

**TERFEZIA BOUDIERI, FIRST RECORDS FROM EUROPE  
OF A RARE VERNAL HYPOGEOUS MYCORRHIZAL FUNGUS**

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*Terfezia boudieri* is reported for the first time from the Iberian Peninsula and Europe. It is illustrated and compared with material and descriptions of similar *Terfezia* species *T. arenaria*, *T. claveryi* and *T. leptoderma*. Specimens of *T. boudieri* from Spain were also compared with those from Morocco.

Plants belonging to the Cistaceae, particularly species of *Helianthemum*, *Xolantha*, *Cistus*, *Halimium* and *Fumana*, occur in many semi-arid regions in the Mediterranean basin. Most of these plants establish mycorrhizas, and have a specific mycota associated with them, notably hypogeous ascomycetes (species of *Tuber*, *Terfezia*, *Tirmania* and *Picoa*) (Alsheikh & Trappe, 1983a; Moreno et al., 1986; 1991; Pacioni & El-Kholy, 1994; Moreno et al., 2000).

Three species of *Terfezia* have been reported so far from Spain: *T. arenaria* (Moris) Trappe, the most common of those occurring on acid sandy soils; *T. leptoderma* Tul. & C. Tul., which also occurs on acid soils but less frequently; and *T. claveryi* Chatin, typical on calcareous soils. These desert truffles, traditionally called in Spain 'criadillas de tierra' or 'turmas' are collected in spring under annual and perennial plants, often *Helianthemum* and *Xolantha* spp. (Moreno et al., 1986). Their abundance in favourable years, their high market value, and their exportation to Arabia, make them an important natural resource.

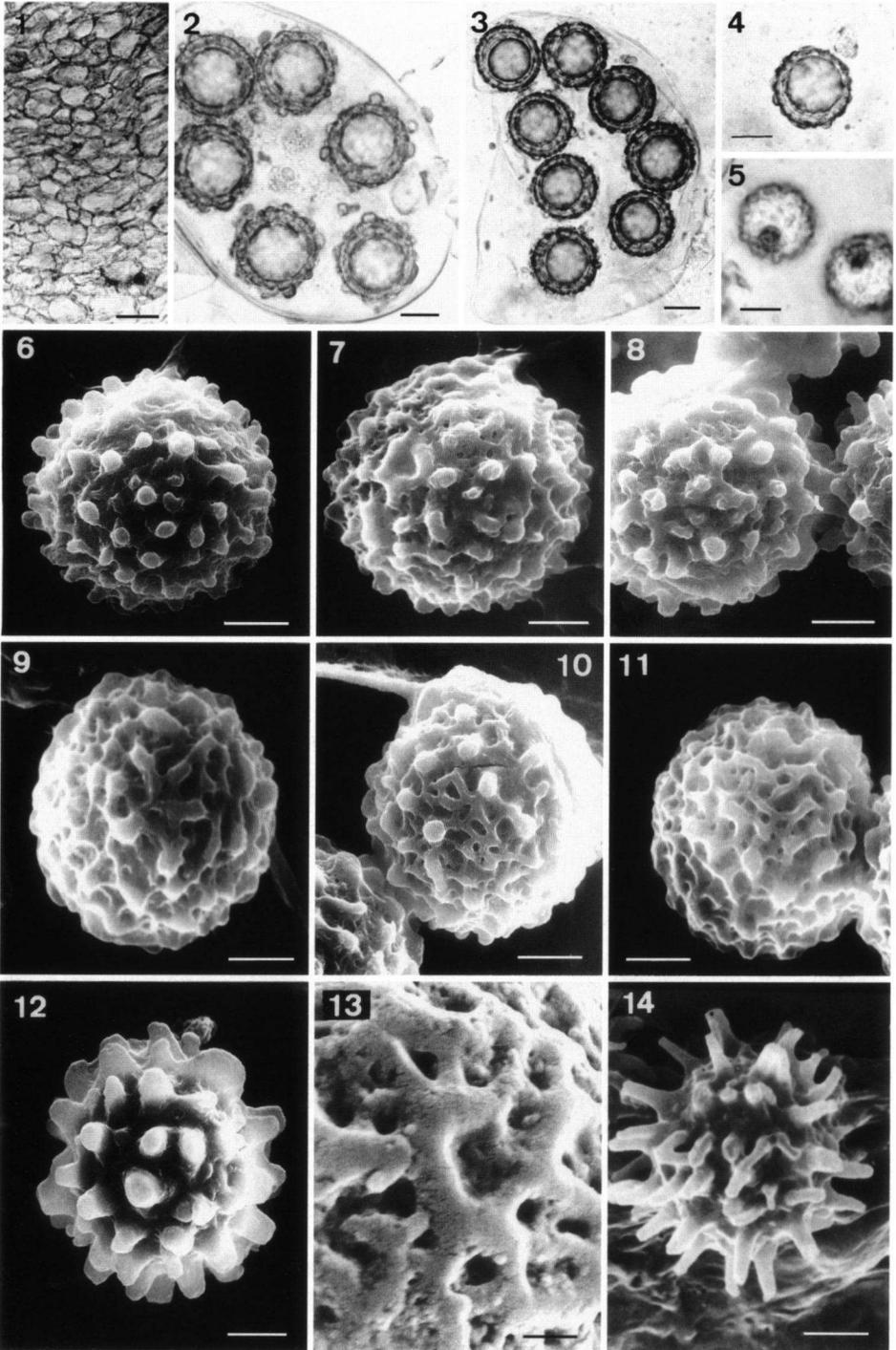
As Moreno et al. (2000) point out, these mycorrhizal fungi play an important role in the maintenance of Mediterranean shrub-lands by preventing erosion and desertification. Hence, it is important to study these fungi and understand their biology and taxonomy more fully. In the present study, we describe a rare and little known species, *Terfezia boudieri* Chatin, not previously reported from Europe. This hypogeous fungus is collected and consumed, without knowledge of its specific identity, in the provinces of Madrid and Toledo on calcareous and gypsiferous soils.

