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Fallujah-Western Iraq first record, Distribution and Ecological Characteristics of *Morchella esculenta*

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Abstract

Morchella esculenta (Yellow Morel) appears as an edible high nutritional value fungis which is a hypermycorrhizal mushroom belonging to the Morchellaceae family and plays a significant role in the ecosystem, and has culinary value. The available data about distribution, habitat preferences and ecological functions of the yellow morel in Iraq is presented in this paper with special consideration of the records reported from many regions in it. It has predominantly been reported from the northern parts of Iraq (mostly from the Kurdistan Region). These environments provide the appropriate host trees, soil nature, and seasonal rainfall that seem to allow its growth and development. It has also recently been found in western Iraq, indicating its range may be much broader than previously recognized. The information presented in this manuscript contains compiled reported data and papers up until October 2023. The number of reported records of this mushroom on Iraq is still few, but all the available studies gave valuable information about its distribution and habitat. Additional field studies and systematic surveys are required to understand its distribution, habitat requirements and ecological significance in Iraq.

Keywords: *Morchella esculenta, Iraq, macrofungi, ecology, distribution, Kurdistan, Fallujah, edible mushrooms.*

Introduction

Morchella is a taxonomically heterogeneous group of saprophytic fungi, which are nationally important because of their unique sponge-like fruiting bodies and their great economic importance as edible mushrooms. Out of these, *Morchella esculenta* (L.) Pers., Yellow Morchella; Common Morchella, appears to be the most widely-distributed and studied among worldwide databases [1], [2]. You have a sharp conical cap from light yellow to light brown with jagged edges and pits, a hollow stem and saprophytic spores in the sporulating layer [3], [4]. Morels play important ecological roles as saprotrophs through decomposition of leaf litter and woody detritus, and as facultative mycorrhizal symbionts by associating with a diverse suite of host plants [5]. The dual strategies employed by *M. esculenta*, as nutrient cyclers and soil-formers, play important roles in the resilience of forest ecosystems as a whole [6].

Seasonal fruiting is often related to seasonal climate drivers, especially spring soil warming and moisture pulses occurring after winter precipitation [7]. Presently, M. esculenta has been reported from temperate and Mediterranean areas of Europe, Asia, and North America [8]. In contrast, the Middle East remains a relatively over-looked region with lack of records on morel taxonomy, ecology, and distribution [9]. Systematic surveys of macrofungal diversity in Iraq have primarily focused on northern montane and forested zones, which have only recently become possible [10], [11]. *M. esculenta* which had been observed in association with oak (*Quercus* spp.) and mixed woodland habitat in the Kurdistan Region, where it fruits in 3 months from March to May [12], [13]. Additionally, an increasing number of field observations and herbarium records indicate that M. esculenta may be more distributed in Iraq than reports have suggested [10], [14].

The event has now been confirmed in western Iraq — the first formal records of it occurring in the area [10]. This emphasises the need for an in-depth evaluation of the pattern of its habitat preference, ecological amplitude and conservation status [15]. Little is known about the phenology, population structure and environmental requirements of *M. esculenta* in Iraq, although it is an ecologically and economically important species [16]. The evidence available indicates that its distribution and productivity is likely limited by edaphic factors such as soil pH, organic matter content, host tree associations and microclimatic conditions that are poorly defined and seldom studied in a systematic manner [17], [18]. Local populations may also be impacted by local pressures including habitat destruction, deforestation, and overexploitation [19]. In this context, this study presents an updated overview of both literature and field observations regarding the distribution and ecology of *M. esculenta* in Iraq, which is mainly targeted to newly acquired data in western Iraq [20]. It also leaves us with new priorities to guide future research and conservation planning [21] to construct a biological concept of this nutritional fungi.

