

Rare recording of *Panaeolina foenisecii* mushroom (family: Galeropsidaceae) in Western Iraq

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ABSTRACT

This work presents a rare discovery of the *Panaeolina foenisecii* (Pers.) Maire (1913) mushroom (Family: Galeropsidaceae) in the Khazraj village, located west of Heet city in western Iraq. The collection took place in December 2018, and regional weather data showed fluctuating temperatures and moderate precipitation, which likely contributed to the emergence of the mushroom's fruiting bodies. The morphological characteristics, including cap shape, gill structure, and stem features, were analyzed to aid in species identification. A microscopic examination of the spores confirmed their typical almond-shaped, small size, dark brown to black color, and smooth surface, consistent with the species of *Panaeolina foenisecii*. The findings underscore the importance of environmental factors in the growth of these mushrooms and contribute to the understanding of their distribution in arid regions, such as western Iraq. This mushroom may cause hallucinations; therefore, its consumption is not recommended. Finally, *P. foenisecii* is considered the first record in Iraq, and it is very useful for enriching Iraqi mycodata.

Keywords: Biodiversity, Mushroom identification, Spore morphology, Weather conditions, Western Iraq

1 INTRODUCTION

The *Panaeolina foenisecii* (Pers.) Maire (1913) (commonly known as lawnmower's mushrooms) is frequently found in lawns and is often ingested by young children. Studies from Germany and Switzerland indicate that consuming five or fewer carefully identified lawnmower's mushrooms did not lead to significant illness [1]. In the Pacific Northwest, properly identified specimens of this mushroom did not contain detectable levels of the hallucinogenic compound psilocybin, and reports suggesting the presence of hallucinogens have not been substantiated [2]. In North America, lawnmower's mushrooms have been associated with gastrointestinal disturbances and central nervous system symptoms, in-

cluding hallucinations and disorientation. However, these symptoms were likely caused by consumption of misidentified mushrooms, with other small brown mushroom species being the true culprits behind the adverse reactions [3].

This mushroom thrives in lawns, woodchips, and forests, where it grows saprotrophically. It is common in well-watered lawns, particularly in summer, across North America and Europe. The cap starts conical, flattening with age, and features a central bump. It transitions in color from brown or orange-brown when wet to light beige with an orange-brown center as it dries. Its matte surface contrasts with the dark brown, mottled gills that mature to a darker hue. The fibrous stem remains consistent in diameter and changes from white to tan, darkening with

handling. The spores are almond-shaped, dark brown, and subtly roughened [4, 5].

However, the genus *Panaeolina* was traditionally placed in the Bolbitiaceae and has recently been moved to the Galeropsidaceae based on molecular phylogenies [6]. Recent DNA sequencing data have placed the genus within the Galeropsidaceae family. Members of Galeropsidaceae are primarily found growing on open lawns, in mountain deserts, and in steppes and prairies. These fungi are distinguished by a cuticle that is seldom and only slightly gelatinous, a partially enclosed or oval-shaped cap, a lacunar hymenophore, or, in some instances, well-developed lamellae that are frequently interconnected by anastomoses. Other distinguishing characteristics include passive spore release, ochre-brown spores with a germ pore, a pileipellis featuring pileocystidia, the presence of hymenial cystidia in some species, and hyphae with clamps [7].

This family includes *Copelandia*, *Panaeolina*, *Panaeolopsis*, and *Panaeolus* [6]. *Panaeolina* is morphologically similar to *Panaeolus* but is distinguished by its ornamented spores and dark brown gills, in contrast to the mottled greyish-black gills and smooth basidiospores found in *Panaeolus* [6, 8]. Also, *Panaeolina* differs from *Panaeolus* in having roughened rather than smooth spores [4, 5]. Moreover, various microscopic characteristics were examined, including the number of spores, the size of the basidium, and the shape, size, and color of the spores. Additionally, the size, shape, and type of cystidia, as well as the absence of cystidia, are used for identification [9].

