ZANCO Journal of Pure and Applied Sciences

TYPE Original article
PUBLISHED 05/02/2024
DOI http://dx.doi.org/10.21271/ZJPAS.36.1.8

OPEN ACCESS

*Corresponding author
Nareen Q. FaqeAbdulla
nareen.faqi@su.edu.krd

RECEIVED 11/06/2023
ACCEPTED 01/10/2023
PUBLISHED 05/02/2024

KEYWORDS:
Mushroom, Basidiomycota, Phallus impudicus, Ascomycota, Bisporella citrina

First-Time Finds: Eight Rare Mushroom Species in Kurdistan's Wilderness

Nareen Q. FaqeAbdulla*, Hero M. Ismael, Musa I. Taha, Farid M. Toma, Sanar A. Suleman

Department of Biology, College of Science, Salahaddin University-Erbil, Kurdistan Region, Iraq.

ABSTRACT

Seventeen mushroom species from fourteen genera were collected and identified from various locations, such as: Bardarash, Barzan, Erbil city center, Hiran, Mergasor, Shaqlawa, Khalefan, Tawska and Taqtaq. The following genus and species have been identified: *Agaricus bisporus, A. campestris, A. incultorum, Coprinus comatus, Lycoperdon umbrinum, Amanita virosa, Panaeolus semiovatus, Pleurotus ostreatus, Omphalina pyxidate*, *O. rosella*, *Phallus impudicus, Fomitopsis betulina, Ganoderma applanatum, Daedaleopsis confragosa, lactarius vellereus, Helvella leucopus* and *Bisporella citrina.* Seven genera (8 species) of mushrooms were discovered for the first timein kurdistan region-Iraq, such as: *Lycoperdon umbrinum, Amanita virosa, Omphalina pyxidate*, *O. rosella*, *Phallus impudicus, Daedaleopsis confragosa, Helvella leucopus* and *Bisporella citrina.* The goal of this research is to investigate and identify wild mushrooms that naturally occur in the Erbil Governorate, Kurdistan Region of Iraq, in various areas and during various seasons.

1. Introduction

Fungi are often the second-largest eukaryotic organisms in nature, with almost 100 000 species documented, 14000 of which are macrofungi, and the majority of them edible and useful (Meenu and Xu, 2019). Numerous and diverse ways, including human diseases, plant infections, industrial products, and human nourishment (mushrooms), fungi have an impact on human life. They are vital components of the ecology (Carlile et al., 2001). The globe has always recognized mushrooms as the most delicious and luscious meal (Christensen, 1981).

A fungal lineage organism is the mushroom. It is the sibling group of eukaryotic organisms, which originally radiated about a billion years ago and include plants, animals, and other living things. It seems that most phyla are terrestrial (Hawksworth et al., 1995). It is creating a wide variety of fruiting bodies, from straightforward forms resembling crusts to intricate, developmentally integrated forms. According to micromorphology, the Friesian system of the 19th century classified the fungus that produce mushrooms. Agaricomycetes produce a vast range of fruiting bodies, including gilled mushrooms (agarics), chanterelles, stinkhorns, corticioid fungi, cyphelloid fungi, polypores, puffballs, fake truffles, bird's nest fungi, coral fungi and other forms that defy easy description. For many years, one of the main aims of fungal systematics has been to reconstruct the evolution of fruiting body morphologies (Hibbett and Thorn, 2001, Hibbett, 2007).

The ascus is the key morphological trait that sets members of the phylum Ascomycota apart from all other fungi. Meiospores (also known as ascospores), which are exclusively formed during the sexual life cycle, are housed in this sac-like meiosporangium. Members of the phylum Ascomycota have a complex taxonomic categorization since there are many different species with a wide range of morphology, habitats, and life histories. The ability to produce a dikaryon distinguishes the mostly unicellular Saccharomycetes from the Mycelial Ascomycetes, the majority of which share a number of traits, including specific cell wall components, septal pores with Woronin bodies, and a dikaryotic phase as part of their life cycle. Typically, mycelial ascomycetes produce ascomata or ascocarps, which are fruiting structures (Alexopoulos et al., 1996, Barr, 2001). using academic articles as a basis of all the fungi species, ascomycota make up half (Kaygusuz et al., 2020). The fruit bodies of members of the Ascomycota are either enormous and more complex, like those of *Helvella, Morchella*, or *Tuber*, or they are smaller and simpler, like those of *Peziza* sp., which are characterized by their cup-shaped fruit bodies. (Skrede et al., 2017). The goal of this study is to investigate and identify wild mushrooms that naturally occur in the Erbil Governorate, Kurdistan Region of Iraq, in various areas and during various seasons.

2. Material and Methods

In the Erbil Governorate, several areas including Bardarash, Barzan, the city center of Erbil, Hiran, Mergasor, Shaqlawa, Khalefan, Tawska and Taqtaq were used to gather diverse genera of wild mushrooms. The Mushroom specimens were collected from 2021-2022. We used conventional collecting, preservation, and identification techniques. Samples discovered in wet areas of public gardens or under shade trees on the decomposing roots of dead trees were photographed, removed from their natural habitats, and stored for identification in a lab. The following taxonomic keys were used to identify the collected fruiting bodies in accordance with identification manuals for fungi: (Christensen, 1981, Laessoe and Lincoff, 1998, Hall et al., 2003, Chang and Miles, 2004). Slides were created to observe ascus and ascospore, detect basidia and basidiospore, and measure the spore diameter using an ocular lens.

