

First Report of *Agaricus aridicola* in Saudi Arabia and Ecological Notes on *Agaricus bisporus*

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Received: January 9, 2015

Accepted: March 20, 2015

ABSTRACT

Agaricus aridicola is reported for the first time from Saudi Arabia while *Agaricus bisporus* is a new record for Northern region of Saudi Arabia. This study includes notes on taxonomy, ecology and distribution of both the species. It was also reported that the habitat of *A. aridicola* and *A. bisporus* are characterized by calcareous sandy soil, poor in organic matter, with presence of little amount of salinity.

KEY WORDS: Saudi Arabia, *Agaricus aridicola*, *Agaricus bisporus*, Taxonomy, Ecology

INTRODUCTION

Saudi Arabia extends for 2,250,000 km² covering the major part of the Arabian Peninsula and is characterized by different ecosystems and a diversity of plant species [1, 2, 3]. On the contrary, the macromycetes diversity is still unexplored especially in Northern region of the country and the information on ecology and distribution of fungi species are scattered in few publications. The oldest record for a mushroom in Saudi Arabia goes back to 350 million years ago and corresponds to a 20 foot tall mushroom called "Prototaxites" [4]. More recently, some ascomycetes belonging to genera of desert truffles *Terfezia* (Tul. & C. Tul.) Tul. & C. Tul. and *Tirmania* Chatin was recorded for the first time in Saudi Arabia [5, 6]. In addition, 14 species of *Basidiomycetes* belonging to 9 genera were collected and identified from seven localities in Al-Taif Governorate at the south-west of Saudi Arabia [7]. Bawadekji *et al.* [8] reported *Picoa lefebvrei* (Pat.) Maire as a new record from Northern Border Region in Saudi Arabia. The knowledge on macrofungi is mainly oriented towards the hypogeous *Ascomycetes* "desert truffles" [6], because these fungi are highly appreciated by local population, while few data on epigeous macromycetes are currently available. Traditionally, epigeous fungi in this region are not appreciated and viewed with suspicion by the people of due to intoxication cases by wild fungi in the neighboring [9, 10] and precisely in Jordan (<http://alarabalyawm.net/?p=409819>) and Iraq (<http://www.nhm.uobaghdad.edu.iq/ArticleShow.aspx?ID=169>).

This paper deals with the first record of *Agaricus aridicola* Geml, Geiser & Royse in Saudi Arabia. New ecological and distributive data on *Agaricus bisporus* (J.E. Lange) Imbach, an under-investigated species in Saudi Arabia, are also provided.

MATERIAL AND METHODS

The investigation was carried out from mid-October 2013 to end of March 2014 in Wadi Arar in the south area of Arar city (Northern Border Region – KSA). The term Wadi is the Arabic term traditionally referring to a "valley". In some cases, it may refer to a dry (ephemeral) riverbed that contains water only during times of heavy rain or simply an intermittent stream (www.wikipedia.org). Wadi Arar extends for 250 km, the upstream begins from Alhanzaliah Faydah (30°43'53.81"N 40°35'0.49"E, alt. 653 m), and Faydah is the Arabic term of a low land that have rain water coming via a talweg. This Wadi pass near Arar city and continue to the east traversing the border with Iraq till arrives to Al Barryt Faydah which represent

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its downstream (31°16'18.08"N 42°19'32.48"E, alt. 340 m). Our specimen collection site represented by small stream of Wadi Arar which is about 15 km at the south of Arar city (30°54'24"N 40°59'56"E alt. 552 m). Basidiomata were identified while fresh and microscopic features were observed in H₂O using a Leica microscope DMLB; spore measurements were based on 50 observations. The description is based both on personal observation, augmented by characters cited in Lincoff^[11], Moser^[12] and Julich^[13]. Nomenclature follows Index Fungorum (<http://www.indexfungorum.org/Names/Names.asp>). The exsiccata are deposited in the newly established Herbarium of the Department of Biological Sciences, Northern Borders University, Kingdom of Saudi Arabia (here cited as KSA) while a duplicate is stored in the Herbarium SAF of the Department of Agricultural and Forest Science (University of Palermo, Italy). Soil analyses were achieved at the Department Soil and Land Reclamation, Faculty of Agriculture, University of Aleppo (Syria).

