

**A STUDY OF NIVICOLOUS MYXOMYCETES  
IN SOUTHERN EUROPE, SIERRA DE GUADARRAMA, SPAIN**

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Eleven taxa of Myxomycetes collected from around melting snow banks in mountainous and alpine areas of the Sierra de Guadarrama (Madrid, Segovia) are presented. From a chronological point of view several new records for the Iberian Peninsula are interesting: *Lepidoderma carestianum*, *Lepidoderma granuliferum*, *Physarum albescens*, *Physarum alpestre* and *Trichia sordida* var. *sordida*. SEM micrographs of spores and capillitia of the most significant species are included.

**Key words:** nivicolous Myxomycetes, *Physarales*, *Stemonitales*, *Trichiales*, Spain, SEM, chronology, taxonomy.

INTRODUCTION

Nivicolous Myxomycetes have scarcely been studied in Spain. Gràcia (1986), who cited three species in the Catalanian Pyrenees, made the first contribution. Later Lado (1992) and Illana et al. (1993) paid attention to the Sierra de Guadarrama, from which they reported new records.

The Sierra de Guadarrama is a mountain range situated in the centre of the peninsula forming part of the provinces Segovia and Madrid. As our last mycological investigations in these mountains yielded success, we were encouraged to study this area more exhaustively; especially the Segovian part of the mountains, where the autochthonous vegetation is better conserved.

In this paper, 11 taxa of the orders *Stemonitales*, *Trichiales* and *Physarales* are presented. A second part will deal with nivicolous species of the genus *Diderma* and, in the last work, the collection of nivicolous *Lamproderma* will be presented.

MATERIAL AND METHODS

The investigated area, Sierra de Guadarrama, is part of Spain, which is surrounded by Portugal, France and Africa (Morocco). From May 1996 to June 1999, 35 samples were collected in 4 different localities situated in Segovia and Madrid as indicated on the map (Fig. 1).

1. Puerto de Cotos, Segovia (1850 m).
2. Puerto de Navacerrada, Segovia (2000–2100 m).
3. Puerto de Navafria, Segovia (1800 m).
4. Mountain pass of Navacerrada, Madrid (1800 m).

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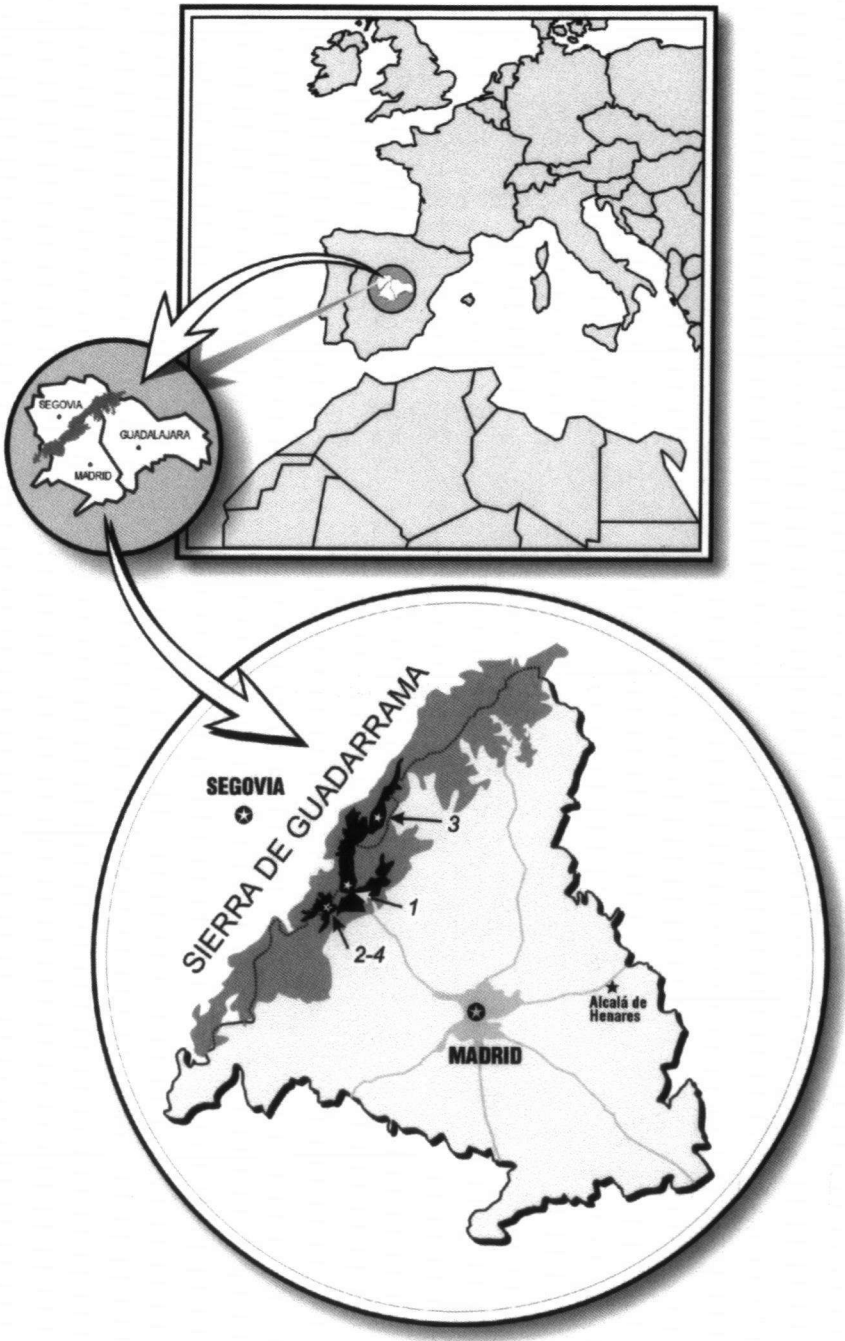


Fig. 1. Map showing the location of Sierra de Guadarrama and the localities from where material has been studied.

