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NEW DATA ON TURKISH HYPOGEOUS FUNGI

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In this study, three species of hypogeous fungi are reported in different regions of Anatolian peninsula. Of these, *Hydnocystis piligera* is presented as the first record of this genus for Turkish mycobiota, while *Melanogaster variegatus* and *Octaviania asterosperma* are given as new locality records for Turkey. Macroscopic and microscopic photographs along with description of the newly recorded taxa are presented.

Key words: biodiversity, first record, taxonomy, Turkish truffles

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Provedenim istraživanjem zabilježene su tri vrste podzemnih gljiva u različitim regijama poluotoka Anatolija. Nalaz vrste *Hydnocystis piligera* predstavlja prvi nalaz ovoga roda za mikobiotu Turske, dok su vrste *Melanogaster variegatus* i *Octaviania asterosperma* zabilježene na novim lokalitetima u Turskoj. U radu se prikazuju makroskopske i mikroskopske fotografije zajedno s tekstualnim podacima o zabilježenim vrstama.

Ključne riječi: bioraznolikost, prvi zapis, taksonomija, turske podzemne gljive

INTRODUCTION

Hypogeous fungi comprise species from the phyla Ascomycota (which include *Tuber* spp. i.e. true truffles), Basidiomycota (a part of false truffles) and some sporocarpic Glomeromycota (Colgan *et al.*, 1999). Most hypogeous fungi are ectomycorrhizal fungi in symbiotic relationships with the roots of Pinaceae, Fagaceae, Betulaceae, Myrtaceae and Salicaceae (Carey *et al.*, 2002; Elliott *et al.*, 2016; Nedelin *et al.*, 2016). The fruiting bodies of these fungi develop partially or wholly underground, and have tuberate forms (Gücin *et al.*, 2010; Şen *et al.*, 2016).

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Because they develop underground, the spore distribution of hypogeous fungi, unlike that of epigeous fungi (above-ground), is not achieved through the air. The distribution of the spores of hypogeous fungi is frequently restricted in distance, and they have developed a spore distribution strategy that is dependent on animals (Trappe & Maser, 1977). When the fruiting bodies or the spores of these fungi ripen, they begin to broadcast an aroma that is a chemical attractant to many animals (Trappe & Maser, 1977; Mleczko *et al.*, 2010). These animals then dig the ripe fruitbodies out of the ground, break them up, and consume them partially or completely (Trappe & Maser, 1977).

These fungi are both delicious and nutritious, and therefore they have been a sought-after part of the human diet since early times (Splivallo *et al.*, 2011; Splivallo & Culleré, 2016). Even though it is very difficult to grow some truffle species, they have been cultivated and traded for many years (Çaka & Türkoğlu, 2016; Şen *et al.*, 2016).

The Anatolian peninsula stands at the intersecting point of three phytogeographical regions (Euro-Siberian, Mediterranean and Irano-Turanian) in the Northern Hemisphere, and for this reason it has a rich plant biodiversity (Doğan & Akata, 2015; Kaygusuz & Çolak, 2017). This allows many species of ectomycorrhizal fungi (Çolak *et al.*, 2017) including hypogeous fungi to flourish (Castellano & Türkoğlu, 2012; Türkoğlu & Castellano, 2013, 2014; Gezer *et al.*, 2014).

According to recent work (Doğan & Akata, 2015; Uzun & Kaya, 2017) and the Checklist of Turkish Truffles (Şen *et al.*, 2016), 71 hypogeous fungi have been reported from Turkey, 26 of which are ascomycetous and 45 are basidiomycetous. The paper aims to make contributions to Turkish hypogeous fungi.