Fungal diversity is rich but has not been thoroughly investigated in Iraq. Some genera of the Galeropsidaceae family, including only one species of *Panaeolina*, and a few species of *Panaeolus*, have been reported in some recent studies in northern Iraq, specifically in the Kurdistan Governorate Region and the Salahadin Governorate. According to mycodata in Iraq, there are no publications about the isolation of *Copelandia* and *Panaeolopsis*. *Panaeolina* was identified in Erbil Governorate through the collection of macrofungi from February 2011 and April 2012 [10]. Additionally, some species of *Panaeolus*, like *P. papilionaceus*, were collected from Erbil (Kurdistan, Iraq) [11–13], Al Qadisiyah (Ad Diwaniyah) [14], Baghdad [15] and Basrah [16]. *Panaeolus semiovatus* was collected from Erbil [11], *Panaeolus guttulatus* from Baghdad [15], *Panaeolus campanulatus* from Basrah *Panaeolus campanulatus*, [16], and *Panaeolus* sp. from Basrah [17]. Although five species of the *Panaeolus* genus were collected, only one species of *Panaeolina* has

been recorded, namely *Panaeolina castaneifolia*, which was reported in Kurdistan, Iraq [9]. However, *Panaeolina foenisecii* has not been previously reported from Iraq

Many genera of Agaricales were recorded in Iraq throughout the rainy season from late November to early March 2022 [18]. The average rainfall in Iraq was lowest in western Iraq, particularly in Heet, Najaf, and Rutba, and highest in Zakho and Emadiyah. The Heet station recorded lower rainfall rates than other regions from 1981 to 2017 [19]. Rainfall in Heet begins from October to May each year, with varying amounts [20].

In Iraq, there is limited data on mushroom collection and identification, and the topic is rarely studied due to a lack of public interest. Hence, this study focuses on the isolation and identification of a new species of cup macrofungi (*Panaeolina foenisecii*: Lawnmower's mushroom) from the family Galeropsidaceae, for the first time in Iraq.

2 MATERIALS AND METHODS

2.1 Descriptions of the study region and weather

Khadaram Orchards, a small village located in Khazraj village, western Heet city (Anbar Governorate), was included in this work. Maximum and minimum temperatures, relative humidity (%), precipitation (mm/day), cloud cover (%), and wind speed and direction were recorded on the date of mushroom collection according to meteoblue AG (A windy.com company), Switzerland.

2.2 Collection and identification of mushroom samples

Fresh *Panaeolina* species were photographed in their natural habitat using a digital camera. A microscopic examination of a spore smear in water was conducted to determine the morphological properties of the spores using an optical microscope [21]. The young and mature samples were collected in December 2018. The fruiting bodies were identified through macroscopic and microscopic examinations, including Cap shape and color, gill structure and attachment, and stem and spore microscopic examination. The specimens were preserved following the techniques outlined by Atri and Saini [22]

3 RESULTS AND DISCUSSION

3.1 Weather of the region

Khazraj village is located west of Hit city in Anbar province, Iraq, at coordinates 33.78°N, 42.73°E, with

an elevation of 65 meters above sea level (m asl). It is situated between the desert and the Euphrates River, as shown in Figure 1. The weather in the region where the fruiting bodies were collected in Khazraj village, located 20 km west of Heet city in Anbar province, Iraq, is also depicted in Figure 1.



Fig. 1 Map of the study area, Khazraj village near Heet city, western Iraq

The collection took place in December 2018. Figure 2 presents a weather archive diagram consisting of three charts that show various weather parameters over time, including temperature, relative humidity (%), precipitation (mm/day), cloud cover (%), wind speed, and direction. This data was obtained from the Meteoblue database for the period from 1 December 2018 to 1 January 2019.