The position of the Sierra de Guadarrama in southernmost Europe and permanent snow cover for over three months until the spring melt (April–June) make this area interesting for taxonomic and chronological studies of nivicolous Myxomycetes.

The vegetation in this area consists mainly of *Pinus sylvestris* L., *Juniperus communis* subsp. *alpina* (Suter) Čelak. and *Cytisus oromediterraneus* Rivas Mart. et al.

The collected material was mounted in Hoyer's medium and studied with a Nikon (Optiphot) microscope. Scanning electron microscopy (SEM) micrographs were taken in the University of Alcalá de Henares using a Zeiss DSM-950.

SEM-preparation: sporocarps were rehydrated in concentrated ammonium hydroxide (28–30%) for 30 minutes, dehydrated in aqueous ethanol (70%) for 30 minutes, fixed for 2 hours in pure ethylene glycol dimethyl ether (= 1, 2-dimethoxymethane) and finally immersed in pure acetone for at least 2 hours followed by critical point drying and sputtering with gold-palladium.

Descriptions of the spore ornamentation under SEM follow the terminology proposed by Rammeloo (1974, 1975).

The specimens are deposited in the herbarium AH (University of Alcalá).

#### DESCRIPTION OF THE SPECIES

##### ***Arcyria versicolor***

*Arcyria versicolor* W. Phillips, *Grevillea* 5 (1877) 115.

*Arcyria versicolor* differs from other red coloured species of this genus in its large sporocarps, the elastic capillitium of variable colour (olive brown to reddish orange), the reddish inner side of the trumpet-shaped calyculus and the large spores of 9–11 µm diameter.

Although this species is not strictly nivicolous, it often appears near melting snow banks. In Spain, two records are reported from the Sierra de Guadarrama of Madrid. We have made very abundant collections in the same area.

*Collections examined.* SPAIN: Puerto de Cotos 1850 m, Segovia, trunk of *Pinus sylvestris* L., 21.V.1996, leg. A. Sánchez, AH 19532 & AH 19533; Puerto de Navacerrada 1900 m, Segovia, bark of dead trunk of *Pinus sylvestris* L., 4.VI.1996, leg. A. Sánchez, AH 19531.

##### ***Comatricha nigricapillitium***

*Comatricha nigricapillitium* (Nann.-Bremek. & Bozonnet) A. Castillo, G. Moreno & Illana, *Mycol. Res.* 101 (1997) 1331.

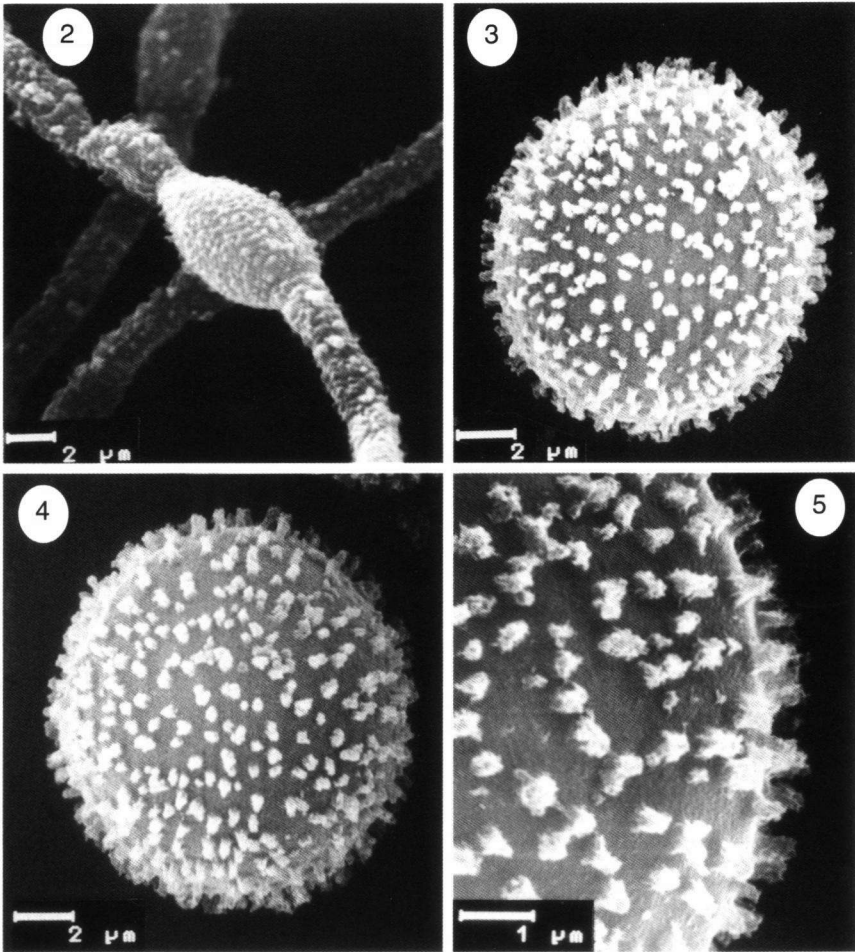
= *Lamproderma nigricapillitium* Nann.-Bremek. & Bozonnet, in Nannenga-Bremekamp, *Proc. Kon. Ned. Akad. Wetensch., Ser. C*, 92 (1989) 510.

= *Collaria chionophila* Lado, *Anales Jard. Bot. Madrid* 50 (1992) 9 & 11.

= *Comatricha chionophila* (Lado) G. Moreno, *Criptogamie, Mycol.* 14 (1993) 243.

This nivicolous species has recently been described and treated taxonomically by Illana et al. (1993) and Castillo et al. (1997). *Comatricha nigricapillitium* is a strictly nivicolous species, very common in the studied area.

