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Original Scientific Paper

Records of lichenicolous fungi new for Turkey and Asia

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ABSTRACT: Three lichenicolous fungi occcuring on *Tephromela atra* and *Lecidea fuscoatra*– *Rhymbocarpus fuscoatrae*, *Sclerococcum tephromelarum* and *Skyttea tephromelarum*, collected from the Tunceli and Bingöl provinces of Turkey – are reported as new to Turkey and Asia, following a recent lichenological survey in those provinces. Short descriptions are provided, together with geographic distributions, hosts, and comparisons with similar taxa.

Keywords: Ascomycota, Bingöl, biodiversity, lichenicolous fungi, Tunceli

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INTRODUCTION

Lichenicolous fungi include a large group of about 1.800 taxa (Lawrey & Diederich 2003). They belong to the Ascomycota (about 95%), and the rest to the *Basidiomycota* and grow as obligate parasites or saprotrophs on lichens (Lawrey & Diederich 2003).

In carrying out our projects "Lichen flora of the Tunceli and Bingöl provinces", we found some interesting lichenicolous fungi. No lichenicolous fungi had been reported previously from the Tunceli and Bingöl provinces. Although studies on the Turkish flora of lichenicolous fungi have been increasing in recent years, there are many unexplored parts of Turkey (Yazici *et al*. 2011; Yazici & Etayo 2014a, b, 2015). Approximately 146 taxa of lichenicolous fungi are known fromTurkey (Halici *et al*. 2012; Kocakaya *et al*. 2014, 2016; John & Türk 2017).

This number is small when compared with other European countries or regions, e.g., the Czech Republic (226 species of lichenicolous fungi and lichenicolous lichens, Kocourková 2009), Fennoscandia (430 species, Santesson *et al*. 2004), Germany (449 species, Brackel 2015a), Great Britain and Ireland (403 lichenicolous fungi and lichenicolous lichens, Hawksworth 2003), Italy (525 species, Brackel 2015b) or Poland (216 species, Czyewska & Kukwa 2009).

Thus, extensive explorations are urgently needed for more regions of Turkey (Etayo & Yazici 2009; Yazici *et al*. 2011).

No taxa of *Skyttea* have been found in Turkey, while one taxon of *Sclerococcum* and one of *Rhymbocarpus* Zopf have been reported (Yazici & Etayo 2014a, b) The present contribution is a result of fieldwork in the Bingöl and Tunceli regions (eastern Turkey). No lichenicolous fungi have been reported from either region so far, but 89 lichen taxa have been identified in Tunceli and 14 in Bingöl (Çobanoğlu & Yavuz 2007; Çobanoğlu & Doğan 2010).

The purpose of the present paper was to report three records of lichenicolous fungi new for Turkey and Asia. The Tunceli study area has a climate characterised by long, very cold and snowy winters, and short cool summers, with a temperature range of -5.4 to 35°C and mean annual rainfall of around 816 mm (Akman 1999).

This region is located in the Taurus orogenic belt of the highland district of Eastern Turkey. Lower Permian meta-sediments and Upper Permian subcrystalline limestone are the oldest exposed formations of this region. Lower Cretaceous flysch overlies partly eroded Up-

