

Turkish truffles I: 18 new records for Turkey

Aziz TÜRKÖĞLÜ^{1*}, Michael Angelo CASTELLANO², James Martin TRAPPE³, Mehrican YARATANAKUL GÜNGÖR¹

¹Biology Department, Faculty of Science, Muğla Sıtkı Koçman University, Muğla, Turkey

²Department of Agriculture, Forest Service, Northern Research Station, Forestry Sciences Laboratory, Corvallis, Oregon, USA

³Department of Forest Ecosystems and Society, Oregon State University, Corvallis, Oregon, USA

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Abstract: We report the first records of 18 truffle species in Turkey. Three belong to the Ascomycota: *Elaphomyces leucocarpus*, *E. muricatus*, and *Genea sphaerica*; and 15 to the Basidiomycota: *Alpova corsicus*, *Gautieria otthii*, *G. retirugosa*, *G. trabutii*, *Hymenogaster citrinus*, *H. hessei*, *H. luteus*, *H. lycoperdineus*, *Hysterangium clathroides*, *H. epiroticum*, *H. fragile*, *H. nephriticum*, *Leucogaster tozzianus*, *Octaviania asterosperma*, and *Protoglossum aromaticum*. We also report new localities within Turkey for *Picoa juniperi*, *P. lefebvrei*, *Geopora cooperi*, *Terfezia arenaria*, *T. claveryi*, *Tuber aestivum*, and *T. nitidum* in the Ascomycota; and *Leucogaster nudus*, *Hymenogaster thwaitesii*, *H. vulgaris*, and *Melanogaster broomeanus* in the Basidiomycota.

Key words: Truffles, hypogeous fungi, Ascomycota, Basidiomycota, Turkey

1. Introduction

Turkey has a potentially rich diversity of truffle taxa due to its unique phytogeographical location, climate and soil variability, and vegetation diversity. More than 2000 fungal species have been recorded from Turkey (Solak et al., 2007; Sesli and Denchev 2014); nearly all of them are epigeous. In Turkey, truffle fungi have received less attention than epigeous fungi. To date only 42 truffle species have been reported from Turkey (Öder, 1988; Işıloğlu and Öder, 1995; Afyon, 1996; Demirel, 1998; Solak et al., 2003; Doğan and Öztürk, 2006; Kaya, 2009; Sesli and Castellano, 2009; Castellano and Türköglü, 2012; Türköglü and Castellano, 2013, 2014). We have begun a concerted effort to collect truffle fungi across all regions of Turkey and herein present our results to date for truffle taxa previously described. In the course of our collecting we have encountered a number of new truffle fungal species that will be presented in subsequent papers.

2. Materials and methods

Truffle fungal specimens were collected in most regions of Turkey except Eastern Anatolia during the period of 2008–2014. Some specimens were found with the help of a truffle dog, but most were discovered by traditional truffle raking in appropriate habitats (Castellano et al., 2004). Macromorphological characteristics (size, fresh color, bruising reactions, and odor) of specimens were recorded and photographed. Micromorphological characters were

recorded from tissue sections rehydrated in water, 3% KOH, or Melzer's reagent. Spores and sterile tissues were photographed by use of a light microscope. Each collection was split and representative specimens are deposited in the herbaria of Muğla Sıtkı Koçman University and Oregon State University (OSC). Authority names are given according to Kirk et al. (2008) and fungal names according to Index Fungorum (2014) and Mycobank (2014).

3. Results

Here we present 18 truffle species determined to be new records for Turkey: 3 species in the Ascomycota (*Genea* 1, *Elaphomyces* 2), 15 in the Basidiomycota (*Leucogaster* 1, *Octaviania* 1, *Hysterangium* 4, *Gautieria* 3, *Hymenogaster* 4, *Alpova* 1, and *Protoglossum* 1). Additional date and locality data are given for *Picoa juniperi*, *P. lefebvrei*, *Geopora cooperi*, *Terfezia arenaria*, *T. claveryi*, and *Tuber aestivum* in the Ascomycota; and *Leucogaster nudus*, *Hymenogaster thwaitesii*, *H. vulgaris*, and *Melanogaster broomeanus* in the Basidiomycota.

3.1. Elaphomycetaceae Tul. ex Paol.

3.1.1. *Elaphomyces leucocarpus* Vittad.

Ascocarp 2–3 cm broad, enclosed in a husk of mycorrhizae and fine roots, irregularly flattened to subglobose, surface brown to yellow-brown, covered by crowded, pyramidal, or irregular, yellow-brown warts 80–200 µm tall, partially embedded in a brown matrix. Inner layer leathery,

* Correspondence: turkoglu.aziz@gmail.com

homogeneous, white (Figure 1a). Gleba rose-brown and cottony in youth, becoming a black, powdery spore mass at maturity. Peridium 1000–1300 μm thick, 2-layered: outer layer 180–200 μm thick, of mottled yellow to yellow-brown, conical warts, partially embedded in a brown matrix of hyaline, parallel, distinctly septate hyphae, 3.5–4.5 μm broad, walls ± 1 μm thick between warts; inner layer 800–1100 μm thick, of hyaline, interwoven hyphae, 2.5–4.5 μm broad, walls ± 1 μm thick. Gleba a black powdery spore mass containing scattered, off-white, fragile dissepiments of hyaline, septate hyphae, 3.5–4.5 μm broad, walls ± 1 μm thick. Asci not seen. Ascospores globose, (21–) 24–33 μm , mean = 29.3 μm , excluding ornamentation of brown spines and short ridges, up to 3.5 μm tall (Figure 1b).

Comments: *Elaphomyces leucocarpus* has often been confused with *E. granulatus* Fr. That species, however, has a rose to rose-brown inner peridium in cross-section in contrast to the white inner peridium of *E. leucocarpus*.

Specimens examined: Artvin: Arhavi, in a mixed stand of *Alnus glutinosa*, *Picea orientalis*, *Salix coprea*, *Rhododendron ponticum*, and *Fagus orientalis*, 28 May 2013, Michael Castellano T36262; Trabzon: Sürmene, Çamburnu, in a mixed stand of *Quercus* sp., *Corylus* sp., *Pinus sylvestris*, *Rhododendron ponticum*, and *Fagus orientalis*, 27 October 2013, Türkoğlu AT-2181; Tekirdağ: Saray, Çayırdere District, under *Pinus nigra*, 21 January 2014, Türkoğlu AT-2222; Tekirdağ: Saray, Bahçeköy, under *Pinus nigra*, 20 March 2014, Türkoğlu AT-2291.

3.1.2. *Elaphomyces muricatus* Fr.

Syn: *Ceraunium muricatum* (Fr.) Wallr.

Elaphomyces variegatus Vittad.

Lycoperdastrum variegatum (Vittad.) Kuntze

Ascocarp 1–2 cm broad, enclosed in a husk of mycorrhizae and fine roots, subglobose to slightly flattened or irregular, the surface covered by yellow-brown to dark red-brown,

polygonal, pointed, tall warts (Figure 2a). Inner layer leathery, grayish brown to dark blackish brown, marbled with pallid veins. Gleba with pale rose to gray-rose veins at first, later becoming filled with a very dark brown, powdery spore mass. Peridium 900–1100 μm thick, 2-layered: outer layer 150–200 μm thick, of yellow-brown to red-brown tissue that forms the warts partially embedded in a brown matrix of hyaline, parallel, agglutinated hyphae, 3.5–7 μm broad, walls 2 μm thick; inner layer 800–900 μm thick, of septate, hyaline, interwoven hyphae, 6–8 μm broad, walls ± 1 μm thick. Gleba of cottony, septate hyphae, 2–3 μm broad, walls ≤ 1 μm thick, filled with spores at maturity. Asci 50–65 μm broad, subglobose to irregular. Ascospores globose, 24–32 μm (mean = 27.6 μm), excluding ornamentation of dark red-brown, slightly curved rods or spines up to 2.6 μm tall (Figure 2b).

Specimens examined: Artvin: Arhavi, in a mixed stand of *Alnus glutinosa*, *Picea orientalis*, *Salix coprea*, *Rhododendron ponticum*, and *Fagus orientalis*, 28 May 2013, Michael Castellano T36260; Karabük: Eskipazar–Mengen road, in a mixed stand of *Quercus* sp., *Pinus sylvestris*, and *Fagus orientalis*, 9 November 2013, Türkoğlu AT-2192.

3.2. Helvellaceae Fries

3.2.1. *Picoa juniperi* Vittad.

This species was previously presented by Türkoğlu and Castellano (2013).

Specimens examined: Kayseri: Bünyan, 6 June 2014, Mustafa Demir AT-2392.

3.2.2. *Picoa lefebvrei* (Pat.) Maire

Syn: *Phaeangium lefebvrei* Pat.

Ascocarp 2–4 cm broad, globose to subglobose; surface pale yellow-brown to yellow-brown, nearly smooth to covered with scattered to numerous, irregular warts, 0.5–2 mm broad and 0.5–1 mm tall, subtomentose (Figure 3a).

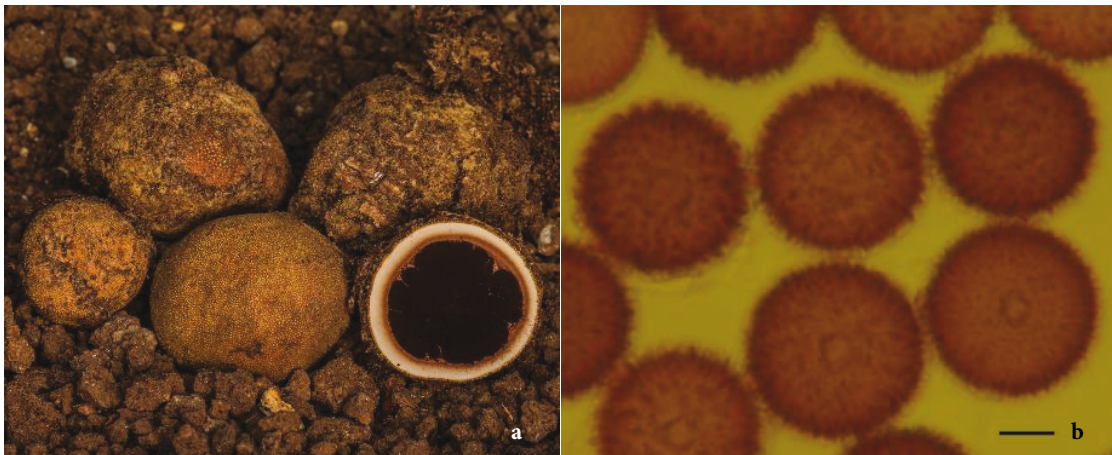


Figure 1. Macroscopic and microscopic appearance of *Elaphomyces leucocarpus*: a- ascocarp, b- ascospores. Scale bar: b = 10 μm .

