

Full Length Research Paper

New records of basidiomycetous macrofungi from Kurdistan region - Northern Iraq

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Received 7 March, 2017; Accepted 15 April, 2017

This study was carried out within February to June, 2015 to 2016 on macrofungi samples collected from different localities within Iraqi Kurdistan region - Northern Iraq. This mountainous region is rich in forest trees with diverse groups of shrubs and herbs and is expected to support the growth of many macrofungal species. However, this part of Iraq is still unexplored from macrofungal point of view. In this paper seven basidiomycetous macrofungal species from seven genera, six families and two orders: *Inocybe flocculosa*, *Pleurotus nebrodensis*, *Psathyrella spadiceogrisea*, *Schizophyllum commune*, *Volvopluteus gloiocephalus* (Agaricales), *Lentinus tigrinus* and *Trametes trogii* (Polyporales) were reported from Iraqi Kurdistan. These macrofungal species are recorded for the first time from Iraq.

Key words: Macrofungi, Agaricales, Polyporales, Iraqi Kurdistan.

INTRODUCTION

Macrofungi (or macromycetes) are fungi that produce fruiting bodies visible to naked eye (Mueller et al., 2007). Macrofungi are Basidiomycota or Ascomycota and most of them are saprotrophic or mutualistic (mycorrhizal) but some are plant pathogens (Mueller et al., 2007; Devi and Shrivastava, 2016). Beside their role in ecosystem processes (decomposers of dead wood, bioremediation and biocontrol agents, mycorrhizal organisms), macrofungi serve as food, medicine and producers of pharmaceutical active compounds and many other benefits (Redhead, 1997; De Silva et al., 2013). Out of 1.5 million species of fungi estimated in the world, only 21,679 macrofungal species (that is, 1.5% of all known

fungi species) have been described (Mueller et al., 2007).

Kurdistan of Iraq is a mountainous region situated at the northern and north eastern parts of Iraq, varying from some 500 to 800 m in altitude in the lowest valleys and 2000 to 3600 m at the summits of the highest ranges (Lahony, 2013).

The Iraqi Kurdistan region (36° 11' 0" N, 44° 0' 0" E) comprises three governorates, Erbil, Suliamaniya and Duhok. It is bordered by Syria to the west, Iran to the east, and Turkey to the north, lying where fertile plains meet the Zagros Mountains. It is traversed by the Sirwan River and the Tigris and its tributaries, the Great Zab and

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the Little Zab.

Kurdistan of Iraq covers about 40,000 Km² of Iraq. It is with a cold winter (December – March or April) and relatively high rainfall upwards to 800 mm and the mountains above approximately the 1800 m level are snowbound for several months and snows often falls in the valleys, while the summer though hot and dry, is comparatively of shorter duration (June to September) than on the other parts of Iraq (May to October). These factors contribute to richer biodiversity situation especially the floral components (Lahony, 2013). Despite its biogeographic importance, Northern Iraq is still unexplored from macrofungal standpoint. However, surveys on macrofungi were reported from some countries bordering Iraq like Turkey (Akata et al., 2014; Güngör et al., 2013; Güngör et al., 2015; Sesli and Denchev, 2008), Iran (Amoopour et al., 2016; Ghobad - Nejhad and Kotiranta, 2008; Ghobad-Nejhad and Hallenberg, 2012), Jordan (Saba, 1991) and Saudi Arabia (Abou - Zeid and Altalhi, 2006). This paper deals with seven basidiomycetous macrofungi new to Iraq.

MATERIALS AND METHODS

Macrofungi samples were collected from different localities within Kurdistan region in the north of Iraq during February to June, 2015 to 2016. These localities are Sami Abdul - Rahman Park (36° 11' 32.6328" N 43° 59' 7.3356" E, elevation 394 m) and Qandil mountains (36° 32' 28" N 44° 59' 46" E, elevation 3587 m), Erbil district; Chuwarta (35° 43' N 45° 34' E, 20 Km NE Suliamaniya, elevation 1361 m), Dukan lake (36° 08' N 44° 55' E, 60 km NW of Suliamaniya, elevation 515 m) and Tawela (35° 12' N 46° 10' E, elevation 1500 m), Suliamaniya district; Amadia (37° 05' 33" N 43° 29' 14"E, 70 km N of Duhok, elevation 1202 m), Amadia district. Habit (solitary, gregarious or other growth form) and habitat (host or substratum) of the samples with season of fruiting body appearance were recorded and samples were photographed in their natural habitats. Macroscopic features (including features such as cap size, shape, color and surface texture; gills color, attachment to stipe (if present); stipe size, color and surface texture) and microscopic features (including characters like basidia size and their spore number, spore shape, size and color and presence or absence of cystidia and their shapes and types) of macrofungi were reported. Cotton blue in lactophenol was used for light microscopy. Macrofungi were identified according to literatures, keys and monographs (Gargano et al., 2011; Justo et al., 2011; Kuo, 2003; Kuo, 2011; Laursen et al., 2013; Phillips, 2013; Ryvarden and Gilbertson, 1993; Senthilarasu, 2015; Watanabe, 2010). All samples were deposited in Biology Department, College of Sciences, Tikrit University.

