

Taxonomic studies on some new fungal records from Trabzon, Turkey*

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Abstract: Basidiomes of *Alnicola subconspersa* (Kühner ex P.D. Orton) Bon, *Amanita pachyvolvata* (Bon) Krieglst., *Cortinarius azureus* Fr., *Cortinarius vernus* H. Lindstr. & Melot, *Melanogaster variegatus* (Vittad.) Tul. & C. Tul., *Paxillus ammoniavirescens* Contu & Dessi, and *Paxillus cuprinus* P. Jargeat, H. Gryta, J.P. Chaumeton & A. Vizzini were reported for the first time for the Turkish mycota from Trabzon. Plant species, possible mycorrhizal relationships, and superficial morphologic structures were noted and photos were taken in situ in the collection area. The samples were brought to the laboratory and dried for future microscopic studies. Basidiospores, cystidia, basidia, marginal cells, and pileipellis of the specimens were observed and measured. Identifications were made according to the data obtained from the collection site, morphological studies, and the current literature. Images, descriptions, and a brief discussion about the new records are provided.

Key words: Macrofungi, new records, biodiversity, Turkey

1. Introduction

Species of *Alnicola* Kühner are small, brownish, strictly ectomycorrhizal with *Alnus* Miller, and are characterized by fusiform to lanceolate cystidia with a narrow neck, warty spores, sterile gill edge, and distinctive pileipellis (Moreau, 2005; Moreau et al. 2006). Two *Alnicola* Kühner species (*Alnicola citrinella* P.A. Moreau & A. de Haan and *Alnicola suavis* (Bres.) Kühner) were reported from Trabzon before the present study (Sesli et al., 2015a).

Amanita Pers. includes both edible and poisonous species that exhibit worldwide distribution, usually as mycorrhizal symbionts with plants, and about 600 species have been described to date. Infrageneric studies based on morphological characteristics have divided this genus into two subgenera (subgen. *Amanita* Pers. and subgen. *Lepidella* (E. J. Gilbert) Vesely emend. Corner & Bas) and seven sections. *Amanita pachyvolvata* (Bon) Krieglst. belongs to subgen. *Amanita* Pers. sect. *Vaginatae* (Fr.) Quel. (Zhang et al., 2004; Tulloss, 2005; Moreno et al., 2008; Kim et al., 2013).

Cortinarius (Pers.) Gray (the largest genus of Agaricales Underw.) is represented by over 2000 species worldwide and 100 taxa in Turkey. *Cortinarius talimultiformis* Kytöv., Liimat., Niskanen, A.F.S. Taylor & Sesli has been

described as a new species for science from Turkey and Europe recently (Kirk et al., 2008; Sesli and Denchev, 2008; Liimatainen et al., 2014).

The species belonging to the genus *Melanogaster* Corda show the distinctive characters of purplish brown to blackish gleba and dark brown, smooth, truncate spores (Pecoraro et al., 2014).

Paxillus Fr. is a genus producing fleshy ectomycorrhizal basidiomes characterized by medium to large size, yellowish to chestnut brown or dark brown, funnel-shaped pileus with typically involute margin, decurrent yellow-brown lamellae, more or less intensely brownish tissues on handling, broadly ellipsoid, smooth, cyanophilic spores, and rusty brown spore prints (Knudsen and Vesterholt, 2008; Gelardi et al., 2014).

The collection site (Hıdırnebi and Sevinç highlands of Trabzon Province) is surrounded by very rich evergreen and deciduous forests. The dominant plant of river beds is *Alnus glutinosa* (L.) Gaertn, which provides a very useful habitat for *Alnicola* Kühner species. The Hıdırnebi highland is about 40 km away from Trabzon city center and the average altitude is 1600 m. Due to high humidity and other climatic and geological conditions, the area has a very rich fungal diversity (Sesli, 1997, 2007, 2014; Sesli

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and Denchev, 2008). The highland is a comparatively flat area with mountain meadows and is surrounded by mixed forests. The Sevinç highland has a drier climate and is covered with similar vegetation. The area is nearly 40 km away from Trabzon and has an average altitude of 1500 m. In addition to fungal diversity, wild boar and roe deer populations attract considerable attention in the research area.

The purpose of the present study was to contribute to knowledge of the Turkish mycota by adding new fungal records. Additionally, we have given a brief discussion regarding fungal diversity in Turkey.

2. Materials and methods

Basidiomes were collected from forests around the Hıdırnebi and Sevinç highlands in Trabzon, and were photographed with a Canon EOS 600 D digital camera equipped with a macro objective. We performed field studies after rain and a decrease in temperature. We made excursions to Hıdırnebi via the side road 20 km along the Akçaabat–Düzköy highway. The sizes of the pileus, stipe, and lamellae were measured; taste, smell, color, mycorrhizal relationships, and the shapes of basidiomes were noted. One to ten basidiomes were collected, put in paper bags, brought to the laboratory, and dried for further study. Microscopic analyses were performed at Karadeniz Technical University (Trabzon) and the University of Lille (France). A Zeiss Axio Imager trinocular research microscope was used to illuminate the internal structures and to measure cell sizes such as pileipellis, cystidia, basidia, and spores (Clémentçon, 2009). All basidiomes were sectioned by hand with a new razor blade under a stereo microscope. Sections were mounted in dilute ammonia and congo red and then examined under the microscope. Microscopic images were obtained with a Zeiss AxioCamERC5s camera and Imager Software. Identifications of the species were made by comparing the macro- and micromorphological data and the current literature (Breitenbach and Kränzlin, 1991, 1995, 2000; Dessi and Contu, 1998; Bas et al., 1999; Moreau, 2005; Moreau et al., 2006; Knudsen and Vesterholt, 2008; De Haan and Moreau, 2012; Vellinga et al., 2012; Jargeat et al., 2014). All names are given according to Robert et al. (1999) and Kirk et al. (2008).

