fago-Abietetum meridionale, Festuco heteroprhyllae-Fagetum and *Gentiano luteae-Pinetum peuces*. *O. alutacea* grows on rich soil in deciduous forests (Hansen & Knudsen 2000) and coniferous forests (Kanouse 1949). In Macedonia has been observed at one locality (Pelister Mt.), in beech forest, and this is new species for the country. *O. auricula* is also new species, collected only on Shar Planina Mt. The data are from spruce and mixed beech-fir forests. *O. bufonia* grows solitary or in small trooping groups on soil under coniferous and deciduous trees with fruiting from late summer to early autumn. This rare species, published in this paper for the first time, is known from one locality, vicinity of Kumanovo, in pine plantings. According to Jordan (2004) it is a rare species in British Isles and northern Europe. *O. cantharella* in Macedonia is known from one locality, Jablanica Mountain (Karadelev et al. 2008a) recorded in beech forest. A recent phylogenetic analysis does not support the separation of *F. cantharella* (type species of *Flavoscypha*) from monophyletic *Otidea*, respectively morphological and molecular data indicate that *Flavoscypha* and *Otidea* are congenerous (Liu & Zhuang 2006b). Records of *O. cochleata* are from two localities: Bistra Mt. and Kozhuf Mt., in beech and beech-fir forests. There are no published data of this species for Macedonia yet. *O. concinna* grows in deciduous forests (Moser 1963). According to Karadelev et al. (2007) it has been recorded in one locality (Pelister Mountain) in *Festuco heterophyllae-Fagetum*. *O. onotica* grows in rich soil in deciduous forests (Hansen and Knudsen 2000). Several localities have been published (Karadelev & Nastov, 1998; Tortić, 1988). In the area of Bogdanci the species is collected in ass. *Coccifero-Carpinetum orientalis*, which represent new data for the country.

Scutellinia (Cooke) Lambotte

This cosmopolitan genus is one of the genera with the most species (approximately 50 species) in the family Pyronemataceae (Choi et al. 2012). It is char-

Tab.1. Pyronemataceae species registered in Macedonia in different trophic groups

SPECIES	SUBSTRATE	ETG
Aleuria aurantia	on soil, mycorrhizal	Sh / ?M
Anthracobia macrocystis	on burnt ground	Carb
Anthracobia subatra	on burnt ground	Carb
Cheilymenia stercorea	on dung	Sc
Cheilymenia vitellina	on soil	Sh
Genea fragrans	hypogeous, mycorrhizal	M
Genea hispidula	hypogeous, mycorrhizal	M
Genea verrucosa	hypogeous, mycorrhizal	M
Geopora arenicola	hypogeous, mycorrhizal	M
Geopora sumneriana	hypogeous, mycorrhizal	M
Humaria hemisphaerica	on soil, mycorrhizal	M
Melastiza chateri	on soil	Sh
Melastiza flavorubens	on soil	Sh
Otidea abietina	on soil, mycorrhizal	M
Otidea alutacea	on soil, mycorrhizal	M
Otidea auricula	on rotten wood, mycorrhizal	M / ?Sw
Otidea bufonia	on soil, mycorrhizal	M
Otidea catharella	on soil, mycorrhizal	M
Otidea cochleata	on soil, mycorrhizal	M
Otidea concinna	on soil, mycorrhizal	M
Otidea onotica	on soil, mycorrhizal	M
Scutellinia cejpii	on rotten wood	Sw
Scutellinia kerguelensis	on soil	Sh
Scutellinia scutellata	on rotten wood	Sw
Scutellinia umbrorum	on soil	Sh
Tarzetta catinus	on soil, mycorrhizal	M
Tarzetta cupularis	on soil, mycorrhizal	M
Trichophaea hemisphaerioides	on burnt ground	Carb
Trichophaeopsis bicuspis	on rotten wood	Sw

Abbreviations: ETC = ecological trophic groups, **Carb** = Carbotroph, **M** = Mycorrhizal, **Sc** = Coprotrophs, **Sh** = humus saprotrophs, **Sw** = wood saprotrophs.

