Nova Hedwigia **87** 3—4 337—360 Stuttgart, November 2008

Nivicolous myxomycetes from the Pyrenees: notes on taxonomy and species diversity. Part 1. Physarales and Trichiales

by

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With 20 figures and 4 tables

Lado, C., & A. Ronikier (2008): Nivicolous myxomycetes from the Pyrenees: notes on taxonomy and species diversity. Part 1. Physarales and Trichiales. - Nova Hedwigia 87: 337-360.

Abstract: The results of a study of 20 species of myxomycetes, belonging to the orders *Physarales* and *Trichiales* and collected in nivicolous locations of the Pyrenees, are given. Description of the species from the *Diderma niveum* complex are provided and supplemented with a discussion about their position in the complex. A taxonomic study of *Diderma peyerimhoffii*, based on a detailed SEM and X-ray analysis of its wall structure, is included. Additionally, a comparative study on the chemical composition of peridium of representatives of the genera *Diderma* and *Lepidoderma* is tested in order to find inter- and intra-generic differences. The conspecificity of *Lepidoderma carestianum* and *L. granuliferum* is argued based on observations on the material from the Pyrenees. The distribution of all species in Spain is summarized. Eight species are reported for the first time from the Pyrenees, two taxa are new to Spain and two others are new to Andorra.

Key words: Andorra, biotic survey, EDS analysis, Eumycetozoa, SEM, Spain, taxonomy, ultrastructure.

Introduction

The nivicolous myxomycetes constitute an ecological group of species growing in the mountains near the melting snow (Lado 2004). The discontinuous distribution of these species is influenced by the ecological demands and habitats available in mountainous environments. The body of data on the distribution of nivicolous myxomycetes in Europe has been gathered mainly in the European Alps, the Swiss

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DOI: 10.1127/0029-5035/2008/0087-0337 0029-5035/08/0087-0337 $ 6.00

Table 1. Nivicolous myxomycetes previously reported from the Spanish Pyrenees; strictly nivicolous species marked in bold.

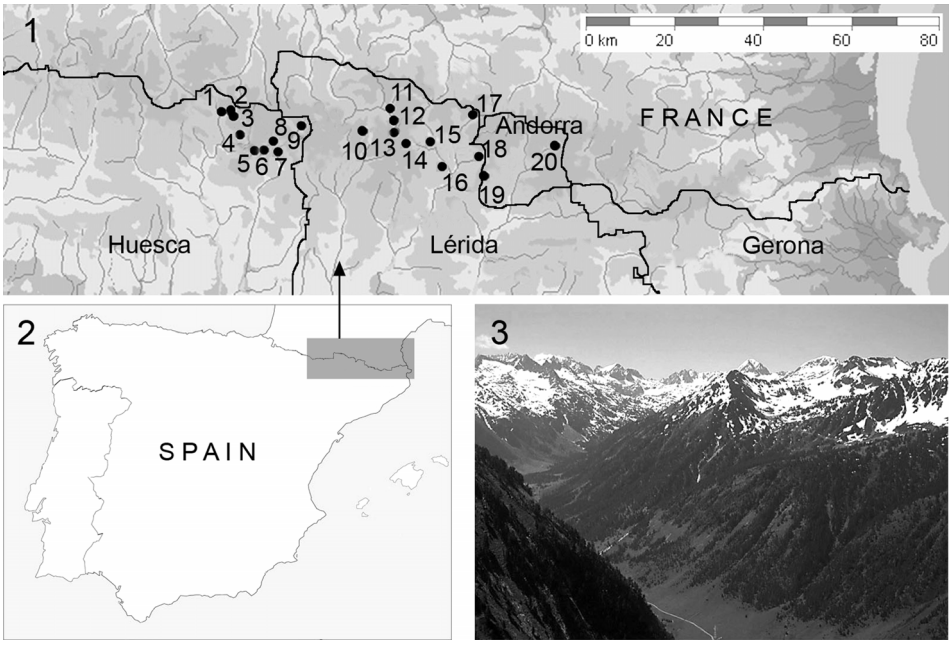
Species	Province	Reference
Arcyria versicolor	Gerona	Gorris et al. (1999)
Collaria chionophila	Huesca	Lado (1992)
Comatricha nigra	Lérida	Vila & Llimona (1998), Gorris et al. (1999)
Comatricha suksdorfii	Lérida	Gràcia (1986), Gorris et al. (1999)
Diderma alpinum	Barcelona, Lérida	Gràcia (1987), Vila & Llimona (1998), Gorris et al. (1999)
Diderma fallax (= *D. lyallii*)	Barcelona, Lérida	Gràcia (1987), Vila & Llimona (1998), Gorris et al. (1999), García-Porta & Llimona (2005)
Diderma niveum	Gerona	García-Porta & Llimona (2005)
Diderma trevelyanii var. ***nivale***	Lérida	Gràcia (1986)
Didymium dubium	Lérida	García-Porta & Llimona (2005)
Lamproderma atrosporum	Lérida	Gorris et al. (1999)
Lamproderma carestiae	Gerona, Lérida	Vila & Llimona (1998), Gorris et al. (1999)
Lamproderma maculatum	Lérida	García-Porta & Llimona (2005)
Lamproderma sauteri	Lérida	Gràcia (1986), Vila & Llimona (1998), Gorris et al. (1999)
Lepidoderma carestianum	Lérida	García-Porta & Llimona (2005)
Physarum bitectum	Lérida	García-Porta & Llimona (2005)
Physarum vernum	Lérida	García-Porta & Llimona (2005)
Prototrichia metallica	Lérida	Gràcia (1977, 1986), Lado & Pando (1997)
Trichia alpina	Huesca	Lado & Pando (1997)

Jura mountains and central and southern Spanish mountains such as Sierra de Gredos, Sierra de Guadarrama, Sierra Nevada (e.g. Bozonnet 1984, Meyer 1986, Müller 2002, Poulain et al. 2002a, 2002b, 2002c, 2002d, Sánchez et al. 2002a, 2002b, 2007, Moreno et al. 2002, 2003a, 2003b, Singer et al. 2003, Lado 2004, Poulain & Meyer 2005, Lado et al. 2005) while very few species have been reported from the Pyrenees, one of the most important parts of the European mountain system. Only 18 species of myxomycetes have been found at nivicolous localities of the Spanish Pyrenees so far (13 strictly nivicolous species, see Tab. 1). Data from the French Pyrenees are even more scarce as only four taxa have been reported there: *Diderma niveum* (Rostaf.) T.Macbr., *D. peyerimhoffii* (Maire & Pinoy) H.Neubert, Nowotny & K.Baumann (as *D. trevelyanii* var. *nivale* Meyl.), *Didymium dubium* Rostaf. (as *D. wilczekii* Meyl.) and *Lamproderma carestiae* (Ces. & De Not) Meyl. [as *L. violaceum* var. *carestiae* (Ces. & De Not) Lister] (Maire 1907, Buchet 1928, 1941, Durrieu 1955).

This paper constitutes the first part of a comprehensive study devoted to the snow-line myxomycetes of the Pyrenees. The taxonomy, species diversity and distribution of the representatives of the orders Physarales and Trichiales are discussed below.

Materials and methods

STUDY AREA: The Pyrenees form a natural barrier between Spain (the Iberian Peninsula) and France. This mountain chain extends from the Cantabrian sea to the Mediterranean sea along a length of over 450 km. It is an important part of the European mountain system, with large massifs exceeding the altitude of 3000 m and remnants of the Quaternary glaciers (Solé-Sabaris 1952). The predominantly



Figs 1-3. Study area and collection sites. 1. Sampled localities (locality number refers to that given in Table 2). 2. Localization of the study area. 3. Landscape of the Arán valley (Lérida province).

granitic central part of the chain harbours the highest peaks of the range (Aneto 3404 m, Posets 3367 m). Several high massifs are also built up of sedimentary rocks, for instance Monte Perdido (3335 m), Peña Collarada (2963 m) and Cotiella (2910 m) peaks. Three sectors with different climates and orographies can be distinguished in the Spanish Pyrenees. All face South making the exposure to the sun greater, which influences the amount of precipitation and thus the vegetation. The western sector located in the provinces of Guipúzcoa and Navarra is characterized by the lowest elevations (Ori 2017 m, Anie 2504 m, Bisaurín 2670 m). Its climate is the warmest and the most humid due to the atlantic influence. Deciduous forests of *Fagus sylvatica* predominate in lower parts of the massif whereas higher elevations are covered with mountain pastures. The central sector situated in the province of Huesca includes high-mountain areas with a mean elevation of 2000-3000 m, where the highest peaks are located. It comprises large areas of the alpine zone with an extreme, alpine climate and a large part of precipitation as snow. The main vegetation consists of *Pinus sylvestris* in the lowest parts, *P. uncinata* and shrubs (*Rhododendron ferrugineum, Vaccinium myrtillus*) in the subalpine zone and psychrophytic meadows in higher elevations. The eastern sector, in the Spanish provinces of Lérida and Gerona, as well as in Andorra, has also large alpine zone areas and several peaks reaching 3000 m (Pica d'Estats 3140 m, Besiberri 3030 m). The Mediterranean influence makes the climate of this sector milder. In this region, woods of *Abies alba, Pinus sylvestris* and *Fagus sylvatica* occur in the montane zone, *P. uncinata* predominates in the subalpine belt, and alpine meadows are developed in higher parts. In general, the forest belt extends in the Pyrenees up to 1800-1900 m, the subalpine zone reaches about 2400 m, and the alpine belt goes up to 3000 m in higher elevations.