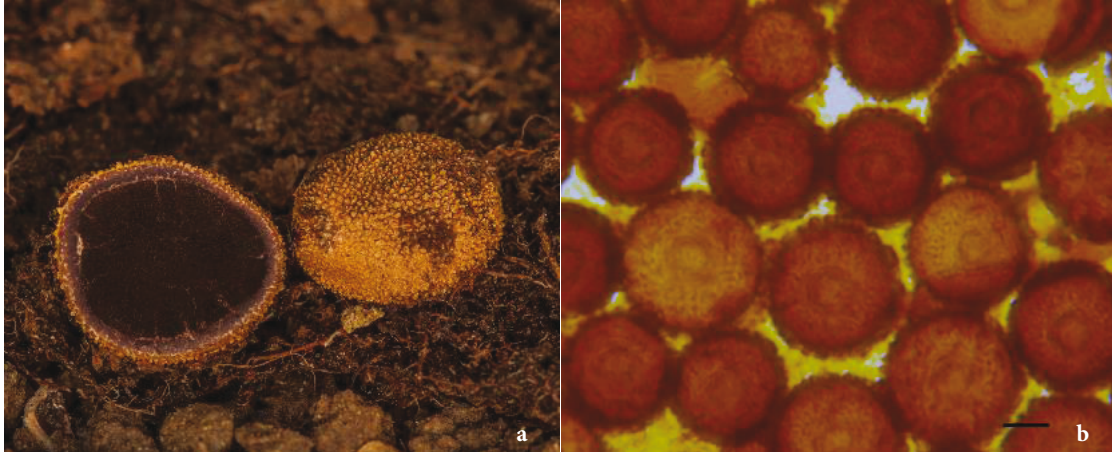


Figure 2. Macroscopic and microscopic appearance of *Elaphomyces muricatus*: a- ascocarp, b- ascospores. Scale bar: b =10 μ m.

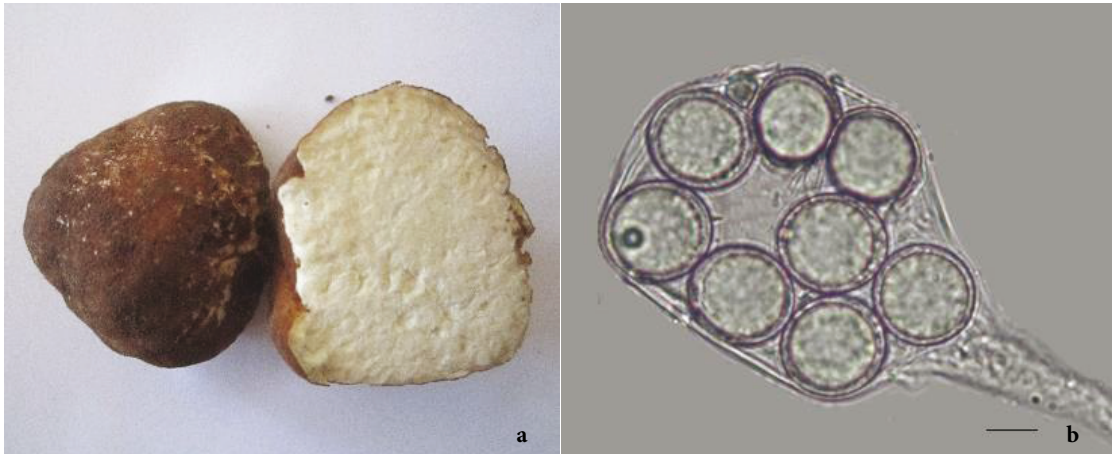


Figure 3. Macroscopic and microscopic appearance of *Picoa lefebvrei*: a- ascocarp, b- ascospores within an ascus. Scale bar: b =10 μ m.

Gleba off-white to pale yellow, marbled with irregular, pale yellow veins. Peridium 440–580 μ m thick, 2-layered: outer layer 100–130 μ m thick, off-white to yellow-brown, of angular cells, 25–30 $\times$ 15–20 μ m, walls 2 μ m thick, surface cells red-brown, sometimes towards the outside bearing prominent, septate, yellow-brown, smooth or granulated hairs, 90–150 μ m tall, up to 12 μ m broad, walls 2 μ m thick; inner layer 340–450 μ m thick, of hyaline, parallel to interwoven hyphae, 5.5–12.5 μ m broad, walls 2 μ m thick. Gleba of hyaline, parallel hyphae, 7–11.5 μ m broad, walls $\pm$ 1 μ m thick. ASCI formed in fertile pockets in the gleba, 130 $\times$ 90 μ m, subglobose with a stem up to 30 μ m long, walls 2 μ m thick, 8-spored. Ascospores broadly ellipsoid to globose, 21–24 $\times$ 22–27 μ m, mean = 21.9 $\times$ 24.2 μ m, walls $\pm$ 1 μ m thick, hyaline at first, then pale olive, with a large guttule filling entire spore, ornamentation of minute, rounded warts (Figure 3b).

Specimens examined: Elazığ, Urfa (Gücin et al., 2010); Denizli: Bozkurt, İnceler, 08 April 2013, *Türkoğlu* AT-1915; Konya: Akşehir, 24 April 2013, *Murat Kılıç* AT-2024; Aksaray: 26 April 2013, *Seyyit Ahmet Akay* AT-2076.

Comments: Our specimens closely match the description by Alsheikh and Trappe (1983).

3.3. Pyronemataceae Corda

3.3.1. *Geopora cooperi* Harkn.

Syn: *Geopora cooperi* Harkn., Bull. f. *cooperi*

Geopora cooperi f. *gilkeyae* Burds.

Geopora gilkeyae (Burds.) Guevara, Göker & Stielow

Ascocarps 2–5 cm broad, irregularly subglobose, surface tomentose, brown to dark brown (Figure 4a). Gleba off-white, of infolded and convoluted tramal veins with a hymenial palisade on exposed surfaces. Peridium 360–500 μ m thick, 3-layered: outer layer 100–130 μ m thick, of yellow-brown to red-brown, mycelial hyphae, 11–13 μ m

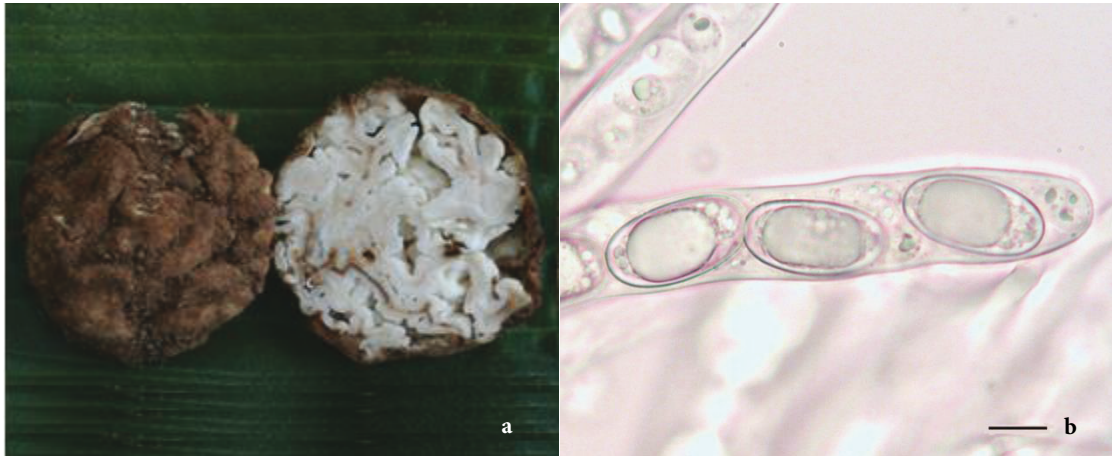


Figure 4. Macroscopic and microscopic appearance of *Geopora cooperi*: a- ascocarp, b- ascospores within an ascus. Scale bar: b =10 μ m.

broad, walls ± 2 μ m thick, encrusted and incorporating substrate particles; middle layer 130–180 μ m thick, of hyaline, subglobose or angular cells, 15–25 $\times$ 20–50 μ m, walls ± 2 μ m thick; inner layer 130–180 μ m thick, of hyaline, parallel hyphae, 2.5–4 μ m broad, sometimes inflated up 11 μ m, walls 1 μ m thick. Asci in a hymenial palisade, 160–190 μ m long $\times$ 15–22 μ m broad, cylindrical, operculate, walls 2 μ m thick, 8-spored. Paraphyses hyaline, septate, cylindrical, 4.5–11 μ m broad, walls ± 1 μ m thick. Ascospores broadly ellipsoid, 10–13 $\times$ 20–26 μ m, mean = 11.7 $\times$ 21.5 μ m, hyaline, rounded at the apex (Figure 4b).

Specimens examined: İzmir (Solak et al., 2003); Bolu: Kartalkaya, 11 November 2012, *Türkoğlu* AT-1597; Denizli, Serinhisar, Kefe Plateau, 14 May 2013, *Niyazi Uluçoban* AT-2102; Burdur: Bucak, Beşkonak village, 12 November 2013, *Türkoğlu* AT-2199; Burdur: Bucak, Beşkonak village, 21 April 2014, *Türkoğlu* AT-2305; Muğla: Ula, 30 April 2014, *Türkoğlu* AT-2305; Denizli: Çivril, 21 May 2014, *Niyazi Uluçoban* AT-2358.

3.3.2. *Genea sphaerica* Tul. & C. Tul.

Syn: *Genea sphaerica* f. *lobulata* Mor.-Arr., J. Gómez & Calonge

Genea sphaerica Tul. & C. Tul. f. *sphaerica*

Genea sphaerica var. *lazzarii* G. Gross

Genea sphaerica Tul. & C. Tul. var. *sphaerica*

Ascocarp 10–15 mm broad, globose, very regular in form; surface glabrous, black-brown, with pyramidal to angular warts (Figure 5a). Gleba chamber much folded and convoluted, lined with an epithecium similar to the ascocarp surface. Peridium 300–450 μ m thick, 3-layered: outer layer 150–200 μ m thick, of dark red-brown, angular cells, 20–50 $\times$ 40–70 μ m, walls 2.2–6.5 μ m thick; middle layer 80–100 μ m thick, off-white, of angular cells, 10–20 $\times$ 20–45 μ m, walls 2 μ m thick; inner layer 100–150 μ m thick, off-white, of interwoven hyphae, 2.5–6.5 μ m broad, walls ± 1 μ m thick; epithecium structure similar to that of the peridium. Asci in a hymenial palisade embedded beneath the epithecium, 190–220 μ m long $\times$ 17–30 μ m



Figure 5. Macroscopic and microscopic appearance of *Genea sphaerica*: a- ascocarp, b- ascospores. Scale bar: b =10 μ m.

broad, cylindrical, broadly rounded at the apex, abruptly narrowed at the base as a short stalk, walls 2 μm thick, 8-spored. Paraphyses hyaline, cylindrical, 2.5–9 μm broad, walls 1 μm thick. Ascospores ellipsoid, 17–22 $\times$ 22–32 μm , mean = 19.2 $\times$ 27.9 μm , excluding ornamentation of hyaline at first, pale yellowish when mature, rounded-hemispheric to sometimes flask-shaped warts, 2.5–3.5 μm broad (Figure 5b).

Specimens examined: İzmir: under mixed stand of *Pinus nigra* and *Quercus cerris*, 15 June 2013, Zülal Totan, AT-2131.

