

Desert Truffles 'Al-Kamah' of the Kingdom of Saudi Arabia

1. Occurrence, Identification and Distribution

H.A. Bokhary

Botany Department, College of Science, King Saud University,
P.O. Box 2455, Riyadh 11451, Saudi Arabia

ABSTRACT. Three edible hypogeous fungi were collected and identified. These were *Tirmania nivea* (Desf. ex Fr.) Trappe, *Tirmania pinoyi* (Maire) Malençon, and *Terfezia boudieri* Chatin. They are recorded, illustrated and described for the first time in Saudi Arabia. Their sites of occurrence, the ecological and biological factors affecting their distribution are discussed.

'Al-Kamah' or 'Kaṁe' is a classic Arabic word for truffles, but the common name is "Al-Fag'a". This means 'bursting forth' and the name is applied because at late stages of truffle maturity the soil surface above the fruiting body is cracked as a result of swelling of the ascocarps. These Ascomycetes truffles (Pezizales) occur in two families, Pezizaceae and Terfeziaceae (Trappe 1979).

Most of truffles collected from the Arabian desert and neighbouring areas of the Arab Gulf belong to two genera, *Terfezia* [local name, 'Al-Kame-Al-Souda' & 'Al-Kame-Al-Bunia' (Kholasi)] and *Tirmania* [local name 'Al-Kame-Al-Baidah' (Zubaidi)].

The first record of Arabian Kame is *Terfezia claveryi* Chatin reported by Chatin (1892) in Syria. *Terfezia combonii* was reported for Kuwait by Dickson (1955). Malençon (1973) also reported the occurrence of *Terfezia* spp. in Kuwait, Iran and Iraq. In addition, Awameh and Al-Sheikh (1980) noted the existence of two species of *Terfezia*, namely *T. claveryi* and *T. boudieri*, two species of *Tirmania*, *T. nivea* (Desf. ex Fr.) Trappe and *T. pinoyi* (Maire) Malençon in Kuwait. *Terfezia* species have been reported from the neighbouring countries of Iraq (Al-Delaimy 1977, and Iran (Fallahyan 1968).

Terfezia species have also been known from other regions of the world. In North Africa, Bataille (1921a,b) reported their occurrence in Algeria, Duggar and Pinoyi (1907) in Tunisia, and Ahmad *et al.* (1981) in Libya. In addition, there are reports of truffles (*Terfezia* spp.) in South Africa (Marloth 1913, Pole-Evans 1981, Marasas and Trappe 1973, and Ackerman *et al.* 1975). The occurrence, ecology and taxonomy of *Terfezia* spp. have been discussed by Trappe (1971, 1975) and recently Al-Sheikh and Trappe (1983) have re-described the desert truffle *Tirmania* (*T. nivea* and *T. pinoyi*).

Since there has been no previous report on the occurrence of truffles in Saudi Arabia and because of their high commercial value their morphological characteristics and distribution together with a key to their identification is presented.

Material and Methods

Several visits were made to truffle bearing areas during the months of January-March in the years 1981-1985. The search area included three regions of Saudi Arabia; the North-Eastern region (Hafer Al-Batin area); the Central region (near to Riyadh) and the Northern region (between Jouf and Hail), Fig. 1. Because