MATERIAL AND METHODS

The specimens were randomly collected from the provinces of Aydın, Bursa and Kütahya in Turkey, without the aid of trained dogs. According to Quezel & Barbero (1985), Aydın province is characterised by a thermo-Mediterranean bioclimate in the broader littoral area represented by completely evergreen sclerophyllous dendro-vegetation with inclusions of thermophilic conifers (*Pinus halepensis* Mill., *P. brutia* Ten. and *Cupressus sempervirens* L.) and by meso-Mediterranean bioclimate represented mainly by evergreen-deciduous dendro-vegetation (composed of mixed elements and/or semi-evergreen species) situated in river valleys and surrounding mountains. On the other hand, Bursa and Kütahya provinces are part of a broad supra-Mediterranean belt, dominated by thermophilic deciduous trees (at least on calcareous soils) as well as of a montane-Mediterranean belt (etage montagnard-méditerraneen) represented by *Pino-Cistion laurifolii*, except for the highest mountains that are settled with Euro-Siberian altimontane *Abies-Fagus* tall forests. Fieldwork was designed to cover three mutually sharply different vegetational representatives of three bioclimatic zones. The research conducted in Aydın province was aimed at the thermo-Mediterranean littoral vegetation dominated by *Pinus brutia* and *Cupressus sempervirens*, while that performed in Kütahya province covered a montane-Mediterranean zone represented by *Cedrus libani* A. Rich., mixed with *Cistus* sp. and deciduous oaks. Research done in Bursa province was concentrated on a Euro-Siberian altimontane forest composed of *Fagus orientalis* Lipsky and *Abies nordmanniana* (Stev.) Spach. The specimens were photographed in the field, and the morphological and ecological characteristics were noted in the field notebook. The assessment of the mycorrhizal plant partners for *Hydnocystis piligera* without sampling of mycorrhizae has been made according to a previously elaborated protocol (Matočec,

Host genus	Matočec 2003 (updated)				This paper	Vidal et al. 1991	Montecchi & Sarasini 2000	Barshegyan & Wasser 2010	Pancorbo & Ribes 2010	Agnello 2011	Alvarado et al. + Kaounas et al. 2011	Kumar et al. 2017
	total obs.	excl. obs.	shared by one	shared by >2								
Eucalyptus	1	1									x	x
Cercis	1			1								
Ficus	1			1								
Coronilla	1			1								
Fraxinus	2			2								
Lonicera	2			2								
Laurus	3	1		2								
Ruscus	3			3								
Cistus	5		1	4			x			x		
Cupressus	6	1	2	3			x			x		
Viburnum	8			8								
Phillyrea	9			9						x		
Myrtus	9		1	8								
Arbutus	9			9								
Erica	10			10		x						
Pistacia	11			11		x	x			x		x
Quercus	15			15				x	x		x	
Juniperus	19	1	6	12		x			x	x	x	
Pinus	27	5	7	15	x	x	x	x		x	x	x
Chamaerops									x		x	
Olea											x	
Picea												x

KEY

	over 40% of total Croatian finds
	10-39% of total Croatian finds
	below 10% of total Croatian finds

Mycorrhizal relationship probability assessment according to Matočec (2003)

	can be found as exclusive arborescent species	mycorrhizal partnership is certain
	found at most with one additional arborescent species	rather probable mycorrhizal partner
	always found with two or more arborescent species	low probability of mycorrhizal partnership
	imperfectly known field data	

NOTE The table presents only modern data (last 50 years)

Tab. 1. Host genus affinity and mycorrhizal relationship probability for *Hydnocystis piligera* according to direct field observations.

2003). Soil characteristics and information about the bedrock are read off from various pedological and geological thematic maps and data. The measurements of microscopic features were taken on dry materials mounted in KOH, Congo red and Melzer's reagent. Identification of the samples was conducted according to the references given in Table 2, 3 and 4. Molecular methods in species identification are not used since all species treated are easily recognizable by morphological characters, organoleptic features and

ecology. Dried samples are kept in the personal fungarium of the second author at Süleyman Demirel University, Isparta. The names of taxa and authors are quoted according to MycoBank (www.mycobank.org) and Index Fungorum (www.indexfungorum.org).