RESULTS AND DISCUSSION

During the survey of different localities of Iraqi Kurdistan region, Northern Iraq, seven basidiomycetous macrofungal species, *Inocybe flocculosa*, *Pleurotus nebrodensis*, *Psathyrella spadiceogrisea*, *Schizophyllum commune*, *Volvopluteus gloiocephalus* (Agaricales), *Lentinus tigrinus* and *Trametes trogii* (Polyporales) were reported. These fungi are reported for the first time from

Iraq. Their description and distribution are given as follows:

Kingdom: Fungi
 Subkingdom: Dikarya
 Phylum: Basidiomycota
 Subphylum: Agaricomycotina
 Class: Agaricomycetes
 Subclass: Agaricomycetidae
 Order: Agaricales
 Family: Inocybaceae
 Species: *Inocybe flocculosa* (Berk) Sacc.
 Fruiting body: Cap 20 to 25 mm broad, tiny, fibrous, bell or convex with light umbonate, pale brown, surface tomentose to squamose appear lighter than the ground color; gills attached to the stipe, pale brown, crowded; stipe 40 to 60 mm long, 3.0 to 3.8 mm wide, cylindrical, surface cream colored, pruinose, solid, bent at the bulbous base, central; ring and volva absent (Figure 1). Microscopic feature: Basidium 20 - 25 × 6.25 - 7.5 µm, 4-spored, spores 8.0 - 11.25 × 5.5 - 6.5 µm, almond, smooth, light brown color; cheilocystidia and pleurocystidia similar 90.6 - 112.0 × 20 - 25 µm, hyaline, fusiform, apically with light brown crystals (Figure 2).

Gregarious among leaf litter in mixed forest of *Quercus* spp. and other tree species in Chuwarta, Suliamaniya district, inedible, March to April. *Inocybe flocculosa* was reported from Japan (Kobayashi and Courtecuisse, 1993), India (Cimap, 2005) and Turkey (Sesli and Denchev, 2008; Solak et al., 2009). Reports are not available on this species from Iran and Arab countries bordering Iraq.

Order: Agaricales
 Family: Pleurotaceae
 Species: *Pleurotus nebrodensis* (Inzenga) Quel.
 Fruiting body: cap 38 to 142 mm broad, 60 to 110 mm high, fleshy, initially hemispherical to convex with inrolled margin, then flattens and finally depressed at centre with uplifted wavy margin, smooth, cracking a part at maturity; gills decurrent, whitish at first then turn white yellowish or creamy or light brown, crowded, edges smooth; stipe 35 to 83 mm long, 17 to 38 mm wide, cream or whitish, central or excentric, unequal cylindrical, often bent, surface with longitudinal grooves, solid; ring and volva absent (Figure 3). Microscopic features: Basidium 45 - 55 × 8 - 10 µm, 4-spored, spores 9.0 - 12.5 × 5.0 - 7.5 µm, hyaline, cylindrical, smooth; cheilocystidia abundant 45 - 50 × 7.5 - 9.0 µm, granular capitate (Figure 4).

Solitary or gregarious on plants debris, edible, Haw Mountain, Amadia district and Qandil Mountain, Erbil district, April to May. *Pleurotus nebrodensis* was reported from Turkey (Sesli and Denchev, 2008) and other countries like Spain (De Román and Boa, 2004) and Italy (Venturella et al., 2002). This species was declared by IUCN as critically endangered species in 2006



Figure 1. *Inocybe flocculosa*. a – c: fruiting body.

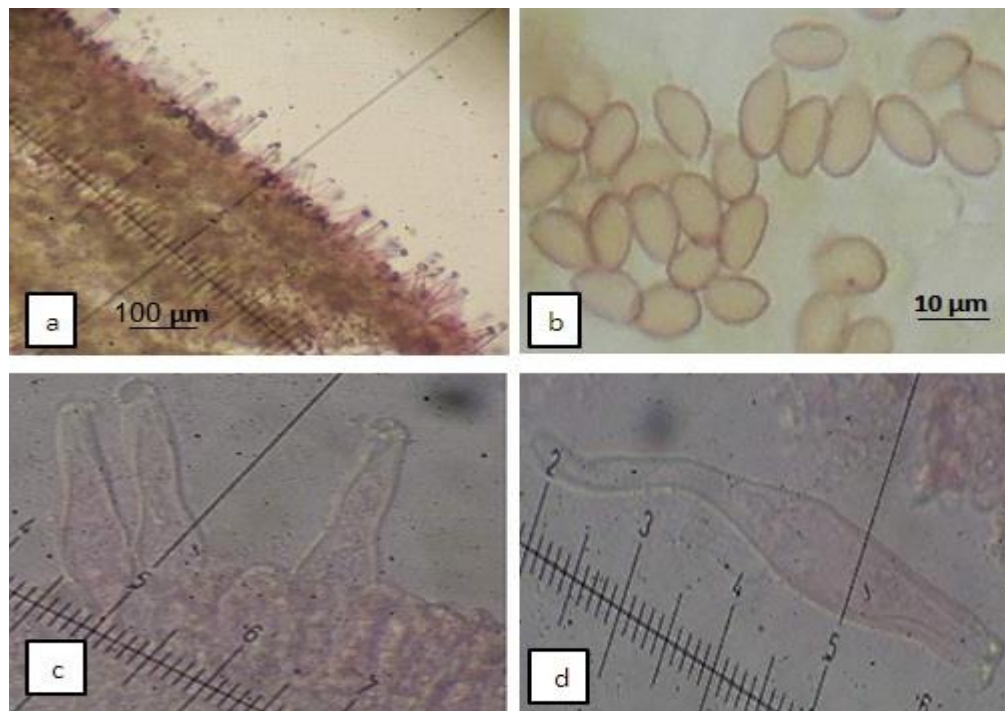


Figure 2. *Inocybe flocculosa*. a, hymenium; b, spores; c, d, cystidia (1 line = 2.5 µm).