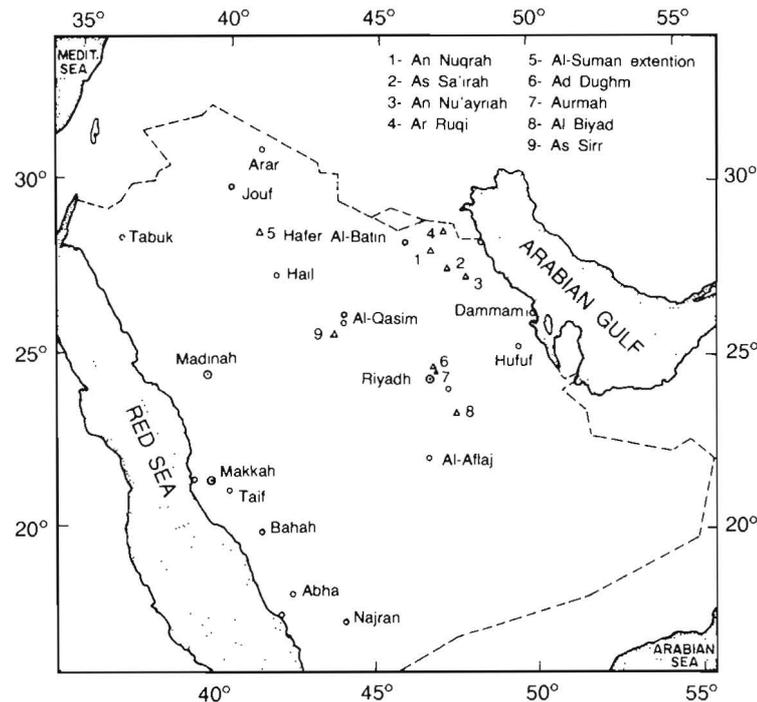


Fig. 1. A sketch map showing the sites (1-9) in which desert truffles are distributed in Saudi Arabia

of the large area of the Kingdom, it is difficult to obtain a comprehensive coverage of possible truffle sites. Moreover, due to their economic importance, local inhabitant (Bedouins) are frequently reluctant to reveal localities in which truffles occur.

Soil samples for analysis were collected from the North-Eastern region in which truffles were most abundant. Rainfall data were collected from the Ministry of Agriculture and Water reports (1982-1985). Moisture contents of soil and truffles were recorded according to the technique given by AOAC (1975). Soil pH was electrometrically determined after mixing 10 g of soil in 20 ml water and about 5 min was allowed for ionic exchange to reach equilibrium prior to take readings. Mechanical analysis of soil samples was carried out using the sedimentation method.

For identification and for the purpose of analysis of the morphology and anatomy of fruit bodies, hand sections, and stained microtomed serial sections of ascocarps were prepared. Truffles were sent to the Royal Botanic Gardens, Kew, Surrey, England and duplicates were deposited in the Herbarium of Botany Department, College of Science, K.S.U.

Results and Discussion

Three hypogeous fungi were collected and identified. These are *Tirmania nivea* and *T. pinoyi* (Pezizaceae) and *Terfezia boudieri* (Terfeziaceae). These can be accommodated in the newly-created order Pezizales of Trappe (1979). All the species reported here are recorded for the first time in Saudi Arabia with the exception of *Tirmania nivea* which has been reported by Al-Sheikh and Trappe (1983) as being part of H.S.B. Philby's (1935) collection deposited at the Royal Botanic Gardens, England (Trappe, 1985, personal communication).

