

MYCOTAXON

Volume 103, pp. 171–187

January–March 2008

Acaulosporaceae **from El Palmar National Park, Entre Ríos, Argentina**

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Abstract — The occurrence of arbuscular mycorrhizal fungi belonging to the genus *Acaulospora* in El Palmar National Park (Entre Ríos Province, Argentina) is reported. In this work *A. entreriana* sp. nov. is described and *A. denticulata*, *A. dilatata*, *A. elegans*, *A. foveata* and *A. rehmi* are reported and illustrated for the first time in Argentina. The distribution area of *A. bireticulata*, *A. delicata*, *A. excavata*, *A. laevis*, *A. mellea*, *A. scrobiculata* and *A. spinosa* was enlarged.

Key words — *Glomeromycota*, taxonomy, palm forest

Introduction

El Palmar National Park is one of the most floristically diverse national parks in Argentina. With over 700 vascular plant species (Biganzoli et al. 2001), the park shelters an important concentration of palm trees, *Butia yatay* (Mart.) Becc., that represents a characteristic edaphic community and one of the last *B. yatay* remnants in the region. Such protected areas have proved to serve as propitious places to conserve floristic biodiversity and associated microorganisms (Hawksworth 1991).

Amongst those symbiotic with land flora, arbuscular mycorrhizal fungi (AMF), which associate with 82% of plant species, are the most common soil fungi (Wang & Qiu 2006). Their ubiquity alone makes them an important component in the soil microbial biomass, and they are directly involved in crucial processes at the plant-soil interface (Harley & Smith 1983, McGee et al. 1989).

The abundance and diversity of AMF in El Palmar National Park is still unknown, although the park's protected environment makes it ideal for

studying these microorganisms. Also, the park offers a wide range of vegetation including scrubland, marsh, palm forest, grassland and gallery forest. In brief, it is clear that vegetation and associated microorganisms within such areas should be protected (APN 1994).

Arbuscular mycorrhizal fungi represent four orders (Schüssler 2007) within the class *Glomeromycetes* (Cavalier-Smith 1988) and phylum *Glomeromycota* (Schüssler et al. 2001). Currently the *Glomeromycota* comprises 10 families and 13 genera (<http://AMF-phylogeny.com> 2007).

Of the arbuscular mycorrhizal genera in El Palmar National Park, *Acaulospora* species are the most dominant. Gerdemann & Trappe (1974) segregated the genus *Acaulospora* from *Endogone* to accommodate the type species, *Acaulospora laevis*, and another species included in their first key. Berch (1985) later added a third species and emended the generic description.

Acaulospora species possess a sporiferous saccule that is developmentally and structurally indistinguishable from the saccule produced by *Archaeospora* species (Morton & Redecker 2001). However, phylogenetic analyses suggest that this structure, which first appeared in *Archaeosporaceae*, was conserved within the *Acaulosporaceae* clade but lost during evolution of *Glomeraceae* (Redecker et al. 2000). Currently accepted *Acaulospora* species include 18 with smooth spore surfaces and 15 with ornamented outer spore walls. Oehl et al. (2006) provide the most recent key to the ornamented *Acaulospora* species.

The aim of this work is to describe and illustrate *Acaulospora* species recorded for the first time for Argentina and expand the known distribution for species previously cited for the country.

Materials and methods

Study area

Soil samples were taken from El Palmar National Park (58° 17' W, 31° 50' S), Entre Ríos Province, Argentina.

We selected 5 sites with different characteristics: 1-SCRUBLAND, dominated by *Baccharis dracunculifolia* and *Eupatorium buniifolium*; 2-MARSH displayed a different proportion of *Cyperaceae* and *Gramineae* were the following genera *Scirpus*, *Andropogon*, *Bromus* predominate; 3-PALM FOREST *Butia yatay* palm savannah; 4-GRASSLAND principal type physiognomical with grass and herbs of variable height and density; 5-GALLERY FOREST with exotic species as *Melia*, *Ligustrum*. Rhizospheric soil samples were collected using a composite random sampling method. Each sample contained three replicates.

Trap culture

In each of the 5 sites, three trap cultures were set up following Oehl et al. (2003). An autoclaved substrate consisting of a mixture of soil:perlite:vermiculite (3:1:1, w/w/w)

was used. The AMF inocula containing 20 g per trap plant of unsterilized soil from field samples were placed in 27x17x20 cm pots.

Lolium perenne, *Medicago sativa* and *Plantago lanceolata* seeds were surface-sterilized with sodium hypochlorite (10% v/v) for 10 min and thoroughly rinsed with sterilized water. After germination, seedlings were selected for uniform size and then transplanted into pots, three of each species per trap culture. These pots were placed in a greenhouse at $24 \pm 1^\circ\text{C}$ day/ $20 \pm 1^\circ\text{C}$ night, and a 16-h photoperiod was provided by incandescent and cool-white lamps; the plants were fertilized with a nutritive solution (Cabello 1997).

Sampling of trap cultures

Trap cultures were grown for 90 days, then 2 soil core samples (15 cm³; sampling depth, 10 cm) were taken from each pot for the extraction of AMF spores.