*Collections examined.* SPAIN: Puerto de Navacerrada, 2100 m, Segovia, trunk of *Pinus sylvestris* L., 24.V.1997, leg. A. Sánchez, AH 18431; Puerto de Navacerrada 1900 m, Segovia, residues of industrial wood of *Pinus* sp., 21.IV.1997, leg. A. Sánchez, AH 18523.



Figs. 2–5. *Lepidoderma carestianum*. 2. Capillitium with ornamentation (AH 18409); 3 & 4. spores (AH 18410); 5. detail of spore ornamentation (AH 18409).

### ***Enerthenema melanospermum***

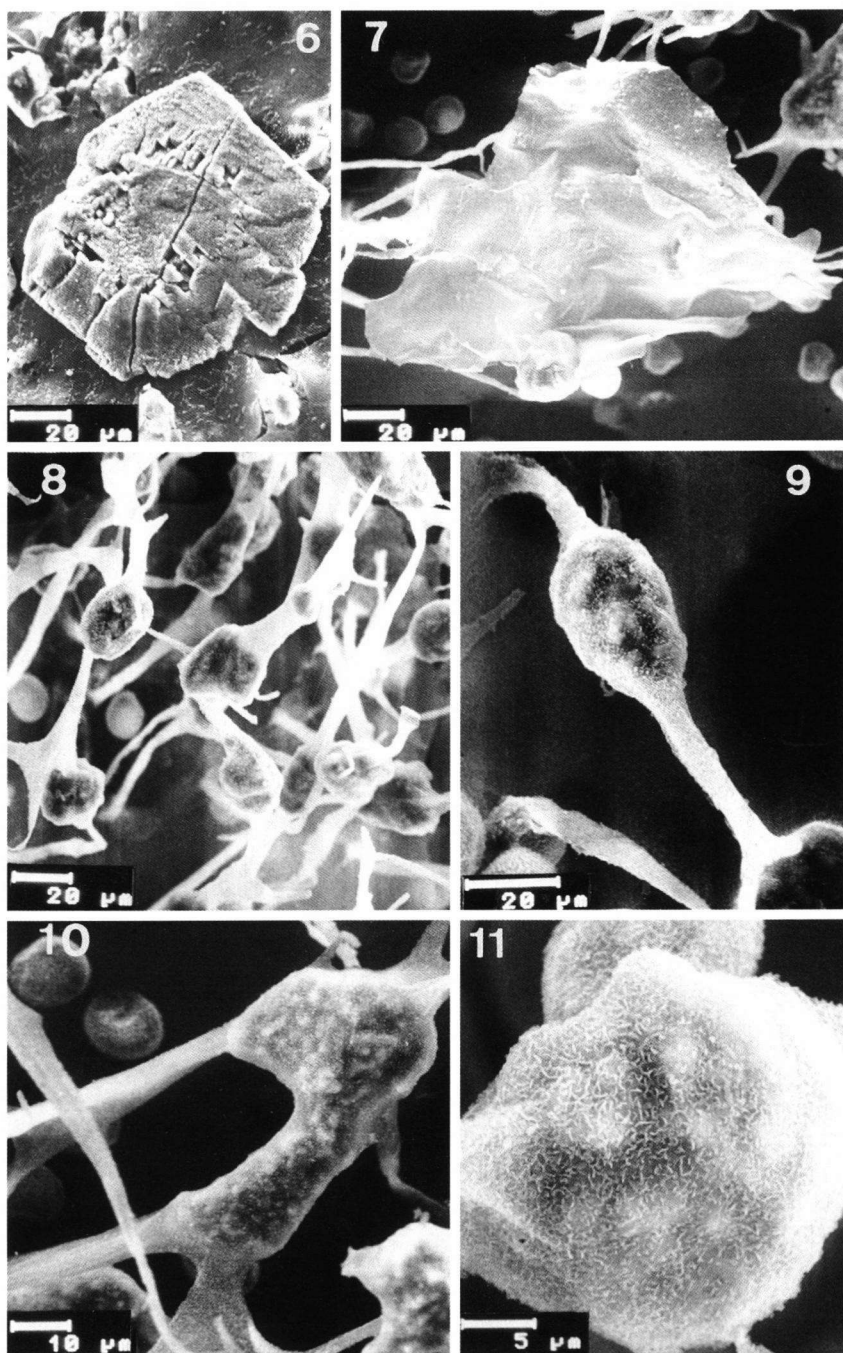
*Enerthenema melanospermum* T. Macbr. & G.W. Martin, J. Wash. Acad. Sci. 22 (1932) 91.

*Enerthenema melanospermum* is not strictly nivicolous. It was commented upon and previously collected in the Sierra de Guadarrama, Madrid (Illana et al., 1993).

*Collections examined.* SPAIN: Puerto de Navacerrada, 1900 m, Segovia, woody residues of *Pinus sylvestris* L., leg. A. Sánchez, 15.VI.1996, AH 18421; Puerto de Navacerrada, 2100 m., Segovia, industrial wood of *Pinus* sp., 1.V.1997, leg. A. Sánchez, AH 18518.

### ***Lepidoderma carestianum* — Figs. 2–5**

*Lepidoderma carestianum* (Rabenh.) Rostaf., Sluzowce Monogr. (1874) 188.  
= *Lepidoderma chailletii* Rostaf., Sluzowce Monogr. (1874) 189.



Figs. 6–11. *Lepidoderma granuliferum* (AH 19504). 6. Lime scale on peridium; 7. peridium; 8. capillitium with nodes; 9 & 10. capillitium nodes; 11. detail of node ornamentation.

Our collections coincide macro- and microscopically with the description of Neubert et al. (1995).

*Lepidoderma carestianum* is characterised by its sporangiate fructifications, sometimes varying to plasmodiocarps, gregarious, covered with large irregular, greyish white lime scales, its dark purple brown capillitium, becoming colourless at the extremities, its spores being 11–15 µm in diameter, globose and spinulose. In SEM the capillitium presents irregularly distributed warts (Fig. 2) and the spores show an ornamentation consisting of baculae with plane apices (Figs. 3–5). These are the first records for the Iberian Peninsula, Lado (1993) rejected earlier citations.

