The nivicolous myxomycetes described by MARIANNE MEYER, MICHEL POULAIN and JEAN BOZONNET 1

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Abstract: Materials from M. MEYER, M. POULAIN, and J. BOZONNET of the following species described as new by them are studied: *Diacheopsis kowalskii*, *D. pauxilla*, *D. reticulospora*, *Dianema inconspicuum*, *Lepidoderma alpestroides* and *L. perforatum*. Their validity is confirmed. SEM micrographs of spores and important characters are provided.

Zusammenfassung: Material von M. MEYER, M. POULAIN und J. BOZONNET der folgenden von ihnen als neu beschriebenen Arten wird untersucht: *Diacheopsis kowalskii*, *D. pauxilla*, *D. reticulospora*, *Dianema inconspicuum*, *Lepidoderma alpestroides* und *L. perforatum*. Ihre Gültigkeit wird bestätigt. SEM Mikrofotografien der Sporen und wichtiger Merkmale werden gegeben.

The nivicolous species of myxomycetes are organisms that belong to different genera sharing the same environmental conditions in their life cycle. These conditions can be found in the mountains, where, on the highest summits, the snow cover remains intact during the coldest months. In spring, with the increase of temperature, when thaw starts slowly, the sudden change from cold to warm favours the germination of the spores that have remained covered under the snow. Subsequently, the formation of plasmodia and fructifications over the vegetation that had remained under the snow occurs.

These extreme environmental conditions inducing the fructification of the nivicolous species can lead to the development of aberrant sporophores that may cause erroneous determinations. This is the case in some species that have been described based on sporocarps and plasmodiocarps with malformations of peridium, capillitium and spores, such as: *Diacheopsis spinosifila* M. L. FARR & R. L. CRITCHF., *Diderma nigrum* KOWALSKI, *Lepidoderma didermoides* KOWALSKI, and *Trichia synspora* KOWALSKI (MORENO & al. 2003 a, b, 2004; SINGER & al. 2003). The study of the type material and the comparison of the material determined with collections of other species can avoid mistakes when it comes to propose new species. In this way, we will be able to achieve a good diagnosis both of the macroscopic and the microscopic characters. The light microscope is in many cases insufficient for the study of the spore ornamentation. Therefore we consider the electron microscope an indispensable tool for correct determinations.

MARIANNE MEYER, MICHEL POULAIN, and JEAN BOZONNET have studied the nivicolous species of myxomycetes of the French Alps, mainly in the department of Savoie, in the east of France. They proposed 12 new species and one new variety, belonging to the genera *Diacheopsis*, *Dianema*, *Lepidoderma*, and *Lamproderma*: *Diacheopsis kowalskii* MEYER & POULAIN, *D. pauxilla* MEYER & POULAIN, *D. reticulospora* MEYER & POULAIN, *Dianema inconspicuum* POULAIN, MEYER & BOZONNET, *Lamproderma aeneum* MEYER & POULAIN, *L. cacographicum* BOZONNET, MEYER & POULAIN, *L. pseudomaculatum* MEYER & POULAIN, *L. pulveratum* MEYER & POULAIN, *L. spinulosporum* MEYER, NOWOTNY & POULAIN, *L. zonatum* MEYER & POULAIN, *Lepidoderma alpestroides* MEYER & POULAIN, *L. perforatum* MEYER & POULAIN, and *Lamproderma maculatum* var. *macrosporum* MEYER & POULAIN (BOZONNET & al. 1991, 1995, 1997; MEYER & al. 1994; MEYER & POULAIN 1990, 1998; POULAIN & al. 2000, 2002 a, b).

They provide keys to all the species known in the genera *Diacheopsis*, *Dianema*, and *Lepidoderma* (MEYER & POULAIN 1998; POULAIN & al. 2000, 2002 a) and a key to the nivicolous species of *Lamproderma* that have a spotted peridium (BOZONNET & al. 1995).

In the present paper we present a revision of all the species proposed by the MEYER team. We excluded the genus *Lamproderma* in this review to which we will dedicate a separate study.

