

Nivicolous Myxomycetes from the Sierra de Gredos (central Spain)

by

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With 39 figures

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Abstract: First data on the diversity of nivicolous myxomycetes from the Sierra de Gredos, the most important mountain range in central Spain, are reported. Twenty one species have been found in alpine grasslands and shrub communities at altitudes between 1900 and 2250 m. All records are new for the area, and three species, *Comatricha* cf. *rigidireta* Nann.-Bremek., *Lamproderma splendens* Meyl. and *Lepidoderma carestianum* (Rabenh.) Rostaf., are also recorded for the first time in Spain. *Comatricha* cf. *rigidireta* and *Lamproderma arcyrioides* (Sommerf.) Rostaf. are reported for the first time from nivicolous habitats. Detailed descriptions, comments on morphology, taxonomy and distribution as well as SEM photographs of the most interesting taxa are included.

Key words: Distribution, ecology, Eumycetozoa, Iberian Peninsula, Mediterranean region, nivicolous species, SEM microphotographs, taxonomy.

Resumen: Se aportan los primeros datos sobre la diversidad de especies quionófilas de Myxomycetes en la Sierra de Gredos, el sistema montañoso mas importante del centro de España. Un total de 21 especies se han encontrado en matorrales y prados alpinos en altitudes comprendidas entre los 1900-2250 m. Todas las especies registradas son nuevas para la zona y tres, *Comatricha* cf. *rigidireta* Nann.-Bremek., *Lamproderma splendens* Meyl. y *Lepidoderma carestianum* (Rabenh.) Rostaf., se citan por primera vez para España. *Comatricha* cf. *rigidireta* and *Lamproderma arcyrioides* (Sommerf.) Rostaf. se mencionan, por primera vez, de ambientes quionófilos. Se aportan descripciones detalladas, comentarios sobre su morfología, taxonomía y distribución, así como fotografías al MEB de los táxones más relevantes.

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Palabras claves: Distribución, ecología, especies quionófilas, Eumycetozoa, microfotografías al MEB, Península Ibérica, región mediterránea, taxonomía.

Introduction

The nivicolous myxomycetes form a peculiar group of species, well defined by their ecological demands. They generally occur in mountainous areas, inhabiting ephemeral microhabitats formed in the vicinity of melting snow in spring (Lado 2004). Their distribution probably includes all high mountains of the world, and yet the information about their chorology is not homogeneous and scarce for most areas. Field research has been mainly focused on a few mountain ranges, such as the Alps in Europe and the Rocky Mountains in North America, and has provided a relatively large amount of data on a local scale. Most of the potentially interesting areas, however, have hardly been explored, e.g. the Carpathians, the Himalayas, the Andes and the high mountains of Africa. In Spain, the first major contributions to the knowledge on diversity and distribution of nivicolous myxomycetes have been published during the last decade (Lado 1992, 2004, Illana et al. 1993, Sánchez et al. 1997, 1999, 2002a, 2002b, 2002c, Vila & Llimona 1998, Gorris et al. 1999, Moreno et al. 2002, 2003a, 2003b, Singer et al. 2003). Despite this increasing number of studies, no data have been available so far concerning the Sierra de Gredos, the most important massif in central Spain. The mountainous regions of Spain are of particular interest, because they establish the potential Southern limits of the distribution of nivicolous myxomycetes in Europe. The extreme climate at these latitudes reduces the sporulation phenology of the nivicolous species to a period of 2-4 weeks a year, which causes particular difficulties in timing their collection. At present, about 80 strictly nivicolous species and 20 facultatively nivicolous species are recognized in the world (Lado 2004). This paper includes data on 21 nivicolous species recorded in the Sierra de Gredos.

Materials and methods

STUDY AREA: The Sierra de Gredos Mts. are located in the central part of Spain (Fig. 1). They run approximately ENE-WSW and form the Central Mountain System (Sistema Central), together with the ranges of Ayllón, Somosierra, Guadarrama, Peña de Francia, Gata, Estrela and Lousa mountains. This mountain system, formed in its present shape during the alpine orogenesis, makes an eminent barrier in the middle of the Iberian Peninsula, dividing it into two halves. The Sierra de Gredos, reaching the altitude of 2592 m (Almanzor peak), is the culmination of the Sistema Central and exhibits a truly alpine character.

Geologically, the Sierra de Gredos is formed mainly of granite rich in silica, and acidic in nature. The landscape is marked by well-pronounced vestiges of the Quaternary glaciation geomorphological processes (especially the Circo de Gredos). In the areas where conditions are favourable for the development of nivicolous myxomycetes, the typical alpine climate prevails, with approximately 2000 mm of annual precipitation, mostly as snow. Annual temperatures extend between -15°C in winter and 25-27°C in summer. The vegetation is determined by the altitudinal gradient of the Mediterranean mountains; in the highest elevations two vegetational levels predominate: (i) the Oro-Mediterranean zone, dominated by alpine shrublands (*Cytisus balansae* (Boiss.) Ball), (ii) the Crioro-Mediterranean zone, with large surfaces covered by psychro-xerophilic grasslands called "cervunales" (with *Nardus stricta* L.) The tree-line forest vegetation, composed mainly of pine (*Pinus sylvestris* L.) and oak woodlands (*Quercus pyrenaica* Willd.), barely reaches 1600 m.

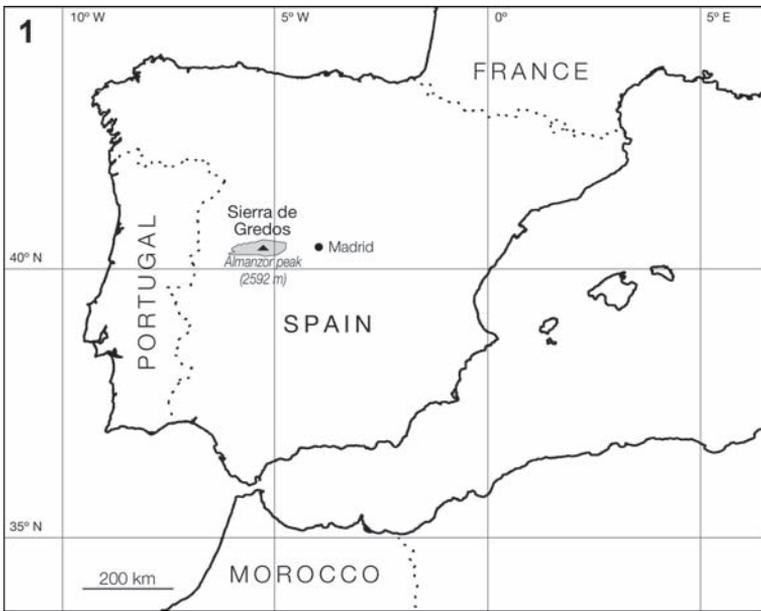


Fig. 1. Localization of research area.

SAMPLING AND ANALYSIS OF COLLECTIONS: Sampling for this study was done during several field surveys in May and June of 1994, 2001 and 2003. Observations were focused on alpine grasslands and shrubs growing at altitudes above 1900 m. Fruiting bodies of myxomycetes were collected on various substrates, mainly blades of grasses, twigs of *Cytisus* spp. or remnants of massive herbaceous plants (mainly *Eryngium bourgatii* Gouan, *Gentiana lutea* L., *Hypericum* sp.), at the borders of melting snow patches and in places freshly devoid of snow cover. More than 100 samples were studied and all specimens were geo-referenced. The collections are deposited in the herbaria MA-Fungi and KRAM-M.

Microscope preparations and measurements were made in water or in Hoyer's medium. The critical-point drying technique was used for scanning electron microscopy (SEM) preparations, and specimens were examined on Hitachi S-4700, Hitachi S-3000N and Jeol T 330 A scanning electron microscopes, at 10-15 kV. SEM analyses were made in the Laboratory of Field Emission Scanning Electron Microscopy and Microanalysis, at the Institute of Geological Sciences of the Jagiellonian University (Kraków) and the Service of Scanning Electron Microscopy of the Royal Botanic Garden of Madrid.

Results and discussion

During this study a total of 100 collections yielded 21 species of nivicolous myxomycetes, which are described below. All these records are new for the Sierra de Gredos, and several species have been previously reported only from single localities in Spanish mountains. *Comatricha* cf. *rigidireta*, *Lamproderma splendens* and *Lepidoderma carestianum*, are reported for the first time for Spain.

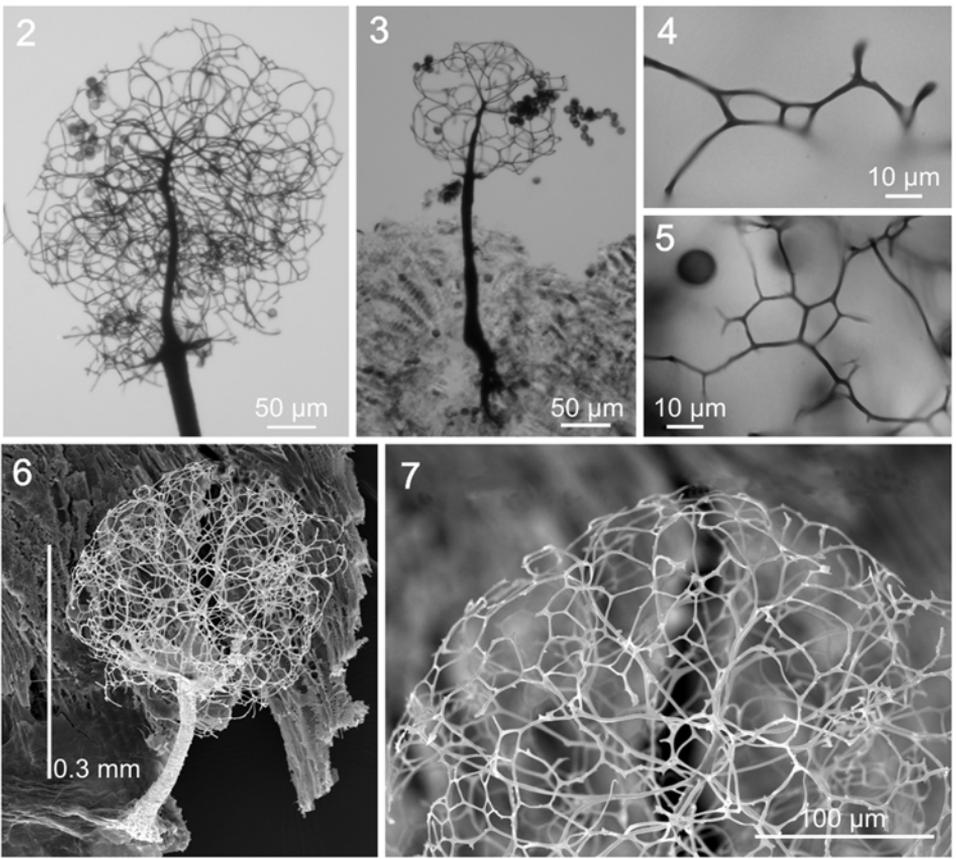
MATERIAL STUDIED: ÁVILA, Sierra de Gredos, Navalperal de Tormes, Llano de Barbellido, 40°17'23" N, 05°14'29" W, 1920 m, 8-V-1994, on *Cytisus balansae* near melting snow, C. Lado, 6715Lado, 6717Lado, 6719Lado, 6720Lado, 6721Lado, 6722Lado, 6723Lado; Navarredonda de Gredos, Risco del Águila, 40°19'00" N, 05°07'30" W, 1900 m, 16-VI-2001, C. Lado & A. Estrada, on *Cytisus balansae* near melting snow, 13234Lado, 13235Lado; San Juan de Gredos, Eastern slopes of Navasomera, approx. 30-50 m below the ruins of the Refugio del Rey, 40°15'10" N, 05°15'17" W, 2160 m, 31-V-2003, alpine pasture, on a fallen twig (?*Cytisus* sp.), at the border of a melting snow patch, A. Ronikier & M. Ronikier, KRAM M-1048, together with smaller specimens with appearance of "*Paradiacheopsis rigida*" - KRAM M-1052; KRAM M-1059, together with *Lamproderma nigricapillitium*.