SAMPLING AND ANALYSIS OF COLLECTIONS: The material was collected along the central and eastern part of the Spanish Pyrenees (provinces of Lérida and Huesca) as well as in Andorra (Figs 1-3, Table 2) during several field surveys in May and June from 1992 to 1997. Most specimens were collected by C.Lado and S.Santamaría near melting snow, or otherwise, the collector's name is listed under the material studied.

Table 2. List of localities. Locality numbers refer to those shown in the Fig. 1 and cited at each species.

Nº	Locality	Coordinates	Altitude
1	Spain: Huesca: Canfranc, Barranco de Izas, Barranco las Negras	42°45'20"N; 0°27'35"W	1800 m
2	Spain: Huesca: Bielsa, trail to Urdiceto lake	42°40'09"N; 0°13'43"E	1400 m
3	Spain: Huesca: Bielsa, Urdiceto lake	42°40'44"N; 0°15'54"E	1900 m
4	Spain: Huesca: Plan, collado del Ibón de Plan	42°33'14"N; 0°18'25"E	1900 m
5	Spain: Huesca: Plan, collado de Sahún, Barranco de los Espuzos	42°33'21"N; 0°23'31"E	1960 m
6	Spain: Huesca: San Juan de Plan, collado de Sahún	42°33'54"N; 0°23'30"E	2000 m
7	Spain: Huesca: San Juan de Plan, Viadós, Millares lake	42°38'14"N; 0°24'03"E	2300 m
8	Spain: Huesca: Chia, collado de Sahún	42°33'24"N; 0°25'43"E	1900 m
9	Spain: Huesca: Benasque, Plan d'Estan	42°40'41"N; 0°37'52"E	1840 m
10	Spain: Lérida: Vielha e Mijarán, Pleta de Mulleres	42°37'36"N; 0°45'18"E	1620 m
11	Spain: Lérida: Naut Arán, Salardú, Aiguamotx, estany de la Restanca	42°37'42"N; 0°50'25"E	2100 m
12	Spain: Lérida: Naut Arán, Arties, Coll de Pruedo	42°39'23"N; 0°54'01"E	2000 m
13	Spain: Lérida: Naut Arán, Salardú, estany Major de Colomers	42°37'14"N; 0°54'49"E	2120 m
14	Spain: Lérida: Naut Arán, Salardú, Aiguamotx, La Muntanyeta	42°37'47"N; 0°54'48"E	2000 m
15	Spain: Lérida: Naut Arán, Baqueira, Pla de Baqueira	42°41'03"N; 0°56'53"E	2120 m
16	Spain: Lérida: Alt Aneu, Valencia d'Aneu, Ruda valley, circo de Saboredo	42°37'50"N; 0°57'44"E	2000 m
17	Spain: Lérida : Lladorre, Tavascan, road to Certascan, Naorte lake	42°40'52"N; 1°18'08"E	2000 m
18	Spain: Lérida: Alins, Tor, Port de Cabrís	42°32'51"N; 1°24'56"E	2200 m
19	Andorra: Andorra: Sant Julià de Lòria, Caborreu mountain pass	42°26'29"N; 1°33'07"E	2300 m
20	Andorra: Andorra: Soldeu, Envalira mountain pass	42°32'32"N; 1°42'28"E	2300 m

Preliminary results of the extensive research in the Pyrenees were summarized by Lado (2004) and the present work is a result of detailed analysis of part of collections mentioned in this review. In the framework of the present study 193 collections were examined and 154 of them have been identified. As some collections were immature, moulded or limeless and could not be determined with certainty, they are not included in this work. Descriptions are based exclusively on the specimens studied. All the collections are deposited in the herbarium MA-Fungi under the collection C. Lado, and all the samples have been georeferenced. A few duplicates are in KRAM.

Microscope preparations and measurements were made in PVA or Hoyer's medium. Spore measurements were made under an oil-immersion objective and include ornamentation.

The critical-point drying technique was used for scanning electron microscopy (SEM) preparations, and specimens were examined on a Hitachi S-3000N scanning electron microscope, at 10-15 kV. SEM studies of the collections were made in the Royal Botanic Garden of Madrid. The energy dispersive X-ray spectroscopy (EDS) technique, previously used in myxomycetes by Schoknecht (1975), was used for the analysis of the chemical composition of lime deposits in the peridium of seven species of *Lepidoderma* and *Diderma*. This method has been used to test thirteen collections

(Tab. 3). Wall fragments of each sample were distributed on the surface of carbon tabs and coated with carbon. The area of a thick and uniform layer of crystals or globules (without a visible matrix) was searched under a SEM microscope for the place of an EDS point analysis. The point analysis was used to avoid a possible contamination by other elements present in the peridium matrix. Two analyses per sample were made in two different regions of each sample. The EDS analysis was carried out in the Laboratory of Field Emission Scanning Electron Microscopy and Microanalysis, at the Institute of Geological Sciences of the Jagiellonian University, Kraków, with a Hitachi S-4700 microscope.

The nomenclature of myxomycetes follows Hernández-Crespo & Lado (2005).

Results and discussion

Twenty species are listed below, including eight species reported for the first time from the Pyrenees (marked with an asterisk "*" in the list). Two taxa are new to Spain: *Diderma globosum* var. *europaeum* Buyck and *Lepidoderma aggregatum* Kowalski, while two others are reported for the first time from Andorra: *Lepidoderma chailletii* Rostaf. and *Physarum albescens* Ellis ex T.Macbr. Descriptions or taxonomic notes are provided below the name of each species. Additionally, the distribution of each taxon in the mountains of Spain is given.

Physarales

Diderma alpinum (Meyl.) Meyl.

MATERIAL STUDIED: LOC. 15, on dung, 5-VI-1996, Lado 8134 (MA-Fungi 73089); on herbaceous plants, Lado 8142 (MA-Fungi 73090), Lado 8147 (MA-Fungi 73091). LOC. 16, on branch of *Rhododendron ferrugineum*, 5-VI-1996, Lado 8165 (MA-Fungi 73087); on branch of *Vaccinium myrtillus*, Lado 8167 (MA-Fungi 73088).

DESCRIPTION: Long or short plasmodiocarps together with usually elongated sporocarps. Peridium double, outer peridium white, with a slight creamy tint, egg-shell like; inner peridium relatively thick, pale ochraceous-orange-pinkish inside, white outside, continuously covered with lime deposits giving a rough and matt appearance, not or only slightly iridescent, breaking in the upper part and usually remaining in the lower part of sporophores in the form of irregular lobes, usually not well separated from the outer layer, pale orange-brownish under a light microscope. Columella poorly developed, flat and elongated, orange due to the colour of inner peridial layer. Capillitium whitish, filiform, limeless, threads slender, after the dehiscence firmly attached to the inner layer of the peridium, very pale or hyaline under light microscope, sinuous or straight, 0.5-1.5(-3) µm diam., smooth, delicately roughened or with spindle-shaped darker swellings, without the small empty holes present in *D. niveum* (see description below). Spores free, globose to subglobose, 10-12 µm diam., grayish-brown by transmitted light, covered with isolated spines.

TAXONOMIC NOTES: A more plasmodiocarpic than sporocarpic habit, with a rough and matt surface of the inner layer of the peridium, are the most characteristic features of *D. alpinum*. Moreover, capillitial threads are usually attached to the peridium, not to the columella. We believe that the latter character together with the shape of sporophores are the most useful for distinguishing *D. alpinum* from *D. globosum*

var. *europaeum* Buyck, a taxon recently reduced to a form of the first, *D. alpinum* f. *europaeum* (Buyck) H.Singer, G.Moreno & Illana (Singer et al. 2004a). We do not concur with this taxonomic change and we consider *D. globosum* var. *europaeum* to be the easiest to recognize and the most characteristic taxon in the *Diderma niveum* complex (see comments under *D. globosum* var. *europaeum* below).

NOTES ON DISTRIBUTION: *Diderma alpinum* is one of the most common nivicolous species in Europe, including the Pyrenees (Gràcia 1987, Vila & Llimona 1998, Gorris et al. 1999). In the Spanish mountains, it has been reported from the Sierra de Guadarrama (Sánchez et al. 1997, 2007, Moreno et al. 2003b) and the Sierra Nevada (Moreno et al. 2003a).

Diderma fallax (Rostaf.) Lado Fig. 4

= *Diderma lyallii* (Massee) T.Macbr.