3.4. Terfeziaceae Dumort.

3.4.1. *Terfezia arenaria* (Moris) Trappe

Syn: *Tuber arenaria* Moris

Ascocarps 3–6 cm broad, globose to subglobose, surface off-white at first, later yellow-brown, finally dark brown (Figure 6a). Gleba off-white at first, later with grayish pockets of fertile tissue separated by irregular, off-white, sterile veins. Peridium 400–450 μm thick, of hyaline, parallel hyphae, 6.5–11 μm broad, walls 1 μm thick, mixed with subglobose or elongate cells, inflated up to 50 μm broad, walls 4 μm thick. Gleba of hyaline, parallel hyphae, 6.5–11 μm broad, walls $\pm$ 1 μm thick. Asci randomly dispersed in the gleba, 75–90 μm long $\times$ 65–80 μm broad, globose to ellipsoid, walls $\pm$ 2 μm thick, 8-spored. Ascospores globose, 16–18 $\times$ 17–19 μm , mean = 17.4–17.5 μm , excluding ornamentation of truncate-conical or rounded warts, 4.5–6 $\times$ 5.5–6 μm , pale brown or yellow-brown to dark brown, (Figure 6b).

Specimens examined: Konya (Öder, 1988; Kaşık et al., 1998); Malatya (İşiloğlu and Öder, 1995); Isparta (Afyon, 1996); Aydın: Çine, Güney, under *Asphodelus aestivus*, 04 May 2008, Mehmet Halil Solak AT-2084.

3.4.2. *Terfezia claveryi* Chatin

Ascocarps 4–6 cm broad, globose to subglobose, surface off-white at first, later red-brown, finally dark red-brown

or black-brown, much wrinkled when mature (Figure 7a). Gleba off-white at first, later pale yellow with distinct sterile veins. Peridium 450–600 μm thick, off-white to pale yellow with a narrow brown zone at the surface; surface hyphae with pale brown walls, 13–17 μm broad, mixed with cells inflated up to 50 μm broad, walls $\pm$ 1 μm thick. Gleba of hyaline, parallel hyphae, 7–12 μm broad, walls $\pm$ 1 μm thick. Asci randomly dispersed in the gleba, 60–80 $\times$ 50–70 μm , globose-ellipsoid, walls $\pm$ 2 μm thick, 8-spored. Ascospores globose, 16–18 $\times$ 16–19 μm , mean = 17.3–17.4 μm , excluding ornamentation of hyaline to pale brown, irregular reticulation, walls 3 μm tall and 2 μm thick (Figure 7b).

Specimens examined: Denizli: Bozkurt 29 April 2012, Türkoğlu AT-1431; Denizli: Bozkurt, 08 April 2013, Türkoğlu AT-1927; Urfa: Viranşehir, 13 April 2013, İdris Şener AT-1937; Konya: Akşehir, 19 April 2013, Murat Kılıç AT-1993; Konya: Ereğli, 24 April 2013, Coşkun Bilgi AT-2043; Aksaray: 26 April 2013, Seyit Ahmet Akay AT-2064; Diyarbakır: Çınar, Bağaçık village, 27 April 2013, Abdulkadir Şimşek AT-2086; Karaman: Ayrancı, Börecik village, 28 April 2013, Ekrem Toprak AT-2090; Yozgat: 30 April 2013, Duran Çelik AT-2170.

3.5. Tuberaceae Dumort.

3.5.1. *Tuber aestivum* Vittad.

Ascocarps 2–8 cm broad, globose to subglobose, the surface black-brown, with 4–6-sided, polygonal warts, 1–2 mm broad, usually with tiny grooves radiating from center (Figure 8a). Gleba initially off-white, by maturity brown marbled with off-white to brownish veins. Peridium 220–530 μm thick, with 2 layers: outer layer 100–150 μm thick, of hyaline, angular cells, 20–30 $\times$ 5–10 μm , walls $\pm$ 2 μm thick; inner layer 110–480 μm thick, of hyaline to pale yellow, interwoven hyphae, 2.5–6 μm broad, walls $\pm$ 1 μm thick. Gleba of hyaline, interwoven hyphae 2.5–4.5 μm

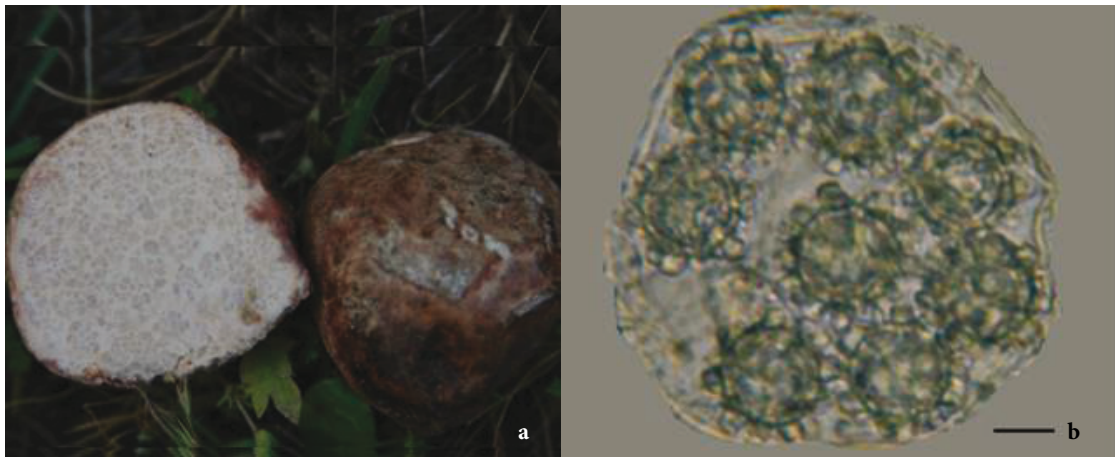


Figure 6. Macroscopic and microscopic appearance of *Terfezia arenaria*: a- ascocarp, b- ascospores within an ascus. Scale bar: b = 10 μm .

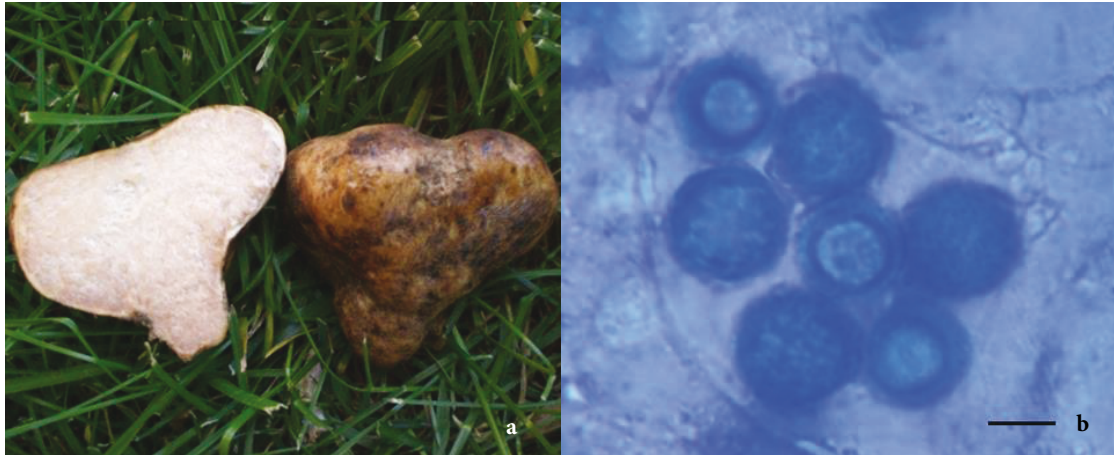


Figure 7. Macroscopic and microscopic appearance of *Terfezia clavaryi*: a- ascocarp, b- ascospores. Scale bar: b = 10 μ m.

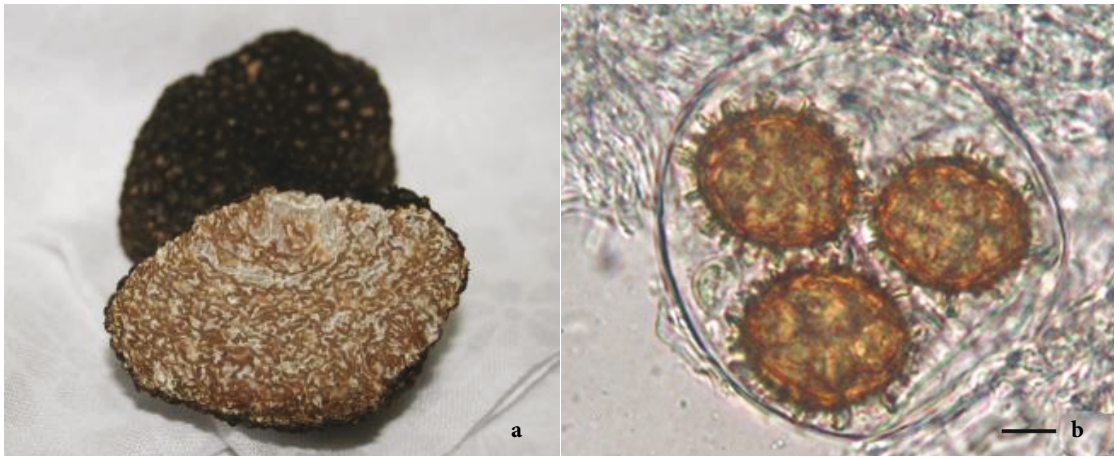


Figure 8. Macroscopic and microscopic appearance of *Tuber aestivum*: a- ascocarp, b- ascospores within an ascus. Scale bar: b = 10 μ m.

broad, walls ± 1 μ m thick. Asci 60–90 μ m long $\times$ 50–70 μ m broad, saccate to short-pedicellate, walls ± 3 μ m thick, 1–6-spored. Ascospores ellipsoid to broadly ellipsoid, (15–) 18–20 (–25) $\times$ (22–) 24–31 (–48) μ m, mean = 20.5 $\times$ 29.3 μ m, excluding ornamentation, yellowish-brown, in 1-spored asci 20–25 $\times$ 26–29 μ m, 2-spored 22–25 $\times$ 31–40 (–44) μ m, 3-spored 20–23 $\times$ 22–28 μ m, 4-spored (15–) 18–20 $\times$ 26–28 (–48) μ m, 5-spored 18–20 $\times$ 26–31 μ m, 6-spored 18–20 $\times$ 24–26 μ m, ornamentation of a coarse reticulum, up to 3–5 μ m tall, with 3–5 irregular, polygonal meshes along the spore axis (Figure 8b).

Specimens examined: Denizli: Honaz, 04 June 2010, *Türkoğlu* AT-1182; Denizli: Bozkurt, 06 June 2010, *Türkoğlu* AT-1245; Denizli: Çal, 15 July 2010, *Türkoğlu* AT-1313; Denizli: Acıpayam, Şahman Plateau, 15 July 2010, *Türkoğlu* AT-1335; Muğla: 12 April 2012, *Türkoğlu* AT-1424; Muğla: 25 January 2013, *Türkoğlu* AT-1899;

İzmir: Seferihisar, 11 April 2013, *Cemhan Bucak* AT-1935; Denizli: Çal, Çökelez mountain, 14 May 2013, *Niyazi Uluçoban* AT-2113; Hatay: İskenderun, 05 June 2013, *Uğur Demirbilek* AT-2117; Burdur: Bucak, 06 June 2013, *Osman Çoban* AT-2120; Burdur: Bucak, 20 June 2013, *Osman Çoban* AT-2145; Antalya: Korkuteli, 20 June 2013 *Mustafa Turunçoğlu* AT-2146; Antalya: Korkuteli, 15 July 2013, *Mustafa Turunçoğlu* AT-2163; İstanbul: Çatalca, İstiranca mountain, 28 August 2013; *Kadir Ceryan*, AT-2168; Kırklareli: Kofçaz, 8 September 2013, *Türkoğlu* AT-2169; Ordu: Fatsa, 23 October 2013, *Mehmet Yücel* AT-2171; Bolu: Mengen, Ahmetler village, 1 November 2013, *Tolga Keser* AT-2173; Artvin, 30 December 2013, *Türkoğlu* AT-2219; Muğla: Fethiye, Gökben village, 2 February 2014, *Türkoğlu* AT-2224; Muğla: Fethiye, Çenger village, 15 March 2014, *Türkoğlu* AT-2261; Muğla: Ula, 30 April 2014, *Türkoğlu* AT-2323; Muğla: Fethiye, Arsaköy village,

18 May 2014, *Türkoğlu* AT-2351; Denizli: Çivril, 21 May 2014, *Türkoğlu* 2356; Antalya: Akseki, 31 May 2014, *Esra Er* AT-2371; Muğla: Dalaman, Darıyeri village, 31 May 2014 *Türkoğlu* 2374; Osmaniye: Kartepe, 3 June 2014, *Kadir Bazlıca* AT-2382; Düzce: Cumayeri, 4 June 2014, *Mehmet Metin* AT-2384.

