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Ten Previously Unreported Basidiomycota Macrofungi from Salahadin Governorate Including Five New Records to Iraq

Talib O. Al-Khesraji*

Department of Biology, College of Education for Pure Sciences, Tikrit University, Iraq

*Corresponding author.

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ABSTRACT

Macrofungi specimens were collected from Tikrit and Dujail districts of Salahadin Governorate (North Central Iraq) between 2017 and 2018. Ten Basidiomycota macrofungal species (*Agrocybe praecox*, *Clitocybe flavidella*, *Conocybe deliquescens*, *Coprinopsis romagnesiana*, *Lentinus tigrinus*, *Panaeolus papilionaceus*, *Parasola plicatilis*, *Psathyrella candolleana*, *P. spadiceogrisea*, *Volvopluteus gloiocephalus*) belonging to 9 genera, 6 families and 2 orders were recorded. Five of these species are new to macrofungi of Iraq. Macroscopic and microscopic characteristics of the recorded fungal taxa are given.

Introduction

Macrofungi (or macromycetes) are fungi that produce fruiting bodies visible to naked eye (Mueller et al., 2007) and can also be defined as fungi that form macroscopic fruiting bodies (Hawksworth et al., 1995; Bates, 2006) or fungi with fruiting bodies greater than one centimeter in diameter (Redhead, 1997). Mushrooms, puffballs, stinkhorns, bracket fungi, toadstools, coral fungi and truffles are well known examples of macrofungi. Most macrofungi are included in Basidiomycota or Ascomycota (Mueller et al., 2007). These fungi are saprobic or mutualistic but

few species are plant pathogens (Devi and Shrivastava, 2016). Macrofungi are among the most important organisms on the planet (Mueller and Bills, 2004). They perform a vital role in both agro and natural ecosystems (Ex.: in cycling of nutrients, decomposing of plant and animal remains, as biofertilizers and in bioremediation) (Redhead, 1997; Gadd, 2001). Beside of this, they are used as food, medicine and sources of pharmaceutical active compounds (Redhead, 1997; Chang and Miles, 2004; De Silva et al., 2013).

Salahadin Governorate (North Central Iraq / North of Baghdad, the capital of Iraq) is one of the most

rural province in Iraq and the arable land covers half of the governorate total area (24,751 Km²). It is divided into 8 districts (Al-Shirkat, Al-daur, Baiji, Balad, Dujail, Samaraa, Tikrit and Tooz). Topography of this governorate includes foothills in north eastern parts and desert and steppe in southwest. Most of southwest parts of the governorate receive low levels of precipitation (175-225mm per year) but more precipitation occurs in hilly areas (250-350mm per year). So, agriculture in the governorate depends on irrigation from Tigris River. Salahadin province is rich in vegetation, including tree species (like *Salix* sp., *Populus* spp., *Pinus* sp. and several fruit trees species) with various shrub and herb species. This vegetation richness is expected to harbour a wide variety of macrofungi. Information on these fungi from Salahadin Governorate is very poor, thus the aim of this study was to identify and document the macrofungi present in two districts (Dujail and Tikrit) from Salahadin Governorate and to provide a new contribution to Iraqi macromycota.

Materials and methods

The macrofungi specimens were collected from

Dujail (33°51'0"N44°14'0" / 65 Km North Baghdad) and Tikrit (34°36'36"N43°40'48" / 180 Km North Baghdad) districts of Salahadin Governorate (Fig. 1), between 2017 and 2018. The fungal specimens were photographed in their natural habitat and necessary data on habit, habitat, locality and season were recorded. Macroscopic (such as colour, size and surface texture of the cap, spore print, gills colour, spacing, attachment to stipe, size, colour and surface texture of the stipe and presence or absence of volva and annulus) and microscopic (such as basidium size, number of spores per basidium, spore size and size and shape of cystidia if present) features were reported. Cotton blue in lactophenol and 3% KOH were used for microscopy. Identification of the specimens was accomplished according to relevant literatures, keys and monographs (Richardson and Watling, 1997; Keirle et al., 2004; Noordeloos et al., 2005; Kuo, 2004, 2006, 2007, 2008, 2010, 2011a-c, 2017; Schafer, 2010; Kaur et al., 2014; Adhikari, 2014; Desjardin et al., 2015; O'Reilly, 2016; Lee et al., 2017; Melzer, 2017; Suliaman et al., 2017). Identified specimens are kept in the Department of Biology, College of Education for Pure Sciences, Tikrit University, Iraq.

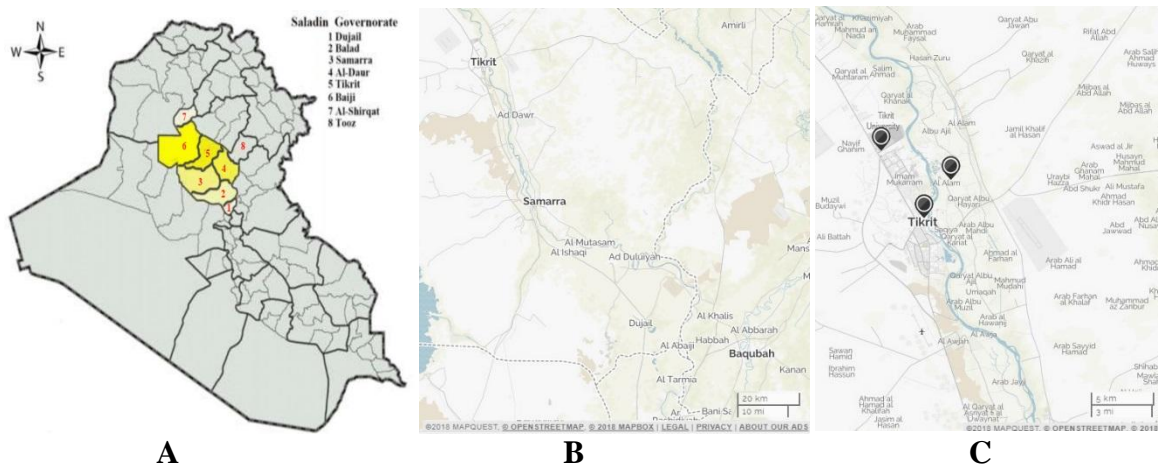


Fig. 1: Maps of study area. A, Iraq and districts of Salahadin Governorate ; B, C, study area.