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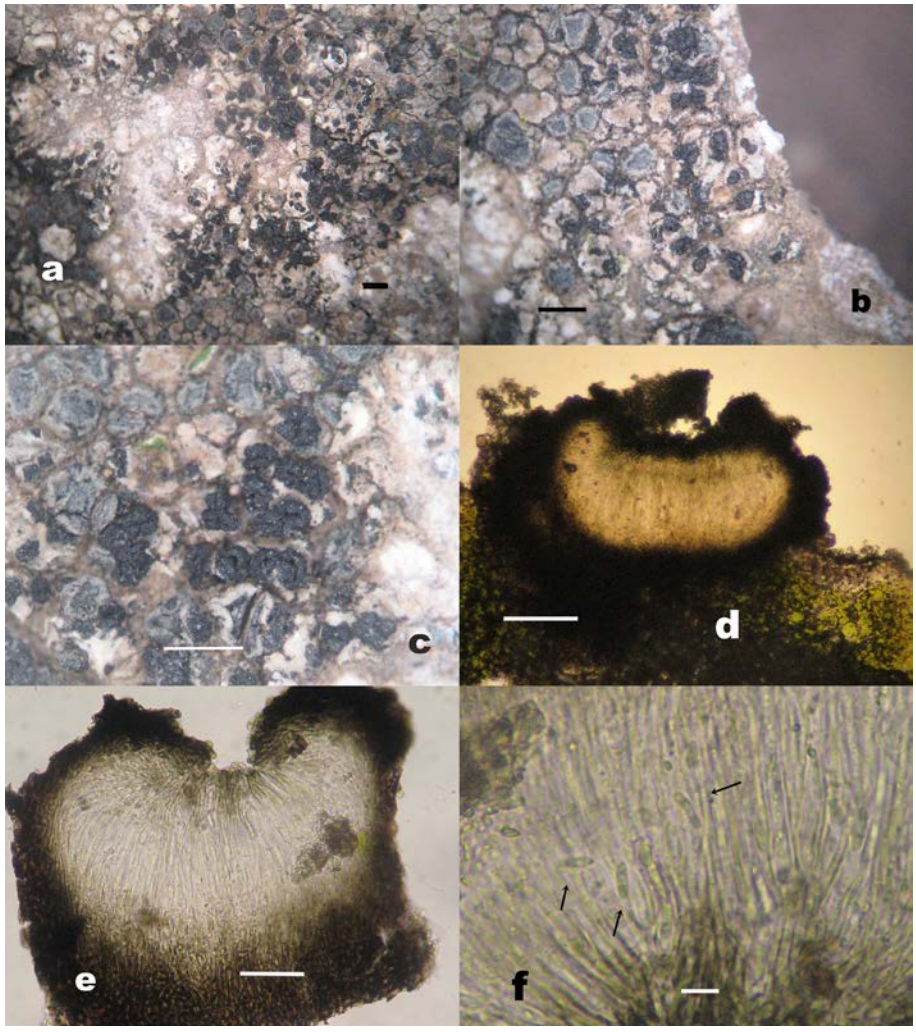

Fig. 1a-f. *Rhymbocarpus fuscoatrae*: **a**,**b,c.** Ascoma on thallus of *Lecidea fuscoatra*. Scale: 1 mm, **d**. Section through an ascomata with epihymenium, hymenium and hypothecium. Scale: 100 µm, **e.** Section through an ascomata with epihymenium, hymenium and hypothecium. Scale: 50 µm, **f.** Section of ascomata with ascospores and hymenium. Scale: 10 µm (in water).

per Permian limestone discordantly. Enormously thick layers of flysch, tuffs, basaltic flows and limestones represent deposits of Lower Cretaceous, Upper Cretaceous and Lower Eocene age; the deposits of each of these periods are more or less clearly separated from each other. Middle Eocene limestone is overlain discordantly by Lower Miocene marine limestone, which grades upwardly into lignite-bearing marls of Middle Miocene and red beds of Upper Miocene age (Afshar 1965).

The Tunceli survey area is mountainous with mostly open areas and poor forests dominated mostly by *Quercus*, but on slopes of the valleys by *Platanus, Fraxinus*, *Juniperus*, *Carpinus* and *Salix*, while the grasslands are covered by bushes and weeds. Additionally, the forest understory flora is very poor in these areas, and all of the nearby mountains have an abundance of rocks (Baytop & Denizci 1963).

Bingöl has a harsh continental climate with plenty of rain and snow. Summers are hot and dry, winters long and snowy. The mean annual temperature is 8.7°C and the temperature ranges from –9 to 39°C. The mean annual rainfall is about 900 mm (Akman 1999).

Bingöl has several valleys with streams and a poor plant cover, 15% of which consists of forests, while meadows and grasslands constitute 75%. Tree communities are formed mostly by *Quercus* trees, but certain areas are completely treeless, deciduous trees such as *Populus* or *Salix* being sometimes seen in villages and along roadsides (Baytop & Denizci 1963).

MATERIALS AND METHODS

The present report is based on collections from the Tunceli and Bingöl regions (Turkey) made on 6 July 2018, 17 July 2018 and 29 August 2018. Microscopic examination of hand-made sections (including all measurements) was performed in water, 10% KOH and lactophenol cotton blue. Air-dried samples were observed and studied with a Nikon Zeiss Stemi 2000-c stereomicroscope and a Zeiss Axio Imager.A2 light microscope. Macrophotographs and microphotographs were taken with a Zeiss AxioCam ERc5s digital camera. The nomenclature of genera and species follows Etayo & Calatayud (1998), Diederich & Etayo (2000, 2004),