All samples were deposited in Biology Department, College of Sciences, Salahaddin University. The fleshy samples are preserved in formalin acetic acid alcohol solution (FAA), which is made up of 200ml of ethyl alcohol (50%) and 13ml of formalin. Samples were photographed in their natural settings using a digital camera, and measurements were taken with a portable Olympus Zoom camera (Hawksworth et al., 1995, Laessoe and Lincoff, 1998). The

description section includes descriptions of the recorded genera and habitats.

3. Results and discussion

The data in table (1) illustrates the distribution and occurrence of wild mushrooms that were collected in the Erbil Governorate, which is a part of Iraqi Kurdistan.

A total of 17 species, 14 genera, 12 families, 6 orders, 3 classes, and 2 phyla of Kingdom fungus were recorded. Numerous collections of basidiomycetes have been created, and their macro- and micro-morphological traits have been researched. Compared to Iraqi mushroom study, seven genera and eight species of mushroom samples were newly discovered in the Kurdistan area of Iraq: *Lycoperdon umbrinum*, *Amanita virosa, Omphalina rosella*, *O. pyxidate*, *Phallus impudicus*, *Daedaleopsis confragosa*, *Helvella leucopus* and *Bisporella citrina*. The categorization and traits of each mushroom genus and species, which were gathered from various locations in Erbil and the Kurdistan region of Iraq, are listed below (Note: The genera that are new records for Iraq are indicated by the symbol *).

Table 1. Collected mushrooms from Erbil-Kurdistan region-Iraq

Kingdom	Phylum	Class	Order	Family	Scientific name	Common name
Fungi	Basidiomycota	Agaricomycetes	Agaricales	Agaricacea	*Agaricus bisporus*	Button mushroom
					A. campestris	Field mushroom
					A. incultorum	Field mushroom
					Coprinus comatus	Shaggy mane
					Lycoperdon umbrinum	Umber-brown puffball
				Amanitaceae	*Amanita virosa*	Destroying Angel
				Galeropsidaceae	*Panaeolus semiovatus*	Shiny mottlegill
				Pleurotaceae	*Pleurotus ostreatus*	Oyster Mushroom
				Tricholomataceae	*Omphalina pyxidate*	None
					O. rosella	None
			Phallales	Phallaceae	*Phallus impudicus*	Common stinkhorn
			Polyporales	Fomitopsidaceae	*Fomitopsis betulina*	Birch polypore
				Ganodermataceae	*Ganoderma applanatum*	Artist's conk
				Polyporaceae	*Daedaleopsis confragosa*	Blushing bracket
			Russulales	Russulaceae	*lactarius vellereus*	Fleecy milk-cap
	Ascomycota	Pezizomycetes	Pezizales	Helvellaceae	*Helvella leucopus*	Elfin saddles
		Leotiomycetes	Helotiales	Helotiaceae	*Bisporella citrina*	Yellow fairy cups

Kingdom: Fungi
I. Phylum: Basidiomycota
Class: Agaricomycetes
A. Order: Agaricales
Family: Agaricaceae
Genus: *Agaricus* (Fig. 1a)

***Agaricus Campestris*:** The cap is convex, white, have fine scales, and it is 7 centimeters in diameter. The gills are pink. The stipe is 6 cm tall, 1.5 cm wide, white in color and bears a single thin ring. The thick-walled, elliptical spores measure 7.5 µm by 4 µm, cheilocystidia are absent. The stipe has a ring, the hymenium contains gills, and the hymenium is free (Miller and Miller, 2006, Davis et al., 2012).

***Agaricus bisporus*:** The cap is a light grey-brown color with broad, flat scales that are lighter in color overall and fade toward the edges. Its diameter is 8 cm. Free and dark brown with a yellowish margin from the cheilocystidia, the crowded, narrow gills are narrow. The cylindrical stipe has a thick and narrow ring and measures 7 cm tall by 2 cm broad. Although it bruises a light pinkish-red, the solid flesh is white. The basidia are typically two-spored, and the spores are oblong to spherical and measure around 4.5 µm by 6 µm (Callac et al., 1993, Callac et al., 2000).

***Agaricus incultorum*:** The cap is 4.5 cm wide, convex, and expands to almost plane, brown to greyish-brown, the squamules often raised near the margin giving a shaggy aspect. Gills free, close, moderately broad, blackish-brown. Stipe is 1.2 cm thick and 2.5 cm long, straight at the base, whitish, forming short, superior ring. Spores 7 x 6 µm, elliptical, smooth, thick-walled (Sánchez, 2008, Kerrigan, 2016).

Genus: *Coprinus* (Fig.1b)

***Coprinus comatus*:** Most of the stem is covered by the conical cap, which is white and has shaggy scales, deliquescent. It is 6 cm to 12 cm in wide and tall. The free gills are dark. The white stipe has a loose ring near the bottom and is 22 cm high by 2.1 cm in diameter. Microscopically, the mushroom is without pleurocystidia, spores measure 11 by 7 µm. Hymenium is free and the gills on hymenium (Trudell and Ammirati, 2009, Davis et al., 2012).