Materials and methods

The material collected was studied with a binocular microscope and, after mounting in Hoyer's medium, with a Nikon (Optiphot) microscope (LM). Spore measurements were made under the oil immersion objective and include surface structures such as spines or warts.

Scanning electron microscopy (SEM) micrographs were taken in the University of Alcalá de Henares using a Zeiss DSM-950. In order to examine the spore ornamentation the critical point drying technique was applied to the specimens according to the protocol cited in SINGER & al. (2005).

List of taxa

***Diacheopsis kowalskii* MEYER & POULAIN,** Bull. Féd. Mycol. Dauphiné-Savoie **38(150)**: 29. 1998 (Figs. 1, 2, 15)

Specimen examined: France: Les Arcs, Savoie, 1900 m s. m., 24. 5. 1996, MM 16593, paratype, duplicate in AH 31777.

Latin diagnosis: Sporocysti gregarii, pulviniformes, brunnei obscuri; peridium iridescens, parvulis aciculis subalbis conspersum; capillitium constitutum ex planis filis, aspectu bicolori, brunneis et hyalinis alternis vicibus, et laxarum macularum reticulum praebens. Sporae tenuibus et uniformiter distributis spinulis ornatae, (15-)16-17(-18,5) µm diam. Plasmodium ignotum.

The specimen examined consists of gregarious to clustered, sessile fructifications. Sporotheca subglobose-pulvinate, 1.2-2.5 mm in diam., more often elongate-pulvinate, 2-2.5 x 0.9-1.3 mm, sometimes forming small plasmodiocarps up to 3.5 mm in length, dark brown, with iridescent silver reflections. Hypothallus little developed, reddish brown. Peridium simple, persistent, membranous, rugose, iridescent silver, light brown

by LM, covered by scattered filiform and white crystals; dehiscence irregular. Columella absent. Capillitium brownish white by magnifying glass, bicoloured by LM, with light brown zones alternating with hyaline zones; threads 1-5 µm in diam., formed by a more or less dense net of irregular and lax meshes with triangular nodes. Spores blackish brown in mass, violaceous brown with a clearer zone by LM, 15-17 µm in diam., crested to crested-subreticulate; by SEM spore ornamentation formed by low fusing crests forming a more or less distinct subreticulum.

Observations: The material studied of *Diacheopsis kowalskii* is characterized by a capillitium with light brown zones alternating with hyaline areas and triangular nodes, and by spores 15-17 µm in diam. crested to crested-subreticulate.

A close species is *Diacheopsis metallica* MEYL., which can be distinguished by the presence of a uniformly coloured capillitium, dark brown to brown, progressively paler towards the extremities, without triangular nodes, and smaller spores (12-)13-14(-15) µm in diam., strongly spinose by LM.

Diacheopsis pauxilla **MEYER & POULAIN,** Bull. Féd. Mycol. Dauphiné-Savoie **38(150)**: 30. 1998. (Figs. 3, 4, 16, 17)

Specimen examined: France: La Bathie, Savoie, on *Vaccinium myrtillus* and *Luzula* spec., 1800 m s. m., 26. 5. 1997, MM 17460, isotype, duplicate in AH 31774.

