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**SOME INTERESTING GASTEROID AND SECOTIOID FUNGI FROM SONORA, MEXICO**G. MORENO<sup>1</sup>, M. ESQUEDA<sup>2</sup>, E. PÉREZ-SILVA<sup>3</sup>, T. HERRERA<sup>3</sup> & A. ALTÉS<sup>1</sup>

Nine rare species of gasteroid and secotiid fungi from Sonora, Mexico are treated here: *Agaricus texensis* (= *Longula texensis*), *Araneosa columellata*, *Calvatia bicolor*, *C. craniiformis*, *C. pygmaea*, *Disciseda hyalothrix*, *D. verrucosa*, *Endoptychum arizonicum*, and *D. stuckertii* (= *Abstoma stuckertii*), which is a new combination. SEM micrographs of all studied taxa are included.

Fungal diversity makes the Mexican State of Sonora highly interesting. The vegetation comprises several types, namely microphyllous desert scrub, tropical thorn forest, tropical deciduous forest, oak and oak-pine forest. Many of these fungi tolerate long dry periods, which characterize arid and semi-arid regions (200–350 mm/yr) and play a decisive role in the conservation of ecosystems, especially in the recycling of organic matter. The present work focuses on these mushrooms of agaricoid and gastroid habits, traditionally classified in the artificial group Gasteromycetes. Nine species of mushrooms, which are little known world-wide or which occur in a very small area, were identified from samples collected during the last decade in Sonora. These include *Endoptychum arizonicum*, a gregarious species limited to the desert between Mexico and the USA; *Araneosa columellata*, recorded for the second time by Esqueda et al. (1998), 60 years after the holotype was registered from Arizona, USA (Long, 1941); and *Calvatia pygmaea*, reported by Fries (1909) from Argentina and Bolivia, and found again in Baja California by Ochoa et al. (1998).

**MATERIALS AND METHODS**

To analyze microscopical features of the basidiomata, freehand samples of the gleba and peridium were mounted in water, lactophenol cotton blue, 5% KOH, and Melzer's reagent. Electronic micrographs were made under a Zeiss DSM 950 SEM following Moreno et al. (1995). The material studied is deposited in the National Herbarium of the Institute of Biology, UNAM, Mexico (MEXU), the mushroom collection of the Centro de Estudios Superiores del Estado de Sonora, Mexico (CESUES), and the Herbarium of the University of Alcalá, Madrid, Spain (AH).

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- 1) Dpto. Biología Vegetal, Universidad de Alcalá, E-28871 Alcalá de Henares, Madrid, Spain; e-mail: gabriel.moreno@uah.es; alberto.altés@uah.es
  - 2) Centro de Investigación en Alimentación y Desarrollo, A.C. Apartado Postal 1735, Hermosillo, Sonora, México, 83000; e-mail: esqueda@cascabel.ciad.mx
  - 3) Laboratorio de Micología, Instituto de Biología, UNAM, Apartado Postal 70-233, Coyoacán, México D.F., 04510; e-mail: psilva@ibiologia.unam.mx; therrera@ibiologia.unam.mx

## SPECIES STUDIED

1. *Agaricus texensis* (Berk. & Curtis) Geml, Geiser & Royse — Figs. 1, 2

*Agaricus texensis* (Berk. & Curtis) Geml, Geiser & Royse, Mycol. Progr. 3 (2004) 172.

*Secotium texense* Berk. & Curtis in Berk., Grevillea 2 (1873) 34–35.

*Gyrophragmium texense* (Berk. & Curtis) Masee, Grevillea 19 (1891) 96.

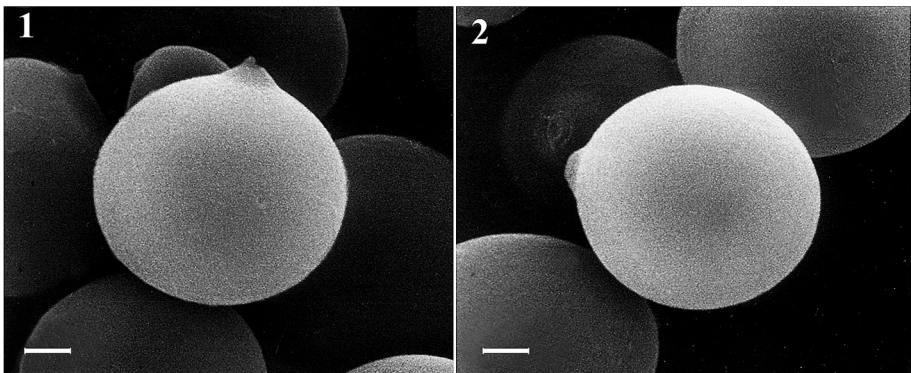
*Longia texensis* (Berk. & Curtis) Zeller, Mycologia 35 (1943) 414.