DESCRIPTION: Sporocarps grouped to scattered or solitary, stalked. Sporotheca subglobose, 150-500 µm diam., dark brown to black (Figs 2, 6). Peridium fugacious but leaving a small collar around the stalk. Stalk 250-500 mm long, 20-30 µm diam., broadening toward the base up to 60 µm diam., dark red-brown in transmitted light, with intertwined fibrils at the base. Columella up to ½ of the sporotheca diameter or almost reaching the apex, tapering. Capillitium merging perpendicularly to the columella, forming a more or less dense and complete surface net with angular meshes 7-50 µm diam., with many very short free ends (Figs 5, 7). Spores black in mass, greyish brown in transmitted light, subglobose, 9.5-12 µm diam., minutely warted.

REMARKS: According to Nannenga-Bremekamp (1966), *C. rigidireta* is characterized by a nearly complete surface net of capillitium, fibrous stalk and large spores [11-13(-16) µm diam.], in our collections the surface net is more or less well developed but the spores are smaller (9.5-12 µm diam.) and we have some doubts on their identity. One specimen (KRAM M-1048) was found by us together with two sporocarps (KRAM M-1052) which have features resembling *Paradiacheopsis rigida* (Figs 3, 4): minute sporocarps, a subglobose sporotheca, hardly reaching 0.2 mm diam., up to 0.25 mm long stalks, and scanty capillitium; but as in *Comatricha*, fragments of a peridium remain as a small collar around the stalk apex, and intertwined, red-brown fibrils are present at the base of the stalk. Features which differ from *C. rigidireta* are: the capillitium is simply branched and hardly anastomosing, forming a loose net at the periphery with a few meshes and many short free ends. The two morphological forms, found by us growing together, differ considerably in size of sporocarps and degree of capillitium development, with smaller forms strongly resembling *Paradiacheopsis rigida*. On the other hand, the two forms show many similarities: the same structure of the basal parts of stalks, identical spores, a very similar colour of stalk, capillitium and spores. Considering the co-occurrence of these two forms, we think that they are conspecific and represent different stages of development - or altered forms - of the same species.

As was already stressed by Rodríguez-Palma et al. (2002), it is difficult to decide where to draw a borderline between the genera *Comatricha* and *Paradiacheopsis*. Further, detailed studies on type specimens as well as on other comparative collections, are necessary to clarify their taxonomic position.

Comatricha rigidireta has never been recorded in Spain; it is only known from the type locality in the Netherlands (Nannenga-Bremekamp 1966), developed in moist



Figs 2-7. *Comatricha rigidireta*. 2. Sporotheca (KRAM M-1048). 3. Sporocarp of specimen close to *Paradiacheopsis rigida* (KRAM M-1052). 4. Meshes of surface net of capillitium of specimen close to *Paradiacheopsis rigida* (KRAM M-1052). 5. Meshes of surface net of capillitium (KRAM M-1059). 6. Sporocarp (KRAM M-1048). 7. Capillitium net of the same sporocarp (KRAM M-1048).

chambers on bark taken from living *Taxodium distichum*, in February 1965. It is not a strictly nivicolous species and these seem to be the first observations of this species in early spring near melting snow.

Diderma fallax (Rostaf.) Lado
= *D. lyallii* (Masse) T. Macbr.

Figs 8-13

MATERIAL STUDIED: ÁVILA, Sierra de Gredos, Navalperal de Tormes, Circo de Gredos, at the South-Eastern side of the Laguna Grande de Gredos lake, 40°15'05" N, 05°16'50" W, 1960 m, humid meadow, on stem of *Gentiana lutea*, 1-VI-2003, A. Ronikier & M. Ronikier, KRAM M-1049.

DESCRIPTION: Sporocarps gregarious to clustered, sessile. Sporotheca subglobose, 0.8-1.2 × 1.4-2 mm. Peridium single, cartilaginous, thick, cream-coloured, ochraceous to brown, or more or less densely covered with white or sand-colour lime squamules

(Fig. 11). Hypothallus thin, shining, sometimes covered with white or sand-colour lime squamules. Columella distinct (Fig. 8), globose to club-shaped, 0.3-0.5 mm diam. in the upper part, 0.2-0.3 mm wide at the base, about 0.5 mm high, cream to ochraceous, densely impregnated by lime squamules. Capillitium dark, dark brown in transmitted light, rough, sometimes with dark brown nodules (Fig. 13), threads 2-2.5 μm wide, nodules 4-6 μm wide. Spores dark brown to black in mass, brown in transmitted light, globose, 14-16 μm diam., loosely covered with prominent spines up to 1.5 μm long; in SEM they are of the baculate type according to the terminology of Rammeloo (1974, 1975), and up to 1.5 μm long (Figs 9, 10).

REMARKS: In part of our collection, the structure of the peridium was typical for *Diderma*, cartilaginous, thick and egg-shell-like (containing lime globules; Fig. 12); but other sporocarps were densely covered with lime scales (Fig. 11), giving the appearance of a *Lepidoderma*. The presence of lime scales is typical for this genus and not for *Diderma*, a character that distinguishes these two genera. However, in *Lepidoderma* the peridium is always devoid of lime globules (cf. Poulain et al. 2002), while in *Diderma* it is mainly built up of lime globules but can also contain crystalline lime (e.g. Nannenga-Bremekamp 1991). The occurrence of lime scales in these two genera is discussed in detail by Kowalski (1971).

The presence of a single peridium in our specimens (Figs 8, 12) is not congruent with characters typical for *Diderma fallax*. However, based on other features, as presence of a prominent globose to club-shaped columella, cream to ochraceous in colour, we think that this record represents poorly developed material of *D. fallax*. This identification is also supported by the characters of spores and capillitium, which are typical of *D. fallax*.

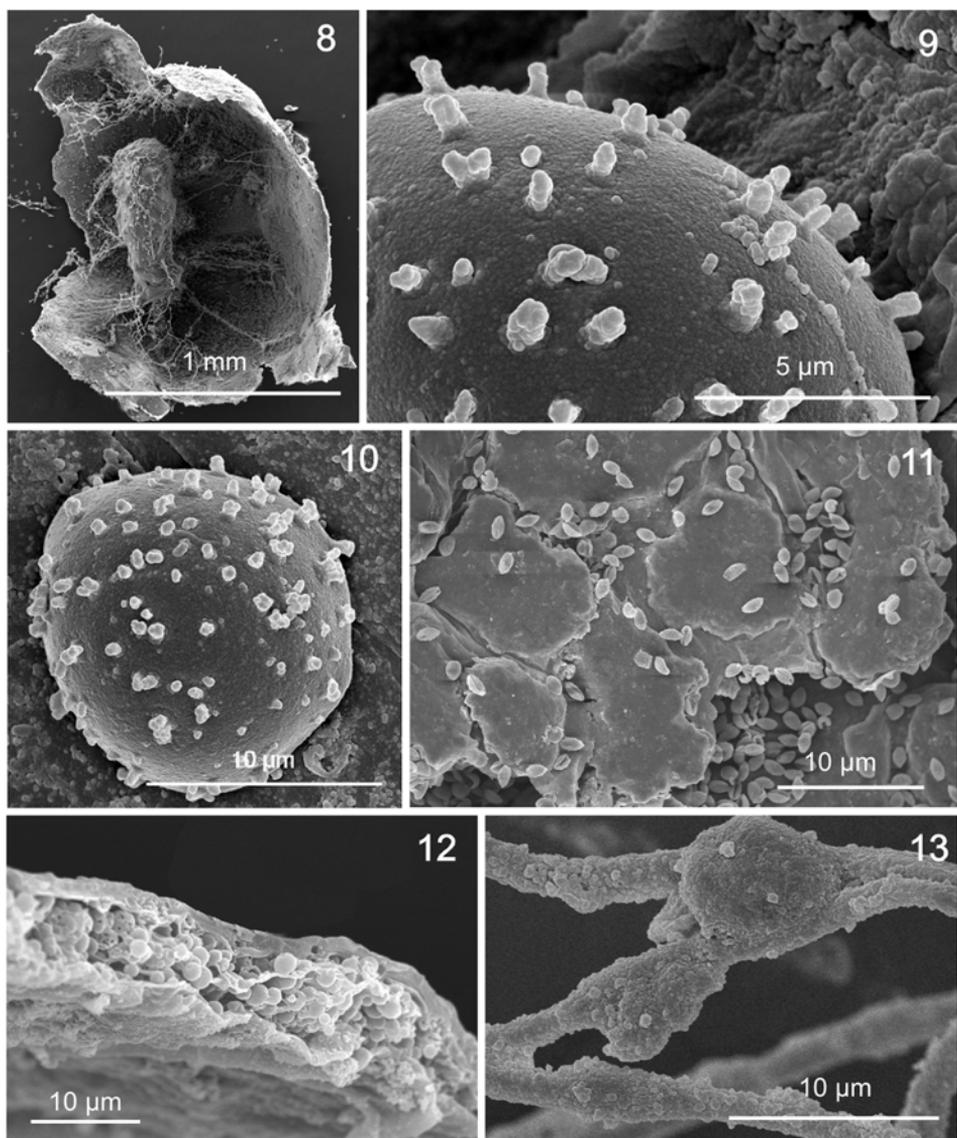
In Spain, the species has previously been reported only from the Pyrenees (Gràcia 1987, Vila & Llimona 1998, Gorris et al. 1999), as *D. lyallii*.

