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SPECIES OF THE GENUS *LECIDEA* (LECANORALES) ON GYPSUM IN SPAIN

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Abstract: The genus *Lecidea* in the lichen flora of the gypsum soils of Spain is represented by two species: *L. gypsicola* Llimona and *L. circinarioides* Casares & Hafellner sp. nov., which are described in this article. Chemical, anatomical and ecological differences are also described, as is the taxonomic value of the morphological characteristics of the mature ascoma.

Introduction

The gypsum areas of the Iberian Peninsula occupy some 35 000 km^2 (Fig. 1) distributed amongst various zones corresponding to the catchment areas of tertiary evaporation: the Duero, the Ebro valley, the upper Tajo and SE Spain. With the exception of the deposit in the Duero, the outcrops of gypsum are not usually found at more than 600 m above sea level in a semi-arid Mediterranean-type climate, which in inland zones can have a continental aspect due to the great variations in temperature.

It is rainfall pattern that determines the presence or absence of gypsum soils since when the rainfall is high the gypsum dissolves, hence the traditional relationship between gypsum soils and arid zones. In these areas, due to the low density of vegetation resulting from the low rainfall, the main factor in soil formation is the nature of the bedrock. Consequently the soils are shallow, poorly structured and subject to a constant process of regeneration.

The lichen communites of these areas have been studied by Llimona (1973, 1974), who, despite carrying out a general survey of the gypsum soils of Spain, concentrated mainly on the Ebro valley, and by Crespo & Barreno (1973, 1975), who studied the catchment area of the upper Tajo. The SE is currently being studied by us with various articles published concerning its flora and vegetation (Casares-Porcel & Gutierrez-Carretero 1993; Gutierrez–Carretero & Casares-Porcel 1995). Generally, the lichen flora, although sparse, is influenced by the substratum, both for its physico-chemical properties (ease of solution, high sulphate concentration, etc.) and for the regional climate characteristics (arid summers, highly erosive torrential rains).

Two species of *Lecidea* s.str. form part of this flora: *L. gypsicola* Llimona and *L. circinarioides* Casares & Hafellner, newly described below.

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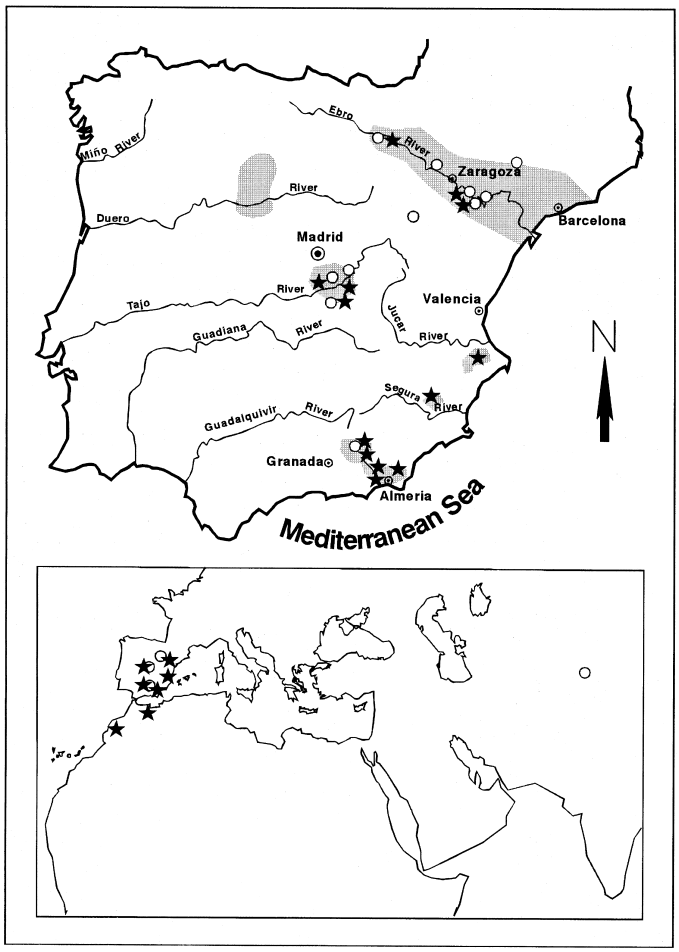

FIG. 1. Map of Spain showing distribution of *Lecidea gypsicola* (○) and *L. circinarioides* (★) and the main areas of gypsum. Inset: world distribution of *L. gypsicola* (○) and *L. circinarioides* (★).