AMF spore isolation and identification

AMF were studied by spore extraction from soil samples or trap culture. Spores were extracted by wet-sieving and decanting (Gerdemann & Nicolson 1963) and the modified sucrose density gradient centrifugation method of Walker et al. (1982).

Fungal spores were examined using an optic microscope and mounted on polyvinyl-lactic acid-glycerine (PVLG) (Koske & Tessier 1983) or PVLG mixed 1:1 (v/v) using Melzer's reagent (Brundrett et al. 1994). Scanning electron microscope (SEM) was used to observe the different ornamentation in spore walls. Specimens were compared with original species described at the Germoplasm Bank Institute Spegazzini, La Plata, Argentina; reference isolates described by the Internacional Culture Collection of Arbuscular and Vesicular-Arbuscular Micorrhizal Fungi (INVAM, USA, <http://invam.cafwvu.edu>), and Błaszowski, <http://www.agro.ar.szczein.pl/~jblaszkowski/>. Terminology of the spore structure follows Stürmer & Morton (1999), as adapted by INVAM and modified by Oehl et al. (2006).

Figures 9–10 were photographed using a digital Olympus camera (model SP-350) on a stereoscopic microscope (Olympus SZ61); Figures 3–5, 7–8, and 11–14 were photographed on a Leitz Dialux 20EB compound microscope. Photographs (fig. 1, 2 and 6) were taken on a scanning microscope. Spores were prepared for scanning electron microscopy by rinsing them in distilled water, piercing them with a fine needle, and allowing them to air-dry on a metal stub. Dried spores were sputter-coated with gold/palladium and observed with a Jeol JSM-6360 LV microscope. Specimens mounted in PVLG and a mixture of PVLG and Melzer's reagent were deposited at LPS (La Plata, Spegazzini) herbarium.

Results

Nineteen species belonging to *Acaulosporaceae* were identified. Twelve spore morphotypes could be unequivocally assigned to species of *Acaulospora*, of which one was found to be a new species and six spore types could not be identified to species level.

Taxonomy

1. *Acaulospora bireticulata* F.M. Rothwell & Trappe,

Mycotaxon 8: 472. 1979

FIGS. 1-2

MATERIAL EXAMINED: ARGENTINA. Entre Ríos: *El Palmar National Park*. VIII-2004, Velázquez. Isolated from soil sample coming from scrubland, marsh, palm forest, grassland and pot cultures associated with *L. perenne*, *M. sativa* and *P. lanceolata*. LPS, slide N° 47994.

DISTRIBUTION AND HABITAT: *A. bireticulata* has a worldwide distribution. Rothwell & Trappe (1979) originally recovered spores of this species from soil sample collected under *Sassafras albidum* growing in Kentucky. Miller et al. (1985) isolated this fungus from the root zone of *Malus domestica* in Michigan. Błaszowski (1989, 1997) reported it in Poland. Lugo & Cabello (1999) in autochthonous mountain grassland in Central Argentina and Schalamuk et al. (2006) also reported it for agroecosystems associated with wheat crops.

GENERAL NOTES: This material agreed with the original descriptions of *A. bireticulata*.

2. *Acaulospora delicata* C. Walker, C. M. Pfeiffer & Bloss,

Mycotaxon 25: 622. 1986

MATERIAL EXAMINED: ARGENTINA. Entre Ríos: *El Palmar National Park*. V-2004, Velázquez. Isolated from soil sample from scrubland, marsh, palm forest, grassland and gallery forest and pot cultures associated with *L. perenne*, *M. sativa* and *P. lanceolata*. LPS, slide N° 47995.

DISTRIBUTION AND HABITAT: *A. delicata* has been cited from *Celtis tala* and *Scutia buxifolia* forests in Argentina (Irrazabal et al. 2004) and from a wheat monoculture (Schalamuk et al. 2006).

GENERAL NOTES: This material agreed with the original descriptions of *A. delicata*.

3. *Acaulospora denticulata* E. Sieverd. & Toro,

Angewandte Botanik 61: 217. 1987

FIG. 3

SPORES single in the soil, and laterally on the neck of a sporiferous saccule, pale orange-brown to dark orange-brown, globose to subglobose; 120-180 µm diam.

SUBCELLULAR STRUCTURE OF SPORES consists of 3 spore walls and 2 inner germinal walls.

SPORE WALL composed of 3 layers (*swl1-3*). *LAYER 1 (swl1)* hyaline, 0.6-1.5 µm thick, and sloughing detached from sporiferous saccule. *LAYER 2 (swl2)* 0.6-0.8 µm thick, with stubby yellow-brown “knobs” attached. Circular to oblong projections arise from the “knobs” and have a smooth outer edge or form a polygon of 6 sides, each projection has a central cavity. *LAYER 3 (swl3)* a single

hyaline layer, <0.8 µm thick, which is detectable only when it separates from the spore wall.

GERMINAL WALL 1 (*gw1*) formed by 2 layers *gw1I1* 0.4-0.6 µm thick and *gw1I2* 1.2-1.4 µm thick. This wall is clearly visible because it separates readily from the spore wall.

GERMINAL WALL 2 (*gw2*) consists of 2 adherent layers. *LAYER 1 (gw2I1)* 0.6-1.0 µm thick, with granular excrescences. *LAYER 2 (gw2I2)* "amorphous" 3-10 µm thick in PVLG, staining red-purple to dark red-purple in Melzer's reagent.

