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ECOLOGY AND DISTRIBUTION OF MORELS (Morchellaceae, Helvellaceae) IN THE REPUBLIC OF MACEDONIA

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АПСТРАКТ

Караделев, М., Русевска, К. и Пампурова, С. (2009). Екологија и дистрибуција на смрчките (Morchellaceae, Helvellaceae) во Република Македонија. Екол. Зашт. Живот. Сред. 12 (1/2): 45-55.

Ова се први податоци за систематски истражувања на смрчките (*Morchellaceae, Helvellaceae*) во Република Македонија. Регистрирани се 22 вида кои припаѓаат на 9 рода: *Disciotis, Gyromitra, Helvella, Leptopodia, Mitrophora, Mitrula, Morchella, Ptychoverpa* и *Verpa*. Следните 11 вида се нови за микобиотата на Република Македонија: *Gyromitra esculenta, Helvella acetabulum, Helvella queletii, Leptopodia elastica, Leptopodia monachella, Mitrophora semilibera, Morchella conica, Morchella deliciosa, Morchella vulgaris, Verpa conica* и *Verpa digitaliformis*. Во овој труд се дадени првите комплетни податоци за видовите од горенаведените родови, како и за нивното распространување и еколошки статус во Република Македонија.

Клучни зборови: габи, смрчки, екологија, Morchellaceae, Helvellaceae, Република Македонија

ABSTRACT

Karadelev, M., Rusevska, K. & Pampurova, S. (2009). Ecology and Distribution of Morels (Morchellaceae, Helvellaceae) in the Republic of Macedonia. Ecol. Zašt. Život. Sred., Vol. 12 (1/2): 45-55.

This paper contains results of research in the distribution and ecology of morels (*Morchellaceae, Helvellaceae*) in the Republic of Macedonia. In the course of the researches 22 species have been registered, belonging to 9 genera: *Disciotis, Gyromitra, Helvella, Leptopodia, Mitrophora, Mitrula, Morchella, Ptychoverpa* and *Verpa*. The following 11 species are new for the mycobiota of the Republic of Macedonia: *Gyromitra esculenta, Helvella acetabulum, Helvella queletii, Leptopodia elastica, Leptopodia monachella, Mitrophora semilibera, Morchella conica, Morchella deliciosa, Morchella vulgaris, Verpa conica* and *Verpa digitaliformis*, therefore the aim of this work is to provide a more comprehensive review on the distribution and ecology of morels in the Republic of Macedonia.

Key words: fungi, morels, distribution, ecology, Morchellaceae, Helvellaceae, Republic of Macedonia.

Introduction

The interest in mycodiversity studies in the Republic of Macedonia has been growing in recent years, and much has been done in this field. Systematic research on morels (*Morchellaceae, Helvellaceae*) in the Republic of Macedonia has not been conducted till now and there are relatively few myco-

logical papers concerned only with individual morel species. Publications making reference to individual species are following: *Gyromitra infula* (Tortich 1988; Karadelev et al. 2003), *Helvella crispa* (Tortich 1988; Rusevska & Karadelev 2004), *Helvella lacunosa* (Tortich 1988; Karadelev et al. 2003, Rusevska & Karadelev 2004), *Helvella leucomelaena* (Rusevska & Karadelev 2004), *Leptopodia elasti-*

ca (Karadelev et al. 2003; Rusevska & Karadelev 2004), *Leptopodia ephippium* (Tortich 1988), *Ptychoverpa bohémica* (Rusevska & Karadelev 2004).

Materials and methods

The sources of this paper are exsiccates deposited in different collections and research notes of the present authors. The previously published data are also included to complete the list of these groups of fungi, while most of the unpublished data are from last ten years. Most of the specimens 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 in the Croatian National Fungarium (CNF) in Zagreb. The specimens in Croatian National Fungarium have been mostly collected and examined by Milica Tortich. All other species without any Herbarium Acronym, in the text have been collected and determined by the present authors. The identification of the species has been done according to Medardi (2006), Hansen & Knudsen (eds.) (2000) and Breitenbach & Kränzlin (1981). In a few cases, the names of the species have been modified according to Index Fungorum 2009 (<http://www.indexfungorum.org>) and Mycobank (<http://www.mycobank.org>). The species are reported alphabetically. Under each fungal species data of geographical distribution, altitude, forest association, substrate, data source and previous publications are provided.

Marks and abbreviations:

- exs. - Collections in which the dried material (exsiccatum) is deposited
 Ref. - References (sources of records and information)
 vill. - Village
 Mt - Mountain
 * - New species for the Republic of Macedonia

Results

1. *Disciotis venosa* (Pers.) Arnould

Collection: MCF

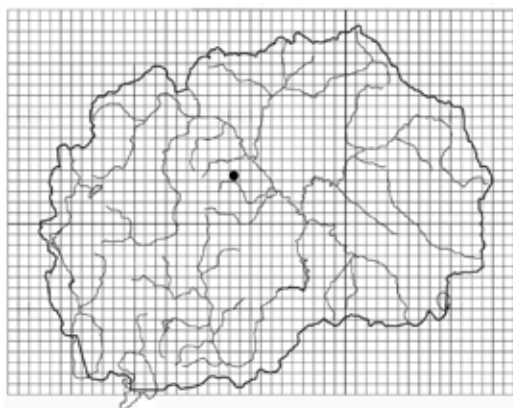


Fig. 1. Distribution of *Disciotis venosa* in Macedonia
 Сл. 1. Дистрибуција на *Disciotis venosa* во Македонија

Jakupica Mt.: Gorno Vranovci vill., 08.11.1998, *Fagetum*, exs. MCF 98/3961.

2. **Gyromitra esculenta* (Pers.) Fr.

Collections: MCF.

Substrate: soil.

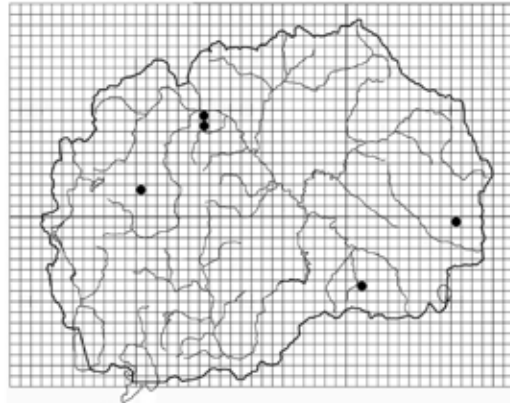


Fig. 2. Distribution of *Gyromitra esculenta* in Macedonia

Сл. 2. Дистрибуција на *Gyromitra esculenta* во Македонија

Dobra Voda Mt.: Popovjane vill., azonal vegetation with *Populus*, under *Populus tremula*, 800 m, 30.04.2009; **Kitka Mt.:** forest-house, oak forest with *Populus tremula*; **Kozjak Mt.:** Tribor, Perun, mixed forest (*Fagus* and *Pinus sylvestris*), 1600 m, 15.05.2006, exs. MCF 06/8808; **Ograzhden Mt.:** Suvi Laki, *Pinus* forest, 1300 m, 15.05.2007, exs. MCF 07/7036; **Skopje (vicinity):** Vodno Mt., Top, birch forest, 1000 m, 16.04.2006, exs. MCF 06/1211.

3. *Gyromitra infula* (Schaeff.) Quél.

