

HYPOGEOUS FUNGI FROM SOUTHERN SPANISH SEMI-ARID LANDS*

M. HONRUBIA**, A. CANO** & C. MOLINA-NIÑIROLA**

Six hypogeous fungi of Ascomycotina and Basidiomycotina have been studied from semi-arid zones in Southern Spain. *Melanogaster variegatus* (Vitt.) Tul. is recorded for the first time from Spain. *Picoa juniperi* Vitt. and *Terfezia claveryi* Chat. are revealed as the most frequent species in semi-arid zones. Taxonomical problems on *Tuber puberulum* Berk. & Br. are discussed; *Geopora arenicola* (Lév.) Kers and *G. cooperi* Hark. are also commented on.

The South-East of Spain has a semi-arid climate (Allué-Andrade, 1966), where extensive zones have marl and gypsum-marl soils (Alias, 1986–89). In these areas a very selected vegetation grows. Some *Pinus halepensis* Miller plantations have been made since a few decades ago; but pine growth rate is very slow because of drought, which produces a compacting of marl soil, thus making normal development impossible for their root systems.

Most of the natural growing plants in these areas are mycorrhizal symbionts with living fungi as well. These fungal species are well adapted to xeric conditions and play an important role in maintenance of these semi-arid ecosystems (Trappe, 1981), not only because of the nutritional exchanges with plant root systems, but also some of these fungi are eaten as food by mammals, mice, rats, rabbits, etc., which then contribute to spore dispersal of fungi, specially the hypogeous ones.

We have studied the mycoflora of these systems and have found the following hypogeous fungi.

Material examined is conserved in the Herbarium of the University of Murcia (MUB) with the corresponding registration numbers (MH, PT, or MH-AC).

ASCOMYCOTINA

Geopora arenicola (Lév.) Kers

Geopora arenicola (Lév.) Kers in Svensk bot. Tidskr. 68: 345. 1974.

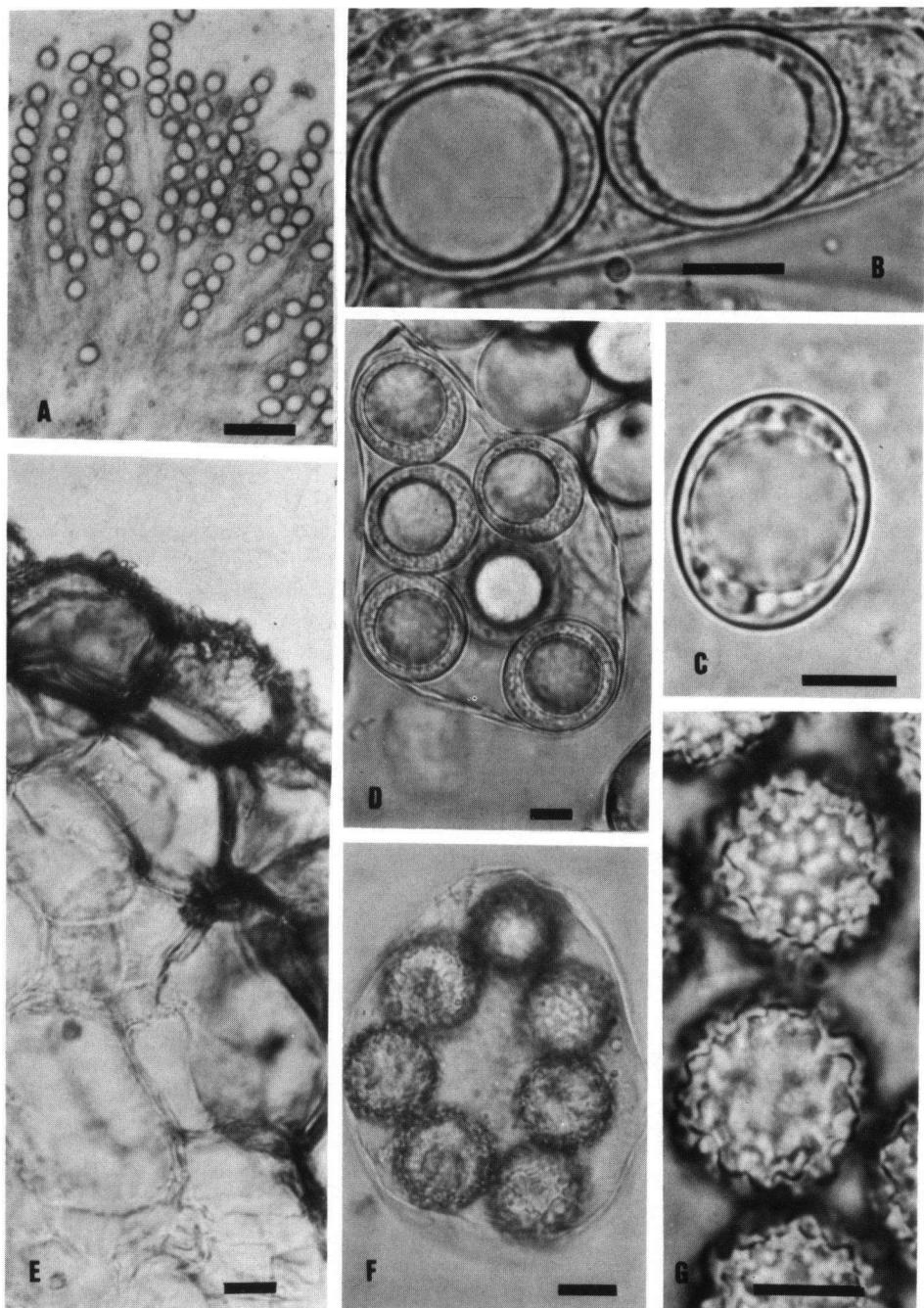
Geopora arenosa (Fuckel) Ahmad in Monogr. biol. Soc. Pakistan 7: 176. 1978.