Materials and Methods

Study Area

Geographical distribution: The surveys were carried out in selected locations in southern and central
Iraq, particularly the Iraqi Kurdistan region (Erbil, Duhok) and in the Anbar province from 2018 to 2023.
These are geographically distributed species that have been reported earlier in fungi; each of which corresponds to different habitats: oak (*Quercus* spp.) forest, soil and grasslands, as per [22] (Figure 1).

Figure 1: Physiographic regions of Iraq based on [22]

Sampling and Identification

Field work was conducted during the primary fruiting periods (March to May). Morchella was sampled by typical mycological procedures, which involved meteorological coordinates, habitat description, and pictures. Another two morphological characteristics of [23], [24].

Ecological Data Collection

Soil characteristics such as type, moisture, pH, and vegetation were noted for each location. The extent of habitat disruption was classified as being low, moderate, or high based on visual inspection [25],
[26].

Data recording and Analysis

Morphological characteristics have been noted in March such as total plant height, stem height, and cone height and diameter, as shown in figure 2 [27].

Figure 2: Some morphological traits of Morchella esculenta from Fallujah

Results and Discussion

Fallujah area

Here in this locality, the morel data had been recorded. Here in this locality, the place is located in Western Iraq. Morels have been observed to grow in irrigation channel in the vicinity of Euphrates River (Figure 3. Found among the residues of some grasses like cogongrass Imperata cylindrica [27, 28]). Some of the morphological features are illustrated in table 1. Wherein, the height of stalk was 3.44±1.69 cm, diameter of stalk 0.69±0.27cm, length of cone 2.70±1.01cm, and diameter of cone 2.78±1.28cm. Moreover, data concerning the mentioned morphological features had been recorded from the year 2008 to 2025 (table 2). Sometimes, the mentioned fruiting fungi failed to appear from the years 2009-2020, 2025.Where, the highest stalk height, stalk diameter, cone length and cone diameter had recorded in 2021 of 3.6±1.6cm, o.7±0.3cm, 2.8±1.0cm and 2.9±1.3, respectively, followed by 2024 of 3.4±1.7cm, 0.69±0.27, 2.7±1.01cm and 2.78±1.28cm. while the lowest one were recorded in 2008 of 3.1±1.4cm, 0.68±0.28cm, 2.5±0.9cm and 2.6±1.2cm, respectively.

Figure 3: Morchella growing in an irrigation channel among cogon grasses in Fallujah

Table 1: Means and standard deviations (SD) for each morphological trait of Morchella grown in march, 2024

Trait	Mean	Standard Deviation (SD)*
(stalk height)	3.44 cm	1.69 cm
(Stalk diameter)	0.69 cm	0.27 cm
(Cone length)	2.70 cm	1.01 cm
(Cone diameter)	2.78 cm	1.28 cm

**n=14*

Table 2: Year, total height, stalk length, cone length and cone diameter in Fallujah

Year	stalk Height (cm)*	Stalk diameter (cm)	Cone Length (cm)	Cone Diameter (cm)
2008	3.1 ± 1.4	0.65 ± 0.28	2.5 ± 0.9	2.6 ± 1.2
2009-2020	disappearance			
2021	3.6 ± 1.6	0.7 ± 0.3	2.8 ± 1.0	2.9 ± 1.3
2022-2023	disappearance			
2024	3.4 ± 1.7	0.69 ± 0.27	2.7 ± 1.01	2.78 ± 1.28
2025	disappearance			

**n=14*

Distribution in Iraq

Morchella esculenta was found mainly in northern Iraq, with documented presence in the Erbil and Duhok governorates and occasional occurrences in central Iraq, in the Anbar governorate (Figure 4). Majority of the fruiting body growth took place under oak groves and in newly disturbed soil [10], [11]. Sulaymaniyah Governorate: Forest area and mountain region with oak as the dominant vegetation. Erbil and Duhok Governorates: Regions that have moderate rainfall and various deciduous trees. This map represents the documentation of M. esculenta (indicated by red dots) in northern and central Iraq. The information is taken from central governorates and occasional regions of Erbil and Duhok governorates in the Kurdistan region and entire Anbar governorate. The background shade illustrates the different types of vegetation, and the areas where there are predominantly oak woodland are highlighted as the predominant habitats for this species. The use of ANOVA with post hoc testing reveals that sampling locations have been illustrated with the help of symbols which represent the levels of habitat disturbances; circular symbols represent no disturbance, triangular symbols moderate disturbance while square symbols represent high disturbances. One of the most important findings in the current study is the identification of Morchella in Heet district of western Iraq, Anbar province.