3.5.2. *Tuber rufum* Pico.

Syn: *Oogaster rufus* (Picco) Corda

This species was previously presented by Türkoğlu and Castellano (2013).

Specimens examined: Burdur: Bucak, 22 July 2013, *Osman Çoban* AT-2167; 1 November 2013, *Osman Çoban* AT-2174; Bolu: Mengen, Ahmetler village, 9 November 2013, *Türkoğlu* AT-2188; Muğla: Fethiye, Çenger village, 9 March 2014, *Türkoğlu* AT-2254; Aydın: Kuyucak, İğdecik village, 19 March 2014, *Türkoğlu* AT-2290; Osmaniye: Zorkun plateau, under mixed stand of *Quercus cerris*, *Pinus nigra*, and *Pinus brutia*, *Fatih Kaya* AT-2301; Burdur: Bucak, 30 April 2014, *Osman Çoban* AT-2318; Denizli: Serinhisar, Yatağan, 8 May 2014, *Niyazi Uluçoban* AT-2331; Denizli: Baklan, 18 May 2014, *Niyazi Uluçoban* AT-2354.

3.5.3. *Tuber nitidum* Vittad

Syn: *Oogaster nitidus* (Vittad.) Corda

Tuber rufum f. *nitidum* (Vittad.) Montecchi & Lazzari

This species was previously presented by Türkoğlu and Castellano (2013).

Specimens examined: Burdur: Bucak, 1 November 201, *Osman Çoban* AT-2174; Denizli: Serinhisar, Yatağan district, 17 March 2014, *Niyazi Uluçoban* AT-2278; 21 March 2014, *Niyazi Uluçoban* AT-2293.

Basidiomycetes

3.6. Albatrellaceae Nuss

3.6.1. *Leucogaster nudus* (Hazsl.) Hollós

Syn: *Hydnangium nudum* Hazsl.

Leucogaster floccosus R. Hesse

Basidiocarp 1.5–3 cm broad, subglobose to irregularly lobed, surface pubescent, off-white at first with yellow patches, later developing red-brown stains (Figure 9a). Gleba off-white to pale olive-brown with globose to angular, locules empty, 0.5–1.5 mm broad. Peridium 220–520 µm thick, 2-layered: outer layer 60–80 µm thick, of brown to yellow-brown, periclinal hyphae, 4.5–6.5 µm broad, walls 2 µm thick, with adhering crystalline structures; inner layer 160–440 µm thick, of hyaline, parallel to interwoven hyphae 2.5–7 µm broad, walls ±1 µm thick. Trama 50–90 µm wide, of white to pale, subparallel to interwoven hyphae, 2.5–4.5 µm broad, walls ±1 µm thick. Basidia not rehydrating. Spores enclosed in a hyaline, smooth, thin-walled episporal membrane, globose to subglobose, 13.2–15.8 × 13.2–17.5 µm, mean 14.1 × 14.9 µm, hyaline to pale yellow, ornamentation a reticulum, 1 µm tall (Figure 9b).

Specimens examined: Çankırı: Ilgaz Mountain (Pilat 1937); Kastamonu: Küre, under *Abies nordmannia* var. *bornmulleriana* and *Fagus orientalis*, 15 June 2013, *Serkan Sevinç* AT-2129.

3.6.2. *Leucogaster tozzianus* (Cavara & Sacc.) Mattir. ex Zeller & C.W. Dodge

Syn: *Endogone tozziana* Cavara & Sacc.

Basidiocarp 0.5–1 cm broad, subglobose, surface off-white with some yellow tones in patches or streaks and scattered black thin and short fibrils (Figure 10a). Gleba very pale yellow with white tramal walls, locules empty, 0.5–1 mm broad, globose to angular. Peridium 150–220 µm thick, 2-layered: outer layer 60–100 µm thick, of yellow-brown to orange, periclinal hyphae, 4.5–7 µm broad, walls 2 µm thick, with adhering crystalline structures; inner layer 90–200 µm thick, of hyaline, parallel to interwoven hyphae, 3.5–4.5 µm broad, walls ±1 µm thick. Trama 40–80 µm wide, of hyaline, gelatinized, interwoven hyphae 2.5–3 µm broad, walls ±1 µm thick. Basidia not rehydrating. Spores

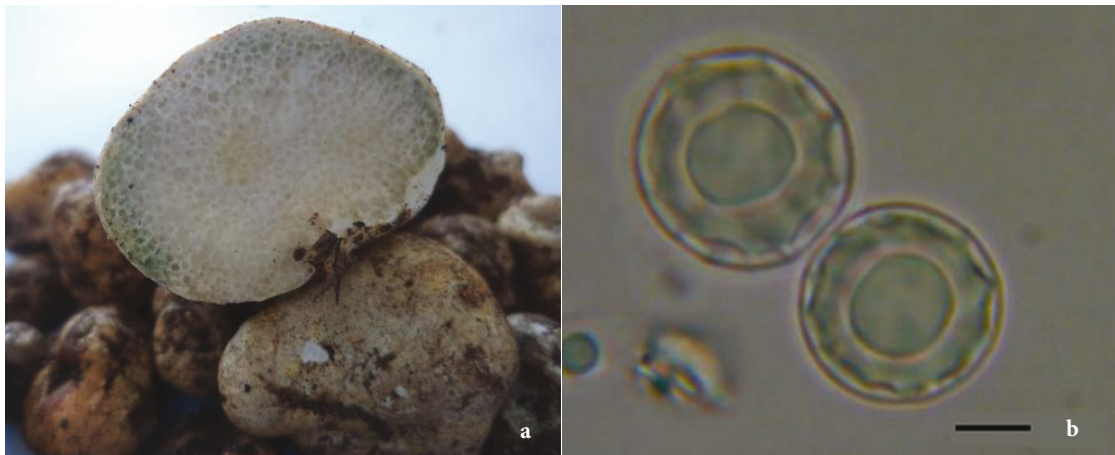


Figure 9. Macroscopic and microscopic appearance of *Leucogaster nudus*: a- basidiocarp, b- basidiospores. Scale bar: b = 10 µm.

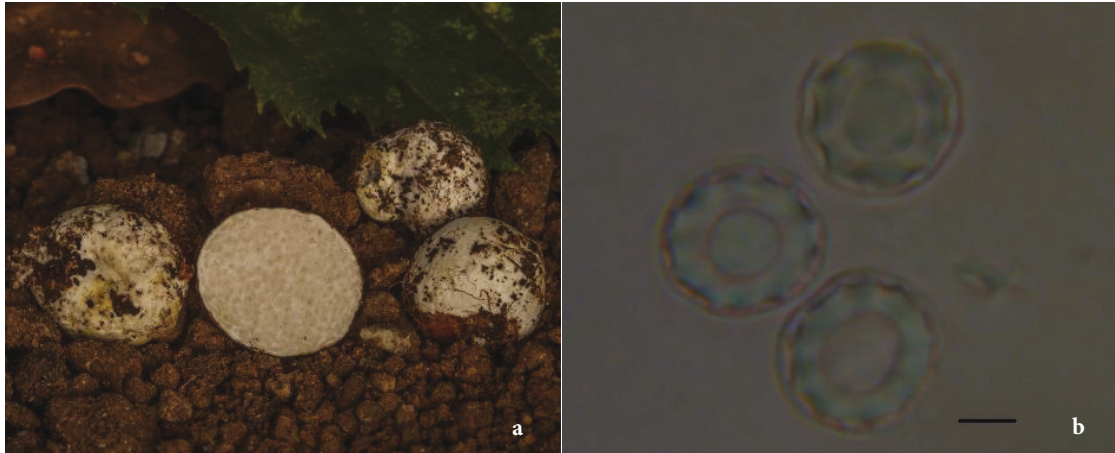


Figure 10. Macroscopic and microscopic appearance of *Leucogaster tozzianus*: a- basidiocarp, b- basidiospores. Scale bar: b = 10 μ m.

enclosed in a hyaline, smooth, thin-walled, episporal membrane, globose, 9.7–11.4 $\times$ 9.7–11.4 μ m, mean 10.1 $\times$ 10.4 μ m, excluding reticulate ornamentation, 1–2 μ m tall, walls 2 μ m thick (Figure 10b).

Specimens examined: Kastamonu: Daday, Ballıdağ, under *Abies nordmannia* var. *bornmulleriana*, *Pinus sylvestris*, and *Fagus orientalis*, 26 May 2013, Michael Castellano T36239; Trabzon: Sürmene, Region 245, under *Fagus orientalis*, *Picea orientalis*, *Castanea sativa*, and *Rhododendron ponticum*, 28 May 2013, Michael Castellano T36255, T36256; Veysel Kodalak T3658.

3.7. Boletaceae Chevall.

3.7.1. *Octaviania asterosperma* Vittad.

Syn: *Arcangeliella asterosperma* (Vittad.) Zeller & C.W. Dodge

Basidiocarp 0.6–1.5 cm broad, subglobose to oblong or lobate, surface finely felty, off-white at first, then staining

dark violet to black when handled, with a cluster of small concolorous rhizomorphs at the base (Figure 11a). Gleba with pale brown locules, 0.5–1 mm broad, irregularly shaped, filled with spores, separated by white tramal veins. Peridium 100–200 μ m thick, 2-layered: outer layer 30–60 μ m thick, of yellow-brown, loosely interwoven, granulated hyphae, 4.5–11 μ m broad, walls 2 μ m thick; inner layer 70–140 μ m thick, of hyaline, parallel hyphae, 2.5–9 μ m broad, inflated up to 22 μ m, walls $\pm$ 1 μ m thick. Trama 40–60 μ m wide, of parallel to interwoven hyphae, 3.5–9 μ m broad, walls $\pm$ 1 μ m thick. Basidia hyaline, clavate, 5–10 $\times$ 20–40 μ m, with 2 sterigmata and 5 μ m tall. Spores globose to subglobose, (8.8–) 10.5–11.4 $\times$ 10.5–11.4 (12.3) μ m; mean 10.5 $\times$ 11.1 μ m, excluding ornamentation of pale yellow to yellow-brown, pyramidal-conical warts, 2–3.5 μ m long and 2.5–3.5 μ m wide (Figure 11b).