Taxonomy

Agaricus aridicola Geml, Geiser & Roysse, in *Mycol. Progr.* **3**(2): 172 (2004) Fig. 1, A and B
(Synonym; *Gyrophragmium dunalii* (Fr.) Zeller, *Mycologia* **35**: 411, 1943

Basionym: *Montagnites dunalii* Fr., *Epicr.* **241**, 1838; *Montagnea delilei* Mont., *Fl. d'A1gérie*, **1**: 369, 1846-1849; **Gyrophragmium delilei* Montagne.

*(In, INPN = Inventaire National du Patrimoine Naturel - France)

Basidiomata epigeous, cap 1.5-4 cm, convex to broadly convex, dry, smooth, ochraceous white, grayish or marked by violet-black, fairly irregularly cracked, papyrus-like. Pseudo gills violet-black, formed by radially placed, triangular tubercles, 4-6 per line, wrinkled, soft and dry and very fragile in unripe basidiomata. Stipe 8-15 × 0.5-1.5 cm, narrowing at both end, lower part with peridial remains, sometimes like one or more rings or volva-like, with yellow marking at base. Pale straw colored flesh, compact but light, suberose. Slight cyanic odor and flavor. Spores blackish brown, globose to elliptical, smooth, 4.5-6.5 μm.

Specimen examined: SAUDI ARABIA. Wadi Arar, 545 m (alt.), on calcareous sandy soil, 21 Feb 2014, collected by A. Bawadekji.

The ideal habitat for *Agaricus aridicola* is sandy soils^[14, 15], equally we have collected basidiomata of this mushroom from the study area which characterized by a high percentage of sand and few amount of salinity.

Agaricus bisporus (J. Lange) Imbach, in *Mitt. naturf. Ges. Luzern* **15**: 15 (1946) Fig. 1, C and D
Basionym: *Psalliota hortensis* (Cke) J. Lange fo. *bispora* J. Lange, in *Dansk Bot. Arkiv*, **4**(12): 8, 1926.

Cap 3-12 cm in diameter, hemispherical in unripe basidiomata then flatten, pale grey-brown in color. The margin of the cap is involute, lobate then stretched out, appendiculate. Cuticle sub-smooth with broad, flat scales on a paler background and fading toward the margins. Gills crowded, free, initially pinkish to pinkish-brown, then red-brown and finally dark brown with a whitish edge from the cheilocystidia. Stipe cylindrical, 2-7 × 1.5-3 cm, with base slightly enlarged, smooth, grayish-white, brown soon after rubbing. Ring thin and open, slightly thickened at the margin, white, located in the middle of the stem, streaked on the upper side. The firm flesh is white although stains a pale pinkish-red on bruising mainly at the base of stipe. Odour and taste weak, pleasant. The spore print is dark brown. The spores are elliptical, oval to round, 4.5-6 × 5-8.5 μm, smooth. Basidia two-spored, cheilocystidia claviform.

Specimen examined: SAUDI ARABIA. Wadi Arar, on calcareous sandy soil, 29 Nov 2013, collected by A. Bawadekji.

