Endangered desert truffles in Egypt and neighbouring Arab countries, with further notes on their distribution

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Received 31 December 2009 / Accepted 8 September 2010

Key words: conservation, desert truffles, *Helianthemum* spp., *Terfezia* spp., *Tirmania* spp.

Introduction

Desert truffles are hypogeous (subterranean) ascomata, which belong mainly to the order *Pezizales.* They are mycorrhizal fungi mostly endemic to arid and semiarid areas of the Mediterranean basin.

Growth of desert truffles is best in calcareous, well-drained, loose-textured soil, usually associated with the roots of some desert plants mainly *Helianthemum* species. This association may play a major role in the maintenance of Mediterranean shrublands and xerophytic grasslands, and thus in preventing erosion and desertification (Honrubia *et al.* 1992).

The truffle is composed of an ascoma, the edible part, which develops under ground and emerges gradually upwards to cause distinct bulging and finally crack of surface soil. The mature ascoma is easily detachable from the basal part (nombril) made of profusely branched hyphae surrounding the host root.

Desert truffles have always been a popular delicacy. The old writings reveal that the pharaohs of ancient Egypt cherished them and the Roman emperors regularly imported massive quantities from Libya and Greece. They are collected for their unique flavour, nutritional value and medicinal properties. They have always been in demand, making them a profitable crop for local populations. They are sold as fresh food, and in some seasons the price may amount, at 2009 prices, to about 100 US Dollars per kg. They may also be canned.

The local names of truffles in Saudi Arabia and the Gulf States are "faga", "faqa" or "kamma", and in Algeria, Libya, Morocco and Tunisia theyare known as "terfaz".

Truffle genera recorded in Egypt and neighbouring Arab countries

Terfezia (Tul. & C. Tul.) Tul. & C. Tul., 1851
Etymology: Drived from "terfaz", the common name for truffles in the western part of the Arabic-speaking world.

The genus embraces 12 species (Kirk *et al.* 2008). It belongs to the family *Terfeziaceae.* Peridium dark-brown to black, pseudoparenchymatous; gleba pinkish, fleshy, asci subglobose to ovoid, rounded at the top, slightly attenuated at the base to form relatively short necks, non-amyloid (negative reaction with Melzer's iodine); ascospores globose, hyaline to golden brown, with verrucose or rerticulate wall. Species of this genus may be known locally as "kholasi" (in literary Arabic this means dark-coloured).

Tirmania Chatin, 1892
Etymology: Named after M. Tirman, the Governor General of Algeria, who sent the type collection to Chatin.

The genus embraces 3 species (Kirk *et. al.* 2008) and belongs to the family *Pezizaceae*. Peridium yellowish white to light brown, gleba white to light yellow; asci subglobose to clavate, rounded at the top, attenuated at the base to form long necks, amyloid (positive reaction with Melzer's iodine reagent); ascospores globose to broadly elliptical, smooth or minutely roughened.

Species of this genus may be known locally as "zobaidi" (in literary Arabic this means white). It is in greater demand and more valuable than the previous one.

Phaeangium Pat., 1894
Etymology: Greek *Phaeo* = dark; *angion* = vessel; probably referring to the dark-coloured ascomata.

This is a monotypic genus; *P. lefebvrei* Pat. is the only species. It belongs in the family *Otideaceae*. Ascomata brown, gregarious (in groups of 4 or five, relatively small in size 5–25 mm, asci non-amyloid; ascospores smooth. It is locally known as the bird's truffle (or "al-sheikh" in Arabic).

Etymology of the species epithet: named after Commander Lefebvre of Gabes, Tunisia, who sent the type collection to Patouillard.

Truffle species recorded in Egypt and neighbouring Arab countries

Egypt
Species: *Terfezia boudieri* Chatin, *T. claveryi* Chatin, *Tirmania nivea* (Desf.) Trappe, *T. pinoyi* (Maire) Malençon.

Associated plants	Family
Anabasis articulate	*Chenopodiaceae*
Deverra turtuosa (syn. *Pituranthus turtuosus*)	*Umbelliferae*
Helianthemum kahiricum	*Cistaceae*
Artemisia herba-alba	*Compositae*
Gymnocarpos decandrum	*Caryophyllaceae*
Helianthemum stipulatum	*Cistaceae*
Helianthemum lippii	*Cistaceae*
Artemisia judaica	*Compositae*

There is no specificity between truffles and host plants, and one plant may be associated with more than one species of truffle.
References: El-Kholy & Ali (1992); Ibrahim (1995); Fungal Reference Collection (Kew).