Results and discussion

Ten Basidiomycota macrofungal species belonging to 9 genera, 6 families and 2 orders (*Agrocybe praecox*, *Clitocybe flavidella*, *Conocybe*

deliquescens, *Coprinopsis romagnesiana*, *Lentinus tigrinus*, *Panaeolus papilionaceus*, *Parasola plicatilis*, *Psathyrella candolleana*, *P. spadiceogrisea*, and *Volvopluteus gloiocephalus*) were reported for the first time from Salahadin

Governorate. Five of these species (*P. papilionaceus*, *C. deliquescens*, *C. flavidella*, *C. romagnesiana*, and *P. plicatilis*) are new to Iraqi macromycota. All recorded fungal species are saprotrophic in habitats, five of which (*C. flavidella*, *C. romagnesiana*, *P. papilionaceus*, *P. plicatilis* and *V. gloiocephalus*) are rarely observed in study area. Below, description and distribution of the identified

species are given.

Kingdom : Mycetae
 Phylum : Basidiomycota
 Class : Agaricomycetes
 Order : Agaricales
 Family : Bolbitiaceae
 Species : *Panaeolus papilionaceus*
 (Bull. ex Fries) Quelet (Fig. 2).

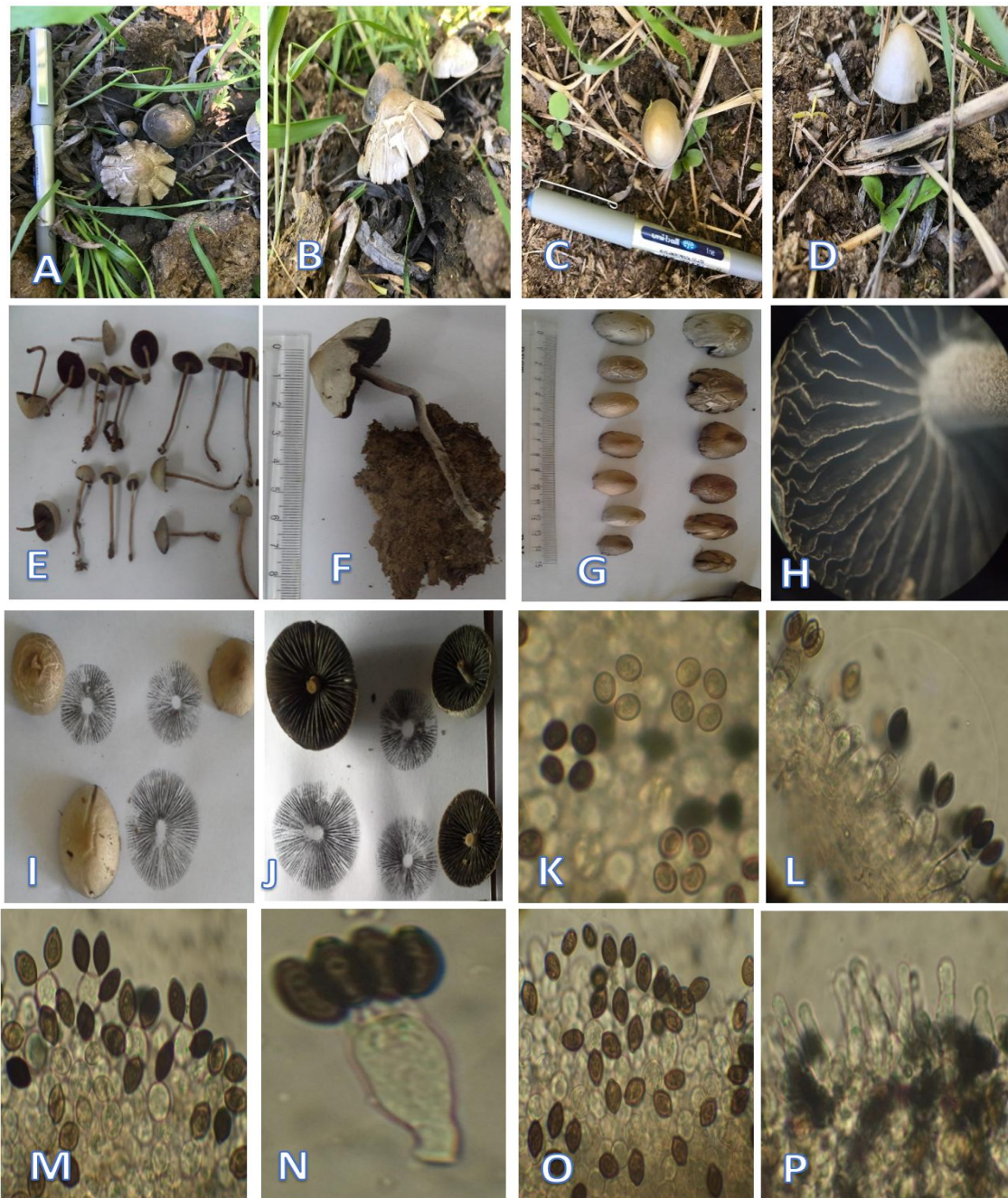


Fig. 2: *P. papilionaceus*. A-D, fruiting bodies in habitat; E-G, fruiting bodies in lab.; H, gills; I, J, spore print; K-N, basidia; O, spores; P, cheilocystidia.

Macroscopic features: *Cap:* 1-3 cm across, conical to bell-shaped or hemispherical when young, expanding to broad bell-shaped at age and sometimes cracked at maturity, gray, brown gray or sometimes olive-brown, surface smooth, margin splitting at age. *Gills:* attached to stipe, crowded or close, unequal, grayish when young then black at maturity, mottled with white edges. *Stipe:* 3-10 cm long, 1.5 -2.5 mm thick, cylindrical, central, equal, solid, some time enlarged toward the base or apex, white, brown gray or pinkish brown, pruinose. Spore print black.

Microscopic features: *Basidia:* 25 -37.5 X 12.5-13.5 μm , 4- spored, spores 12.5- 15 X 10 - 11.5 μm , elliptical or lemon-shaped with broad apical germ pore, smooth, black or blackish brown.