***Diderma niveum* (Rostaf.) T.Macbr.**

Figs 14-19

MATERIAL STUDIED: ÁVILA, Sierra de Gredos, San Juan de Gredos, Eastern slopes of Navasomera, approx. 30-50 m below the ruins of the Refugio del Rey, 40°15'10" N, 05°15'17" W, alt. 2160 m, alpine pasture, on compact clusters of old grass and stems of mosses, at the border of a melting snow patch, 31-V-2003, A. Ronikier & M. Ronikier, KRAM M-1051a, KRAM M-1051b, KRAM M-1051c; Zapardiel de la Ribera, central part of the Circo de Gredos, slopes to the South-West upwards from the Refugio Elola, 40°14'55" N, 05°17'14" W, 2020-2100 m, small patches of alpine meadows among granitic rocks, on dead stems of grass, 31-V-2003, A. Ronikier & M. Ronikier, KRAM M-1050a, KRAM M-1050b; El Hornillo, La Mira peak, Los Pelasos, 40°16'10" N, 05°11'10" W, 2260 m, 8-VI-2003, alpine pasture, herbaceous stems, C. Lado, 14700Lado, 14702Lado; Navalperal de Tormes, El Morezón peak, Las Pozas, 40°5'21" N, 05°15'24" W, 2135 m, alpine pasture, on herbaceous remnants, 11-VI-2003, C. Lado & M. Romeralo, 14719Lado.

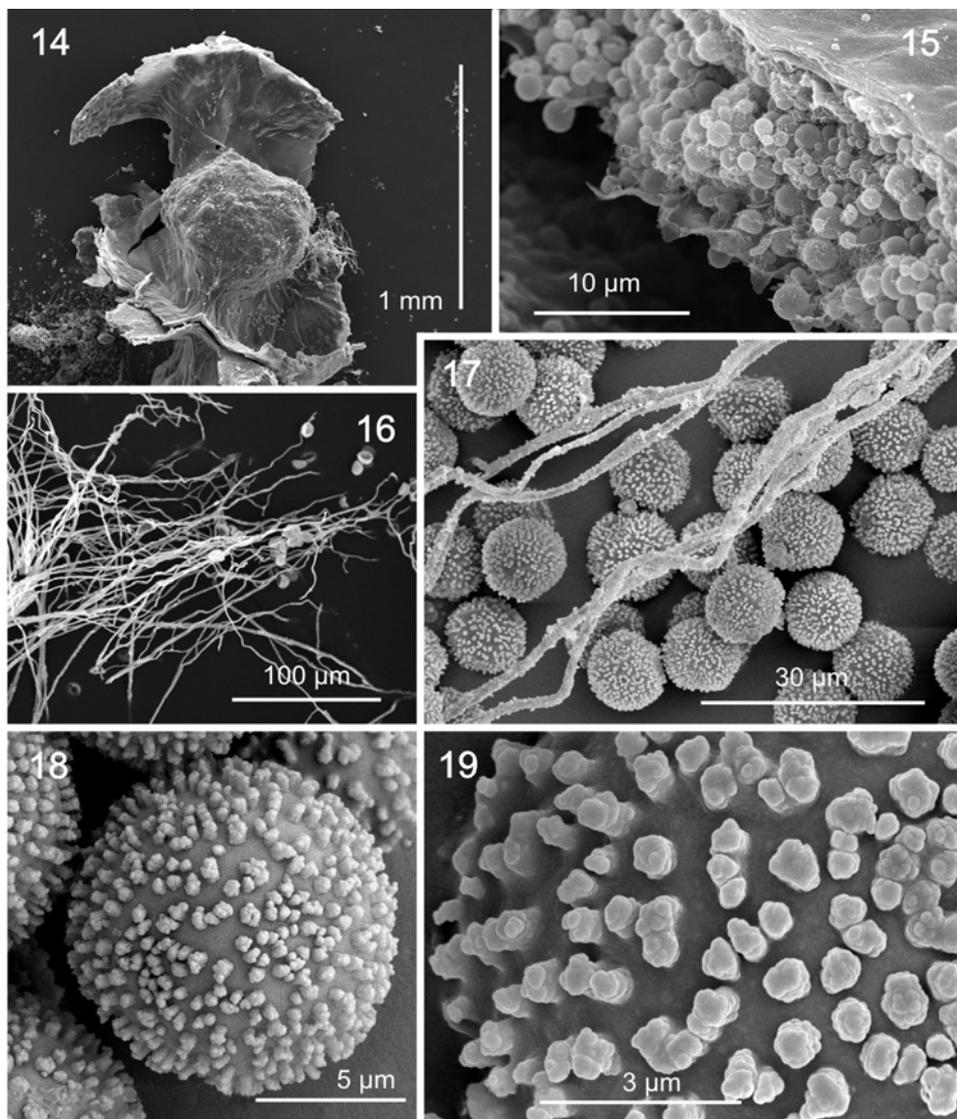
DESCRIPTION: Sporocarps clustered, sessile. Sporotheca globose to subglobose, 0.5-1.6 mm diam., white. Peridium double, the outer layer thick, densely limy, egg-shell-like, white, the inner layer thin, pale brown, membranous, iridescent, with slight lime granulation forming a reticulum-like pattern (Fig. 15). Hypothallus distinct, white, covered by a dense layer of lime. Columella broad, flat, 0.5 mm diam., 0.1-0.2 mm high, white to cream-coloured (Fig. 14). Capillitium thin, flexuose (Figs 16, 17), pale brownish to hyaline, smooth or slightly roughened, up to 1 μm diam. or more stout, dark brown, about 2 μm diam. Spores subglobose,



Figs 8-13. *Diderma fallax* (KRAM M-1049). 8. Inner side of sporotheca with prominent columella. 9. Details of spore ornamentation. 10. Spore with scanty but prominent ornamentation. 11. Peridium covered with lime scales. 12. Cross-section of peridium. 13. Capillitium threads with nodes.

(10-)11-12(-13) μm diam., covered with more or less prominent spines; in SEM they can be described as baculate or warted, with fused warts (Figs 18, 19).

REMARKS: The most variable feature of the specimens studied by us is the structure and appearance of the capillitium, which in some specimens (KRAM M-1050a, 1050b)



Figs 14-19. *Diderma niveum*. 14. Inner side of sporotheca with visible columella and double peridium (KRAM M-1050). 15. Cross-section of inner peridium (KRAM M-1050). 16. Capillitial threads (KRAM M-1050). 17. Group of spores and capillitial threads (KRAM M-1051). 18. Spore (KRAM M-1051). 19. Detail of spore ornamentation (KRAM M-1050).

is very flexuous and thin (1-2 µm wide), while in others (KRAM M-1051a, 1051b) it is thick (2-3 µm wide), stout, dark brown, with thin and wide membranes at the ramifications. Specimens with dark and stout capillitium grow together with specimens with thin, hyaline, flexuous capillitium. The morphology of these structures is the

most important feature separating *D. alpinum* (Meyl.) Meyl. from *D. niveum* according to the key by Moreno et al. (2003b), but in our opinion this character is sometimes not sufficient to distinguish the two species. Also ornamentation of spores within one of our collections is more variable than that described by Moreno et al. (2003b) for this species. In some of our collections spores are covered by baculae, similar to those showed on many pictures by these authors, while in other collections (KRAM M-1051) the warts are lower with a tendency to fuse (Figs 18, 19), but not forming crest-like patterns like in the case of *Diderma meyerae* H. Singer, Illana & A. Sánchez (Moreno et al. 2003b). Taking into account the variability of the characters, we prefer to treat *D. niveum* in a wider sense, including as for now *D. alpinum* and *D. meyerae*.

Didymium dubium Rostaf.

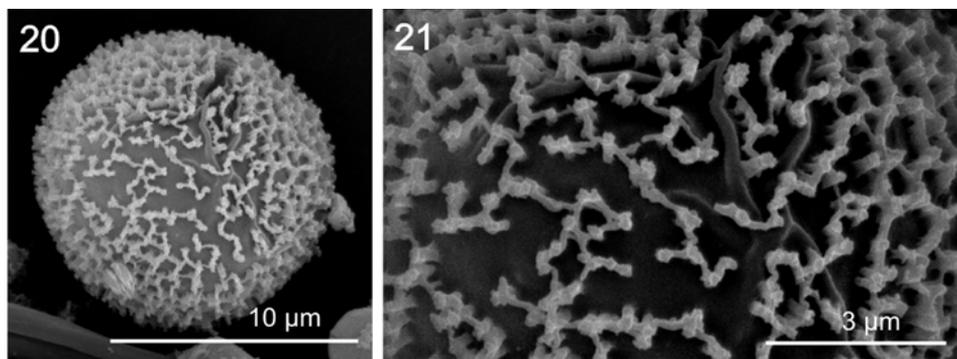
Figs 20, 21

MATERIAL STUDIED: ÁVILA, Sierra de Gredos, San Juan de Gredos, Prado de las Pozas, 40°17'23" N, 05°13'47" W, 1880 m, 7-V-1994, on old stems of *Eryngium bourgatii* and *Carduus* sp., C. Lado, 6696Lado, 6702Lado, 6704Lado, 6708Lado, 6713Lado; Navalperal de Tormes, Llano de Barbellido, 40°17'23" N, 05°14'29" W, 1920 m, 8-V-1994, on dead herbaceous remnants and *Polytrichum* sp., C. Lado, 6724Lado; Puerto Castilla, Laguna del Barco, 40°16'18" N, 05°36'15" W, 1750 m, 1-V-2001, on old stems of *Eryngium bourgatii* and herbaceous remnants, C. Lado, 13222Lado, 13228Lado, 13229Lado; Navalperal de Tormes, Los Barrerones, 40°17'23" N, 05°15'11" W, 2100 m, 17-VI-2001, on herbaceous remnants, C. Lado & A. Estrada, 13239Lado; Zapardiel de la Ribera, central part of the Circo de Gredos, slopes to the South-West upwards from the Refugio Elola, 40°14'55" N, 05°17'14" W, 2020-2100 m, small patches of alpine meadows among granitic rocks, on old stems and inflorescences of *Eryngium bourgatii*, 31-V-2003, A. Ronikier & M. Ronikier, KRAM M-1032; Zapardiel de la Ribera, South-Western upper part of the Circo de Gredos, 40°14'45" N, 05°17'22" W, 2200-2250 m, small patches of alpine meadows among granitic rocks, on old stems and inflorescences of *Eryngium bourgatii*, 1-VI-2003, A. Ronikier & M. Ronikier, KRAM M-1033a, KRAM M-1033b, KRAM M-1033c; Navalperal de Tormes, the Circo de Gredos, at the South-Eastern side of the Laguna Grande de Gredos lake, 40°15'05" N, 05°16'50" W, 1960 m, humid meadow, on grass leaf and remnants of *Gentiana lutea*, 1-VI-2003, A. Ronikier & M. Ronikier, KRAM M-1034; Navalperal de Tormes, Prado de las Pozas, 40°15'46" N, 05°14'40" W, 2085 m, on herbaceous remnants, 11-VI-2003, C. Lado & M. Romeralo, 14711Lado.