Tab. 2. Comparison of micro- and macroscopic characters of *H. piligera.*

Size of ascoma (mm)	Size of asci (µm)	Size of ascospores (µm)	Width of paraphyses at the top (µm)	References
4–20	375–450 × 25–38	24–35	1–3	Burdsal (1968)
10	25–35	25.5–33.5	–	Vidal *et al.* (1991)
10–25	180–350 × 20–45	22–31	1–3	Barseghyan & Wasser (2010)
5–20	–	25–32.7 × 24.7–32	–	Pancorbo & Ribes (2010)
5–35	190–310 × 30–45	28–36	3–5	Agnello (2011)
5–35	300 × 50	27–32	5	Kaounas *et al.* (2011)
5–40	250–300 × 30–50	28–35	3–5	Kumar *et al.* (2017)
5–25	**200–300 × 25–45**	**25.4 – 37.3 (-37.7)**	**3–5**	**This study**

Tab. 3. Comparison of micro- and macroscopic characters of *M. variegatus.*

Size of basidioma (mm)	Size of basidia (µm)	Size of basidiospores (µm)	References
–	–	10–5	Massee (1889)
–	–	7.5–10 × 5.0–7.5	Zeller & Dodge (1936)
20–25 × 10–15	–	(6.5-) 8–10.5 × 5– 6.5 (-11)	Cázares *et al.* (1992)
20–40	–	(6-) 7.5(-8.5) × 4 (-5.5)	Honrubia *et al.* (1992)
10–60	40–50 × 8–10	7–10 × 5–7	Moreno-Arroyo *et al.* (2005)
20–50	15–20 × 5–8	5–10 × 3.5–4.5	Sesli & Moreau (2015)
35–50	**–**	**(5-) 5.5–8.5 (-9.5) × 4–5**	**This study**

Tab. 4. Comparison of micro- and macroscopic characters of *O. asterosperma.*

Size of basidioma (mm)	Size of basidia (µm)	Size of basidiospores (µm)	References
–	–	14–15	Massee (1889)
35–50	20–22	13–16	Zeller & Dodge (1936)
–	–	9–11	Smith (1962)
10–30	–	13–18	Arora (1986)
20–30	–	16–18	Yoshimi & Doi (1989)
10–50	–	10–20	Ellis & Ellis (1990)
10	20.5–23 × 9.5–13	14–16.5	Cázares *et al.* (1992)
30	20–35 × 7–15	9–11 × 12–17	Martín *et al.* (1994)
10–20	–	9–12	Vidal (1994)
16–25	30 × 8–12	10–12	Lenne (2005)
10–25	25–35 × 5–10	10–13 × 10–12	Moreno-Arroyo *et al.* (2005)
10 – 15 × 18 – 25	–	13.8 – 17.5 (-18.8)	Huffman *et al.* (2008)
7.5–25	–	18–19	Hobart (2009)
25–35	21-28 × 10-15	13–18	Mleczko *et al.* (2010)
6–15	5–10 × 20–40	(8.8-) 10.5–11.4 × 10.5–11.4 (-12.3)	Türkoğlu *et al.* (2015)
10–20	**–**	**(11.5-) 12–13.5 (-14) × (9-) 10–12 (-12.5)**	**This study**

RESULTS AND DISCUSSION

A record of a new hypogeous fungus for Turkey

Ascomycota Caval.-Sm.

Pezizales J. Schröt.

Pyronemataceae Corda

Hydnocystis piligera Tul. & C. Tul., *Giornale Botanico Italiano* 1 (2): 59 (1844) **Fig. 1.**

Ascoma 5-25 mm in diameter, closed astipitate ptychothecium, hypogeous when small, larger ascomata semi-hypogeous or sometimes epigeous, generally globose to subglobose, sometimes slightly lobed, hollow, pale yellow, yellowish ochraceous to flesh-coloured, finely hairy, pubescent. **Peridium** composed of an outer layer of wavy or creased hairs forming an up to 0.5 mm thick layer, and an inner layer composed of round or polygonal elements. **Gleba** thin, whitish, swollen cotton-like structure covered in fine hairs, and with a clear aroma of sweet ripe fruit. **Asci** 200–300 × 25–45 µm, cylindrical, tapering gradually from apex toward base, inamyloid, uniseriate, 8–spored. **Ascospores** 25.4–37.3(–37.7) µm in diam., Q = 1.0 (1.1), Me = 31.3 × 30.5, Qe = 1.0, globose, hyaline, smooth, comparatively thin–walled, without oil drops. **Paraphyses** 3–5 µm broad at the apex, filiform, septate, generally longer than asci, hyaline, thin-walled.