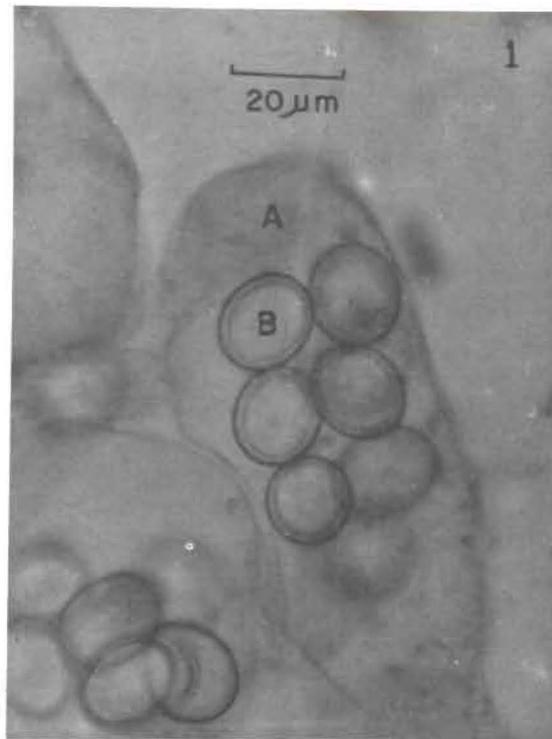
Description of fungi

Tirmania niva (Desf. ex Fr.) Trappe

Ascocarps hypogeous, light yellowish white or with some reddish colour, varying in size and shape subglobose, lobed or turbinate with basal attachment, fresh weight of ascocarps range between 0.8-to-172 g., water content 75%. *Gleba* white becoming yellow with age or sometimes pinkish, fertile pockets separated by undifferentiated hyphae. *Asci*, blue to green in Melzer's reagent, hyaline in KOH: smooth, ellipsoid, ovoid, with or without narrow base (shape of the asci are very variable). *Asci* double-layered, the outer layer thicker than the inner. Varying in size between 70-90 × 45-65 µm. *Ascospores*, round, oval, ellipsoid, two layered, the outer layer being thicker than inner, smooth, 11-18 × 16-26 µm, with a distinct

germ pore measuring $2-5 \times 16-20 \mu\text{m}$. Cells surrounding fertile pockets are pentagonal, rectangular $6-10 \times 10-40 \mu\text{m}$.

A detailed description of *Tirmania nivea* is given by Al-Sheikh and Trappe (1983) and Trappe (1979). The biggest truffle (*T. nivea*) purchased from Hafr Al-Batin market weighed 407 g. Collection sites were, North-Eastern region, As S'airah (March 1983, March 1985); An Nugrah, (March 1983) An Nu'airiyah (March 1983); Northern region, Hail and Al Jouf (March 1983), Plate 1.



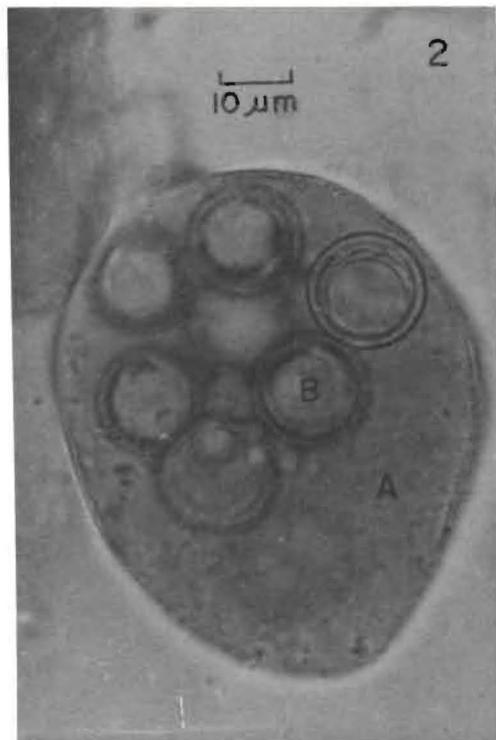
1. *Tirmania nivea*, double layered ascus containing 8 smooth, oval-shaped thick walled ascospores

Tirmania pinoyi (Maire) Malençon

Ascocarps globose, sub-globose or turbanate with basal mycelial attachment, yellowish brown while young becoming dark brown with age when it becomes difficult to separate *Tirmania pinoyi* and *Terfezia* spp. from surface views. Fresh

weight of ascocarps between 2-to-180 g., water content 72-80%. *Gleba* yellowish to pale pink or brown, fertile pockets separated by undifferentiated hyphae. *Hyphae* 9.5 μm wide at septa, hyaline. *Asci* blue to green in Melzer's reagent, hyaline in KOH. *Asci* are of different shape, ranging from ellipsoid to broadly clavate, hyaline, double layered, measuring 75-115 \times 53-68 μm , 2-8 spored, mainly 6-spored. *Ascospores*, smooth, round, smaller in size than *Tirmania nivea*, double layered, thin walled, 17-21 μm , mostly 17 μm in diameter. *Germ pore* distinct, measuring 5-9 μm . Cells surrounding fertile pockets are 8-12 \times 15-40 μm in size.