(Venturella, 2006).

Order: Agaricales
Family: Psathyrellaceae

Species: *Psathyrella spadiceogrisea* (Schaeff.) Maire.
Fruiting body: Cap 10 to 30 mm broad, 5 to 10 mm high, somewhat fleshy, conical or convex, smooth, medium brown; gills attached to the stipe, dark brown; stipe 10 to

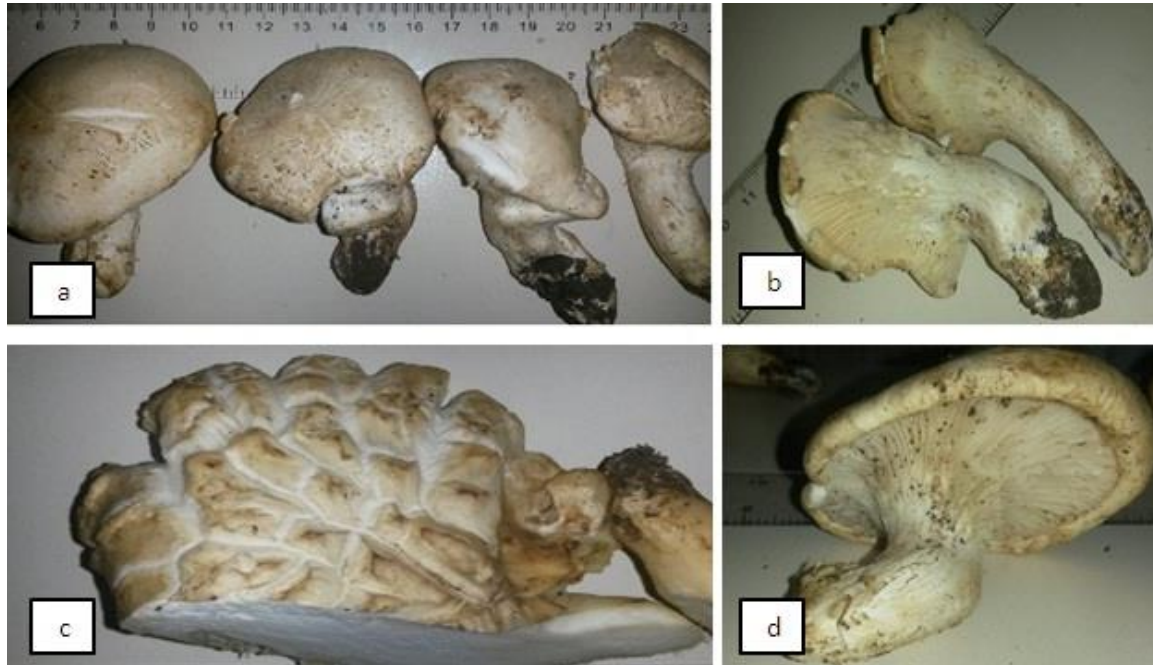


Figure 3. *Pleurotus nebrodensis*. a - d, fruiting body. Note the bent stipe in d.