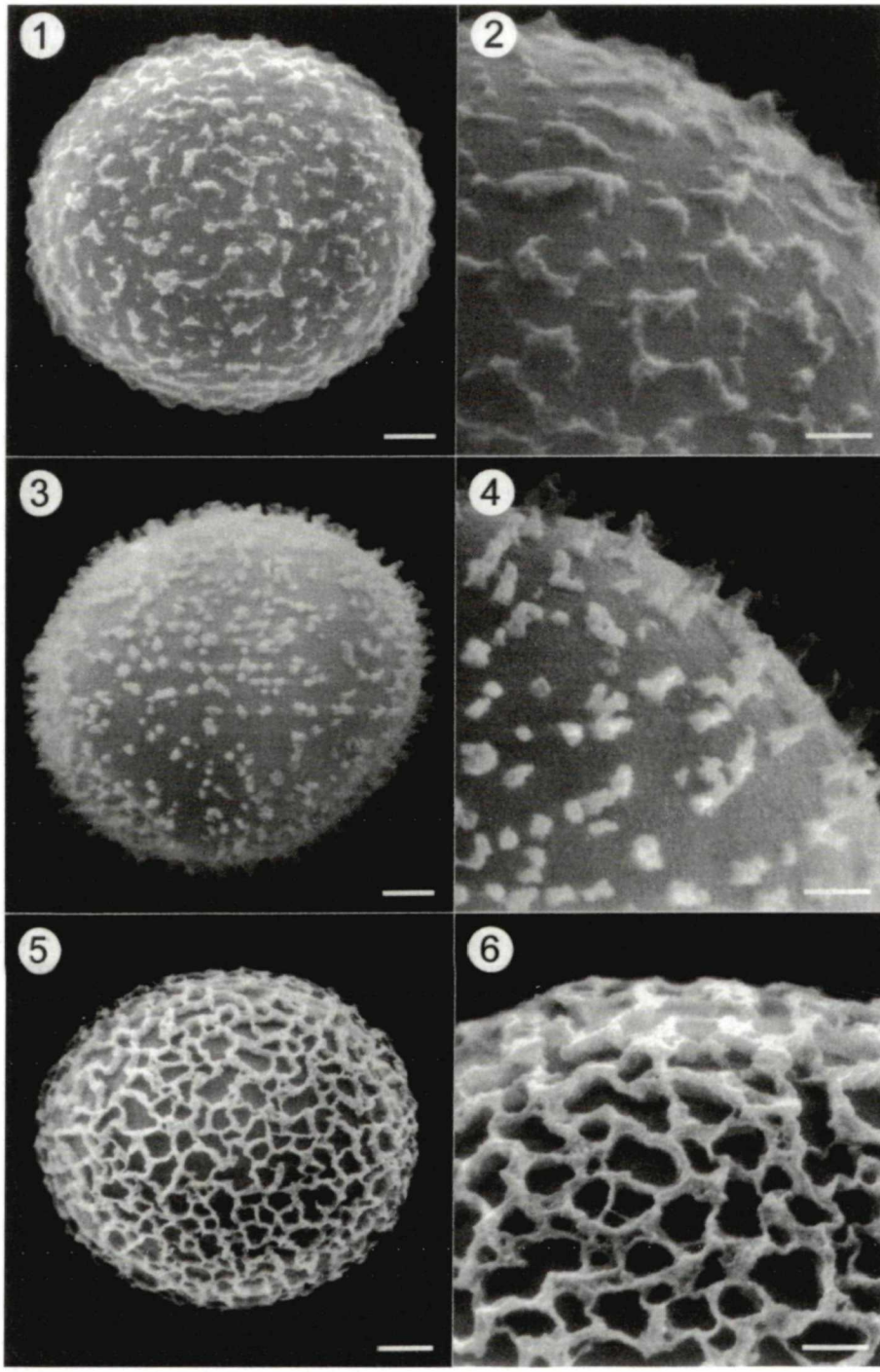
Latin diagnosis: Sporocysti pulviniformes, 1-2 mm longi, conjuncti in laxas turmas; peridium maxime iridescens, praebens varietates coloris caeruleas, virides, violaceas et aureas. Capillitium brunneum, erectum, anastomosans. Sporae densis et uniformiter distributis spinulis ornatae, 13,5-17 µm diam. Plasmodium ignotum.

The isotype studied has solitary to scattered, sessile sporocarps. Sporotheca subglobose-pulvinate to elongate-pulvinate, 0.6-1.2 x 0.6-0.8 mm, dark brown, iridescent with bluish and greenish reflections. Hypothallus inconspicuous, reddish brown. Peridium simple, persistent, membranous, rugose, iridescent with bluish and greenish reflections, light brown by LM; dehiscence irregular. Capillitium brown by magnifying glass, dark brown by LM; threads 2-3 µm in diam., very sinuous, forming a lax net with more or less triangular nodes. Spores blackish brown in mass, violaceous brown with a clearer zone by LM, 14-15 µm in diam., spinulose, by SEM spore ornamentation formed by irregularly distributed baculae.