M a t e r i a l e x a m i n e d . — In sandy soil, near the reservoir in Santomera (Murcia), *T. Lorano*, 3.II.1980 (MH 2950). On wet banks, under *Pinus halepensis*, in sandy soil, near the Cenajo (Murcia) reservoir, *T. Lorano*, 3.II.1979 (MH 394).

It is a widely distributed species in Europe (Moreno & al., 1986). Honrubia & al. (1983) noted this species from Southern Spain and discussed the taxonomical problems existing be-

* This paper has been presented at the 'V Reunión Conjunta de Micología', in Barcelona (1–4 October 1990).

** Departamento de Biología Vegetal (Botánica), Facultad de Biología, Campus de Espinardo, Universidad de Murcia, Spain.



tween *G. arenicola* (Lév.) Kers and *G. arenosa* (Fuckel) Ahmad. Now we agree with Moreno & al. (1986) in considering *G. arenosa* a synonym of *G. arenicola*.

Geopora cooperi Harkn.—Fig. 1A–C

Geopora cooperi Harkness in Bull. Calif. Acad. Sci. 1: 168. 1885.

M a t e r i a l e x a m i n e d.—Under *Helianthemum almeriense*, in marl-calcareous soils, University Campus in Espinardo (Murcia), A. Roldán, 21.II.1990 (MH-AC 9010).

Ortega & al. (1981) and Moreno & al. (1986) previously recorded this species in Spain.

The inwardly cerebriform and nuciform-sized (2 cm diam. in MH-AC 9010) apothecia and widely elliptical (18–25 × 15–20 µm in MH-AC 9010) ascospores with obtuse ends (Fig. 1B, C) characterize this species (Moreno & al., 1986).

It is an infrequent putative mycorrhizal species of *Helianthemum* species in Southern Spanish semi-arid zones, that grows in the same environment as *Picoa juniperi* Vitt. and *Terfezia claveryi* Chat.

Picoa juniperi Vitt.—Fig. 1D, E

Picoa juniperi Vittadini, Monogr. tub.: 55. 1831.

Picoa juniperina Tul., Fung. hyp.: 169. 1851.

M a t e r i a l e x a m i n e d.—Under *Helianthemum almeriense* in marl calcareous soils, University Campus in Espinardo (Murcia), P. Torres, 21.II.1990 (MH-AC 9015); under *H. almeriense* in marl-gypsum soil, on the roadside from Murcia to Granada, near Cullar, M. Honrubia, 20.III.1990 (MH-AC 9016).