Genus: *Lycoperdon* (Fig. 1b)

***Lycoperdon umbrinum**:** The sporocarp is pear-shaped to turbinate, 5 cm tall and 3 cm wide, and suddenly to abruptly tapering below to a well-developed pseudostipe, gleba is brown to olive-brown; subgleba alveolate, buff-brown to ochre-brown. Spores are 5.0 µm, globose, asperulate, moderately thick-walled, with a droplet and stub-like pedicel; spores dull olive-brown in deposit (Siegel and Schwarz, 2016, Jeppson, 2018).

Family: Amanitaceae

Genus: *Amanita* (Fig. 1c)

***Amanita virosa**:** Hymenium is unbound, Stipe has a ring and volva, and the cap is convex or flat. All of the gills, stipes, and caps are white in color. The diameter of cap is 14 cm. The thin stipe is 16 cm in tall, with a hanging grooved ring. The spores are 9 µm long, conical, and egg-shaped (Nilson and Olle, 1977, Benjamin, 1995).

Family: Galeropsidaceae

Genus: *Panaeolus* (Fig. 1c)

***Panaeolus semiovatus*:** The cap is convex, it is 9 cm, dark buff to white and convex. The stem is firm and smooth, measuring 15 cm by 20 mm, and it has a black annulus. The adnexed, brown to black gills is broader in the centre and narrower at both ends. Gills on hymenium and hymenium is adnexed (Phillips, 2010).

Family: Pleurotaceae

Genus: *Pleurotus* (Fig. 1c)

***Pleurotus ostreatus*:** Oyster-shaped, brown, with an eccentric stem, the cap is 5 to 18 cm across, gradually depressed in the center, and has a wavy margin. It is sometimes seen in overlapping groups, but each stem is attached to the substrate independently. Gills are white, aging to a pale ochre, numerous, and decurrent. White or cream stems with wooly bases, short stems that are typically 1 to 3 cm long and 1 to 2 cm in diameter, taper toward the base, and no stem rings are sometimes present (Beltran-Garcia et al., 1997).

Family: Tricholomataceae

Genus: *Omphalina* (Fig. 1d)

***Omphalina rosella**:** Cap surface is glabrous, striate-sulcate to near the disc, convex, becoming convex-depressed to infundibulate, and 0.5 to 2.0 cm in width. Long decurrent, nearly distant, pale-pink Gills matures to a pallid color after first appearing pinkish-cream. Stipe is 2 cm long, 1-3 mm thick, straight, and vinaceous to pinkish-brown in color, just like the cap. Spores are 9 x 5 µm, smooth, ellipsoid, with granular contents and a conspicuous hilar appendage (Redhead et al., 2002).

***Omphalina pyxidate**:** Small setae with caps between 7 and 12 mm in diameter, deeply umbilicated and striated. gills very decurrent, separated, with lamellae and cream-white with slight pinkish stipe (Bigelow, 1985).

B. Order: Phallales

Family: Phallaceae

Genus: *Phallus* (Fig. 1e)

***Phallus impudicus**:** The fruiting structure is tall, white, and has a conical head that is slimy and dark olive in color. This substance, known as the gleba, houses the spores. The immature stinkhorn is about 5 cm long, egg-shaped, and

white or pinkish. The mature stinkhorn is 23 cm tall, 5 cm wide, and has a conical cap that is 2 to 4 cm high and covered in the slimy, greenish-brown gleba. The spores are 4 to 2 m in size and elliptical to oblong in shape, has no stipe (Niksic et al., 2004).

C. Order: Polyporales

Family: Fomitopsidaceae

Genus: *Fomitopsis* (Fig. 1e)

***Fomitopsis betulina*:** The pale fruit bodies (basidiocarps), which have a smooth, greyish-brown top surface, with hundreds of pores on the creamy white underside that house the spores. The texture of the fruit's body is corky. The spores are ellipsoidal to cylindrical in shape and are 4 by 2 µm in size (Phillips, 2010).

Family: Ganodermataceae

Genus: *Ganoderma* (Fig. 1f)

***Ganoderma applanatum*:** The fruiting bodies that are 7 cm thick ×25 cm long × 20 cm wide, woody in texture, as tough as leather, dark red-brown in color. The pores on the bottom of the fruiting body discharge brown spores. The tubes are 4-12 mm deep, contain extremely concentrated spores, and end in rounded holes with a density of 4 per millimeter. The Pores are on hymenium and hymenium is decurrent, has no stipe (Ginns, 2017).

Family: Polyporaceae

Genus: *Daedaleopsis* (Fig. 1f)

***Daedaleopsis confragosa**:** The fruit bodies are semicircular, robust, and measure 16 cm in diameter and 2 cm in thickness. They have an upper surface that is concentrically banded brownish. Its upper surface is gray-brown in hue, broadly convex to flat, dry, smooth, or somewhat hairy. Spores have a smooth cylindrical shape and a 9 by 2 m size. The basidia (spore-bearing cells) are 25 by 4 µm in size and can range in shape from cylindrical to club-shaped. Pores are on hymenium and hymenium is decurrent, has no stipe (Roberts and Evans, 2011).