Pleurocystidia absent, cheilocystidia many, capitate, clavate, subcylindrical, lageniform. *Habit and habitat:* singly or gregariously on cow dung; fruiting spring and winter. Al-Efri village / Al-Alam City / Tikrit district. This species occurs on different kinds of dung (horse, camel, donkey, cow) (Gerhardt, 1996; Mohammed et al., 2017). Here is the first detailed report on *P. papilionaceous* from Iraq. *P. papilionaceus* was found in Argentina (Niveiro and Alberto, 2012), Europe (O'Reilly, 2016), Guatemala (Florea et al., 2012), India (Amandeep et al., 2015), Nigeria (Mohammed et al., 2017), North America (Kuo, 2007), Greece (Polemis et al., 2012) and Turkey (Sesli and Denchev, 2008).

Species : *Conocybe deliquescens* Hauskn. and Krisai. (Fig. 3).

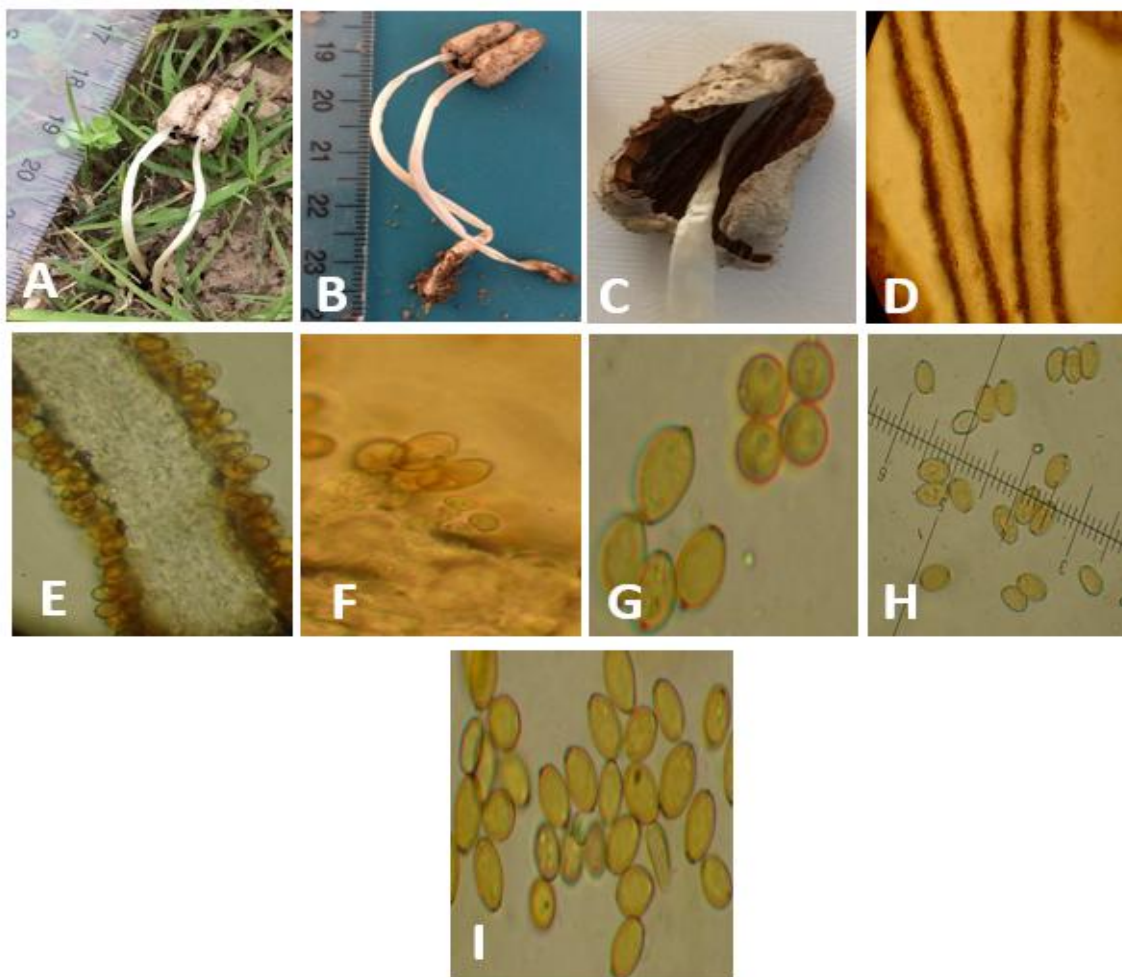


Fig. 3: *C. deliquescens*. A, fruiting body in habitat; B, C, fruiting body in lab.; D, E, deliquesced gill; F, basidium; G, spores of 4-spored basidium; H, I, spores.

Macroscopic features: Cap 1 -1.5 cm wide, 0.5-1.5 cm height, conical to conico-cylindrical, whitish at first, brown to rusty brown in age, smooth, slimy. *Gills:* whitish when young, becoming brown to rusty brown in age, close, deliquescent. *Stipe:* up to 8 cm long, up to 0.3 cm thick, central, hollow, cylindrical with swollen base, bent at maturity, white.

Microscopic features: *Basidia:* 4-spored, 25-30 × 10-12.5 μm, spores 8-14 × 6-9 μm, ellipsoidal,

smooth. Cystidia not distinguished. *Habit and habitat:* saprotrophic, solitary, grassy areas, gardens. *Locality:* University campus / Tikrit city / Tikrit district. March –May. This is the first report of *C. deliquescens* from Iraq. The species was reported from Turkey by Sesli and Denchev (2008).

Family : Pluteaceae

Species : *Volvopluteus gloiocephalus* (DC.) Vizzini, Contu & Justo (Fig. 4).