3. Results

3.1. Agaricales Underw.

3.1.1. Strophariaceae Singer

3.1.1.1. *Alnicola subconspersa* (Kühner ex P.D. Orton) Bon, Documents Mycologiques 9 (33): 41 (1979) [Syn. *Naucoria subconspersa* Kühner. ex P.D. Orton, Transactions of the British Mycological Society 43 (2): 323 (1960)] [Figure 1]

Pileus 15–55 mm across, typically conical to campanulate when young, later conical to campanulate or convex, never plane. The surface of the pileus is dull, fibrillose, sometimes cracked, hygrophorous, olivaceous brown when moist and beige brown (the center darker) when dry, striate when moist. The margin of the pileus is typically dentate, somewhat split and acute. Umbo indistinct, sometimes umbilicate, **Lamellae** beige to pale brown when young, later brown to dark brown, decurrent. **Stipe** 55–70 × 2–5 mm, cylindrical and somewhat enlarged towards the base, bright, generally curved especially at the base, often slightly bulbous and covered with whitish-grayish mycelium, surface honey when young later dark olive brown to reddish brown, somewhere whitish pruinose and sometimes brownish fibrillose. **Context** scanty, flesh cream-colored to light brown. **Taste** acrid. **Spores** 9.5–12 × 5.5–6 µm, amygdaliform to citriform, moderately verrucose, pale brown to greenish, with drops (mostly with a big drop in the middle of the cell), **Basidia** 28–30 × 9–11 µm, 2–4-spored with basal clamp connections and granules. **Marginal cells** clavate, 24 × 11 µm. **Pileipellis** and **subpellis** have different cells (25–190 × 5–30 µm). Oval or cylindrical cells of the pileipellis are very large (25–80 × 10–30 µm). Most hyphae have clamp connections. **Cystidia** polymorphic, generally ventricose and rostrate with basal clamps, sometimes subcapitate, 40–55 × 9–14 µm. Some hymenial cystidia (rarely) mucronate and 17.5 × 4.5 µm, while others (rarely) vase- or jug-shaped and their size is 40 × 14 µm.

Specimens examined: Trabzon, Akçaabat, Hıdırnebi highland, 08/10/2013, gregarious under *Alnus glutinosa* (L.) Gaertn., Herbarium of Fatih Faculty of Education (FEFH Sesli 3279).

3.1.2. Amanitaceae R. Heim ex Pouzar

3.1.2.1. *Amanita pachyvolvata* (Bon) Krieglst., Beihefte zur Zeitschrift für Mykologie 5: 191 (1984) [Syn. *Amanitopsis pachyvolvata* Bon] [Figure 2]

Pileus 50–150 mm across, ovoid when young, later hemispherical, plano-convex when mature, the surface of the pileus is dull, ochraceous to gray brownish, slightly viscid, the margin typically sulcate or striate, sometimes split, umbonate, darker towards center, without velar remnants. **Lamellae** white to creamy white when young, later slightly yellowish white, rather broad, the edge slightly fimbriate. **Stipe** 100–200 × 15–25 mm, cylindrical and enlarged towards base, without a ring and with a very large volval sac, white when young, grayish, yellowish or brownish gray when old, covered with pale yellowish brown woolly tufts, hollow when mature, the volva membranous, 65 mm high, white at first, brownish or pale yellowish brown later. **Taste** not significant. **Odor** fungoid. **Spores** 12–13.5 × 10.5–12.5 µm, subglobose, with drops (mostly with a big drop in the middle of the cell), **Basidia**