SPORIFEROUS SACCULE hyaline, mostly globose, 130-160 µm diam.

CICATRIX not observed.

MATERIAL EXAMINED: ARGENTINA. Entre Ríos: *El Palmar National Park*. IX-2004, Velázquez. LPS, slide N° 47996.

DISTRIBUTION AND HABITAT: *A. denticulata* was isolated from soil collected in Cauca, Colombia (Sieverding & Toro 1987). *A. denticulata* was found associated with woody and herbaceous vegetation in soils of El Palmar National Park. *A. denticulata* was found in soil samples emerging from 4 treatments, scrubland, marsh, palm forest and gallery forest. The spore density of *A. denticulata* in soil samples was 2-4 in 100 g dry soil. The fungi accompanying *A. denticulata* were *Glomus etunicatum* W. N. Becker & Gerd. and *Glomus sp.*

MYCORRHIZAL ASSOCIATIONS: *A. denticulata* was associated with woody and herbaceous vegetation.

GENERAL NOTES: *A. denticulata* was not recovered in trap culture. *A. denticulata* was reported by Menendez et al. (2001) in natural and cultivated grasslands in Argentina. However, this species seemed to be *Entrophospora infrequens* (I. R. Hall) R. N. Ames & R. W. Schneid. rather than *A. denticulata* as shown in the figure.

4. *Acaulospora dilatata* J. B. Morton, Mycologia 78: 641. 1986

FIGS. 4-5

SPORES single in the soil, and laterally on the neck of a sporiferous saccule, pale yellow to brown, mostly globose to subglobose; 100-130 µm diam.

SUBCELLULAR STRUCTURE OF SPORES consists of 1 spore wall and 2 inner germinal walls.

SPORE WALL composed of 3 layers (*sw1-3*). *LAYER 1 (sw1)* hyaline, <0.5 µm thick, and sloughing, showing a clear detachment from the sporiferous saccule. *LAYER 2 (sw2)* laminate, smooth, pale yellow-brown, 2.8-5.5 µm thick. At maturity, the pore between spore and saccule neck is closed by continuous sublayers of this layer, sealing in spore contents. *LAYER 3 (sw3)* pale yellow-brown, 1-4 µm thick, and somewhat flexible when it is separated from layer 2 of the spore wall. This layer also appears to have sublayers (laminae) which can

separate more readily from each other than those of layer 2, forming folds that resemble numerous separate “inner walls”.

GERMINAL WALL 1 (*gw1*) 2-layered hyaline wall that separates easily from the spore wall and thus it can be seen readily. Layers separate slightly in many spores but they can also be adherent and appear as a single layer. *LAYER 1 (gw1I1)* <0.5 µm thick, folding slightly when separated from layer 2. *LAYER 2 (gw1I2)* 0.5-1.0 µm thick. This wall has some inherent rigidity because it breaks with the spore wall.

GERMINAL WALL 2 (*gw2*) consists of 2 adherent hyaline layers. *LAYER 1 (gw2I1)* 0.5-1.2 µm thick, presents granular excrescences. *LAYER 2 (gw2I2)* plastic, amorphous, 1.0 µm thick, becoming red purple to dark red purple in Melzer's reagent.

SPORIFEROUS SACCULE hyaline, mostly globose to subglobose, occasionally irregular, 100-135 µm diam. Saccule wall consist of 1 layer with smooth surface, 1.0-1.4 µm thick.

CICATRIX very narrow lip circumscribing the scar, circular to oval-shaped.