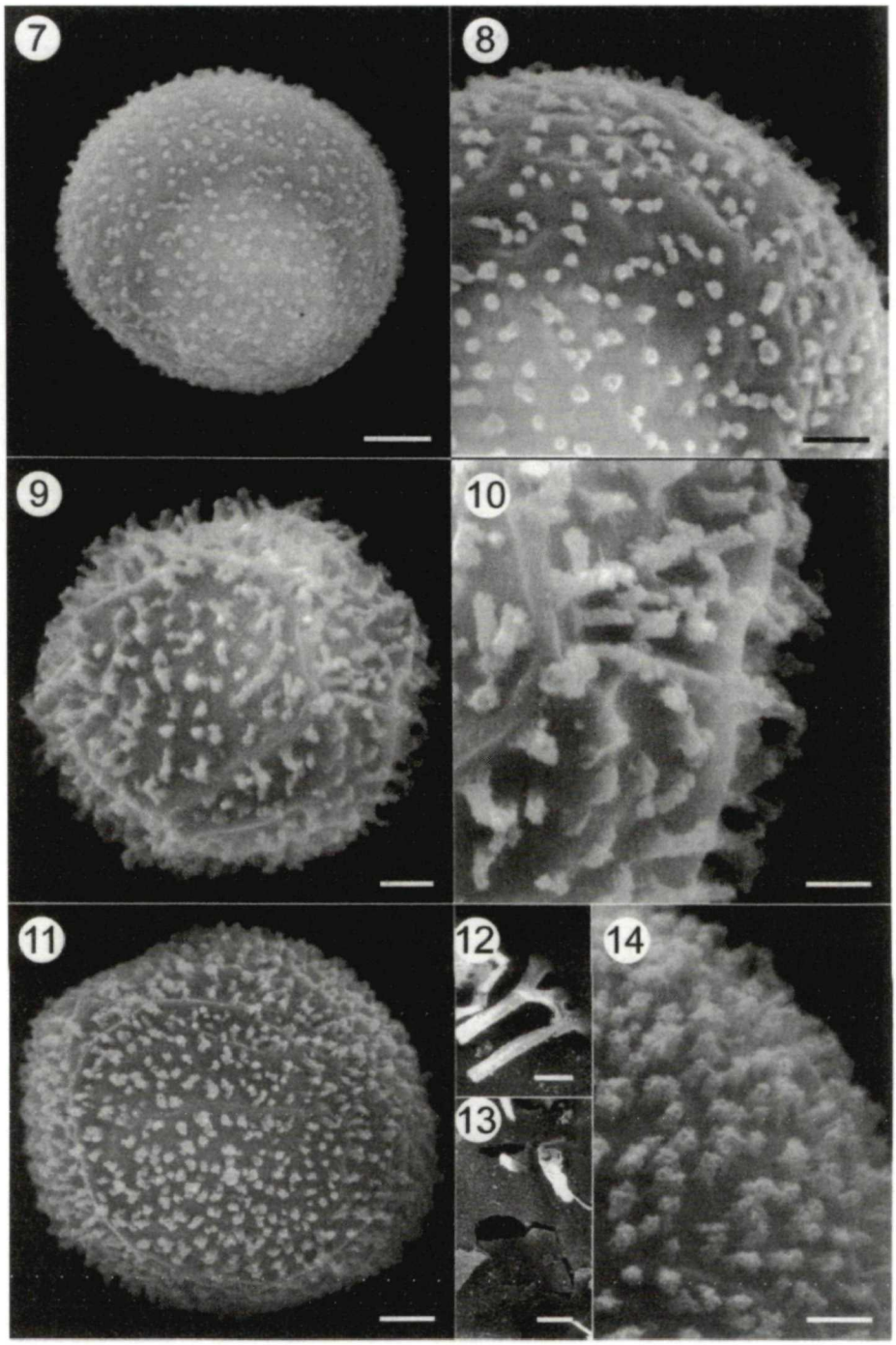
Observations: *Diacheopsis pauxilla* is very close to *D. kowalskii* and *D. metallica*. *Diacheopsis pauxilla* differs by dispersed growth habit, small fructifications, dark brown capillitium net formed by very sinuous filaments and spores 14-15 µm in diam., with a spore ornamentation formed by baculae by SEM.