The material from Spain, herein reported, was compared with specimens of *T. boudieri* from Morocco, where this desert truffle is sold in local markets or 'zocos'.

**MATERIAL AND METHODS**

Microscopic examination and measurement of ascoma elements were carried out in tap water, 10% aqueous NH<sub>4</sub>OH, Melzer's reagent and Congo-Red. The photomicrographs were made with a Nikon microscope (Optiphot model), with phase-contrast and automatic photography. The SEM photographs were taken with a Zeiss DSM-950 microscope.

Voucher specimens were deposited in AH (herbarium of Alcalá University, Spain).



***Terfezia boudieri* Chatin — Figs. 1–11**

*Terfezia boudieri* Chatin, Compt. Rend. Acad. Sci. Paris 113 (1891) 530.

Ascomata hypogeous, isolated, 4–9 cm diam., subglobose, obconical, irregular, depending on whether soils are more or less sandy, with a basal cord or attachment formed by sand and mycelium and connected to roots of vascular plants. Peridium smooth, with adherent sand, brown-red to brown, reminding of potato peels. Gleba yellow-brown with red tones, at maturity with red-brown fertile pockets, surrounded by paler off-white infertile veins. Smell not distinct.

Peridium composed of parenchymatous cells with thick walls. Asci 56–90 µm in diam., globose, (3–4–)6–8-spored, when immature with a short wide pedicel, non amyloid. Spores 18–22 µm diam. (ornamentation included), globose, pale yellow-brown, with a large guttule. Ornamentation 1–3 µm thick and variable depending on maturity. At first reticulate, then more or less warty with large obtuse warts often with a truncate tip, similar to *T. arenaria* (Fig. 12) but with abundant small warts. At maturity with short crests and wide rounded warts over a reticulum, non amyloid.

**Collections studied.** SPAIN: Fuentidueña del Tajo (Madrid), gypsum shrub-land, associated with *Helianthemum squamatum* (L.) Dum. Cours., March 1997, B. Anta & A. Fernández, AH 22364; Valdeguerra, Colmenar de Oreja (Madrid), on calcareous gypsiferous soil together with *Picoa lefebvrei* (Pat.) Maire, and associated with *Helianthemum salicifolium* (L.) Mill., 18 Apr. 1999, J. Cámara, G. Moreno, K. Kreisel & H. Kreisel, AH 19743; Cabezamesada, Toledo, 2 May 1999, E. Rubio, AH 19581. — MOROCCO: Market of Tanger, 19 May 1997, Laghzaoui Rabie, AH 22363, duplicate in Montecchi Herbarium.