Specimens examined: Ordu: Ünye, Çaybaşı, under pure *Fagus orientalis*, 27 May 2013, Michael Castellano

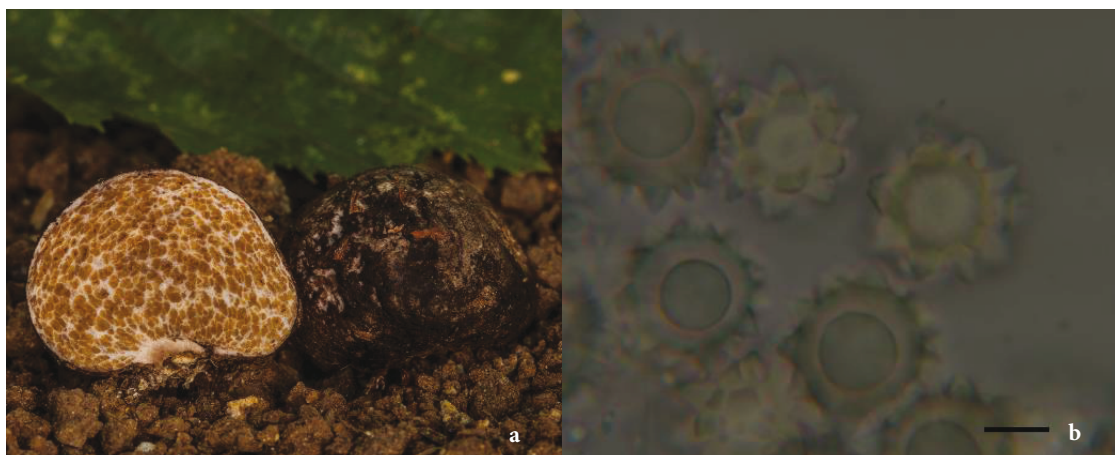


Figure 11. Macroscopic and microscopic appearance of *Octaviania asterosperma*: a- basidiocarp, b- basidiospores. Scale bar: b = 10 μ m.

T36249; Trabzon: Sürmene, Region 245, under *Fagus orientalis*, *Picea orientalis*, *Castanea sativa*, *Rhododendron ponticum*, and *Alnus glutinosa*, 28 May 2013, Michael Castellano and Aziz Türkoğlu T36254, T36257, T36259; Artvin: Arhavi, Arılı, in a mixed stand of *Alnus glutinosa*, *Picea orientalis*, *Salix coprea*, *Rhododendron ponticum*, and *Fagus orientalis*, 27 October 2013 Türkoğlu AT-2177-b; Trabzon: Sürmene, Aksu village, under *Fagus orientalis*, *Picea orientalis*, *Castanea sativa*, and *Rhododendron ponticum*, 27 October 2013, Türkoğlu AT-2180b; Trabzon: Sürmene, Çamburnu, in a mixed stand of *Quercus* sp., *Corylus* sp., *Pinus sylvestris*, *Rhododendron ponticum*, and *Fagus orientalis*, 29 October 2013, Türkoğlu AT-2184.

3.8. Cortinariaceae R. Heim

3.8.1. *Protoglossum aromaticum* (Velen.) J.M. Vidal

Syn: *Hymenogaster aromaticus* Velen., České Houby
Basidiocarp 1–2.5 cm broad, subglobose to ellipsoid, surface silky to felty-fibrillose, with various mixtures of lilac and pale yellow to yellow-brown with some brown stains in age, with a distinct base (Figure 12a). Gleba at maturity cinnamon, locules irregular, empty; columella lacking. Peridium 300–400 µm thick, off-white to pale yellow, 1-layered, of hyaline, subparallel to interwoven hyphae, 3.5–7 µm broad, walls ±1 µm thick. Trama 60–90 µm wide, of hyaline, interwoven hyphae, 5.5–7 µm broad, walls ±1 µm thick, with some inflated cells 8–10 × 13–20 µm. Basidia 5–8 × 20–25 µm, clavate, hyaline, walls 1 µm thick, 2-spored; sterigmata hyaline, 4–5 µm tall. Spores ellipsoid, 5.2–7.8 × 9–12 µm, mean 6.8 × 10.2 µm, including ornamentation of small, red-brown warts, with a hyaline pedicel, 1–2 µm long (Figure 12b).

Specimens examined: Kastamonu: Daday, Ballıdağ, Soğucakova District, under *Abies nordmanniana* var. *bornmulleriana*, *Pinus sylvestris*, and *Fagus orientalis*, 26 May 2013, Michael Castellano and Aziz Türkoğlu T36238;

Artvin: Kafkasör, Region 47, under *Fagus orientalis*, *Populus tramula*, *Rhododendron ponticum*, and *Picea orientalis*, 29 May 2013, Michael Castellano and Aziz Türkoğlu T36264–T36265–T36266; Ankara: Çamlıdere, under mixed stand of *Pinus nigra* and *Quercus* spp., 25 May 2014, Ahmet Öksüzoğlu AT-2370.

3.9. Hysterangiaceae E. Fisch.

3.9.1. *Hysterangium clathroides* Vittad.

Syn: *Hysterangium cistophilum* (Tul.) Zeller & C.W. Dodge, Ann.

Hysterangium clathroides var. *cistophilum* Tul. & C. Tul.

Hysterangium clathroides Vittad. var. *clathroides*

Hysterangium clathroides var. *mutabile* Bucholtz

Basidiocarp 0.6–1 cm broad, subglobose, indented at base, surface pubescent, red-brown to brown (Figure 13a). Gleba olive to gray-green; locules elongate, filled. Peridium 180–260 µm thick, 2-layered: outer layer 140–200 µm thick, of hyaline to golden-yellow, incrustated, filamentous hyphae, somewhat parallel to surface, 2.5–6.5 µm broad, walls ±1 µm thick, with adhering crystalline particles on outer layer; inner layer 50–70 µm thick, of hyaline, interwoven and subparallel hyphae, 4.5–9 µm broad, walls 1 µm thick. Trama 90–200 (–300) µm wide, of hyaline, interwoven hyphae in gelatinized matrix, 2–4.5 µm broad, walls ±1 µm thick. Basidia hyaline, cylindrical to clavate, 8–11 × 25–35 µm, 2-spored. Spores ellipsoid-fusiform, (4.4–) 5.3–7 (–7.9) × 16.7–23.7 µm, mean 6.0 × 18.8 µm, walls ±1 µm thick, green-brown, verrucose, apex slightly papillate, sterigmatal appendix 2.5 µm long and 2.5 µm wide (Figure 13b).

Specimens examined: Kütahya: Dörttyol District, under *Fagus orientalis* and *Pinus sylvestris*, 9 June 2013, Michael Castellano T36279; Trabzon: Sürmene, Aksu village, under *Fagus orientalis*, *Picea orientalis*, *Castanea sativa*, and *Rhododendron ponticum*, 27 October 2013, Türkoğlu AT-2180a.



Figure 12. Macroscopic and microscopic appearance of *Protoglossum aromaticum*: a- basidiocarp, b- basidiospores. Scale bar: b = 10 µm.



Figure 13. Macroscopic and microscopic appearance of *Hysterangium clathroides*: a- basidiocarp, b- basidiospores. Scale bar: b =10 μ m.

3.9.2. *Hysterangium epiroticum* Pacioni

Basidiocarp 0.4–0.6 cm broad, subglobose, surface pubescent, off-white at first, later red-brown (Figure 14a). Gleba gray-green to dark green, locules elongate, empty. Peridium 220–260 μ m thick, 3-layered: outer layer 65–80 μ m thick, of brown to yellow-brown, interwoven hyphae, 4.5–8.5 μ m broad, walls $\pm$ 1 μ m thick, hyphae generally erect and forming as a encrusted structure; middle layer 110–150 μ m thick, of hyaline to pale brown, subglobose and somewhat broadly ellipsoid cells, 10–45 μ m broad; inner layer 45–60 μ m thick, of pale brown, subparallel hyphae, 2–4.5 μ m broad, walls 1 μ m thick. Trama 100–150 μ m wide, of hyaline, interwoven hyphae in gelatinized matrix, 1–2.5 μ m broad, walls $\pm$ 1 μ m thick. Basidia not rehydrating well, hyaline, 2- or 4-spored. Spores ellipsoid-fusiform, 5.3–6.1 $\times$ 17.5–21.9 (–24.6) μ m, mean 5.9 $\times$ 21.0 μ m, wall $\pm$ 1 μ m thick, olive-green, verrucose, apex

acuminate, sterigmal appendix 2.5–3 μ m long and 1.5–2.5 μ m wide (Figure 14b).

Specimens examined: Kastamonu: Çatalzeytin, under pure *Fagus orientalis*, 26 May 2013, Michael Castellano T36246.

3.9.3. *Hysterangium fragile* Vittad.

Basidiocarp 1.5–2.5 cm broad, subglobose, indented at base with single small concolorous rhizomorph at the base, surface pubescent, off-white and pale yellow to pale yellow-brown with handing, KOH on surface yellow (Figure 15a). Gleba olive-gray, columella dendroid, 2 mm broad at the base. Peridium 450–600 μ m thick, of hyaline, 2-layered: outer layer 400–520 μ m thick, of subglobose cells, 20–30 $\times$ 45–60 μ m broad, walls 2 μ m thick; inner layer 30–80 μ m thick, of hyaline, interwoven hyphae, 4.5–11 μ m broad, walls $\pm$ 1 μ m thick. Trama 100–150 μ m wide, of hyaline, gelatinized, interwoven hyphae 2.5–5.5 μ m broad, walls $\pm$ 1



Figure 14. Macroscopic and microscopic appearance of *Hysterangium epiroticum*: a- basidiocarp, b- basidiospores. Scale bar: b =10 μ m.



Figure 15. Macroscopic and microscopic appearance of *Hysterangium fragile*: a- basidiocarp, b- basidiospores attached a basidium. Scale bar: b =10 μ m.

μ m thick. Basidia hyaline, cylindrical to subclavate, 7–10 $\times$ 25–45 μ m, 1-2-3-spored. Spores ellipsoid-fusiform, 6.1–7.0 (–8.8) $\times$ (17.5–) 18.4–24.0 μ m, mean 6.9 $\times$ 21.2 μ m, wall $\pm$ 1 μ m thick, hyaline to pale green, smooth, sterigmal appendix 1.5–2.5 μ m long and 2.5 μ m wide (Figure 15b).

Specimens examined: Kastamonu: Daday, Ballıdağ, under *Abies nordmannia* var. *bornmulleriana*, *Pinus sylvestris*, *Fagus orientalis*, 26 May 2013, Michael Castellano T36240; Kastamonu: Ağlı, Tunuslar village, Adalar District, under *Abies nordmannia* var. *bornmulleriana*, *Pinus sylvestris*, *Crategeus* sp., *Corylus cornea*, 26 May 2013, Michael Castellano T36243; Ordu: Ünye, Çaybaşı, under pure *Fagus orientalis*, 27 May 2013, Michael Castellano and Okan Kurşun T36250; Kastamonu: Küre, under *Abies nordmannia* var. *bornmulleriana* and *Fagus orientalis*, 15 June 2013, Serkan Sevinç AT-2127.

3.9.4. *Hysterangium nephriticum* Berk.