acterized by sessile, solitary or gregarious, shallow cup-shaped or nearly saucer-shaped apothecia; hymenium is whitish, orange, reddish-brown, outside and margin with long dark hairs, pointed and septate. Species are terricolous or growing on degraded woody debris, also among mosses, generally in wet places and are hummus and wood saprotrophs (Medardi 2006). Four species of the genus are recorded in Macedonia: *Scutellinia cejpii, S. kerguelensis, S. scutellata* and *S. umbrorum*. *S. cejpii* grows on soil, rotten wood and plant debris with fruiting summer to autumn. The only record is from Kozhuf Mountain, registered on beech remnants, published in this paper for the first time. *S. kerguelensis* is known from one locality, Maleshevski Planini Mountain, found in the ass. *Festruco heterophyllae-Fagetum* (Karadelev et al. 2002c). *S. scutellata* is verry common and cosmopolitan species, with a wide range of habitats, recorded numerous times in alpine environments in Europe (González et al. 1997). It is also a species that has been reported to occur widely in temperate regions (Alexopoulos et al. 1996). In Macedonia it is found in more than 10 localities, noted in different associations: beech, oak, mixed forests, mountain pastures, mostly on rotting wood, wet places, moist soil. Mountains of Bistra, Dobra Voda, Galichica, Jablanica, Kitka, Korab, Kozhuf, Plakenska Planina and Ruen are new localities. According to this data it is frequent species. *S. umbrorum* is probably common species in Europe, exploiting habitats of divergent climatic regimes (Hallgrímsson & Schumacher 1990), and it is known by its preference on soil (Dennison 1959). There is only one published data for the country, collected in beech forest.

Tarzetta (Cooke) Lambotte

Tarzetta is characterized by sessile or stalked, more or less deeply cup-shaped apothecia; hymenium is cream colored, yellowish gray, pale ochraceous, brownish gray-orange, with dented margin; spores are ellipsoid, smooth, and hyaline, containing two or several large oil-drops. Two species have been recorded in Macedonia: *Tarzetta catinus* and *T. cupularis*. *T. catinus* grows often gregarious on soil in broadleaf woodlands. *Tarzetta* species are mycorrhizal, and recent molecular data suggest that *T. catinus* may be able to form a biotrophic relationship with *Fagus sylvatica* (Tedersoo et al. 2006). The new data for our country are from three localities (mountains of Galichica and Shar Planina and the surrounding area of Skopje), registered in oak, beech and mixed deciduous forest. According to the current data, *T. catinus* may have preference to deciduous forests. *T. cupularis* has been observed at one locality (surrounding area of Kumanovo), in mixed deciduous forest, and this is new species for Macedonian mycobiota.

Trichophaea Boud.

Trichophaea species are characterized with sessile, disc-shaped apothecia; hymenium is grayish white or grayish brown, with long, brown, pointed and septate hairs; spores are ellipsoid, smooth or ornamented, with large oil-drops. Only one species of the genus is registered in Macedonia, *T. hemisphaerioides*. According to Doğan (2010) this species is similar to *Humaria hemisphaerica* for its macroscopic features but it is easily to separate by its microscopic characters. *T. hemisphaerioides* is also postfire, carbotroph species, fruiting on soil 20-50 weeks after the burning (Hansen and Knudsen 2000). Until now it has been found in two localities in Macedonia; therefore, a conclusion on its distribution cannot be drawn, and this is first record of this genus for the country.

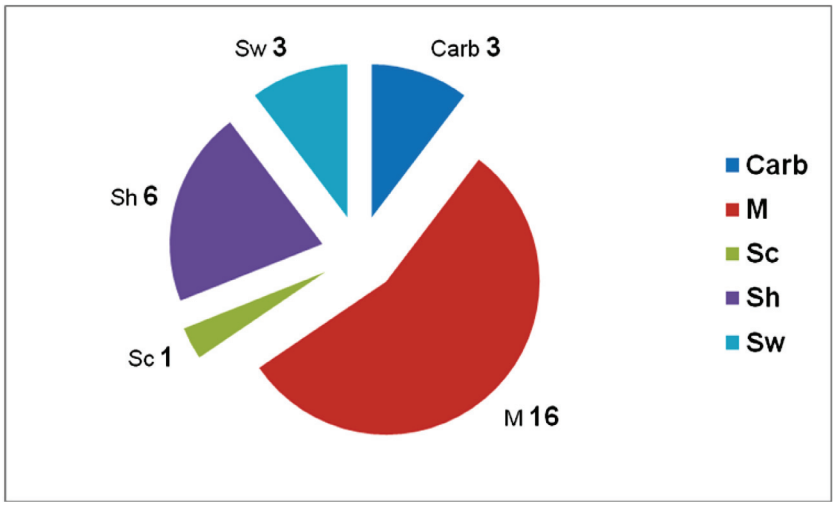

Fig. 2. Number of listed Pyronemataceae species in the different trophic groups.
Abbreviations: **Carb** = Carbotroph, **M** = Mycorrhizal, **Sc** = Coprotrophs, **Sh** = humus saprotrophs, **Sw** = wood saprotrophs.