A detailed description of *Tirmania pinoyi* is given by Al-Sheikh and Trappe (1983). Collection sites were: North-Eastern region, As S'airah (March 1983, 1985); An Nugrah (March 1983); Ar Ruqi (March 1985) Northern region, Hail and Jouf (March 1983), Plate 2.

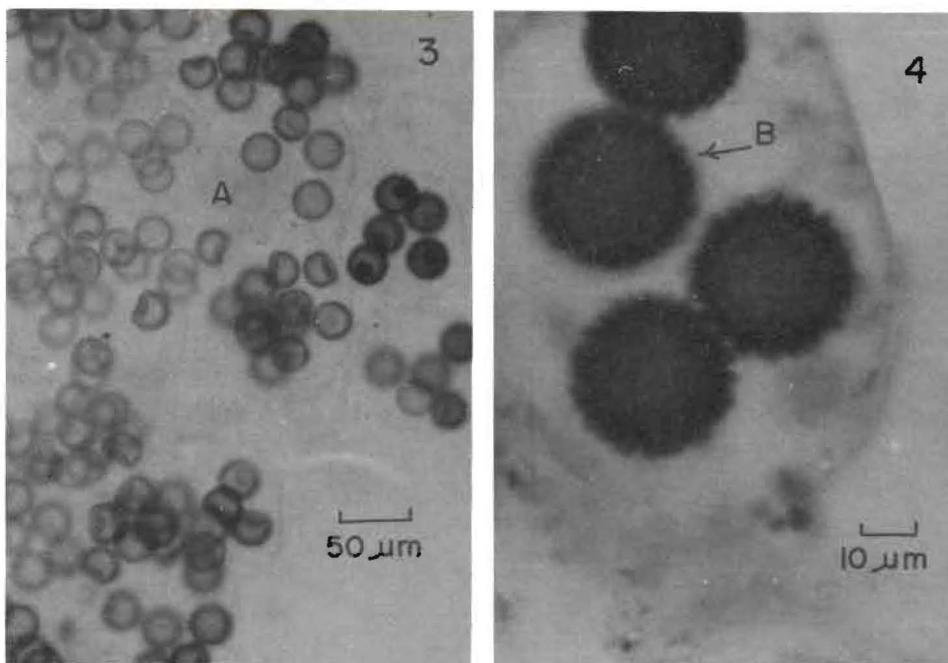


2. *Tirmania pinoyi*, double layered ascus with 8 smooth, round thick walled ascospores.

Terfezia boudieri Chatin

Ascocarps hypogeous, potato shaped to napiform with basal attachment, fresh weight of ascocarps between 0.8-to-173 g., light brown to blackish brown, surface slightly roughened, water content was 71%. *Peridium* prosenchymatous, nearly 1 mm thick with compact flattened cells, dark brown to black upper surface and light brown lower surface. *Gleba* fleshy, olivaceous grey or whitish, odour present. *Hyphae* 8-9.5 μm thick at septa, hyaline. *Asci*, hyaline, double layered thin walled, ovoid, subglobose, or globose 71-75 \times 75-105 μm and 2-5 spored. *Ascospores*, globose, round, brown 23-29 μm , double layered, outer layer with papillose reticulation, 2.5-2.9 μm , inner layer dark 0.6-0.8 μm . *Cells* surrounding fertile pockets flattened, rectangular 4-8 \times 6-32 μm in size.

Chatin (1892) and Ceruti (1960) have given detailed description of *Terfezia boudieri* but did not mention the double wall of asci and ascospores. Collection sites were: As S'airah (March 1983, 1985); An Nugrah (March 1983); Ar Ruqi (near Kuwait) (March 1985); Hail and Jouf (March 1983); An Nauriyah (March 1983); Ad Dugham (March 1983); As Sirr (March 1985), Plates 3 & 4.



3-4. *Terfezia boudieri*, thin walled asci containing 3-5 raticulate ascospores.

Plate 1-4, Asci (A) and ascospores (B) of truffles

This study does not attempt to reveal all sites of truffle occurrence in Saudi Arabia, but is likely to include the most prolific areas.