Basidiocarp 0.8–1 cm broad, subglobose, surface off-white, staining yellow-brown in areas, somewhat filamentous. Gleba olive-gray, locules irregular, filled. Peridium 250–400 μ m thick, 2-layered: outer layer 160–300 μ m thick, of hyaline, periclinal hyphae, 3–6.5 μ m broad, walls 1 μ m thick, with abundant crystalline particles; inner layer 80–100 μ m thick, of hyaline, of subglobose to irregular cells 10–20 μ m, walls 1 μ m thick (Figure 16a). Trama 50–130 μ m wide, of hyaline, gelatinized, interwoven hyphae, 2–4.5 μ m broad, walls $\pm$ 1 μ m thick. Basidia hyaline, cylindrical, 8–10 $\times$ 30–50 μ m, 2-spored. Spores ellipsoid-fusiform, 5.3–6.1 $\times$ 15.8–18 μ m, excluding sterigmal appendix, mean 5.8 $\times$ 17.5 μ m, wall $\leq$ 0.5 μ m thick, hyaline to pale brown, smooth, sterigmal appendix 2.5 μ m long and 1.5 μ m wide, perisporium wrinkled, up to 1 μ m at maturity (Figure 16b).

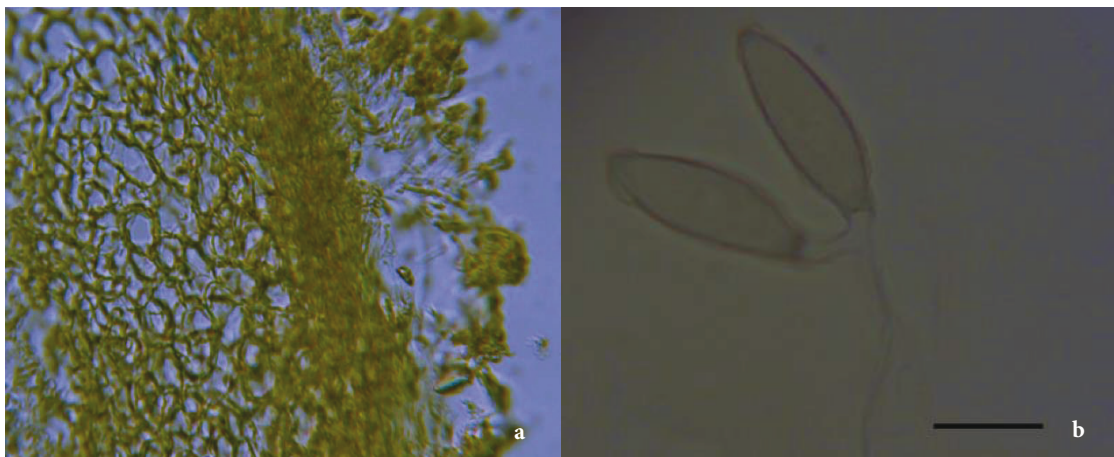


Figure 16. Microscopic appearance of *Hysterangium nephriticum*: a- peridium, b- basidiospores attached to a basidium. Scale bar: b =10 μ m.

Specimens examined: Sakarya: Sapanca, İstanbul dere mevkii, under pure *Fagus orientalis*, 23 May 2013, Michael Castellano T36282.

3.10. Gomphaceae Donk

3.10.1. *Gautieria otthii* Trog

Syn: *Gautieria graveolens* var. *otthii* (Trog) Zeller & C.W. Dodge

Basidiocarp 1–3 cm broad, subglobose to lobate or irregular, surface smooth, off-white with pale yellow patches (Figure 17a). Gleba off-white, abundant yellow-brown spores lining each locule, locules elongate to labyrinthiform, empty. Columella dendroid and gelatinized. Peridium 130–200 µm thick, of hyaline, gelatinized parallel hyphae, 4.5–7 µm broad, walls 1 µm thick. Trama 60–100 µm wide, of hyaline, gelatinized, parallel hyphae, 2.5–3.5 µm broad, walls 1 µm thick. Subhymenium of hyaline, hyphae, somewhat inflated up to 20 µm, walls 1 µm thick. Basidia 7–14 × 25–60 µm, clavate, hyaline, walls 1 µm thick, 2-spored; sterigmata 4–8 µm tall. Spores ellipsoid, 7–9.5 × 12.5–17.5 µm including ornamentation, mean 7.9 × 14.9 µm, pale yellow, ornamentation of 8–10 longitudinal ribs, rarely with warts, pedicel hyaline, 2–2.5 µm long and 1.5–2.5 µm wide (Figure 17b).

Specimens examined: Bolu: Abant, 10 November 2012, Türkoğlu AT-1596; Kastamonu: Küre, under *Abies nordmannia* var. *bornmulleriana* and *Fagus orientalis*, 15 June 2013, Serkan Sevinç AT-2128; Kastamonu: Daday, Ballıdağ, under *Abies nordmannia* var. *bornmulleriana*, *Pinus sylvestris* and *Fagus orientalis*, 10 November 2013, Gülsüm Türkoğlu AT-2194.

3.10.2. *Gautieria retirugosa* Th. Fr.

Basidiocarp 1–2 cm broad, subglobose or irregular lobate, with basally attached, thin, mycelia cords, surface smooth, off-white at first, later pale yellow (Figure 18a). Gleba off-

white, abundant yellow-brown spores lining each locule, locules labyrinthiform, empty. Peridium 220–300 µm thick, 2-layered: outer layer 90–130 µm thick, pale yellow to yellow-brown, interwoven hyphae, 4.5–6.5 µm broad, walls 1 µm thick, sometimes with inflated cells, 20–30 × 30–40 µm; inner layer 130–170 µm thick, of hyaline, parallel hyphae, 2.5–4.5 µm broad, walls 1 µm thick. Trama 70–130 µm wide, of hyaline, gelatinized, parallel hyphae, 2.5–3.5 µm broad, walls <0.5 µm thick. Subhymenium of hyaline hyphae, somewhat inflated up to 10 µm, walls <0.5 µm thick. Basidia 5–10 × 35–40 µm, clavate, hyaline, walls <0.5 µm thick, 2-spored; sterigmata 3–4 µm long. Spores ovoid to ellipsoid, 9–12 × 15–21 µm including ornamentation, mean 10.5 × 17.7 µm, pale yellow, ornamentation of 9–10 longitudinal ribs, pedicel hyaline, 2–3 µm long and 1–2 µm wide (Figure 18b).

Specimens examined: Bolu: Gerede, Sevilier, 9 November 2012, Türkoğlu AT-1591.

3.10.3. *Gautieria trabutii* (Chatin) Pat.

Syn: *Hymenogaster trabutii* Chatin

Basidiocarp 2–4 cm broad, subglobose to irregularly lobed, surface smooth, off-white at first, later pale yellow (Figure 19a). Gleba off-white, abundant yellow-brown spores lining each locule, locules elongate, 2–3 mm broad, empty. Peridium 220–440 µm thick, 2-layered: outer layer 70–90 µm thick, pale yellow to yellow, interwoven hyphae, 4.5–9 µm broad, walls 1 µm thick; inner layer 150–350 µm thick, of hyaline, loosely interwoven to parallel hyphae, 3.5–6 µm broad, walls 1 µm thick. Trama 90–180 µm wide, of hyaline, gelatinized parallel hyphae, 3.5–5.5 µm broad, walls 1 µm thick. Basidia 7–10 × 35–40 µm, clavate, hyaline, walls <0.5 µm thick, 2-spored; sterigmata 4–5 µm tall. Spores ellipsoid, 8–11 (–12.5) × 15–18 (–19.7) µm including ornamentation, mean 11.2 × 17.9 µm, yellow to yellow-brown, ornamentation of 8–10 longitudinal ribs



Figure 17. Macroscopic and microscopic appearance of *Gautieria otthii*: a- basidiocarp, b- basidiospores. Scale bar: b = 10 µm.

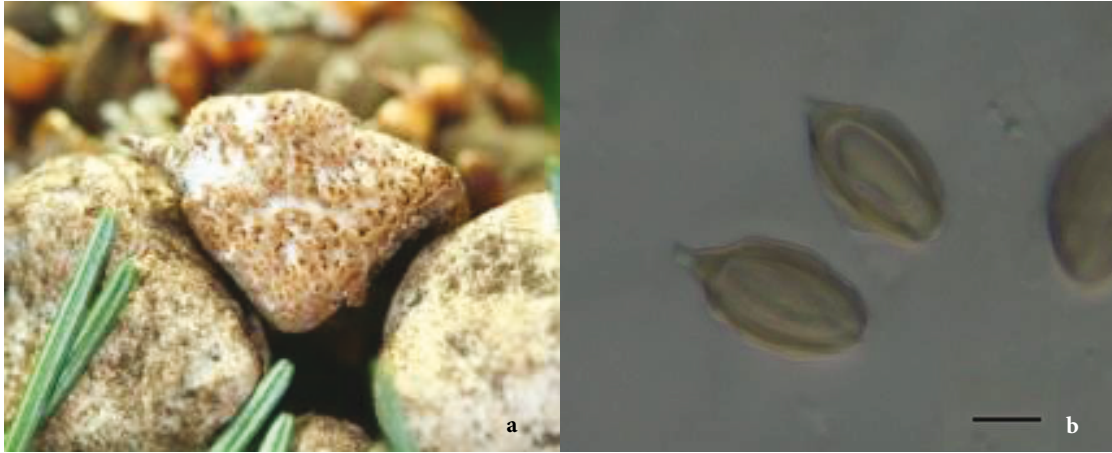


Figure 18. Macroscopic and microscopic appearance of *Gautieria retirugosa*: a- basidiocarp, b- basidiospores. Scale bar: b = 10 μ m.

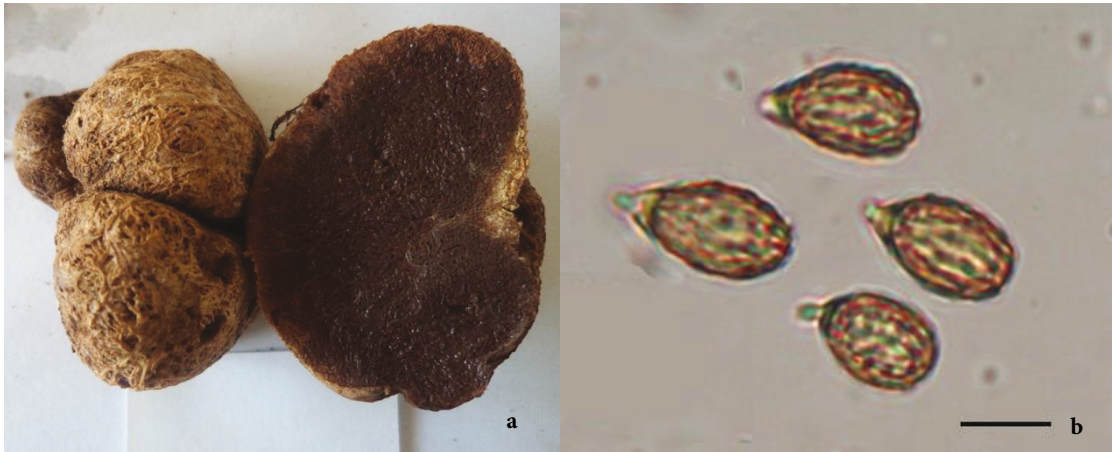


Figure 19. Macroscopic and microscopic appearance of *Gautieria trabutii*: a- basidiocarp, b- basidiospores. Scale bar: b = 10 μ m.

with several hemispherical nubs, pedicel hyaline, 2–3 μ m long and 1–2 μ m wide (Figure 19b).