Algeria
Species: *Terfezia arenaria* (Moris) Trappe, *T. claveryi, T. leonis* (Tul. & C. Tul.) Tul., *Tirmania pinoyi*.
Associated plant: *Helianthemum guttatum*.
References: Fortas & Chevalier (1992); Fungal Reference Collection (Kew).

Iraq
Species: *Terfezia boudieri, T. claveryi, Tirmania nivea, T. pinoyi, Phaeangium lefebvrei*.
Associated plants: *Helianthemum ledifolium, H. salicifolium*.
References: Ewaz & Al Neama (1984); Abdullah *et al*. (1989); Fungal Reference Collection (Kew).

Fig. 1. Partially emerging ascoma causing crack of soil beside the host plant (*Helianthemum* sp.) (Moubasher 1993)

Fig. 2. Fully-emerged ascoma (Moubasher 1993)

Fig. 3. *Terfezia* species ascomata (botit.botany.WISC.edu/toms_fungi/jan2007.html)

Kuwait
Species: *Terfezia boudieri, T. claveryi, Tirmania nivea* (incl. *T. cambonii* Chatin), *T. pinoyi, Phaeangium lefebvrei*.
Associated plants: *Helianthemum aegyptiacum, H. ledifolium, H. salicifolium, Plantago* sp. (*Plantaginaceae*), *Schismus barbatus* (*Gramineae*).
References: Awameh & Alsheikh (1979); Alsheikh & Trappe (1983a, b); Moustafa (1985); Montecchi & Lazzari (1993); Fungal Reference Collection (Kew).

Libya
Species: *Terfezia boudieri, Tirmania nivea*.
Associated plants: not noted.
References: Ahmed *et al.* (1981); Fungal Reference Collection (Kew).

Qatar
Species: *Terfezia claveryi, Tirmania nivea*.
Associated plants: *Helianthemum kahiricum*, *H. lippii*.
Reference: Moubasher (1993).

Saudi Arabia
Species: *Terfezia boudieri*, *T. claveryi, Tirmania africana* Chatin, *T. nivea*.
Associated plants: *Helianthemum ledifolium, H. lippii, Stipa capensis* (*Gramineae*).
References: Bokhary (1987); Fungal Reference Collection (Kew).

Syria
Species: *Terfezia claveryi, T. leonis*.
Associated plants: not noted.
Reference: Fungal Reference Collection (Kew).

Further notes on the distribution of desert truffle species

Canary Islands
Species: *Terfezia leonis*.
Associated plants: not noted.
Reference: Fungal Reference Collection (Kew).

Cyprus
Species: *Terfezia boudieri*.
Associated plants: not noted.
Reference: Fungal Reference Collection (Kew).

India
Species: *Terfezia terfezioides* (Mattir.) Trappe.
Associated plants: not noted.
Reference: Fungal Reference Collection (Kew).

Iran
Species: *Terfezia pfeillii* Henn.
Associated plants: not noted.
Reference: Fungal Reference Collection (Kew).

Israel
Species: *Terfezia arenaria, T. claveryi, Tirmania africana*.
Associated plants: *Helianthemum aegyptiacum, H. sessiliflorum*.
Reference: Rayss (1940, 1956); Binyamini (1980); Fungal Reference Collection (Kew)

Italy
Species: *Delastria rosea* Tul. & C. Tul.
Associated plants: *Helianthemum* and *Cistus* spp.
Reference: Capelleti *et al.* (1960).

Pakistan
Species: *Terfezia spinosa* Harkn.
Associated plants: not noted.
Reference: Fungal Reference Collection (Kew).

Portugal
Species: *Terfezia claveryi*.
Associated plants: not noted.
Reference: Fungal Reference Collection (Kew).

Spain
Species: *Terfezia arenaria, T. claveryi, T. leptoderma* Tul.
Associated plants: *Helianthemum almeriense, H. lavandulifolium*.
References: Honrubia *et al.* (1992); Fungal Reference Collection (Kew).

Turkey
Species: *Terfezia arenaria, T. boudieri*.
Associated plants: not noted.
Reference: Sesli & Denchev (2005, 2009).