DESCRIPTION: Plasmodiocarps rounded, oblong, plate-shaped to reticulate, flattened, sessile, 2-20 mm long, 1-5 mm wide, 0.5-1.5 mm high, white or slightly greyish white, dark brown to almost black and shining when limeless. Peridium single, hyaline in transmitted light, silvery iridescent, more or less densely covered by white lime crystals, rough or thick and almost smooth. Hypothallus inconspicuous. Columella in the form of a cream-coloured thin layer inside the plasmodiocarps. Capillitium very variable, reddish brown, pale brown to almost hyaline in transmitted light, threads smooth, flexuous, slightly to distinctly roughened or with small nodes, about 1 µm wide, with hyaline, blunt or slightly expanded ends. Spores dark brown to almost black in mass, brown in transmitted light, 11-14(-15) µm diam., covered by distinct warts often arranged in lines or more or less subreticulate pattern.

REMARKS: The most characteristic features of this species are flat plasmodiocarps and subreticulate spores; in SEM they can be described, according to the terminology of Rammeloo (1975), as subreticulate type with perforated muri (Figs 20, 21).

Didymium dubium was one of the most common species found in the vicinity of the Almanzor peak (2592 m), the highest massif of the Sierra de Gredos, as well as



Figs 20-21. *Didymium dubium* (MA-Fungi, 6702Lado). 20. Spore with subreticulate ornamentation. 21. Details of spore ornamentation with murus perforatus.

in lower places of these mountains. It was always found on old herbaceous stems, very commonly on *Eryngium bourgatii*. In Spain it was recently reported from the Sierra Nevada, also as an abundant species (Moreno et al. 2003a); it was also found in the massif of Peñalara in the Sierra de Guadarrama, 12-VI-2004, KRAM M-1066 (M.Ronikier, unpubl. data); according to our observations, it is probably distributed throughout the high mountains of Spain, from the Pyrenees to the Sierra Nevada.

***Enerthenema melanospermum* T.Macbr. & G.W.Martin**

MATERIAL STUDIED: ÁVILA, Sierra de Gredos, Zapardiel de la Ribera, central part of the Circo de Gredos, slopes to the South-West upwards from the Refugio Elola, 40°14'55" N, 05°17'14" W, 2020-2100 m, small patches of alpine meadows among granitic rocks, on compact clusters of old grass, 31-V-2003, A. Ronikier & M. Ronikier, KRAM M-1035.

DESCRIPTION: Sporocarps in small groups, stalked. Sporotheca spherical, 0.5-1.1 mm diam., black. Peridium evanescent. Stalks short, 0.2-0.3 mm long, black and shining. Hypothallus distinct, continuous under a group of sporocarps, thick, black and shining. Columella black, reaching the top of the sporotheca where it forms a peridial plate about 0.2 mm diam. (damaged or not well developed in most of the sporocarps). Capillitium branching from the top of the columella and the peridial plate, additionally also from the upper part of the columella, dark brown to black in transmitted light, capillitial threads about 1 µm wide, roughened, with many short branches. Spores black in mass, dark brown in transmitted light, subglobose, 12-14 µm diam., covered with small warts.

REMARKS: The most distinctive feature of the species is the presence of a peridial plate of about 0.2 mm diam. and large black spores. *Enerthenema melanospermum* has been previously reported in Spain from the Sierra de Guadarrama (Illana et al. 1993, Moreno et al. 2002) and from the Pyrenees (Gràcia 1977).

***Lamproderma arcyrroides* (Sommerf.) Rostaf.**

MATERIAL STUDIED: ÁVILA, Sierra de Gredos, Zapardiel de la Ribera, central part of the Circo de Gredos, slopes to the South-West upwards from the Refugio Elola, 40°14'55" N, 05°17'14" W, 2020-2100 m,

small patches of alpine meadows among granitic rocks, on old stems and inflorescences of *Eryngium bourgatii*. 31-V-2003, A. Ronikier & M. Ronikier, KRAM M-1056a, KRAM M-1056b.

DESCRIPTION: Sporocarps gregarious, stalked. Sporotheca subglobose or slightly ovoid, 0.6-1.1 mm diam., 0.5-1 mm high. Peridium persistent, breaking away into big pieces, shining, with golden and, rarely, blue reflections. Stalk 0.5-0.8 mm long, black, shining. Hypothallus distinct, yellowish brown, dark brown around the stalk base, shining. Columella reaching about half of the sporotheca diameter, membranously broadened at the top. Capillitium radially branching from the top of the columella and the upper part of the columella, brown, pale to almost hyaline at the very ends, delicate, with coralloid swellings up to 10 µm diam. Spores globose, 9.5-11(-12) µm diam., densely warted.

REMARKS: *Lamproderma arcyrioides* is not a strictly nivicolous species, and it has not been found in the vicinity of melting snow so far. It differs from the two other closely related nivicolous species, *L. sauteri* and *L. ovoideum*, by its more slender habit and microscopic features. *L. sauteri* has paler, red-brown, more wavy capillitium and much bigger spores, while *L. ovoideum* has more stout capillitium branching from the whole length of the columella.

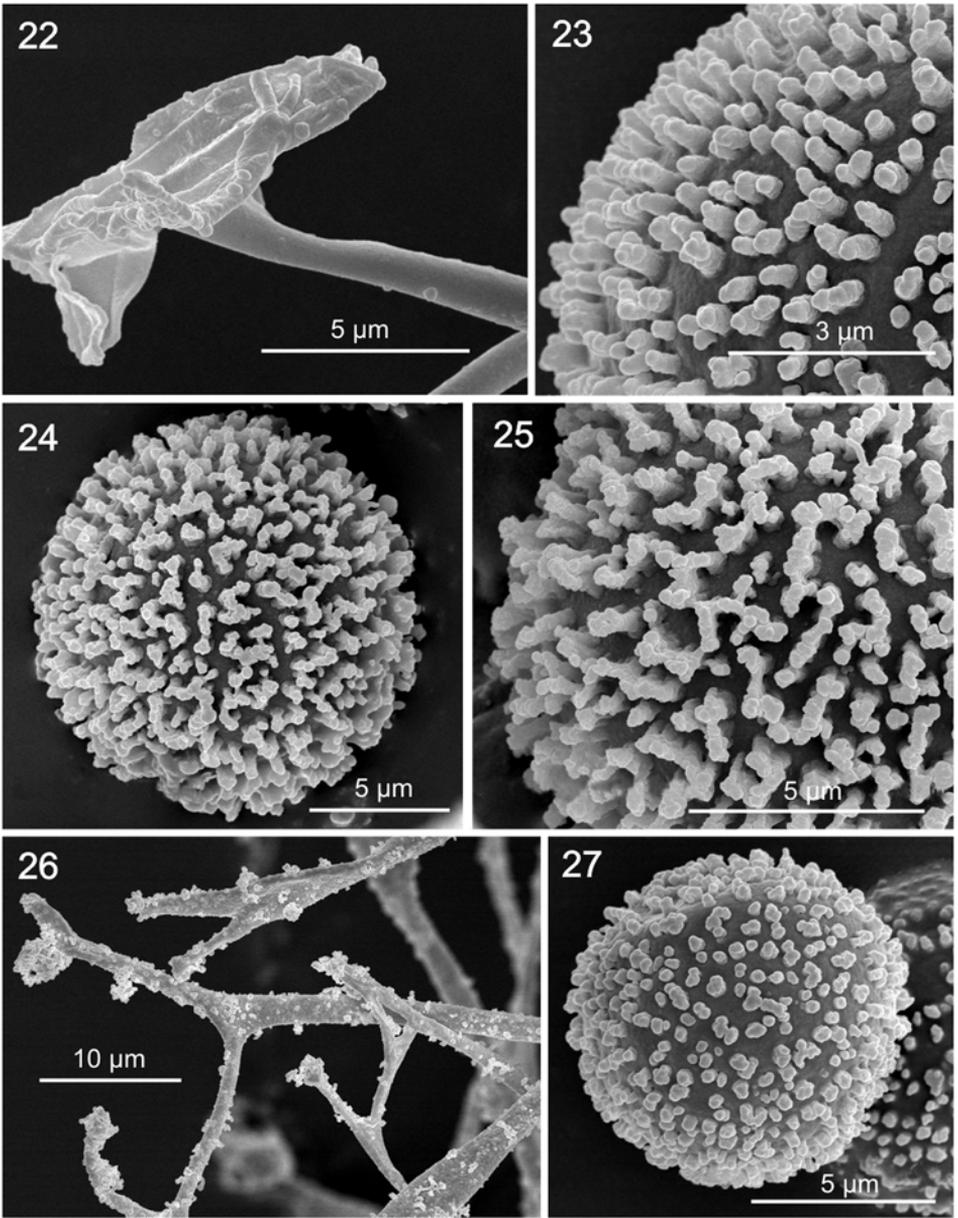
Lamproderma cribrarioides var. **atrosporum** (Meyl.) G.Moreno, H.Singer, Illana & A.Sánchez Figs 22, 24, 25

MATERIAL STUDIED: ÁVILA, Sierra de Gredos, Zapardiel de la Ribera, central part of the Circo de Gredos, slopes to the South-West upwards from the Refugio Elola, 40°14'55" N, 05°17'14" W, 2020-2100 m, small patches of alpine meadows among granitic rocks, on old stems and inflorescences of *Eryngium bourgatii*, 31-V-2003, A. Ronikier & M. Ronikier, KRAM M-1037; Navalperal de Tormes, Prado de las Pozas, 40°15'46"N, 05°14'40" W, 2085 m, on grasses, 11-VI-2003, C. Lado & M. Romeralo, 14704Lado.

DESCRIPTION: Sporocarps in small groups, distinctly stalked. Sporotheca subglobose or slightly ovoid or pyriform (narrower in the lower part), 0.8-1.0 mm high and 0.6-1.1 mm diam. Peridium breaking up into small fragments, black with slightly silvery reflections. Stalk 100-500 µm long, black and shining, slightly broadening toward base, base membranous and laterally flattened. Hypothallus distinct, light brown, thicker near the base of the stalk, almost hyaline, sometimes joining neighbouring stalks. Columella reaching about $\frac{1}{2}$ to $\frac{2}{3}$ of the sporotheca, slightly swollen and bluntly ended, dark brown in transmitted light. Capillitium dark brown in transmitted light, ends funnel-shaped (Fig. 22), radiating from the upper half of the columella. Spores black in mass, dark brown in transmitted light, globose, very variable in size, 12-27 µm diam., spinose, spinulose or with subreticulate pattern (Figs 24, 25), spines up to 1.5 µm long.

REMARKS: For the identification of the taxon we follow Singer et al. (2003). This taxon was commonly known as *L. atrosporum* Meyl., but, as the authors point out, its concept has been misinterpreted. Our material shows the typical dark brown to black sporocarps, with tips of the capillitial threads expanded into a funnel shape and attached to the peridium.