A key for the identification of Saudi Arabian truffles is presented. It follows the taxonomic keys of Trappe (1979), and Al-Sheikh and Trappe (1983).

1. Asci amyloid
(Blue to green in Melzer's reagent) *Pezizaceae*-3
2. Asci non-amyloid
(Melzer's reagent test negative) *Terfeziaceae*-5
3. Asci 2-8 spored, smooth, or sometimes
minutely roughened *Tirmania*-4
4. a. Asci 8 spored, ellipsoid to globose,
round oval, 11-18 × 16-26 μm *Tirmania nivea*
b. Asci 2-8 spored, mainly 6 spored, spores globose,
17-21 μm, mostly 17 μm in diameter *Tirmania pinoyi*
5. Asci 2-8 spored, spores reticulate or
sometimes smooth *Terfezia*-6
6. Asci 2-5 spored, spores brown, warty
23-29 μm, globose *Terfezia boudieri*

Mycorrhizal Relationships

Mycorrhizal associations between annual plants and truffles have been reported by many authors. For example, *Helianthemum ledifolium*, *H. salicifolium*, *Plantago* spp. and *Artemisia* spp. were reported as being host plants in gypsiferous, gravely gypsiferous or saline gypsiferous deserts in Kuwait (Awameh and Al-Sheikh 1980; Al-Sheikh and Trappe 1983). In Iran, Falhahyan (1968) found *Helianthemum* sp. and *Castanea sativa* (Chestnuts) associated with *Terfezia* sp. in plains, mountains and forests.

Two annual plants were found regularly to be associated with the truffles. These were *Helianthemum ledifolium* and *H. lippi*. The latter was also found to grow apparently independent of truffles in different parts of Saudi Arabia, and was noted to grow in the truffle sites in seasons as such 1984 when low rainfall eliminated truffle growth. However, although it was infrequent, some short plants were found. Thus, mycorrhizal association between truffles and these annuals is suggested (Trappe 1971, and Halwagy and Halwagy 1974). The physiological relationships between truffles and annual plants have yet to be studied, but it is likely that truffles are dependant upon them for carbon. Truffles are very rich in carbohydrates, aminoacids and proteins (Bokhary *et al.* 1986), and this high nutritional value may contribute to their high market price. To date, attempts to grow these fungi in pure culture have failed, but further attempts to culture them are necessary.

Geographical Distribution

Three species of desert truffles were found to grow in the wild in certain regions of Saudi Arabia with variable densities.

These regions are:

1. The North Eastern (Hafer Al-Batin) region: This includes As S' airah 46° 55'E, 28° 2'N; An Nugrah 46° 66'E, 28° 35'N (North of As Saydawi about 14 km around Prince Sultan Bin Abdul Aziz Camp); Ar Ruqi near Kuwait & Iraq border); An Nu' ayriyah 47° 62'E, 27° 9'N (East and West about 15-20 km).
2. The North region: This included as Soumann extension only (half way between Hail and Jouf 40° 0'E, 29° 8'N).
3. The Central region: This include Al Dugham 46° 67'E, 24° 4'N, Aurmah 46° 76'E, 24° 4'N (East Riyadh); Al Biyad 47° 62'E; 33° 2'N (Between Al-Kharj and Al Aflaj) and As SIRR 42° 38'E, 25°, 0'N (Qassim area) (see Fig. 1). Truffles occur between 40-47° 62'E longitude and 23° 2'-30° 9'N latitude in the region. *Terfezia boudieri* was collected from all locations mentioned above, while *Tirmania nivea* and *T. pinoyi* were restricted to regions 1 and 2 only.

Rainfall

The five-year period of field study revealed that rainfall is a very important factor for the occurrence of truffles. Awameh and Al-Sheikh (1980) from Kuwait reported 160-180 mm per year rainfall was sufficient for a good harvest. During the five-years survey, only 1983 and 1985 were found to be a good harvesting seasons, when sites had a total rainfall of above 100 mm (122-264 mm). This rainfall was also evenly distributed throughout the year (Halwagy and Halwagy 1974). It is also important to note that truffles did not grow if rains failed in October and November (locally known as 'Alwasm' rain) followed by a cold period (December and January). Truffles usually started flourishing in February and March. A high amount of rainfall was recorded in October and November (1982, 1984) the best years for truffles occurrence.