*Longula texensis* (Berk. & Curtis) Zeller, Mycologia 37 (1945) 636.

The agaricoid basidiocarps have an obese and striate stalk, which extends as a percurrent columella through the pileus. The subglobose pileus remains closed until maturity, when it expands to a broad, convex pileus similar to those of Agaricaceae. At expansion, the peridium exposes the hymenophore, with its dark, crowded, wavy, free, sometimes anastomosing lamellae; remains of the peridium frequently form a typical double membranous annulus. Spores (statismospores) are subglobose to ovoid, smooth, very dark, lacking a germ pore. Excellent illustrations of *A. texensis* are included in Lloyd (1904c), Barnett (1943), Harding (1957), and States (1990).

The genus *Longia* was proposed by Zeller (1943), based on *S. texense* Berk. & Curtis. It was later abandoned on nomenclatural grounds, with the species transferred to the new genus *Longula* (Zeller, 1945). It is closely related to *G. dunalii* (Fr.) Zeller, and some authors (i.e. Guzmán & Herrera, 1969) considered both taxa as conspecific. Zeller (1943) based their separation into two genera on account of the sturdiness of *Longula* (*Longia*) and veil remnants at the base of the stipe of *Gyrophragmium*, features which he compared with those of *Amanita* and *Lepiota*. Masee (1891) proposed the combination *G. texense*, based on the presence of a volva in that species. Harding (1957) supports that argument in his work on *L. texensis* var. *major* Zeller.

A recent molecular study has confirmed the differences between these two taxa (Geml et al., 2004) based on sequences of the internal transcribed spacers (ITS) and partial large subunit of ribosomal DNA, demonstrating that secotioid species *G. dunalii* and *L. texensis* evolved from different species of *Agaricus*, and proposing their classification in this genus as *A. aridicola* Geml, Geiser & Royse and *A. texensis*, respectively. However, the relationship between *L. texensis* and the genus *Agaricus* is not new: it has been



Figs. 1, 2. *Agaricus texensis* from Sonora (AH 31729). Spores under SEM. Scale bars: 1  $\mu\text{m}$ .

put forth by several authors and it is broadly accepted. In this sense, Barnett (1943) found the development of *L. texensis* to be similar to that of some species of *Agaricus*.

*Agaricus texensis* (= *L. texensis*) is only known from the area between southwestern United States and northwestern Mexico. It has been cited in Texas by Berkeley (1873) as *S. texense* and by Lloyd (1904c) as *G. texense*; in New Mexico by Barnett (1943); in California by Lloyd (1904b) as *G. decipiens* (Peck) Lloyd; in Oregon by Zeller (1943); in Baja California by Ochoa et al. (1990) as *G. dunalii* (later corrected as *L. texensis* by Ochoa, 1993). We have not examined the material studied by Urista et al. (1985), which was recorded as *G. dunalii*; their description fits *A. texensis* instead. If this proposal is accepted, its distribution would thus extend to the Mexican states of Nuevo León and Coahuila. The only report of this species in Sonora was made by Ochoa (1993).