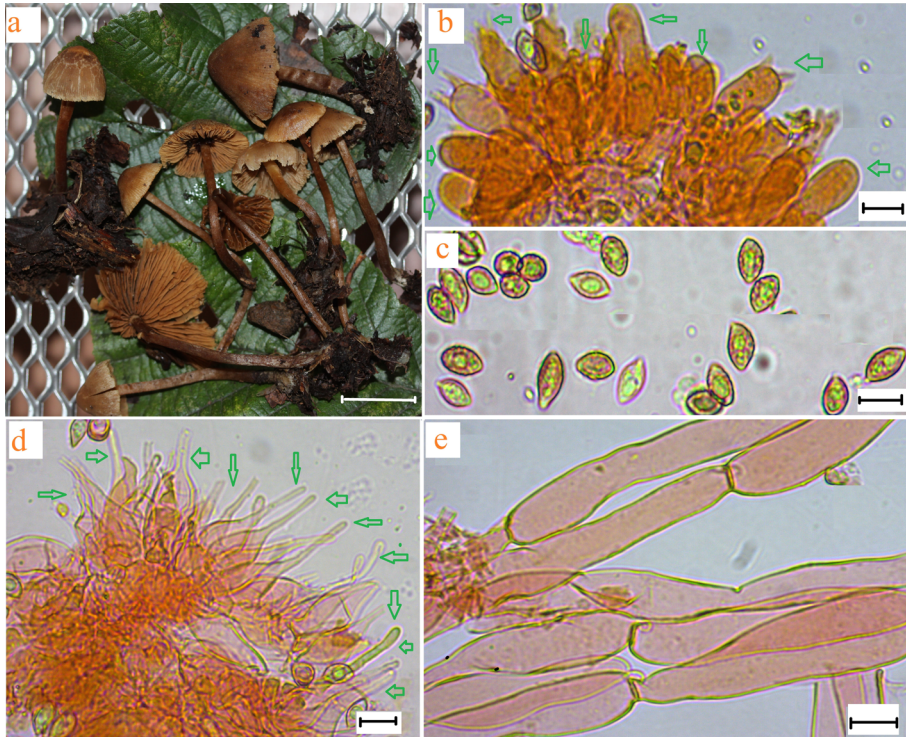


Figure 1. *Alnicola subconspersa*: a- basidiomes, b- basidia (each arrow shows a separate basidium), c- spores, d- cheilocystidia (each arrow shows a separate cheilocystidium), e- hyphal cells (scale bars: a = 20 mm; b, c, d, and e = 10 μ m).

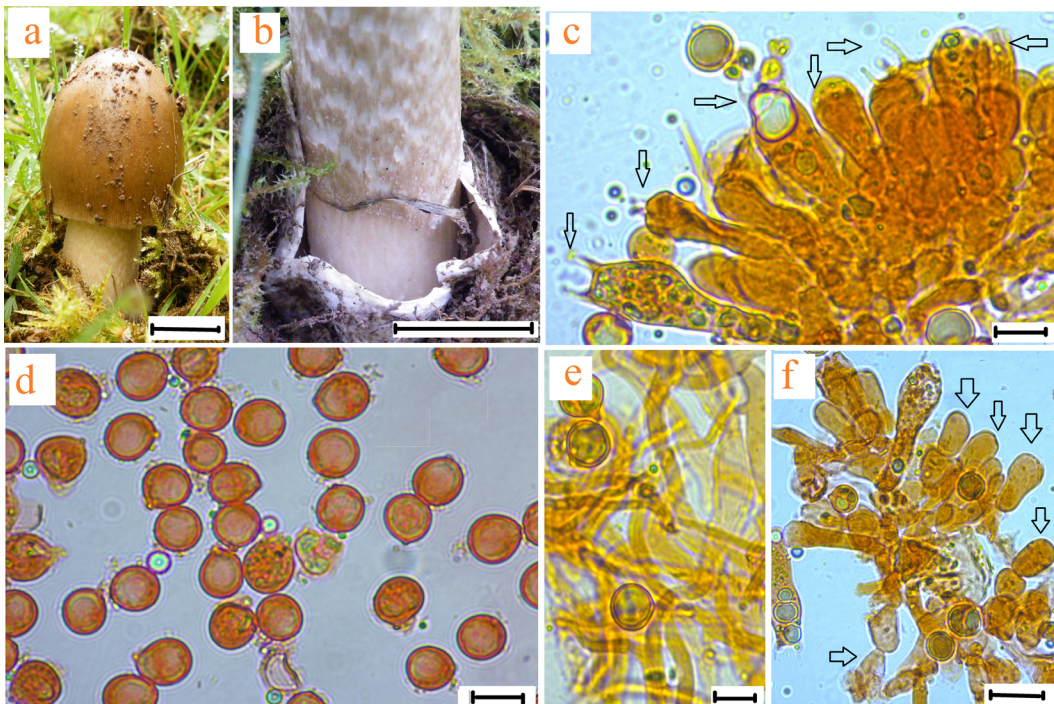


Figure 2. *Amanita pachyvoluta*: a and b- basidiome, c- basidia (each arrow shows a separate basidium), d- spores, e- pileipellis, f- marginal cells (each arrow shows a separate marginal cell) (scale bars: a and b = 25 mm; c, d, and e = 10 μ m, f = 20 μ m).

35–50 × 10–14 μm, 2–4-spored. Marginal cells clavate. Pileipellis composed of periclinal hyphae.

Specimens examined: Trabzon, Akçaabat, Hidirnebi highland, 01/10/2010, gregarious to solitary in the meadow, Herbarium of Fatih Faculty of Education (FEFH Sesli 2969).

3.1.3. Cortinariaceae R. Heim ex Pouzar

3.1.3.1. *Cortinarius azureus* Fr., Epicrisis Systematis Mycologici: 286 (1838) [Syn: *Cortinarius anomalus* var. *azureus* (Fr.) Krieglst.; *Dermocybe azurea* (Fr.) Ricken] [Figure 3]