Diacheopsis reticulospora **MEYER & POULAIN,** Beitr. Kenntnis Pilze Mitteleur. **6**: 35. 1990. (Figs. 5, 6, 18)

Specimen examined: France: Esserts-Blay, Savoie, on *Vaccinium myrtillus*, 1700 m s. m., 19. 5. 2000, MM 21082, duplicate in AH 31778.



Figs. 1-6. Spores by SEM. - Figs. 1, 2. *Diacheopsis kowalskii* (paratype). 1. Spore, bar: 2 µm. 2. Detail of spore ornamentation, bar: 1 µm. - Figs. 3, 4. *Diacheopsis pauxilla* (isotype). 3. Spore, bar: 2 µm. 4. Detail of spore ornamentation, bar: 1 µm. - Figs. 5, 6. *Diacheopsis reticulospora* (MM 21082). 5. Spore, bar: 2 µm. 6. Detail of spore ornamentation, bar: 1 µm.



Figs. 7-14. Spores, capillitium and peridium by SEM. - Figs. 7, 8. *Dianema inconspicuum* (isotype). 7. Spore, bar: 2 µm. 8. Detail of spore ornamentation, bar: 1 µm. - Figs. 9, 10. *Lepidoderma alpestroides* (isotype). 9. Spore, bar: 2 µm. 10. Detail of spore ornamentation, bar: 1 µm. - Figs.11-14. *Lepidoderma perforatum* (isotype). 11. Spore, bar: 2 µm. 12. Capillitium ends attached to endoperidium, bar: 5 µm. 13. Perforations in endoperidium, bar: 5 µm. 14. Detail of spore ornamentation, bar: 1 µm.

Latin diagnosis: Fructificationibus sessilibus, praecipue in forma plasmodiocarporum, (extendentibus usque ad 5 cm), ab 0,5 ad 1 mm latis, atrobrunneis, nitentibus cum reflexibus aureis; hypothallo atro; peridio membranaceo, persistenti, simplici, laevi; columella nulla, capillitio atro, vix ad apices clariore, densissimum et cohaerens et paulum elasticum reticulum efficiente, a toto peridio facile soluto; sporis globosis, tenuiter et dense reticulatis, brunneis, 12,5-15 µm diam; plasmodio ignoto.

The specimen studied has vermiform plasmodiocarps, 0.6-1 mm broad and up to 1.2 cm long, sometimes effuse, extensive and forming a small reticulum, shiny dark brown. Hypothallus little developed, blackish. Peridium simple, persisting, membranous, iridescent silver, brownish by LM; with irregular dehiscence. Capillitium very abundant, dark by magnifying glass, blackish brown by LM, with clearer ends; threads 1-2 µm in diam., filiform, forming a very dense net with meshes of very variable sizes. Spores dark brown in mass, dark brown with a clearer zone by LM, 12-14 µm in diam., verrucous-reticulate, by SEM spore ornamentation formed by a reticulum of irregular and tight meshes.

Observations: *Diacheopsis reticulospora* can easily be recognized by plasmodiocarpous fructifications, capillitium forming a very dense network with meshes of very variable sizes and spores 12-14 µm in diam., completely reticulate. Other nivicolous species of the genus *Diacheopsis* that form plasmodiocarps are *D. effusa* KOWALSKI and *D. serpula* KOWALSKI. However, *D. reticulospora* differs clearly by the spore ornamentation which is unique in the genus.

Dianema inconspicuum **POULAIN, MEYER & BOZONNET**, Stapfia **73**: 86. 2000. (Figs. 7, 8, 19, 20)

Specimens examined: France: La Bathie, Savoie, on *Vaccinium myrtillus*, 1800 m s. m., 15. 7. 1999, MM 20461, isotype, duplicate in AH 31775; - - 3. 7. 1999, MM 20415, duplicate in AH 31779.