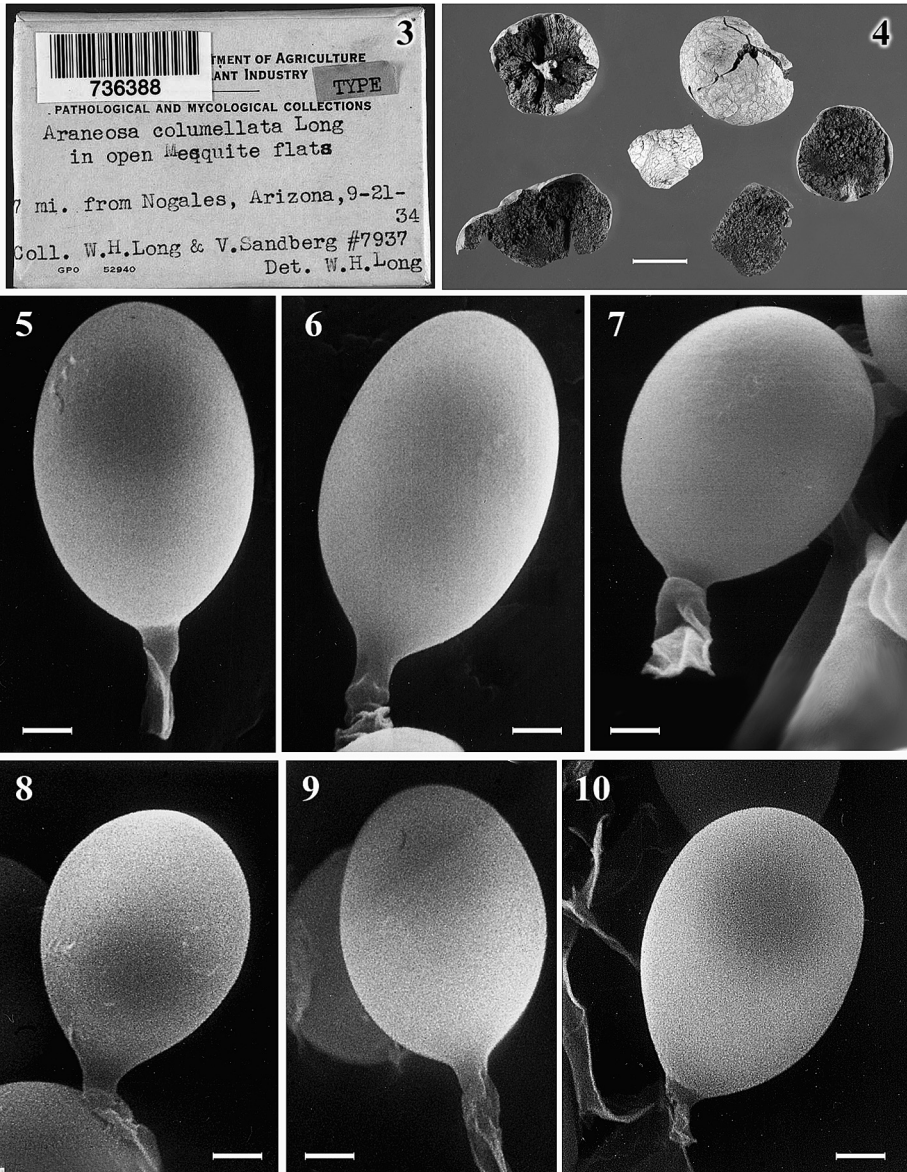
*Specimens examined.* MEXICO: Sonora, La Colorada municipality, Km 31 Hermosillo to Yécora road, microphyllous desert scrub, leg. M. Esqueda, A. Armenta, A. Núñez & R. Santos, 24.XI.1995, CESUES 2215; *ibidem*, 16.II.1996, CESUES 2354; *ibidem*, 11.IX.1996, CESUES 2785. Km 40 Hermosillo to Yécora road, microphyllous desert scrub, leg. M. Esqueda, A. Armenta, A. Núñez & R. Santos, 24.XI.1995, CESUES 2220; *ibidem*, 11.IX.1996, CESUES 2886. Km 100 Hermosillo to Yécora road, tropical thorn forest, leg. M. Esqueda, A. Armenta, A. Núñez & R. Santos, 24.XI.1995, CESUES 2230, duplo in AH 31728; *ibidem*, 14.V.1998, CESUES 3973; *ibidem*, 26.VIII.1998, CESUES 4369, duplo in AH 31729.

## 2. *Araneosa columellata* Long — Figs. 3–10

*Araneosa columellata* Long, Mycologia 33 (1941) 353.

*Araneosa columellata* produces closed gastroid carpophores, cream-coloured to pale ochraceous, often pyriform, with a short and somewhat bulbous stipe as properly illustrated by Long (1941). As he noted, the stipes of *A. columellata* detach easily from the spore sac; the conic basal hole left by the stipe facilitates the breaking of the fragile peridium, thus exposing the gleba. The Sonoran collections lack a stipe and have a highly fragmented pileus. This is also found in the type collection of the species. As the specific epithet reflects, a conspicuous columella protrudes through the pileus. The gleba is formed by small, easily detachable peridioles, dark grey in the herbarium specimens, surrounding the columella. The subglobose to irregularly ovoid spores are 5–6(–7) × 4–5(–6)  $\mu\text{m}$  in diameter, pedicellate, reddish brown, smooth both under LM and SEM, and without capillitium.

When Long (1941) created the genus *Araneosa*, he stated that *A. columellata* was closely related to *Arachnion* Schwein. as the gleba is formed by small peridioles in both cases. The latter does not possess a stipe nor columella. These two genera formed the Arachniaceae, after being emended by Long himself (1941), who established a relationship with Lycoperdaceae as in both families the gleba presents chambers until maturity. With this similarity, *Arachnion* would be the closest genus to *Lycoperdon* (*A. rufum* Lloyd and *A. album* Schwein.). Demoulin (1972) defended that relationship but did not discuss the differences with *Araneosa*. To date, the Dictionary of Fungi (Kirk et al., 2001) classifies *Arachnion* as Lycoperdaceae but leaves *Araneosa* in Agaricaceae. The study and comparison of DNA sequences will allow to clarify the real affinities of *A. columellata*.