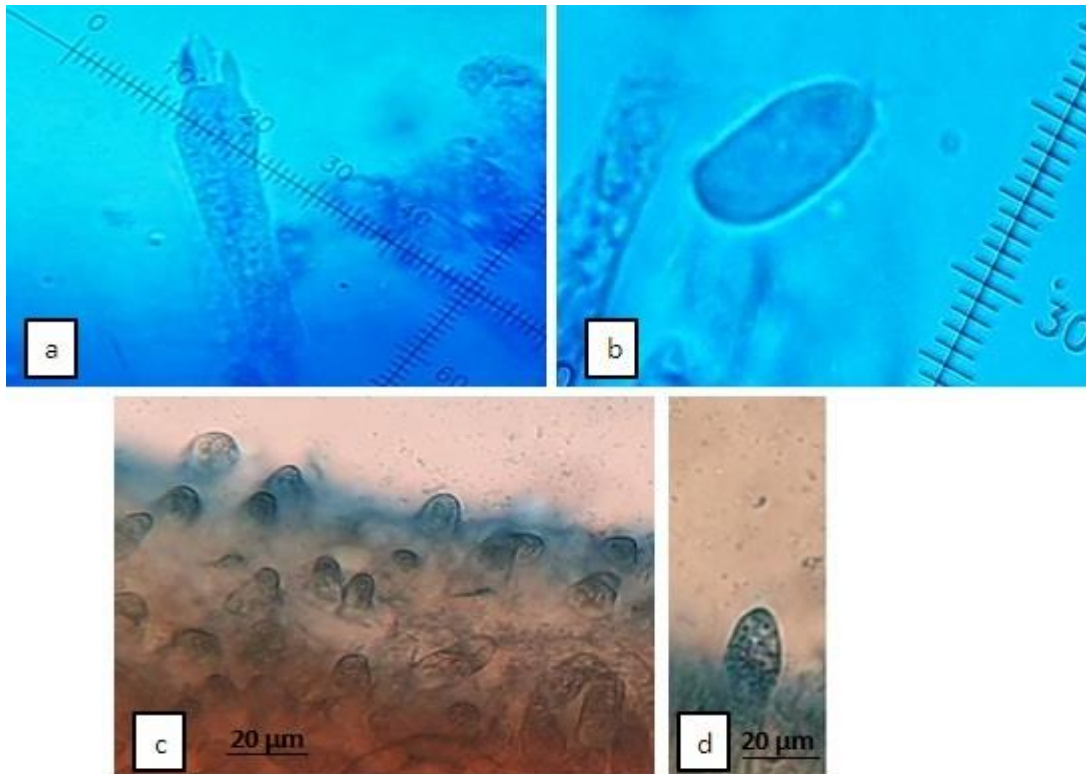


Figure 4. *P. nebrodensis*. a, basidium; b, spore; c, cheilocystidia - surface view; d, granular capitates cystidia . a, c, d: 1 line = 2 μ m.

50 mm long, 10 to 12 mm wide, unequal cylindrical, central, hollow, whitish, appear dark brown at the upper

part near the cap, without ring and volva (Figure 5).
Microscopic features: Basidium 20 - 25 \times 10 - 12 μ m, 4



Figure 5. *Psathyrella spadiceogrisea*. a, fruiting body in natural habitat; b, unequal cylindrical stipe; c, gills - stipe attachment.

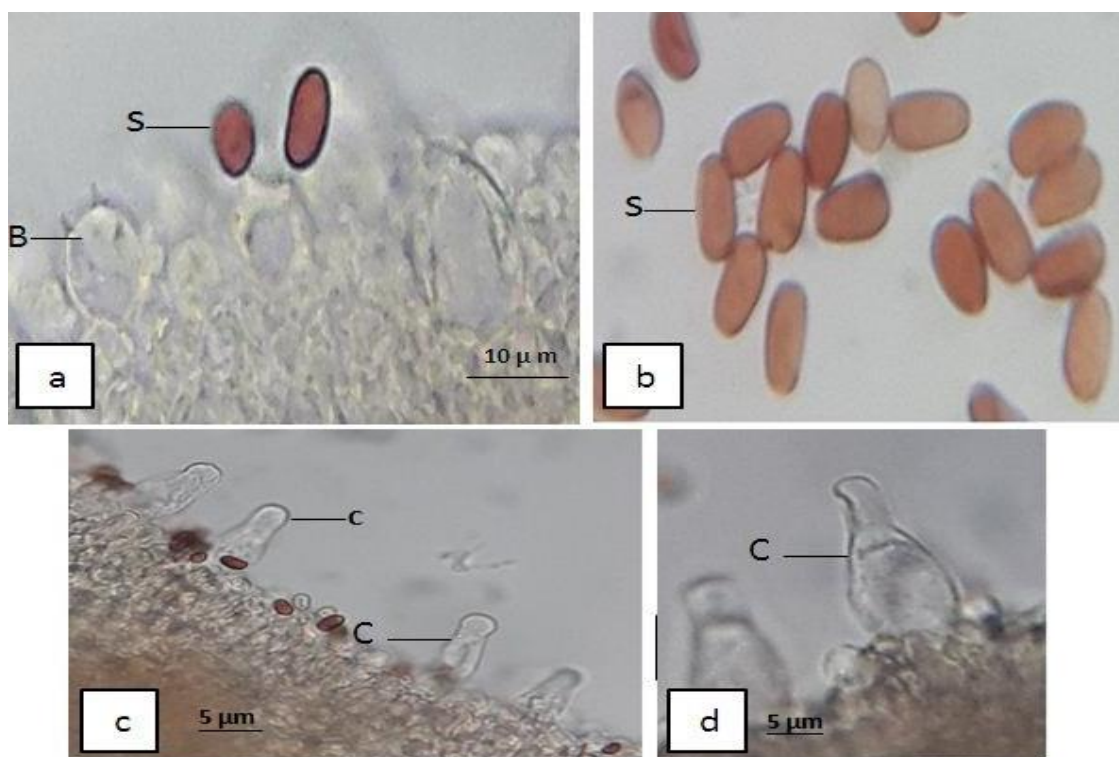


Figure 6. *P. spadiceogrisea*. a, basidium (B) and spores (S); b, spores; c, pleurocystidia - surface view ; d, utriform pleurocystidia (C).

- spored, spores $7 - 10 \times 4.0 - 6.5 \mu\text{m}$, elliptical with pore, smooth, deep brown; pleurocystidia clavate and utriform to about $50.0 \times 12.5 \mu\text{m}$; cheilocystidia similar to utriform pleurocystidia (Figure 6) .