Latin diagnosis: Sporocysti saepissime solitarii, sessiles, pulviniformes-complanati, 0,8-1,1(-4) x 0,7-0,8(-1,5) mm, et circa 0,3 mm alti. Peridium membranaceum, persistens, spadiceum, lucens, laeve vel plus minus plicatum. Columella nulla. Capillitium copiosum filamentis tenuibus, erectis, flexuosis, raras ramificationes et anastomosas praebentibus. Sporae globosae, hyalinae flavidae, tenuibus spinulosis ornatae, (9,5-)10-11(-12) µm diam. Plasmodium ignotum.

In the isotype studied, solitary sessile sporocarps can be observed. Sporothecae pulvinate to flattened, 0.4-1 mm in diam., ochraceous yellowish. Hypothallus inconspicuous. Peridium simple, persisting, membranous, ochraceous yellowish by magnifying glass and LM; with irregular dehiscence. Capillitium light brown by magnifying glass, pale yellowish by LM; threads 2-4 µm in diam., hardly branched and anastomosed, strongly united with the peridium. Spores yellowish ochraceous in mass, yellowish hyaline by LM, 10-12 µm in diam., spinulose, by SEM spore ornamentation formed by small lax baculae.

Observations: *Dianema inconspicuum* is characterized by solitary rather flattened fructifications, ochraceous yellowish, hardly branched and anastomosed capillitium,

yellowish by LM, and spores 10-12 µm in diam. As the name indicates, it is a tiny or inconspicuous species that due to the small fructifications may have been overlooked until recently.

Lepidoderma alpestroides **MEYER & POULAIN in POULAIN, MEYER & BOZONNET,** Bull. Féd. Mycol. Dauphiné-Savoie **42(165)**: 9. 2002. (Figs. 9, 10, 21, 22)

Specimens examined: France: Bourg-St. Maurice, Les Arcs, Savoie, on *Vaccinium myrtillus*, 1900 m s. m., 24. 5. 1996, MM 16595, isotype; - - on living shrub, mainly *Rhododendron* spec., 28. 5. 1997, MM 17476, duplicate in AH 31776.

Latin diagnosis: Plasmodiocarpi albi vel cremei, saepe robiginis maculis notati. Peridium duplex, pars exterior exilibus squamulis imbricatis constituta, fere levem crustam opacam efficientibus; pars interior hyalina flavida luce transmissa. Capillitium brunneum obscurum, rigidum. Sporae (12,5-)14-15(-17) µm. Plasmodium ignotum. Species nivalis.

The isotype examined has vermiform plasmodiocarps, 4-8 x 1.4-2.5 mm, sinuous and confluent. Hypothallus little developed, yellowish. Peridium double; exoperidium formed by a calcareous layer, thick, granulose, creamy white to yellowish creamy, somewhat shiny, rarely with some reddish spots; endoperidium membranous, hyaline by magnifying glass, yellowish hyaline by LM, closely united with the exoperidium from which it is hardly separable; dehiscence irregular. Columella in the form of a crest spreading out all along the plasmodiocarp, with a broad base occupying almost the whole base of the fructification. Capillitium abundant, blackish brown by magnifying glass, dark brown by LM, with a greyish apex; threads 1-2 µm in diam., rigid, straight, hardly ramified and anastomosed, except at the apices, with scanty nodes. Spores blackish brown in mass, violaceous brown by LM, 14-15 µm in diam., spinose, by SEM the spore ornamentation formed by large baculae with coralloid apices.

Observations: *Lepidoderma alpestroides* is characterized by creamy coloured fructifications in the form of plasmodiocarps, resembling those of *Physarum alpestre* MITCHEL, S. W. CHAPM. & M. L. FARR, with an exoperidium formed by a layer of very dense, not distinguishable calcareous scales, abundant dark brown capillitium formed by parallel and straight filaments and spores 14-15 µm in diam., with large baculae with coralloid apices by SEM.

Lepidoderma carestianum (RABENH.) ROSTAF. and *L. granuliferum* (W. PHILLIPS) R. E. FR. are two very close nivicolous species that share with *L. alpestroides* the plasmodiocarpic growth. *Lepidoderma granuliferum* differs principally by the presence of calcareous nodes in the capillitium and *L. carestianum* by the absence of a columella, a light capillitium, hyaline to light brown, branched and anastomosed, and spore ornamentation formed by large spines with pointed and not coralloid apices by SEM.