*Lepidoderma carestianum* is a strictly nivicolous species.

*Collections examined.* SPAIN: Puerto de Cotos 1900 m, Segovia, dead and living stalks of *Rubus ulmifolius* Schott, leg. A. Sánchez, 16.V.1996, AH 18409; Puerto de Navacerrada 1850 m, Segovia, living stalks of *Cytisus oromediterraneus* Rivas Mart. et al., leg. A. Sánchez, 12.III.1997, AH 18411; Puerto de Navafria 1800 m, Segovia, dead branches of *Pinus sylvestris* L., leg. A. Sánchez, 15.III.1997, AH 18412 & AH 19519; Puerto de Navafria 1850 m, Segovia, dead branches of *Pinus sylvestris* L., leg. A. Sánchez, 16.III.1997, AH 18410; Segovia, ibidem, 22.III.1997, AH 19520; Puerto de Navacerrada 1900 m, Segovia, woody residues, leg. A. Sánchez, 20.IV.1997, AH 19521.

### **Lepidoderma granuliferum** — Figs. 6–15

*Lepidoderma granuliferum* (W. Phillips) R. E. Fr., Ark. Bot. 6 (7) (1906) 3.

Our collections coincide macro- and microscopically with the description of Neubert et al. (1995).

*Lepidoderma granuliferum* can easily be recognised by its plasmodiocarpous fructifications with characteristic lime scales (Fig. 6) covering the peridium (Fig. 7) and its capillitium with typical nodes or expansions (Figs. 8–10). In SEM both the threads of the capillitium and the nodes bear an ornamentation formed by small crests, resulting in a subreticular or wrinkled appearance (Figs. 11–13). The nodes furthermore bear coarse warts (Figs. 10–11). In SEM the spores are densely spinulose, the spines are very susceptible to collapse and bend easily (Figs. 14, 15).

This species is considered by the most authors to be nivicolous and is cited by Bozonnet, Meyer & Poulain (1991) in: 'Liste des espèces nivales de Myxomycètes'.

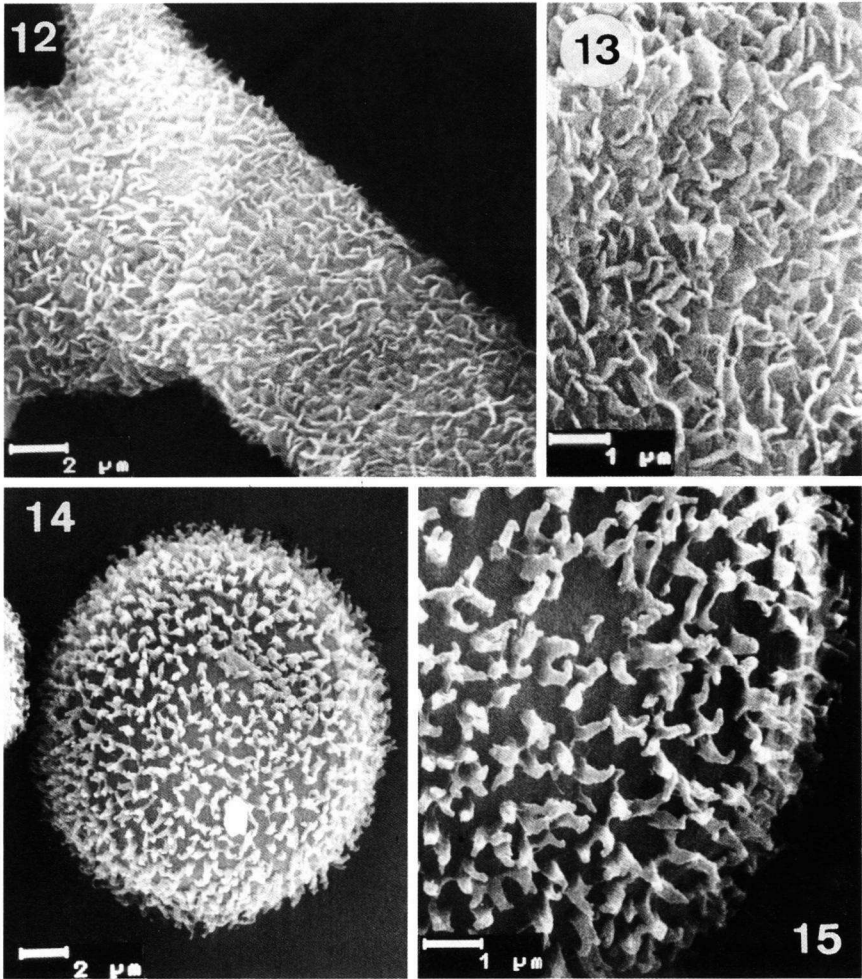
In Spain Pando & Lado (1990) have cited *Lepidoderma granuliferum* proceeding from a culture of living bark of *Juniperus thurifera*. This material does not correspond with this species and probably represents a different taxon. Hence we consider our citations as the first records for the Iberian Peninsula.

*Collections examined.* SPAIN: Puerto de Navacerrada 2100 m, Segovia, residues of dead stalks of Poaceae, 1.V.1997, leg. A. Sánchez, AH 19504; Puerto de Navacerrada 2150 m, Segovia, *Senecio pyrenaicus* L., 27.V.1999, leg. A. Sánchez, AH 19398; Puerto de Navacerrada 2000, 2050 & 2100 m, Segovia, *Senecio pyrenaicus* L., 7.VI.1999, leg. A. Sánchez, AH 19379, AH 19311 & AH 19380.

### **Physarum albescens** — Figs. 16, 17

*Physarum albescens* Ellis ex T. Macbr., N. Amer. Slime-Moulds, ed. 2 (1922) 86.