MATERIAL STUDIED: LOC. 1, on herbaceous plants, 28-III-1997, Lado 8468 (MA-Fungi 73096), Lado 8471 (MA-Fungi 73095), Lado 8477 (MA-Fungi 73097), Lado 8484 (MA-Fungi 73098). LOC. 6, on herbaceous plants, 6-VI-1996, Lado 8230 (MA-Fungi 73094, duplicate in KRAM M-1295). LOC. 9, on herbaceous plants, 6-VI-1996, Lado 8264 (MA-Fungi 73093). LOC. 18, on herbaceous plants, 4-VI-1996, Lado 8071 (MA-Fungi 73092), Lado 8077 (MA-Fungi 73224).

NOTES ON DISTRIBUTION: *Diderma fallax* is much rarer than other strictly nivicolous *Diderma* species. In Spain, the majority of its localities are situated in the Pyrenees (Gràcia 1987, Vila & Llimona 1998, Gorris et al. 1999, García-Porta & Llimona 2005). It has also been reported from the Sierra de Guadarrama (Sánchez et al. 1997) and the Sierra de Gredos mountains (Lado et al. 2005).

****Diderma globosum*** var. ***europaeum*** Buyck

MATERIAL STUDIED: LOC. 1, on herbaceous plants, 28-III-1997, Lado 8476 (MA-Fungi 73117). LOC. 3, on branch of *Rubus* sp., 19-VI-1991, Lado 5271 (MA-Fungi 73114). LOC. 4, on leaves and wood of *Pinus uncinata*, 6-VI-1996, Lado 8253 (MA-Fungi 73112); on herbaceous plants and a stone, Lado 8256 (MA-Fungi 73113). LOC. 8, on herbaceous plants and leaves of *Rhododendron* sp., 6-VI-1996, Lado 8214 (MA-Fungi 73110); on herbaceous plants, Lado 8218 (MA-Fungi 73234), Lado 8224 (MA-Fungi 73111). LOC. 9, on herbaceous plants, 6-VI-1996, Lado 8263 (MA-Fungi 73109); on herbaceous plants, 17-VI-1991, Lado 5231 (MA-Fungi 73116), Lado 5232 (MA-Fungi 73115). LOC. 14, on herbaceous plants, 29-VI-1994, Lado 6780 (MA-Fungi 73105); on a fern, Lado 6797 (MA-Fungi 73106); on branch of *Rubus* sp., Lado 6798 (MA-Fungi 73107); on wood, Lado 6799 (MA-Fungi 73108). LOC. 16, on a fern, 5-VI-1996, Lado 8161 (MA-Fungi 73099); on branch and leaves of *Rhododendron ferrugineum*, Lado 8162 (MA-Fungi 73100). LOC. 17, on leaves of *Rhododendron ferrugineum*, 4-VI-1996, Lado 8103 (MA-Fungi 73101); on herbaceous plants, Lado 8105 (MA-Fungi 73102); on branch of *Betula* sp., Lado 8115 (MA-Fungi 73103); on branch of *Rhododendron ferrugineum*, Lado 8116 (MA-Fungi 73104).

DESCRIPTION: Sporocarps pulvinate, not very convex, purely white all over, about 1 mm diam., occasionally short plasmodiocarps. Peridium double, outer peridium snow-white, egg-shell like; inner peridium membranous and slightly iridescent, distinctly separated from the outer layer. Columella flat, sometimes almost inconspicuous, purely white. Capillitium very pale, greyish-white, flexuous; when the peridium has dehisced, the capillitium remains more strongly attached to the columella than to the inner layer of the peridium, under light microscope the capillitium is usually pale brown or pale greyish brown, smooth or slightly roughened

on the surface or with dark more or less spindle-shaped swellings, typically without the small empty holes present in *D. niveum* (see description below). Spores free, globose to subglobose, 10-13 µm diam., darker on one side, and often with small conical germ pore area, covered with isolated spines.

TAXONONIC NOTES: *Diderma globosum* was described by Persoon (1794) and, as already pointed out by Rostafiński (1874), the lack of the type material in Persoon's herbarium did not allow him to describe the species in its original concept. Following Fries (1829), Rostafiński gives several possible synonyms of *D. globosum* but, as he writes in the comments, all these names might refer to many various species. Because of the lack of the type specimen, Buyck (1988) chose a neotype for *D. globosum* and described its new var. *europaeum* Buyck for European collections. According to Buyck (1988), the var. *europaeum* differs from the var. *globosum* mainly in the structure of its capillitium. The neotype of *D. globosum* var. *globosum* chosen by Buyck was collected in the Cheyenne mountains in September (Colorado, USA), and all the other collections examined by this author were made late in the season (July-October), therefore the species does not seem to be nivicolous. On the other hand, the typus of *D. globosum* var. *europaeum* was collected in Switzerland and seems to be nivicolous. Unfortunately, the data on the label of the type collection is not provided, but other specimens quoted by Buyck (1988) were found in April. Moreover, the predominantly nivicolous preference of *D. globosum* is mentioned twice by this author (Buyck 1988). Singer et al. (2004a) examined the type of *D. globosum* var. *europeaum* and the description provided by these authors is in full agreement with our concept of *D. globosum* var. *europaeum*. Those authors, however, consider it to be a form of *D. alpinum*. In our opinion, *D. globosum* var. *europaeum* is different from *D. alpinum* and it is one of the nivicolous species of *Diderma* which is the easiest to recognize. Its most distinctive features are small, pulvinate sporocarps, snow-white all over, and a very pale, flexuous capillitium that, when the peridium is broken, remains in the shape of the sporocarp as it is more strongly attached to the columella than to the inner layer of the peridium. In addition, the spores are slightly darker under a light microscope than in other species making up the *D. niveum* complex, and more strongly spiny; also a germ pore area was observed by us in this taxon more often than in *D. niveum* and *D. alpinum*.

Our observation agrees with those made by Marianne Meyer (pers. comm.), who also recognizes *D. globosum* var. *europaeum* as a separate taxon and considers *D. niveum* f. *endoleucum* Meyl. to be conspecific with the previous one. This form is also characterized by white colours all over (Meylan 1924). A good colour photograph of *D. niveum* f. *endoleucum* is provided by Neubert et al. (1995), and the specimens shown in this picture are indeed identical to our *D. globosum* var. *europaeum* collections.

NOTES ON DISTRIBUTION: *D. globosum* var. *europaeum* was not previously reported either from the Pyrenees or from other Spanish mountains.

Diderma niveum (Rostaf.) T.Macbr.

MATERIAL STUDIED: LOC. 1, on herbaceous plants, 28-III-1997, Lado 8480 (MA-Fungi 73126), Lado 8481 (MA-Fungi 73127). LOC. 6, on herbaceous plants, 6-VI-1996, Lado 8231 (MA-Fungi 73125);

on herbaceous plants and dung, Lado 8241 (MA-Fungi 73231). Loc. 9, on herbaceous plants, 6-VI-1996, Lado 8265 (MA-Fungi 73123). Loc. 8, on herbaceous plants, 6-VI-1996, Lado 8225 (MA-Fungi 73124). Loc. 12, on herbaceous plants, 5-VI-1996, Lado 8199 (MA-Fungi 73118). Loc. 15, on herbaceous plats, 5-VI-1996, Lado 8128 (MA-Fungi 73119); on dung, Lado 8130 (MA-Fungi 73120), Lado 8141 (MA-Fungi 73121); on herbaceous plants, Lado 8138 (MA-Fungi 73122), Lado 8126 (MA-Fungi 73221). Loc. 18, on herbaceous plants, 4-VI-1996, Lado 8077 (MA-Fungi 73223).

Description: Sporocarps globose, up to 3 mm diam., not purely white, always with more or less creamy, ochraceous or orange component present, especially inside the sporocarps, at its base or on the columella surface. Peridium double, outer peridium white to creamy, egg-shell like, inner peridium transparent, iridescent and usually with a discontinuous cover of lime deposits giving punctate or subreticulate pattern, more rarely limeless, distinctly separated from outer peridium. Hypothallus sometimes strongly calcified, sometimes in the form of a transparent membrane. Columella globose, usually slightly narrower at base, surface smooth, rough and sometimes with radially arranged calcified threads, originating from its surface. Capillitium dark, rather rigid, dark brown under light microscope, with more or less numerous dark nodes and with characteristic round small empty spaces present inside the capillitial threads resembling small holes (visible under light microscope); they are solitary and scattered or sometimes very numerous and a few grouped together in places, on a capillitial thread. Spores free, globose to subglobose, 10-12(-13) µm in diam., grayish-brown by transmitted light, covered with isolated spines.

Taxonomic notes: In our opinion, the habit of sporocarps, creamy or orange-brownish colours of the inner side of sporocarps, and a thick, rigid, dark brown capillitium, which usually has round small empty spaces inside the capillitial threads that resemble small holes, and are visible under a light microscope, are the most characteristic features of *Diderma niveum*. We do not recognize a recently described species, namely *D. meyerae* H.Singer, G.Moreno, Illana & A.Sánchez, which is characterized by verrucose-crested spores (Moreno et al. 2003b). As we have already pointed out (Lado et al. 2005), intermediate spore ornamentation between baculate (*D. niveum*) and verrucose-crested (*D. meyerae*) can be observed in some collections.