Lepidoderma perforatum **MEYER & POULAIN in POULAIN, MEYER & BOZONNET,** Bull. Féd. Mycol. Dauphiné-Savoie **42(165)**: 6. 2002. (Figs.11-14, 23)

Specimen examined: France: La Bathie, Savoie, on *Vaccinium myrtillus*, 1300 m s. m., 22. 4. 1987, MM 2696, isotype, duplicate in AH 31773.

Latin diagnosis: Plasmodiocarpi ochraceolutei. Peridium duplex, pars exterior exilibus squamulis tecta; pars interior subcartilaginosa, brunneolutea luce transmissa, et perforata ubi capillitii fila haerent. Capillitium fuscum satis rigidum. Sporae 14,5-16,5 µm, gracilibus spinulis ornatae. Plasmodium ignotum. Species nivalis.

The isotype studied has flattened plasmodiocarps, 2-5 mm broad and up to 3 cm long. Hypothallus little developed, reddish brown. Peridium double; exoperidium thick, honey yellowish, covered by large whitish, calcareous, separated, more or less isodiametric scales; endoperidium membranous, dark brown by magnifying glass, light brown and perforated by LM, closely attached to the exoperidium; dehiscence irregular, by SEM perforations of the internal peridium originating by the rupture of it in the areas of union with the capillitium. Columella absent. Capillitium abundant, blackish brown by magnifying glass, dark brown by LM, with hyaline ends; threads 2-3 µm in diam., rigid and parallel between them, strongly attached to the endoperidium, hardly branched and anastomosed. Spores blackish brown in mass, dark brown with a clearer zone by LM, 15-16 µm in diam., spinulous, by SEM spore ornamentation formed by dense baculae with an irregular surface.

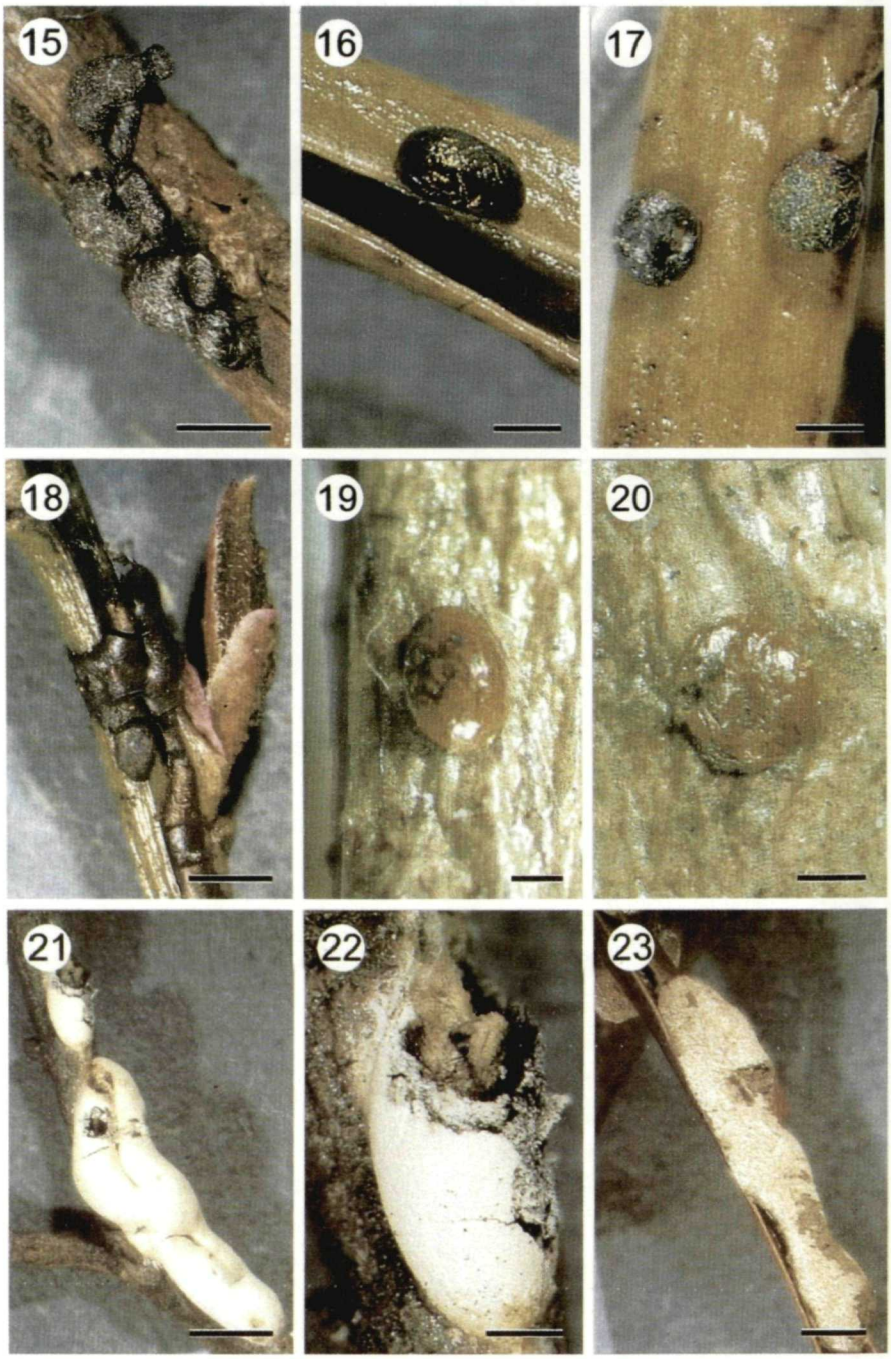
Observations: According to POULAIN & al. (2002 a) *Lepidoderma perforatum* is close to *L. carestianum*, with which it has in common the plasmodiocarpous fructifications, double peridium and verrucose to finely spinulous spores. However, *L. perforatum* differs by an internal peridium having perforations, resulting by the separation or rupture of the capillitium united to the endoperidium, by robust dark brown capillitium threads and by honey yellowish fructifications. Whereas *L. carestianum* has a non-perforated endoperidium, a capillitium formed by thin hyaline to light brown threads and greyish brown fructifications.