Materials and Methods

This work is based on material collected in the gypsum zones of Spain by the authors; they are kept in GDA. Specimens from BCC, GZU, *Lichenes selecti exiccati* fasc. XLVII of Vězda and Etayo (Pamplona) were also studied.

The external morphological characteristics of the thallus were studied and measured, using specimens from the herbarium, with a binocular Zeiss IVb with a measuring eyepiece. Anatomical features were investigated by light microscopy using an Olympus BH2 with measuring eyepiece, polarization and micrograph equipment, on hand-cut and freezing microtome sections obtained with a Bright 8000 microtome with Anglia thermal electric freezing. To study the ascomata it was also necessary to prepare a squash. Generally, for mounting and measurement, water was used and for specific observations the preparations were treated with lactophenol cotton blue. The usual chemical reactions of the thallus were studied using stereomicroscopy and those of the ascomata on sections of these mounted in water. A Lugol's solution was used to provoke amyloid reactions in the hymenium, which were studied both progressively and regressively. Chemical data were analysed using standardized TLC techniques (e.g. White & James 1985).

The Species

Lecidea gypsicola Llimona

In Vězda, *Schedae ad Lich. sel. exs., fasc.* 47, n. 1160 (1973). Typus: España, Zaragoza, Caparroso, 1973, *Llimona* (BBC—holotypus; isotypus in Vězda *Lich. sel. exs.*) For description and detailed iconography see (Hertel 1977: 248).

(Figs 2 & 5)

Notes: Based on the anatomy of the thallus and the ascomata, which have a pigmented hypothecium (Fig. 2C), and its chemical characteristics, Llimona (1974) and Hertel (1977) have indicated that *L. gypsicola* is closely related to the *L. fuscoatra* group. However, its thallus is nearly white (Fig. 2A, B), which makes the C+ red reaction easily observable due to the presence, as in other species of the group, of gyrophoric and lecanoric acid in the cortical layer. *Lecidea fuscoatra* is a species with a number of intraspecific taxa described, the majority of which are based on unusually well-developed or under-developed samples (Hertel 1977). One of these forms with a pale thallus (*L. grisella* Flörke) is usually considered a variety [*L. fuscoatra* var. *grisella* (Flörke ex Schaerer) Nyl.], due to the existence of transitional forms between the two. *Lecidea gypsicola* might also be thought to be one of these ecological forms. In fact, this viewpoint has been adopted by Clauzade & Roux (1985), who include it within *L. fuscoatra* var. *grisella*. However, as Hertel (1977) has already indicated, there are two arguments against this: firstly, its distribution and ecology, and secondly, the difference in size of the spores.

Lecidea fuscoatra s.lat. is a suboceanic taxon, not found in arid zones, which are precisely the areas inhabited by *L. gypsicola*. Also, although the var. *grisella* can occasionally colonize slightly calcareous rocks, it is basically a species of siliceous rocks, whereas *L. gypsicola* is, at the moment, strictly confined to basic rocks. Llimona (1973) carried out a biometric study on spore size, finding net differences between the two, above all in the average values of the longitudinal axis (10–12 μm for *L. grisella*, 13–16 μm for *L. gypsicola*). Intermediate forms could not be detected amongst the numerous populations studied.

Consequently, although agreeing with Hertel (1977) that *L. fuscoatra* s.lat. needs detailed study to resolve doubts about these species, we prefer to maintain *L. gypsicola* as an independent species.

We must also confirm Hertel's (1977) observations concerning the size of the spores since the values given by Llimona in the original description [(12·5–)15·3(–18) × (4·5–)5·3(–6·5) μm], although undoubtedly intended to show the full range of variability of the species, are too wide. According to our observations sizes around 16 × 5·5 μm are more frequent. For this reason the value of the length/width ratio (L/W) at around 2·9 may perhaps be more significant.