D. Order: Russulales

Family: Russulaceae

Genus: *Lactarius* (Fig. 1f)

***lactarius vellereus*:** Instead of being fibrous, the fruit body's flesh is crumbly, and when this is damaged, the fungus emits a milky latex. The adult caps are 26 cm in diameter, white to cream in color, and funnel-shaped. The stem Colored the same as the cap, it is cylindrical or tapers in slightly towards the base and is 3 cm in diameter and 5 cm long. Spores Broadly ellipsoidal to subglobose, 8 x 6 µm (Verbeken and Nuytinck, 2013).

II. Phylum: Ascomycota

Class: Pezizomycetes

Order: Pezizales

Family: Helvellaceae

Genus: *Helvella* (Fig. 1g)

***Helvella leucopus**:** Ascocarps, the fruiting bodies, have stems and are grown above the earth. The apothecium, a cup-shaped fruiting body, can take on a number of shapes, including an ear-like (auriculate) or saddle-like shape, as well as being bent and irregularly lobed. The hymenium, which bears spores, has a smooth, wrinkled, and black-colored surface. The stem is ribbed and grooved or cylindrical and tapered. The flesh is about 2 mm thick (Landvik et al., 1999).

Class: Leotiomycetes

Order: Helotiales

Family: Helotiaceae

Genus: *Bisporella* (Fig.1g)

***Bisporella citrina**:** The compact, disc-shaped, smooth, bright yellow fruit bodies are usually less than 3 mm in diameter and up to 1 mm height. The exterior surface is a lighter yellow, while the interior surface is smooth and brightly colored. The smooth spores are 11 by 3 µm in size, generally oval, and feature an oil drop at either end (Trudell and Ammirati, 2009).

Our findings are comparable to those of other studies, such as: (Toma et al., 2018), who gathered and identified a number of

basidiomycota taxa and species from various locations in Erbil, Kurdistan Region, Iraq, including: Erbil City Center, Salahaddin (Permum), Hanara, Heran, Barzan, Khalefan, Koysnjaq, Tawska, Mergasur and Shaqlawa. The following genus and species have been identified: *Agaricus bitorquis, Ampulloclitocybe clavipes, lyophyllum decastes, Coprinus micaceus, Hebeloma mesophaeum, Bovista plumbea, Mycena inclinata, Meruliopsis taxicola, Panaeolus papilionaceus, Pleurotus ostreatus, Trametes hirsute, Russula turci, Schizophyllum commune, Polyporus arcularius, Scleroderma verrucosum,* and *Vascellum pretense.* (Toma et al., 2013), who collected and identified 24 genera and 44 species of mushrooms from various locations in the Erbil Governorate of the Kurdistan Region. The following genera contain the identified species and varieties, such as *Auricularia auricula-judae, Agaricus* sp*., Clitocybe* sp*., Collybia* sp*., Coprinus* sp*., Cortinarius sp., Craterellus sp., Crepidotus* sp*., Inocybe* sp*., Exidia* sp*., Fomes* sp*., Galerina* sp*., Mycena* sp*.*, *Hebeloma* sp*., Helvella* sp*., Hygrocybe pratensis, Lactarius* sp*., Laccaria* sp*., Russula fellea*, *Peziza* sp., *Pluteus* sp., *Psathyrella* sp., *Panellus* sp., *Paxillus atrotomentosus*, *Scutellinia scutellata*, *Trichloma* spp., *Tyromyces* spp*., Cystoderma* sp. and *Lepiota* sp. (Aziz and Toma, 2012), collected mushroom in mountain areas in Sulaimani and Erbil Governorate especially in Soran, Joman, Qandil, Sedakan, and Zalm areas between 1996-2010. A total of 34 species in 23 genera, 17 families and 7 orders belong to woody and fleshy species were identified at the first time in Iraq. (Al-Rawi and Abdul-Hadi, 2022), were gathered samples of the fruiting bodies of *Helvella* mushrooms in the Nimrud region, which is south of Mosul, Iraq. These samples were first identified morphologically using the size, color, and shape of the fruiting body and the shape of the ripples, and then they were identified microscopically using the shape of the cysts and ascospores, and finally they were identified molecularly using DNA sequence information from the F- ITS1 and R- ITS4 nuclear regions. (Owaid et al., 2014), were gathered and identified fifteen different species from several localities of Heet district, Anbar province, Iraq. Two species, naming *Armillaria mellea* and *Coprinus disseminates* were identified as species level and others: *Morchella* sp., *Agaricus* spp., *Fomes* sp., *Calvatia* sp., *Telephora* sp., *Lepiota* sp. and *Pleurotus* spp. as genus level only. (Kim et al., 2017), were gathered from the Western Siem Pang Protected Forest in Stung Treng Province, the Central Cardamom Protected Forest in Koh Kong Province, the Kirirom National Park in Kampong Speu Province, the Seima Biodiversity Conservation Area in Kratie Province, the Mondulkiri Protected Forest in Mondulkiri Province, the Phnom Bokor National Park in Kampot Province, and the Ream National Park in Sihanoukville Province of Cambodia from 2009 Polyporaceae (26.2%), Ganodermataceae (7.7%), Marasmiaceae (9.1%), Hymenochaetaceae (7.5%), and Mycenaceae (7.1%) are the mushroom families with the highest species richness, accounting for 57.5% of the total specimens discovered. (Lee et al., 2021), were collected mushrooms in the Dong Hua Sao National Biodiversity Conservation area from early July to October of 2019. They were taken from 6 distinct places, and morphological and molecular investigations were used to identify and classify them into 103 species, 74 genera, 37 families, 15 orders, and 6 classes. Among these mushrooms, the most species-rich families are Mycenaceae (8.9%), Marasmiaceae (17.3%), Meruliaceae (3.0%), Polyporaceae (13.1%), Agricaceae (8.3%), Xylariaceae (6.5%), Auriculariaceae (4.8%), Ganodermtaceae (3.6%), Dacrymycetaceae (3.0%), Russulaceae (3.0%) and comprised 71.4% of the total specimens identified.