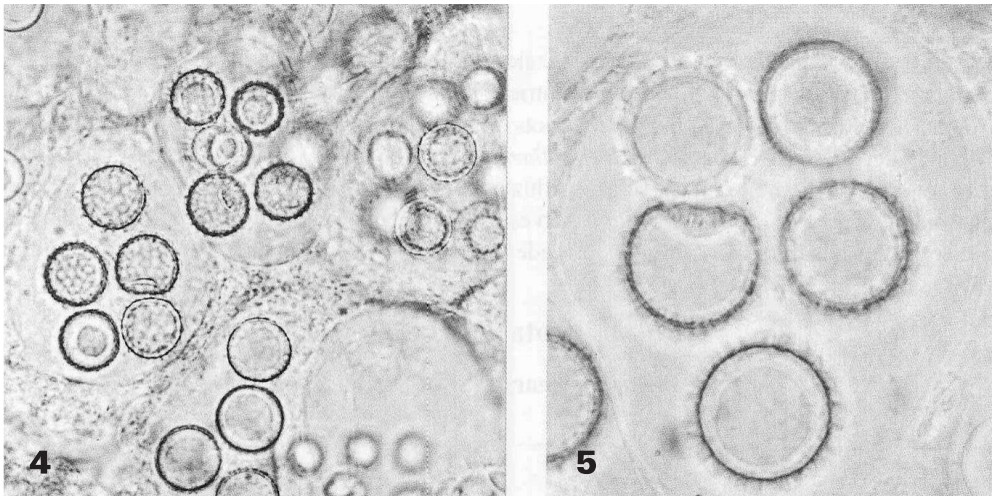
Types of mycorrhizal association in desert truffles

1. Ectomycorrhizal (Ibrahim 1995).
2. Ectomycorrhizal, but without a mantle in phosphorus-rich substrata, or with a mantle in the phosphorus-deficient substrata (Fortas & Chevalier 1992).
3. Ectendomycorrhizal, with a mantle but vesicular arbuscular may be produced in the cells of the seedling stage of two *Helianthemum* species (Harley & Smith 1983).

Nutritional values of desert truffles

In Saudi Arabian truffles, *Terfezia claveryi* and *Tirmania nivea,* the protein and fat contents were 19.6 and 27.2 %, and 2.8 and 7.4 % on dry weight basis respectively (Sawaya *et al.* 1985).

In-vitro protein digestibility (82.8–86.7 %) of Saudi Arabian truffles was slightly lower than that of Animal



Figs 4-5. *Terfezia claveryi* asci and ascospores (Moubasher 1993)

Nutrition Research Council (ANRC) casein (90.0 %), but all essential amino acids were present in "fairly good" amounts (Sawaya *et al.* 1985).

Essential amino acids constituted 6.1 % of dry weight, and no mycotoxins were detected in Libyan truffles (Ahmed *et al.* 1981).

Cultivation of desert truffles

The harvest season of desert truffles in the Arab Countries occurs between January and April. A good harvest is usually preceded by rainfall between September and November or December. The data of the following table reveal clearly that the seasons of 1982-1983 and 1989-1990 were rich in harvest because of the early and high amount of rainfall. In February 1982, rainfall was high but late in the season and, as a result, the harvest was poor (Table 1).

Table 1. Monthly rainfall (mm) in Doha, Qatar (Moubasher 1993)

Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Type of harvest
		1981		1982		
0	0	0	trace	2.6	18.8	poor
		1982		1983		
trace	trace	20.3	21.2	8.1	5.1	rich
		1988		1989		
0	0	0	0	0	1.0	poor
		1989		1990		
0	0	14.6	66.8	10.6	1.8	rich

In Qatar, Saudi Arabia, Kuwait and Iraq, trials to increase truffles harvests have been made using artificial irrigation in dry seasons and the results were positive, but the cost/benefit ratio was not encouraging. Water is costly in arid and semiarid countries.