Chemistry: Lecanoric and gyrophoric acids plus two unidentified substances with R_F classes in the solvent systems A/B/C of 4/4/5 and 4–5/6/5–6, respectively. Before charring, both substances exhibit a weak grey fluorescence in UV light. After charring, these remain more or less colourless with no

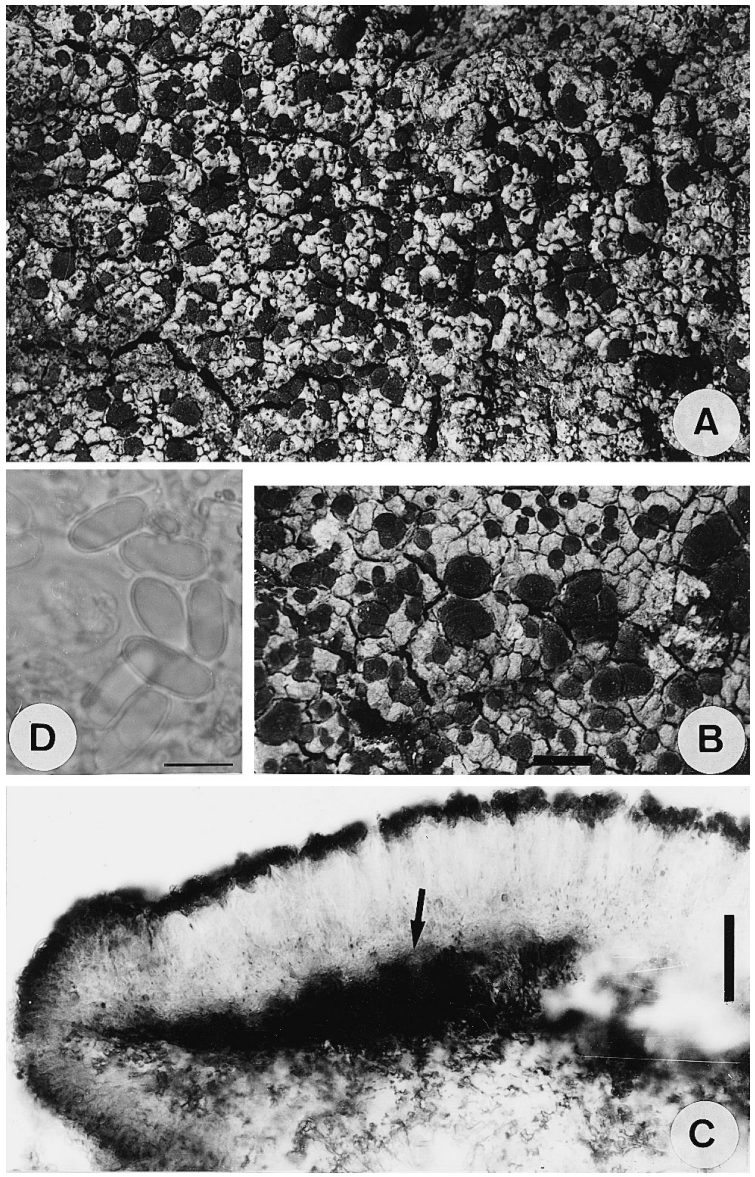

FIG. 2. *Lecidea gypsicola*. A, Habit (magnification × 1). B, Apothecia. C, Vertical section of apothecium showing the dark hypothecium. D, Ascospores. Scales: B = 1 cm; C = 50 μm; D = 10 μm.

fluorescence shown in long-wavelength UV light. Spot tests: cortex and medulla K −, C+ pink-red, KC+ red, PD −, I −; epihymenium K −, C −, KC −, N −; hymenium K −, C −, KC −; hymenial gelatine I+ blue.

Distribution: Lecidea gypsicola has been found in the inland gypsum areas of the Iberian Peninsula (Llimona 1974, Crespo & Barreno 1975, Casares-Porcel & Gutiérrez-Carretero 1993) and in central Asia in the ex-soviet republic of Tadzhikistan, near the border of Afghanistan with China (Hertel 1977); see Fig. 1.

Ecology: In spite of its name and the fact that in Spain it is found on very compact gypsum substrata, in Asia it is present on calciferous sandstone apparently devoid of gypsum. The frequency with which the species that colonize compact gypsum soils are also found on other calcareous rocks shows the close relationship that exists between these communities and those that evolve on limestone (Casares-Porcel & Gutierrez-Carretero 1993). This suggests that the importance of the sulphate ion in determining the presence of these species may have been overestimated.

Lecidea circinarioides Casares & Hafellner sp. nov.