Collections: MCF

Ref.: Tortich 1988; Karadelev et al. 2003;

Substrate: rotten wood, soil.

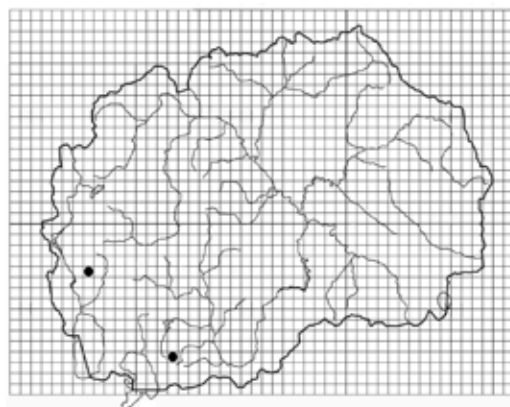


Fig. 3. Distribution of *Gyromitra infula* in Macedonia

Сл. 3. Дистрибуција на *Gyromitra infula* во Македонија

Karaorman Mt.: near Radomirovo vill., *Festuco heterophyllae*-*Fagetum*, rotten wood, 1150-

1200 m; **Pelister Mt.:** around Palisnopje, Digitali viridiflorae-Pinetum peucis with *Fagus*, soil, 1500 m, 06.10.2001, exs. MCF 01/1559.

4. **Helvella acetabulum* (L.) Quél.,

Collections: MCF

Substrate: soil.

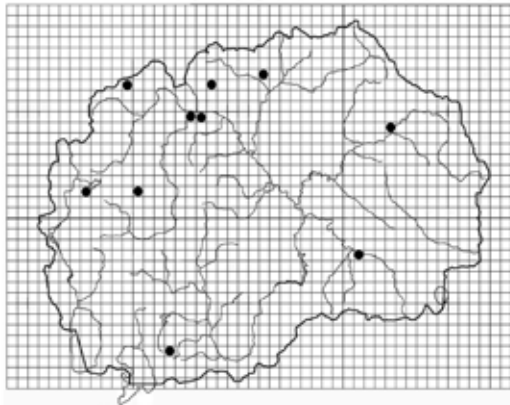


Fig. 4. Distribution of *Helvella acetabulum* in Macedonia

Сл. 4. Дистрибуција на *Helvella acetabulum* во Македонија

Bistra Mt.: Mavrovo, Mavrovi Anovi, dam, 1300 m, Abieti-Fagetum, 05.06.2009, exs. MCF 09/10700; **Demir Kapija:** Kaludjerska Chuka, 600 m, meadow, 21.05.2005, exs. MCF 05/4907; **Dobra Voda Mt.:** Cheloica Mt. above Premka vill., 800-900 m, Quercetum frainetto-cerris, under *Quercus* sp., 10.05.2009, exs. MCF 09/10585; between Popovjane vill. and Zhubrino, 750-800 m, Quercetum frainetto-cerris, under *Quercus* sp., 15.04.2008, exs. MCF 08/9369; Popovjane vill., 750-800 m, Quercetum frainetto-cerris, 23.04.2008, exs. MCF 08/9268; Popovjane vill., 800 m, oak forest, under *Quercus* sp., 30.04.2009, exs. MCF 09/10577; **Kumanovo:** Malotino vill., 22.07.1989, exs. MCF 89/4790; **Kochani:** dam Gratche, (above artificial lake Kochansko Ezero), r. Velika Reka, 500 m, Querco-Carpinetum orientalis macedonicum, 22.04.2007, exs. MCF 07/6914; **Begova Chesma Mt.:** 1400 m, meadow, damp, 18.07.1989, exs. MCF 89/4292; **Pelister Mt.:** Kopanki, 08.06.2009, exs. MCF 09/10832; **Skopje (vicinity):** Matka, 300 m, deciduous forest (*Platanus*, *Carpinus*, *Buxus*), under *Buxus*, 08.05.2009, exs. MCF 09/10604; Vodno Mt., footpat to Sredno Vodno, mixed forest, 16.05.2009, exs. MCF 09/10658; footpath between Sredno Vodno and Markovo Krivche, mixed forest, 09.05.2009, exs. MCF 09/10618; **Skopska Crna Gora Mt.:** Kuchevishte vill., above St. Arhangel monastery, 700 m, Querco-Carpinetum orientalis, 12.05.2009, exs. MCF 09/10609; **Shar Planina Mt.:** above Varvara vill., 830-900 m, deciduous forest, 25.05.2009, exs. MCF 09/10670.

5. *Helvella crispa* (Scop.) Fr.

Collections: MCF, CNF.

Ref.: Tortich 1988; Rusevska & Karadelev 2004.

Substrate: soil.

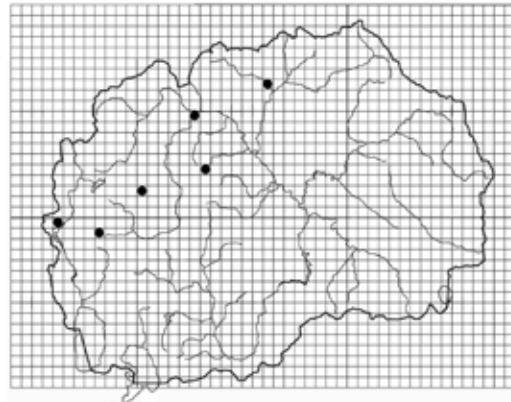


Fig. 5. Distribution of *Helvella crispa*

Сл. 5. Дистрибуција на *Helvella crispa* во Македонија

Bistra Mt.: above Ehloec vill., 700 m, oak forest (*Quercus cerris*), 14.10.2006, exs. MCF 06/6077; Mavrovo, Bunec, 1350-1400 m, Calamint-ho grandiflorae-Fagetum, 29.09.2002; **Cheloica Mt.:** above Srbica vill., 800-850 m, Quercetum frainetto-cerris, 09.06.2009, exs. MCF 09/10861; **Debarska Banja:** 600-700 m, Querco-Carpinetum orientalis macedonicum, exs. CNF; **Jakupica Mt.:** Babina Rupa, 1900-2000 m, Abieti-Fagetum, 13.07.1999, exs. MCF 99/2325; **Kumanovo:** Vince vill., 700-800 m, Querco-Carpinetum orientalis macedonicum, 2002, exs. MCF 02/2999; **Rac canyon:** 12.12.2009; **Skopje:** Matka, 250-300 m, Querco-Carpinetum orientalis (*Fraxinus ornus*, *Quercus pubescens*, *Buxus sempervirens*, *Carpinus orientalis*, *Pistacia terebinthus*), 25.10.1998; Vodno Mt., 750-1000 m, Querco-Carpinetum orientalis macedonicum, 16.10.2002, exs. MCF 02/2794; Vodno Mt., 750-900 m, Castanetum sativae macedonicum, soil; Vodno Mt., between Sredno Vodno and „PTT“, plantings, 29.09.2002, exs. MCF 02/4769; Vodno Mt., near Krushopek vill., 800 m, oak forest, 28.10.2004, exs. MCF 04/4104; Vodno Mt., above St. Pantelejmon monastery, mixed plantings (*Castanea*, *Quercus*), 27.09.2009, exs. MCF 09/11206.

6. *Helvella lacunosa* Afzel.

Collections: MCF, CNF.

Ref.: Tortich 1988; Karadelev et al. 2003, Rusevska & Karadelev 2004.