The temperature and relative humidity data are presented in Figure 2a. The red line represents the temperature, while the blue line indicates relative humidity. The temperature fluctuates between 10°C and 25°C, exhibiting a general downward trend from early December 2018 to early January 2019. Relative humidity is higher in December and gradually decreases until stabilizing around 30-40%. The shaded regions around the lines represent the expected range of variation, illustrating potential deviations in temperature and humidity from the forecast values. The dotted lines indicate the upper and lower limits of these variations.

The precipitation diagram for Khazraj shows the number of days per month when specific precipitation amounts were recorded. Figure 2b displays both cloud cover and precipitation data. Precipitation is represented by blue bars, with taller bars indicating greater precipitation (measured in millimeters) on a given day. The most

significant precipitation occurred around 5 December, as evidenced by a peak, while minimal precipitation was observed during the remainder of the period.

The graph in Figure 2b shows the daily distribution of sunny, partly cloudy, overcast, and precipitation days. According to Meteoblue Co., days with less than 20% cloud cover are categorized as sunny, those with 20-80% cloud cover as partly cloudy, and those with more than 80% cloud cover as overcast. The grey background in the graph represents cloud cover, with darker grey areas indicating denser clouds. The light blue areas signify clear skies with little to no cloud cover. Notable intervals with heavy cloud cover occur in mid-December, while some clear skies are observed later in the period.

Finally, Figure 2c shows wind speed and wind direction. The green line represents wind speed, fluctuating between 0 km/h and 7 km/h throughout the period. The wind rose, which illustrates the origin of the wind. Wind direction changes slightly over time, predominantly coming from the north, with occasional eastward shifts. Wind speed generally remains low, with occasional peaks, particularly toward the end of December, reaching up to 7 km/h. The shaded areas around the wind speed line represent the expected variation in wind speed, showing that it typically remains within the lower range, except during a few specific intervals.

Overall, this meteogram provides valuable insights into the general weather trends during this period, highlighting moderate temperatures, low wind speeds, sporadic precipitation, and fluctuating cloud cover, with intervals of clear skies.

Figure 3 shows the average annual weather trends in this region over the past 40 years. This figure illustrates the decline in temperatures and the increase in precipitation starting from November, which contribute to the appearance of mushroom fruiting in this arid region along the Euphrates River. These results align with those of Owaid et al. [23], who reported collecting wild mushrooms in Heet City starting in November.

These results agree with some studies in Iraq. Generally, many genera of Agaricales were recorded in Iraq, such as *Agaricus bitorquis*, *Conocybe velutipes*, *Coprinellus radians*, *Gymnopilus purpureosquamulosus*, and *Psathyrella trinitatis* in Basrah Governorate, southern Iraq, throughout the rainy season from late November to early March 2022 [18]. With increased rainfall, the number of mushroom species appearing increases, especially in northern Iraq, such as *Coprinus*, *Coprinellus*, *Coprinopsis*, and *Parasola*, which were collected in Tikrit

(Salahadin Governorate), northern Iraq [24]. *Abortiporus biennis* (Polyporales) and *Inocutis levis* were collected in Mousl [25].

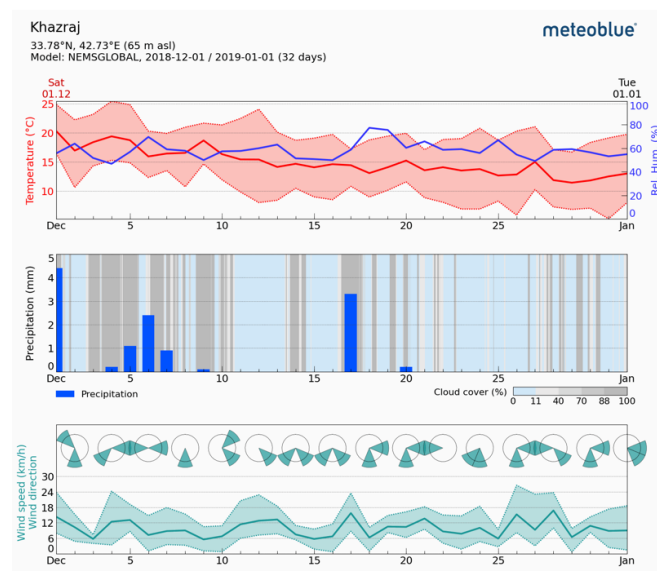


Fig. 2 Weather Archive of Khazraj Village, West of Heet City, during December 2018