Conclusions

This study indicated that different genera of mushroom were found in Erbil governorate, most of them were new record in Erbil City.

Acknowledgment: Our special thanks go to (Komelgey kwargewanani Kurdistan), who help us receive two mushroom samples that found in Erbil governorate, Iraqi Kurdistan. Thanks to the students who gave us some of these samples.

Not applicable.

Financial support: No financial support.

Potential conflicts of interest. All authors report no conflicts of interest relevant to this article.

Figure 1a: Different genera belong to Class Agaricomycetes
A. *Agaricus bisporus* B. *Agaricus campestris* C. *Agaricus incultorum*

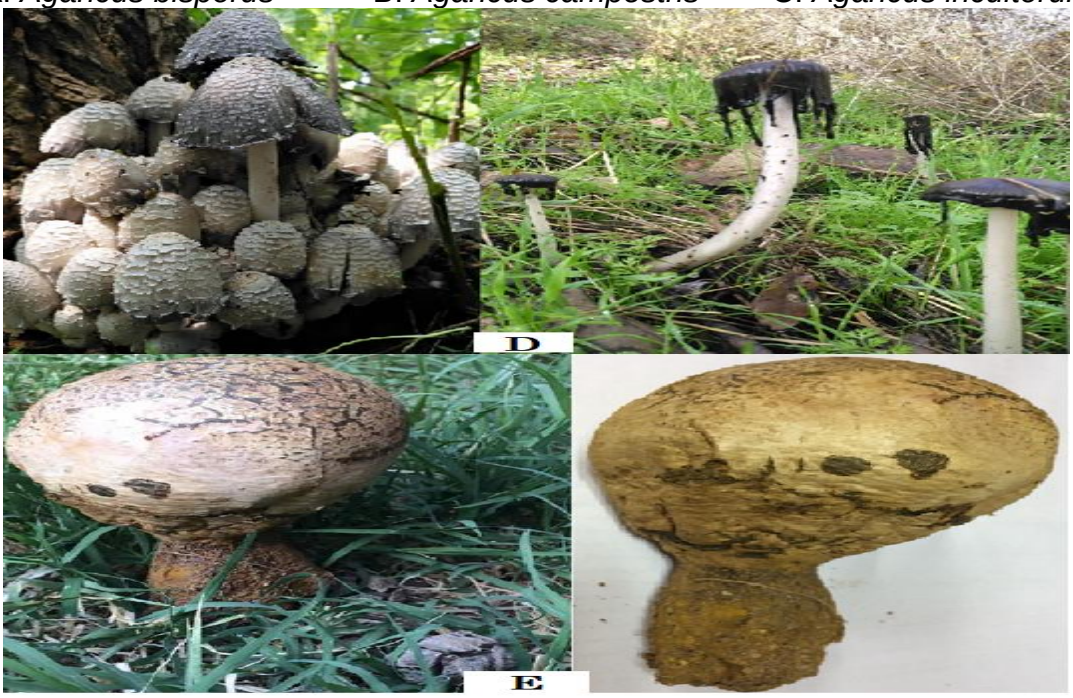

Figure 1b: Different genera belong to Class Agaricomycetes
D. Coprinus comatus *E. Lycoperdon umbrinum*

Figure 1c: Different genera belong to Class Agaricomycetes
F. *Amanita virosa* G. *Panaeolus semiovatus* H. *Pleurotus ostreatus*

Figure 1d: Different genera belong to Class Agaricomycetes
I. *Omphalina rosella* J. *Omphalina pyxidata*