Substrate: soil, rotten branch of *Fagus*.

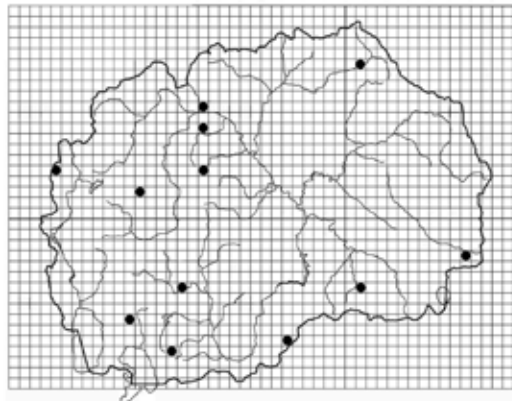


Fig. 6. Distribution of *Helvella lacunosa* in Macedonia

Сл. 6. Дистрибуција на *Helvella lacunosa* во Македонија

Belasica Mt.: Smolare vill., near waterfall, 400 m, *Festuco heterophyllae*-Fagetum, 01.05.2002, exs. MCF 02/2682; **Cheloica Mt.:** above Srbica vill., 800-850 m, *Quercetum frainetto-cerris*, 09.06.2009, exs. MCF 09/10872; **Demir Hisar:** Zhurce vill., oak forest, 20.10.2002, exs. MCF 02/2919; **Galichica Mt.:** Volko Legalo, 1600 m, *Abieti*-Fagetum, rotten branch of *Fagus*, 15.09.2006, exs. MCF 06/7581; **Jakupica Mt.:** above Papradishte vill., 1100 m, *Festuco heterophyllae*-Fagetum, 06.07.1999, exs. MCF 99/2342; **Kitka Mt.:** vicinity of Aldinci and near Kadina Reka, 1000-1300 m, *Festuco heterophyllae*-Fagetum, r. Kadina Reka, 24.05.2002, exs. MCF 02/9156; above Gorno Kolichani vill., 700-900 m, *Quercetum frainetto-cerris macedonicum*, 19.10.1998; between Gorno Kolichane vill. and Kitka Mt., 1350 m, mixed forest (*Fagus*, *Quercus*, *Corylus*), 30.05.1999; **Korab Mt.:** above Strezimir watch tower, 1350-1500 m, at roadsides, beech forest edges, 04.09.2005, exs. MCF 05/5057; **Kozhuf Mt.:** 700-1700 m, Fagetum, soil; **Nidze Mt.:** Kopanki, 1400 m, mixed forest (*Pinus sylvestris*, *Abies*, *Populus tremula*), 16.07.2002, exs. MCF 02/5664; **Osogovski Planini Mt.:** (Kratovo), Popovo, 1400 m, *Calamintho grandiflorae*-Fagetum, 10.06.2007, exs. MCF 07/7098; (Kriva Palanka), Kostadinica, 1420 m, *Calamintho grandiflorae* -Fagetum, 09.06.2007, exs. MCF 07/7093; Bela Voda, 1570 m, *Calamintho grandiflorae*-Fagetum, 09.06.2007, exs. MCF 07/7082; **Pelister Mt.:** around Trnovo vill., 1200 m, *Festuco heterophyllae*-Fagetum, 26.05.2002; MCF 07/6820; Kopanki, 1610 m, *Digitali viridiflorae*-*Pinetum peucis*, 22.09.2002, exs. MCF 02/3545; 1600 m, *Digitali viridiflorae*-*Pinetum peucis*, 26.09.2002, exs. MCF 02/3134; **Skopje:** Drachevo, 250 m, yard, 30.04.2006, exs. MCF 06/5533; Konjare vill., by r. Pchinja, 250, meadow, 22.04.2006, exs. MCF 06/8810; Vodno Mt., 750-900 m, at the margin of planted *Pinus nigra* stand, exs. CNF; Vodno Mt., 750-1000 m, *Quercus-Carpinetum orientalis macedonicum*, 27.10.2002, exs. MCF

02/2891; Vodno Mt., 600-850 m, *Quercus-Carpinetum orientalis macedonicum*, 16.10.2002, exs. MCF 02/2814.

7. *Helvella leucomelaena* (Pers.) Nannf.

Collections: MCF.

Ref.: Rusevska & Karadelev 2004.

Substrate: soil.

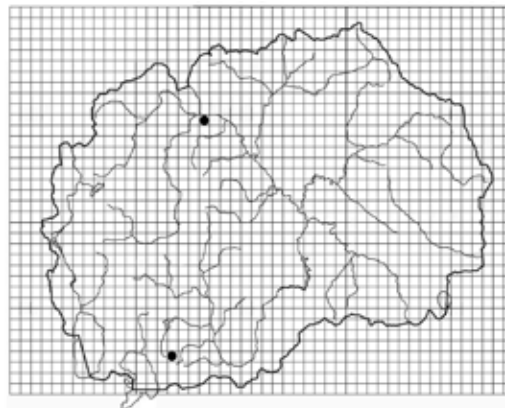


Fig. 7. Distribution of *Helvella leucomelaena* in Macedonia

Сл. 7. Дистрибуција на *Helvella leucomelaena* во Македонија

Pelister Mt.: between hotel Molika and Mt. house Kopanki, 1450-1600 m, *Digitali viridiflorae*-*Pinetum peucis*, under *Pinus peuce*, 02.05.2007, exs. MCF 07/6820; **Skopje:** Vodno Mt., 600 m, mixed forest, 26.04.2003, exs. MCF 03/3092; Vodno Mt., 600 m, *Pinus* plantings, 04.05.2003, exs. MCF 03/3091.

8. **Helvella queletii* Bres.

Collections: MCF.

Substrate: soil.

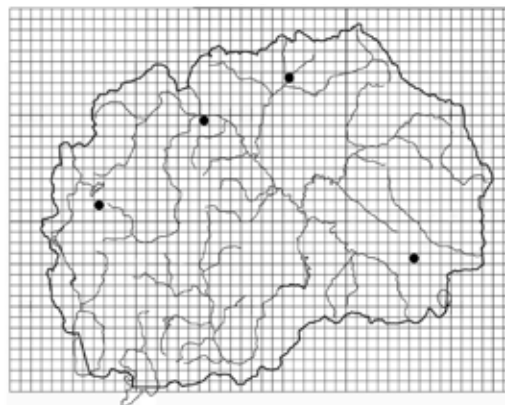


Fig. 8. Distribution of *Helvella queletii* in Macedonia

Сл. 8. Дистрибуција на *Helvella queletii* во Македонија

Bистра Mt.: Lazaropole vill., above Markova Stopalka, 1300 m, *Fagus* forest, 09.08.2006, exs. MCF 06/5958; **r. Pchinja:** Zubovce vill., mixed forest (*Populus*, *Salix*), 12.05.2005, exs. MCF 05/4925; Dragominci vill., 10.04.2007, exs. MCF 07/6657; **Skopje** (vicinity): Matka, *Quercus-Carpinetum orientalis*, 30.04.2009, exs. MCF 09/10557; Vodno Mt., footpath between Sredno

Vodno and Markovo Krivche, mixed forest, 09.05.2009, exs. MCF 09/10619; **Strumica**: Monospitovo vill., near the fish pond, 16.04.2006, exs. MCF 05/1362.

9. *Leptopodia atra* (Konig: Fr.) Boud.

Collections: MCF.