Thallus crustaceus, albus, rimosus ad areolatus, areolis (0·3–)1(–0·5) mm magnis; areolae in sectione transversali strato corticali, male evoluto et crystallis insperso, obtectae. Nec cortex nec medulla cum K, C, KC, Pd, Lugol reagentes. Apothecia cryptolecanorina, atra et pruina alba obtecta, finaliter plerumque confluentes; marginibus albidis tenuibus, parce ad non prominentibus et fissuris angustis circumdata; discis planis ad leviter convexis. In sectione transversali excipulo rudimentario. Hypothecium et subhymenium hyalinum, hymenium hyalinum 60–80 µm altum et epihymenium caeruleo-olivaceum. Asci tip generis *Lecidea*, ad 60 × 25–30 µm magni, octospori. Paraphyses ramosae et anastomosantes, *c.* 2 µm crassae, ad apicem versus parce incrassatae et gelatina caeruleo-olivacea circumdatae et crystallis hyalinis obtectae. Ascosporae unicellulares, ellipsoideae, hyalinae, non halonatae, (10–)12·0(–13) × (6–)7·7(–9) µm magnae. Pycnidia in thallo immersa, globosa, circum ostiolum caeruleo-olivacea pigmentosa. Pycnoconidia bacilliformia, 8–10 × 2 µm magna, acrogyne formata. Gelatina hymenialis et stratum externum parietis ascorum Lugol conc.+rufofusce reagentes. Pigmentum epihymenii N+ purpureum.

Typus: Spain, Province of Almeria, Tabernas, Venta de los Yesos, UTM 30SWG6204, 570 m, 27 July 1990, *M. Casares* (GDA—holotypus).

(Figs 3–5)

Etymology: From *Circinaria* Link, a generic name proposed for *Aspicilia* cf. *contorta* due to the resemblance between our species and *A. calcarea* (L.) Körb.

Thallus crustose, chalky white, rimose-areolate. Areoles (0·3)–1–(1·5) mm diam., convex and at times somewhat granular, forming a thick thallus, badly delimited, up to 5 cm in diameter (Fig. 3A). Pseudocortex formed by a thick hyaline layer consisting of an accumulation of calcium oxalate crystals and other substances amongst which dead or altered algal cells and some live hyphae are present. This suggests that the hyphal tissue grows continuously from a deep zone and is superficially eroded. *Photobiont* chloroccoid, organized in glomerules forming a discontinuous algal layer. *Medulla* thick, formed by very few active hyphae and a large quantity of calcium oxalate crystals.

Apothecia numerous, at first cryptolecanorine in appearance and included in the thallus, but later tending to be prominent; (0·5–)1(–1·5) mm diam., frequently confluent and deformed by mutual pressure (Fig. 3B). No proper margin visible but with a fine margin of thalline appearance, generally shared