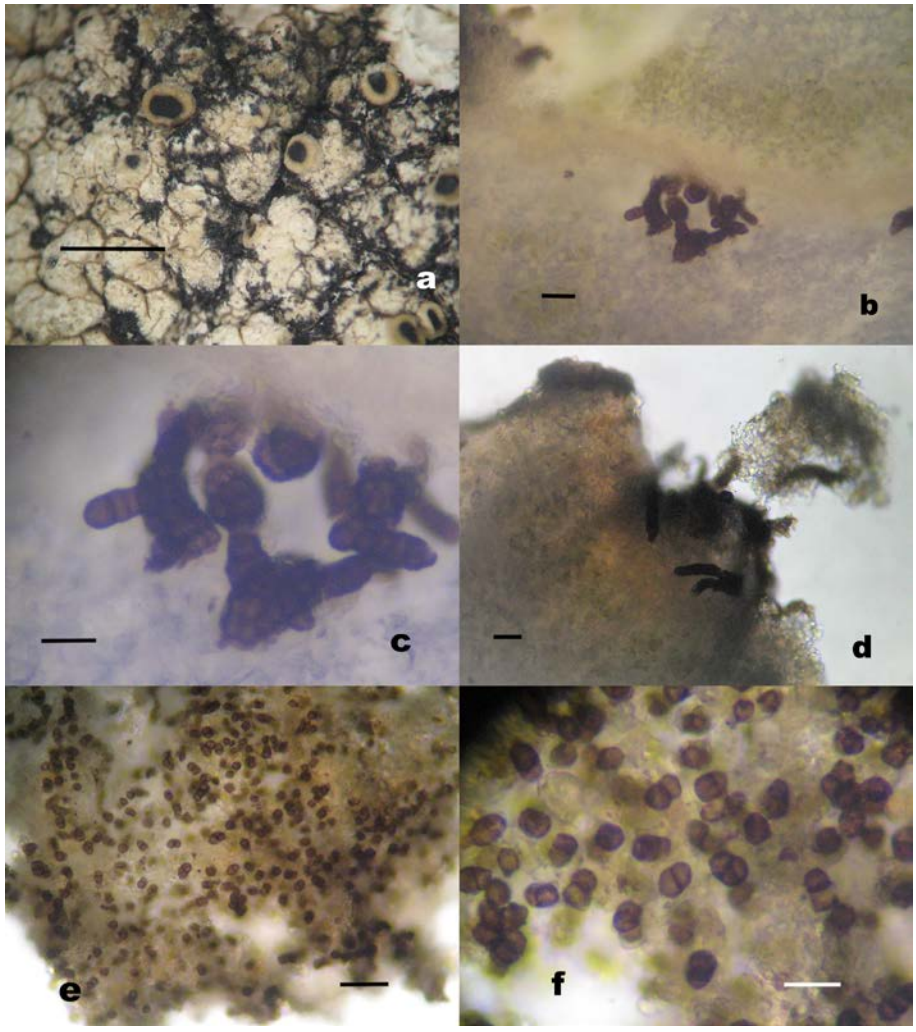

Fig. 2a-f. *Sclerococcum tephromelarum*: **a.** Sporodochia on thallus of *Tephromela atra*. Scale: 1 mm, **b.** Hyaline mycelia and 2-3--celled conidia. Scale: 20 µm (in water), **c**. Hyaline mycelia and 2-3-celled--conidia in K. Scale: 20 µm, **d,e,f**. Hyaline mycelia and conidiophores and conidigenous cells. Scale **d**: 40 µm, **e**: 20 µm, **f:** 40 µm (in water).

Zhurbenko (2010) and Diederich (2015). Specimens are stored in the herbarium of the Biology Department, Faculty of Science, Karadeniz Technical University, Trabzon, Turkey (KTUB). The descriptions are based on Turkish specimens.

RESULTS AND DISCUSSION

Rhymbocarpus fuscoatrae (Hafellner) Diederich & Etayo, Lichenologist 32(5): 465 (2000)

Ascomata immersed at first, but margin visible, attached to the substratum, deeply cruciate and erumpent later, 0.30-0.50 mm in diameter; thick and black margin with 3-4(-5) deep fissures, spreading on the disc (Fig. 1a, b, c); exciple hyaline, dark-brown, K+ dull-brown, hymenium hyaline, 98-135 µm, KI- and subhymenium hyaline, epihymenium olivaceous green, greenish- black, paraphyses simple or branched, septate, more or less swollen, pigment absent (Fig. 2d, e); asci clavate, apical wall not thickened, eight-spored. Ascospores large, 9.8 - 12.25 × 2.45 -4 (-4.5) µm, aseptate, smooth, lacking a distinct perispore, oblong-ellipsoid, slightly curved (Fig. 2f).