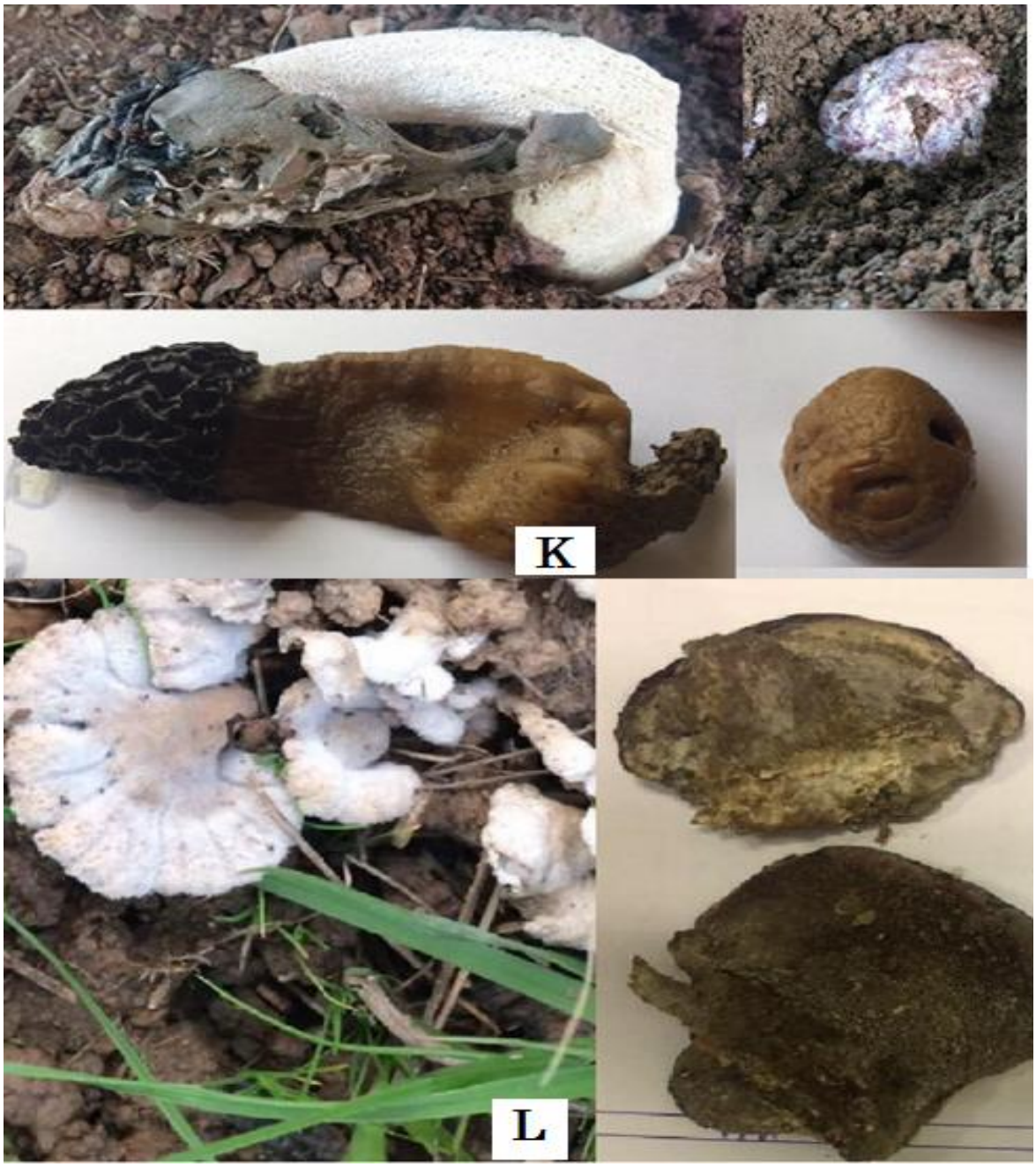

Figure 1e: Different genera belong to Class Agaricomycetes
K. *Phallus impudicus* L. *Fomitopsis betulina*