Habitat: Fruitbodies of *H. piligera* grow hypogeally or semi-hypogeally, in sandy soils developed from calcareous rocks containing various levels of $CaCO_3$, especially in coastal thermophilic pine forests and scrubland in Mediterranean ecosystems (thermo-Mediterranean fully evergreen sclerophyllous vegetation type), most frequently associated or most certainly mycorrhizal with plant genera such as *Pinus, Juniperus*, *Quercus*, *Pistacia*, *Olea, Cupressus*, *Cistus*, *Laurus* and *Eucalyptus* (Tab. 1).

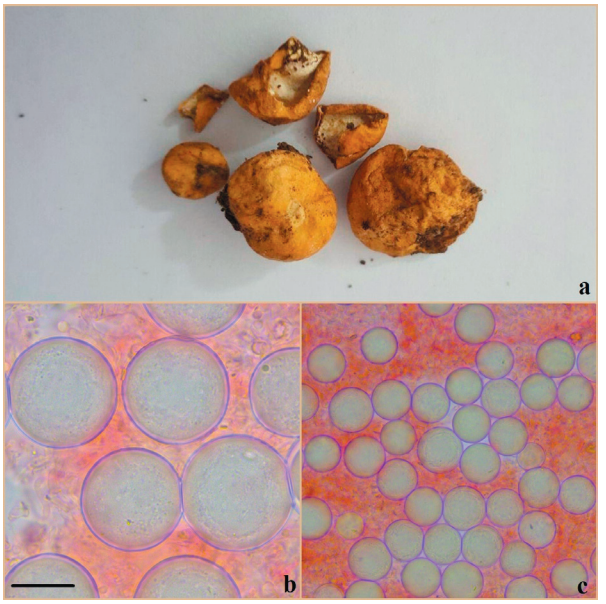

Fig. 1. *Hydnocystis piligera*; a: ascomata, b-c: ascospores (in Congo red) (scale bar: 20 µm).

Specimen examined: Turkey. Aydın Province, Kuşadası district, on the ground, under *Pinus brutia*, 12 m a.s.l., 21 Nov 2015, leg. & det. O. Kaygusuz (OKA 1504).

Discussion: In previous studies, *Hydnocystis piligera* and *H. clausa* (Tul. & C. Tul. Ceruti) have been reported from different parts of Europe (Pancorbo & Ribes, 2010). These two species, which share similar habitats, can be easily distinguished by their macromorphological and microscopic characteristics. The two species were however ascribed to different genera, namely *Hydnocystis* and *Geopora* in some studies (Burdsall, 1968; Matočec, 2003; Alvarado *et al.,* 2011; Kaounas *et al.,* 2011; Kumar *et al.,* 2017). *H. piligera* has an ascoma that varies from pale yellow to skin colour and globose spores 25.4–37.7 μm in size, and is easily distinguishable from *H. clausa*, now a certain member of *Geopora*, which has a dark coloured ascoma and ellipsoidal (20–30 × 13–18) spores (Moreno-Arroyo *et al.,* 2005; Pancorbo & Ribes, 2010; Agnello, 2011).

Detailed descriptions of *H. piligera* have been provided in previous studies (Burdsall, 1968; Montecchi & Sarasini, 2000; Matočec, 2003; Barseghyan & Wasser, 2010; Pancorbo & Ribes, 2010; Agnello, 2011; Kaounas *et al.,* 2011; Kumar *et al.,* 2017). A comparative analysis of Turkish specimens and data provided by other authors is presented in Tab. 2: it shows that the sizes of macroscopic and microscopic structures of our samples are compatible with previous findings.