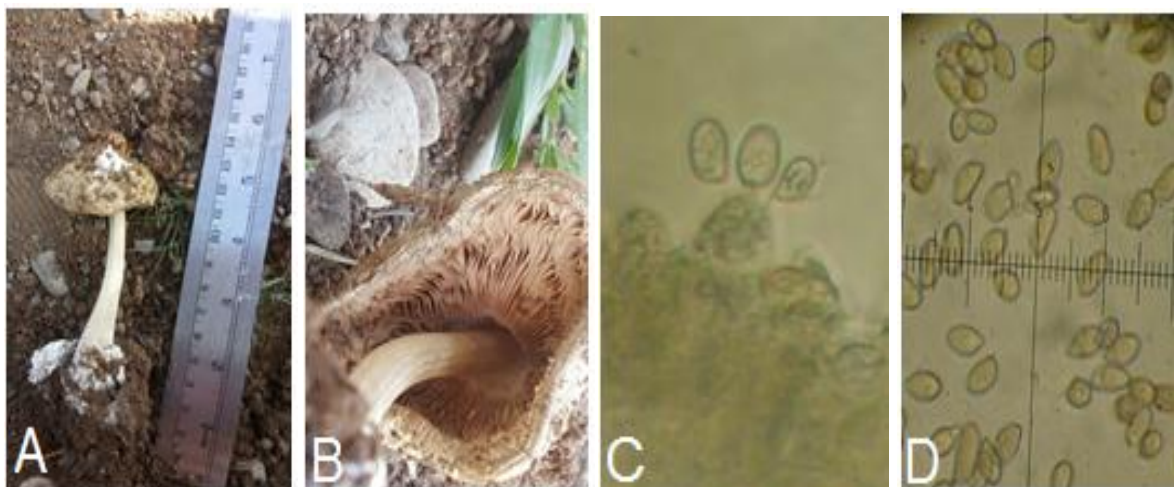


Fig. 4: *V. gloiocephalus*. A, B, fruiting bodies in habitat; C, basidium; D, spores.

Macroscopic features: Cap 5 cm across, convex, greyish brown. *Gills:* white at first, turning pink in age. *Stipe:* 8 cm tall, 1 cm thick, cylindrical with swollen base, central, smooth, volva 1.5 cm high, saccate, smooth, white.

Microscopic features: *Basidia:* 4-spored, 35-40 × 10-15 μm, spores ellipsoidal, 10-16 × 7.5-10 μm, clamp-connections absent. *Habit and habitat:* Saprobic, in grassy areas. *Locality:* University campus / Tikrit district. January- March. This taxon was reported from Northern Iraq by Suliaman et al. (2017) and here is the first report of the fungus from central Iraq (Tikrit district). *V. gloiocephalus* was found in Europe and North America (Justo et al., 2011), India (Amandeep et al., 2015), Morocco (Ajana et al., 2017), Greece (Polemis et al., 2012) and in some countries bordering Iraq like Turkey (Sesli and Denchev, 2008) and Iran (Fadavi et al., 2015).

Family : Psathyrellaceae

Species : *Coprinopsis romagnesiana* (Singer) Redhead, Vilgalys & Moncalo (Fig. 5).

Macroscopic features: Cap 3.5- 7 cm across, ovate at first then to bell-shaped or convex, beige, light brown, with persistent brown scales. *Gills:* attached to the stem or free, crowded, white turned to black at maturity, deliquescing at age. *Stipe:* 6 cm long, 1 cm thick, with slightly rimmed bulbous base, central, solid or slightly hallow, white.

Microscopic features: *Basidia:* 4-spored, 25- 30 × 8 -10 μm, spores 8.75-11.25 × 5-6.25 μm, elliptical, smooth, orange, reddish brown, hymenial cystidia cylindrical 125 × 25 μm. *Habit and habitat:* saprobic, scattered on stumps under *Salix* trees. September-December. Defsha village- Al-Alam city / Tikrit district. This is the first record of *C. romagnesiana* from Iraq. This

fungus was reported from Turkey (Sesli and Denchev, 2008), Korea (Lee et al., 2017), USA

(Kuo, 2008) and Netherlands (Noordeloos et al., 2005).