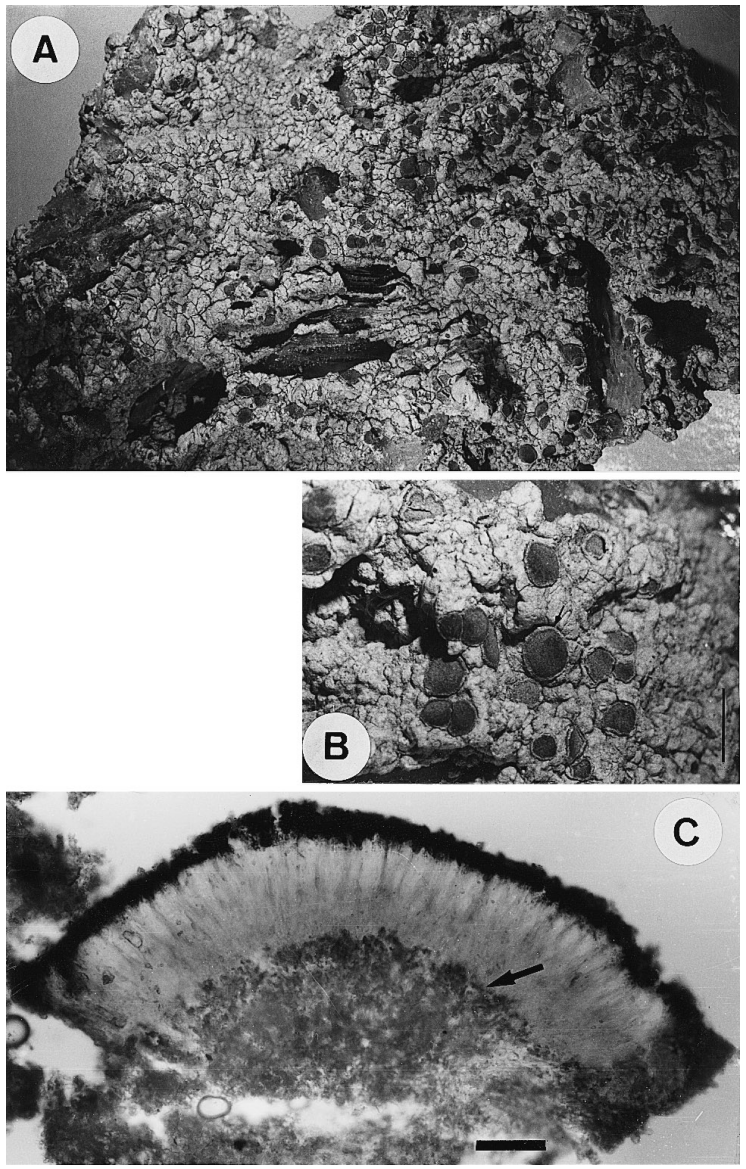

FIG. 3. *Lecidea circinarioides*. A, Habit (magnification × 1). B, Apothecia. C, Vertical section of apothecium showing the hyaline and opaque hypothecium. Scales: B = 2 mm; C = 50 μm.

by various adjacent apothecia, formed from the areole from which it is eventually separated by a continuous fissure. Disc flat or eventually slightly convex, black and covered by a fine layer of white pruina, giving it a greyish colour. *Exciple* clearly differentiated from the medulla by a deposit of a non-crystalline substance (Fig. 4A & Fig. 5C), which may be the same

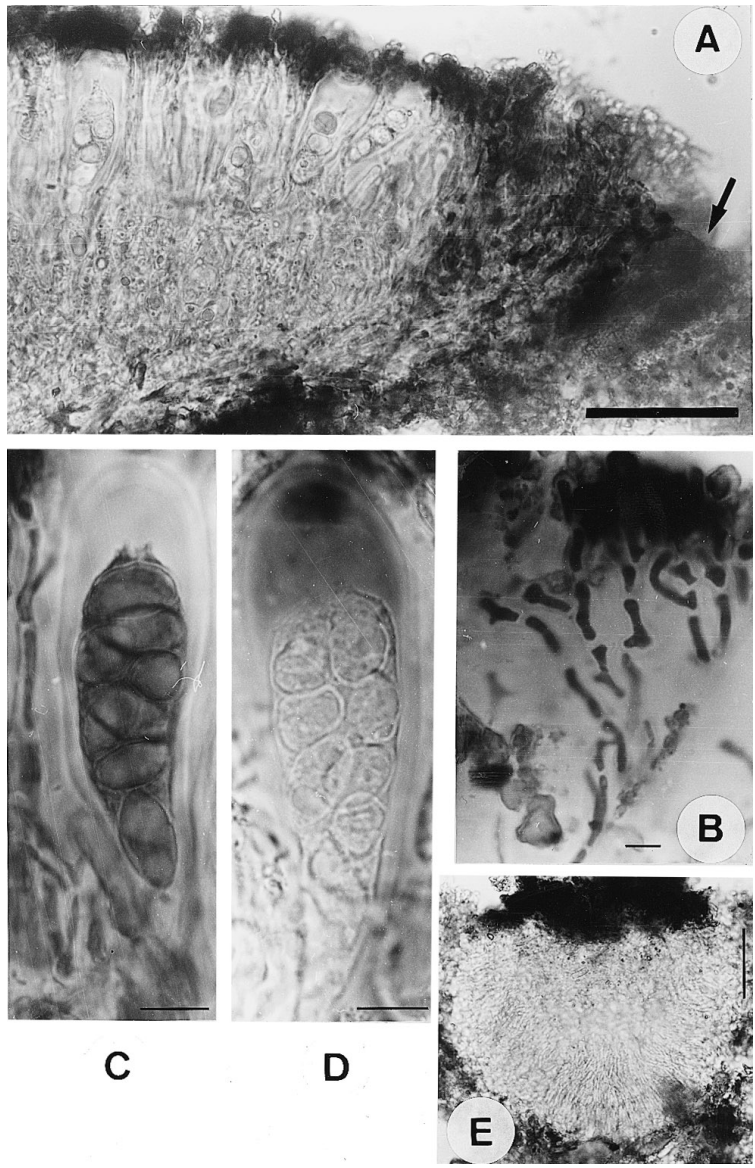

FIG. 4. *Lecidea circinarioides*. A, Vertical section of apothecium showing the exciple. B, Ramified and anastomosing paraphyses. C, Ascus in lactophenol cotton blue. D, Ascus in iodine showing the amyloid apical zone. E, Vertical section of a pycnidium. Scales: A=50 μm; B=3 μm; C & D=10 μm; E=20 μm.