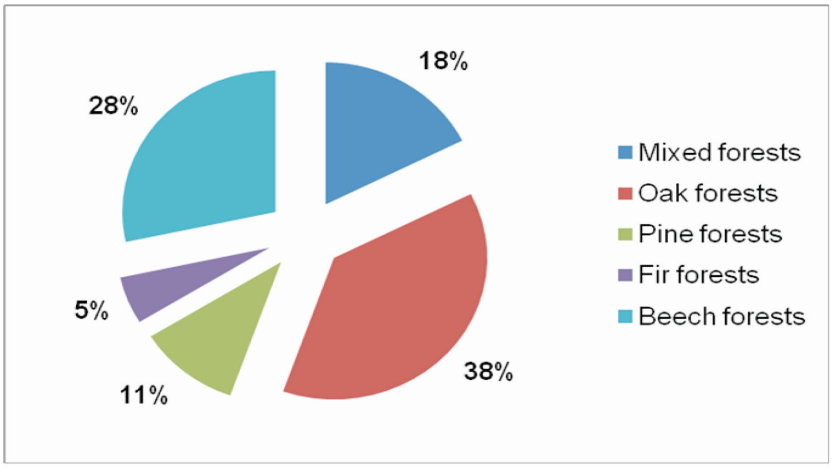

Fig.3. Habitat preference of mycorrhizal species in different forest communities in R. Macedonia.

Trichophaeopsis Korf & Erb

Species of the genus are characterized of sessile, turbinate to disk-shaped apothecia, marginate; hymenium is whitish, outside brownish with long, brownish multiseptate pointed hairs; spores are smooth, subglobose to ellipsoid. Only the species *Trichophaeopsis bicuspis* is known from Macedonia and represents a new record for the country. It is saprotroph and usually grows near *Populus* spp. (Hansen and Knudsen 2000). Our data are from the mountains of Kitka and Kozhuf, on rotten deciduous wood.

Majority of the Pyronemataceae taxa were known as terrestrial saprotrophs but recent studies has changed and confirmed different trophic strategies of some genera. Insights into the substrates and the ecological requirements of the species are shown in Tab. 1. Genera *Aleuria, Humaria, Otidea, Tarzetta* formerly known as saprotrophs, now are confirmed as mycorrhizal (Hobbie et al. 2001; Tedersoo et al. 2006; Erös-Honti et al. 2008; Smith & Healy 2009). Therefore, species with doubtful ecological requirement and species registered on several different substrata are included in two trophic groups. The data in the graph in Fig. 1 provides the number of listed Pyronemataceae species in different trophic groups. Mycorrhizal species are represeted with highest number of species with total number of 16 species (M = 16). Terestrial saprotrophs are represented with 13 species devided in: six humus saprotrophs (Sh = 6), three wood saprotrophs (Sw = 3), three carbotrophs (Carb = 3) and one coprotroph species (Sc = 1). The graph in Fig. 2 shows the habitat preference of the mycorrhizal Pyronemataceae species in different forest associations in Macedonia. Most species are associated with oak forests (38 %) and beech forests (28 %). In mixed forests it is registered (18 %). Lowest number of Pyronemataceae species is registered in pine forests (11 %) and fir forests (5 %).

Conclusions

The study on Pyronemataceae family in Macedonia resulted in total of 29 species. They belong to 12 genera and the genus *Otidea* includes the highest number of species (7), followed by *Scutellinia* (4) and *Genea* (3 species). Five of them: *Anthracobia, Cheilymenia, Melastiza, Trichophaea* and *Trichophaeopsis* are reported as new for the country. The following 14 species are new for the mycobiota of Macedonia: *Anthracobia macrocystis*, *A. subatra*, *Cheilymenia stercorea*, *Cheilymenia vitellina*, *Melastiza chateri*, *M. flavorubens*, *Otidea alutacea*, *O. auricula*, *O. bufonia*, *O. cochleata*, *Scutellinia cejpii*, *Tarzetta cupularis*, *Trichophaea hemisphaerioides* and *Trichophaeopsis bicuspis*. According to the data known until now, *Aleuria aurantia, Humaria hemisphaerica* and *Scutellinia scutellata* are widespread species in Macedonia. Majority of the recorded species are mycorrhizal (16) and the rest are terrestrial saprotrophs (13). Most of the mycorrhizal species are associated with oak forests (38 %) and beech forests (28 %) and lowest number with fir forests (5 %). The species *Genea fragrans, G. hispidula, G. verrucosa, Geopora arenicola* and *G. sumneriana* are semi-hypogeous fungi. For the species that do not occur frequently (known from one or two localities), which distribution and ecology is not well studied and are assumed to be rare, a conclusion cannot be drawn and there is a need for further research and observations in order to be provided a more comprehensive review of this systematic category in Macedonia.

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