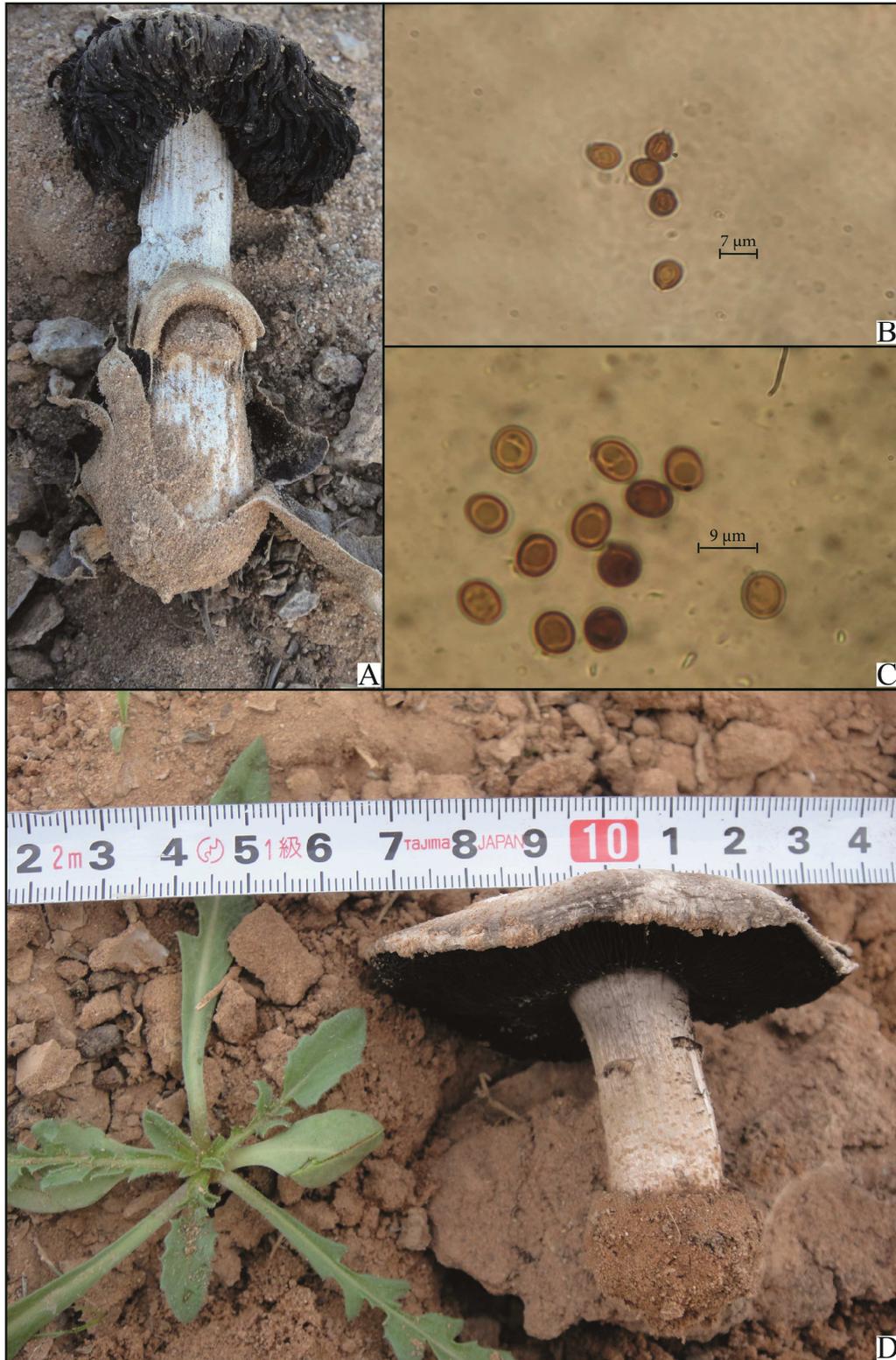


Fig.1 A-D: A. basidioma of *Agaricus aridicola*; B. basidiospores of *A. aridicola*; C. basidiospores of *Agaricus bisporus*; D. basidioma of *A. bisporus*.

DISCUSSION AND CONCLUSION

Hegazy and Alghamdi ^[16] reported that the type of the deposit in Wadi Arar is sand silt and gravel. This in accord with our analysis results of Wadi Arar soil where our samples of basidiomata are collected. The soil is essentially composed of sand silt and clay; 78%, 16%, 6% respectively (Table 1), it's essentially composed as a "fluvial" deposit.

A recent study mentioned the possibility of using non axenic soil composed of fine sand and silt as a casing cover and found to be positively correlated with the yield of *Agaricus blazei* ^[17], this may be applied to the deposited soil of the study area to use it as a casing layer for *A. bisporus* production in Northern Border Region of Saudi Arabia. An advanced research studies were recommended, in local conditions, regarding this subject.

Table 1: Physico-chemical analysis of habitat of *A. aridicola* and *A. bisporus* in Wadi Arar.