Notes on distribution: *Diderma niveum* is a common nivicolous species. It is known from all the most important massifs in Spain: the Sierra de Guadarrama (Sánchez et al. 1997, 2007, Moreno et al. 2003b), the Sierra de Gredos (Lado et al. 2005), the Pyrenees (García-Porta & Llimona 2005), the Montseny (Girbal 1986) and the Sierra Nevada mountains (Ortega & Calonge 1980).

Diderma peyerimhoffii (Maire & Pinoy) H.Neubert, Nowotny & K.Baumann
Figs 5, 7-8

≡ *Lepidoderma peyerimhoffii* Maire & Pinoy

= *D. trevelyanii* var. *nivale* Meyl.

= *D. nivale* (Meyl.) Nowotny, H.Neubert & K.Baumann

Material studied: Loc. 1, on herbaceous plants, 28-III-1997, Lado 8474 (MA-Fungi 73133), Lado 8475 (MA-Fungi 73134). Loc. 9, on herbaceous plants, 6-VI-1996, Lado 8262 (MA-Fungi 73131), Lado 8266 (MA-Fungi 73132). Loc. 11, on herbaceous plants, 28-VI-1994, Lado 6762 (MA-Fungi 73128). Loc. 15, on herbaceous plants, 5-VI-1996, Lado 8123 (MA-Fungi 73129), Lado 8125 (MA-Fungi 73130, duplicate in KRAM M-1305), Lado 8126 (MA-Fungi 73222).

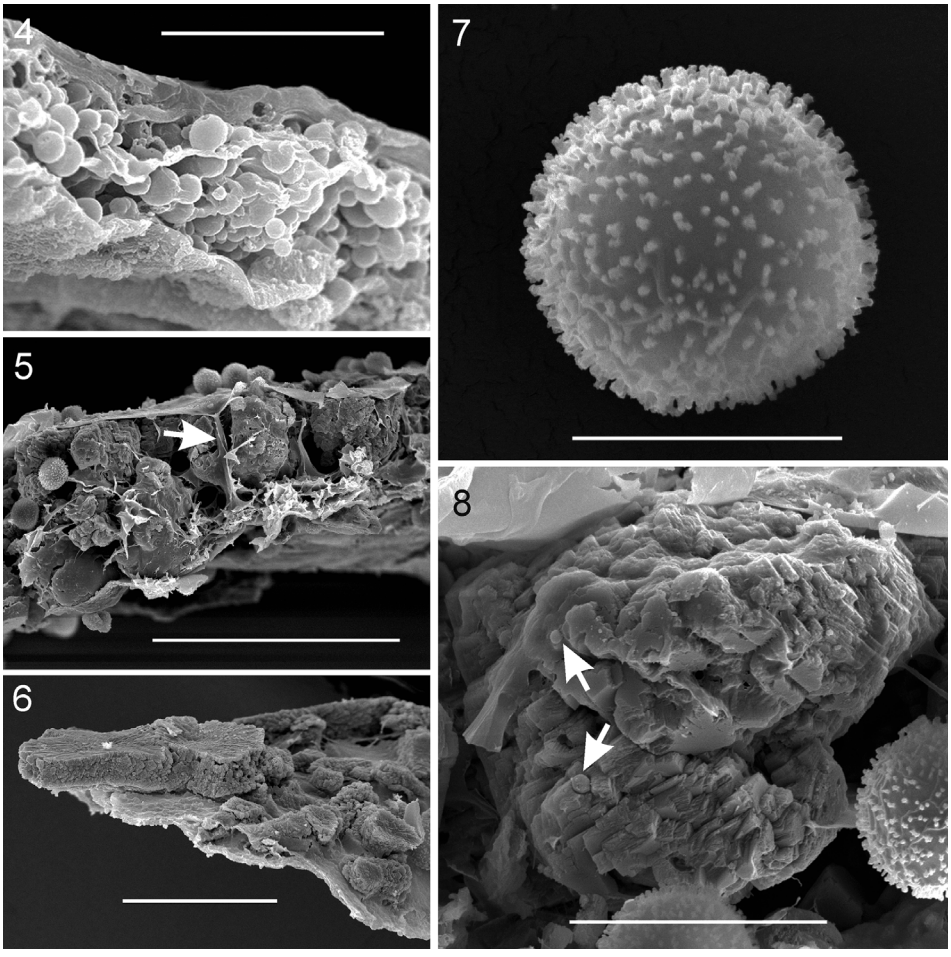


Fig. 4. Structure of the peridium of *Diderma fallax* (KRAM M1049); note globular lime deposits between the two membranous layers. Fig. 5. Structure of the peridium of *Diderma peyerimhoffii* (Lado 8125); note packed polygonal crystals between the two membranous layers and a perpendicular membranous connection (arrow). Fig. 6. Structure of the peridium of *Lepidoderma chailletii* (Lado 8159); note a membranous layer with crystaline scales on the surface. Fig. 7. Spore of *Diderma peyerimhoffii* (Lado 8125). Fig. 8. Packed polygonal crystals in the peridium of *Diderma peyerimhoffii* (Lado 8125); note the presence of globular lime deposits (arrows). Scale bars: Fig. 4 = 20 μm, Fig. 5 = 100 μm, Fig. 6, 8 = 30 μm, Fig. 7 = 10 μm.

TAXONOMIC NOTES: *Diderma peyerimhoffii* was originally described in the genus *Lepidoderma* (Maire et al. 1926). Independently, Meylan (1914) described a new variety of *Diderma trevelyanii* (Grev.) Fr., namely *D. trevelyanii* var. *nivale* Meyl. Having examined the original material of *Lepidoderma peyerimhoffii* Maire & Pinoy, Meylan (1931) stated that this species was identical with his variety. He did not transfer his variety to the genus *Lepidoderma* retaining the name *D. trevelyanii* var.

nivale for this taxon. Neubert et al. (1991) raised the variety to the specific level, *D. nivale* (Meyl.) Nowotny, H.Neubert & K.Baumann, and a new combination was made using the older name, *Diderma peyerimhoffii*, nine years later (Neubert et al. 2000).

The species was left in the genus *Diderma* for a long time (Lister 1925, Nannenga-Bremekamp 1991, Neubert et al. 1995, Ing 1999), although all authors point out its questionable position in the genus. A transfer to the genus *Lepidoderma* was recently proposed again for the species (Poulain et al. 2002b) due to the presence of crystalline calcareous scales (des écailles cristallines) in the peridium and the absence of globular lime.

Indeed, the presence of crystals packed in irregular scale-like plates in the peridium of *D. peyerimhoffii* indicates the genus *Lepidoderma.* In the original diagnosis of the genus *Lepidoderma* de Bary (Rostafinski 1873), however, the peridium is described as externally covered with lime scales "…Oberfläche mit zahlreichen glänzenden Schüppchen bedeckt", and this feature is accepted in all other descriptions of the genus (e.g. Lister 1911, 1925, Martin & Alexopoulos 1969, Nannenga-Bremekamp 1991, Neubert et al. 1995) (Fig. 6), whereas the crystalline lime in *Diderma peyerimhoffii* is located in the middle of the peridium in between two membranes (Figs 5, 8). These two membranes are connected by perpendicular membranes in places (Fig. 5), therefore the peridium is apparently single but its structure is complex. The peridium of many *Diderma* species has a similar structure of two membranes, between which there is globular lime instead of packed polygonal crystals (see Fig. 4 of *D. fallax*). The structure of the peridium of *D. peyerimhoffii,* which is remarkably different from that in species of *Lepidoderma* and more similar to that of representatives of *Diderma,* is the most important character supporting the placement of the species in the genus *Diderma*, not *Lepidoderma,* in our oppinion. We also observed the presence of round lime deposits in the peridium between the packed crystals (Fig. 8). These lime deposits were, unfortunately, scarce and small, and we cannot be sure whether they are of amorphous or crystalline structure. In fact, Schoknecht & Keller (1989) point out that the globular lime in the peridium of *Diderma* might be more correctly described as cryptocrystalline rather than amorphous.

Regardless of the placement of the species in the genus *Diderma* or *Lepidoderma*, its position is somewhat questionable. Therefore, we tested the material to see if some chemical characters could support the placement of the species in one of these genera. We examined 13 collections of 7 species belonging to the two genera using the EDS method to compare the composition of lime deposits in the peridium of representatives of *Lepidoderma* and *Diderma* (Tab. 3).

The analysis revealed no significant differences in the element composition (Figs 9-14), either between the genera or between the species. In general, lime deposits in all the tested collections are built up of Ca, with traces of Mn, P, S and sometimes with an addition of Si or Fe (Tab. 3, Figs 9-14). The chemical composition of lime deposits of the peridium is similar in many species of the two genera, therefore this character can not be helpful in distinguishing the taxa on the generic level. Schoknecht

Table 3. Elements in the peridium of the collections analyzed with the EDS method. Elements in parantheses were present in one of two analyzed samples.