Sporocarps gregarious or scattered, sessile, with yellowish strand-like stalks formed as an extension of the hypothallus, obovoid or subglobose, 0.8–1 mm in diameter.

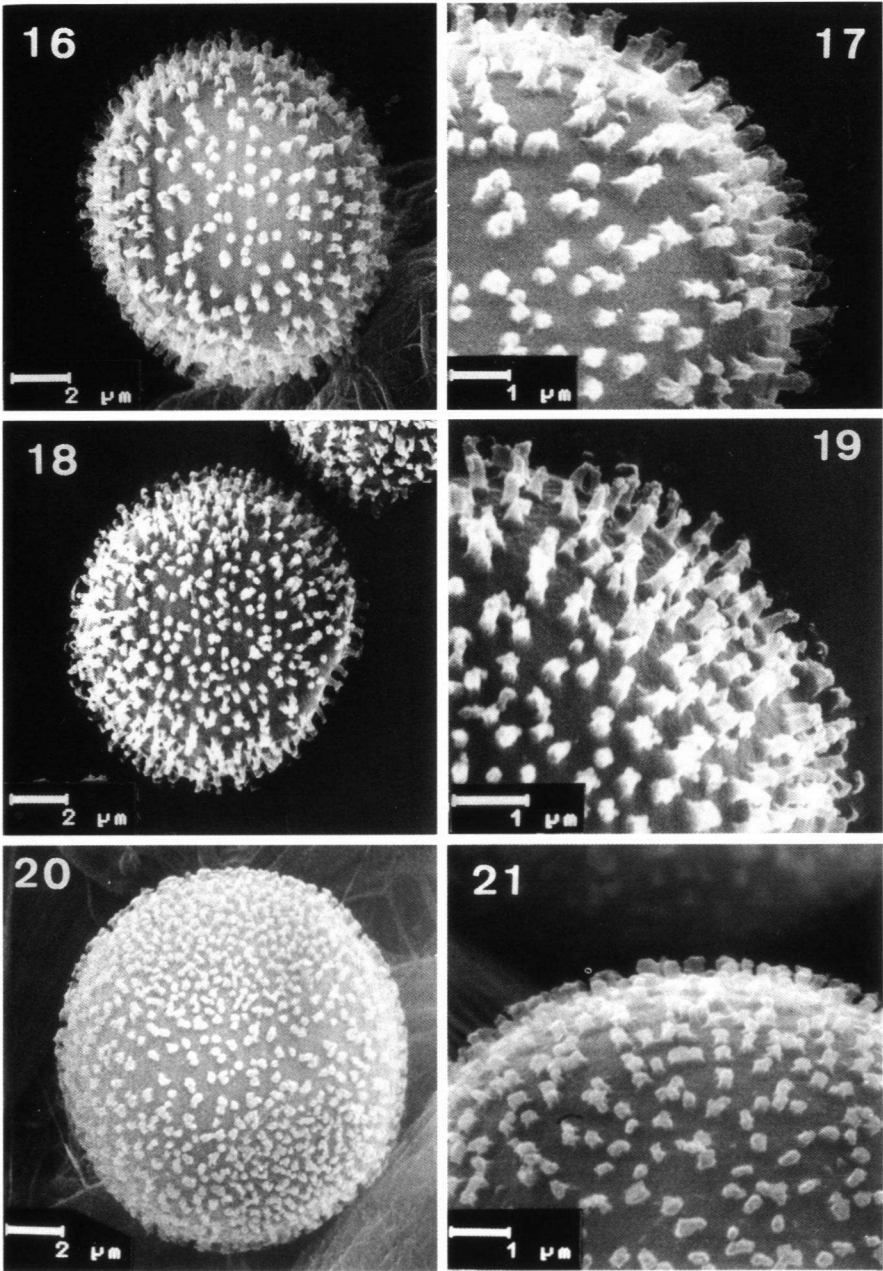


Figs. 12–15. *Lepidoderma granuliferum* (AH 19504). 12 & 13. Details of capillitium ornamentation; 14. spore; 15. detail of spore ornamentation.

Peridium double, the outer layer calcareous, white or pale yellow to greenish, the inner layer membranous, iridescent. Dehiscence irregular, the peridium persistent below as a shallow cup. Hypothallus membranous, pale yellow to brownish yellow, venulose. Capillitium abundant, consisting of flattened, calcareous, yellow nodes, connected by hyaline threads. Spores globose, black in mass, dark violaceous brown by transmitted light, 12–13 µm in diameter, verrucose. By SEM the spores bear baculae with irregular apices (Figs. 16, 17).

*Physarum albescens* is characterised by its obovoid or subglobose sporocarps with a double peridium (yellow to greenish), its capillitium with yellow nodes and its nivicolous habitat (Bozonnet, Meyer & Poulain, 1991).

*Physarum albescens* is a strictly nivicolous species. This is the first record from Spain.



Figs. 16 & 17. *Physarum albescens* (AH 19505). 16. Spore; 17. detail of spore ornamentation. — Figs. 18 & 19. *Physarum alpestre* (AH 18412). 18. Spore; 19. detail of spore ornamentation. — Figs. 20 & 21. *Physarum vernum* (AH 19516). 20. Spore; 21. detail of spore ornamentation.



*Collections examined.* SPAIN: Navacerrada, 2050 m, Segovia, on living and dead stems of *Cytisus oromediterraneus* Rivas Mart. et al., near melting snow, 23.IV.1997, leg. A. Sánchez, *AH 19505*; mountain pass of Navacerrada, 1900 m, Segovia, on a rock, near melting snow, 1.V.1997, leg. A. Sánchez, *AH 18519*.

### **Physarum alpestre** — Figs. 18, 19

*Physarum alpestre* Mitchel, S.W. Chapm. & M.L. Farr, *Mycologia* 78 (1986) 68.