Discussion

After revision of material of the six taxa described by M. MEYER, M. POULAIN, and J. BOZONNET, we consider the following species to have remarkable characters that make possible their distinction from other close taxa: *Diacheopsis reticulospora*, *Dianema inconspicuum*, *Lepidoderma alpestroides* and *L. perforatum*.

Diacheopsis reticulospora has spores 12-14 µm in diam., reticulate, especially visible by SEM. This ornamentation is unique and unmistakable within the genus. *Dianema inconspicuum* can easily be distinguished by solitary sporocarps, of such small size that makes it difficult to find it in the field, and spores with little-developed ornamentation. *Lepidoderma alpestroides* is a very characteristic species due to its morphological resemblance to *Physarum alpestre*. However, the layer composed of calcareous scales covering the endoperidium distinguishes it clearly, as well as the different capillitium. *Lepidoderma perforatum* is easily distinguishable by microscopic characters, having an endoperidium with typical perforations, and furthermore it presents a spore ornamentation formed by tight baculae of irregular surface.

On the other hand, *Diacheopsis kowalskii* and *D. pauxilla* are very close to *D. metallica*. The latter species differs by the morphology of the capillitium and spore ornamentation. *D. pauxilla* furthermore presents a dispersed growth habit and small fructifications.



Figs. 15-23. Fructifications. - Fig. 15. *Diacheopsis kowalskii*, paratype, bar: 2 mm. - Figs. 16, 17. *Diacheopsis pauxilla*, isotype, bar: 0.5 mm. - Fig. 18. *Diacheopsis reticulospora*, MM 21082, bar: 2 mm. - Figs. 19, 20. *Dianema inconspicuum*, isotype, bars: 0.25 mm, 0.5 mm. - Figs. 21, 22. *Lepidoderma alpestroides*, isotype, bars: 2 mm, 0.5 mm. - Fig. 23. *Lepidoderma perforatum*, isotype, bar: 1 µm.

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