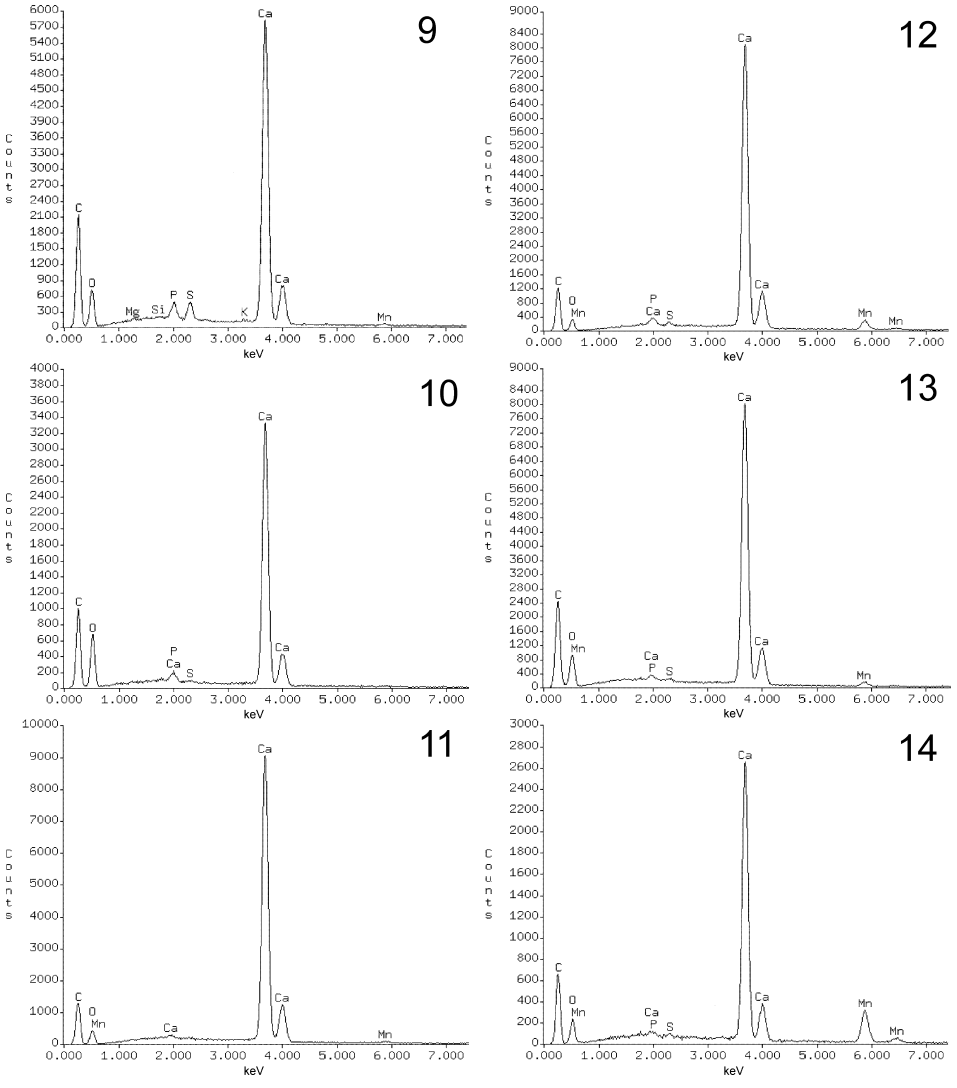
Species	herbarium collection	origin	elements
Diderma fallax	Lado 8230	Spain, Pyrenees	Ca, traces of Mn, P, S (Mg, Si, K)
Diderma fallax	KRAM M-1049	Spain, Sierra de Gredos	Ca, traces of P, S (Si)
D. globosum var. *europaeum*	KRAM M-1149	Poland, Carpathians	Ca, traces of P, S (Si)
D. globosum var. *europaeum*	KRAM M-1151	Poland, Carpathians	Ca, traces of P (S)
D. niveum	KRAM M-1208	Poland, Carpathians	Ca, traces of Mn, P (S)
D. niveum	KRAM M-1150	Poland, Carpathians	Ca, traces of Mn, P, S
D. peyerimhoffii	Lado 8125	Spain, Pyrenees	Ca, traces of Mn (P, S)
D. peyerimhoffii	KRAM M-1272	Slovenia, Alps	Ca, traces of (Mn, S)
Lepidoderma aggregatum	KRAM M-1148	Poland, Carpathians	Ca, traces of Mn, P, S (Fe)
L. chailletii	Lado 8160	Spain, Pyrenees	Ca, traces of Mn, P, S
L. chailletii	KRAM M-1146	Poland, Carpathians	Ca, traces of Mn, P, S
L. carestianum	Lado 8106	Spain, Pyrenees	Ca, traces of Mn, (P, S)
L. carestianum	Lado 8219	Spain, Pyrenees	Ca, traces of Mn, P, S

(1975) noticed differences in the chemical composition of calcareous deposits at the family level between representatives of Physaraceae and Didymiaceae. This author detected Ca, as the major element in two species of *Diderma* [*D. globosum* and *D. effusum* (Schwein.) Morgan] and several *Didymium* species (with traces of P in one species), indicating that peridial deposits are in the form of calcium carbonate, while phosphorus was another important component in all the species from the family Physaraceae examined by this author, suggesting the presence of calcium phosphate. A trace of phosphorus in the peridium of our specimens of *Diderma* could be a possible contamination by the matrix adhered to the calcareous crystals (or globules) as explained by Schoknecht & Keller (1989). It confirms the observations of Schoknecht (1975) that representatives of the genus Didymiaceae mainly contain calcium in the form of calcium carbonate in the peridium.

Notes on distribution: *Diderma peyerimhoffii* has been reported from the Sierra Nevada mountains (Moreno et al. 2003a) and has been found in the Pyrenees (Gràcia 1986), in the Vall d'Arán (1500-1830 m) in the eastern sector, on herbaceous plants and stems of *Myrrhis odorata*.

Didymium dubium Rostaf.

Material studied: Loc. 5, on branch of *Rhododendron ferrugineum*, 6-VI-1996, Lado 8249 (MA-Fungi 73147); on herbaceous plants, 6-VI-1996, Lado 8252 (MA-Fungi 73148). Loc. 6, on herbaceous plants, 6-VI-1996, Lado 8239 (MA-Fungi 73229). Loc. 8, on branch of *Betula* sp., 6-VI-1996, Lado 8212 (MA-Fungi 73145); on herbaceous plants, Lado 8217 (MA-Fungi 73237); on branch of *Betula* sp., Lado 8229 (MA-Fungi 73146). Loc. 11, on herbaceous plants, 28-VI-1994, Lado 6763 (MA-Fungi 73140), Lado 6766 (MA-Fungi 73149). Loc. 12, on bark of *Pinus nigra*, 5-VI-1996, Lado 8189 (MA-Fungi 73138); on herbaceous plants, Lado 8204 (MA-Fungi 73139). Loc. 13, on branch of *Sambucus* sp., 30-VI-1994, Lado 6850 (MA-Fungi 73150). Loc. 14, on herbaceous plants, 29-VI-1994, Lado 6787 (MA-Fungi 73143), Lado 6808 (MA-Fungi 73144). Loc. 15, on herbaceous plants, 5-VI-1996, Lado 8136 (MA-Fungi 73141), Lado 8143 (MA-Fungi



Figs 9-14. Spectra from EDS. Fig. 9. *Diderma fallax* (Lado 8230). Fig. 10. *Diderma globosum* (KRAM M-1149). Fig. 11. *Diderma peyerimhoffii* (Lado 8125). Fig. 12. *Lepidoderma chailletii* (Lado 8160). Fig. 13. *Lepidoderma carestianum* (Lado 8106). Fig. 14. *Lepidoderma aggregatum* (KRAM M-1148).

73142), Lado 8150 (MA-Fungi 73228). Loc. 18, on twigs and leaves of *Aconitum* sp., 4-VI-1996, Lado 8069 (MA-Fungi 73135); on herbaceous plants, Lado 8081 (MA-Fungi 73136), Lado 8090 (MA-Fungi 73225), Lado 8079 (MA-Fungi 73217); on twig of *Rubus* sp., Lado 8093 (MA-Fungi 73137).

Taxonomic notes: The collections from the Pyrenees usually form long (up to 10 cm) and flat (up to 1 cm) or cylindrical plasmodiocarps. Most specimens

have no columella, and the peridium is limeless in some cases. Our material is variable, especially the type of the capillitium, which is usually pale and slightly rough, often anastomosing, but sometimes dark brown and almost completely smooth. Spiral ornamentation is present in places in several collections (Lado 8189, Lado 8249, Lado 8204, Lado 6766, Lado 6850, Lado 6763 and Lado 6808). The dimensions of spores in most collections are (10.6-)11.2-13.4(-14.4) µm diam., but they reach 15.6(-16.2) µm in some collections. Spore ornamentation in most specimens occurs as spines tending to fuse into lines or a subreticulate pattern although the spines are irregularly distributed in other collections. One collection (Lado 8229) is characterized by ovoid to broadly ellipsoid spores. The variability of the material from the Pyrenees is in our opinion caused by unstable environmental conditions in the habitats of myxomycetes growing in nivicolous locations, and we therefore believe that all the collections mentioned here represent one species.