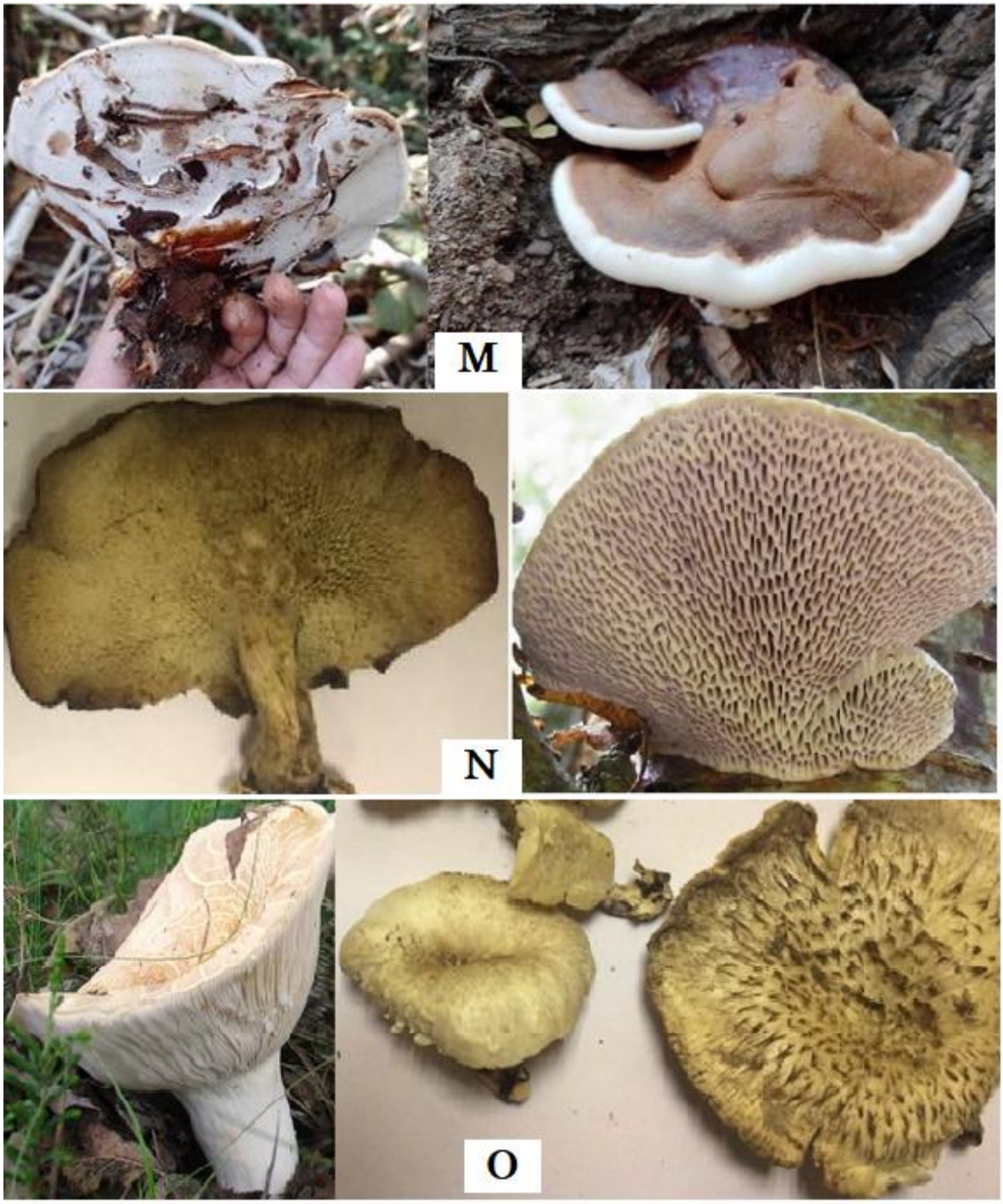

Figure 1f: Different genera belong to Class Agaricomycetes
M. *Ganoderma applanatum* N. *Daedaleopsis confragosa* O. *lactarius vellereus*

Figure 1g: Different genera belong to Class Pezizomycetes and Leotiomycetes
P. *Helvella leucopus* Q*. Bisporella citrina*

References:

Al-Rawi, J. M. & Abdul-Hadi, S. Y. 2022. First New Record and Molecular Identification of Helvella bachu (Ascomycetes) Isolated from Iraq/Mosul. *International Journal for Research in Applied Sciences and Biotechnology,* 9(4)**,** 143–148:

Alexopoulos, C. J., Mims, C. W. & Blackwell, M. 1996. Introductory Mycology. Wiley, New York. 880 pages.

Aziz, F. H. & Toma, F. M. 2012. First Observations on the Mushroom in Mountain Area of Iraqi Kurdistan Region *Journal of Advanced Laboratory Research in Biology,* 3**,** 302-3012.

Barr, M. E. 2001. Ascomycota. In: McLaughlin DJ, McLaugh lin EG, Lemke PA (eds) *The Mycota, Systematics and Evolution, part A. Springer, Berlin Heidelberg New York,* 7A**,** 161–177.

Beltran-Garcia, M. J., Estarron-Espinosa, M. & Ogura, T. 1997. Volatile Compounds Secreted by the Oyster Mushroom (Pleurotus ostreatus)and Their Antibacterial Activities. *Journal of Agricultural and Food Chemistry,* 45(10)**,** 4049-4052:10.1021/jf960876i.

Benjamin, D. R. 1995. Mushrooms: Poisons and Panaceas : a Handbook for Naturalists, Mycologists, and Physicians. New York: W.H. Freeman. ISBN 978-0716726494.**,** pp. 198–241.

Bigelow, H. E. 1985. North American Species of Clitocybe. Part II. J. Cramer: Berlin, Germany. 241 p.

Callac, P., Billette, C., Imbernon, M. & Kerrigan, R. W. 1993. Morphological, genetic, and interfertility analyses reveal a novel, tetrasporic variety of Agaricus bisporus from the Sonoran Desert of California. *Mycologia,* 85**,** 835-851.

Callac, P., Imbernon, M., Guinberteau, J., Pirobe, L., Granit, S., Olivier, J. M. & Theochari, I. 2000. Discovery of a wild Mediterranean population of Agaricus bisporus, and its usefulness for breeding work. *Mushroom Science.,* 15**,** 245–252.

Carlile, M. J., Watkinson, S. C. & Goody, G. W. 2001. The Fungi. Academic Press, Harcourt Science and Technology Company. London, UK. Pp.565.

Chang, S. T. & Miles, P. G. 2004. Mushrooms Cultivation, Nutritional Value, Medicinal Effect and Environmental Impact. 2nd Edn., CRC Press, Boca Raton. pp: 450.

Christensen, C. M. 1981. Edible Mushrooms. 2nd Edn., Printed in the United States of America. pp: 118.

Davis, R. M., Sommer, R. & Menge, J. A. 2012. Field Guide to Mushrooms of Western North America. Berkeley: University of California Press. ISBN 978-0-520-95360-4. OCLC 797915861. pp. 224–225.

Ginns, J. 2017. Polypores of British Columbia (Fungi: Basidiomycota). Victoria, BC: Province of British Columbia - Forests, Lands, and NR Operations. p. 105.