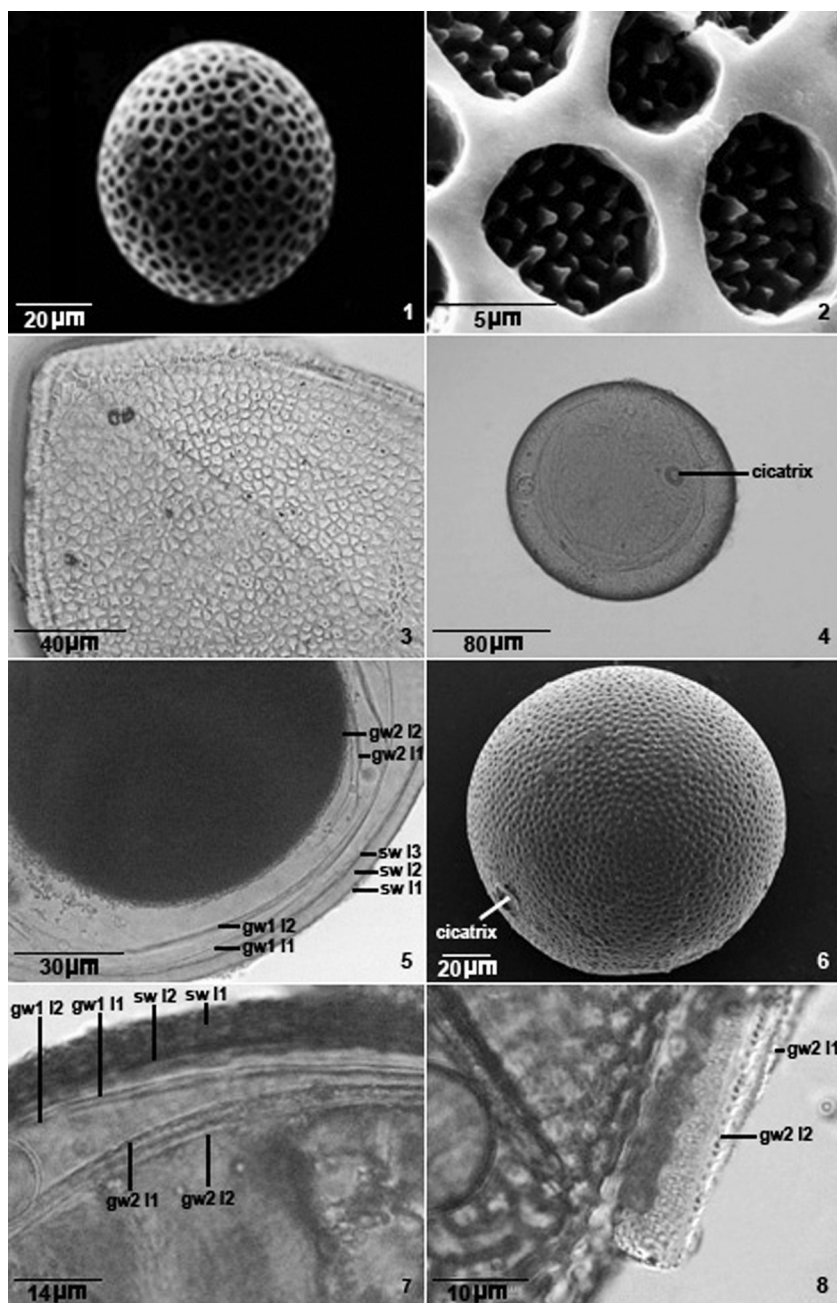
MATERIAL EXAMINED: ARGENTINA. Entre Ríos: *El Palmar National Park*. V-2004, Velázquez. LPS, slide N° 47997.

DISTRIBUTION AND HABITAT: *A. dilatata* was found in 2 coal minesoils in Preston; also on a roadside embankment with acid mine drainage near Sabraton (Morton 1986). *A. dilatata* was found associated with woody and herbaceous vegetation in soils of El Palmar National Park. *A. dilatata* was found in soil samples and trap cultures from 5 treatments, scrubland, marsh, palm forest, grassland, and gallery forest. The spore density of *A. dilatata* in soil samples was 44-156 in 100 g dry soil, the gallery forest evidenced the highest density, whereas in trap culture was 3-21 in 100 g dry soil. The fungi accompanying *A. dilatata* were *G. etunicatum* and *Glomus sp.*

MYCORRHIZAL ASSOCIATIONS: *A. dilatata* was associated with woody and herbaceous vegetation and trap cultures with *L. perenne*, *M. sativa*, and *P. lanceolata*.

GENERAL NOTES: *A. dilatata* spores resembled *Acaulospora lacunosa* J.B. Morton in colour, size and shape, but *A. lacunosa* presented a distinctive ornamentation in the external wall.

Figures 1-2. *Acaulospora bireticulata*. Fig. 1. Mature spore. Scanning electron microscopy. Fig. 2. Ornamented wall. Scanning electron microscopy. Figure 3. *A. denticulata*, ornamented wall. Figures 4-5. *A. dilatata*. Fig. 4. Mature spore with cicatrix. Fig. 5. Broken spores with 3-layered spore wall (*sw1*-3), and 2 inner germinal walls (*gw1I1*-2 and *gw2I1*-2). *Gw2I2* becoming red purple to dark red purple in Melzer's reagent. Figures 6-8. *A. elegans*. Fig. 6. Mature spore with cicatrix. Scanning electron microscopy. Fig. 7. Broken spores with 2-layered spore wall (*sw1*-2), and 2 inner germinal walls (*gw1I1*-2 and *gw2I1*-2). Fig. 8. Bilayered germinal wall 2 (*gw2I1*-2) with granular excrescences.



5. *Acaulospora elegans* J.W. Trappe & Gerd.,

Mycologia Memoir 5: 34. 1974

FIGS. 6-7-8

SPORES single in the soil, and laterally from the neck of a sporiferous saccule. Dark brown, globose to subglobose; 140-280 x 145-330 µm diam.

SUBCELLULAR STRUCTURE OF SPORES consists of 1 spore wall and 2 inner germinal walls.

SPORE WALL composed of 2 layers (*sw1*-2). *LAYER 1 (sw1)* hyaline, continuous with the wall of the hyphal neck subtending the saccule. *LAYER 2 (sw2)* consisting of laminae within which spines are crowded. Light brown spines 2.0 µm wide x 0.5 µm high, with total layer as much as 12 µm. An alveolate reticulum of hyaline ridges is superimposed on the spines. Alveoli are 4-8 µm long.

GERMINAL WALL 1 (*gw1*) consists of 2 thin adherent flexible layers (*gw1**1*-2), which almost appear to be of equal thickness, presenting granular excrescences.