Plasmodiocarps scattered to gregarious, sessile, flat, 0.3–15 mm long, 0.3–10 mm wide, with two or more plasmodiocarps adherent to each other, sometimes also as sessile sporocarps. Hypothallus lacking. Peridium double: the outer layer persistent, calcareous, yellow, rarely white, smooth, bright; the inner layer thin, translucent, iridescent, membranous. Columella as a thickened base. Capillitium abundant, of angular, yellow, fusiform or branched, calcareous nodes, connected by hyaline threads. Spores globose, black in mass, dark violaceous brown by transmitted light, 12–13 µm in diameter. In SEM the spores bear baculae with irregular apices (Figs. 18, 19).

*Physarum alpestre* is a strictly nivicolous species and can be recognised by its typical yellow plasmodiocarps.

*Physarum alpinum* (Lister & G. Lister) G. Lister is distinguished from *P. alpestre* by its subglobose to pulvinate sporocarps (Mitchel et al., 1986).

This is the first record from Spain.

*Collections examined.* SPAIN: mountain pass of Navafria, 1820 m, Segovia, on trunks and bark of *Pinus sylvestris* L., near melting snow, 23.III.1997, leg. A. Sánchez, *AH 18412*; mountain pass of Navacerrada, 1850 m, Segovia, on branches of *Pinus sylvestris* L., near melting snow, 6.IV.1997, leg. A. Sánchez, *AH 18520*; mountain pass of Navacerrada, 1900 m, Segovia, on living leaves of *Digitalis purpurea* L., 21.IV.1997, leg. A. Sánchez, *AH 18521*; mountain pass of Navacerrada, 2100 m, Segovia, on herbaceous debris, 20.V.1997, leg. A. Sánchez, *AH 18522*.

### **Physarum vernum** — Figs. 20, 21

*Physarum vernum* Sommerf. in Fr., *Syst. Mycol.* 3 (1829) 146.

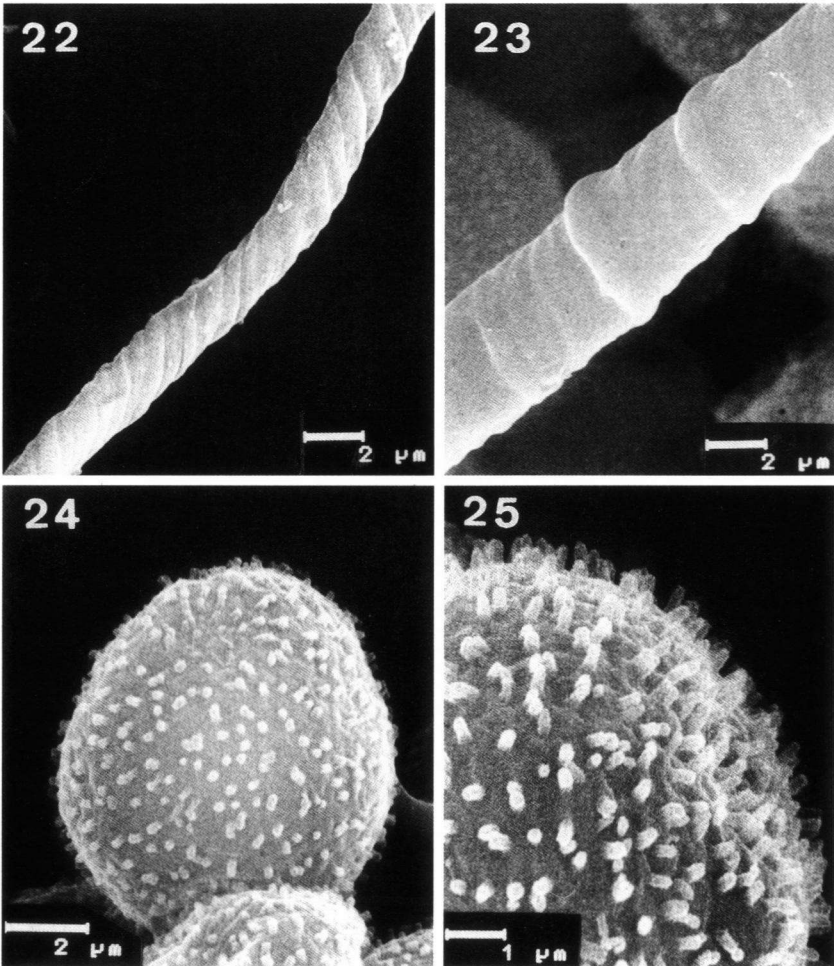
*Physarum vernum* is readily recognised by its greyish white sporocarps, its peridium covered with coarse granular lime, its whitish grey, irregular nodes of the capillitium and its spores in SEM with an ornamentation formed by short aggregated baculae (Figs. 20, 21).

According to Bozonnet, Meyer & Poulain (1991) this is a nivicolous species, nevertheless there are many records from Spain in Mediterranean areas (Lado, 1993).

*Collections examined.* SPAIN: mountain pass of Navacerrada, 1800 m, Madrid, on stems of *Cytisus oromediterraneus* Rivas Mart. et al., and Poaceae, 18.IV.1996, leg. M. Lizárraga, *AH 22215*. mountain pass of Navacerrada, 1850 m, Segovia, on stems of *Cytisus oromediterraneus* Rivas Mart. et al., 12.III.1997, leg. A. Sánchez, *AH 19516*; mountain pass of Navafria, 1850 m, Segovia, on branch of *Pinus sylvestris* L., 15.III.1997, leg. A. Sánchez, *AH 19517*; mountain pass of Navacerrada, 2200 m, Segovia, on stems of Poaceae, 24.V.1997, leg. A. Sánchez, *AH 19518*.

### **Prototrichia metallica** — Figs. 22–25

*Prototrichia metallica* (Berk.) Masee, *J. Roy. Microscop. Soc.* London (1889) 350.