The species was recently reported from the Pyrenees (Gorris et al. 1999), the Guadarrama (Moreno et al. 2002; Singer et al. 2003) and from the Sierra Nevada (Moreno et al. 2003a).



Figs 22, 24-25. *Lamproderma cribrarioides* var. *atrosporum* (KRAM M-1037). 22. Funnel-shaped capillitium end. 24. Spore with subreticulate ornamentation. 25. Detail of spore ornamentation. Fig. 23. *Lamproderma sauteri* (KRAM M-1041). Detail of spore ornamentation with bacula. Figs 26-27. *Lamproderma splendens* (KRAM M-1042). 26. Capillitium ends. 27. Spore with verrucate ornamentation.

Lamproderma maculatum Kowalski

MATERIAL STUDIED: ÁVILA, Sierra de Gredos, Navalperal de Tormes, Los Barrerones, 40°17'23" N, 05°15'11" W, 2100 m, on stems of *Cytisus balansae*, 17-VI-2001, C. Lado & A. Estrada, 13237Lado; Zapardiel de la Ribera, central part of the Circo de Gredos, slopes to the South-West upwards from the Refugio Elola, 40°14'55" N, 05°17'14" W, 2020-2100 m, small patches of alpine meadows among granitic rocks, on old stem of *Eryngium bourgatii*, 31-V-2003, A. Ronikier & M. Ronikier, KRAM M-1053.

DESCRIPTION: Sporocarps in loose groups, sessile or slightly stalked. Sporotheca subglobose or slightly ovoid, 0.3-1.0 mm diam., 0.3-0.9 mm high. Peridium persistent, thin, silvery-blackish, iridescent with colourful reflections, mottled with black areas, especially at the base; basal part of the peridium brown in transmitted light, upper part hyaline with big brown dots. Stalk, if present, 0.1 mm high, black, shining. Hypothallus distinct, thick, continuous under groups of sporocarps, forming darker discs around the stalk base, brown in transmitted light. Columella reaching to about half of the sporotheca diameter, cylindrical and bluntly ended, black in transmitted light. Capillitium dense, rigid, branching from the upper half of the columella, dark brown, hyaline only at the very ends; ends firmly attached to the peridium. Spores black in mass, dark brown in transmitted light, slightly paler at one side, subglobose, 13-15(-16) µm diam., densely and minutely warted.

REMARKS: The most distinguishing feature of this species is the peridium which is mottled with black areas in transmitted light, especially at the base. It differs from other similar species with a mottled peridium mostly by spore size and ornamentation. In Spain, it was previously reported from the Sierra de Guadarrama (Moreno et al. 2002).

Lamproderma nigricapillitium Nann.-Bremek. & Bozonnet

≡ *Collaria nigricapillitia* (Nann.-Bremek. & Bozonnet) Lado

MATERIAL STUDIED: ÁVILA, Sierra de Gredos, Navalperal de Tormes, Llano de Barbellido, 40°17'23" N, 05°15'29" W, 1920 m, on stems of *Cytisus balansae*, 8-V-1994, C. Lado, 6717Lado, 6720Lado; Navarredonda de Gredos, Risco del Águila, 40°19'00" N, 05°07'30" W, 1900 m, stems of *Cytisus balansae*, 16-VI-2001, C. Lado & A. Estrada, 13234Lado, 13236Lado; Navalperal de Tormes, Eastern slopes of Navasomera, approx. 30-50 m below the ruins of the Refugio del Rey, 40°15'10" N, 05°15'17" W, 2160 m, alpine pasture, on wood remnants, at the border of a melting snow patch, 31-V-2003, A. Ronikier & M. Ronikier, KRAM M-1054a, KRAM M-1054b.

DESCRIPTION: Sporocarps grouped, stalked. Sporotheca subglobose, 0.7-1.5 diam., black. Peridium fugacious, quickly disappearing except at the base where it remains as a little collar. Stalk 0.3-0.6 mm long, black, shining. Hypothallus distinct but small, continuous under two or three sporocarps, black, shining. Columella up to about ¾ of the sporotheca diameter, cylindrical, bluntly ended, black. Capillitium black, rough, with many short free ends. Spores black, pale brown in transmitted light, subglobose, (9.5-)-10-12(-13) µm diam., densely and regularly covered with small spines.

REMARKS: All samples of this species studied by us were developed on woody debris. The specimen KRAM-M-1054a occurred together with *Comatricha* cf. *rigidireta*.

In Spain, this species has been previously reported from the Sierra de Guadarrama (Lado 1992; Sánchez et al. 2002b) and the Pyrenees (Lado 1992) as *Collaria*

chionophila Lado and *Comatricha nigricapillitia* (Nann.-Bremek. & Bozonnet) A. Castillo, G. Moreno & Illana, two conspecific taxa as pointed out by Lado (2001).

Lamproderma ovoideum Meyl.

MATERIAL STUDIED: ÁVILA, Sierra de Gredos, San Juan de Gredos, Prado de las Pozas, 40°17'23" N, 05°13'47" W, 1880 m, on stems of *Eryngium bourgatii*, *Juncus effusus*, *Echinospartum barnadesii* and a grass, 7-V-1994, C. Lado, 6696Lado, 6697Lado, 6698Lado, 6699Lado, 6700Lado, 6705Lado, 6706Lado, 6707Lado, 6709Lado, 6710Lado, 6711Lado; Puerto Castilla, Laguna del Barco, 40°16'18" N, 05°36'15" W, 1750 m, on old stems of *Eryngium bourgatii*, C. Lado, 13223Lado, 13224Lado, 13225Lado, 13226Lado; San Juan de Gredos, Eastern slopes of Navasomera, approx. 30-50 m below the ruins of the Refugio del Rey, 40°15'10" N, 05°15'17" W, 2160 m, alpine pasture, on old stems of a plant, at the border of a melting snow patch, 31-V-2003, A. Ronikier & M. Ronikier, KRAM M-1039, on plant remnants, 31-V-2003, A. Ronikier & M. Ronikier, KRAM M-1060; Zapardiel de la Ribera, central part of the Circo de Gredos, slopes to the South-West upwards from the Refugio Elola, 40°14'55" N, 05°17'14" W, 2020-2100 m, small patches of alpine meadows among granitic rocks, on old stems and inflorescences of *Eryngium bourgatii*, 31-V-2003, A. Ronikier & M. Ronikier, KRAM M-1061, KRAM M-1058; Navalperal de Tormes, the Circo de Gredos, at the North-Eastern side of the Laguna Grande de Gredos lake, 40°15'20" N, 05°16'44" W, 1960 m, humid meadow, on dead stems of plants (Compositae), 1-VI-2003, A. Ronikier & M. Ronikier, KRAM M-1038; Navalperal de Tormes, North-Western slopes of Morezón, 40°15'35" N, 05°16'24" W, 2120 m, on rigid old stems of plants (Compositae), 1-VI-2003, A. Ronikier & M. Ronikier, KRAM M-1057.

DESCRIPTION: Sporocarps gregarious, distinctly stalked to almost sessile. Sporotheca subspherical, ovoid to shortly cylindrical, 0.6-2 mm high, 0.5-1 mm diam. Peridium persistent, breaking into big fragments from the upper part of the sporotheca and forming a calyculus-like structure in the lower part, opaque, with or without golden-blue reflections. Stalk 0.15-0.4 mm long, black and shining, broadening toward the base; base membranous and laterally flattened. Hypothallus distinct, dark brown and shining, thicker near the base of the stalk. Columella reaching about $\frac{2}{3}$ to $\frac{3}{4}$ of the sporotheca diameter, tapering toward the top and bluntly ended, dark brown in transmitted light. Capillitium dark brown in transmitted light, hyaline only at very ends, radiating from the upper half of the columella and forming a reticulum with big meshes. Spores dark brown to black in mass, dark brown in transmitted light, spherical, (11-)13-14(-19) μm diam., covered by small warts or distinct spines up to 1.5 μm long.

REMARKS: *Lamproderma ovoideum* is one of the most variable species of the genus. In our collections we have found spherical, short cylindrical, stalked to almost sessile sporocarps. Spores are also very variable in size and ornamentation.

In Spain, the species was recently reported from the Sierra de Guadarrama (Moreno et al. 2002) and the Sierra Nevada (Moreno et al. 2003a).

Lamproderma retirugisporum G. Moreno, H. Singer, Illana & A. Sánchez = *Lamproderma cribrarioides* (Fr.) R. E. Fr., sensu auct. plurimum non Fr.

MATERIAL STUDIED: ÁVILA, Sierra de Gredos, Navalperal de Tormes, El Morezón peak, Las Pozas, 40°15'21" N, 05°15'24" W, 2135 m, on old stem of *Gentiana lutea*, 11-VI-2003, C. Lado & M. Romeralo, 14717Lado.

DESCRIPTION: Sporocarps grouped to clustered, stipitate or sessile, erect, 1-2 mm in total height. Sporotheca subglobose, iridescent, with greenish shadows, 0.8-1.2 mm diam. Hypothallus continuous, common to a group of sporocarps, brownish. Stipe blackish, erect, slightly widened towards the base, 0.2-0.7 mm high. Peridium

membranous, thin, persistent, iridescent, shiny; dehiscence irregular and fissural. Columella cylindrical, blunt at the apex, attaining half of the sporotheca. Capillitium radiating from the upper part of the columella, branching, scarcely anastomosed, primary branches rigid, reddish brown, paler toward the surface, with hyaline and acute tips. Spores blackish in mass, greyish brown in transmitted light, subglobose, 13-15 µm diam., entirely and hardly reticulate.

REMARKS: Our specimen is concordant with the description of Singer et al. (2003) of *L. retirugisporum*, a new species created to include the traditional concept of *L. cribrarioides* (Fr.) R.E.Fr. but apparently misinterpreted. The reticulate spores and the sharp tips of the capillitial threads without expansions into a funnel shape, are the most distinctive features of this species.

The species was previously reported from Spain (Sierra de Guadarrama) as *L. cribrarioides* (Fr.) R.E.Fr. on stems of *Digitalis purpurea*, *Senecio pyrenaicus* and *Cryptogramma crista* (Moreno et al. 2002).

Lamproderma sauteri Rostaf.

Fig. 23

MATERIAL STUDIED: ÁVILA, Sierra de Gredos, Zapardiel de la Ribera, central part of the Circo de Gredos, slopes to the South-West upwards from the Refugio Elola, 40°14'55" N, 05°17'14" W, 2020-2100 m, small patches of alpine meadows among granitic rocks, on old stems of *Eryngium bourgatii*, 31-V-2003, A. Ronikier & M. Ronikier, KRAM M-1041.