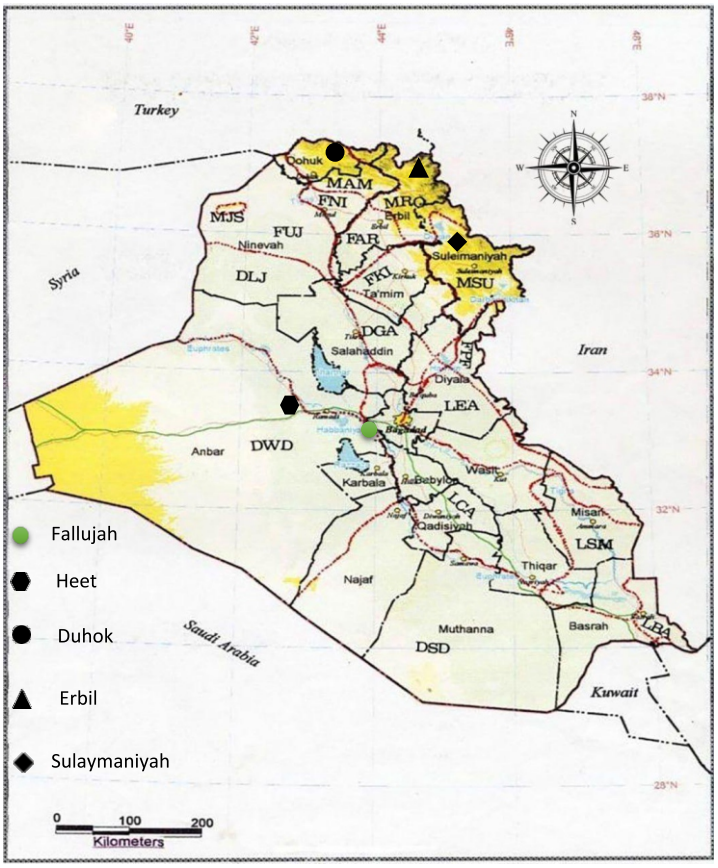

Figure 4: Geographic distribution of Morchella esculenta in Iraq based on field surveys and published records (2018–2023)

Habitat and Ecological Role

The *M.* esculenta prefers Deciduous forest understory where they grow exceptionally well under the oak (*Quercus* spp.), elm, and ash trees. The soil should be loose and well-drained; loamy and slightly alkaline or neutral soils are best for this species. They thrive in regions where the decaying matter of plants and animals is plentiful. Morchella was collected from orchards and gardens, which was an interesting yet essential habitat class for Heet district. These mushrooms produced fruits during the winter season (between November to February) probably due to microclimatic conditions and possible irrigation. The ecology of M. esculenta has a saprotrophic and facultative ectomycorrhizal lifestyle. This helped improve the ecological balance of nutrients in the soil. This species, in particular, grows best in well-drained loamy soils with neutral to low acidic pH (6.5-7.2) [29].The majority of sporocarps were observed in moderately disturbed habitat conditions, for instance, in the forest edge and areas subjected to heavy grazing. It was noted through field observation and literature survey that M. esculenta fruitions occur during late March until May, when conditions are most favorable for the growth of spring moisture and temperatures ranging from 12°C to 20°C [30]. this happened, or morels grown in Fallujah as illustrated in figure 5.