NOTES ON DISTRIBUTION: Although not strictly nivicolous, *Didymium dubium* is one of the most frequently occurring myxomycetes near melting snow in the Spanish mountains. It is very common in the Sierra de Gredos (Lado et al. 2005), the Sierra de Guadarrama (Lado et al. 2005, Sánchez et al. 2007, Lado, unpubl. data) as well as the Sierra Nevada mountains (Moreno et al. 2003a). It was recently reported from the Pyrenees (García-Porta & Llimona 2005).

****Didymium nivicolum*** Meyl.

MATERIAL STUDIED: LOC. 15, on herbaceous plants, 5-VI-1996, Lado 8150 (MA-Fungi 73227, duplicate in KRAM M-1304).

NOTES ON DISTRIBUTION: *Didymium nivicolum* is a strictly nivicolous myxomycete (Bozonnet et al. 1991) and, unlike the previous species, is very rare in Spain. This is the second record for Spain and the first for the Pyrenees; the species was previously found at only one locality in the Sierra Nevada mountains (Moreno et al. 2003a).

****Lepidoderma aggregatum*** Kowalski

MATERIAL STUDIED: LOC. 16, on branch of *Rhododendron* and herbaceous plants, 5-VI-1996, Lado 8156 (MA-Fungi 73151).

TAXONOMIC NOTES: *Lepidoderma aggregatum* was recently synonymized with *L. chailletii* by Moreno et al. (2004), who claim that the latter differs only in the size of fructifications and in the presence of a discontinuous layer of calcareous scales. On the other hand, Poulain et al. (2002b) distinguish the two species because of the number of layers of the peridium: *L. chailletii* has a single peridium covered with calcareous scales while the peridium of *L. aggregatum* is double: the inner membranous layer is separate from the outer coarsely covered with scales. The differences in the number of peridial layers are obvious in our collections from the Pyrenees, therefore we agree with the criteria of Poulain et al. (2002b).

NOTES ON DISTRIBUTION: *Lepidoderma aggregatum* is much rarer than the two other species of the genus listed below. This is the first report of the species in Spain.

Lepidoderma carestianum* (Rabenh.) Rostaf. Figs 15-20

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

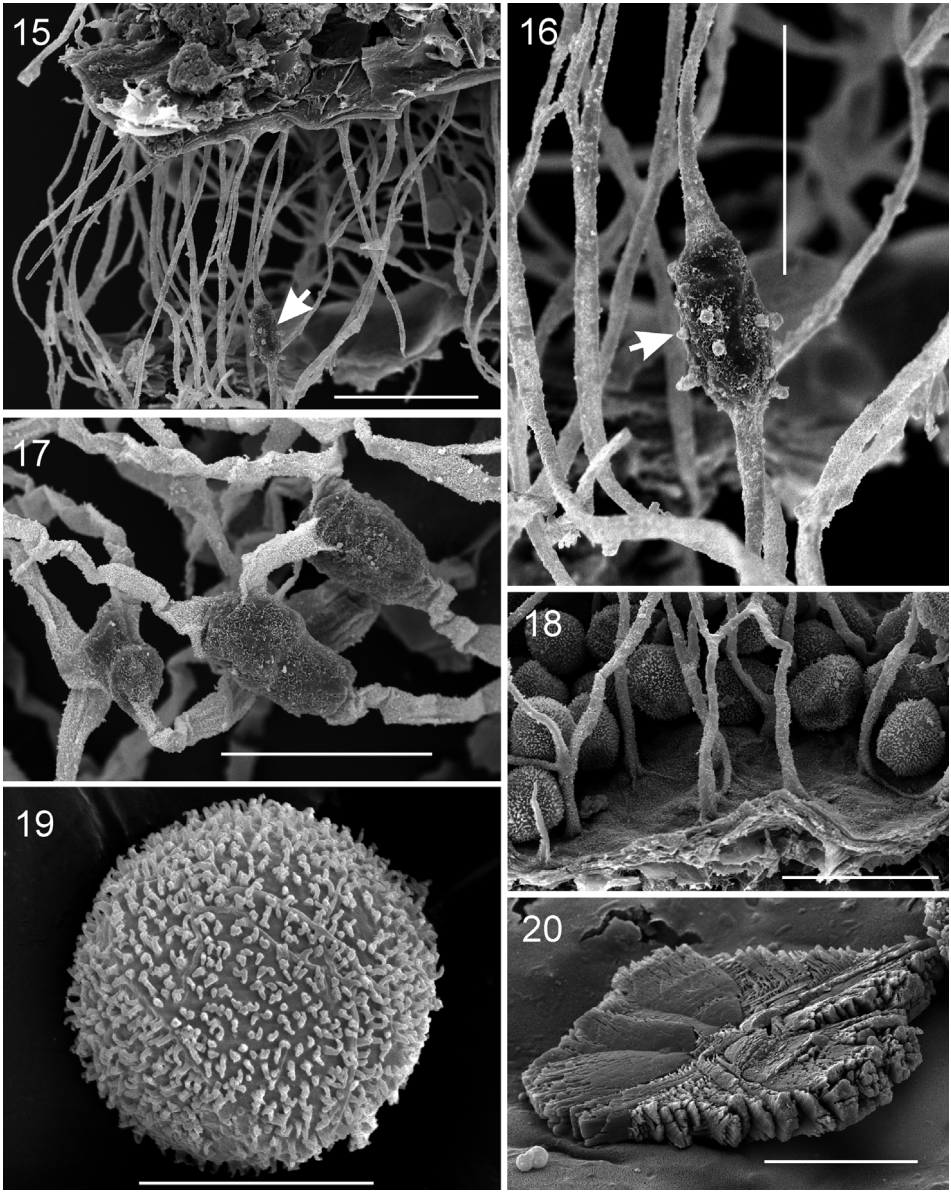
MATERIAL STUDIED: LOC. 8, on herbaceous plants, 6-VI-1996, Lado 8219 (MA-Fungi 73155, duplicate in KRAM M-1301); on branch of *Betula* sp., Lado 8226 (MA-Fungi 73156, duplicate in KRAM M-1303); Lado 8227 (MA-Fungi 73157). LOC. 12, on herbaceous plants, 5-VI-1996, Lado 8198 (MA-Fungi 73154). LOC. 17, on branch of *Betula* sp., 4-VI-1996, Lado 8106 (MA-Fungi 73153, duplicate in KRAM M-1308). LOC. 18, on herbaceous plants, 4-VI-1996, Lado 8078 (MA-Fungi 73152).

TAXONOMIC NOTES: Because of the taxonomic proposal of Kowalski (1971), *L. carestianum* was for a long time considered conspecific with *L. chailletii* Rostaf. A recent study of the type collection of *L. carestianum* (Poulain et al. 2002b), however, confirmed that these two species are clearly different, not only in the fructification type (plasmodiocarpic vs. sporocarpic) but also in the number of peridial layers, the structure of the capillitium and spore ornamentation. This is in agreement with the observations of Meylan (1931), who recognized these two species as very distinct based on the abundant material collected in the Swiss Jura and the Alps.

We believe that some characters of *Lepidoderma carestianum* make this species closer to *L. granuliferum* (W.Phillips) R.E.Fr. than to *L. chailletii*. *Lepidoderma granuliferum* forms plasmodiocarpic fructifications and is readily recognizable because of the presence of calcareous inclusions in capillitial threads (e.g. Neubert et al. 1995, Poulain et al. 2002b). *Lepidoderma granuliferum* was originally described in the genus *Didymium* (Phillips 1877) and later transferred to *Lepidoderma* (Fries 1906). Lister reduced *L. granuliferum* to a variety of *L. carestianum*. In his opinion, "all stages occur between plasmodiocarps having normal capillitium free from lime, and those with capillitium branching to form the sponge-like network enclosing abundant lime-nodules characteristic of the var. *granuliferum*…" (Lister 1911, 1925). Our material supports this observation. In the collections from the Pyrenees (all plasmodiocarps long and flat) we could find specimens with "normal capillitium free from lime", hardly branching and built up of parallel threads connecting the basal part of the plasmodiocarp with the upper part of the peridium (Fig. 15), as well as with capillitium "branching to form the sponge-like network enclosing abundant lime-nodules" (Fig. 17). But even in the specimens with a normal capillitium, we could always find at least a single expansion of the capillitium enclosing small lime deposits upon careful and detailed examination of several preparations (Figs 15, 16). The best developed spongy-like network was observed in collection from the Sierra de Gredos Mts. (Lado et al. 2005: Fig. 34), in Central Spain.

Poulain et al. (2002b) pointed out a close affinity between *L. carestianum* and *L. granuliferum* and the variability of the capillitium of *L. granuliferum*. Although they consider them as separate species, they named the form of *L. granuliferum* with flattened plasmodiocarps and hardly branching capillitium '*granulosum*' *ad. int.*, and they noticed that it could also be a form of *L. carestianum*.

According to our observations, the variability of the capillitium, between hardly branching and limeless to bearing a very obvious network structure with many big lime nodules, is continuous, and all the stages between the most extreme forms can be found. Therefore, we believe that there are no reasons for maintaining *L. granuliferum* and *L. carestia-num* as separate, and we consider them conspecific.