Substrate: soil.

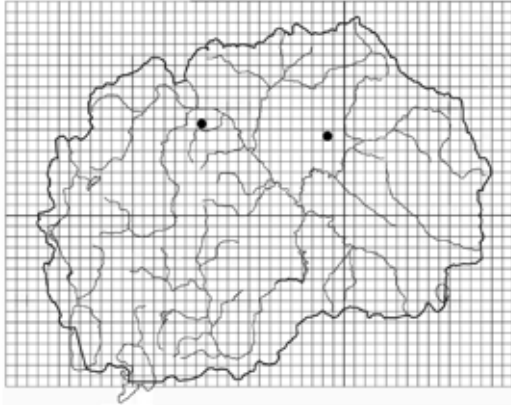


Fig. 9. Distribution of *Leptopodia atra* in Macedonia

Сл. 9. Дистрибуција на *Leptopodia atra* во Македонија

Kitka Mt.: above Gorno Kolichani vill., 700-900 m, Quercetum frainetto-cerris, 19.10.1998, exs. MCF 98/2225; **Ruen Mt.:** 400-450 m, near brook, 09.04.2005, exs. MCF 05/4863.

10. **Leptopodia elastica* (Bull.) Boud.

Collections: MCF.

Ref.: Karadelev et al. 2003; Rusevska & Karadelev 2004.

Substrate: soil.

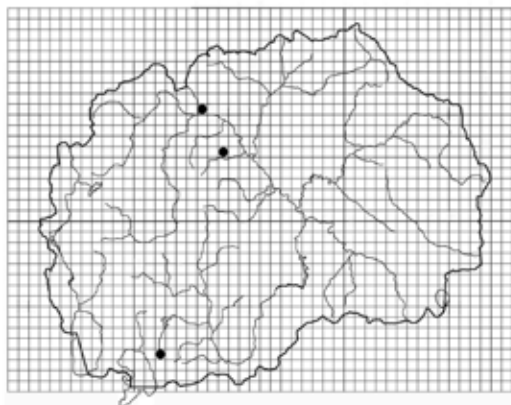


Fig. 10. Distribution of *Leptopodia elastica* in Macedonia

Сл. 10. Дистрибуција на *Leptopodia elastica* во Македонија

Karazdica Mt.: r. Kadina Reka, 1100-1200 m, Festuco heterophyllae-Fagetum, 11.10.2001, exs. MCF 01/747; **Pelister Mt.:** r. Rotinska Reka, beside brook, 1400 m, Digitali viridiflorae-Pinetum peucis, 14.07.2001, exs. MCF 01/492; 1300 m, Digitali viridiflorae-Pinetum peucis, 30.09.2002, exs. MCF 02/3566; **Skopje** (vicinity): Vodno Mt., 750-1000 m, Quercu-Carpinetum orientalis macedonicum, soil, 16.10.2002, exs. MCF 02/2802;

750-1000 m, Quercu-Carpinetum orientalis macedonicum, soil, 27.10.2002, exs. MCF 01/2890.

11. *Leptopodia ehippium* (Lév.) Boud.

= *Helvella ehippium* Lév.

Collections: CNF.

Ref.: Tortich 1988.

Substrate: soil.

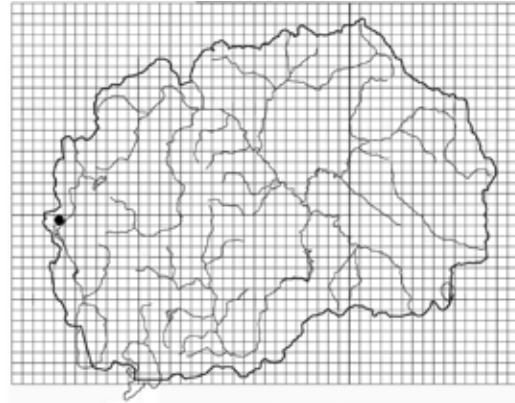


Fig. 11. Distribution of *Leptopodia ehippium* in Macedonia

Сл. 11. Дистрибуција на *Leptopodia ehippium* во Македонија

Debarska banja: 600-700 m, planted mixed forest with *Pinus nigra*, exs. CNF.

12. **Leptopodia monachella* (Scop.) Boud.

Collections: MCF.

Substrate: soil.

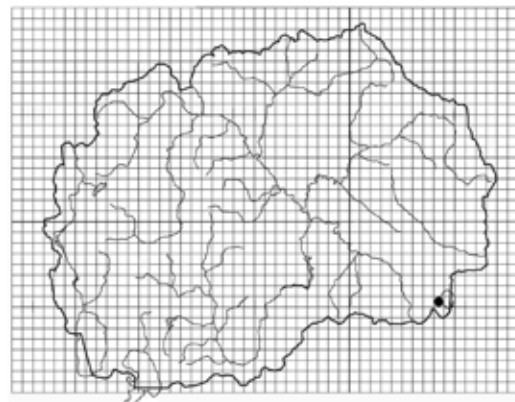


Fig. 12. Distribution of *Leptopodia monachella* in Macedonia

Сл. 12. Дистрибуција на *Leptopodia monachella* во Македонија

Dojran: camp Achikot, *Populus tremula* plantings, under *Populus tremula*, 19.04.2002, exs. MCF 02/4926.

13. **Mitrophora semilibera* (DC.) Lév.

Collections: MCF.

Substrate: soil.

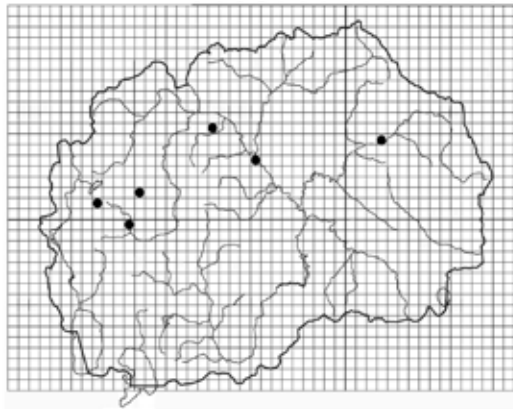


Fig. 13. Distribution of *Mitrophora semilibera* in Macedonia

Сл. 13. Дистрибуција на *Mitrophora semilibera* во Македонија

Bistra Mt.: Sretkovo vill., meadow, 1000 m, 20.04.2009, exs. MCF 09/10565; Mavrovo: stand with *Populus tremula* and *Salix caprea*; Bunec: deciduous forest, under *Populus tremula*, 1300 m, 24.04.2004, exs. MCF 04/3968; **Dobra Voda Mt.:** below Popovjane vill., by river, Quercetum frainetto-cerris, under *Populus tremula*, 750-800 m, 15.04.2008, exs. MCF 08/9370; Popovjani vill., azonal vegetation with *Populus*, under *Populus*, *Salix*, 800 m, 30.04.2009, exs. MCF 09/10579; **Kichevo:** Staroec vill., 600-650 m, 21.05.2000; **Kitka Mt.:** forest-house; **Kochani:** dam Gratche, (above artificial lake Kochansko Ezero), r.Velika Reka, Salicetum, 500 m, 22.04.2007, exs. MCF 07/6934; **Kumanovo:** Staro Nagorichane vill., by r. Pcinja, meadow, Salicetum, 23.04.2005, exs. MCF 05/5091; r. Pchinja (Kumanovo area), Staro Nagorichane vill., *Salix*, *Populus*, 04.2007, exs. MCF 07/6652; **Skopje:** Belimbegovo vill., Ilinden, *Populus nigra* and *Betula* plantings, 250 m, 08.04.1999, exs. MCF 99/1881; Vodno Mt., above the police station, 23.04.2009, exs. MCF 09/10543; **Veles:** 02.05.1997.