Hall, I. R., Stephenson, S. L., Buchanan, P. K., Yun, W. & Cole, A. L. J. 2003. Edible and Poisonous Mushrooms of the World. Printed through Colorcraft Ltd., Hong Kong. pp: 370.

Hawksworth, D. L., Kirk, P. M., Sutton, B. C. & Pegler, D. N. 1995. Ainsworth and Bisby's Dictionary of the Fungi. 8th Edn., CAB International, Walling Ford, U.K. pp: 616.

Hibbett, D. S. 2007. After the gold rush, or before the flood? Evolutionary morphology of mushroom-forming fungi (Agaricomycetes) in the early 21st century5. *British mycological society***,** 1001-1018.

Hibbett, D. S. & Thorn, R. G. 2001. Basidiomycota: Homobasidiomy cetes. In: McLaughlin DJ, McLaughlin EG, Lemke PA (eds), The Mycota. Vol. II. Part B. Systematics and Evolution, Springer Verlag, Berlin. pp. 121–168.

Jeppson, M. 2018. Puffballs of Northern and Central Europe. Sveriges Mykologiska Förening: Gothenburg, Sweden. 359p.

Kaygusuz, O., Türkekul, İ. & Battistin, E. 2020. Some noteworthy records of Helvella from Turkey based on morphology and DNA sequence data. *Journal of Fungal Biology,* 10**,** 290–299

Kerrigan, R. W. 2016. Agaricus of North America. New York Botanical Garden: Bronx, NY. . 574 p.

Kim, N. K., Lee, J. H., Jo, J. W. & Lee, J. K. 2017. A Checklist of Mushrooms of Cambodia. *Journal of Forest and Environmental Science,* 33**,** pp. 49-65.

Laessoe, T. & Lincoff, G. 1998. Mushrooms (Eyewitness Handbooks) Kyodo Printing Co., Singapore, . 303pp.

Landvik, S., Kristiansen, R. & Schumacher, T. 1999. Pindara: a miniature Helvella *Mycologia,* 91**,** 278–85.

Lee, J., Kim, D., Nguyen, M. H., Bae, Y. J. & Manilak, P. 2021. A Checklist of Mushrooms of Dong Hua Sao National Biodiversity Conservation Area (DHSNBCA) of Lao-PDR. *Journal of Forest and Environmental Science,* 37**,** 163-167.

Meenu, M. & Xu, B. 2019. Application of vibrational spectroscopy for classification, authentication and quality analysis of mushroom: A concise review. *Food Chemistry***,** 289, 545–557.

Miller, H. R. & Miller, O. J. 2006. North American Mushrooms: A Field Guide to Edible and Inedible Fungi. Guilford, Connecticut: Falcon Guides. p. 283.

Niksic, M., Hadzic, I. & Glisic, M. 2004. Is Phallus impudicus a mycological giant?". *Mycologist,* 18**,** 21-22.

Nilson, S. & Olle, P. 1977. Fungi of Northern Europe 2: Gill-Fungi. Penguin. ISBN 978-0-14-063006-0. p. 54.

Owaid, M. N., Muslat, M. M. & Tan, W. C. 2014. First Collection and Identification of Wild Mushrooms in Western Iraq. *Journal of Advanced Laboratory Research in Biology,* V.

Phillips, R. 2010. Mushrooms and Other Fungi of North America. Buffalo, NY: Firefly Books. p. 236.

Redhead, S. A., Moncalvo, J. M., Vilgalys, R. & Lutzoni, F. 2002. Phylogeny of Agarics: Partial Systematics Solutions for Bryophilus Omphaloid Agarics Outside the Agaricales (Euagarics). *Mycotoxan,* 82**,** 151-168.

Roberts, P. & Evans, S. 2011. The Book of Fungi. Chicago, Illinois: University of Chicago Press p.378.

Sánchez, L. a. P. 2008. Agaricus L.; Allopsalliota Nauta & Bas; Tribu Agariceae S. Imai: Part 1. Edizioni Candusso: Alassio, Italy.**,** 824 p.

Siegel, N. & Schwarz, C. 2016. Mushrooms of the Redwood Coast. Ten Speed Press: Berkeley, CA.**,** 601 p.

Skrede, I., Carlsen, T. & Schumacher, T. 2017. A synopsis of the saddle fungi (Helvella: Ascomycota) in Europe-species delimitation, taxonomy and typification. *Persoonia* 39**,** 201-253.

Toma, F. M., Ismael, H. M. & Faqi Abdulla, N. Q. 2018. Survey and Identification of some New Record Mushrooms in Erbil Governorate Kurdistan Region-Iraq *Raf. J. Sci., Special Issue for the Third Scientific Conference of Biology,* 27**,** pp.19-32.

Toma, F. M., Ismael, H. M. & Faqiabdulla, N. Q. 2013. Survey and Identification of Mushrooms in Erbil Governorate. *Research Journal of Environmental and Earth Sciences* 5**,** 262-266.

Trudell, S. & Ammirati, J. 2009. Mushrooms of the Pacific Northwest. Timber Press Field Guides. Portland, Oregon: Timber Press. pp. 293–4.

Verbeken, A. & Nuytinck, J. 2013. Not every milkcap is a *Lactarius*. *Scripta Botanica Belgica,* 51**,** 162–168.