Figs 15-20. *Lepidoderma carestianum*. Fig. 15-16. Capillitium with parallel threads; note single lime-nodule (arrows), (Lado 8226). Fig. 17. Capillitium forming a net structure with numerous lime-nodules (Lado 8106). Fig. 18. Capillitial threads attached to the inner side of the inner peridium (Lado 8219). Fig. 19. Spore (Lado 8219). Fig. 20. Crystaline scale on the surface of the outer peridium (Lado 8219). Scale bars: Fig. 15 = 50 µm, Fig. 16-18 = 30 µm, Fig. 19 = 10 µm, Fig. 20 = 20 µm.

NOTES ON DISTRIBUTION: *Lepidoderma granuliferum* has been reported from the Sierrra de Guadarrama and Sierra de Gredos mountains (Sánchez et al. 2002b, Lado et al. 2005).

Lepidoderma chailletii Rostaf.

MATERIAL STUDIED: LOC. 8, on branch of *Betula* sp., 6-VI-1996, Lado 8211 (MA-Fungi 73160). LOC. 16, on branch of *Vaccinium myrtillus*, 5-VI-1996, Lado 8159 (MA-Fungi 73161, duplicate in KRAM M-1291); Lado 8160 (MA-Fungi 73162, duplicate in KRAM M-1293). LOC. 17, on herbaceous plants, 4-VI-1996, Lado 8099 (MA-Fungi 73158); on branch of *Betula* sp., Lado 8111 (MA-Fungi 73159). LOC. 20, on herbaceous plants, 26-V-1992, leg. C.Lado & M.I. del Teso, Lado 5494 (MA-Fungi 73163, duplicate in KRAM M-1289).

TAXONOMIC NOTES: See comments under *L. aggregatum* and *L. carestianum*.

NOTES ON DISTRIBUTION: *Lepidoderma chailletii* is a common species, known from the Sierra Nevada (Moreno et al. 2003a, as *L. carestianum*), the Sierra de Guadarrama (Sánchez et al. 2002b, 2007), and the Sierra de Gredos mountains (Lado et al. 2005). The species was not previously reported from the Pyrenees, but the specimen shown in the illustration of *L. carestianum* by García-Porta & Llimona (2005), represents *L. chailletii* in our opinion. The collection found at locality 20 represents the first one from Andorra.

****Physarum albescens*** Ellis ex T.Macbr.

MATERIAL STUDIED: LOC. 13, on herbaceous plants, 29-VI-1994, Lado 6823 (MA-Fungi 73165). LOC. 15, on dung, 5-VI-1996, Lado 8132 (MA-Fungi 73164). LOC. 19, on herbaceous plants, 26-V-1992, leg. C.Lado & M.I. del Teso, Lado 5483 (MA-Fungi 73166), Lado 5484 (MA-Fungi 73167).

NOTES ON DISTRIBUTION: *Physarum albescens* is also a common nivicolous species and is known from all the massifs in Spain examined so far: the Sierra Nevada (Moreno et al. 2003a), the Sierra de Guadarrama (Sánchez et al. 1997, 1999, 2002b, 2007) and the Sierra de Gredos mountains (Lado et al. 2005). The species is new to the Pyrenees and the collection from locality 19 is the first for Andorra.

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

MATERIAL STUDIED: LOC. 1, on herbaceous plants, 28-III-1997, Lado 8483 (MA-Fungi 73168). LOC. 8, on herbaceous plants, 6-VI-1996, Lado 8222 (MA-Fungi 73235), Lado 8217 (MA-Fungi 73228).

TAXONOMIC NOTES: The plasmodiocarpic fructifications, a double peridium with a smooth outer layer and the spore size, 11-13 µm in diameter, are the distinctive features of this species (Mitchell et al. 1986). While the collections from the Pyrenees are typically plasmodiocarpic, spores of two of them (Lado 8483 and Lado 8217) are smaller, 9.4-11.9 µm diam. Such a smaller spore size is typical of another closely related species, *Physarum alpinum* (Lister & G.Lister) G.Lister; this species, however, forms sessile sporocarps covered with a rough external peridial layer. Smaller spores in typical plasmodiocarpic collections of *Ph. alpestre* were also observed by Yamamoto et al. (1993) and Singer et al. (2001), in specimens from Japan and the Austrian Tyrol.

NOTES ON DISTRIBUTION: The species has been reported from the Sierra de Guadarrama (Sánchez et al. 1997, 1999, 2002b, 2007) and Sierra de Gredos mountains (Lado et al. 2005). This is the first report from the Pyrenees.

Physarum vernum Sommerf.

MATERIAL STUDIED: LOC. 6, on herbaceous plants, 6-VI-1996, Lado 8232 (MA-Fungi 73187), Lado 8233 (MA-Fungi 73188), Lado 8234 (MA-Fungi 73189), Lado 8235 (MA-Fungi 73190), Lado 8236 (MA-Fungi 73191), Lado 8237 (MA-Fungi 73192), Lado 8238 (MA-Fungi 73193), Lado 8239 (MA-Fungi 73230), Lado 8240 (MA-Fungi 73194); on branch of *Juniperus* sp., Lado 8242 (MA-Fungi 73195), Lado 8243 (MA-Fungi 73196); on herbaceous plants and dung, Lado 8241 (MA-Fungi 73232). LOC. 8, on herbaceous plants, 6-VI-1996, Lado 8215 (MA-Fungi 73183), Lado 8220 (MA-Fungi 73184), Lado 8221 (MA-Fungi 73185), Lado 8223 (MA-Fungi 73186), Lado 8218 (MA-Fungi 73233), Lado 8222 (MA-Fungi 73236). LOC. 12, on herbaceous plants, 5-VI-1996, Lado 8200 (MA-Fungi 73181). LOC. 15, on herbaceous plants, 5-VI-1996, Lado 8127 (MA-Fungi 73182), Lado 8124 (MA-Fungi 73197). LOC. 18, on herbaceous plants, 4-VI-1996, Lado 8067 (MA-Fungi 73169), Lado 8074 (MA-Fungi 73170), Lado 8075 (MA-Fungi 73171), Lado 8076 (MA-Fungi 73172), Lado 8079 (MA-Fungi 73218), Lado 8082 (MA-Fungi 73173), Lado 8083 (MA-Fungi 73174), Lado 8091 (MA-Fungi 73175), Lado 8096 (MA-Fungi 73176), Lado 8090 (MA-Fungi 73226); on leaves and twigs of *Rhododendron ferrugineum*, Lado 8070 (MA-Fungi 73177), Lado 8087 (MA-Fungi 73178), Lado 8094 (MA-Fungi 73179); on herbaceous plants and dung, Lado 8089 (MA-Fungi 73180).

TAXONOMIC NOTES: The material from the Pyrenees is greatly variable (Tab. 4). Fructifications occur as sporocarps and plasmodiocarps up to 3 cm long. The peridium is limeless and transparent, slightly calcified and then with a rough surface, or strongly calcified and then appearing double, with a thick and smooth outer layer. The capillitium is usually very strongly calcified, even in sporocarps with a limeless peridium. More rarely, the capillitium is also limeless and built up of transparent tubules. The size and ornamentation of the spores are also greatly variable (Tab. 4). A total of 30 spores from each collection were measured for the ranges of spore diameters for the Table 4. The spores are usually pale with easily visible darker areas, but in some collections they are darker on one side, and sometimes a germ pore can be observed; the ornamentation is about 0.5 µm height and in the form of densely arranged warts. Spores have bigger warts in places, formed by a fusion of a few small warts, in two collections (Lado 8091 and Lado 8070). These two collections, however, are probably not well developed, and one of them is completely limeless. Singer et al. (2004b) distinguished two forms, differing only in the spore size and ornamentation, in the type study of *Ph. vernum*, namely *Ph. vernum* f. *vernum* with spores (12-)13-14(-15) µm and *Ph. vernum* f. *parvisporum* with smaller spores (10-)11-12 µm. In some collections from the Pyrenees (Table 4), the spores are 11-15(-16) µm in diameter, covering the whole range of the two forms, therefore, distinguishing the two forms of *Physarum vernum* according to the spore size is not justified in our opinion. The spore colour and the presence or absence of darker areas in the material from the Pyrenees is not correlated with the spore size. Moreover, we could not identify any relationship between spore characters and fructification habit: e.g. spores with darker areas were present both in sporocarpic and plasmodiocarpic forms (see Tab. 4). The amount of lime in the peridium was also variable, and rough-walled forms were present together with smooth-walled forms. Taking into account the morphological variability of the collections examined by us, we conclude that *Ph. vernum* is a highly variable species in which extreme morphological forms are strikingly different, while the continuity of characters between the extremes can be found even in one collection.

Table 4. Variability of some characters in the collections of *Physarum vernum*.