**Additional collections studied.** (1) *Terfezia arenaria* (Moris) Trappe. SPAIN: Naval Moral de la Mata (Cáceres) associated with *Helianthemum guttatum* (L.) Miller, March 1995, J.L. Manjón & J. Díez, AH 22331 (Fig. 12). (2) *Terfezia claveryi* Chatin. SPAIN: Guadix (Granada) with *Helianthemum salicifolium* (L.) Mill., 30 Apr. 1977, A. Ortega, AH 3813 (Fig. 13). (3) *Terfezia leptoderma* Tul. & C. Tul. SPAIN: Trujillo (Cáceres) with *H. guttatum* (L.) Mill., 26 Feb. 1977, leg. J.M. Hernández, AH 1809 (Fig. 14).

*Terfezia boudieri* occurs on basic, either calcareous soils or gypsiferous marl. It is characterized by large ascomata, and spores bearing warts over a reticulum.

*Terfezia claveryi* also occurs in such soils, and is macroscopically very similar. Microscopical examination is required to differentiate one from another based on spore ornamentation. *Terfezia claveryi* has reticulate spores without warts (Fig. 13), whereas the spores of *T. boudieri* have warts over a reticulum (Figs. 2–11).

On acid soils, two other species fruit, namely *T. arenaria* and *T. leptoderma*. Although both acidophilous species occur on sandy sites associated with the same host, they are easy to distinguish from each other. The former has a pale brown gleba with pink tones at maturity while *T. leptoderma* has green-olive tones to its gleba at maturity. These species are also very different in microscopy, the spores of *T. arenaria* bearing warts with obtuse apices (Fig. 12), whereas spores of *T. leptoderma* have long spines (Fig. 14) (Moreno et al., 1986).

Figs. 1–11. *Terfezia boudieri* (1–5: AH 19743; 6–11: AH 19581). 1. Parenchymatous cells of ascoma peridium (MO); 2. 6-spored ascus; 3. 8-spored ascus; 4 & 5. detail, spore ornamentation (MO); 6–11. spores showing variation in ornamentation (SEM), from warty over a weak reticulum to reticulate with scattered warts. — 12. *Terfezia arenaria* (AH 22331). Spore with large truncate warts (SEM). — 13. *Terfezia claveryi* (AH 3813). Spore with complete reticulum without warts (SEM). — 14. *Terfezia leptoderma* (AH 1809). Spore with long spines (SEM). — Scale bars: Fig. 1 = 20 µm; Fig. 2–5 = 10 µm; Figs. 6–12 & 14 = 5 µm; Fig. 13 = 1 µm.

There is an excellent iconography of *T. boudieri* by Ceruti (1960), who reported this fungus as a common truffle in northern Africa. However, Malençon (1973) curiously did not mention this species in his broad treatment of North Africa. Pacioni & El-Kholy (1994) described *T. boudieri* from Egypt, and provided the first SEM microphotographs of the spore ornamentation.

In certain areas of the Iberian Peninsula (i.e. the provinces of Madrid and Toledo) *T. boudieri* is consumed by the locals. In certain favourable years, large amounts of this desert truffle are collected. In these regions, it is called 'criadilla or turma', the same name used to refer to the most abundant and commonly collected species in other regions of Spain (i.e. Extremadura, western Spain), namely *T. arenaria*.

Until now, *Terfezia boudieri* has been known to occur only in North Africa and West Asia. It had never been reported from southern Europe, though it was likely misidentified as other *Terfezia* spp. because of its variable spore ornamentation. We observed that the features of the ornamentation depend on the spore maturity (Figs. 6–11). At first, the spores are reticulate with scattered small warts, hence it is easily confused with *T. claveryi*. Later, spores become warty as in *T. arenaria*, but with numerous small warts. Furthermore, we believe the figure published by Montecchi & Lazzari (1993: 214), showing spores with rounded warts over a reticulum, likely represents *T. boudieri* instead of *T. claveryi*.

In the Iberian Peninsula, *T. boudieri* occurs on basic soils associated with *Helianthemum* spp., either with annual species such as *H. ledifolium* (L.) Miller or *H. salicifolium* (L.) Miller or with perennial species such as *H. squamatum* (L.) Dum. Cours., the last one a gypsumophilous plant endemic to the Iberian Peninsula.

As Moreno et al. (2000) point out in a previous work, the Iberian Peninsula is located between the African and the European continents. Moreover, these regions share a heliophilous flora and the associated mycota, which suggests this region may play an important role in the migration of mycorrhizal fungi between both continents, particularly of those species associated with *Cistaceae*.

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