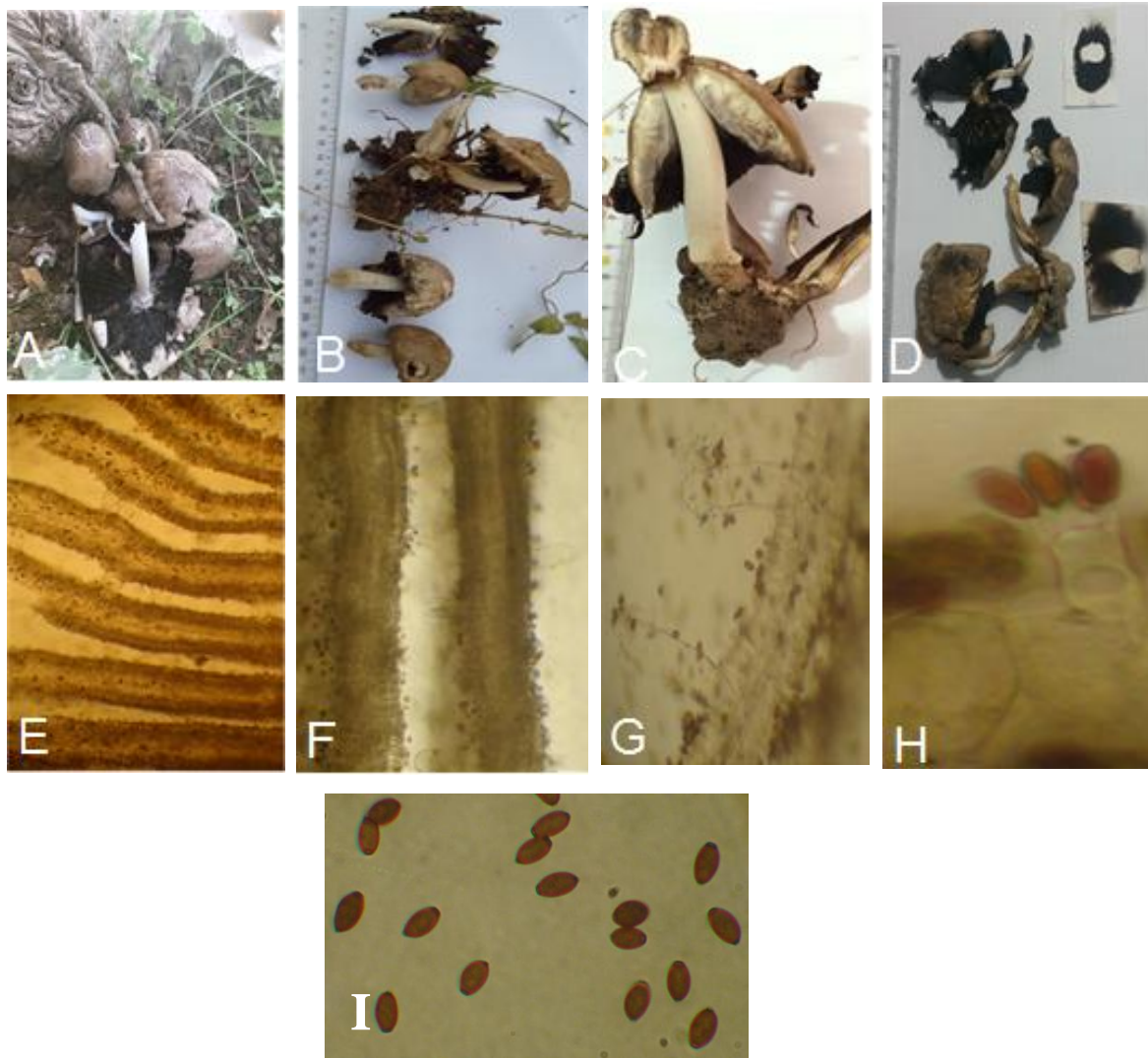


Fig. 5: *C. romagnesiana*. A, fruiting bodies in habit; B, C, fruiting bodies in lab.; D, spore print; E-G, gills and hymenial cystidia; H, basidium; I, spores.

Species: *Parasola plicatilis* (Curtis) Redhead et al. (Fig. 6).

Macroscopic features: Cap up to 2.5 cm in diameter, oval at first then convex to flattened or umbrella-like at maturity, with distinctive central brown disc, strongly grooved, gray, gray-metallic, not deliquescent. *Gills:* free, moderately separated, radiate from a collar around the stipe apex on the underside of the cap, black in age. *Stipe:* up to 7 cm tall, white, hollow, equal, fibrillose. Spore print black.

Microscopic features: *Basidia:* 4-spored, 10 μm in diameter (in surface view), spores ellipsoidal, subellipsoid, oblong, subglobose, $8.75\text{-}11.25 \times 5\text{-}8.25 \mu\text{m}$, with eccentric or central germ pore, dark reddish brown. Both cheilocystidia and pleurocystidia widely cylindrical to subcylindrical, $75\text{-}100 \times 25\text{-}30 \mu\text{m}$. *Habit and habitat:* short lived saprobic fungus grows singly in roads and gardens. Tikrit city (University campus) / Tikrit district. Autumn-Winter. This is the first report of *P. plicatilis* from Iraq. It is a cosmopolitan species, widely distributed in Europe, North America and

USA (Keirle et al., 2004; Kuo, 2011; O'Reilly, 2016) and is found also in Argentina (Niveiro and

Alberto, 2012) and some countries bordering Iraq like Turkey (Sesli and Denchev, 2008).

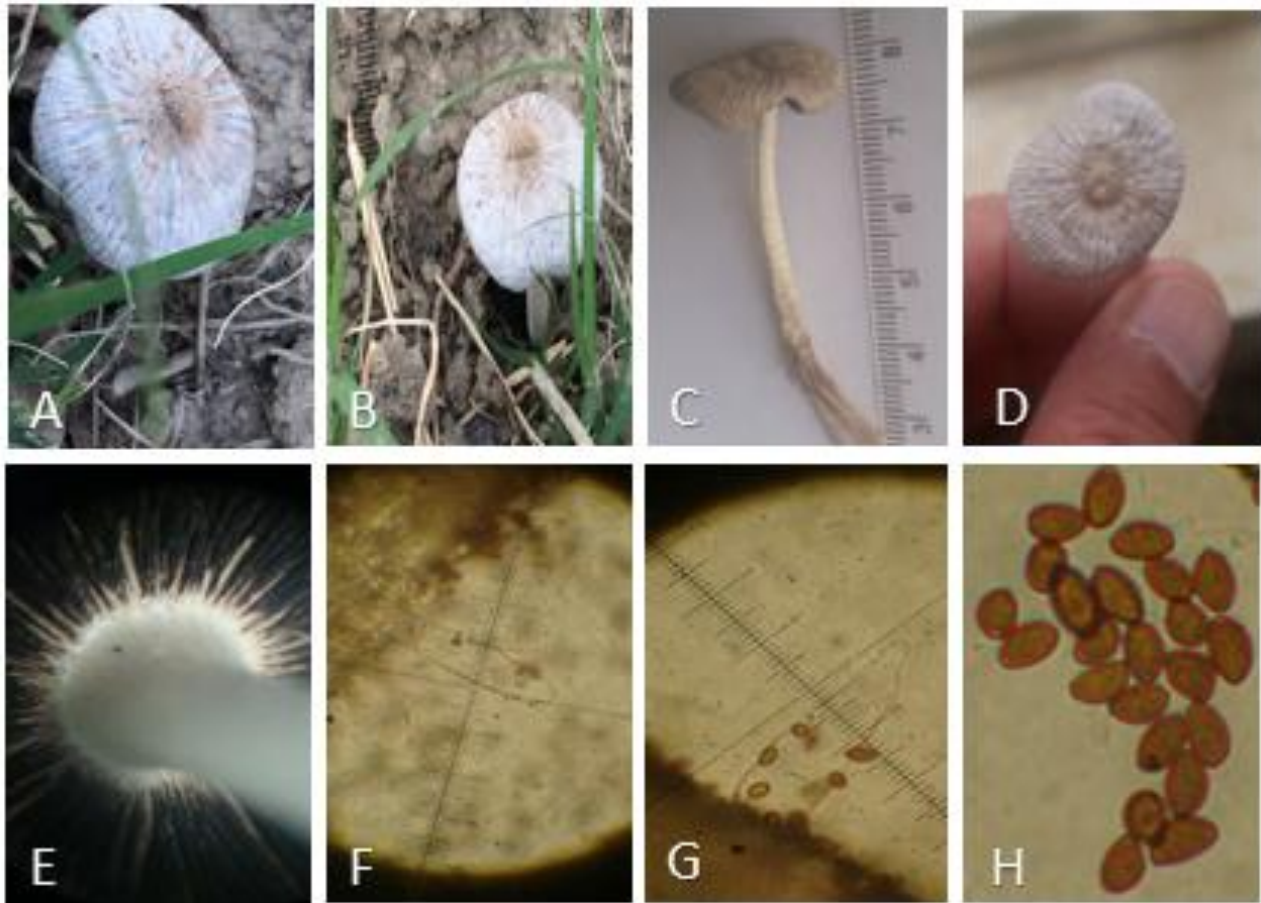


Fig. 6: *P. plicatilis*. A, B, fruiting bodies in habitat; C, D, fruiting bodies in lab.; E, collar and gills; F, G, cystidia; H, spores.