hydrophobic substance that appears on TLC plates. Using lactophenol cotton blue it is seen to consist of sinuous hyphae and more swollen cells than those of the medulla. *Subhymenium* hyaline, 20 μm thick, formed by interlaced

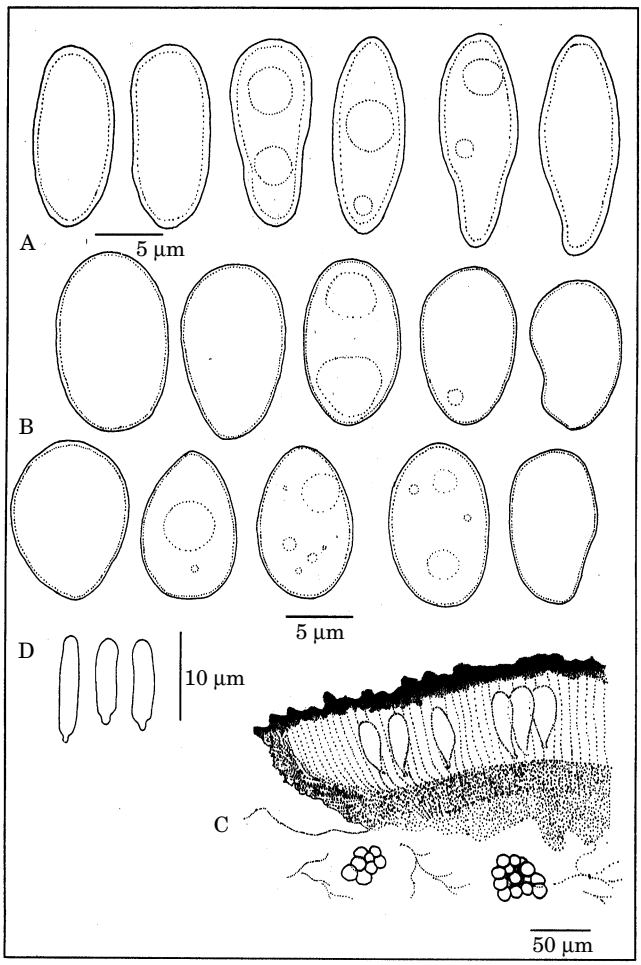

FIG. 5. A, *Lecidea gypsicola* ascospores. B–D, *L. circinarioides*: B, Ascospores; C, Mature apothecium; D, Conidia.

hyphae. *Hypothecium* hyaline, *c.* 30 µm thick, distinguishable from the subhymenium only by its spongy texture, which stores air and makes it opaque, and from the medulla by the absence of crystals (Fig. 3C). *Hymenium* hyaline, 60–80 µm thick. *Paraphyses* coherent, ramified and anastomosing, approximately 2 µm thick, with the apical cell slightly claviform (Fig. 4B). *Epihymenium* 14–20 µm thick, olive-green due to a pigment (*Lecidea* green, Bachmann 1890:19) dissolved in the gelatine and being rather more concentrated around the paraphyses; a crystalline layer up to 20 µm thick formed of 5 µm crystals can be observed over the epihymenium. *Asci Lecidea* s.str. type, 60 × 25–30 µm (Fig. 4C, D). *Spores* ellipsoid and frequently guttulate (10–)12(–13) × (6–)7·7(–9) µm; ratio L/W 1·6 (Fig. 5B).

Pycnidia inconspicuous and not always present, embedded in the thallus with greyish irregularly shaped ostioles; in transverse section appearing spherical with blue-green pigmentation in the zone nearest the ostiole (Fig. 3E). Conidiphores Type II of Vobis (1980). *Conidia* bacilliform, hyaline, acrogenous, 8–10 × 2 μm (Fig. 5D).