H. piligera has been reported hitherto from Algeria, Austria, Belgium, China, Croatia, Cyprus, France, Germany, Greece, Israel, Italy, Lichtenstein, Netherlands, Russia, Spain and Switzerland (Burdsall, 1968; Vidal *et al.,* 1991; Matočec, 2003; Montecchi & Sarasini, 2000; Barseghyan & Wasser, 2010; Pancorbo & Ribes, 2010; Agnello, 2011; Alvarado *et al.,* 2011; Kaounas *et al.,* 2011; Kumar *et al.,* 2017). Although this primarily Mediterranean species has been reported from the medio-European area too, it is regarded as very rare (Switzerland) to extremely rare (Germany) (cf. www.123pilze.de, also Krieglsteiner (1993)), while the species is missing from recent species list of Austria (Dämon & Krisai-Greilhuber, 2017). *H. piligera* is reported in this study as a newly reported genus for Turkey, extending the known distribution to a new geographical region (Sesli & Denchev, 2008; Solak *et al.,* 2015; Şen *et al.,* 2016).

In terms of habitat (Tab. 1), it has been reported in previous studies that *H. piligera* generally grows under Angiosperms (*Chamaerops humilis* L., *Cistus* spp., *Erica multiflora* L., *Eucalyptus* sp., *Olea europaea* L., *Phillyrea angustifolia* L., *Pistacia lentiscus* L., *P. terebinthus* L., *Quercus ilex* L.), but even more frequently under Gymnosperms (especially *Pinus* spp., *Juniperus* spp. and *Cupressus sempervirens*) (Vidal *et al.,* 1991; Montecchi & Sarasini, 2000; Matočec, 2003; Barseghyan & Wasser, 2010; Pancorbo & Ribes, 2010; Agnello, 2011; Kaounas *et al.,* 2011; Kumar *et al.,* 2017). The samples identified in the present study were collected very close to the coast under *Pinus brutia*.

New localities of two hypogeous fungi for Turkey

Basidiomycota Whittaker ex Moore

Boletales E.-J. Gilbert

Melanogastraceae E. Fisch.

Melanogaster variegatus (Vittad.) Tul. & C. Tul., *Fungi Hypogaei: Histoire et Monographie des Champignons Hypogés*: 92, t. 2:4, 12:6 (1851) **Fig. 2.**

Fig. 2. *Melanogaster variegatus*; a-c: basidiomata, d: basidiospores (in KOH and Congo red) (scale bar: 10 μm).

Habitat: Fruitbodies of *M. variegatus* grow hypogeally or semi-hypogeally, under *Cedrus libani*, near *Quercus* sp. and *Cistus* sp. mixed montane-Mediterranean forest.

Specimen examined: Turkey. Kütahya Province, Domaniç district, Küçükköy village, 19 May 2014, leg. & det. Ö.F. Çolak (ÖFÇ 893).

Discussion: *Melanogaster variegatus* can sometimes be confused with *M. broomeanus* Berk. However, *M. variegatus* has elliptical to ovoid spores, while *M. broomeanus* has ellipsoid-cylindrical spores (Breitenbach & Kränzlin, 1986; Honrubia *et al.*, 1992; Lacheva, 2015; Türkoğlu, 2015). Also, the peridium of *M. variegatus* is yellowish-brown in colour, while that of *M. broomeanus* is pinkish (Cázares *et al.*, 1992; Honrubia *et al.*, 1992). Because of its smaller spore dimensions, *M. variegatus* (5–9.5 × 4–5 μm) can also be easily distinguished from *M. ambiguus* (Vittad.) Tul. & C. Tul. (13–17 × 6–10 μm) and *M. macrosporus* Velen. (10–14 × 5–6 μm) (Uzun *et al.*, 2014; Elliot *et al.*, 2016). These two latter species are also easily separated from both *M. broomeanus* and *M. variegatus* by their specific and well differentiated aroma.