Species : *Psathyrella candolleana* (Fr.) Maire (Fig. 7).

Macroscopic features: Cap up to 7 cm wide, conic at first then becoming broadly convex or flate, margin with white partial veil remnants when young, upturned, often cracked, with brown or light brown disc, hygrophanous, smooth, beige, light brown or nearly white. *Gills:* attached to the stem or free, close or crowded, white or light brown when young, brown to dark brown in age. *Stipe:* up to 8 cm tall, 0.3- 0.7 cm thick, nearly solid when young, hollow in age, cylindrical, white, central.

Microscopic features: *Basidia:* 4-spored, $25-32 \times 10 \mu\text{m}$. Spores $7-8.5 \times 3.5-5 \mu\text{m}$, elliptical with

truncated end, smooth, brown. Spore print purple brown. Pleurocystidia absent, cheilocystidia many, subtriangular, clavate, subclavate. *Habit and habitat:* singly or gregarious in grassy areas or in gardens and cultivated areas. Tikrit University campus. Spring-Winter. *P. candolleana* was first reported from Iraq (in subarid region of Aljazira) by Al-Habib et al. (2014). The present paper reports this species for the first time from Tikrit district / Salahadin Governorate-North central Iraq. *P. candolleana* was reported from North America (Kuo, 2011 a, b), Iran (Karim and Kavosi, 2013), Turkey (Sesli and Denchev, 2008), Poland (Luszczynski, 2007), Greece (Polemis et al., 2012), Pakistan (Razaq et al., 2014), Argentina (Niveiro and Alberto, 2012) and India (Gogoi and Parkash, 2015).

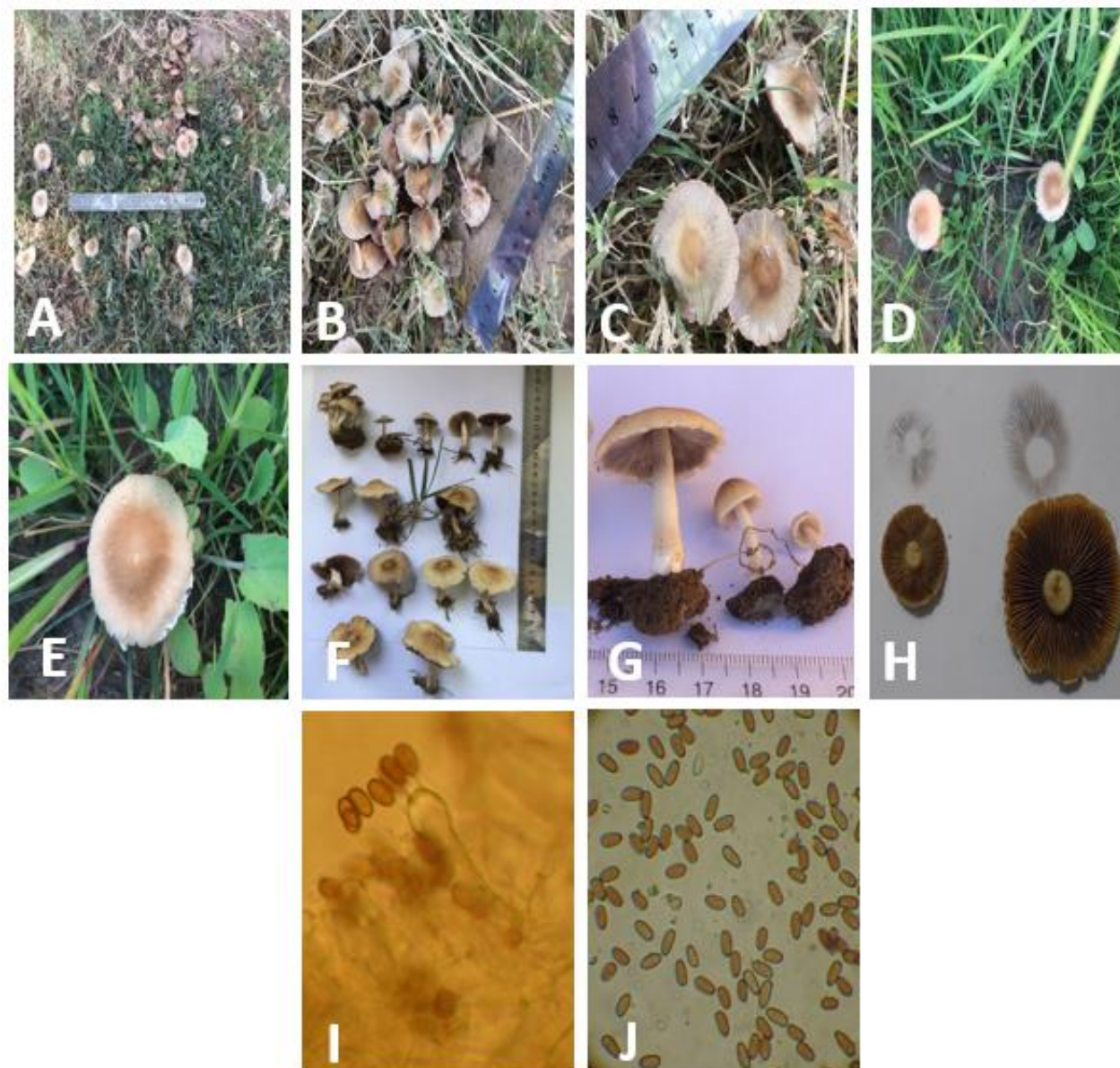


Fig. 7: *P. candolleana*. A-E, fruiting bodies in habitat; F,G, fruiting bodies in lab.; H, gills and spore print; I, basidium; J, spores.