- pH	7.04
- Electrical Conductivity	1.1 m mho
- Total Carbonate	21.4 g/100 g of soil
- CaCO ₃ (active)	3.12 g/100 g of soil
- Organic matter	0.91 g/100 g of soil
- Phosphorus	12.6 ppm
- Exchangeable Potassium	102 ppm
- Clay	6%
- Silt	16%
- Sand	78%
- Texture	Sandy

Sandy dune and sandy areas are important and relatively unspoiled ecosystems which bear very specialized macrofungi ^[18, 19]; Saprophytic basidiomycetes have the ability to efficiently stabilize soil particles ^[20]. Besides sandy environments represent a large fungal reservoir whose role is little understood but is possibly important for animals and plants ^[21] or may be existence of synergism type with other microorganisms especially halophytes. According to Sarasini ^[22], *A. aridicola* is widespread in North Africa and, rarely, in South America. Wasser ^[14] has provided a more detailed distribution of the species that includes Europe, Asia, Africa, North America, and South America. The selected habitats by this basidiomycete are sandy places, coastal and desert dunes. Guinberteau ^[15] also mentioned that *A. aridicola* or "Agaric of desert" can be found in western and southern of Europe especially in western littoral of France, he considered it as a rare and endangered species needs to be protected.

Abou-Zeid and Altalhi ^[7] recorded that the highest frequency occurrence of wild mushrooms in Al-Taif Governorate in Saudi Arabia was for *A. bisporus*, *Macrolepiota procera* (Scop.) Singer and *M. rachodes* (Vittad.) Singer. In our investigation *A. bisporus* was collected in sandy soil with vegetation cover of biennial and perennial plant species belonging to *Compositae*, *Gramineae* and *Leguminosae* families which are widespread in Wadi Arar as reported by Osman *et al.* ^[23].

Binyamini ^[24] reported that *A. aridicola* is recorded in sandy habitats and described it as non-important edible fungi and humus saprotroph. Also, basidiomata of *A. aridicola*, were collected from the study area, which are localized in the bed of Wadi Arar that contains an important quantity of sand and vegetal wastes. It is important that these basidiomata were not found out of Wadi's bed; because textures of the soil differ drastically between bed and border of the Wadi. The border in certain area of the Wadi were characterized by non-developed A horizon of soil and an important amount of sand were drifted under the effect of water runoff. The sandy soil of Wadi's Arar bed originated from other localities during rainy season which cause transferring of soil particles and vegetal wastes during running of water and deposited in the long of this Wadi's bed. This transferred sand affect the basidiomata appearance during fructification season. Bawadekji ^[25] reported for the first time a type complete hypogeous fructification of *A. bisporus* in Wadi Arar of northern border region in Saudi Arabia, the entire basidiomata rest buried under the sandy soil and may totally release their spores inside the soil.

A. bisporus is nearly a world widespread mushroom ^[14]. It is considered as the most important and cultivated mushroom in the world. It grows on a composted substrate and poultry litter or horse manure supplemented with water and gypsum. The total production of this mushroom in 1999-2000 ^[26] reached 1,678,304 ton, the importance of *A. bisporus* represented by nutritional ^[27] and medicinal ^[28] value. In the study area, this fungus can be used as genetic resource for hybridization with cultivated strains and amelioration of local one in an objective to launch this activity in the study area. It also may improve

economic situation of rural population; this in accord with Bawadekji ^[29] and Zotti *et al.* ^[30] that edible saprophytic fungi may alleviate poverty and participate in food security.

Our new findings allow to extend the distribution of *A. aridicola* to Saudi Arabia, to report a new locality of growth of *A. bisporus* in Saudi Arabia and to provide additional ecological data of the habitat of *A. aridicola* and *A. bisporus* that are characterized by calcareous sandy soil, poor in organic matter, with presence of little amount of salinity.

ACKNOWLEDGMENTS

The authors wish to acknowledge the approval and the support of this research study by the grant N° 5-118-435 from the Deanship of the Scientific Research in Northern Border University (N.B.U.), Arar, KSA.

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