14. *Mitrula paludosa* (Fr).

Collections: MCF.

Substrate: soil.

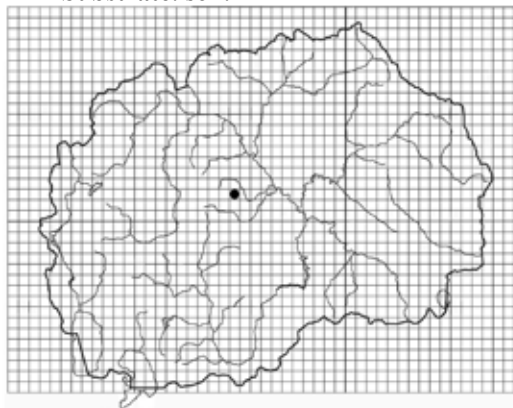


Fig. 14. Distribution of *Mitrula paludosa* in Macedonia

Сл. 14. Дистрибуција на *Mitrula paludosa* во Македонија

Jakupica Mt.: Cheples, *Calamintho grandiflorae-Fagetum*, 1400 m, 07.1999.

15. **Morchella conica* Pers.

Collections: MCF.

Substrate: soil.

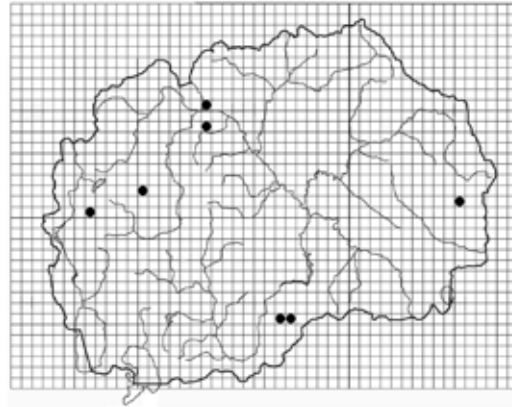


Fig. 15. Distribution of *Morchella conica* in Macedonia

Сл. 15. Дистрибуција на *Morchella conica* во Македонија

Bistra Mt.: Izvor vill., by the Treska river, *Fagus* forest, 600 m, 02.05.2009, exs. MCF 09/10576; Mavrovo, Bunec: deciduous forest, under *Populus*, 1300 m, 24.04.2004, exs. MCF 04/3974; **Dobra Voda Mt.:** below Popovjane vill., by river, Quercetum frainetto-cerris, under *Populus tremula*, 750-800 m, 15.04.2008, exs. MCF 08/9372; Cheloica Mt.: Crvivci vill. *Pinus* plantings, uder *Pinus sp.*, 750-800 m, 10.05.2009, exs. MCF 09/10586; **Kitka Mt.:** stand with stand with *Populus tremula*; **Kozjak Mt.:** Alshar, Perun, *Calamintho grandiflorae-Fagetum*, 1400-1650 m, 12.06.2004, exs. MCF 04/3974; **Mariovo (Prilep):** Vitolishte vill., under *Populus*, 15.05.2005, exs. MCF 05/4900; **Ograzhden Mt.:** Suvi Laki, Poplar forest, 1400-1500 m, 04.2005, exs. MCF 05/4927; **Skopje (vicinity):** Orman vill., yard, 270 m, 12.04.2009, exs. MCF 09/10539.

16. **Morchella deliciosa* Fr.

Collections: MCF.

Substrate: soil.

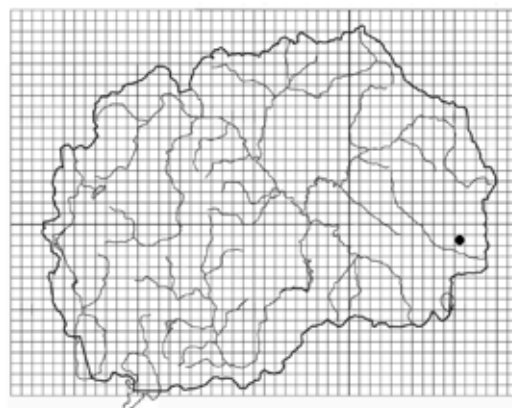


Fig. 16. Distribution of *Morchella deliciosa* in Macedonia

Сл. 16. Дистрибуција на *Morchella deliciosa* во Македонија

Ograzhden Mt.: Suvi Laki, Poplar forest, 1400-1500 m, 04.2005, exs. MCF 05/4928.

17. *Morchella elata* Fr.

Collections: MCF.

Substrate: soil.

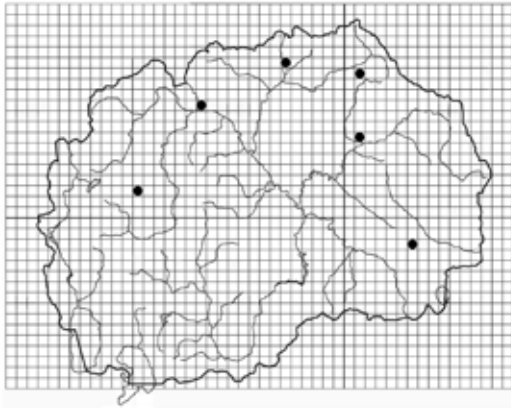


Fig. 17. Distribution of *Morchella elata* in Macedonia
Сл. 17. Дистрибуција на *Morchella elata* во Македонија

Bistra Mt.: Mavrovo, Bunec, deciduous forest, under *Populus tremula*, 1300 m, 24.04.2004, exs. MCF 04/3966; Calamintho grandiflorae-Fagetum, 1350-1400 m, 29.09.2002, exs. MCF 02/8831; **Dobra Voda Mt.:** Popovjani vill., meadow, 800 m, 25.04.2009, exs. MCF 09/10578; Gorica vill., Quercetum frainetto-cerris, under *Quercus sp.*, 750-800 m, 13.04.2008, exs. MCF 08/9366; **Kochani** (vicinity): Cheshinovo vill., 25.04.2009, exs. MCF 09/10540; **Osogovski Planini Mt.:** road to monastery St. Joakim Osogovski, mixed forest (*Pinus*, *Quercus*), 01.05.2006, exs. MCF 06/5680; **r. Pchinja** (Kumanovo area): Staro Nagorichane vill., 04.2007, exs. MCF 07/6649; **Strumica:** 09.05.2006, exs. MCF 06/8812; **Skopje** (vicinity): Gorno Konjare vill. (above Katalanovo, r. Pchinja), 19.04.2008, exs. MCF 08/9339.

18. *Morchella esculenta* (L.) Pers.

Collections: MCF.

Substrate: soil.