Soil Types

Soil collected from sites of the North-Eastern region where an abundance of truffles was found, were found to be both sandy and alkaline (Table 1). It has been reported previously that these truffles occur in saline deserts, gravelly gypsiferous and gypsiferous-saline soil (Al Sheikh and Trappe 1983 and Halwagy and Halwagy 1974). However, much data are not available on soil analysis of truffles native areas, because previous studies have been mainly concentrated on to describe truffles collected from sand dunes, deserted areas or purchased from the market

(Bataille 1921a,b, Ceruti 1960, Trappe 1971, 1975, 1979, Pole Evans 1981 and Fallayhan 1968).

Table 1. Analysis of soil collected from truffles site in North-Eastern regions of Saudi Arabia

Locality	Water content	Particle size %				Soil category	pH	Total soluble solids (ppm)
		C.sand	F.sand	Silt	Clay			
As-S'aira	1.78	60.1	38.0	0.4	0.8	Sandy soil	9.8	384
Al-Nuqrah*	0.8	55.5	41.5	1.5	1.2	Sandy soil	9.6	704
Al-Nuqrah*	1.2	48.8	47.6	1.9	1.0	Sandy soil	9.5	621
Al-Nuqrah*	1.99	68.5	28.9	0.6	1.1	Sandy soil	9.7	410

* Three different locations

Conclusion

For truffle occurrence, three regions *viz.*, North-Eastern, North and Central region have been searched. The whole areas are situated between 40-47° 62'E longitude and 23-30° 9'N latitude. Two plants *Helianthemum ledifolium* and *H. lippi* have been found associated with truffles in these areas. Rainfall, in a good harvesting season recorded, was between 122-264 mm. But for good harvest, a good rainfall should occur in October and November. Only soils of North-Eastern region (where truffles occur in abundance) has been analysed and found to be sandy and alkaline with a pH ranging between 9.5-9.8. *Tefezia boudieri* was found in all regions searched, but *Tirmania nivea* and *T. pinoyi* were restricted to regions 1 and 2 only.

Acknowledgement

I am grateful to Mr. B.M. Spooner for identification of truffles, and Dr. J.M. Trappe for confirmation of *Tirmania pinoyi* and *Terfezia boudieri* identification and to Dr. D. Read of Botany Department, Sheffield University for reading the manuscript and his comments.

References

- Ackerman, L.G.J., van Wyk, P.J., and du Plessis, L.M. (1975) Some aspects of the composition of the Kalahari Truffle of N'abba, S.A. *Food Rev.* 2(5): 145-147.
- Ahmad, A.A., Mohamed, M.A., and Hami, M.A. (1981) Libyan truffles "*Terfezia boudieri* Chatin": Chemical composition and toxicity, *J. Food Sci.* 11: 927-929.