Figure 5: Morels grown in moist in spring from Fallujah

Discussion

This is the first comprehensive study of morphology, distribution, and ecology of *Morchella esculenta* in Iraq. Of course, these types of fungi occur naturally mostly in oak forests and disturbed soil, which corresponds to observations about morels worldwide as opportunistic decomposers, which appear in nutrient rich, well aerated soil [31], [32]. Timing of the fruiting in spring corresponds to climatic conditions suitable for mycelia growth and sporocarps production. Stimulating effect of moderate disturbances on fruiting could be explained by high availability of substrates and low competition as shown in North America and Europe [33]. Taxonomical questions were solved with molecular sequencing of the ITS region and emphasize the importance of integrative morphological and molecular approach. Limited number of field studies and environmental data in Iraq requires further monitoring in order to evaluate dynamics of *M. esculenta* fungal populations, connections with their host plants and influence of environmental change on their population. Due to economic and ecological significance, conservation of this species has to be implemented in forest management plan of the region.A number of studies have reported the existence of M. esculenta and other M. esculenta species in Iraq [34], [35], [36], [37]. *Morchella esculenta* is one of the most esteemed mushrooms in the Kurdish area of northern Iraq (and beyond), where it is used as an edible wild mushroom [38]. Morels are commonly gathered by the locals during spring soon after rains stimulate their reproduction. The collection is usually done in oak-dominated forests, grasslands, and shrublands where the mushrooms grow [31], [39]. These are valued because of their taste and culinary use. Commonly served in soups or stews, or fried with herbs as a seasonal delicacy. In markets, morels are always known to be relatively costly than other wild mushrooms, acting as an important source of income for rural people who have no other brokering options during the spring months [31], [40]. Traditional ecological knowledge is supportive of harvesting that is sustainable in nature. For instance, in order to conserve productivity for subsequent years, the harvesters will not over-exploit within one season, harvesting mature mushrooms and leaving the less mature ones to mature and shed spores [31], [41].

In particular, local customs control access to productive areas as well as the time when the harvest occurs, thereby preventing local depletion and promoting cultural aspects of the harvest. While economically speaking, morels are highly significant, but culturally, morels are also very important for some of the Kurds. Morels' hunting is considered an intergenerational family/community activity which defines a cultural landscape. Intangible cultural heritage includes oral stories, place names and recipes related to morel harvesting passed down from one generation to another in these regions/forests [41]. However, M. esculenta has never been reported nor studied in relation to western Iraq. We could not find any published information regarding the acquisition and use of morels in these areas, mainly because of recent reports of their occurrence in this region. This is a particularly missing piece of information.

Conclusion

The presence of Morchella esculenta in northern and western Iraq has extended our understanding of the distribution of Morchella esculenta as well as provided additional information about the adaptations of macrofungi to the existing environmental conditions in Iraq. While the Kurdistan Region seems relatively well explored, the current evidence obtained from western Iraq poses new research questions. Hence, there is a necessity for further research involving molecular analysis, ecological surveys, and ethnomycological data collection. Establishment of local fungal herbaria and increased public awareness will be important to promote morel consumption and increase knowledge about morels in Iraq. Morels are abundant throughout northern and central Iraq and can be often found in oak woodlands as well as mildly disturbed areas. The period of fruiting is perfectly timed to coincide with favorable conditions for germination. However, molecular, ecological, and genetic analysis is needed to establish conservation and sustainable exploitation strategy. In addition, species verification and contribution to fungal diversity documentation of Iraq are the goals of these studies. Hence, the future ethnomycological research should: Perform participatory surveys among the local communities for the purpose of data gathering regarding recognition, vernacular nomenclature, and uses of M. esculenta. Check whether the species is being harvested for consumption, commerce, or medicinal purposes. Evaluate indigenous understanding of sustainability, habitat requirements, and pressure on populations in the area. Look for ways to include traditional knowledge in sustainable harvest and conservation practices. This way, sustainable and equitable harvest management in the western parts of Iraq can be accomplished while working on cultural heritage preservation.

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