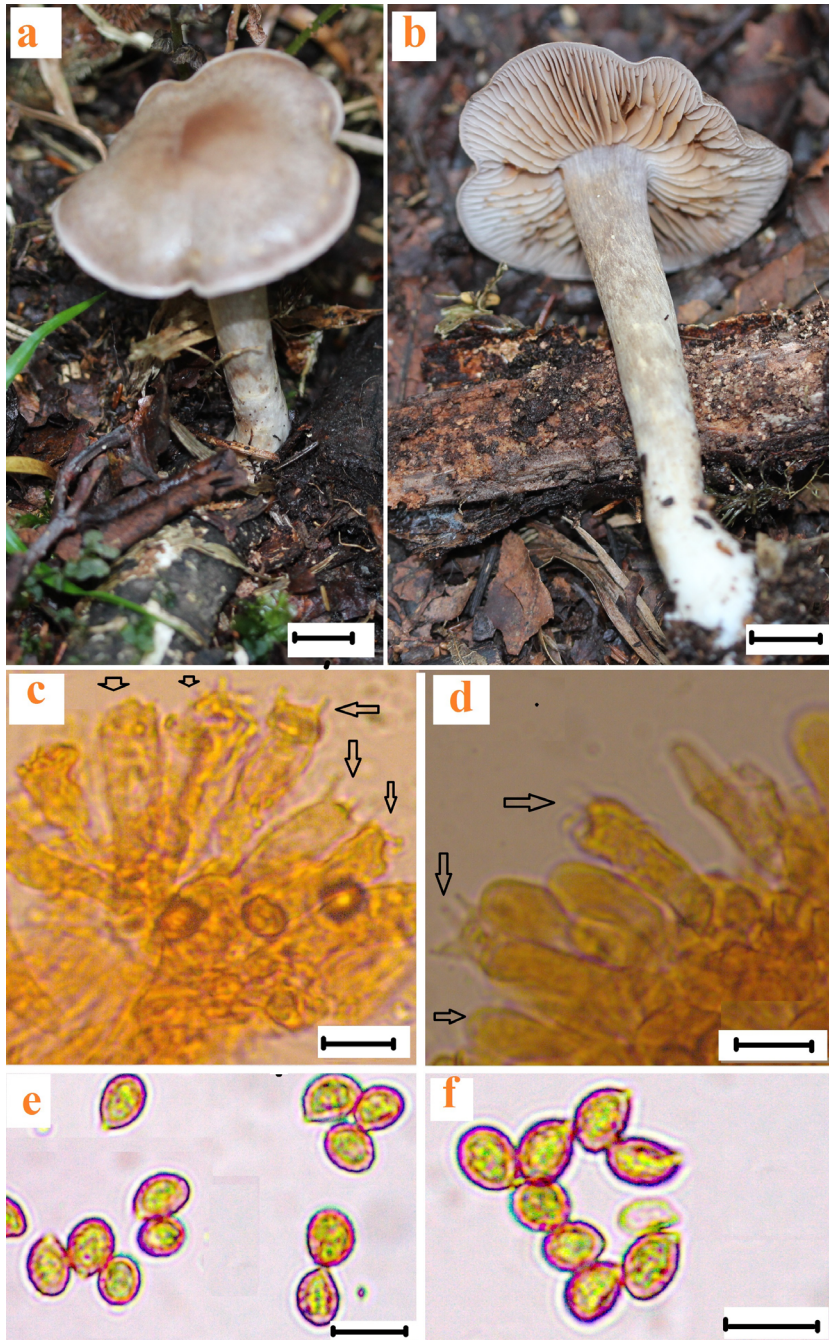


Figure 3. *Cortinarius azureus*: a and b- basidiome, c and d- basidia (each arrow shows a separate basidium), e and f- spores (scale bars: a and b = 10 mm; c, d, e, and f = 10 μm).

Pileus 30–60 mm across, at first conical, then convex or almost plane when mature, typically undulate, the surface dull, smooth to somewhat tomentose, purple brown to violet gray. Darker at the center and lighter towards the acute margin. The margin of the pileus is typically dentate, somewhat split and acute. Umbo wide and low. **Lamellae** beige to violet brown, broadly adnate, the edge crenate. **Stipe** 40–75 × 5–8 mm, cylindrical, flattened towards the apex, slightly enlarged towards base, somewhat clavate, violet or grayish purple on a whitish background, more grayish-whitish towards base and hollow. **Taste** mild, **odor** weak or insignificant. **Spores** 7–8.5 × 5–7 μm, elliptical, verrucose, yellowish brown. **Basidia** 25–30 × 7–9 μm, 4-spored with basal clamp connections. **Pileipellis** composed of periclinal hyphae.

Specimens examined: Trabzon, Akçaabat, Hıdırnebi highland, 09/09/2013, under *Fagus orientalis* Lipsky and *Picea orientalis* (L.) Peterm., Herbarium of Fatih Faculty of Education (FEFH Sesli 3181).

3.1.3.2. *Cortinarius vernus* H. Lindstr. & Melot, in Brandrud, Lindström, Marklund, Melot & Muskos, *Cortinarius*, Flora Photographica [English translation by J. Melot] (Matfors) 3: 27 (1994) [Syn: *Cortinarius erythrinus* sensu Ricken; *Cortinarius castaneus* var. *erythrinus* (Fr.) Moëgne-Locoz & Reumaux; *Cortinarius uraceus* sensu Lange; *Cortinarius vernus* var. *nevadavernus* Suár.-Sant. & A. Ortega; *Cortinarius vernus* var. *rubescens* A. de Haan & Volders] [Figure 4]

Pileus 25–70 mm across, conical to campanulate, plane and sometimes irregularly funnel shaped in rainy weather, umbonate, hygrophanous, grayish to olivaceous brown or reddish brown, sometimes blackish brown, darker towards center. Whitish fibrillose close to the edges and the margin acute incurved when young, split in mature. **Lamellae** beige to pale brown, reddish brown, moderately broad, broadly adnate to subdecurrent. **Stipe** 40–70 × 5–10 mm, cylindrical and sometimes curved especially at the base, longitudinally fibrillose, purple and whitish from place to place (stipe with irregular white bands on the violet to brownish violet background). **Taste** mild. **Odor** indistinct. **Spores** 7.5–9.5 × 5–6.5 μm, elliptical, verrucose, dark yellow to golden brown. **Basidia** 25–35 × 8–10 μm, 4-spored with basal clamp connections. **Marginal cells** clavate to pyriform, 20–25 × 7–12 μm. **Pileipellis** composed of periclinal and hyaline to brownish hyphae (4–13 μm wide). **Clamp connections** present.