Species : *P. spadiceogrisea* (Schaeff.) Maire (Fig. 8)

Macroscopic features: Cap up to 7cm wide, convex, conical, bell-shaped, flat-cone at maturity, margin finely lined, brown to yellow - brown or gray brown. *Gills:* attached to the stipe, close or slightly distant, first white becoming dark brown. *Stipe:* up to 7c m tall, up to 0.5 cm thick, cylindrical, slightly tapered near the apex, mostly bald, white, hallow. Spore print dark brown with

purple shade.

Microscopic features: *Basidia:* 4- spored, $20-30 \times 7.5-10 \mu\text{m}$, *Spores:* $6.25-10 \times 3-5 \mu\text{m}$, ellipsoidal oval, subcylindrical, often with truncate end, smooth, brown. Cheilocystidia, capitate, cylindrical, utriform $30-45 \times 12.5-15 \mu\text{m}$, pleurocystidia utriform. *Habit and habitat:* Solitary or gregarious on stumps. Tikrit city/ Salahadin Governorate. Spring-Summer. Suliaman et al. (2017) reported this species from Iraqi Kurdistan (Northern Iraq) and the present paper reports this

fungus for the first time from Salahadin Governorate / Tikrit district/ central Iraq. *P. spadiceogrisea* was reported from North America

(Kuo, 2011c), Turkey (Sesli and Denchev, 2008), Poland (Luszczynski, 2007), Serbia (Vukojevic et al., 2016) and Cameron (Kinge et al., 2013).

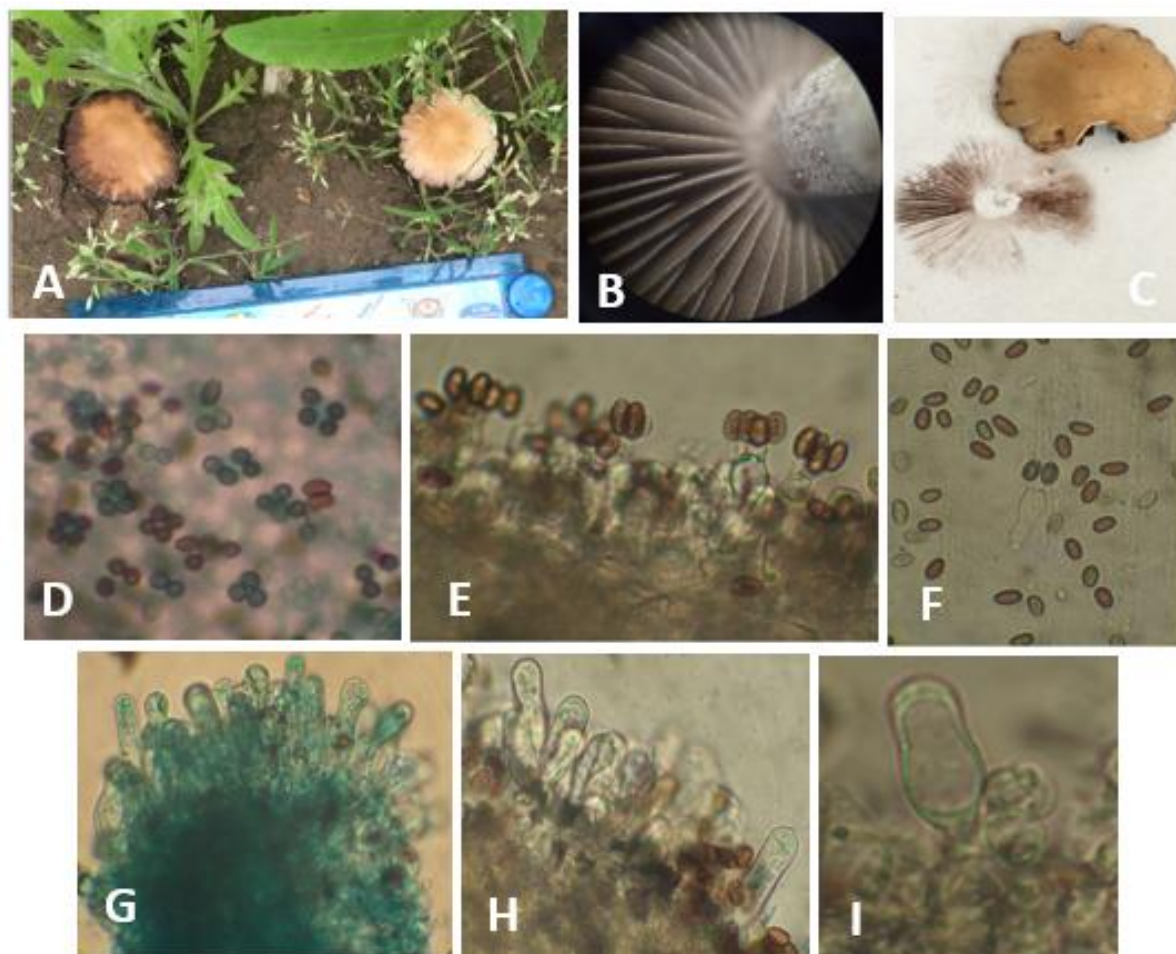


Fig. 8: *P. spadiceogrisea*. A, fruiting bodies in habitat; B, gills; C, spore print; D,E, basidia; F, spores and basidium; G, H, cheilocystidia; I, pleurocystidia.

Family: Strophariaceae

Species: *Agrocybe praecox* (Pers.) Fayod (Fig. 9).

Macroscopic features: Cap 1-5 cm across, convex when young then becoming broadly convex, smooth at first, showing white cracks in age, when young white veil remnants are visible on the margin, brown. *Gills:* attached, close, initially white and covered by a white partial veil, brown in age. *Stipe:* up to 7cm long, 1.5 cm thick, white, equal, smooth, sold, with white ring. Flesh white. Spore print brown.