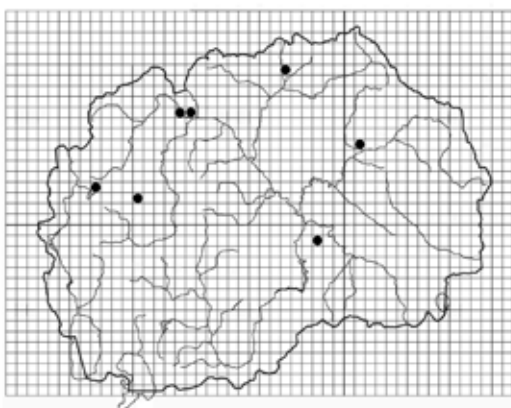


Fig. 18. Distribution of *Morchella esculenta* in Macedonia
Сл. 18. Дистрибуција на *Morchella esculenta* во Македонија

Dobra Voda Mt.: Jagol vill., Quercetum frainetto-cerris, under *Populus tremula*, 750-800 m, 13.04.2008, exs. MCF 08/9371; Popovjani vill., oak forest, under *Quercus sp.*, 800 m, 30.04.2009, exs. MCF 09/10580; **Kochani** (vicinity): Cheshinovo vill., 25.04.2009, exs. MCF 09/10541; **Kumanovo:** Staro Nagorichane vill., by r. Peinja, meadow, *Salicetum*, 23.04.2005, exs. MCF 05/5088; Staro Nagorichane vill., meadow, 24.03.2008, exs. MCF 08/9224; Dobroshane vill., mixed forest, 350 m, 10.04.2005, exs. MCF 05/4864; **Matka:** Ljubin vill., deciduous tree, 200 m, 14.04.2004; **Negotino:** near planted forest „Goceva Shuma“, winery, 03.04.2003, exs. MCF 03/3067; **r. Pchinja** (Kumanovo area): Dobroshane vill., 04.2007, exs. MCF 07/6658; **Skopje:** between Ilinden vill. and Jurumleri vill., *Populus nigra* and *Betula* plantings, under *Populus*, 250 m, 22.04.1999, exs. MCF 99/3927; Konjare vill., by r. Pchinja, *Ulmus* and *Robinia* forest, 250 m, 22.04.2006, exs. MCF 06/8809; Vodno Mt., above the police station, 23.04.2009, exs. MCF 09/10542.

19. **Morchella vulgaris* Pers.

Collections: MCF.

Substrate: soil.

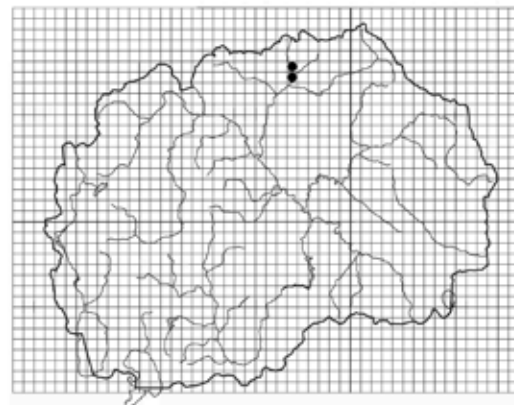


Fig. 19. Distribution of *Morchella vulgaris* in Macedonia

Сл. 19. Дистрибуција на *Morchella vulgaris* во Македонија

Kumanovo: Staro Nagorichane vill., meadow, 24.03.2008, exs. MCF 08/9224; Dobroshane vill., mixed forest, 350 m, 10.04.2005, exs. MCF 05/4864; **r. Pchinja:** (vicinity of Kumanovo), Dobroshane vill., 04.2007, exs. MCF 07/6658.

**20. *Ptychoverpa bohemica* (Krombh.) Boud.
= *Verpa bohemica* (Krombh.) J. Schröt.**

Collections: MCF.

Ref.: Rusevska & Karadelev 2004.

Substrate: soil.

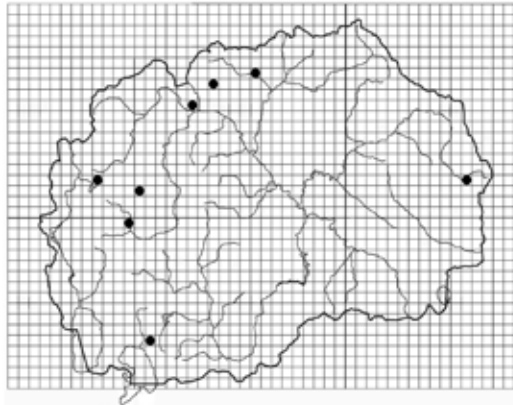


Fig. 20. Distribution of *Ptychoverpa bohemica* in Macedonia

Сл. 20. Дистрибуција на *Ptychoverpa bohemica* во Македонија

Bistra Mt.: Mavrovo, Bunec, 1300 m, deciduous forest, under *Populus tremula*, 24.04.2004, exs. MCF 04/3969; **Dobra Voda Mt.:** Popovjane vill., 800 m, azonal vegetation with *Populus*, under *Populus tremula*, *Salix*, 20.04.2009, below Popovjane vill., 750-800 m, *Quercetum frainetto-cerris*, under *Salix* and *Populus*, 15.04.2008, exs. MCF 08/9367; **Kichevo (vicinity):** Krushino, 25.04.2009; **Kumanovo:** 08.04.2004, exs. MCF 04/3995; **Maleshevski Planini Mt.:** 1000 m, *Festuco heterophyllae-Fagetum*, 21.04.2008, exs. MCF 08/9333; **Pelister Mt.:** Gjavato, old road to Bitola, 1150 m, small forest of *Alnus glutinosa*, 24.04.2002, exs. MCF 02/2668; between hotel „Molika“ and mountain house Kopanki, 1100 m, pastured place with *J. communis* and *P. peuce*, under *Salix*, 26.04.2002; around Trnovo vill., 1200 m, *Festuco heterophyllae-Fagetum*, 26.05.2002; **Skopje (vicinity):** near Orman vill., 270 m, deciduous forest (*Salix*, *Populus*, *Quercus*), plant debris, 03.03.2007, exs. MCF 07/7959; Belimbegovo vill., around hotel „Belvi“, 240 m, landmark of arable land, under poplar, 13.03.2002, exs. MCF 02/1920; Belimbegovo vill., Ilinden, 250 m, *Populus nigra* and *Betula* plantings, 08.04.1999, exs. MCF 99/1882; Vodno Mt., Sredno Vodno to St. Pantelejmon, beside road, 04.05.2004, exs. MCF 04/4029.

21. *Verpa conica (O.F. Müll.) Sw.

Collections: MCF.

Substrate: soil.

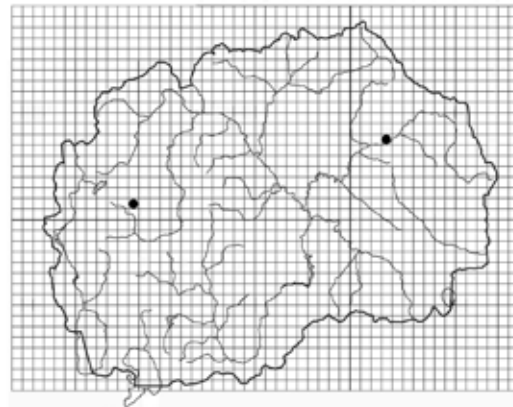


Fig. 21. Distribution of *Verpa conica* in Macedonia

Сл. 21. Дистрибуција на *Verpa conica* во Македонија

Dobra Voda Mt.: Jagol-Dolenci vill., above Naim Frasheri primary school, 800 m, azonal vegetation, 05.05.2009, exs. MCF 09/10582; **Kichevo (vicinity):** Krushino vill., 25.04.2009; **Osogovski Planini Mt.:** St. Pantelejmon (vicinity of Kochani), meadow, 12.04.2008, exs. MCF08/9361.