Legend: The weather archive diagram is divided into three charts. Chart A displays temperature and relative humidity at hourly intervals. Chart B shows cloud cover (represented by a grey background) and clear skies (represented by a light blue background). The darker the grey background, the denser the cloud cover. Chart C shows wind speed and direction (with 0° representing North, 90° East, 180° South, and 270° West). In the meteogram, the green line represents wind speed, and the wind rose indicates wind direction.

The maximum temperature diagram for Khazraj shows the number of days per month when specific temperatures are reached. In December, the temperature (Figure 4) shows a decline in maximum temperatures, with a range between 24°C and 28°C (indicated by the orange/yellow color) observed over several days. This gradual decrease in temperature during this period is likely a contributing factor to the appearance of mushroom fruiting bodies in this region [26], as mushrooms typically thrive in cooler conditions. The temperature drop throughout the month plays a crucial role in creating an ideal environment for mushroom growth [27]. However, since this mushroom is lawn-inhabiting [1], note the substrate conditions at the collection site (grassy soil, organic debris, and irrigation practices). Thus, this result agrees with the ecological context.

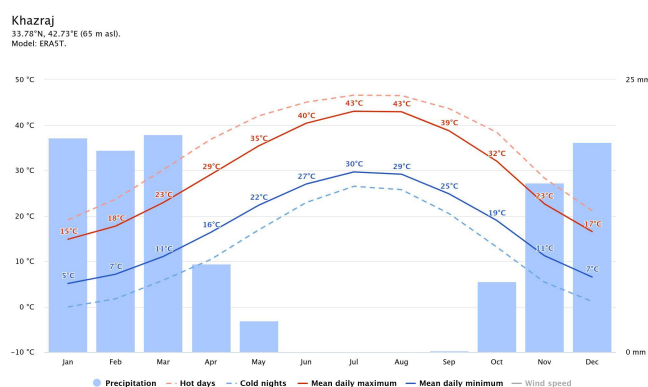


Fig. 3 Average temperatures and precipitation based on simulated historical climate and weather data for Khazraj over a 40-year period

Legend: The solid blue line represents the average daily minimum temperature for each month in Khazraj village. Similarly, the solid red line shows the average daily maximum temperature. The dashed blue and red lines indicate the average coldest night and hottest day, respectively, of each month over the past 40 years.

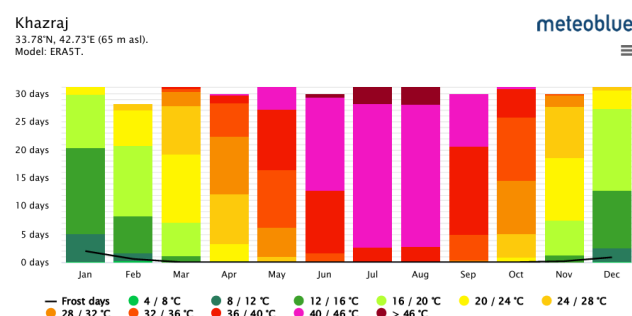


Fig. 4 Maximum temperatures based on simulated historical climate and weather data for Khazraj Village over a 40-year period

3.2 Identification of *Panaeolina*

Based on Figure 5, there are several images of the *Panaeolina* mushroom at various growth stages, along with detailed views. To accurately identify the species, there are general features to consider, such as cap shape and color, gill structure and attachment, and stem, in addition to microscopic analysis of spores. This mushroom is saprotrophic on soil; it grows in grassy areas like lawns, gardens, parks, and cemeteries, fruiting in groups [6]. Table 1 shows the macroscopic properties of this mushroom.