Specimens examined: Trabzon, Akçaabat, Hıdırnebi highland, 24/07/2013, gregarious under *Picea orientalis* (L.) Peterm., Herbarium of Fatih Faculty of Education (FEFH Sesli 3152).

3.2. Boletales E.-J. Gilbert

3.2.1. Paxillaceae Lotsy

3.2.1.1. *Melanogaster variegatus* (Vittad.) Tul. & C. Tul., Fungi hypog.: 92 (1851) [Syn: *Elaphomyces muricatus* f. *variegatus* (Vittad.) Ceruti; *Bulliardia inquinans* Jungh.;

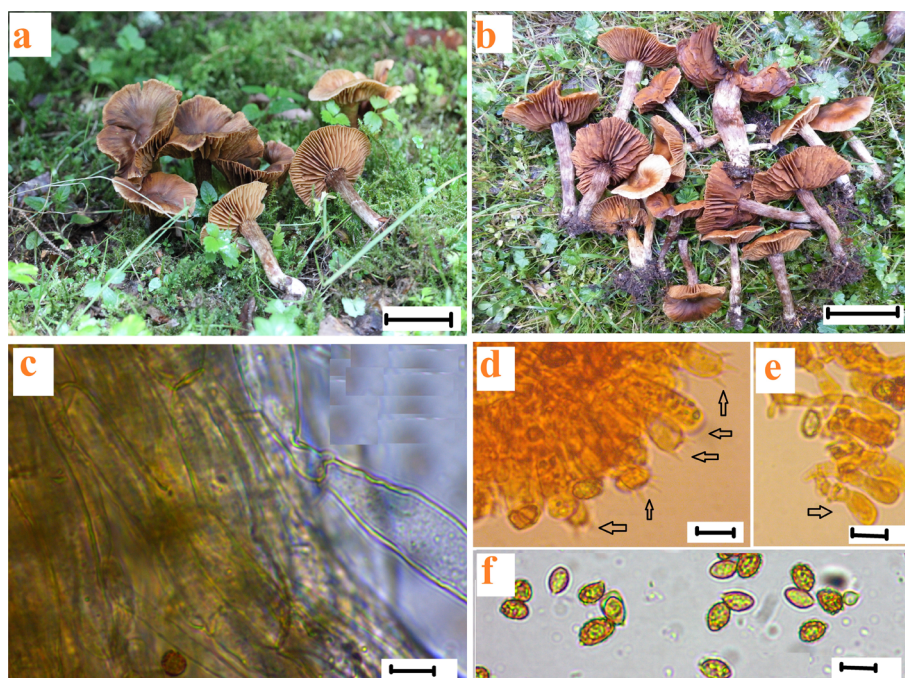


Figure 4. *Cortinarius vernus*: a and b- basidiomes, c- pileipellis, d- basidia (each arrow shows a separate basidium), e- marginal cells (the arrow shows a marginal cell), f- spores (scale bars: a and b = 40 mm; c, d, e, and f = 10 μm).

Hyperrhiza inquinans (Jung.) Rabenh.; *Melanogaster variegatus* (Vittad.) Tul. & C. Tul. var. *variegatus*; *Octaviania variegata* Vittad.] [Figure 5]

Carpophore 20–50 mm in diameter, spheroidal and somewhat elongated, mycelial cord typical. Peridium dark yellow, rusty brown to reddish brown, blackish when crushed. Gleba thick with numerous chambers, purplish brown to black. **Taste** and **smell** similar to wild strawberries. **Spores** 5–10 × 3.5–4.5 μm, ellipsoid, blackish or reddish brown and smooth. **Basidia** 15–20 × 5–8 μm, 2–4-spored and without basal clamp connections.

Specimens examined: Trabzon, Maçka, Sevinç village, 06/09/2013, near *Alnus glutinosa* (L.) Gaertn., Herbarium of Fatih Faculty of Education (FEFH Sesli 3175).

3.2.1.2. *Paxillus ammoniavirescens* (Contu & Dessi, in Dessi & Contu, *Micol. Veg. Medit.* 13(2): 123 (1999) [Figure 6]

Pileus 60–130 mm across, umbilicate, umbo indistinct, irregularly distorted, undulate, the surface fibrillose, sometimes cracked, viscid, margin slightly inrolled,

olivaceous brown to pale or reddish brown. **Lamellae** sulfur color, reddish brown when handled, decurrent, sometimes forked with entire edge. **Stipe** 30–70 × 10–20 mm, cylindrical and somewhat tapered towards the base, generally curved, concolorous with the pileus and covered with dark fibrils. **Context** moderately thick, flesh yellowish, darkening to brown when bruised. **Taste** indistinct. **Odor** acidic. **Spores** 7–8.5 × 4.5–5.5 μm, ovoid to ellipsoid, olivaceous to yellowish brown with mostly a big drop in the middle of the cell. **Basidia** 25–35 × 7–8 μm, 4-spored, clamped. **Pileipellis** consists of parallel and irregular hyphae 4–9 μm wide with clamp connections. **Cheilocystidia** fusiform 30–50 × 5–13 μm.