Microscopic features: *Basidia:* 4-spored, spores $7.5-11 \times 5-7 \mu\text{m}$, ellipsoid, smooth. *Habit and habitat:* saprotrophic, gregarious on wood debris (under apple and willow trees). Spring, summer and autumn. *Locality:* Al-Alam city and Dujail area(Dujail district). *A. praecox* was reported for the first time from Northern Iraq by Suliaman et al. (2017) and here is the first report on this species from two districts, Dujail and Tikrit, from Salahadin Governorate. This fungus was reported from North America (Kuo, 2006), Europe and North Africa (Courtecuisse and Duhem, 1994), Turkey (Sesli and Denchev, 2008) and Netherlands (Noordeloos et al., 2005).



Fig. 9: *A. praecox*. A, fruiting bodies in habitat; B, C, fruiting bodies in lab.; D, spore print; E, basidium; F, spores.



Fig. 10: *C. flavidella*. A, B, fruiting bodies in habitat; C-F, fruiting bodies in lab.; G, gills; H, I, basidium; J, spores.

Family: Tricholomataceae

Species: *Clitocybe flavidella* (Peck) Sacc. (Fig. 10).

Macroscopic features: Cap 1-3 cm across, smooth, white, cream, off-white, convex with enrolled margin at first, flat with center depressed in age. **Gills:** attached or run down the stipe, close, white. **Stipe:** 1-3 cm long, 0.3-0.8 cm thick, white, central, equal, hollow.

Microscopic features: **Basidia:** 25 × 5 μm, 4-spored, spores 3.5- 5 × 2.5-3.75 μm, ellipsoidal,

sobglobose, smooth. Cystidia absent. Clamp-connections present. **Habit and habitat:** saprobic, gregarious, on decayed fallen leaves near rotting wood under willow trees. Al- Alam –Defsha village. January – April. This is the first report of *C. flavidella* from Iraq. Reports on this fungal species are not available from countries bordering Iraq.

Order: Polyporales

Family: Polyporaceae

Species: *Lentinus tigrinus* (Bull.) Fri. (Fig. 11).

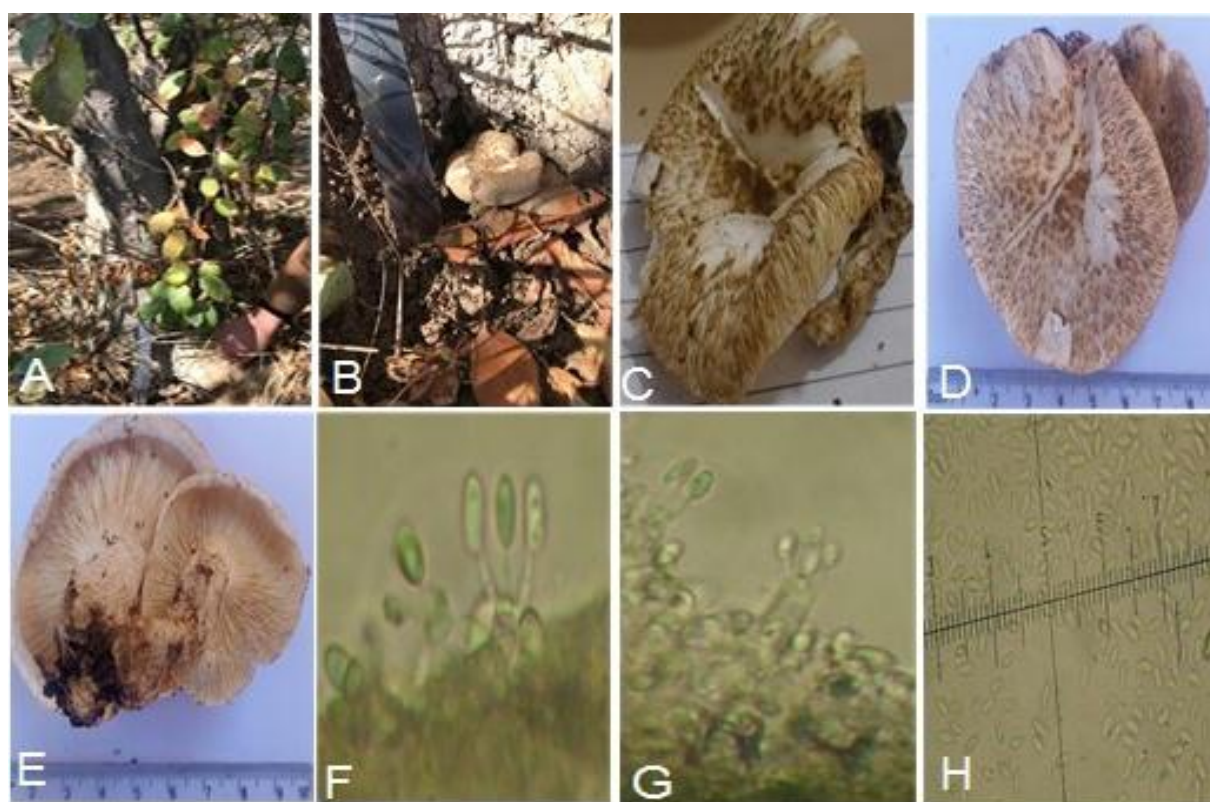


Fig. 11: *L. tigrinus*. A, B, fruiting bodies in habitat; C-E, fruiting bodies in lab.; F, G, basidia; H, spores.

Macroscopic features: Cap up to 7 cm across, convex, broadly convex to funnel-shaped, with central depression, incurved margin, covered with brown scales and hairs. Gills decurrent, crowded, white. **Stipe:** up to 4 cm long, up to 1cm thick, central or eccentric, tapering toward the base, sometimes bent, white with brown scales similar to those on the cap, solid. **Microscopic features :** Basidia 4- spored, spores 6.25-8.75 X 2.5- 4.0 μm,

cylindric,ellipsoidal, sometimes with a fine nipple, smooth. Cheilocystidia and pleurocystidia not distinguished. **Habit and habitat:** Saprotrophic, solitary or clustered on the streambank trees (like apple and willow trees). December-February. **Locality:** orchards in Dujail city/ Dujail district. This fungus was first reported in Iraqi Kurdistan(North of Iraq) by Suliaman et al.(2017). *L.tigrinus* was found in USA (Kuo,2017), Turkey

(Sesli and Denchev, 2008), Iran (Shahtahmasebi et al., 2017), India (Gogoi and Parkash, 2015) and Cameroon (Kinge et al., 2013).

Conflict of interest statement

Author declares that here is no conflict of interest.

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