Collection number	spore size [µm]	spore characters	habit
Lado 8236	9.4-16.9 (-18.1)	with darker areas	clustered sporocarps or plasmodiocarps, peridium rough
Lado 8091	9.4-17.5	with bigger warts in places	sporocarps or plasmodiocarps, peridium limeless
Lado 8200	9.7-10.9	with darker areas	mainly plasmodiocarps, peridium thick, appearing double
Lado 8079	9.7-11.9	only some with darker areas	mainly plasmodiocarps, peridium rough
Lado 8233	10-11.2	with darker areas	long plasmodiocarps, peridium rough or thick and smooth, appearing double
Lado 8242	10-12.2	uniformely coloured or with darker areas	mainly plasmodiocarps, peridium rough
Lado 8094	10.3-11.9	with darker areas	sporocarps or plasmodiocarps, peridium thick and smooth
Lado 8223	10.6-11.9	with darker areas	long plasmodiocarps, some fusing into reticulate ones, peridium limeless or thick, appearing double
Lado 8096	10.6-11.9	with darker areas	clustered sporocarps or plasmodiocarps, peridium thick and sooth
Lado 8235	10.9-12.5 (-13.1)	with darker areas	sporocarps or plasmodiocarps, peridium rough, some limeless
Lado 8243	10-13.7 (-16.9)	with darker areas	mainly plasmodiocarps, peridium rough or thick and smooth
Lado 8067	10.6-12.5	uniformely coloured	mainly long plasmodiocarps, peridium thick
Lado 8215	10.6-12.5	with darker areas	sporocarps, peridium rough
Lado 8075	10.9-12.2	with darker areas	mainly plasmodiocarps, peridium thick, appearing double
Lado 8238	10.6-13.1	darker at one side	mainly sporocarps or short plasmodiocarps, peridium rough
Lado 8082	11.9-13.1	darker at one side	sporocarps or plasmodiocarps, peridium mainly limeless
Lado 8089	11.2-12.5	darker at one side	sporocarps or plasmodiocarps, peridium mainly limeless
Lado 8239	11.2-13.1	with darker areas	sporocarps or short plasmodiocarps, peridium rough
Lado 8234	11.2-13.1	with darker areas	sporocarps or plasmodiocarps, peridium mainly limeless
Lado 8074	11.2-13.1	uniformely coloured	mainly sporocarps, peridium limeless
Lado 8083	11.2-13.7 (-14.4)	with darker areas	clustered sporocarps or plasmodiocarps, peridium thick and sooth, some limeless
Lado 8070	11.2-15.6 (-16.2)	with bigger warts in places	mainly sporocarps, peridium rough
Lado 8220	11.6-13.1	darker at one side	clustered sporocarps, peridium appearing double (?) recrystalized
Lado 8237	11.9-16.9	with darker areas	mainly sporocarps, peridium rough or thick and smooth, some limeless
Lado 8232	12.5-13.7	darker at one side	mainly sporocarps, peridium rough
Lado 8240	12.5-15.9	with darker areas	mainly plasmodiocarps, peridium thick appearing double
Lado 8221	13.7-15.9	with darker areas	mainly plasmodiocarps, peridium rough or thick and smooth, some limeless

NOTES ON DISTRIBUTION: *Ph. vernum* is known from numerous localities in Spain; it has lately been found in the Pyrenees (García-Porta & Llimona 2005). According to the literature, it is a common nivicolous species in the mountains of Guadarrama (Sánchez et al. 2002b, 2007) and Sierra Nevada (Moreno et al. 2003a, Singer et al. 2004b).

Trichiales

Dianema corticatum Lister

MATERIAL STUDIED: LOC. 3, on trunk of *Pinus uncinata*, 19-VI-1991, leg. C.Lado & M.Dueñas, Lado 5272 (MA-Fungi 73205). LOC. 4, on trunk of *Pinus unicata*, 6-VI-1996, Lado 8255 (MA-Fungi 73206). LOC. 12, on trunk of *Pinus unicata*, 5-VI-1996, Lado 8181 (MA-Fungi 73200), Lado 8193 (MA-Fungi 73201), Lado 8206 (MA-Fungi 73202), Lado 8207 (MA-Fungi 73203), Lado 8187 (MA-Fungi 73219), Lado 8192 (MA-Fungi 73240). LOC. 14, on branch of *Pinus uncinata*, 29-VI-1994, Lado 6782 (MA-Fungi 73204). LOC. 16, on trunk of *Pinus unicata*, 5-VI-1996, Lado 8152 (MA-Fungi 73198). LOC. 17, on trunk of *Pinus unicata*, 4-VI-1996, Lado 8101 (MA-Fungi 73199).

NOTES ON DISTRIBUTION: The species is not strictly nivicolous, but it is mostly found in the mountains of Spain at the time when the snow melts (Illana et al. 1993, Lado 1993, Lado & Pando 1997, Sánchez et al. 2007).

Prototrichia metallica (Berk.) Massee

MATERIAL STUDIED: LOC. 12, on trunk of *Pinus unicata*, 5-VI-1996, Lado 8173 (MA-Fungi 73208, duplicate in KRAM M-1310), Lado 8183 (MA-Fungi 73209), Lado 8187 (MA-Fungi 73220), Lado 8192 (MA-Fungi 73239). LOC. 17, on trunk of *Pinus unicata*, 4-VI-1996, Lado 8113 (MA-Fungi 73207).

NOTES ON DISTRIBUTION: Although not strictly nivicolous, the species is mostly reported from nivicolous locations in various regions of Spain, including the Pyrenees (Gràcia 1977, 1986, Lado & Pando 1997) and the Guadarrama mountains (Sánchez et al. 1997, 2002b, 2007).

Trichia alpina (R.E.Fr.) Meyl.

MATERIAL STUDIED: LOC. 16, on branch of *Salix* sp., 5-VI-1996, Lado 8151 (MA-Fungi 73210).

NOTES ON DISTRIBUTION: This very characteristic and typical nivicolous species is surprisingly rarely recorded in Spain. Although found in the Sierra de Guadarrama (Sánchez et al. 1997, 2002b, 2007), the Sierra de Gredos mountains (Lado et al. 2005) and the Pyrenees (Lado & Pando 1997), one to three localities are known in these massifs. The species was present in only one collection in the material examined by us and it represents the second locality in the Pyrenees.

Trichia contorta (Ditmar) Rostaf.

MATERIAL STUDIED: LOC. 5, on branch of *Abies alba*, 6-VI-1996, Lado 8247 (MA-Fungi 73211).

NOTES ON DISTRIBUTION: This is a common non-nivicolous species known from numerous Spanish localities (Lado 1993).

Trichia favoginea (Batsch) Pers.

MATERIAL STUDIED: LOC. 10, on trunk of *Fagus sylvatica*, 27-VI-1994, Lado 6770 (MA-Fungi 73212), Lado 6771 (MA-Fungi 73213).

NOTES ON DISTRIBUTION: This is a common species occurring mostly in autumn in Europe, but occasionally it can also be found close to melting snow in spring. In Spain, the species is more frequent in the North (Lado 1993, Lado & Pando 1997); it has already been reported from the Pyrenees (Lado 1993).

**Trichia lutescens* (Lister) Lister

MATERIAL STUDIED: LOC. 2, on trunk of *Corylus avellana,* 19-VI-1991, Lado 5275 (MA-Fungi 73214).

NOTES ON DISTRIBUTION: The species is more common in the central and southern part of Spain. It is new to the Pyrenees.

**Trichia sordida* Johannesen

MATERIAL STUDIED: LOC. 12, on trunk of *Pinus nigra*, 5-VI-1996, Lado 8182 (MA-Fungi 73215).

NOTES ON DISTRIBUTION: Similarly to *T. alpina*, *Trichia sordida* is a typical nivicolous myxomycete and it is another species infrequently found in Spain. It has been reported from the Sierra de Guadarrama (Illana et al. 1993, Sánchez et al. 1997, 2002b) and Sierra de Gredos mountains (Lado et al. 2005). The species is new to the Pyrenees.

The nivicolous myxomycetes constitute an ecological group of species growing in mountains in the proximity of the melting snow. The body of data on the distribution of nivicolous myxomycetes in Europe has been gathered mainly in the European Alps, Swiss Jura mountains and central and southern Spanish mountains. Results of the first part of a comprehensive study devoted to the snow-line myxomycetes of the Pyrenees are discussed in this paper. Twenty species belonging to the orders Physarales and Trichiales are presented. Eight of them are reported for the first time from the Pyrenees, two taxa are new to Spain, and two others are new to Andorra. The distribution of all reported species in the mountains of Spain is summarized. The following taxonomic conclusions are also proposed: (i) *Diderma globosum* var. *europaeum* is considered to be a distinct taxon in the *Diderma niveum* complex, (ii) the affinity of *Lepidoderma peyerimhoffii* with the genus *Diderma* is confirmed based on the analysis of the ultrastructure of the peridium wall, (iii) *Lepidoderma carestianum* and *L. granuliferum* are considered to be conspecific.

Acknowledgements

This project was supported by the European Community Programme "Structuring the European Research Area", under SYNTHESYS at the Real Jardín Botánico (CSIC), granted to Anna Ronikier. Our thanks are due to Marianne Meyer for valuable discussions on the *Diderma niveum* complex, Sergio Santamaría for his help in collecting material, and Diana Wrigley de Basanta for her comments. Support was also provided by the Myxotropic project (CGL2005-00320/BOS) from the Ministry of Education and Science of Spain.

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Received 29 January 2008, accepted in revised form 10 April 2008.