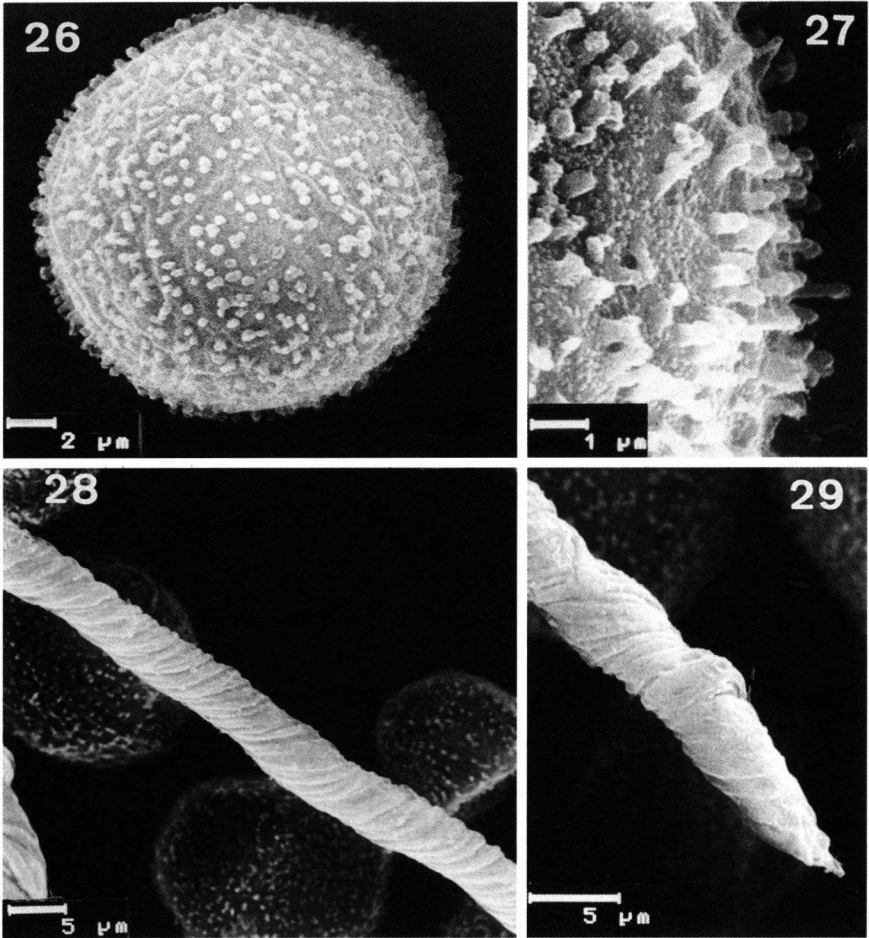


Figs. 22–25. *Prototrichia metallica* (AH 19503). 22. Capillitium; 23. detail of capillitium; 24. spore; 25. detail of spore ornamentation.

*Prototrichia metallica* is characterised by its stalked and sessile sporocarps, its thin, membranous and iridescent peridium, its spirally twisted capillitium (Figs. 22, 23) with many pointed penicillate free ends and its spinose spores with 10–12 µm in diameter (Figs. 24, 25).

This species is not strictly nivicolous, and has been cited previously from Spain (Lado, 1993), but this is the first record from Central Spain (Sierra de Guadarrama).

*Collections examined.* SPAIN: mountain pass of Navacerrada, 1950 m, Segovia, on wood of *Pinus sylvestris* L., near melting snow, 23.V.1997, leg. A. Sánchez, AH 19503; mountain pass of Navacerrada, 2000 m, Segovia, on a dead branch of *Pinus* sp., near melting snow, 17.VI.1999, leg. A. Sánchez, AH 19576.



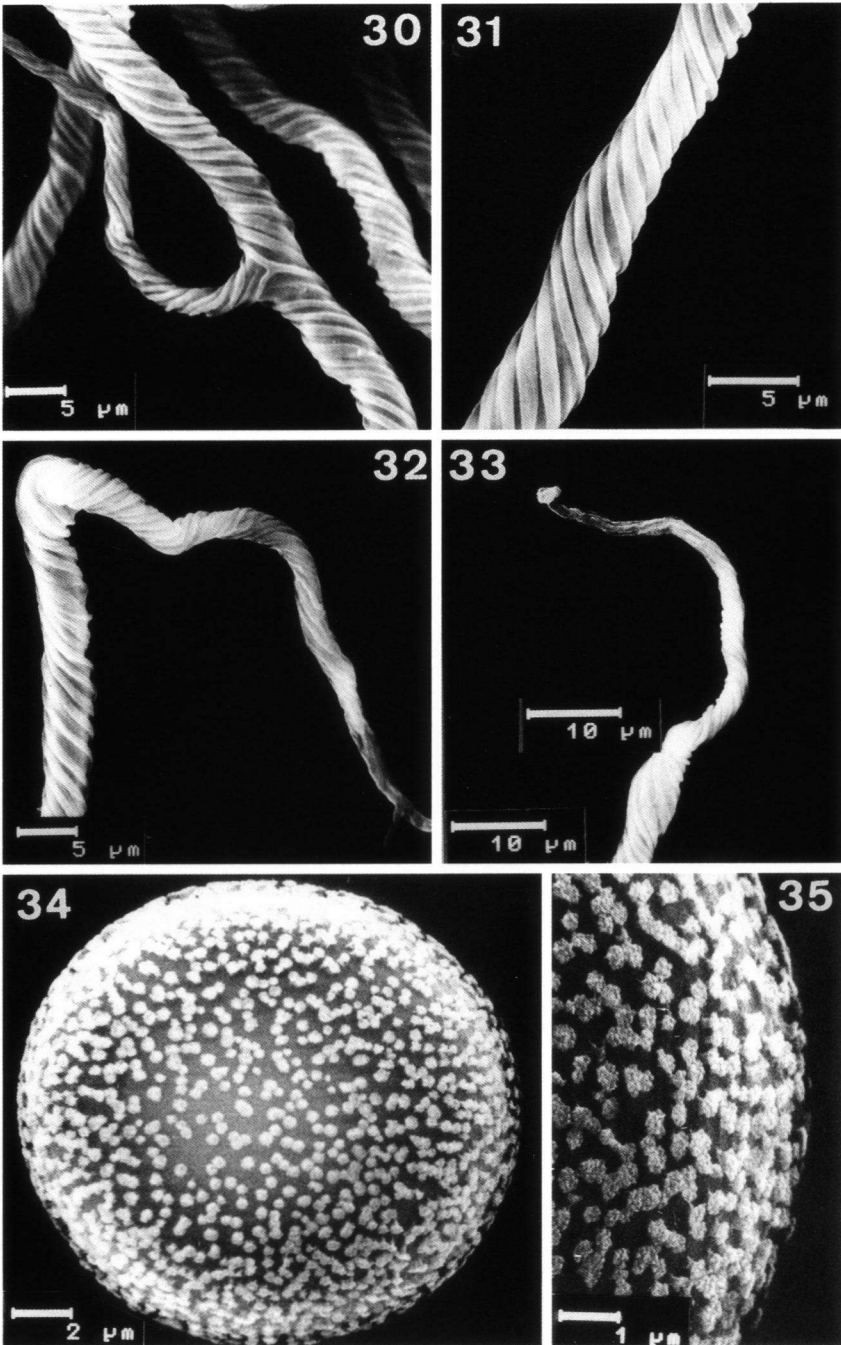
Figs. 26–29. *Trichia alpina* (AH 18418). 26. Spore; 27. detail of spore ornamentation; 28. capillitium; 29. free end of capillitium.