- Al-Delaimy, K.S.** (1977) Protein and amino acid composition of truffles, *Can. Inst. Food Sci. & Tech. J.* **10**(3): 221-222.
- Al-Sheikh, A.M. and Trappe, J.M.** (1983) Desert truffles: The genus *Tirmania*, *Trans. Br. Mycol. Soc.* **81**(1): 83-90.
- Awameh, M.S., and Al-Sheikh, A.M.** (1980) Ascospore germination of black kame (*Terfezia boudieri*), *Mycologia*. **72**: 50-54.
- Awameh, M.S. and Al-Sheikh, A.M.** (1979) Laboratory and field study of four kinds of truffles (Kamah). *Terfezia* and *Tirmania* species for cultivation, *Mushroom Sci.* **10**: 507-517.
- AOAC** (1975) *Official Methods of Analysis*. 12th ed., Association of Official Analytical Chemists, Washington, D.C.
- Bataille, M.F.** (1921a) Flora analytique et descriptive des tuberoidees de l'Europe et de l'Afrique du Nord. *Bull. Soc. Mycol. France.* **37**: 24-26.
- Bataille, M.F.** (1921b) Flora analytique et descriptive des tuberoidees de l'Europe et de l'Afrique du Nord. *Bull. Soc. Mycol. France.* **37**: 155-207.
- Bokhary, H.A., Suleiman, A.A.A., Basalah, M.O. and Parvez, S.** (1986) Chemical composition of desert truffles from Saudi Arabia. *Can. Inst. Fd. Sci. Technol.* (submitted for publication).
- Ceruti, A.** (1960) Elaphomycetales et Tuberales, *Iconographia Mycol.* **28**: Suppl. 2, 48 pl.
- Chatin, A.D.** (1892) *La Truffe*, J.B. Bailliere et fils, Paris, 371 p.
- Dickson, V.** (1955) *The wild flowers of Kuwait and Bahrain*, Allen & Unwin, London, 144 p.
- Duggar, B.M. and Pinoyi, E.** (1907) Sur le parasitisme des Terfas, *Soc. Bot. France. Session Extraordinaire en Oranie*, 16 Avril 1906, **53**: LXXII-LXXIV.
- Fallayhan, F.** (1968) Hypogeous fungi of Iran, *Rev. Mycol. (Paris)* **33**(5): 416-417.
- Halawagy, R. and Halawagy, M.** (1974) Ecological studies on the desert of Kuwait. 1. The Physical environment, *J. Univ. Kuwait (Sci.)* **1**: 75-86.
- Malençon, G.** (1973) Champignons hypogeous du Nord du l'Afrique. I-Ascomycetes, *Persoonia*. **7**: 261-279.
- Marasas, W.F.O. and Trappe, J.M.** (1973) Notes on Southern African Tuberales, *Bothalia*. **11**: 139-141.
- Marloth, R.** (1913) *The Flora of South Africa* 1(XI) "Eumycetes", Darter Bros. & Co., Capetown, pp. 20-34.
- Ministry of Agriculture and Water Reports** (1982-1985) Hydrology Division, Dept. of Water Resources Development, Ministry of Agriculture and Water, Riyadh, K.S.A.
- Pole-Evans, I.B.** (1981) Notes on the genus *Terfezia*. A truffle from Kalahari, *Trans. Roy. Soc. S. Africa.* **7**: 117-118.
- Trappe, J.M.** (1971) A synopsis of the Carbomycetaceae and Terfeziaceae (Tuberales), *Trans. Br. Mycol. Soc.* **57**(1): 85-92.
- Trappe, J.M.** (1975) Generic synonyms in the Tuberales, *Mycotaxon*. **2**(1): 109-122.
- Trappe, J.M.** (1979) The order, families, and genera of hypogeous Ascomycotina. (Truffles and their relatives), *Mycotaxon*. **9**(1): 297-340.

(Received 05/05/1986;
in revised form 05/05/1986)

الكمأة الصحراوية في المملكة العربية السعودية تعريفها - وأماكن إنتشارها

حسن عبدالحكيم بخاري

قسم النبات - كلية العلوم - جامعة الملك سعود
ص.ب: ٢٤٥٥ - الرياض ١١٤٥١ - المملكة العربية السعودية

تم جمع ثلاث من الفطريات الزقية (الأسكية) الأرضية، التي تصلح غذاءاً للإنسان، من أماكن مختلفة بالمملكة العربية السعودية. وأنواع هذه الفطريات هي:

Tirmania nivea (Desf. ex Fr.) Trappe, *Tirmania pinoyi* (Maire) Malencon *Terfezia boudieri* Chatin.

حيث تم وصف وشرح وتسجيل هذه الفطريات لأول مرة بالمملكة العربية السعودية، كما نوقشت العوامل البيئية والأحيائية التي تؤثر على توزيعها وأماكن وجودها في الصحراء.