Solitary or gregarious on trunks of dead grape (*Vitis vinifera*) trees, inedible, Dukan Lake, Sulaimaniya district, February to March . This fungal species was reported from Italy (Perini et al., 1999), Austria (Pidlich - Aigner et



Figure 7. *Schizophyllum commune*. a, b, fruiting body in natural habitat; c, fruiting body on burned trunk.

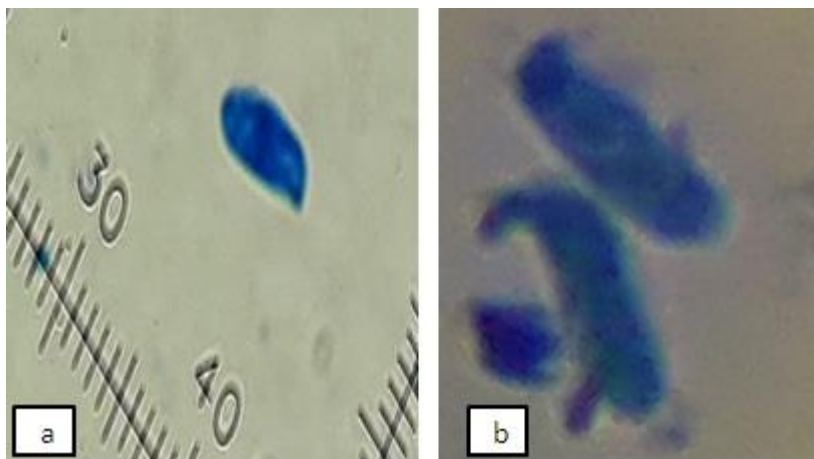


Figure 8. *S. commune*. a, spore; b, spores magnified . 1 Line = 1 µm.

al., 2001), Czech Republic and Slovakia (Vašutová, 2006), Nordic countries (Larsson and Örstadius, 2008), Turkey (Doğan et al., 2007; Sesli and Denchev, 2008) and Cameron (Kinge et al., 2013).

Order: Agaricales

Family: Schizophyllaceae

Species: *Schizophyllum commune* Fries

Fruiting body: Cap 10 to 50 mm broad, tiny, sessile or on short stem, fan shaped or shell shaped, irregular, depending on where it attached to the trunk, white to light grayish or tan, upper surface covered with dense hairs; gills grayish, narrow, diffuse from the attachment point,

split longitudinally and they curl back to protect the hymenium during dry weather (Figure 7). Microscopic features: basidium 4 - spored; spores 5.5 - 7.0 × 0.9 - 3.0 µm, cylindrical, curved in one end, smooth, hyaline; clamp connections present; cystidia absent (Figure 8).

Overlapping or gregariously on dead or living *Prunus domestica* and *P. armeniaca* trees, edible, Dukan Lake, Sulaimaniya district, March to April. *Schizophyllum commune* was reported from Turkey (Afyon et al., 2005; Sesli and Denchev, 2008), Iran (Ghobad-Nejhad and Wallenberg, 2012) and other countries like Brazil (Groposo and Loguercio, 2005).



Figure 9. *Volvopluteus gloiocephalus*. a, b, fruiting body in natural habitat with bell shaped cap in a and convex cap in b; c, crowded gills; d, stipe with volva; e, stipe with white granules.

Order: Agaricales

Family: Pluteaceae

Species: *Volvopluteus gloiocephalus* (DC.) Vizzini, Contu & Justo

Fruiting body: Cap 76 to 90 mm broad, fleshy, bell shaped at early stage becoming convex or flat in age with umbonate, radially streaked with appressed pale grayish fibrils, smooth, shiny, whitish to creamy; gills free from the stipe, broad, thick, crowded and have a pink color; stipe 124 to 129 mm long, 10 to 12 mm wide, solid, easy to separate from the cap, cylindrical tapering slightly to top, pruinose, ring absent; volva: 21 to 25 mm long, membranous, sac-like (Figure 9). Microscopic features: Basidium $22.5 - 40.0 \times 10.0 - 12.5 \mu\text{m}$, 4-spored; spores $10.0 - 17.5 \times 8.0 - 11.25 \mu\text{m}$, elliptical with smooth wall, pinkish brown color; both pleurocystidia ($50 - 75 \times 10 - 15 \mu\text{m}$) and cheilocystidia clavate; clamp connections absent (Figure 10).

Solitary, scattered on soil, edible, Sami Abdul - Rahman Park, Erbil district, March to April. *Volvopluteus gloiocephalus* was reported from Turkey (Atila and Kaya, 2008; Kaya, 2015) and Iran (Fadavi and Abbasi, 2015).

Order: Polyporales

Family: Polyporaceae

Species: *Lentinus tigrinus* (Bull.) Fr.

Fruiting body: Cap 42 to 140 mm broad, fleshy, convex at early stage with blackish brown then becoming funnel shaped and white yellowish color with a somewhat wavy margin, upper surface covered with dense blackish brown hairs or scales which become scattered and crowded over the center in age; gills - like decurrent, white to yellowish white, crowded, toothed; stipe 48 to 62 mm long, 6 to 12 mm wide, yellowish white, centric, cylindrical, attenuate downwards into blackish root-like extension, covered with blackish brown hairy scales, dark at the base, often bent, hollow; ring and volva absent (Figure 11). Microscopic features: basidium $18 - 20 \times 4.5 - 5.0 \mu\text{m}$, 4-spored; spores $6.25 - 10.0 \times 2.5 - 3.75 \mu\text{m}$, narrow cylindrical or fusiform, hyaline, smooth; clamp connections present; cystidia absent (Figure 12).