22. *Verpa digitaliformis Pers.

Collections: MCF.

Substrate: soil.

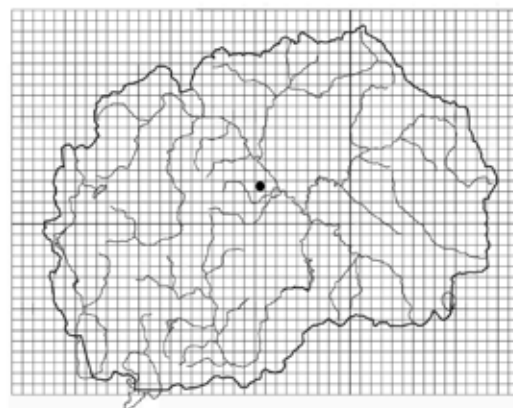


Fig. 22. Distribution of *Verpa digitaliformis* in Macedonia

Сл. 22. Дистрибуција на *Verpa digitaliformis* во Македонија

Veles (vicinity): Martolci vill., burned place with *Rubus* and *Ulmus*, 03.05.1997.

Discussion

Disciotis venosa grows in marshy places in deciduous or in coniferous forest and is fruiting in spring to early summer. It is known from one locality Jacupica Mt. Inferring from the researches in the Republic of Macedonia, this is rare species. According to Breitenbach & Kränzlin (1981); Ryman &

Holmazen (1984); Smith & Weber (1981), it is very rare in Europe too. Can be confused with *Discina perlata*. (Fig. 1).

Gyromitra esculenta grows on sandy soil, in coniferous and rarely in deciduous forest, under *Populus* and *Pinus* with fruiting in March and May. This is new species for the mycobiota of the country, registered in the following localities: Skopje, Kitka Mt., Ograzden Mt., and Dobra Voda Mt., published in this paper for the first time. It is very frequent in Europe especially in Central Europe, West Turkey, and Nordic Islands etc. This species contain lethal toxin, gyromitrin (Karadelev 2002). (Fig. 2).

Gyromitra infula grows mostly alone or scattered, proximity of coniferous trees, also can be found on rotten wood with fruiting in autumn. This species forms mycorrhizal associations with *Picea*, *Pinus*, *Abies*, etc. According to Tortich (1988) and Karadelev et al. (2003) it was recorded in Macedonia in two localities, mountains Pelister and Karaorman, in the associations Digitali viridiflorae-Pinetum peucis, Festuco heterophyllae-Fagetum, between 1150-1500 m altitude. (Fig. 3).

Helvella acetabulum grows alone or in group, on rich calcareous soil, in deciduous or mixed forest, also can be found on burned soil with fruiting in summer to autumn. It is found in more than 10 localities in the following associations: Abieti-Fagetum, Quercetum frainetto-cerris, Querco-Carpinetum orientalis macedonicum, deciduous forest (*Platanus*, *Carpinus*, *Buxus*), between 300-1400 m altitude. According to this data it is frequent species. All localities are new for Macedonia. (Fig. 4).

Helvella crispa can be found in deciduous forest, beside pathways, meadows, on grass with fruiting in summer to late autumn. According to Tortich (1988); Rusevska & Karadelev (2004), is registered from seven localities: Bistra Mt., Debarska Banja, Jacupica Mt., Kumanovo, Raec canyon, Skopje and Cheloica Mt., in following associations: Quercetum frainetto-cerris, Calamintho grandiflorae-Fagetum, Querco-Carpinetum orientalis macedonicum, Abieti Fagetum, Querco-Carpinetum orientalis (*Fraxinus ornus*, *Quercus pubescens*, *Buxus sempervirens*, *Carpinus orientalis*, *Pistacea*), Castanetum sativae macedonicum and *Quercus cerris*, between 50-2000 m altitude. Five localities are new (Bistra Mt., Jacupica Mt., Kumanovo, Raec canyon, Cheloica Mt.). Although this species is known for several localities, it is not a common species. Except in Europe it is known in North America, China and Japan. (Fig. 5).

Helvella lacunosa grows in deciduous and coniferous forest sometimes can be found in degrade forest too, in open areas with fruiting in spring to late autumn. According to Tortich (1988); Karadelev et al. (2003), Rusevska & Karadelev (2004), it is found between 250 m and 1700 m altitude, registered in more than ten localities in following associations: Querco-

Carpinetum orientalis macedonicum, Abieti-Fagetum, Quercetum frainetto-cerris macedonicum, mixed forest (*Fagus*, *Quercus*, *Corylus*), mixed forest (*Pinus sylvestris*, *Abies Populus tremula*), Calamintho grandiflorae-Fagetum, Festuco heterophyllae-Fagetum, Digitali viridiflorae-Pinetum peucis, and Festuco heterophyllae-Fagetum. According to the current data it is very common and widespread species in Republic of Macedonia. It is very common in Europe too. This species is edible, but only dried or cooked. (Fig. 6).

Helvella leucomelaena grows on calcareous soils where the white stem can be hidden from plant debris or can be buried in the soil. According to Rusevska & Karadelev (2004) it has been recorded in two localities in Digitali viridiflorae-Pinetum peucis associations under *Pinus* at 600-1600 m altitude, with fruiting in spring to autumn. Locality of Pelister Mt. is new for the mycobiota of the Republic of Macedonia. This species it is not eatable. (Fig. 7).

Helvella queletii grows in areas like other species from genus *Helvella*. In the Republic of Macedonia four localities have been recorded: Bistra Mt., r. Pchinja, Strumica and vicinity of Skopje. It is not a very common species. There are no published data for this species for the Republic of Macedonia. According to Breitenbach & Kränzlin (1981) this is a common species in North Europe. (Fig. 8).

Leptopodia atra grows in mixed forest with fruiting from summer to autumn. In Republic of Macedonia it is found in two localities: Kitka Mt. (Quercetum frainetto-cerris) and Ruen Mt. (open area), between 400-900 m altitude. According to the existing data, it is not a very common species. This species is also rare in Europe and America. (Fig. 9).

Leptopodia elastica grows alone, scattered or in groups, in deciduous and coniferous forest with fruiting from summer to autumn. In the Republic of Macedonia it is found in three localities (Pelister Mt., Karazdica Mt. and vicinity of Skopje), two of them have been recorded: Pelister Mt. (Karadelev et al. 2003) and vicinity of Skopje (Rusevska & Karadelev 2004). The mountine Karazdica is new locality for this species. It is found in the following associations: Festuco heterophyllae-Fagetum, Digitali viridiflore-Pinetum peucis, Querco-Carpinetum orientalis macedonicum, between 750-1400 m altitude. This species contains a small percent of the toxin gyromitrin. (Fig. 10.)

Leptopodia ephippium grows in areas as *Leptopodia elastica* in deciduous and coniferous forest with fruiting from summer to autumn. In the Republic of Macedonia it is known from one locality Debarska Banja (Tortich 1988). It is found in mixed forest with *Pinus nigra*, between 600-700 m altitude. According to the existing data, it is a very rare species. (Fig.11).

Leptopodia monachella is also rare species with one locality in Republic of Macedonia-Dojran

It is found in stand with *Populus tremula* under *Populus tremula*. (Fig. 12).