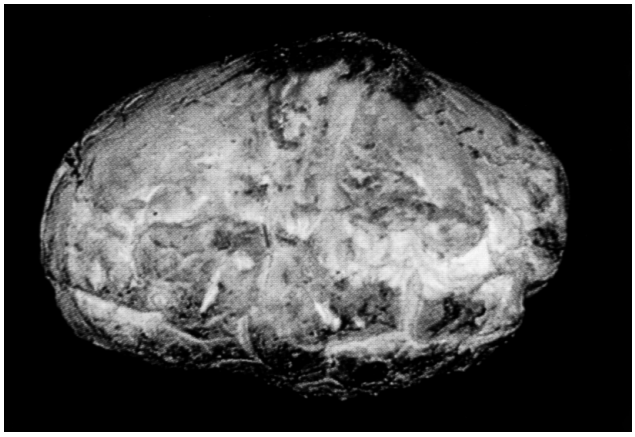


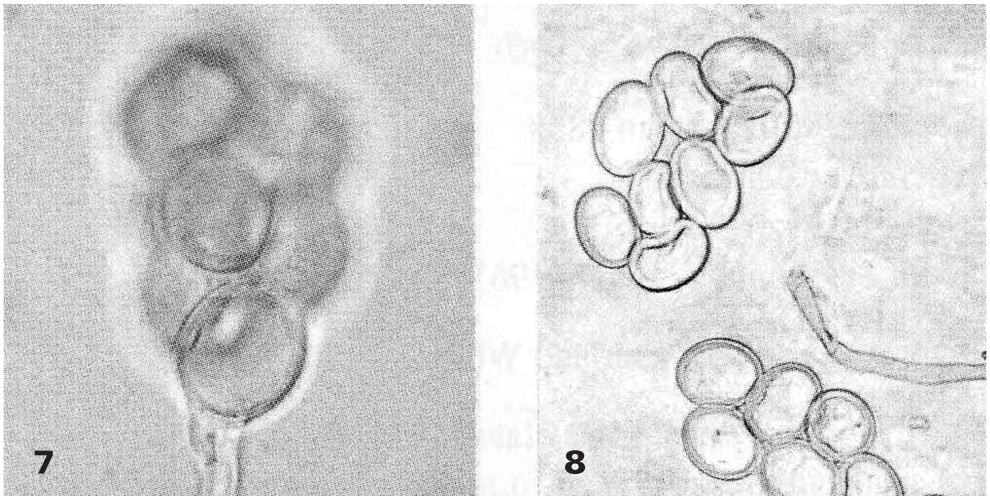
Fig. 6. *Tirmania nivea* ascoma (about 9 cm in diameter) (Moubasher 1993)

Proposed means of truffle cultivation

1. Selection of suitable associated plants.
2. Germination of their seeds in a nursery and inoculation with suitable truffle fungus.
3. Transplantation of inoculated seedlings to suitable desert sites, which should be protected from grazing animals, and planting in the appropriate season.
4. Use of adequate means of artificial irrigation in dry seasons.

Desert truffles in Egypt are endangered

The two main centres for collection of desert truffles (El-Kholy & Ali, 1992; Ibrahim 1995) are Marsa Matruh Governorate, on the Mediterranean coast of western Egypt, adjacent to the Libyan border (this is the major centre), and Al-Arish, on the eastern coast of the Mediterranean, in the Sinai Penninsula (this area has been and continues to be affected by its proximity to a Middle East conflict area).



Figs 7-8. *Tirmania nivea* asci and ascospores (Moubasher 1993)

Human activities likely to be adverse to desert truffles are currently taking place on the coastal area near Alexandria. They comprise construction of tourist resort villages (these have already reached to about midway between Alexandria and Marsa Matruh), and associated construction of new roads, factories, academic institutions, playgrounds, houses for permanent residence and other infrastructural developments. Where they have already occurred, these activities haveinflicted tremendous destruction on the natural vegetation including *Helianthemum* spp., the main plant associated with desert truffles.

The population of Egypt has risen very sharply in the last 20 years and has now reached 80 million, with a young demographic profile. About 98% of the population is concentrated in the Nile Valley which represents about 4% of the total area of Egypt while the rest of the country is desert. The urbanization resulting from this population increase is expected to expand to reach Marsa Matruh Governorate, thereby threatening further similar destructive effects on the vegetation and desert truffles.

Fig. 9. Map of Egypt

Brief outline of a proposed research project for conservation of desert truffles

Objectives:

1. Conservation of desert truffles (*Terfezia* and *Tirmania* spp.).
2. Conservation of *Helianthemum* spp. (the main associated plants) and of their habitats.
3. Increase of the potentialities of the *Helianthemum*-truffle interrelationships.

Research area:

To be selected between Marsa Matruh and Sallum on the western coast of the Mediterranean of Egypt, rich in *Helianthemum* spp.

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