Specimens examined: Burdur: Bucak, 15 July 2013, *Osman Çoban* AT-2154; Muğla: Dalaman, Darıyeri village, 31 May 2014, *Türkoğlu* AT-2375.

3.11. Strophariaceae Singer & A.H. Sm.

3.11.1. *Hymenogaster citrinus* Vittad.

Syn: *Gautieria citrina* (Vittad.) Bougher & Castellano
Basidiocarp 1–1.5 cm broad, irregularly globose, surface smooth, pale yellow at first, later yellow-brown with some dark brown patches, finally red-brown (Figure 20a). Gleba firm, pale brown at first, later red-brown, finally dark brown, locules irregular, nearly full. Peridium 150–180 μ m thick, pale yellow to yellow-brown, 2-layered: outer layer 90–100 μ m thick, of hyaline, interwoven hyphae, 5–12.5 μ m broad, walls 1 μ m thick, sometimes inflated cells 12–25 $\times$ 25–30 μ m, walls 2 μ m thick; inner layer 60–80 μ m thick,

of hyaline, parallel hyphae, 2.5–3.5 μ m broad, walls 1 μ m thick. Trama 20–40 μ m wide, of hyaline, parallel hyphae, 2.5–5 μ m broad, walls <1 μ m thick. Basidia 7–9 $\times$ 25–30 μ m, cylindrical-clavate, hyaline, walls <0.5 μ m thick, 2- or 4-spored. Spores citriform to elongate-fusoid, 11–20 $\times$ 25–32.5 (–40) μ m, including ornamentation, mean 16.6 $\times$ 31.5 μ m, hyaline at first without ornamentation, later with pale yellow to yellow ornamentation, with a smooth papilla, ornamentation of longitudinal folds, appearing somewhat ribbed, pedicel hyaline, 5 μ m long and 4–5 μ m wide (Figure 20b).

Specimens examined: Samsun: Çarşamba, Köklü village, under *Corylus* sp., 12 November 2013, *Türkoğlu* AT-1606.

3.11.2. *Hymenogaster hessei* Soehner

Syn: *Hymenogaster hessei* f. *bisporus* G. Gross, A. Runge, Winterh. & Krieglst.



Figure 20. Macroscopic and microscopic appearance of *Hymenogaster citrinus*: a- basidiocarp, b- basidiospores. Scale bar: b =10 μ m.

Hymenogaster hessei Soehner f. *hessei*

Hymenogaster hessei f. *tetrasporus* G. Gross, A. Runge, Winterh. & Krieglst.

Basidiocarp 1–2 cm broad, irregularly globose to lobed, surface wrinkled and tomentose, off-white to grayish with some brown mottling (Figure 21a). Gleba dark brown at first, later black, locules irregular, nearly full. Peridium 60–90 μ m thick, pale yellow to yellow-brown, 2-layered: outer layer 45–65 μ m thick, of hyaline, interwoven to subparallel hyphae, 9–11 μ m broad, walls 1 μ m thick, sometimes inflated to 10–20 $\times$ 30–45; inner layer 15–25 μ m thick, of hyaline, parallel hyphae, 2.5–3.5 μ m broad, walls 1 μ m thick. Trama 45–65 μ m wide, of hyaline, parallel hyphae, 3.5–7 μ m broad, walls <0.5 μ m thick. Subhymenium of hyaline hyphae, sometimes inflated up to 10 μ m, walls 1 μ m thick. Basidia 5–9 $\times$ 20–35 μ m, cylindrical-clavate,

hyaline, walls <0.5 μ m thick, 2-spored. Spores ellipsoid or ellipsoid-fusoid, 12.5–17.5 $\times$ 19–27 μ m, including ornamentation, mean 14.2 $\times$ 22.9 μ m, pale yellow with brown or red-brown ornamentation, with or without an acute, ornamentation of longitudinal folds, appearing nearly ribbed, pedicel hyaline, 1–2 μ m long and 3–4 μ m wide (Figure 21b).

Specimens examined: Kastamonu: Bozkurt, Şeyh Şaban, Orta Sökün District, under *Fagus orientalis*, *Rhododendron* sp., *Ilex* sp., 26 May 2013, Michael Castellano T36245; Kastamonu: Daday, Ballıdağ, Soğucakova mevkii, under *Abies nordmannia* var. *bornmulleriana*, 29 May 2013, Michael Castellano T36237.

3.11.3. *Hymenogaster luteus* Vittad.

Syn: *Hysterogaster luteus* (Vittad.) C.W. Dodge

Basidiocarp 0.1 cm broad, subglobose to ellipsoid, regular

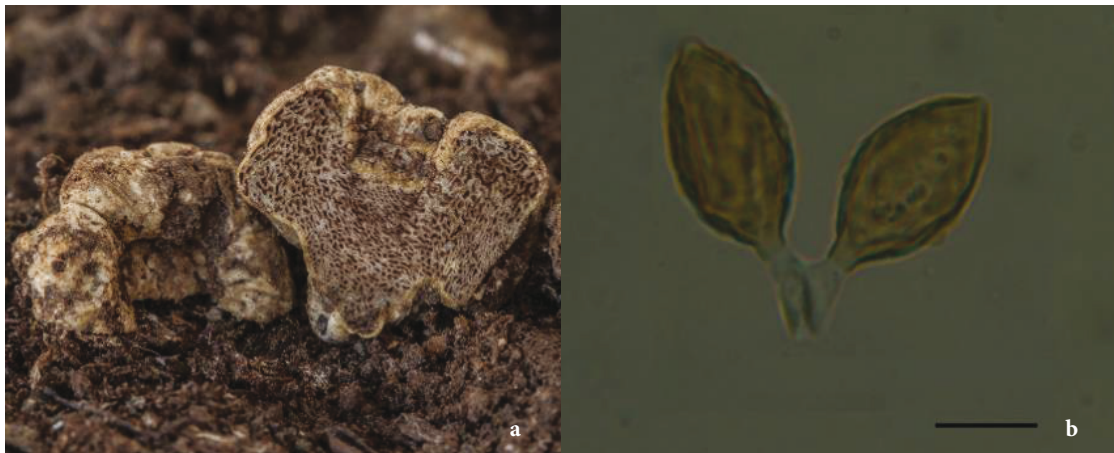


Figure 21. Macroscopic and microscopic appearance of *Hymenogaster hessei*: a- basidiocarp, b- basidiospores. Scale bar: b =10 μ m.

in shape, surface wrinkled and tomentose, off-white or gray to pale yellow (Figure 22a). Gleba green to pale yellow, dark brown, abundant pale yellow spores lining each irregularly shaped locule. Peridium 90–180 μm thick, pale yellow to yellow-brown, 1-layered, of hyaline, interwoven to parallel hyphae, 2.5–6 μm broad, walls 1 μm thick. Trama 25–45 μm wide, of hyaline, parallel hyphae, 2.5–4.5 μm broad, walls <0.5 μm thick. Subhymenium of hyaline, hyphae sometimes inflated up to 8 μm , walls <0.5 μm thick. Basidia 5–7 $\times$ 20–25 μm , cylindrical to clavate, hyaline, walls <0.5 μm thick, 2-spored; sterigmata hyaline, 3–4 μm tall. Spores ovoid to ellipsoid or fusoid, 9–12 $\times$ 12–20 μm , including ornamentation, mean 10.4 $\times$ 16.8 μm , with an acute or round apex, pale yellow, surface smooth, pedicel hyaline, 2–3 μm long and 3–4 μm wide (Figure 22b).

Specimens examined: Osmaniye: Zorkun plateau, under mixed stand of *Quercus cerris*, *Pinus nigra*, and *Pinus brutia*, 13 January 2013, *Yavuzalp Türkoğlu* AT-1872; Isparta: Eğirdir, Yukarı Gökdere, Kasnak Meşesi Koruma Alanı, under *Quercus volcanica*, 1 June 2013, *Michael Castellano* T36275-1; Yalova: Güneyköy, under mixed stand of *Quercus petraea*, *Fagus orientalis*, and *Rhododendron* sp., 21 November 2013, *Türkoğlu* AT-2202; Tekirday: Saray, Ergene District, under mixed stand of *Pinus nigra*, *Quercus* sp., and *Carpinus betulus*, 22 November 2013, *Türkoğlu* 2208; Osmaniye, Zorkun plateau, under mixed stand of *Quercus cerris*, *Pinus nigra*, and *Pinus brutia*, 6 February 2014, *Fatih Kaya* AT-2232.

3.11.4. *Hymenogaster lycoperdineus* Vittad.

Basidiocarp 0.5–1 cm broad, subglobose, lobed to irregularly shaped, surface smooth, off-white at first later brown and finally dark brown. Gleba pale brown, abundant dark brown spores lining each locule, locules irregular, nearly full. Peridium 80–150 μm thick, off-white to pale yellow, 1-layered, of hyaline, subparallel to interwoven

hyphae, 4.5–6.2 μm broad, walls 1 μm thick (Figure 23a). Trama 45–70 μm wide, of hyaline, interwoven hyphae, 3.5–8 μm broad, walls 1 μm thick. Basidia 8–10 $\times$ 20–30 μm , clavate, hyaline, walls <0.5 μm thick, 2-spored. Spores elongate-ellipsoid, 9.5–13.5 $\times$ 15.5–22 μm , including ornamentation, mean 11.1 $\times$ 18.4 μm , sometimes papillate or with rounded apex, dark brown, perisporium wrinkled, with short small folds, pedicel hyaline, 2–3 μm long and 4–5 μm wide (Figure 23b).

Specimens examined: Isparta: Eğirdir, Yukarı Gökdere, Kasnak Meşesi Koruma Alanı, under *Quercus volcanica*, 1 June 2013, *Michael Castellano* T36275-2.

3.11.5. *Hymenogaster thwaitesii* Berk. & Broome

This species was previously presented by Türkoğlu and Castellano (2013).

Specimens examined: Muğla (Türkoğlu and Castellano, 2013); Osmaniye: Zorkun plateau, under mixed stand of *Quercus cerris*, *Pinus nigra*, and *Pinus brutia*, 13 January 2013, *Türkoğlu* AT-1870; Muğla: Fethiye, Gökben village, 2 January 2014, *Türkoğlu* AT-2226; Denizli: Çivril, under *Quercus* spp., 21 May 2014, *Niyazi Uluçoban* AT-2369:

3.11.6. *Hymenogaster vulgaris* Tul. & C. Tul.

Syn: *Hymenogaster vulgaris* var. *hessei* Soehner
Hymenogaster vulgaris var. *madeirensis* Torrend
Hymenogaster vulgaris Tul. & C. Tul. var. *vulgaris*
Rhizopogon albus Berk.

This species was previously presented by Türkoğlu and Castellano (2013).

Specimens examined: Muğla (Türkoğlu and Castellano, 2013); Specimens examined: Yalova: Güneyköy, under mixed stand of *Quercus petraea*, *Fagus orientalis*, and *Rhododendron* sp., 21 November 2013, *Türkoğlu* AT-2200; Tekirday: Saray, Ergene District, under mixed stand of *Pinus nigra*, *Quercus* sp., and *Carpinus betulus*, 22 November 2013, *Türkoğlu* AT-2204.