3.3 Cap shape and gills structure

The shape of the mushroom cap is a key indicator [28]. In Figures 5a and 5c, some caps are conical, while others are flatter or bell-shaped, with cap diameters ranging from 1.8 to 2.5 cm. The hygrophanous nature of the cap was dark brown when moist and pale when dry, with a striate margin. Moreover, Figures 5a and 5b show the fruiting body with distinct, deeply ridged gills. That could point to a specific family, like the *Panaeolina* species [1].

Shape: Delicate and slender appearance with a relatively small cap with color light to medium brown [6]. Gill structure is closely aggregated and thin, with one or three short lamellulae between two lamellae, with a smooth margin, mottled, narrowly adnate. The underside of the cap displays widely spaced gills. This result agrees with [9].

The gills in this mushroom are very prominent and appear to be adnate, meaning they are attached to the stem but not extending downward much. This type of gill attachment is typical of some mushrooms, such as *Panaeolina* [9], but it can also be found in other genera. The gills are dark, a common feature in mature mushrooms, especially those in the genus *Panaeolina* [1], which have dark, often purple-brown or black spores. Also, the gill structure appears to be finely spaced and well-defined, which can also suggest a genus with similar traits, such as *Panaeolina*.

3.4 Stipe

The stems in Figure 5c show varying textures and lengths, which are also useful for identification. The stalks are relatively long and thin, with a smooth texture. The stipe is 9-7 cm long. The coloration of the stems varies, with some showing a lighter, almost translucent, or pale hue that darkens toward the base or where they have been disturbed. The stems in Figure 5c are somewhat slender and tapered, a trait often seen in mushrooms such as species of the genus *Panaeolina*. Annulus and volva do not find. The stipe (stem), whitish to grey in color, has a smooth surface, occasionally featuring fine longitudinal fibers, and a hollow interior. These results agree with [9, 29].

On the other hand, Figure 5c shows the last three stems on the right side with a hollow core, which is indeed a helpful feature for classification. The hollow stem can be an important characteristic, as some species, especially in the genus *Panaeolina*, exhibit hollow stems as part of their morphological traits, which is consistent

with Alzurgany and Alazzawi [9].

This feature, combined with the gill structure and spore shape, can help narrow down the species identification. It would be particularly useful in differentiating between similar-looking mushrooms from different genera. The gill structure in Figure 5b seems to fit with the characteristics of the *Panaeolina* genus.



Fig. 5 Morphological characteristics of *Panaeolina* genus in western Heet city (a) fruiting bodies in the field (b) the gill structure (c) young and mature fruiting bodies with hollow stems

3.5 Microscopic analysis (spore characteristics)

Figure 6 shows microscopic details, likely of spores. The shape, size, and color of these spores are critical for identifying certain mushroom species, particularly those in the genus *Panaeolina*. Based on their appearance, gill structure, and microscopic features, these fruiting bodies may belong to the genus *Panaeolina*, which includes species such as *Panaeolina foenisecii* (Pers.). Maire (1913) (known as the common name of Lawn mower's mushroom) [1]. The spore details shown in Figure 6b can help confirm if they match known species, as in Table 2. Spore print is dark purplish-brown. These results agree

with [9] who reported that spores are black, and verrucose or roughened, elliptical (W: 11–14 × L: 6–8 μm); basidia club-shaped with 4-spored, often flask-shaped. Gills are composed of regular, parallel hyphae.

Table 1 Details of macroscopic characteristics of *Panaeolina* sp.