Gregarious on dead *Pistacia atlantica* trees (Habbat Khadra in Arabic, Qazwan in Kurdish), locally edible, Haw mountain, Amadia, Amadia district, April to June. This

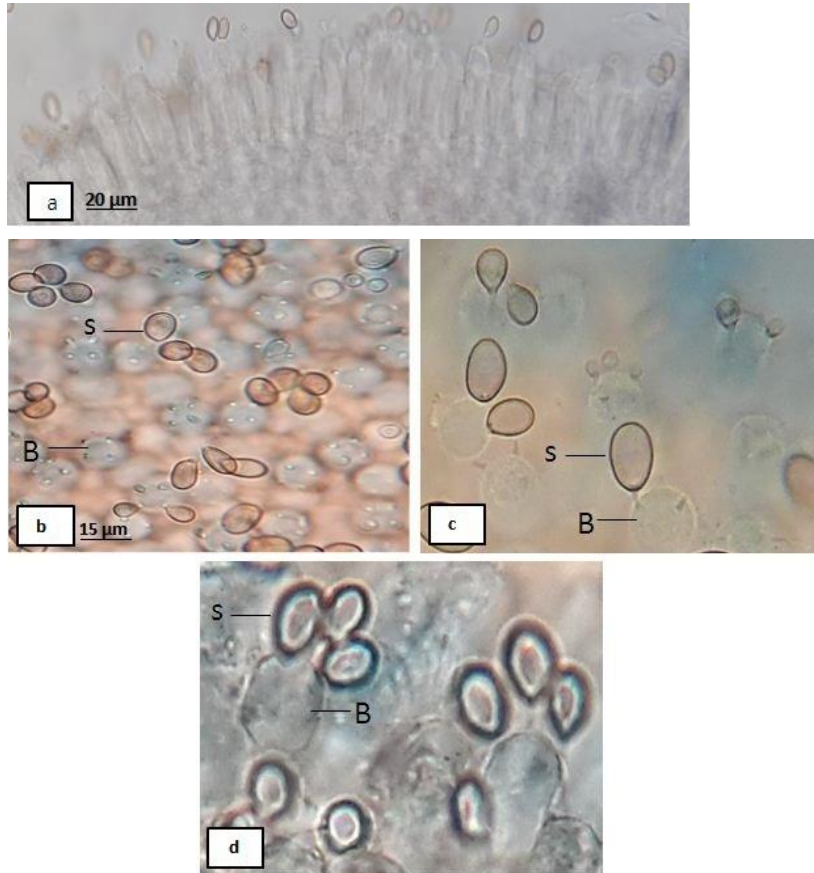


Figure 10. *V. gloiocephalus*. a, hymenium; b, basidia (B) and spores (S) surface view; c, d, basidia and spores magnified.

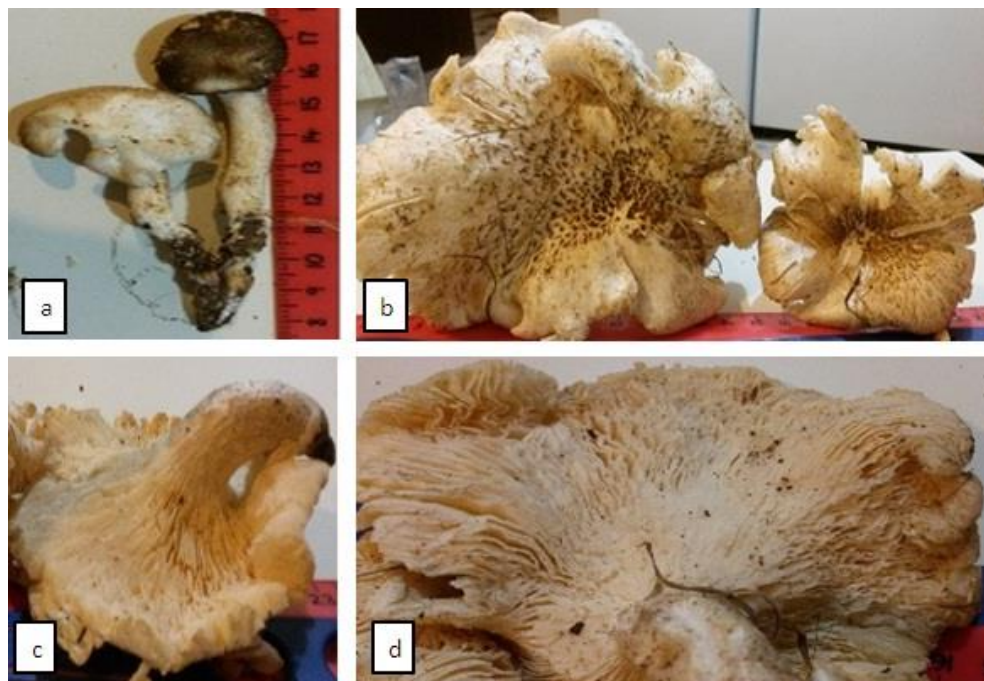


Figure 11. *Lentinus tigrinus*. a, young fruiting body with blackish cap; b, cap upper surface covered with blackish brown hairs; crowded hairs over cap center; c, hairs on the stipe; d, toothed gills .