M. variegatus was first reported from Turkey by Sesli & Moreau (2015). The macroscopic and microscopic characteristics of *M. variegatus* in the present study, which presents a second locality record for the mycobiota of Turkey, are in accordance with information in the literature (Tab. 3).

M. variegatus has been reported so far from Algeria, France, Germany, Greece, Hungary, Italy, Mexico, Spain, Turkey, USA (Massee, 1889; Zeller & Dodge, 1936; Cázares *et al.*, 1992; Honrubia *et al.*, 1992; Moreno-Arroyo *et al.*, 2005; Diamandis & Perlerou, 2008; Nuhn *et al.*, 2013; Bratek *et al.*, 2013; Pecoraro *et al.*, 2014; Sesli & Moreau, 2015). In this study, a second locality record for Turkey is presented for *M. variegatus.*

In previous studies, *M. variegatus* has been reported as growing with *Fagus* sp., *Quercus* sp., *Pinus* sp., *Alnus glutinosa* (L.) Gaertn., *A. incana* (L.) Moench, *Anthyllis cytisoides* L., *Cistus clusii* Dunal, *C. incanus* L., *C. monspeliensis* L., *Helianthemum almeriense* Pau, *Quercus canbyi* Trel., *Q. ilex* L. and *Q. suber* L. (Massee, 1889; Zeller & Dodge, 1936; Cázares *et al.*, 1992; Honrubia *et al.*, 1992; Diamandis & Perlerou, 2008; Ortega *et al.*, 2010; Graf & Frei, 2013; Sesli & Moreau, 2015). In the present study, a new habitat for *M. variegatus*, *Cedrus libani*, is reported as an update to the literature.

Basidiomycota

Boletales

Boletaceae Chevall.

Octaviania asterosperma Vittad., *Monographia Tuberacearum*: 17, t. 3:7 (1831), **Syn.:** *Arcangeliella asterosperma* (Vittad.) Zeller & C.W. Dodge, *Annals of the Missouri Botanical Garden* 22: 366 (1935) **Fig. 3.**

Habitat: Fruitbodies of *O. asterosperma* grow hypogeally or semi-hypogeally, under *Fagus orientalis* and *Abies nordmanniana* (Stev.) Spach subsp. *bornmuelleriana* (Mattf.) Coode et Cullen mixed Euro-Siberian altimontane forest.

Specimen examined: Turkey. Bursa Province, Uludağ National Park, 7 Sep 2017, leg. & det. Ö.F. Çolak (ÖFÇ 1302).

Discussion: *Octaviania* Vittad. (orthographic variant: *Octavianina* O. Kuntze (Gams, 1999); Boletales), is a genus of truffle-like fungi from the Boletaceae family. This genus has a wide distribution, and so far has 15-20 accepted species (Kirk *et al.*, 2008; Orihara *et al.*, 2012). Various species of the *Octaviania* Vittad., *Sclerogaster* R. Hesse and *Wa-*

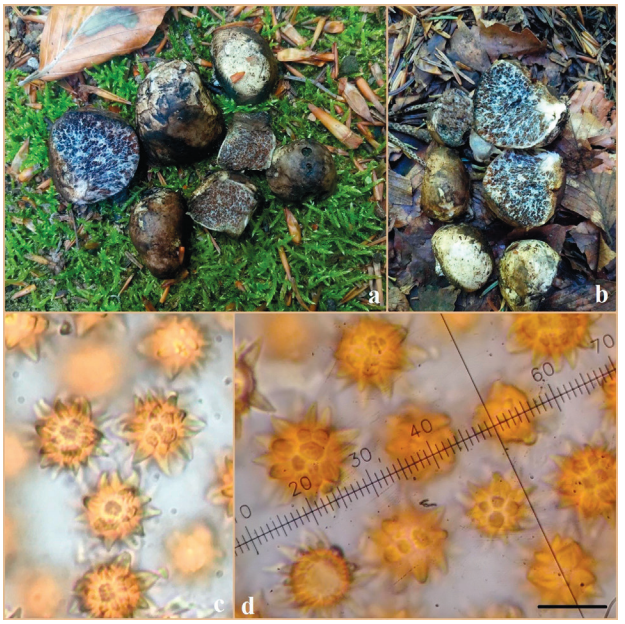

Fig. 3. *Octaviania asterosperma*; a-b: basidiomata, c: basidiospores (in Melzer's reagent), d: basidiospores (in KOH) (scale bar: 10 μm).