DESCRIPTION: Sporocarps gregarious, distinctly stalked or almost sessile. Sporotheca subglobose, 0.9-1.1 mm high and 0.9-1.5 mm diam. Stalk 0.2-0.4 mm long, black and shining, slightly broadening toward the base and at the sporotheca, base slightly membranous. Peridium persistent, breaking into large fragments from the upper part of the sporotheca, iridescent, with rose-lilac, blue or golden reflections. Hypothallus distinct, brown and shining, thicker near the base of the stalk. Columella reaching to about half of the sporotheca, cylindrical, bluntly ended, red-brown in transmitted light. Capillitium red-brown in transmitted light, radiating from the upper half of the columella and becoming progressively paler toward the tips. Spores black in mass, dark brown in transmitted light, spherical, 12-15 µm diam., spinulose, spines up to 0.5 µm long, of baculate type in SEM (Fig. 23), with bacula up to 0.6 µm long.

REMARKS: We have found only one collection of this fairly common species.

Lamproderma sauteri is also known in Spain from the Sierra de Guadarrama, the Catalanian Pyrenees and the Sierra Nevada (Gràcia 1986; Illana et al. 1993; Vila & Llimona 1998; Gorris et al. 1999; Moreno et al. 2003a).

Lamproderma splendens Meyl.

Figs 26, 27

MATERIAL STUDIED: ÁVILA, Sierra de Gredos, Navalperal de Tormes, North-Western slopes of Morezón, 40°15'35" N, 05°16'24" W, 2120 m, on rigid old stems of plants (*Compositae*), 1-VI-2003, A. Ronikier & M. Ronikier, KRAM M-1042.

DESCRIPTION: Sporocarps gregarious, distinctly stalked. Sporotheca subglobose to slightly ovoid, 0.6-1.1 mm diam., 0.6-0.8 mm high. Stalk 0.3-0.6 mm long, black and shining, slightly broadening toward the base. Peridium persistent, dehiscing into large fragments, iridescent, with rose, blue or yellow and green reflections.

Hypothallus brown and shining, thicker and darker near the base of the stalk. Columella reaching to about half of the sporotheca, cylindric bluntly ended, dark brown in transmitted light. Capillitium pale, whitish after sporulating, pale to almost hyaline in transmitted light. Spores black in mass, dark brown in transmitted light, spherical, 10-12 μm diam., warty (Fig. 27).

REMARKS: The most characteristic feature of this species is the capillitium that appears whitish after the release of the spores, pale to almost hyaline in transmitted light, branched and anastomosed (Fig. 26).

This is the first documented record of this species from Spain. Lado (2004), based on personal unpublished data, cited it as a nivicolous species present in Spain.

Lepidoderma carestianum (Rabenh.) Rostaf.

Figs 28-30

MATERIAL STUDIED: ÁVILA, San Juan de Gredos, Prado de las Pozas, 40°17'23" N, 05°13'47" W, 1880 m, on old stems of *Eryngium bourgatii*, 7-V-1994, C. Lado, 6696Lado.

DESCRIPTION: Plasmodiocarps sessile, scattered, not branched, depressed, spreading over 5-50 mm, 0.3-0.8 mm high, 0.5-5 mm diam., greyish brown. Hypothallus membranous, slender, continuous. Peridium double, membranous or slightly coriaceous, opaque, dark greyish brown, covered with whitish limy scales of 20-60 μm diam. (Fig. 28); dehiscence fissural and irregular. Columella as a slight basal thickening or inconspicuous. Capillitium tubular but apparently membranous, limeless, light brownish grey in transmitted light, tubules slender, 2.5-7 μm wide, straight, branched, anastomosed, 200-250 μm in length, smooth, frequently enlarged funnel-shaped at the tips, sometimes filled with numerous small, dark, irregularly distributed granules. Spores free, black in mass, brown to dark brown or greyish purple in transmitted light, subglobose, 12-15 μm diam., densely spiny, of baculate type in SEM (Figs 29, 30).

REMARKS: There is no agreement on the concept of this taxon. Some authors recognize *L. carestianum* as a narrowly delimited species (e.g. Poulain et al. 2002) characterised by its flattened plasmodiocarps, while others (e.g. Kowalski 1971, Sánchez et al. 2002b) treat *L. carestianum* in a wider sense including *L. chailletii*, which forms subglobose sporocarps or short plasmodiocarps. We follow the criteria of Poulain et al. (2002) who, after the study of the type material of *L. carestianum* preserved at BR, clearly distinguished it from *L. chailletii* Rostaf. The main difference between these two species, apart from shape of fructifications, is the structure of the peridium, which is single in *L. chailletii*, and double in *L. carestianum*, and the spores are densely spiny (baculate type in SEM) in *L. carestianum* but warty in *L. chailletii*. In Spain, the species was previously reported from the Sierra de Guadarrama (Sánchez et al. 2002b), but, according to the description made by these authors, the specimens represent *L. chailletii* Rostaf.

Lepidoderma chailletii Rostaf.

Figs 31-33

MATERIAL STUDIED: ÁVILA, Sierra de Gredos, San Juan de Gredos, Prado de las Pozas, 40°17'23" N, 05°13'47" W, 1880 m, on stems of *Echinopartum bernadesii*, on bryophytes and a grass, 7-V-1994, C. Lado, 6701Lado, 6703Lado; Navarredonda de Gredos, Risco del Águila, 40°19'00" N,

05°07'30" W, 1900 m, on twigs of *Cytisus balansae* and a grass, C. Lado & A. Estrada, 13230Lado, 13231Lado, 13233Lado; San Juan de Gredos, Eastern slopes of Navasomera, approx. 30-50 m below the ruins of the Refugio del Rey, 40°15'10" N, 05°15'17" W, 2160 m, alpine pasture, on stems and leaves of old grass (*Festuca* sp.), at the border of a melting snow patch, 31-V-2003, A. Ronikier & M. Ronikier, KRAM M-1043; Zapardiel de la Ribera, central part of the Circo de Gredos, slopes to the South-West upwards from the Refugio Elola, 40°14'55" N, 05°17'14" W, 2020-2100 m, small patches of alpine meadows among granitic rocks, on clusters of grasses (*Festuca* sp.) and stems of mosses, 31-V-2003, A. Ronikier & M. Ronikier, KRAM M-1044; El Hornillo, La Mira peak, Los Pelaos, 40°16'10"N, 05°11'10" W, 2260 m, alpine grassland, on herbaceous stems, 8-VI-2003, C. Lado, 14701Lado; Navalperal de Tormes, Prado de las Pozas, 40°15'46" N, 05°14'40" W, 2085 m, on grass, 11-VI-2003, C. Lado & M. Romeralo, 14706Lado, 14707Lado, 14708Lado, 14709Lado.

DESCRIPTION: Sporocarps or small plasmodiocarps, gregarious, sessile. Sporotheca spherical to ovoid, sometimes slightly flattened, 0.8-1.5 mm diam. Peridium single, brown to black, yellowish in transmitted light, covered with dispersed but uniformly distributed lime scales of 10-50 µm diam. (Fig. 31), rarely limeless and shining. Hypothallus thin, brown, covered with lime squamules. Columella small, irregular, cream-coloured. Capillitium brown in transmitted light with hyaline ends and coralloid thickening, with threads 2-3.5 µm wide, simple, straight, sometimes slightly sinuous and anastomosing, thickening, 5-6 µm diam. Spores brown-black in mass, brown in transmitted light, subglobose, 12-15 µm diam., warty, of verrucate to short baculate type (Figs 32, 33) in SEM, according to the terminology of Rammeloo (1974, 1975).

REMARKS: We recognize the species *L. chailletii* as distinct from *L. carestianum* (see remarks under the latter species).

This species was previously recorded in Spain from the Sierra Nevada (Moreno et al. 2003a) and the Sierra de Guadarrama (Sánchez et al. 2002b) - see note under *L. carestianum*.

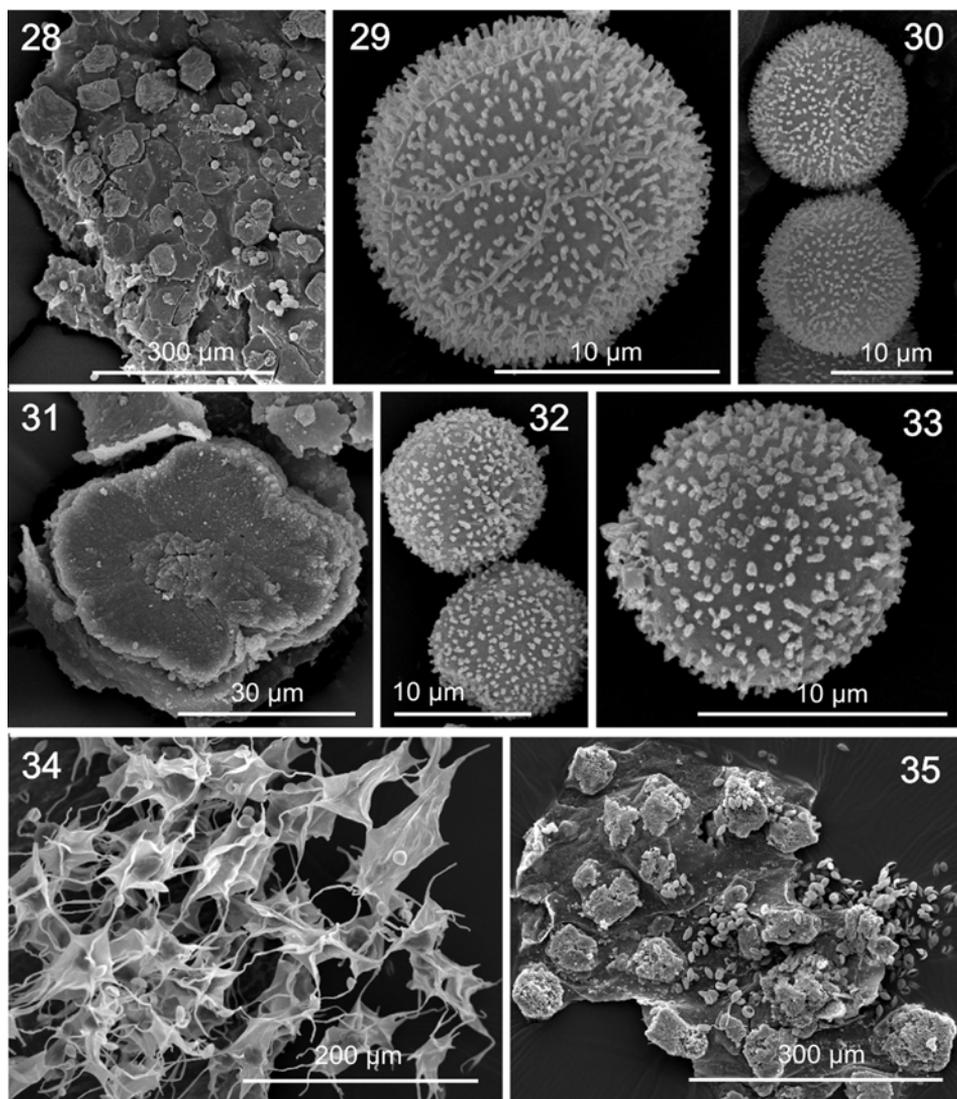
Lepidoderma granuliferum (W.Phillips) R.E.Fr.