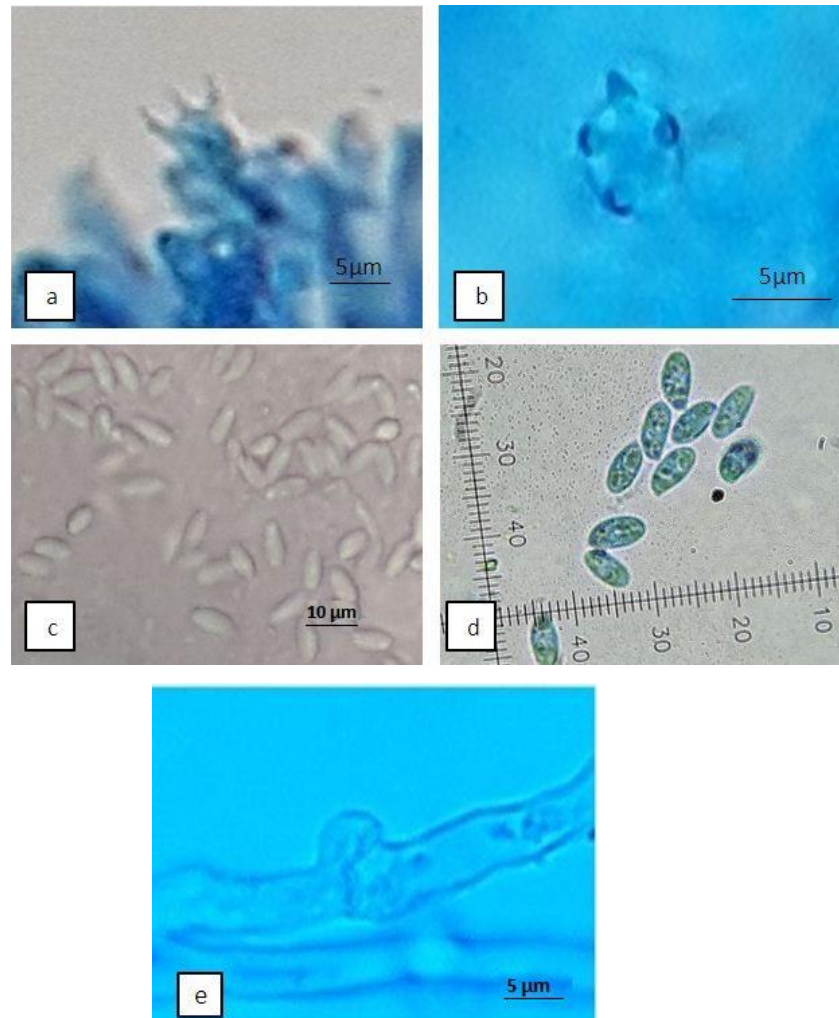


Figure 12. *L. tigrinus*. a, basidium in section; b, basidium in surface view with four sterigmata; c, spores unstained; d, spores stained ; e, clamp connection.

fungus was reported from Turkey (Sesli and Denchev, 2008), south western Nigeria (Adejumo and Awosanya, 2005), Thailand (Karunarathnas et al., 2011), Philippine (Dulay et al., 2014; Dulay et al., 2012), Pakistan (Razaq and Shahzad, 2015) and India (Senthilarasu, 2015; Sharma and Atri, 2015).

Order: Polyporales

Family: Polyporaceae

Species: *Trametes trogii* Berk.

Fruiting body: Cap 46 to 163 mm long, sessile, effused or resupinate, snowy white or cottony colored flesh. In maturity, the color turns to cream - buff or brown - buff, the upper surface covered with roughen brown hairs and the texture of the fungus becomes tough and wooden in age and shows the surface of the cap divided into zonate and sharp edges, flesh brown, continuous with tubular layer and characterized by the inability to separate the tubes from each other and ends at apex with circular

brown pores (Figure 13). Microscopic features: Basidium 19 - 22 × 5.5 - 7.5 μm wide, 4 - spored, spores 10.0 - 12.5 × 2.5 - 5.0 μm, cylindrical, hyaline; hyphal system, trimitic, generative hyphae with clamp connections, skeletal hyphae with non - septate and binding hyphae that is frequently branching; cystidia absent (Figure 14).

Gregarious to cluster on soil in orchards and on dead *Populus* trees, inedible, Amadia, Amadia district, April to June. *Trametes trogii* was reported from Turkey (Sesli and Denchev, 2008) and warmer parts of Europe (Ryvarden and Gilbertson, 1993).