GERMINAL WALL 2 (*gw2*) consists of 2 hyaline layers (*gw2**1*-2), granular excrescences, the outer layer thinner than the inner 1, which produces a red-brown reaction in Melzer's reagent.

SPORIFEROUS SACCULE pale brown, mostly globose to ellipsoid, 150-240 µm diam.

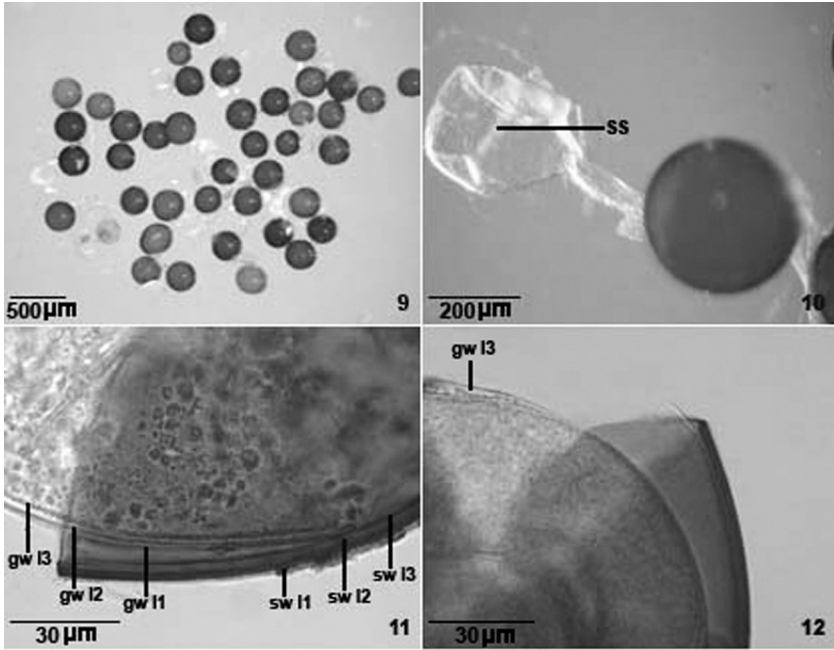
CICATRIX not observed.

MATERIAL EXAMINED: ARGENTINA. Entre Ríos: *El Palmar National Park*. XI-2006, Velázquez. LPS, slide N° 47998.

DISTRIBUTION AND HABITAT: *A. elegans* has a widely distributed in coastal sands of northern California to southwestern Washington (Gerdemann & Trappe 1974). *A. elegans* was found in trap cultures containing soil from marsh of El Palmar National Park. The spore density of *A. elegans* in trap culture was 53 in 100 g dry soil. The fungus accompanying *A. elegans* was *G. etunicatum*.

MYCORRHIZAL ASSOCIATIONS: *A. elegans* was associated in trap cultures with *L. perenne*, *M. sativa* and *P. lanceolata*.

GENERAL NOTES: spores of *A. elegans* resembled *A. bireticulata* except for pattern of ornamentation in layer 2 (*sw2*) of the spore wall. Gerdemann & Trappe (1974) described the spore wall as a 3-layered reticulum over "angular processes" 1 µm high, whereas the spore wall of *A. elegans* was described as a single-layered reticulum over crowded spines only 0.5 µm high. Therefore, concerning these differences these species would be considered as separate. The germinal wall ornamentation in El Palmar National Park *A. elegans* spores is quite different from that characterized by INVAM. Spores found in El Palmar exhibited granular excrescences in 2 germinal walls (*gw1*-2) whereas INVAM spores are only in *gw2**2*.



Figures 9-12. *Acaulospora entrerriana*. Figure 9. Spores. Figure 10. Spore laterally on the neck of a sporiferous saccule (ss). Figure 11. Broken spores with 3-layered spore wall (sw1-3) and 3-layered germinal wall (gw1-3). Figure 12. Broken spores with gw13 ornamented with teeth.

6. *Acaulospora entrerriana* M.S. Velázquez & Cabello, sp. nov.

Figs. 9–12

MYCOBANK MB 511190

Sporae singulare in solo efformatae, lateraliter gestae ad collum sacculi sporangiferi; brunneae, globosae, subglobosae vel ovoideae 260-300 x 280-330 µm diam. Sacculus sporifer hyalinus, globosus vel subglobosus, aliquando irregularis 240-280 µm diam. Sporae tunicis duobus, tunica exterior et interior. Tunica exterior in totum 4,5 µm crassa, stratis tribus: stratum exterius tenue et evanescens, hyalinum; stratum medium laminatum, brunneum; stratus interius hyalinum. Tunica interior stratis tribus 3,6 µm in totum, hyalina, stratis uno hyalino minutis granulatis; stratis duobus hyalino; stratis tribus conspicue dentata, dentibus 0,5µm longis. Formans vesicular-arbuscular mycorrhizae.

ETYMOLOGY: *entrerriana*, referring to Entre Ríos Province where the species was first found.

TYPUS: isolated from trap culture at the Institute of Botany Spegazzini, Universidad Nacional de La Plata, Argentina. XI-2006, Velázquez. Holotypus LPS, slide N° 47993.