Chemistry: Four unidentified substances are present, of which two are hydrophobic with R_F classes in the solvent systems A/B/C of 4–5/4/5–6 and 4/5–6/6, respectively. Both exhibit a dark grey colour in UV light before charring, turning yellow and showing a lemon-yellow fluorescence in long-wavelength UV after charring. The other two substances, which appear to be present in low concentrations, have R_F classes 3/3/3–4 and 4/4/5, respectively. Both have a slight grey colour in UV light before charring and remain colourless with no fluorescence after charring. In some samples small quantities of an accessory substance with R_F classes 7/7/7 may appear. Spot tests: cortex and medulla K −, C −, KC −, PD −, I −; epihymenium K −, C −, KC −, N+ purple; hymenium K −, C −, KC −; hymenial gelatine I+ blue (at higher concentration the reaction colour becomes a dull orange).

Lecidea circinarioides and *L. gypsicola* exhibit very different chemotypes with no substances in common. The absence of lecanoric and gyrophoric acids facilitates the identification of *L. circinarioides*.

Distribution: Lecidea circinarioides is a very common species in the majority of the gypsum zones of Spain. Is currently known in the desert of Los Monegros (province of Zaragoza), Tajo depression (provinces of Toledo and Madrid), the gypsums of Sax (province of Alicante), Hoya de Baza (province of Granada) and gypsums of the SE (province of Almeria). In Africa it has been collected in Morocco in the gypsum zones of Oued Nekor between Melilla and Taza and Safi (Casares-Porcel *et al.* 1994); (see Fig. 1).

Ecology: It always colonizes walls or shady horizontal surfaces, on gypsum crystals or crust.

Discussion: On account of its rather short conidia and its being a lowland, thermophilous species, *L. circinarioides* may belong to *Lecidea* subg. *Lecidea* as circumscribed by Rambold (1989). However, the reaction of the hymenium with iodine also connects it to subgen. *Rehmiopsis*. The cryptolecanorine apothecia (aspicilioid) within the *Lecanorales* are found also amongst the Hymeneliaceae (*Aspicilia, Hymenelia, Ionaspis*), the Lecanoraceae (*Clauzadeana, Lecanora, Miriquidica, Tephromela*), the Porpidiaceae (*Amygdalaria, Bellemerea, Immersaria, Porpidia*) (Clauzade & Roux 1984; Rambold 1989; Roux 1983) and, while not to the same degree, they are present in the Physciaceae (*Buellia, Dimelaena, Rinodina, Rinodinella*) and the Acarosporaceae (*Acarospora*) amongst others.

In the Lecideaceae this type of apothecium has already been recorded in three Southern hemisphere species, *L. atromorio* and *L. fuscoatrula*, both belonging to the subgen. *Lecidea*, and in *L. lygomma* Nyl., which Hertel (1984) placed in the genus *Zosterodiscus* and Rambold (1989) in the subgenus

Rehmiopsis. Therefore, our species is one of the few *Lecidea* subgen. *Lecidea* (sensu Rambold 1989) to exhibit this type of ascoma and the only one of the genus to also possess a hyaline hypothecium as well as aspicilioid apothecia, which give it an almost perfect resemblance to *Aspicilia*. We believe that this has led other authors to confuse this species with *A. cheresina* on the gypsums of Spain. This again shows that the morphology of the mature ascoma has little generic value (Hafellner 1988).

Key

The *Lecidea* species from the gypsum soils of Spain can be easily identified using the following keying couplet:

Thallus brownish, C+ (or at least KC+) red (gyrophoric and lecanoric acids). Apothecia prominent with well-differentiated margins and with a dark brown hypothecium and exciple. Ascospores (13–)16·1(–18) × (4·5–)5·6(–7) µm, ratio L/W 2·9 (Figs 2D and 5A). In Spain it is found on compact gypsum in inland sites . . . . . **L. gypsicola**

Thallus white, C −, KC −, K −. Apothecia flat or slightly convex with a white ' false ' thalline margin and apparently without their own margin (with the appearance of *Aspicilia*); subhymenium and hypothecium hyaline; exciple uncoloured and only slightly developed. Epihymenium N+ purple. Ascospores (10–)12·0(–13) × (6–)7·7(–9) µm, ratio L/W 1·6 (Fig. 5B). More widely distributed than *L. gypsicola* in hot dry areas on compact gypsum . . . . . **L. circinarioides**

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