A detailed description is provided by Hafellner (1996).

Rhymbocarpus fuscoatrae grows on the thallus of *Lecidea fuscoatra* (L.) Ach.

Specimen examined: Turkey. Tunceli: 3 km from the village of Yolkonak (Tunceli: center) toward Pertek, main roadside, 38°57'04.22" N 39°28'40.74" E, 1222 m, on *Lecidea fuscoatra*, 06.07.2018, leg. K.Yazıcı, A. Aslan and D. Karahan. (KTUB-2466), det. K. Yazıcı, A. Aslan and J. Etayo.

Distribution: *Rhymbocarpus fuscoatrae* was previously known from the Canary Islands, England, Scotland, Ireland, Wales (Merioneth) and Lauri Macaronesia (Hafellner 1996, 2002; Diederich & Etayo 2000). New to Turkey and Asia.

Remarks: *Rhymbocarpus fuscoatrae* resembles *Rhymbocarpus cruciatus* (Sherwood, D. Hawksw. & Coppins) Etayo & Diederich, but *R. cruciatus* growing on *Diploicia canescens* (Dicks.) A. Massal. differs from *R. fuscoatrae* in having excipular marginal hairs, thicker margins, deeper fissures and smaller ascospores (Diederich & Etayo 2000).

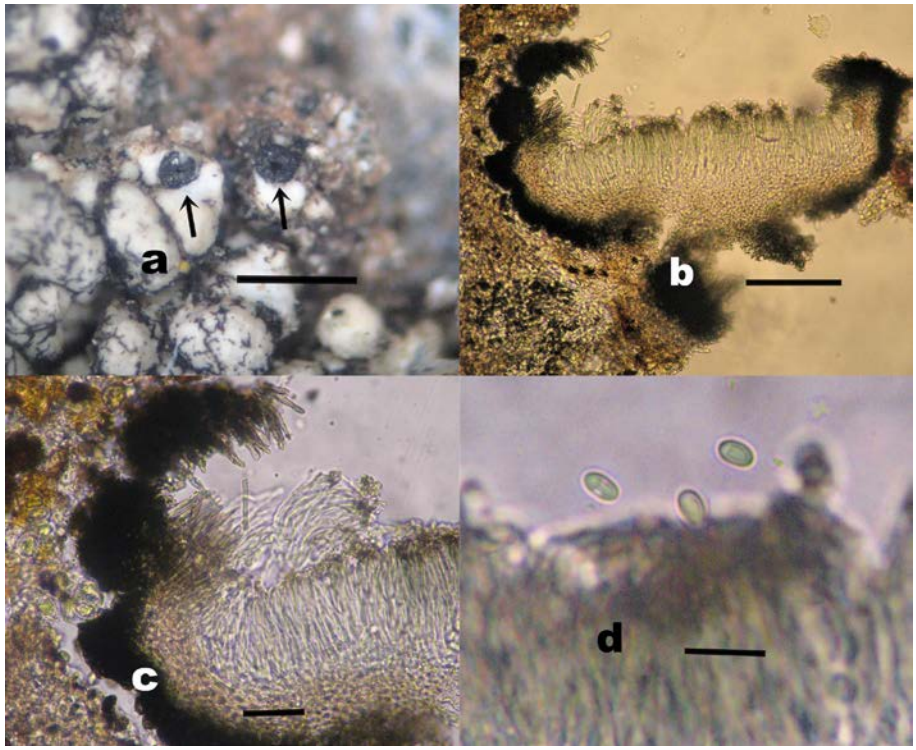

Fig. 3a-d. *Skyttea tephromelarum*: **a**. Ascoma on thallus of *Tephromela atra*. Scale: 1 mm, **b**. Section through an ascomata with exciple, hymenium, hypothecium and olivaceous cells. Scale: 100 µm, **c.** Exciple and exciple hairs Scale: 20 µm, **d.** Ascospores. Scale: 20 µm.

Sclerococcum tephromelarum Etayo & Calat., Annal. Naturh. Mus. Wien, Ser. B, Bot. Zool. 100: 679 (1998)

Mycelium more or less indistinct, hyaline, immersed, conidiomata sporodochia, partly immersed or superficial, 50-170 µm in diameter, convex to crateriform-concave, black to dark- brownish black, more or less rounded or more or less elongated, growing generally on pale and naked areas of the host thallus (Fig. 2a). Vegetative hyphae hyaline, light-brown or brown. Conidiophores clustered in sporodochia, dark-brown, with pigmented conidigenous cells 4.3-4.9-6.2 × 7.35-10.5 µm in terminal part (Fig. 2b, c, d); conidia 6.7-7.35 × 9.8-14.7 µm, with 1-2 septa, brown to dark-brown, thick and with fissured lacerate-granulose walls (Fig. 2e, f).