SPORES single in the soil, and laterally on the neck of a sporiferous saccule, brown, globose to subglobose; 280-300 µm diam, sometimes ovoid; 260-300 x 280-330 µm.

SUBCELLULAR STRUCTURE OF SPORES consists of 1 spore wall and inner germinal wall. Neither spore nor germinal walls react in Melzer's reagent.

SPORE WALL composed of 3 layers (*swl1-3*), 4.5 µm thick. *LAYER 1 (swl1)* evanescent, hyaline, 0.9 µm thick, rarely present in mature spores, continuous with the wall of a sporiferous saccule. *LAYER 2 (swl2)* smooth, light brown to dark brown, (1.2-)2.7(-4.6) µm thick. *LAYER 3 (swl3)* smooth, composed of 3–4 tightly attached laminae, hyaline, (0.7)1.0(-2.7) µm thick, commonly adhered to layer 2.

GERMINAL WALL 3-layered, hyaline, (*gwl1-3*) 3.6 µm thick. *LAYER 1 (gwl1)* smooth, hyaline, covered with small beads, (0.7-)2.7(-1.2) µm thick. *LAYER 2 (gwl2)* smooth hyaline. *LAYER 3 (gwl3)* hyaline 0.9-1.5 µm thick in PVLG, ornamented with teeth 0.5 µm high.

SPORIFEROUS SACCULE hyaline, mostly globose to subglobose, occasionally irregular, 240-280 µm diam. Distance from saccule to spore 100-150 µm.

CICATRIX not observed.

DISTRIBUTION AND HABITAT: *A. entreriana* was found in trap cultures built up with soil from scrubland, palm forest, grassland, and gallery forest of El Palmar National Park. The spore density of *A. entreriana* in trap culture was 4-200 in 100 g dry soil, the scrubland evidenced the highest density. The fungi accompanying *A. entreriana* were *A. delicata*, *E. infrequens*, *Glomus clarioideum* N. C. Schenck & G. S. Sm. and *G. etunicatum*.

MYCORRHIZAL ASSOCIATIONS: Forms vesicular arbuscular mycorrhizae. *A. entreriana* was associated in trap cultures with *L. perenne*, *M. sativa* and *P. lanceolata*.

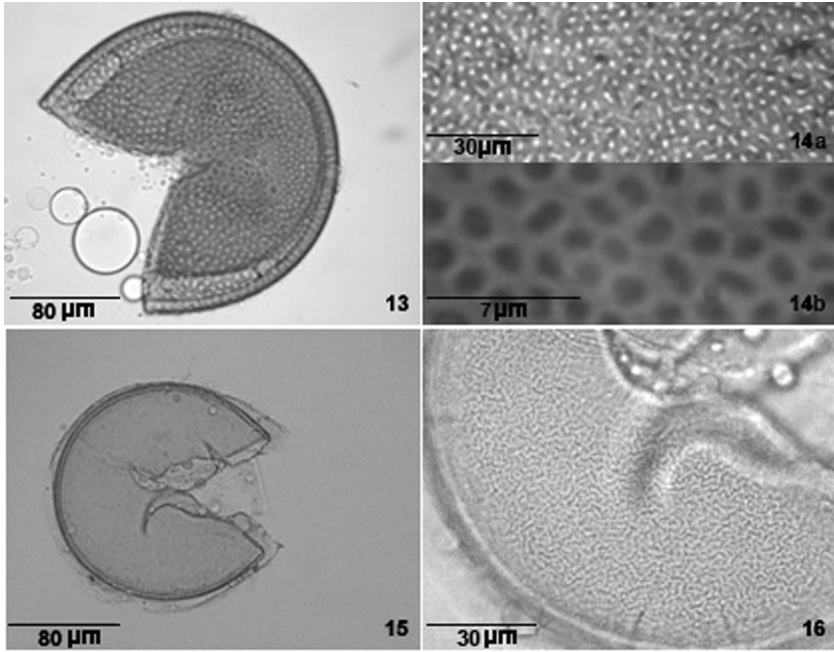
GENERAL NOTES: In colour and shape, *A. entreriana* spores resemble those of *Acaulospora koskei* J. Błaszk. (Błaszkowski 1995), except larger and with an ornamented inner wall. The wall in *A. entreriana* did not react in Melzer's, whereas the smooth wall of *A. koskei* turned red-purple in the same reagent. Both *A. entreriana* and *A. splendida* E. Sieverd. et al. are the only species known in *Acaulospora* that have a single germinal wall, a character that is very important considering that germinal walls are involved in germination. *A. entreriana* walls do not react in Melzer reagent, a character shared with *A. polonica* J. Błaszk.

A. entreriana spores were not recovered in soil samples.

7. *Acaulospora excavata* Ingleby & C. Walker, Mycotaxon 50: 100. 1994

MATERIAL EXAMINED: ARGENTINA. Entre Ríos: *El Palmar National Park*. VIII-2004, Velázquez. Isolated from soil sample from scrubland, marsh and palm forest. LPS, slide N° 47999.

DISTRIBUTION AND HABITAT: this species was found for the first time at Ivory Coast, Africa. Later it was found in Central Argentina mountain grasslands (Lugo & Cabello 1999) and agroecosystems (Schalamuk et al. 2006).