Together with *Terfezia claveryi* Chat., *P. juniperi* Vitt. is the most frequent hypogeous fungus in semi-arid lands in Southern Spain. We mostly found it under species of *Helianthemum* with which it establishes mycorrhizal symbiosis as does *T. claveryi*. *Picoa juniperi* is known in this area as 'la turma negra (black turma)' or 'el chivato de la turma (turma's informant)', because it produces the sporocarps 2–3 weeks earlier than *T. claveryi*.

Picoa juniperi is characterized by the following: subglobose ascocarps of 3–7 cm in diam.; black warty peridium with an outer layer of rounded to subpolygonal cells of 30–50 × 17–30 µm (Fig. 1E); white solid gleba; ellipsoid to ovoid or globose ascii of 70–90 µm in diam., with 6–8 ascospores; and subglobose, smooth and hyaline spores of 24–30 µm in diam. (Fig. 1D).

Calonge (1982) and Calonge & al. (1985) previously reported this species in Spain. They considered *P. juniperi* as an infrequent species, collected under *Stypa tenacissima* and in an uncultured site. Tulasne & Tulasne (1851) also cited this species near *Juniperus* spec. and grasses. Nevertheless, Poaceae and Cupressaceae mainly establish endomycorrhizal symbiosis with VAM-fungi. We always picked Vittadini's species under Cistaceae with which we consider it associated.

Fig. 1. A–C. *Geopora cooperi* Harkn., MH-AC 9010. — A. Hymenium. — B, C. — Ascospores. — D, E. *Picoa juniperi* Vitt., MH-AC 9016. — D. Ascus with six smooth globose ascospores. — E. Detail of the peridium with polygonal cells. — F, G. *Terfezia claveryi* Chat., MH-AC 9017. — F. Ascus with seven ascospores. — G. Detail of the reticulate-verrucose ascospores. — Bar markers = 10 µm (B–G), and 50 µm (A).

Terfezia claveryi Chatin—Fig. 1F, G

Terfezia claveryi Chatin in C. r. hebd. Séanc. Acad. Sci. 13: 381. 1892.

M a t e r i a l e x a m i n e d.—Among *Pinus halepensis*, *Quercus coccifera*, and *Cistaceae* in calcareous soils, Sierra Espuria (Murcia), *P. Sanchez*, 29.V.1986 (PT 8849); in marl-gypsum soil, under *Helianthemum almeriense*, La Alcayna-Molina de Segura (Murcia), *M. Honrubia*, 21.II.1990 (MH-AC 9013); in marl calcareous and sandy soils, under *H. almeriense* and *H. lavandulifolium*, University Campus in Espinardo (Murcia), *C. Molina-Niñirola*, 23.II.1990 (MH-AC 9014); in marl soil, under *Helianthemum almeriense*, near Puentes reservoir, Lorca (Murcia), *A. Cano*, 10.IV.1990 (MH-AC 9017).

Torres & al. (1988) reported this species in the South-East of Spain as *T. arenaria* (Morris) Trappe. We agree with Moreno & al. (1986) in separating *T. claveryi* from *T. arenaria* (Morris) Trappe and *T. leptoderma* (Tul. & Tul.) Tul. & Tul. 'on the basis of the ascospores, which have a reticulate surface', but also by their ecologies. The three species establish mycorrhizas with *Cistaceae*, but *T. claveryi* grows in calcareous soils whereas *T. arenaria* and *T. leptoderma* prefer acid soils (Moreno, pers. comm.).

The species of Chatin, which in Spanish semi-arid zones is called 'turma' is well adapted to xeric conditions in the Southern Mediterranean area (Malençon, 1973; Awameh & Alsheikh, 1978), where it is very appreciated.

Tuber puberulum Berk. & Br.—Fig. 2A–C

Tuber puberulum Berkeley & Broome in Ann. Mag. nat. Hist. 8: 81. 1846.