Mitrophora semilibera grows on rich soil, in humid deciduous forest, gardens, parks with fruiting from spring to summer. In the Republic of Macedonia it is not a common, but rather a widespread species. It is registered on eight localities in the following associations: Quercetum frainetto-cerris, Salicetum, under *Populus tremula*, *Populus nigra*, *Salix caprea*, *Betula*, between 250-1000 m altitude, published in this paper for the first time. According to Breitenbach & Kränzlin (1981); Lange & Lange (1961). In Europe it is also rare. This is not edible species. (Fig. 13).

Mitrula paludosa grows in marshy forest, on humid decomposing plant debris, needles with fruiting in spring and summer. In Macedonia is known from one locality, Jakupica Mountain. It is found in Calamintho grandiflorae-Fagetum association at 1400 m altitude. According to this data it is very rare species and it is new for this country. (Fig. 14).

Morchella conica grows on sandy soil, in open areas, in deciduous and coniferous forest with fruiting in spring to early summer. This species is known from few localities in Macedonia: Bistra Mt., Dobra Voda Mt., Skopje, Kozjak Mt., Mariovo, Ograzden Mt. and Kitka Mt. It has been found between 600 and 1650 m altitude, in Quercetum frainetto-cerris, Calamintho grandiflorae-Fagetum and *Pinus* plantings, forming mycorrhiza with *Pinus* and *Populus*. According to the current data it is very common species. This is first record of this species for the Republic of Macedonia. It is edible and is one of the most delicious mushrooms. (Fig. 15).

Morchella deliciosa has a similar characteristics like *M. conica*. In Macedonia has been recorded in one locality-Ograzden Mt., found in forest with *Populus* between 1400-1500 m altitude. (Fig. 16).

Morchella elata grows in small groups, on soil, in meadows or in woods. The new data are from the following localities: Dobra Voda Mt., Kochani, Osogovski Planini Mt., r. Pchinja, Skopje and Strumica. This species is fruiting in spring and is edible like all morels. (Fig. 17).

Morchella esculenta grows in meadows, in deciduous and mixed forest, beside pathways, in parks and gardens with fruiting in early spring. This is a new species for the mycobiota of the country, recorded in following localities: Bistra Mt., Dobra Voda Mt., Kochani, Kumanovo, Matka, Negotino and Skopje. It is found in the following associations: Calamintho grandiflorae-Fagetum, Quercetum frainetto-cerris, Salicetum, *Betula* plantings and mixed forest with *Ulmus* and *Robinia*, between 200-1400 m altitude. In the Republic of Macedonia is common and widespread species. It is edible and is much exploited. (Fig. 18).

Morchella vulgaris in the Republic of Macedonia has been observed at one locality, Kumanovo

and vicinity. It is found in mixed forest and meadows. According to these data it is rare species, which is published in this paper for the first time. For all morels it is common that they form mycorrhizal associations with *Populus*, *Picea*, *Abies*, *Ulmus*, *Fagus*, *Salix*, *Quercus*, *Betula* etc., and have delicious fruit body. (Fig. 19).

Ptychoverpa bohemica grows alone or in groups, on soil, in mixed forest with fruiting in spring. In Republic of Macedonia is known from the following localities: Bistra Mt. (*Populus tremula*), Dobra Voda Mt. (*Populus tremula*, *Salix*, Quercetum frainetto-cerris), Kichevo, Kumanovo, Maleshevski Planini Mt. (*Festuco heterophyllae*-Fagetum), Pelister Mt. (*Alnus glutinosa* forest, *Festuco heterophyllae*-Fagetum) and Skopje (under *Salix*, *Populus*, *Quercus*) (Rusevska & Karadelev 2004). All localities except Skopje are new for this species. According to Granmo et al. 1982 it is frequent in the Czech Republic and also in North Europe and North America. (Fig. 20).

Verpa conica grows on rich soils, beside rivers, in deciduous and coniferous forest grows alone or in groups with fruiting in spring to summer. In Republic of Macedonia is known from three localities: Dobra Voda Mt., Kichevo and Osogovski Planini Mt. in azonal vegetation and meadows. There are no published data about this species for the Republic of Macedonia yet. (Fig. 21).

Verpa digitaliformis in Macedonia is known from one locality, vicinity of Veles, found in areas with *Ulmus* and *Rubus*. Grows on rich soils with fruiting in spring to summer. This species is also new for the Republic of Macedonia published in this paper for the first time. (Fig. 22).

Conclusions

In the course of the researches in the Republic of Macedonia a total of 22 species of morels have been registered. According to Moser (1963) a total of 37 species are known in Europe. The registered species belong to the following genera: *Disciotia*, *Gyromitra*, *Helvella*, *Leptopodia*, *Mitrophora*, *Mitrula*, *Morchella*, *Ptychoverpa* and *Verpa*. The following eleven species are new for the mycobiota of the Republic of Macedonia: *Gyromitra esculenta*, *Helvella acetabulum*, *Helvella queletii*, *Leptopodia elastica*, *Leptopodia monachella*, *Mitrophora semilibera*, *Morchella conica*, *Morchella deliciosa*, *Morchella vulgaris*, *Verpa conica*, and *Verpa digitaliformis*. The species which are known from one or two localities need further investigations to provide a more comprehensive review on the ecology and distribution of this systematic category in the Republic of Macedonia.

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ЕКОЛОГИЈА И ДИСТРИБУЦИЈА НА СМРЧКИТЕ (MORCHELLACEAE, HELVELLACEAE) ВО РЕПУБЛИКА МАКЕДОНИЈА

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Резиме

Ова се први податоци за систематски истражувања на смрчките од фамилиите *Morchellaceae* и *Helvellaceae* во Република Македонија. Со цел да се презентира комплетна листа на видови во трудот се вклучени и претходно објавени податоци, додека најголем дел од необјавените податоци се од истражувања вршени од 2000 година до денес. Од вкупно 37 вида регистрирани во Европа со истражувањата во Република Македонија се утврдени следните 22 вида: *Disciotis venosa*, *Gyromitra esculenta*, *Gyromitra infula*, *Helvella acetabulum*, *Helvella crispa*, *Helvella lacunose*, *Helvella leucomelaena*, *Helvella queletii*, *Leptopodia atra*, *Leptopodia elastica*, *Leptopodia ephippium*, *Leptopodia monachella*, *Mitrophora semilibera*, *Mitruula paludosa*, *Morchella conica*, *Morchella deliciosa*, *Morchella elata*, *Morchella esculenta*, *Morchella vulgaris*, *Ptychoverpa bohémica*, *Verpa conica* и *Verpa digitaliformis*.

За видовите кои се најдени на еден или на два локалитета, како и за оние кои не се со сигурност потврдени потребни се дополнителни истражувања со цел да се добие комплетна слика за нивната дистрибуција во Р. Македонија. Истражувањата се вршени во различни заедници: букови, дабови, елови, борови, мешани шуми, насади од багрем, ливади, а супстрати се различни листокапни и четинарски дрвја. Следните 11 вида се нови за микобиотата на Република Македонија: *Gyromitra esculenta*, *Helvella acetabulum*, *Helvella queletii*, *Leptopodia elastica*, *Leptopodia monachella*, *Mitrophora semilibera*, *Morchella conica*, *Morchella deliciosa*, *Morchella vulgaris*, *Verpa conica* и *Verpa digitaliformis*. Од видовите обработени во овој труд ниту еден не е ставен во Прелиминарната црвена листа на габи во Република Македонија.