Conclusion

It is concluded that the vegetation and climatic conditions make Iraqi Kurdistan an ideal place for growth and development of macrofungi. This region is still unexplored

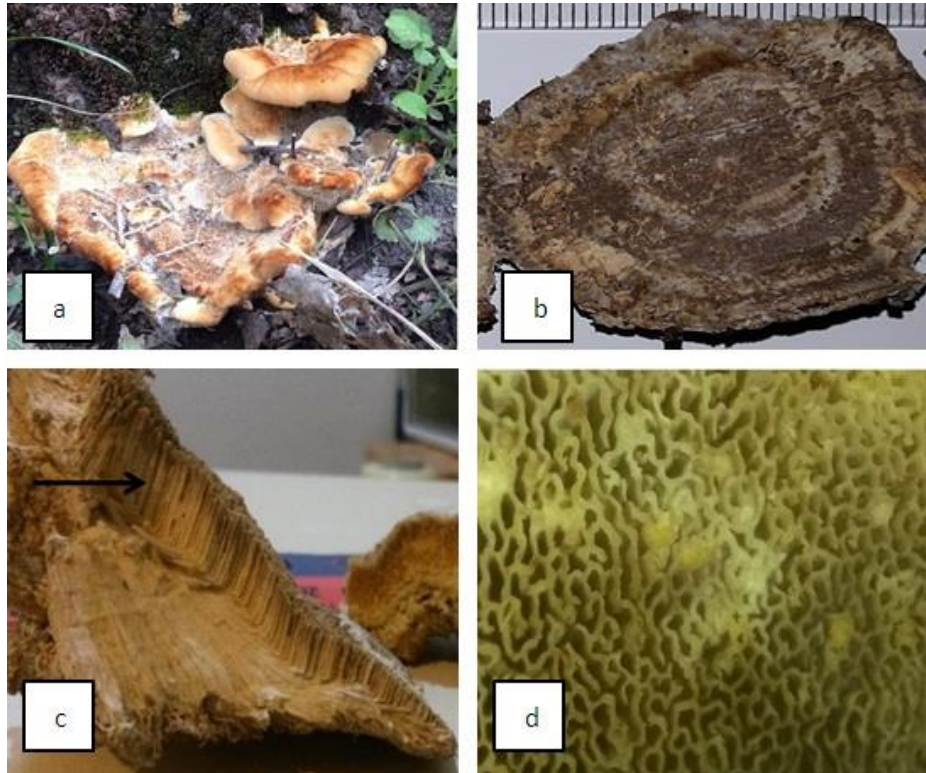


Figure 13. *Trametes trogii*. a, fleshy fruiting body in natural habitat; b, woody fruiting body with zonate upper surface; c, tubular layer of fruiting body; d, porous upper surface.

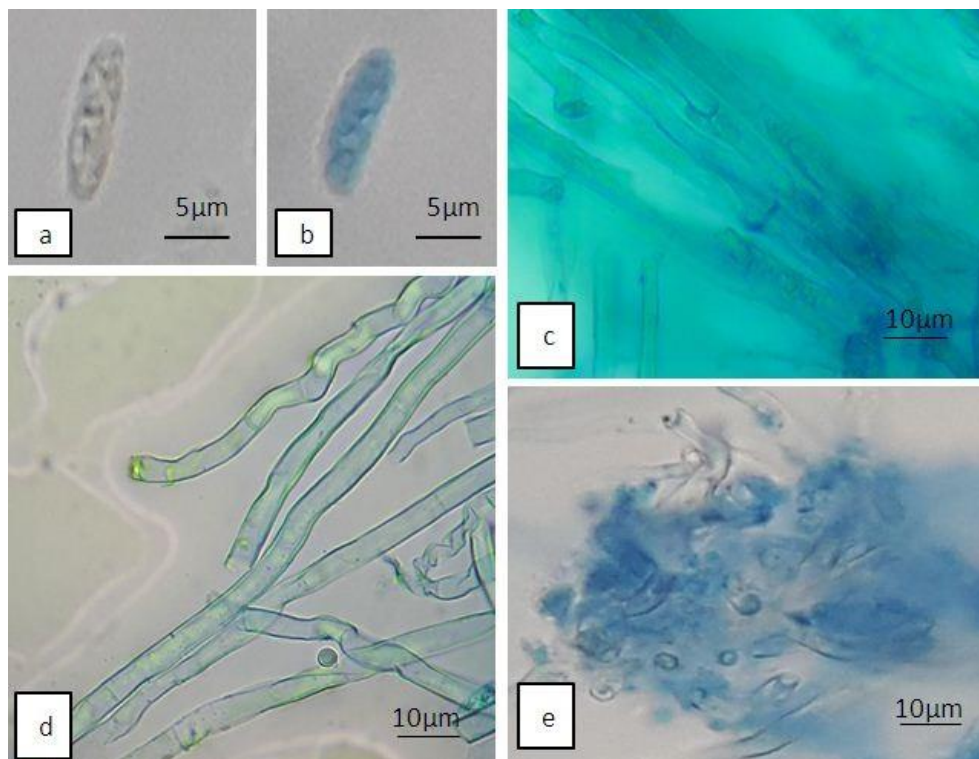


Figure 14. *Trametes trogii*. a, stained spore; b, unstained spore; c, generative hyphae with clamp connections; d, skeletal hyphae; e, binding hyphae.

from macrofungal point of view. Hence further survey of this group of fungi in this region is of great importance towards creating a checklist of macrofungi in Iraq.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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