Figs 34, 35

MATERIAL STUDIED: ÁVILA, Sierra de Gredos, Navalperal de Tormes, Llano de Barbellido, 40°17'23" N, 05°14'29" W, 1920 m, on stems of *Cytisus balansae*, 8-V-1994, C. Lado, 6716Lado; Navalperal de Tormes, Los Barrerotes, 40°17'23" N, 05°15'11" W, 2100 m, stems of *Cytisus balansae*, 17-VI-2001, C. Lado & A. Estrada, 13238Lado; San Juan de Gredos, North-Eastern slopes of Navasomera, 40°15'15" N, 05°15'25" W, 2190-2200 m, on twigs of *Cytisus*, 31-V-2003, A. Ronikier & M. Ronikier, KRAM M-1045.

DESCRIPTION: Plasmodiocarps sessile, oblong, cylindrical to reticulate, flattened, 0.2-1 mm diam., up to 20 mm long, 0.5-1 mm high. Peridium double, dark brown, both layers brown to pale brown in transmitted light, very closely attached to each other, outer layer covered with white lime squamules of 20-100 µm diam. (Fig. 35). Hypothallus thin, brown. Columella lacking. Capillitium reticulate, pale yellow in transmitted light, with many membranous expansions 15-50 µm diam., filled with lime granules of 10-30 µm diam. (Fig. 34); connecting threads short, only 12-35 µm long. Spores dark brown to almost black in mass, brown in transmitted light and slightly paler at one side, subglobose, 11.5-14 µm diam., minutely and densely warty.

REMARKS: This species is characterized by its sessile, flattened plasmodiocarps, and especially by its capillitium with many membranous expansions filled with lime granules. In Spain, it was recorded in the Sierra de Guadarrama (Sánchez et al. 2002b) and the Sierra Nevada (Moreno et al. 2003a).



Figs 28-30. *Lepidoderma carestianum* (MA-Fungi, 6696Lado). 28. Scales of the peridium. 29-30. Spores. Figs 31-33. *Lepidoderma chailletii* (MA-Fungi, 6701Lado). 31. Peridium with a limy scale. 32-33. Spores. Figs 34-35. *Lepidoderma granuliferum* (KRAM M-1045). 34. Capillitium. 35. Peridium with limy scales.

***Licea minima* Fr.**

MATERIAL STUDIED: ÁVILA, Navarredonda de Gredos, Risco del Águila, 40°19'00" N, 05°07'30" W, 1900 m, on stems of *Cytisus balansae*, 16-VI-2001, C. Lado & A. Estrada, 13235Lado.

DESCRIPTION: Sporocarps scattered to grouped, sessile. Sporotheca dark brown to blackish, pulvinate, angular, 100-400 μm diam. Peridium with two layers, persistent

as a whole, thick, tough, reddish brown in transmitted light; external layer waxy when wet, drying horny; the inner layer membranous, the peridial platelets with margins thickened, forming distinct ridges, sculptured at the margin of the inner surface with free peg-like protuberances, arranged in a single row; inner surface of peridium glossy, densely, evenly and minutely papillate; dehiscence irregular by angular platelets. Spores free, ferruginous-brown in mass, olive-brown in transmitted light, globose, 10-12 μm diam., minutely warted, the spore wall with a diffuse thinner area.

REMARKS: *Licea minima* is not strictly nivicolous, but frequently found on wood near melting snow. It is not uncommon in Spain (Lado 1993).

Physarum albescens Ellis ex T.Macbr.

MATERIAL STUDIED: ÁVILA, Navalperal de Tormes, Prado de las Pozas, 40°15'46" N, 05°14'40" W, 2085 m, on grass, 11-VI-2003, C. Lado & M. Romeralo, 14703Lado, 14704Lado, 14710Lado.

DESCRIPTION: Sporocarps grouped or clustered, sessile or stipitate, 1.5-3 mm in total height. Sporotheca subglobose to pyriform, 1-2 \times 0.7-1 mm, yellow to greyish yellow or light grey. Hypothallus membranous, abundant, common to a group of sporocarps, yellowish or orange. Stipe weak, erect or prostrate, membranous, as thread-like extension of the hypothallus, yellowish, 0.5-2 mm long. Peridium single, usually very limy and appearing double, membranous, partially evanescent, iridescent, covered with abundant lime granules in the form of a crust; dehiscence irregular by means of fissures. Capillitium netted, calcareous, formed by colourless or yellowish, limeless, netted tubules connecting yellow, orange or white, round or elongated, single or branched lime nodes. Spores free, blackish in mass, dark greyish brown in transmitted light, often lighter on one side, subglobose, 10-13 μm diam., spinulose or warted.

REMARKS: In Spain, this species usually occurs on twigs of living shrubs, such as *Cytisus balansae*, *Juniperus communis* subsp. *nana* or *Rhododendrum ferrugineum*, but we collected abundant fruitbodies developed on grasses.

Physarum albescens was previously reported from the Sierra de Guadarrama (Sánchez et al. 2002b) and the Sierra Nevada (Moreno et al. 2003a).

Physarum alpestre Mitchel, S.W.Chapm. & M.L.Farr

MATERIAL STUDIED: ÁVILA, San Juan de Gredos, Prado de las Pozas, 40°17'23" N, 05°13'47" W, 1880 m, on grass, 7-V-1994, C. Lado, 6712Lado.

DESCRIPTION: Plasmodiocarps or short sporocarps, grouped or crowded, sessile, effused, pulvinate. Sporotheca with the upper part flattened, spreading over 2-5 mm, 0.5-1 wide, 0.3-1 mm high, yellow or greenish yellow, smooth. Hypothallus membranous, thin, translucent, colourless to light yellow, inconspicuous. Peridium triple, the layers well differentiated, fragile, partially evanescent; the middle layer thick, smooth, calcareous, crusty, covered by a yellow, translucent layer which frequently dries to leave a shriveled surface; inner layer membranous, thin, lightly powdered with white lime; dehiscence irregular due to fissures, not breaking away together. Columella

white or yellow, as a central ridge or in the form of a thickened base. Capillitium netted, calcareous, formed by colourless, limeless, rigid, netted, tubules that connect large, yellowish, branching, calcareous nodes. Spores free, blackish in mass, dark greyish brown in transmitted light, subglobose, 11-13 μm diam., coarsely warted.

REMARKS: Only one fructification of this nivicolous and easily recognizable species was found by us.

The species was previously recorded from Spain from the Sierra de Guadarrama (Sánchez et al. 2002b).

Trichia alpina Meyl.

MATERIAL STUDIED: ÁVILA, Sierra de Gredos, Puerto Castilla, Laguna del Barco, 40°16'18" N, 05°36'15" W, 1750 m, on stems of *Eryngium bourgatii*, 1-V-2001, C. Lado, 13227Lado; Zapardiel de la Ribera, South-Western upper part of the Circo de Gredos, 40°14'45" N, 05°17'22" W, 2200-2250 m, small patches of alpine meadows among granitic rocks, on inflorescence of *Eryngium bourgatii*, 1-VI-2003, A. Ronikier & M. Ronikier, KRAM M-1047.

DESCRIPTION: Sporocarps sessile or plasmodiocarps, grouped to solitary. Sporotheca 1.25-4.7 mm long, 0.6 mm high, black, shining. Peridium double, outer part blackish, orange-brown in transmitted light, the inner part pale yellow, membranous. Hypothallus distinct, pale brown to almost colourless, shining. Capillitium yellow in transmitted light, elateriform, threads 5-6 μm wide, with 3 to 4 spiral bands, short-ended, ends forked. Spores yellow in mass, pale yellow in transmitted light, spherical, 14-18 μm diam., covered with minute dense warts.

REMARKS: The sessile plasmodiocarps, with a hard black peridium that contrasts with the yellow mass of the capillitium and the spores, in addition to the large spores, are the most distinctive features of this nivicolous species.

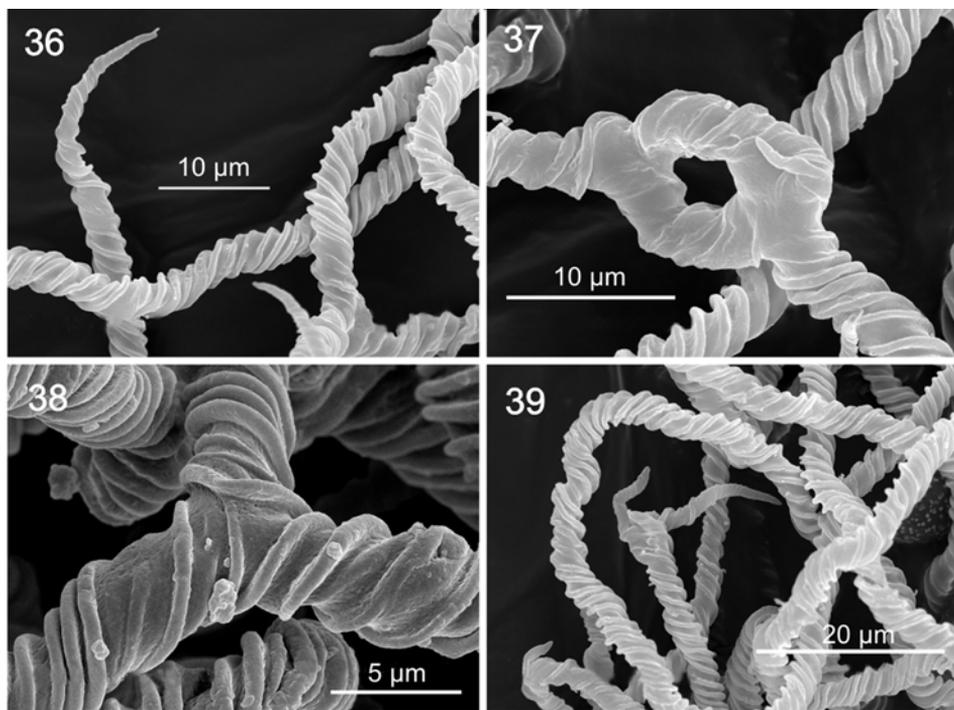
In Spain, it is also known from the Pyrenees (Lado & Pando 1997), from the Sierra de Guadarrama (Sánchez et al. 2002b), and from the Sierra Nevada (Moreno et al. 2003a).