Figures 13-14. *Acaulospora foveata*. Figure 13. Mature spore in Melzer's reagent. Figure 14 a-b. Ornamented wall. Figures 15-16. *A. rehmi*. Figure 15. Broken spores. Figure 16. Broken spores with labyrinthiform ornamentation.

GENERAL NOTES: This species was not recovered on trap plants. This material agrees with the original descriptions of *A. excavata*.

8. *Acaulospora foveata* J. M. Trappe & Janos,

Mycotaxon 15: 516. 1982

FIGS. 13-14 a, b

SPORES single in the soil, and laterally on the neck of a sporiferous saccule, red-orange to dark red-orange, globose to subglobose; 240-320 µm diam.

SUBCELLULAR STRUCTURE OF SPORES consists of 1 spore wall and 2 inner germinal walls.

SPORE WALL composed of 3 layers (*swl1-3*). *LAYER 1 (swl1)* hyaline, 2.0 µm thick, rarely present in mature spores. *LAYER 2 (swl2)* 9-18 µm thick at maturity. Initially a single layer, forms in undulations that establish the shape and depth of surface concave circular to ovoid depressions (8-12 µm across and 0.5-3 µm deep in the mature layer). *LAYER 3 (swl3)* 3-5 µm thick, produces a dark red-brown reaction in Melzer's reagent.

GERMINAL WALL 1 (*gw1*) consists of 2 adherent layers (*gw1l1-2*), both are of near-equal thickness, ranging from 0.6-1.0 µm thick.

GERMINAL WALL 2 (*gw2*) consists of 2 adherent layers (*gw2I1-2*), produces pinkish red to a reddish-purple reaction in Melzer's reagent.

SPORIFEROUS SACCCULE not observed.

CICATRIX not observed.

MATERIAL EXAMINED: ARGENTINA. Entre Ríos: *El Palmar National Park*. VIII-2007, Velázquez. LPS, slide N° 48000.

DISTRIBUTION AND HABITAT: *A. foveata* was found in wet tropical forests in Mexico, Costa Rica and Panama (Janos & Trappe 1982). *A. foveata* was found in trap cultures built up with soil from palm forest of El Palmar National Park. The spore density of *A. foveata* in trap culture was 6 in 100 g dry soil. The fungi accompanying *A. foveata* were *A. delicata* and *G. etunicatum*.

MYCORRHIZAL ASSOCIATIONS: *A. foveata* was associated in trap cultures with *L. perenne*, *M. sativa* and *P. lanceolata*.

GENERAL NOTES: *A. foveata* spores were not recovered in soil samples. This material agreed with the original descriptions of *A. foveata*.

9. *Acaulospora laevis* J. W. Gerd. & Trappe, Mycologia Memoir 5: 33. 1974

MATERIAL EXAMINED: ARGENTINA. Entre Ríos: *El Palmar National Park*. V-2004, Velázquez. Isolated from soil sample from scrubland, marsh, palm forest, grassland and gallery forest. LPS, slide N° 48001.

DISTRIBUTION AND HABITAT: *A. laevis* has a worldwide distribution. Abundant from the coast of northern California to Washington. Also reported from Florida, Australia, New Zeland, Pakistan and Scotland. *A. laevis* was found associated with mountain grasses in Central Argentina (Lugo et al. 1999) and with *C. tala* and *S. buxifolia* forests (Irrazabal et al. 2004).

GENERAL NOTES: *A. laevis* spores were not recovered on trap plants.

10. *Acaulospora mellea* Spain & N. C. Schenck, Mycologia 76: 689. 1984

MATERIAL EXAMINED: ARGENTINA. Entre Ríos: *El Palmar National Park*. V-2004, Velázquez. Isolated from soil sample from scrubland, marsh, palm forest, grassland and gallery forest and pot cultures associated with *L. perenne*, *M. sativa* and *P. lanceolata*. LPS, slide N° 48002.

DISTRIBUTION AND HABITAT: *A. mellea* was found in Poland in uncultivated and cultivated soils (Błaszowski 1993) and associated with dune plants (Błaszowski et al. 2002). In Central Argentina, it was found associated with mountain grassland (Lugo & Cabello 1999) and agroecosystems (Schalamuk et al. 2006).

GENERAL NOTES: Our material agreed with the original descriptions of *A. mellea*.

11. *Acaulospora rehmsii* Sieverd. & S. Toro,

Angewandte Botanik 61: 219. 1987

Figs. 15-16

SPORES single in the soil, and laterally on the neck of a sporiferous saccule, pale yellow to light brown, globose to subglobose 90-160 µm diam.

SUBCELLULAR STRUCTURE OF SPORES consists of 1 spore wall and 2 inner germinal walls.

SPORE WALL composed of 3 layers (*sw1*–3). *LAYER 1 (sw1)* evanescent, hyaline, 1.0 µm thick, continuous with the wall of a sporiferous saccule, rarely present in mature spores. *LAYER 2 (sw2)* laminate, pale yellow, 4-10 µm thick, ornamented with labyrinthiform folds. *LAYER 3 (sw3)* semiflexible, hyaline, 0.5 µm thick, rarely separated from layer 2.