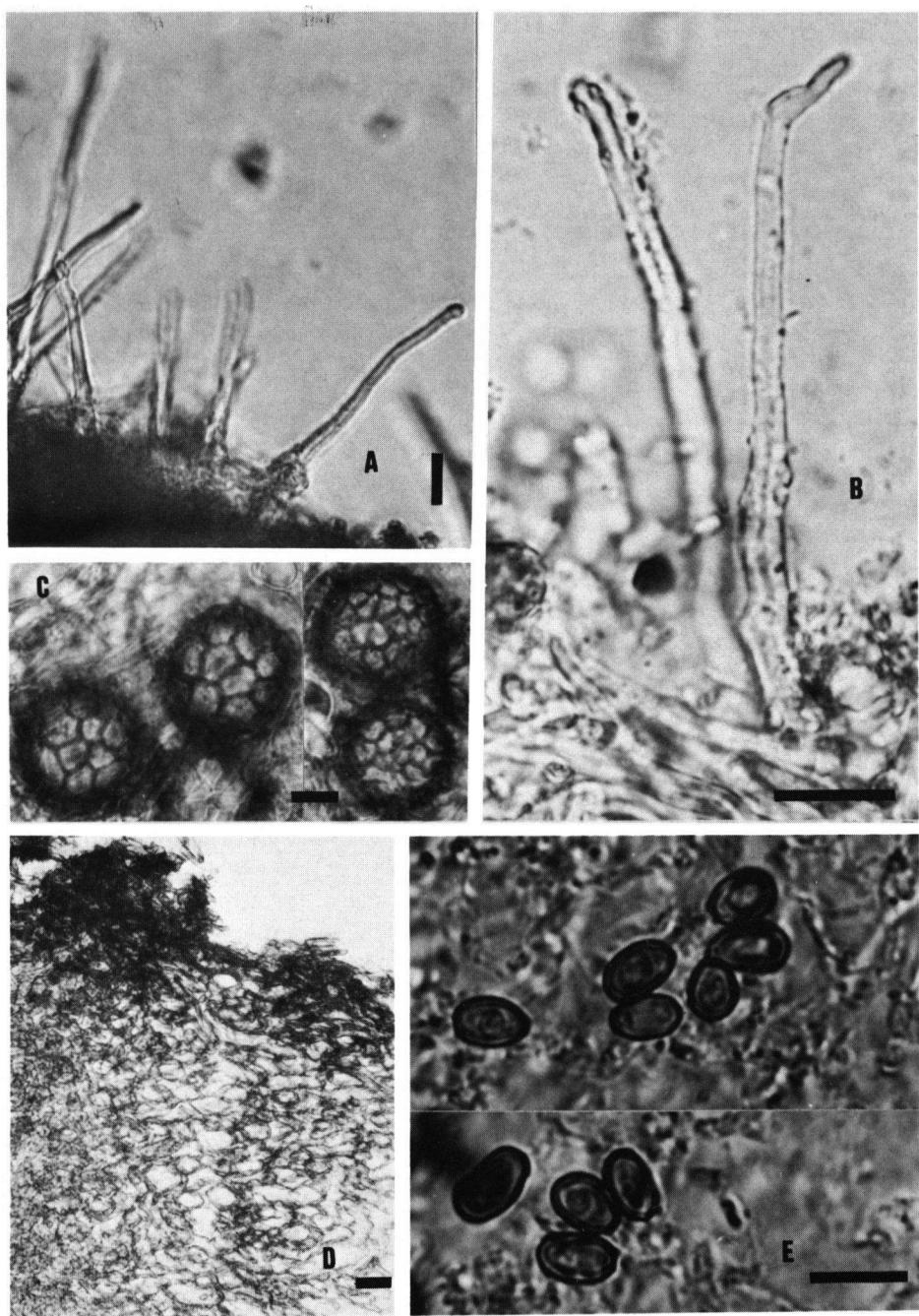
M a t e r i a l e x a m i n e d.—In a thirty-year-old *Pinus halepensis* plantation, under pine. Sierra de El Valle (Murcia), *A. Cano*, 28.III.1990 (MH-AC 9011).

Our material fits Hawker's (1953) description, who considered it as the commonest British hypogeous species. In Spain it has only been reported once (Calonge & al., 1977; 1985).

This species is characterized by the following: small size (1–2 cm); globose to irregular, white to pinkish sporocarps; gregarious growth; soft and very thin peridium, with short, pointed, septate hairs (Fig. 2A, B); spherical brown-yellowish to red-brown, reticulate spores of 25–40 µm in diam. depending on the number of spores per ascus (Fig. 2C).