### ***Trichia alpina* — Figs. 26–29**

*Trichia alpina* (R.E. Fr.) Meyl., Bull. Soc. Vaud. Sci. Nat. 53 (1920) 460.

The characteristic features of *Trichia alpina* are the sessile sporocarps or small, dark brown to blackish plasmodiocarps, and the nivicolous habitat. By SEM the capillitium consists of elaters decorated with smooth, densely wound spiral bands (Fig. 28) with short, sharp-pointed free ends (Fig. 29). The spores show an ornamentation formed by irregularly arranged baculae with irregular apices (Figs. 26, 27).

This species is strictly nivicolous, previously records were published from Spain in the Pyrenees (Lado & Pando, 1997).



Figs. 30–35. *Trichia sordida* var. *sordida* (AH 18419). 30. Capillitium with secondary branchlet; 31. capillitium; 32 & 33. free ends of capillitium; 34. spore; 35. detail of spore ornamentation.

*Collections examined.* SPAIN: mountain pass of Cotos, 1900 m, Segovia, on stems of *Rubus ulmifolius* Schott, 10.V.1996, leg. A. Sánchez, AH 18418; mountain pass of Navacerrada, 2100 m, Segovia, on debris of *Cryptogramma crispa* (L.) R. Br. ex Hook., 20.V.1997, leg. A. Sánchez, AH 18516; mountain pass of Navacerrada, 2200 m, Segovia, on herbaceous stems, 24.V.1997, leg. A. Sánchez, AH 18427.

### ***Trichia sordida* var. *sordida* — Figs. 30–35**

*Trichia sordida* var. *sordida* Johannesen, Mycotaxon 20 (1984) 81–82.  
= *Trichia bicolor* S.L. Stephenson & M.L. Farr, Mycologia 82 (1990) 513.  
= *Trichia contorta* var. *engadinensis* Meyl., Bull. Soc. Vaud. Sci. Nat. 53 (1921) 460.

*Trichia sordida* var. *sordida* can be recognised by its subglobose sporocarps, its deep yellowish peridium with brown patches, and its ‘trichioid’, elateriform capillitium, ornamented with 4 or 5 smooth spiral bands (Fig. 31) with pointed free ends (Figs. 32, 33) and a few short secondary branchlets (Fig. 30). The spore ornamentation is dense and consists of baculae with plane, broad and coralloid apices (Figs. 34, 35). This collection coincides with the description of the type material presented by Illana et al. (1993).

*Trichia sordida* var. *sordidoides* Illana & G. Moreno is characterised by its ‘hemitrichioid’ capillitium with 4 to 5 smooth spiral bands, many short secondary branchlets and few free ends. The striking difference between the two variations is the form of the capillitium being ‘trichioid’ in *T. sordida* var. *sordida* and ‘hemitrichioid’ in *T. sordida* var. *sordidoides*. We did not observe intermediate capillitia between the two varieties. Hence we prefer to maintain the two varieties and do not follow the concept of Lado & Pando (1997), who unify these two taxa.

Illana et al. (1993) considered *T. contorta* var. *engadinensis* Meyl. and *Trichia bicolor* S.L. Stephenson as synonyms of *T. sordida* var. *sordida*, which was later accepted by Lado & Pando (1997).

*Trichia sordida* var. *sordida* is strictly nivicolous and is cited for the first time from the Iberian Peninsula. Previously only *T. sordida* var. *sordidoides* was known from the peninsula, i.e. from Puerto de Cotos in the Sierra de Guadarrama.

*Collection examined.* SPAIN: mountain pass of Navafria, 1850 m, Segovia, on bark of *Pinus sylvestris* L., near melting snow, 22.IV.1997, leg. A. Sánchez, AH 18419.

### ACKNOWLEDGEMENTS

We wish to express our gratitude to Mr. D.W. Mitchel for the revision of the manuscript. We thank J.A. Pérez and A. Priego (Servicio de Microscopía Electrónica, Universidad de Alcalá) for their invaluable help with the SEM. We are grateful to Virginia Fernández for designing the map. H. Singer thanks the National Program of the Professorship Formation, Ministry of Education and Culture of Spain the conceded scholarship for the realization of his doctoral thesis in the University of Alcalá.

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