kefieldia Corner & Hawker (genera of the order Boletales) can be confused under certain ecological conditions. However, both *Octaviania* and *Wakefieldia* species have spore diameters of generally more than 10 μm, while those of the genus *Sclerogaster* have spores smaller than 10 μm. In addition, while the spores of *Octaviania* species are subglobose and have spore ornamentation extending for approximately 4 μm and are dextrinoid in character, those of the genus *Wakefieldia* have spore ornamentation which extends approximately 1.5 μm, and are not dextrinoid in character (Lenne, 2005).

O. asterosperma can be sometimes confused with *O. olida* Malençon & Astier. While *O. asterosperma* has a peridium varying in colour from yellowish to brownish and round spores, *O. olida* has a yellow peridium and ellipsoid spores with straight spines (Astier, 1993; Mleczko *et al.,* 2010). Also, Mleczko *et al.* (2010) reported that yellow woolly colonies of *Sepedonium laevigatum* Sahr & Ammer formed on the surface of the basidiomata of ripe *O. asterosperma*. However, *S. laevigatum* is a non-specialised parasite/saprotroph on a number of boletalean species and could not be used as an indicator of host species. The morphological and microscopic characteristics of *O. asterosperma* given in the present study are in accordance with the data reported by previous researchers (Tab. 4).

O. asterosperma has been reported from Asia (Japan) (Yoshimi & Doi, 1989), Algeria, Europe (Austria, Belgium, Bulgaria, Czech Republic, Czechoslovakia, Denmark, England, France, Germany, Hungary, Ireland, Italy, Norway, Poland, Portugal, Serbia, Spain, Sweden, Switzerland, Turkey, Netherlands, Ukraine) (Massee, 1889; Pim, 1898; Zeller & Dodge, 1936; Smith, 1962; Martín *et al*., 1994; Vidal, 1994; Lenne, 2005; Hobart, 2009; Mleczko *et al*., 2010; Orihara *et al*., 2012; Bratek *et al*., 2013; Nuhn *et al*., 2013; Rana *et al*., 2015; Türkoğlu *et al*., 2015), North America (Mexico, USA) (Zeller & Dodge, 1936; Arora, 1986; Cázares *et al*., 1992) and North Africa (Massee, 1889). *O. asterosperma* has a broad distribution, mostly in Europe but also in the rest of the world, and in this study a new locality record is reported from Turkey.

In terms of habitat, *O. asterosperma* has been reported in many previous studies as growing together with *Alnus glutinosa* (L.) Gaertn., *Castanea sativa* Mill., *Carpinus* sp., *Corylus* sp., *Fagus orientalis*, *F. sylvatica* L., *Picea orientalis* (L.) Link., *Pinus sylvestris* L., *Pseudotsuga* sp. (Douglas fir), *Quercus* sp., *Q. ilex* subsp. *ballota* [Desf.] Samp., *Q. rysophylla* Weath., *Q. suber* L., *Rhododendron ponticum* L., *Tilia* sp., *Salix caprea* L. and *Sequoia* sp. (Redwood) (Arora, 1986; Cázares *et al*., 1992; Vidal, 1994; Desjardin, 2003; Lenne, 2005; Moreno-Arroyo *et al*., 2005; Mleczko *et al*., 2010; Türkoğlu *et al*., 2015). The sample presented in this study is similar in terms of general habitat data to those reported in the literature.