Trichia sordida Johannesen

Figs 36-39

MATERIAL STUDIED: ÁVILA, Navalperal de Tormes, Prado de las Pozas, 40°15'46" N, 05°14'40" W, 2085 m, on grass, 11-VI-2003, C. Lado & M. Romeralo, 14705Lado; Navalperal de Tormes, El Morezón peak, Las Pozas, 40°15'21" N, 05°12'24" W, 2135 m, on grass, 11-VI-2003, C. Lado & M. Romeralo, 14714Lado, 14718Lado, 14720Lado; Zapardiel de la Ribera, central part of the Circo de Gredos, slopes to the South-West upwards from the Refugio Elola, 40°14'55" N, 05°17'14" W, 2020-2100 m, small patches of alpine meadows among granitic rocks, on old stem of *Eryngium bourgatii*, 31-V-2003, A. Ronikier & M. Ronikier, KRAM M-1036.

DESCRIPTION: Sporocarps grouped, sessile. Sporotheca subglobose, slightly flattened, 0.8-1.15 mm diam., 0.8 mm high, dirty yellowish to yellow-brown, slightly darker at the base. Peridium ochraceous-yellow mottled, pale yellowish in transmitted light, with remnants of the brown outer layer remaining in irregularly distributed patches of fine threads, especially abundant at the base. Hypothallus pale yellowish, inconspicuous. Capillitium ochraceous-yellow, yellow in transmitted light, threads 4-4.5 μm wide, with large tips (25-40 μm long) and short lateral branches (Figs 36-39), ends sometimes forked. Spores orange-yellow in mass, pale yellow in transmitted light, 14-18(-20) μm diam., minutely warted.



Figs 36-39. *Trichia sordida* (KRAM M-1036). Threads of the capillitium.

REMARKS: Most specimens from the Sierra de Gredos show the typical peridium with remnants of the brown outer layer remaining in irregularly distributed patches of fine threads, especially abundant at the base, although the spores are bigger than Johannesen (1984) mentioned in its description [(13.5-)14-15(-16.5) µm diam]. The collection KRAM M-1036 has only a few sporocarps, with the peridium entirely ochraceous-yellow, without the patches of fine threads. The capillitial threads are more branched, with short tips (about 20 µm long), sometimes forked, and with spores of 11-13 µm diam. This collection matches the description of *Trichia sordida* (= *T. contorta* var. *engadinensis* Meyl.) as well as *T. sordida* var. *sordidoides* Illana & G. Moreno, but, as Lado & Pando (1997) point out, the latter variety deserves no taxonomic recognition, as such specimens can reflect a response to special environmental conditions occurring during their development.

In Spain, the species was previously reported from the Sierra de Guadarrama (Illana et al. 1993; Sánchez et al. 2002b).

General discussion

The most common species observed in the massif were: *Didymium dubium*, *Lamproderma ovoideum* and *Lepidoderma chailletii*. In the case of some collections

the set of characters was ambiguous, making the taxonomic issues difficult (detailed discussions are provided under these taxa). Most of the species collected are considered to be strictly nivicolous, but some more ubiquitous taxa (more frequently occurring in lowland habitats throughout the year) were also found.

In total, forty species of myxomycetes [Lado (2004) reported a number of forty eight including unpublished data] occurring in nivicolous habitats are known from the major Spanish mountains so far (Gorris et al. 1999, Gràcia 1977, 1986, Illana et al. 1993, Lado 1992, Moreno et al. 2002, 2003a, 2003b, Sánchez et al. 2002a, 2002b, 2002c, Singer et al. 2003, Vila & Llimona 1998). Only three of them, *Diderma niveum*, *Lamproderma cribrarioides* var. *atrosporum* and *Lamproderma sauteri*, were found in all regions studied, but we suspect that the majority of these species will also be found in other mountain regions, when further sampling is done, since the myxobiota are similar in all mountain areas studied so far. All Spanish nivicolous myxomycetes have also been found in the Alps (M.Meyer, pers. comm.), the most intensively studied region in Europe.

The data presented here also corroborate the unique nature of nivicolous myxobiota, since 80% of the species reported are exclusively nivicolous. In the Gredos and Guadarrama mountains, which are geographically close and have similar climate and vegetation, 32 species have been reported, which is 80% of all known Spanish nivicolous myxomycetes.

The mountains of the Spanish interior are the richest in species of nivicolous myxomycetes in the country. It is worth noting, however, that only 15 species (less than 47%) are common to both mountain ranges. We feel this is due more to undersampling than to a real difference in the myxomycete assemblages. The sporulation phenology of these species is reduced to 2-4 weeks a year, so sampling at the optimum time is difficult at these latitudes, where the accumulated winter snow is subject to brusque changes in climate, which occur frequently at the moment of sporulation. Another possible reason for the differences is that in Guadarrama many species were found on woody remains of shrubs and trees, and these substrates were not sampled in Gredos. The number of species reported is bound to increase with a more complete survey spread over five years, as well as the exploration of new potential substrates as trunks or woody remnants.

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References

GORRIS, M., E. GRÀCIA, J. VILA & X. LLIMONA (1999): Alguns mixomicets, principalment quionòfils, nous o poc citats als Pirineus catalans. - Revista Catalana Micol. **22**: 23-34.

- GRÀCIA, E. (1977): Contribución a la flora de mixomicetes de Cataluña. - *Mediterranea* **2**: 79-87.
- GRÀCIA, E. (1986): Mixomicets quionòfils. - *Collect. Bot. (Barcelona)* **16**: 251-253.
- GRÀCIA, E. (1987): Mixomicetes quionófilos. II. In: *VII Simposium Nacional de Botànica Criptogàmica* (libro de resúmenes), pp. 123. Madrid.
- ILLANA, C., G. MORENO & A. CASTILLO (1993): Spanish myxomycetes. VIII. Some nivicolous myxomycetes from Central Spain. - *Cryptog. Mycol.* **14**: 241-253.
- JOHANNESSEN, E.W. (1984): A new species of *Trichia* (Myxomycetes) from Norway. - *Mycotaxon* **20**: 81-84.
- KOWALSKI, D.T. (1971): The genus *Lepidoderma*. - *Mycologia* **63**: 490-516.
- LADO, C. (1992): *Collaria chionophila*, a new myxomycete from Spain. - *Anales Jard. Bot. Madrid* **50**: 9-13.
- LADO, C. (ed.) (1993): Bases corológicas de Flora Micológica Ibérica. - *Cuad. Trab. Fl. Micol. Ibér.* **7**: 1-305.
- LADO, C. (2001): NOMENMYX. A nomenclatural taxabase of Myxomycetes. - *Cuad. Trab. Fl. Micol. Ibér.* **16**: 1-221.
- LADO, C. (2004): Nivicolous myxomycetes of the Iberian Peninsula: considerations on species richness and ecological requirements. - *Syst. Geogr. Pl.* **74**: 143-157.
- LADO, C. & F. PANDO (1997): Flora Micológica Ibérica. Vol. 2. Myxomycetes, I. *Ceratiomyxales*, *Echinosteliales*, *Liceales*, *Trichiales*. - Real Jardín Botánico de Madrid and J. Cramer. Madrid, Berlin, Stuttgart.
- MORENO, G., A. SÁNCHEZ, A. CASTILLO, H. SINGER & C. ILLANA (2003a): Nivicolous myxomycetes from the Sierra Nevada National Park (Spain). - *Mycotaxon* **87**: 223-242.
- MORENO, G., A. SÁNCHEZ, H. SINGER, C. ILLANA & A. CASTILLO (2002): A study on nivicolous Myxomycetes. The genus *Lamproderma* I. Fungi non delineati raro vel haud perspete et explore descripti aut definite picti. Pars XIX. - Edizioni Candusso. Alassio.
- MORENO, G., H. SINGER, C. ILLANA & A. SÁNCHEZ (2003b): SEM-studies on nivicolous *Myxomycetes*. The *Diderma niveum* complex in Europe. - *Cryptog. Mycol.* **24**: 39-58.
- NANNENGA-BREMEKAMP, N.E. (1966): Notes on Myxomycetes XI. Some new species of *Stemonitis*, *Comatricha*, *Badhamia*, *Physarum*, *Diderma* and *Didymium*. - *Proc. Kon. Ned. Akad. Wetensch., C* **69**: 350-363.
- NANNENGA-BREMEKAMP, N.E. (1991): A guide to temperate myxomycetes. Biopress Limited, Bristol.
- POULAIN, M., M. MEYER & J. BOZONNET (2002): Deux espèces nouvelles de myxomycètes: *Lepidoderma alpestroides* et *Lepidoderma perforatum*. - *Bull. Fed. Mycol. Dauphiné-Savoie* **165**: 5-18.
- RAMMELOO, J. (1974): Structure of the epispore in the Trichiaceae (Trichiales, Myxomycetes) as seen with the scanning electron microscope. - *Bull. Soc. Roy. Bot. Belgique* **107**: 353-359.
- RAMMELOO, J. (1975): Structure of the epispore in the Stemonitales (Myxomycetes) as seen with the scanning electron microscope. - *Bull. Jard. Bot. Belgique* **45**: 301-306.
- RODRÍGUEZ-PALMA M., A. VARELA-GARCÍA & C. LADO (2002): Corticolous myxomycetes associated with four tree species in México. - *Mycotaxon* **81**: 345-355.
- SÁNCHEZ, A., C. ILLANA & G. MORENO (1997): Nuevos datos sobre Myxomycetes nivícolas del Sistema Central. In: *XII Simposi de Botànica Criptogàmica* (libro de resúmenes), pp. 155-156. Valencia.

SÁNCHEZ, A., G. MORENO & C. ILLANA (1999): Contribution to the study of the nivicolous Myxomycetes from Central Spain. *XIII Congress of European Mycologist* (abstracts volume), pp. 118. Alcalá de Henares.

SÁNCHEZ, A., G. MORENO & C. ILLANA (2002a): *Diderma cristatosporum*, a nivicolous Myxomycete from Spain. - *Persoonia* **17**: 643-647.

SÁNCHEZ, A., G. MORENO, C. ILLANA & H. SINGER (2002b): A study of nivicolous myxomycetes in southern Europe, Sierra de Guadarrama, Spain. - *Persoonia* **18**: 71-84.

SÁNCHEZ, A., G. MORENO, A. CASTILLO, H. SINGER & C. ILLANA (2002c): Nivicolous myxomycetes from Sierra Nevada National Park (Spain). - *Scripta Bot. Belg.* **22**: 79

SINGER, H., G. MORENO, C. ILLANA & A. SÁNCHEZ (2003): *Lamproderma retirugisporum* spec. nova, a misinterpreted species of the Myxomycetes. - *Oesterr. Z. Pilzk.* **12**: 13-21.

VILA, J. & X. LLIMONA (1998): Els fongs del Parc Naconal d'Aigüestortes i Estany de Sant Maurici i àrees pròximes, segons dades recents (1991-1997). - *IV Jornades sobre Recerca al Parc Nacional d'Aigüestortes i Estany de Sant Maurici*, pp. 137-151. Espot (Pallars Sobirà).

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