Hawker (1953) considered this species as very common under beech, but also under other deciduous and coniferous trees. We only found it under *P. halepensis* with which it possibly establishes mycorrhizal associations. It is interesting to note that we have quite frequently found the same kind of hairs shown in the peridium of this species as in the mantle of natural mycorrhizas of *P. halepensis* seedlings cultured in several nursery-trees in Murcia. Nursery workers take soil from old pine plantations to use as substratum in nurseries. Spores, mycelia, and sporocarps of *T. puberulum* are possibly carried in the soil to the nurseries which explains the frequency of the 'type *Tuber*' natural mycorrhizas that we have found in pine seedlings. *Tuber puberulum* might be a more frequent species in Spain, but due to its small size it can go unnoticed.

Fig. 2. A–C. *Tuber puberulum* Berk. & Br., MH-AC 9011. — A, B. Hairs of the peridium. — C. Reticulate ascospores. — D, E. *Melanogaster variegatus* (Vitt.) Tul., MH-AC 9012. — D. Detail of the peridium. — E. Basidiospores. — Bar markers = 10 µm.



Honrubia & Llimona (1981) noted the presence of *T. borchii* Vitt. in Murcia. It is a species related to *T. puberulum*. The young specimens of *T. borchii* could have hairs in the peridium and globose spores (Malençon, 1938), but the sporocarp size is always bigger. Malençon (1973) described *T. borchii* Vitt. var. *sphaerosperma* under *P. halepensis* and *P. pinea* from Morocco, with spores ‘parfaitement et constamment sphériques (!), ornées d’un réseau d’alvéoles 5–6 gones ...’, which coincides with our material, but sporocarp size and peridium anatomy separate both taxa. Malençon (1973) also commented that at first he himself identified his *T. borchii* var. *sphaerosperma* material as *Delastreopsis oligosperma* (Tul. & Tul.) Mattiolo, which has been combined to *Tuber* (Trappe, 1979). Possibly, Tulasne’s and Malençon’s taxa are the same species, being distinguished from *T. puberulum* by the peridium and sporocarp size.

BASIDIOMYCOTINA

Melanogaster variegatus (Vitt.) Tul.—Fig. 2D, E

Melanogaster variegatus (Vittadini) Tulasne in Annls Sci. nat. (Bot). Sér. II, 19: 377, Tab. 17, f. 22. 1843.

M a t e r i a l e x a m i n e d.—In marl soils, among *Helianthemum almeriense* and *Anthyllis cytisoides*, and under *Cistus clusii*, on the roadside to the Puentes reservoir, Lorca (Murcia), A. Cano, 10.IV.1990 (MH-AC 9012).

This is an uncommon species in semi-arid zones, characterized by: yellow colour (never pinkish) in the peridium and gleba in young specimens, that changes to a dark brown colour in peridium and black in the gleba in older sporocarps; the sporocarps are reniform to globose, 4 × 2 cm; spores elliptical to ovoid, dark brown, (6–)7.5(–8.5) × 4(–5.5) µm, thick walled (Fig. 2E). Our material fits Svrček’s (1958) description.

Melanogaster broomeianus Berk. emend. Zeller & Dodge is related to *M. variegatus* (Vitt.) Tul., and is considered as a variety by Hawker (1953). Nevertheless, both differ in the colour of sporocarps and gleba, which are yellow in Vittadini’s species, while Berkeley’s species has a pinkish peridium and white-fleshy gleba. The spores in *M. variegatus* are elliptical to ovoid, dark brown and those of *M. broomeianus* are ellipsoid and light brown (Montecchi & Lazzari, 1989). *Melanogaster broomeianus* has been widely reported in Spain (Calonge & Demoulin, 1975; Calonge & al., 1985), but *M. variegatus* has never been cited, which thus constitutes a new Spanish record.

ACKNOWLEDGEMENTS

This is a work included in the ‘Proyecto LUCDEME (ICONA) – Universidad de Murcia’ programme. We are grateful to Dr. G. Moreno (University of Alcalá de Henares) for helping us in the identification of *G. cooperi* and generating many ideas on the study of hypogeous fungi. The junior authors, A.C. and C.M.-N. are grateful to the ‘Instituto de Fomento de la Región de Murcia’ and to the Spanish Ministerio de Educación y Ciencia (CICYT) respectively, which conceded the grants.

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