GERMINAL WALL 1 (*gw1*) consists of 2 tightly adherent hyaline, semiflexible layers. *LAYER 1 (gw11)* and *layer 2 (gw12)* reach 0.5-1.0 µm thick. These layers tightly adhere to each other and hence are quite difficult to differentiate.

GERMINAL WALL 2 (*gw2*) composed of 2 adherent layers. *LAYER 1 (gw21)* flexible, hyaline, 0.5-1.0 µm thick, covered with granules. *LAYER 2 (gw22)* flexible, hyaline, 0.6-1.4 µm thick in PVLG.

SPORIFEROUS SACCULE hyaline, globose to subglobose, 90-150 µm diam, usually collapsed and detached in mature spores.

CICATRIX not observed.

MATERIAL EXAMINED: ARGENTINA. Entre Ríos: *El Palmar National Park*. IX-2006, Velázquez. LPS, slide N° 48003.

DISTRIBUTION AND HABITAT: *A. rehmsii* was originally isolated from a crop field at Caicedonia, Valle de Cauca, Colombia (Sieverding & Toro 1987). This fungus has been associated with cassava, beans, sorghum and *Crotalaria* species. Additionally, Sieverding & Toro (1987) found *A. rehmsii* spores in a culture containing a soil sample from Brasilia, Brazil. Wu et al. (1995) isolated *A. rehmsii* spores from among roots of *Phyllostachys pubescens* growing in a garden at Chitou Experimental Station, National Taiwan University.

A. rehmsii was found in trap cultures containing soil from the El Palmar National Park palm forest. Its trap culture spore density was 6 per 100 g dry soil. The fungi accompanying *A. rehmsii* were *G. etunicatum* and *Glomus* sp.

MYCORRHIZAL ASSOCIATION: *A. rehmsii* was associated in trap cultures with *L. perenne*, *M. sativa* and *P. lanceolata*.

GENERAL NOTES: *A. rehmsii* is a species easily recognized by the unique labyrinthiform ornamentation of its layer 2 spore wall.

12. *Acaulospora scrobiculata* J. M. Trappe, Mycotaxon 6: 363. 1977

MATERIAL EXAMINED: ARGENTINA. Entre Ríos: *El Palmar National Park*. V-2004, Velázquez. Isolated from soil sample from scrubland, marsh, palm forest, grassland and gallery forest and trap cultures associated with *L. perenne*, *M. sativa* and *P. lanceolata*. LPS, slide N° 48004.

DISTRIBUTION AND HABITAT: *A. scrobiculata* was originally described from spores collected in Mexico (Trappe 1977). This fungus has a global distribution and is found in many localities in the U.S.A. (Friese & Koske 1991, Gemma & Koske 1989, Koske 1987, 1988), Canada (Dalpé 1989), Australia (Koske 1975), China (Zhang et al. 1992), Taiwan (Wu & Chen 1986), and Argentina (Lugo & Cabello 1999).

GENERAL NOTES: The spores of our material correspond in colour, form and size with those originally described.

13. *Acaulospora spinosa* C. Walker & Trappe, Mycotaxon 12: 515. 1981

MATERIAL EXAMINED: ARGENTINA. Entre Ríos: *El Palmar National Park*. V-2004, Velázquez. Isolated the soil sample from scrubland, marsh, palm forest, grassland and gallery forest. LPS, slide N° 48005.

DISTRIBUTION AND HABITAT: This fungus has a worldwide distribution and is found in many localities in the U.S.A. and Mexico. *A. spinosa* was found in a mountain grassland in Central Argentina (Lugo & Cabello 1999). Irrazabal et al. (2004) also record it from *C. tala* and *S. buxifolia* forests.

GENERAL NOTES: *A. spinosa* spores were not recovered in trap plants.

Discussion

These species of *Acaulosporaceae* were identified in field samples and in trap culture; a total of 19 species were detected in El Palmar National Park. *Acaulospora* diversity in El Palmar National Park was found to be higher than that reported for other ecosystems (Lugo & Cabello 1999, 2002, Lugo et al. 1999, Irrazabal et al. 2004) or agroecosystems (Albornoz & Catania 1996, Menéndez et al. 2001, Schalamuk et al. 2006) in Argentina. AM fungal communities dominated by *Acaulospora* spp. have been reported in other forested ecosystems (Helgason et al. 1998, Merryweather & Fitter 1998a, b), and in alluvial soils (Lovelock et al. 2003).

The decrease of anthropoid disturbance in protected areas such as El Palmar National Park is well known to markedly favour diversity conservation (Jasper et al. 1991). On the other hand, heterogeneity of the environment involving scrubland, marsh, palm forest grassland and gallery forest play an essential role in keeping the abundance and distribution of these fungi.

Acknowledgements

The authors are indebted to N. Tedesco and Dr. L. Norvell for improving use of English language. Velázquez and Irrazabal are recipients of scholarships from CONICET, Cabello is a research scientist from the Comisión de Investigaciones Científicas (CIC) Bs. As. Province, and Godeas is a research scientist from CONICET. This research is part of N411UNLP project. This work was carried out with the financial support of CIC, UNLP and ANPCyT No 13404 BID 1201/OC-AR. The authors wish to thank Dr L. Varela-Fregoso and Dr. G. Cuenca for their suggested revisions of the manuscript.

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