Cap Diameter	2.5 – 1.8 cm
Cap Shape	Bell-shaped, Convex
Cap Surfaces	Smooth
Gills	Adnate to adnexed attachment; close; mottled between gray and black
Gill Attachment	 Free to Attached
Stipe	Stem 9-7 cm, slightly enlarged at the base, brittle, fragile, lacks veil remnants
Stipe Shapes	 Cylindrical
Stipe Cross Sections	 Hollow or cottony hollow
Ring	Ringless
Spore Print Color	Dark purplish-brown

Table 2 Details of the characteristics of *Panaeolina* spores

Features	Details
Size	The spores of <i>Panaeolina</i> are typically small, and they have an oval to ellipsoid shape (almond-shaped).
Color	<i>Panaeolina</i> spores are generally dark brown to black, with a purplish tint, and sometimes appear almost black.
Surface	The spores usually have a verrucose surface with sharp edges.

Microscopic features include spores with an apical germ pore and a cellular pileipellis [30]. In general, the spores of *Panaeolina* are typically small, oval to ellipsoid in shape, and dark brown to black with a purplish tint. They typically measure 11–18 × 6–9 μm, are almond-shaped, dark brown, with a subtly roughened surface in some cases. However, the genus was recently redefined under the Galeropsidaceae [6]. The classification of *Panaeolina* sp. below:

- Kingdom: Fungi

- Division: Basidiomycota
- Class: Agaricomycetes
- Order: Agaricales
- Family: Galeropsidaceae (formerly Bolbitiaceae sensu lato)
- Genus: *Panaeolina*
- Species: *Panaeolina foenisecii* (Pers.) Maire (1913)

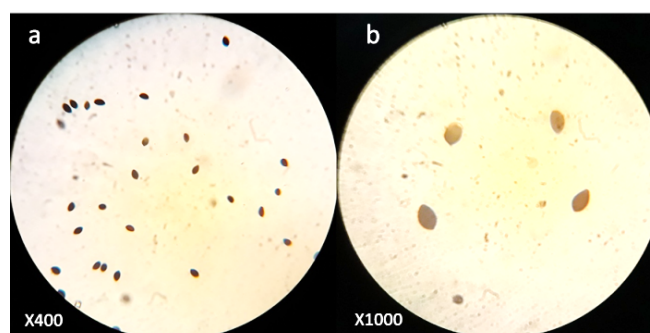


Fig. 6 Microscopic images of spores under the optical microscope

Based on the spore image under the microscope (Figure 6), the spores appear to be oval or round, which is a characteristic feature of *Panaeolina foenisecii*. The roughened surface and brown color of the spores further suggest that they match the typical features of this species. Moreover, the field mushroom image (Figure 5) shows the cap with visible gills, and the dark brown to black coloration is consistent with *Panaeolina foenisecii*. The clear gill structure also aligns with the characteristics of this genus. Finally, based on these properties, it appears likely that the mushroom is *Panaeolina foenisecii*, particularly given its distinctive spore shape and gill structure.

4 CONCLUSION

The discovery of the *Panaeolina foenisecii* (Pers.) Maire (1913) in Khazraj village is a notable event, as it expands the known range of this genus in Iraq. The favorable weather conditions in December, characterized by moderate temperatures, low wind speeds, and sporadic precipitation, likely facilitated the growth of these mushrooms in this arid region. Morphological and microscopic

analyses of the collected specimens confirmed their identification as members of the genus *Panaeolina*, characterized by specific spore and gill structures. This finding not only enhances the geographical knowledge of *Panaeolina* but also underscores the role of environmental conditions in mushroom fruiting. Further studies could explore the ecological implications and potential psychoactive properties of these fungi in the region. Finally, based on the microscopic characterization, it appears likely that the mushroom is *Panaeolina foenisecii*, particularly given its distinctive spore shape and gill structure. This mushroom may cause hallucinations; therefore, its consumption is not recommended.

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Author contributions

Owaid M.N. designed the study; conducted experiments; analyzed the data; and wrote the manuscript.

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Conflict of interest

The authors declare no competing interests

Consent to publish

N/A

Ethical approval

N/A

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