Specimens examined: Trabzon, Maçka, Sevinç village, 06/09/2013, in association with *Alnus glutinosa* (L.) Gaertn., Herbarium of Fatih Faculty of Education (FEFH Sesli 3170).

3.2.1.3. *Paxillus cuprinus* P. Jargeat, H. Gryta, J.P. Chaumeton & A. Vizzini, in Jargeat, Chaumeton, Navaud, Vizzini & Gryta, *Fungal Biology*: 27 (2014) [Figure 7]

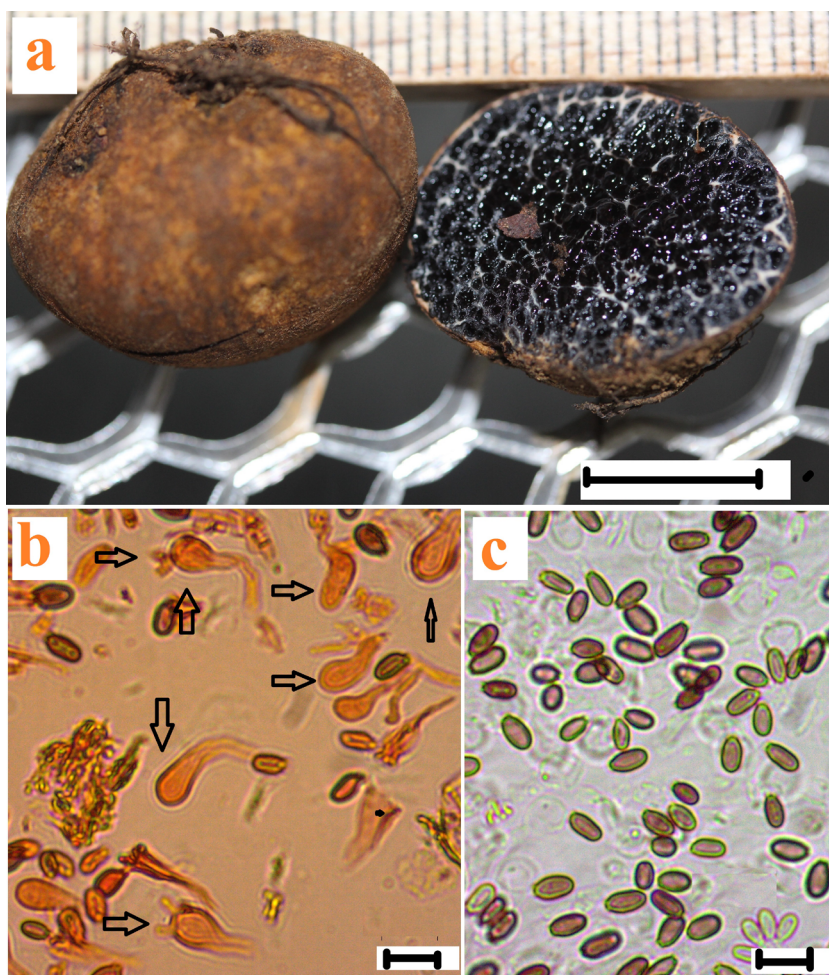


Figure 5. *Melanogaster variegatus*: a- basidiome, b- basidia (each arrow shows a separate basidium), c- spores (scale bars: a = 20 mm, b and c = 10 μm).

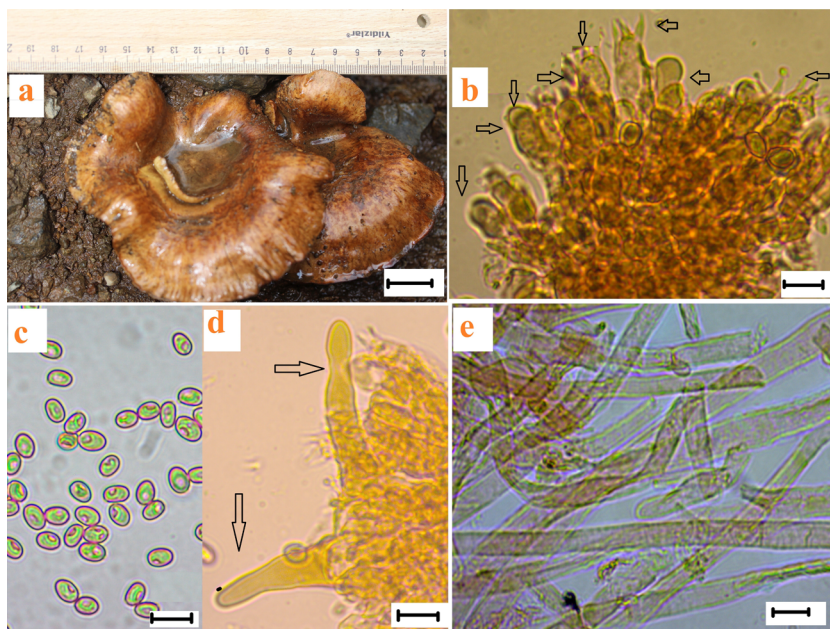


Figure 6. *Paxillus ammoniavirescens*: a- basidiomes, b- basidia (each arrow shows a separate basidium), c- spores, d- cheilocystidia (each arrow shows a separate cheilocystidium), e- hyphae of pileipellis (scale bars: a = 20 mm; b, c, d, and e = 10 μ m).