Figure 22. Macroscopic and microscopic appearance of *Hymenogaster luteus*: a- basidiocarp, b- basidiospores. Scale bar: b = 10 μm .

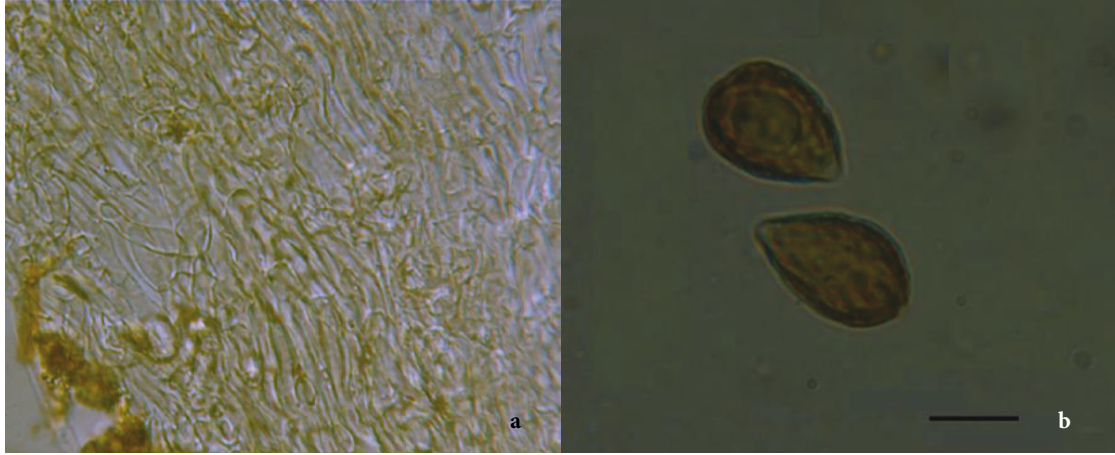


Figure 23. Microscopic appearance of *Hymenogaster lycoperdineus*: a- peridium, b- basidiospores. Scale bar: b =10 μ m.

3.12. Paxillaceae Lotsy

3.12.1. *Alpova corsicus* P.-A. Moreau & F. Rich.

Basidiocarp 1.8–2.2 cm broad, irregular to subglobose or irregularly lobed, surface finely pubescent, off-white to pale flesh or pale pink-brown, with handling darker in areas, with some dark brown rhizomorphs scattered on peridium (Figure 24a). Gleba pale yellow-brown, with off-white trama at first, later dark brown. Peridium 550–700 μ m thick, 1-layered: of pale yellow to dark red brown, interwoven hyphae, 4.5–11 μ m broad, walls 2 μ m thick, sometimes inflated up to 20 μ m broad and mixed with subglobose cells 40 $\times$ 60 μ m. Trama 40–60 μ m wide, of white to yellowish white, parallel to interwoven hyphae, 4.5–8 μ m broad, walls $\pm$ 2 μ m thick. Basidia not rehydrating. Spores ellipsoid, 1.8–2.6 $\times$ (3.5–) 5.3–6.1 μ m, mean 2.4 $\times$ 5.5 μ m, hyaline to pale greenish, smooth (Figure 24b).

Specimens examined: Artvin: Arhavi, under *Alnus glutinosa*, *Picea orientalis*, *Salix coprea*, *Rhododendron ponticum*, and *Fagus orientalis*, 28 May 2013, Michael Castellano and Aziz Türkoğlu T36261, T36263.

3.12.2. *Melanogaster broomeanus* Berk.

Syn: *Melanogaster broomeanus* Berk. var. *broomeanus*
Melanogaster broomeanus var. *pseudorubescens* Svrček
Melanogaster variegatus var. *broomeanus* (Berk.) Tul. & C. Tul.
 This species was previously presented by Türkoğlu and Castellano (2013).

Specimens examined: Artvin (Demirel 1998); Denizli (Türkoğlu and Castellano 2013); Samsun: Çarşamba, Köklü village, under *Corylus* sp., 12 November 2012, Türkoğlu AT-1599, AT-1601, AT-1605, AT-1607; Samsun: Çarşamba, Zümrüt village, under *Corylus* sp., 13 November 2012, Türkoğlu AT-1611; Kastamonu, Çatalzeytin, 26 May 2013, Michael Castellano T36247.

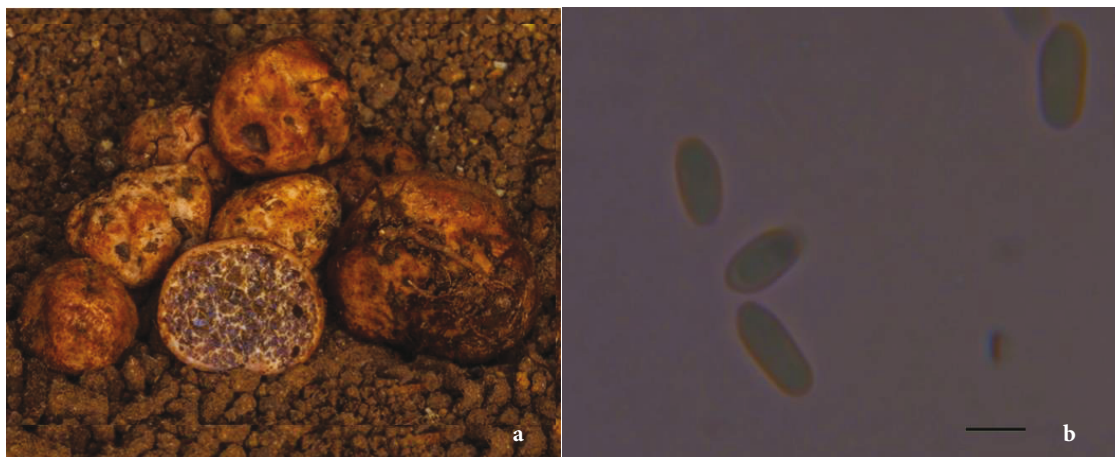


Figure 24. Macroscopic and microscopic appearance of *Alpova corsicus* : a- basidiocarp, b- basidiospores. Scale bar: b =10 μ m.

4. Discussion and conclusion

We report 3 Ascomycete and 15 Basidiomycete truffle taxa found in Turkey for the first time: *Alpova corsicus*, *Elaphomyces leucocarpus*, *E. muricatus*, *Gautieria otthii*, *G. retirugosa*, *G. trabutii*, *Genea sphaerica*, *Hymenogaster citrinus*, *H. hessei*, *H. luteus*, *H. lycoperdineus*, *Hysterangium clathroides*, *H. epiroticum*, *H. fragile*, *H. nephriticum*, *Leucogaster tozzianus*, *Octaviania asterosperma*, and *Protoglossum aromaticum*. We also report new localities within Turkey for *Geopora cooperi*, *Hymenogaster thwaitesii*, *H. vulgaris*, *Leucogaster nudus*, *Melanogaster broomeanus*, *Picoa juniperi*, *P. lefebvrei*, *Terfezia arenaria*, *T. claveryi*, *Tuber aestivum*, *T. nitidum*, and *T. rufum*. We report the genera *Alpova*, *Elaphomyces*, *Octaviania*, and *Protoglossum* for the first time from Turkey.

Elaphomyces leucocarpus has a brown to yellow-brown peridial surface with pyramidal or irregularly warts and brown ascospores, while *Elaphomyces muricatus* has a yellow-brown to dark red-brown peridial surface with fairly distinct, polygonal pointed, tall warts and dark red-brown ascospores. *Elaphomyces leucocarpus* and *E. muricatus* both occur under *Alnus glutinosa*, *Picea orientalis*, *Salix coprea*, *Rhododendron ponticum*, and *Fagus orientalis* in the Black Sea region. *Picoa lefebvrei* has a pale yellow-brown to yellow-brown peridial surface with scattered to numerous, irregular warts, while *Picoa juniperi* has a brown-black to black peridial surface with regularly arranged and uniformly distributed warts. Our material of *Geopora cooperi* has a brown to dark brown, tomentose peridial surface and matches well the characters reported by Montecchi and Sarasini (2000). *Genea sphaerica* has globose, slightly lobed ascocarps while *G. verrucosa* has irregular and very lobed-folded ascocarps. *Genea sphaerica* has spores ornamented with rounded-hemispheric warts while *G. klotzschii* and *G. verrucosa* have spores with either flask-shaped and fork-shaped warts or irregularly conical warts.

Terfezia claveryi and *T. arenaria* both have an off-white peridial surface at first but later *T. arenaria* has a yellow-brown, finally dark brown peridial surface while *T. claveryi* has a red-brown, finally dark red-brown or black-brown peridial surface. *Terfezia arenaria* has a gleba with grayish zones of fertile tissue separated by whitish veins while *T. claveryi* has a pale yellow gleba with distinct sterile veins. *Terfezia claveryi* has spores ornamented with a prominently irregular reticulation with irregular alveolae, while spores of *T. arenaria* have ornamentation consisting of verrucae that are truncate-conical or rounded. Montecchi and Sarasini (2000) reported *T. arenaria* from under *Helianthemum guttatum*, *Quercus ilex*, and *Q. suber* but our collections occurred under *Asphodelus aestivus*. *Leucogaster nudus* has a peridial surface with yellow

patches at first, later staining red-brown while *Leucogaster tozzianus* has an off-white peridial surface with some yellow spots or streaks with scattered black thin and short fibrils. *Leucogaster nudus* has a gleba with pale olive-brown, empty locules while *L. tozzianus* has a very pale yellow gleba with white tramal walls. *Leucogaster nudus* and *L. tozzianus* have similarly shaped spores but *L. nudus* has larger spores than *L. tozzianus*. *Octaviania asterosperma* and *Protoglossum aromaticum* fit well the descriptions by Montecchi and Sarasini (2000). *Hysterangium clathroides* and *H. epiroticum* have reddish brown to brown peridial surfaces and verrucose spores while *H. fragile* and *H. nephriticum* have off-white and yellowish brown peridial surfaces and smooth spores. *Hysterangium clathroides* and *H. nephriticum* have glebae with filled locules while *H. epiroticum* has empty locules. The gleba of *H. fragile* has a dendroid columella. *Hysterangium epiroticum* has a 3-layered peridium while *H. clathroides*, *H. fragile*, and *H. nephriticum* have 2-layered peridia. *Gautieria otthii* has a 1-layered peridium and small spores while *Gautieria retirugosa* and *G. trabutii* have 2-layered peridia and larger spores. *Gautieria* species have ornamented spores with longitudinal ribs. Spores of *G. otthii* have smooth ribs while the ribs of *G. trabutii* have verrucae giving a knotted aspect. *Gautieria retirugosa* has reticulated ribs at the base. *Hymenogaster citrinus* and *H. lycoperdineus* have a smooth peridial surface while *H. hessei* and *H. luteus* have a wrinkled and tomentose surface. *Hymenogaster citrinus* and *H. hessei* have 2-layered peridia while *H. luteus* and *H. lycoperdineus* have 1-layered peridia. *Hymenogaster luteus* has pale yellow, smooth spores while *H. hessei*, *H. citrinus*, and *H. lycoperdineus* have a distinct enveloping perisporium. *Hymenogaster citrinus* has large, citriform spores up to 40 µm long while the others have smaller and ellipsoid spores. The spores of *H. hessei* have a rib-like ornamentation while *H. lycoperdineus* has distinctly papillated spores.

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