A detailed description is provided by Etayo & Calatayud (1998).

Sclerococcum tephromelarum mainly occurs on the thallus of *Tephromela atra* (Huds.) Hafellner (Etayo & Calatayud 1998), as in the case of this specimen.

Specimen examined: Turkey, Bingöl: Center, 300 m from the village of Sancak, 39°04'57.17" N 40°23'40.31" E, 1575 m, on the thallus of *Tephromela atra*, 29.08.2018, leg. K.Yazıcı, D. Karahan. (KTUB-2456), det. K. Yazıcı, A. Aslan and J. Etayo.

Distribution: This species was previously known from Europe (Germany, England, Scotland, Spain, the Netherlands), (Etayo & Calatayud 1998; van den Boom 2003; Zhurbenko 2009; Etayo 2010; Schiefelbein *et al.* 2014), Lauri Macaronesia: Madeira (Hafellner 2002). New to Turkey and Asia.

Remarks: *Sclerococcum tephromelarum* resembles *Sclerococcum leuckertii* Diederich & P. Scholz with its ornamented conidial walls, but the greenish colour of conidia and larger sporodochia (Lindsay 1869) in *S. leuckertii* help differentiate *S. tephromelarum* from *S. leuckertii* (Lindsay 1869; Etayo & Calatayud 1998).

Skyttea tephromelarum Kalb & Hafellner, in Kalb, Lichenes Noetropici, Exs. Fascicle 10 (nos 401-450) (Neumarkt): 15 (1988)

Lichenicolous fungi with ascomata black, 250-350 (400) µm, immersed, more or less compact and lirellate at first, erumpent and cruciate with middle part expanded later (Fig. 3a, b); opened ascomata to 350 µm, with 3-4 deep marginal fissures; hymenium hyaline, thick, 45-68 µm; hypotheium ± 24.5 µm; exciple green to olivaceous, with more or less globose cells, 4-7 µm (Fig. 3c, d); marginal excipular hairs more or less olivaceous, 44-36.75 µm (Fig. 3d, e) ascospores hyaline, ellipsoid, 5.5-9.8 × 3.0-3.5 µm (Fig. 3f), growing on the thallus of *Tephromela atra* (Fig. 3f).

A detailed description is provided by Diederich & Etayo (2000).

Skyttea tephromelarum mainly grows on the thallus and thalline margins of *Tephromela atra* (including the corticolous var. *torulosa*) and *Tephromela tropica* Kalb (Diederich & Etayo 2000; Zhurbenko 2007, 2009; Brackel 2010).

Specimen examined: Turkey, Tunceli: in the Munzur National Park, alongside the main road, 39°10'53.69" N 39°41'12.05" E, 997 m, 17.07.2018, on the thallus of

Tephromela atra (Huds.) Hafellner, leg. K.Yazıcı, A. Aslan and D. Karahan. (KTUB- 2462), det. K. Yazıcı, D. Karahan and J. Etayo.

Distribution: Previously known from Africa, America, Asia (Russia), Canary Islands, Europe (Austria, England, France, Ireland, Italy, Norway, Spain, Sweden) and Macaronesia: Madeira (Triebel 1989; Diederich & Etayo 2000; Zhurbenko 2007, 2009; Brackel 2010; Diederich *et al.* 2018). Arctic to Antarctic islands (Diederich & Etayo 2000, Diederich & Etayo 2004). New to Turkey.

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REZIME

Novi podaci o lihenikolnim gljivama za Tursku i Aziju

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Tri lihenikolne gljive koje se javljaju na *Tephromela atra* i *Lecidea fuscoatra* – *Rhymbocarpus fuscoatrae*, *Sclerococcum tephromelarum* i *Skyttea tephromelarum*, sakupljene u provincijama Tuncel i Bingöl– su zabeležene kao nove za Tursku i Aziju, prema skorašnjim lihenološkim istraživanjima u ova dva regiona u Turskoj. Dat je kratak opis, uključujući i distribuciju, navedeni su domaćini, kao i poređenje sa sličnim vrstama.

Ključne reči: Ascomycota, Bingöl, biodiverzitet, lihenikolne gljive, Tunceli