Pileus 60–130 mm across, umbilicate, umbo indistinct, hemispherical to convex, very slimy and sticky, shining, the surface fibrillose, sometimes cracked; margin typically inrolled, olivaceous or gray brown to pale or reddish brown. Reddish brown to purplish brown with dilute ammonia solution. **Lamellae** pale olivaceous to yellowish white when young, rusty brown to reddish brown with age, decurrent, crowded, forked. **Stipe** 25–50 \times 10–25 mm, mostly central, cylindrical and sometimes curved, light yellowish to pale brownish with white fibrils, reddish brown to dark brown when cut. Stipe base covered with pale brown to whitish mycelium. **Context** thick, yellowish to reddish or dark brown when handled. **Taste** mild or slightly acrid. **Odor** fruity. **Spores** 7.5–9.5 \times 5–6 μ m, ovoid to ellipsoid or amygdaloid, smooth, yellow brown or olivaceous. **Basidia** 25–45 \times 8–10 μ m, 2–4-spored, clavate with rather stout sterigmata and clamped. **Pileipellis** a cutis to an intricate trichoderm with **clamp connections**. **Cheilocystidia** fusiform, ventricose or irregularly flexuose to lageniform, 40–90 \times 8–14 μ m.

Specimens examined: Trabzon, Maçka, Sevinç village, 06/09/2013, near *Alnus glutinosa* (L.) Gaertn., Herbarium of Fatih Faculty of Education (FEFH Sesli 3172).

4. Discussion

Seven basidiomycetous fungi (*Alnicola subconspersa* (Kühner ex P.D. Orton) Bon, *Amanita pachyvolvata* (Bon) Krieglst., *Cortinarius azureus* Fr., *Cortinarius vernus* H. Lindstr. & Melot, *Melanogaster variegatus* (Vittad.) Tul.

& C. Tul., *Paxillus ammoniavirescens* Contu & Dessi, and *Paxillus cuprinus* P. Jargeat, H. Gryta, J.P. Chaumeton & A. Vizzini) were collected, identified, described, and reported for the first time from Trabzon, Turkey.

According to the present literature (Phillips, 1981; Breitenbach and Kränzlin, 1991; Breitenbach and Kränzlin, 1995; Breitenbach and Kränzlin, 2000) basidiomes of *M. variegatus* (Vittad.) Tul. & C. Tul. are edible; those of *A. subconspersa* (Kühner ex P.D. Orton) Bon, *A. pachyvolvata* (Bon) Krieglst., *C. azureus* Fr., and *C. vernus* H. Lindstr. & Melot are inedible; and those of *P. ammoniavirescens* Contu & Dessi and *P. cuprinus* P. Jargeat, H. Gryta, J.P. Chaumeton & A. Vizzini are poisonous. However, none of these are known by the local people in the research area.

In addition to the new records, we reviewed articles on the Turkish mycota and established that the total number of larger fungal genera recorded in Turkey is 448, including 87 ascomycetous and 361 basidiomycetous fungi. Nearly 2186 species have been recorded to date in Turkey, including 218 larger Ascomycota and 1968 larger Basidiomycota, excluding *Lyophyllum turcicum* Sesli, Vizzini & Contu, which has been described recently. Species belonging to the genera *Peziza* Fr., *Morchella* Dill. ex Pers., *Helvella* L., *Russula* Pers., *Cortinarius* (Pers.) Gray, *Inocybe* (Fr.) Fr., *Mycena* (Pers.) Roussel, and *Lactarius* Pers. represent 52% of all larger fungi of Turkey (Solak et al., 2007; Sesli and Denchev, 2008; Demirel et al., 2010; Kaya et al., 2010; Uzun et al., 2010; Doğan et al., 2012; Akata and Kaya, 2013a, 2013b; Akata et al., 2014, Sesli et al., 2015b).