CONCLUSIONS

According to the literature 27 genera of the family *Pyronemataceae* have been reported from Turkey (Sesli & Denchev, 2008; Solak *et al.,* 2015; Çolak & Kaygusuz, 2017a, 2017b; Uzun *et al.,* 2018). In this study, *Hydnocystis piligera* is reported as a new record for the mycobiota of Turkey, becoming the 28th known genus of the *Pyronemataceae* occurring in this country. The ecological data are compared to those collected from Croatia (Matočec, 2003) where this species has been specially monitored for 30 years with almost two thirds of all finds being recorded under one or several *Pinus* species, which is in high accordance with the Turkish record (Tab. 1). With the extension of its known range to Turkey, the main ecological frame of *H. piligera* in Europe, Asian Middle East and Africa falls into the thermo-Mediterranean zone (represented by fully evergreen sclerophyllous and/or

thermophilic coniferous vegetation) of the Mediterranean basin where this species is fairly common. The number of hypogeous fungi in Turkey has increased from 71 to 72 (Doğan & Akata, 2015; Şen *et al.*, 2016; Uzun & Kaya, 2017). Also, new locality records have been reported from Turkey for two truffles: *Melanogaster variegatus* and *Octaviania asterosperma* both having wide transcontinental ranges.

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SAŽETAK

Novi podaci o podzemnim gljivama Turske

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Podzemne vrste gljiva klasificiraju se u tri odjeljka carstva gljiva: Ascomycota, Basidiomycota i Glomeromycota. Većina njih tvori ektomikoriznu vezu s korijenovim sustavom biljaka iz porodica Pinaceae, Fagaceae, Betulaceae, Myrtaceae i Salicaceae. Plodišta ovih gljiva razvijaju se djelomično ili u potpunosti pod zemljom te da bi se rasprostranile u zrelosti razvijaju mirise i tako privlače životinje koje se njima hrane. Spore se rasprostiru putem životinjskih ekskremenata. Zbog svoje ukusnosti i hranjivosti podzemne gljive dio su i ljudske prehrane od davnih vremena. Zbog svojeg položaja unutar tri fitogeografske regije, poluotok Anatolija odlikuje se velikom raznolikošću biljaka, što za posljedicu ima i visoku bioraznolikost podzemnih gljiva kojih je do danas u Turskoj zabilježeno 71 vrsta. Uzorci podzemnih gljiva prikazanih u ovome radu sakupljeni su na području turskih provincija Aydın, Bursa i Kütahya bez pomoći treninranih pasa u okviru planiranih istraživanja tri međusobno vrlo različitih tipova staništa: (a) termomediteranske primorske vegetacije u kojoj dominira brucijski bor (*Pinus brutia*) i obični čempres (*Cupressus sempervirens*) pokrajine Aydın, (b) montano-mediteranskoj vegetaciji libanonskog cedra (*Cedrus libani*), termofilnih listopadnih hrastova i bušina pokrajine Kütahya, te (c) Euro-sibirskoj altimontanoj šumi azijske bukve (*Fagus orientalis*) i kavkaske jele (*Abies nordmanniana*) pokrajine Bursa. Mirisna šupljoglavka (*Hydnocystis piligera*) je novozabilježena vrsta kao i rod (šupljoglavke) za mikobiotu Turske. Ekološki podaci kod ove vrste uspoređeni su s podacima iz Hrvatske (gdje je ona već 30 godina pod posebnim monitoringom) i ostalih država u kojima je zabilježena. Najveći broj nalaza pronađen je u sastojinama termofilnih vrsta mediteranskih borova. S proširenjem areala na područje Turske, glavni ekološki okvir ove vrste potpada pod termomediteranski bioklimatski pojas Sredozemlja s karakterističnom trajnozelenom tvrdolisnom vegetacijom i/ili termofilnom vegetacijom četinjača. Široko rasprostranjene transkontinentalne vrste *Melanogaster variegatus* i *Octaviania asterosperma* zabilježene su na novoistraženim lokalitetima u Turskoj.