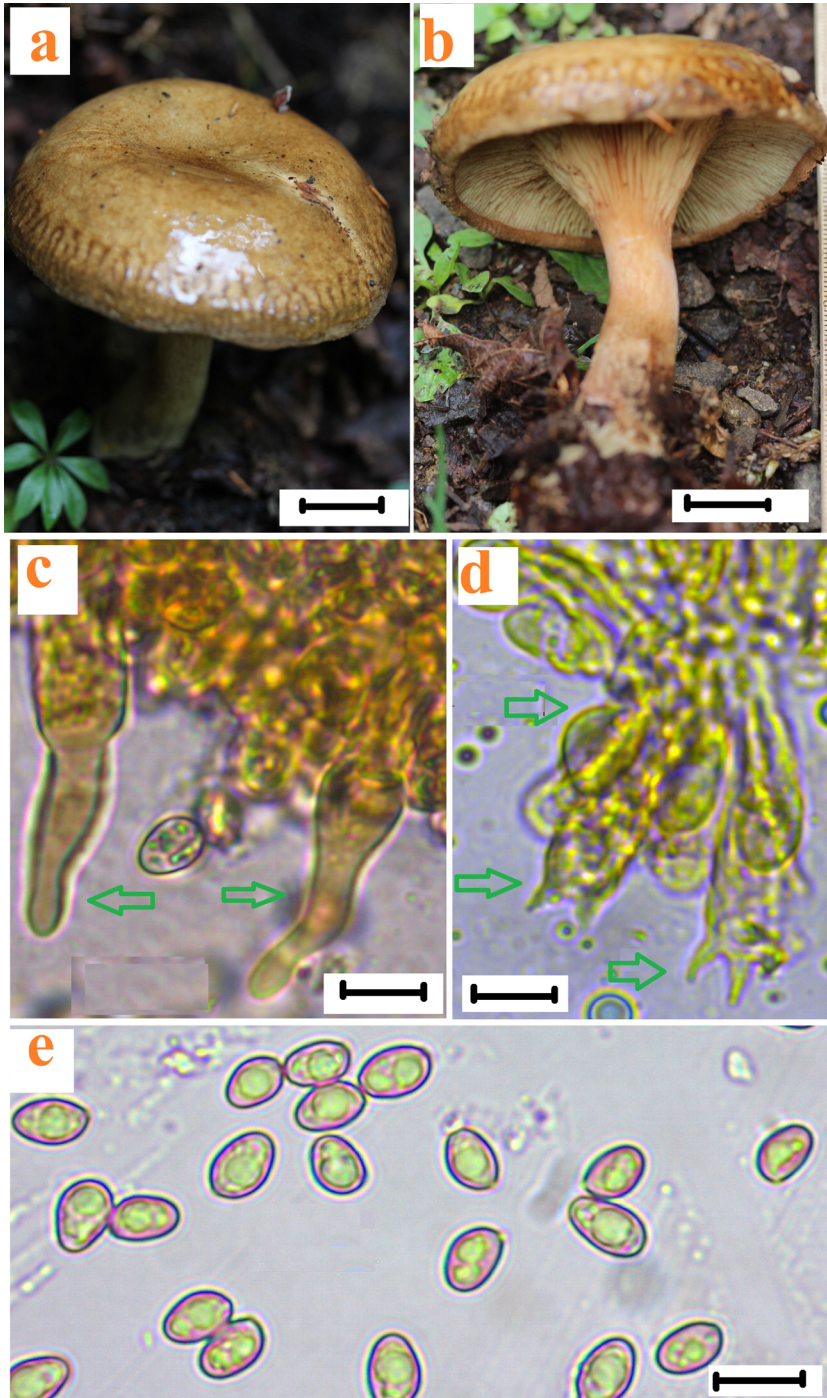


Figure 7. *Paxillus cuprinus*: a and b- basidiome, c- cheilocystidia (each arrow shows a separate cheilocystidium), d- basidia (each arrow shows a separate basidium), e- spores (scale bars: a and b = 20 mm; c, d, and e = 10 μ m).

Alnicola scolecina (Fr.) Romagn. was recorded by Öner and Gezer (2004) as *Naucoria scolecina* (Fr.) Quél. in West Anatolia. Then two *Alnicola* Kühner species (*Alnicola citrinella* P.A. Moreau & A. de Haan and *Alnicola suavis* (Bres.) Kühner) were reported (Sesli et al., 2015a), and

so with the present study the number of *Alnicola* Kühner species recorded in Turkey reached 4. Numbers of species belonging to *Cortinarius* (Pers.) Gray reached 102, of *Amanita* Pers. 34, of *Melanogaster* Corda 2, and of *Paxillus* Fr. 5 with this study. *Alnicola subconspersa* (Kühner

ex P.D.Orton) Bon is one of the usual interpretations of “*Alnicola scolecina* (Fr.) Romagn.,” and the name *A. scolecina* (Fr.) Romagn. (which is discussed) is usually used for two distinct but very similar species: *A. umbrina* (R. Maire) Kühner and *A. subconspersa* (Kühner ex P.D. Orton) Bon. Both differ mainly on account of their microscopic features, especially the shape of cheilocystidia (with distinct rounded base for *A. subconspersa* (Kühner ex P.D. Orton) Bon, more slender and fusiform in *A. umbrina* (R. Maire) Kühner) (Moreau, 2005).

Paxillus cuprinus P. Jargeat, H. Gryta, J.P. Chaumeton & A. Vizzini has the largest spores in the genus ($8.2\text{--}9.6 \times 5.7\text{--}6.6 \mu\text{m}$). Spore dimensions of Sesli 3170 were consistent with *Paxillus obscurisporus* C. Hahn and *Paxillus ammoniavirescens* Contu & Dessi; however, considering the macroscopy (rather small specimens with purplish colors when dry), it was easily identified as *P. ammoniavirescens* Contu & Dessi, which is common in Mediterranean areas. *P. ammoniavirescens* Contu & Dessi is also very similar to *P. rubicundulus* P.D. Orton, but

has slightly larger and darker spores and has a green reaction with ammonia in fresh basidiomes. Molecular studies have demonstrated that *Paxillus ammoniavirescens* Contu & Dessi is genetically different from known species (Dessi and Contu, 1998). It seems to be a common species and has been collected in Italy, France, Great Britain, Spain, and Germany. It seems to grow mainly under poplars, but Dessi and Contu (1998) picked it up under *Eucalyptus camaldulensis* Dehnh., *Abies cephalonica* Link, and *Cistus monspeliensis* L., while it was collected under *Alnus glutinosa* (L.) Gaertn. during this study.

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