Figs. 3–7. Holotype of *Araneosa columellata* (W.H. Long & V. Sandberg 7937 in BPI 736388). 3. Label of the collection; 4. basidiomes; 5–7. spores under SEM. — Figs. 8–10. *Araneosa columellata* from Sonora (AH 31712). Spores under SEM. Scale bars: 4 = 10 mm; 5–10 = 1  $\mu$ m.

According to the only two reports of *A. columellata* (Long, 1941; Esqueda et al., 1998) its distribution seems to be restricted to a small area between Nogales and Tucson, Southern Arizona, and around Hermosillo, in central Sonora. This paper does not change this range, but increases the scarce records of this species.

*Specimens examined.* MEXICO: Sonora, La Colorada municipality, Km 40 Hermosillo to Yécora road, in *Acacia constricta*, *Bursera microphylla* and *Guaiacum coulteri* scrub, leg. M. Esqueda, A. Armenta, A. Núñez & R. Santos, 14.X.1995, CESUES 2185, duplo in AH 31712. — USA: Arizona, 7 mi. from Nogales, in open mesquite flats, leg. W.H. Long & V. Sandberg 7937, 21.IX.1934, BPI 736388, holotype, and BR, isotype.

### 3. *Calvatia bicolor* (Lév.) Kreisel — Figs. 11, 12

*Calvatia bicolor* (Lév.) Kreisel, *Persoonia* 14 (1992) 435.

*Bovista bicolor* Lév., *Ann. Sci. Nat., Bot.* 5 (1846) 162.

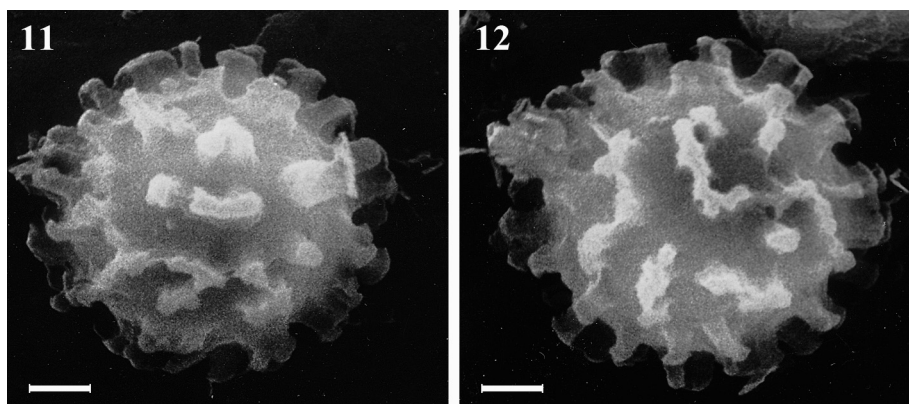
*Lanopila bicolor* (Lév.) Pat., *Bull. Soc. Mycol. France* 15 (1899) 203.

*Langemannia bicolor* (Lév.) Demoulin & Dring, *Bull. Jard. Bot. Belg.* 45 (1975) 350.

*Lasiosphaera fenzlii* Reichardt in Fenzl, *Reise Austr. Freg. Nov.* 1 (1870) 135.

The Sonoran specimens are subglobose, approximately 50 × 70–80 mm. The dry exoperidium looks like a thin, fragile copper-coloured crust attached to the endoperidium, which appears membranous and flexible, and is cream to pale ochre. Noticeable colour variations of the exoperidium in some specimens are the origin of the specific epithet, as pointed out by Bottomley (1948). The lack of subgleba and mycelial strands, and the presence of the brown, cotton like, compact and persistent gleba (referring to the name *Lanopila*), characterizes this species. The capillitium is abundant, dark, extensively interwoven, c. 4 µm in diameter, somewhat branched, septate, not pitted. The spores are yellow brownish, 5–6 µm in diameter, strongly ornamented, with SEM showing almost cylindrical processes with rounded to almost planar tips, which sometimes form small groups.

*Calvatia bicolor* may be clearly told apart from a *Bovista* when its gleba and the features of the peridium are observed under the microscope, regardless of their macroscopic similarities. In any case, several authors have recorded this taxon under the genera *Bovista*, *Langemannia*, *Lanopila*, or *Lasiosphaera*. This study follows Kreisel (1992), who placed this taxon in genus *Calvatia* section *Lanopila*, but declines the generally accepted conspecificity of *C. bicolor* and *Lanopila wahlbergii* Fr. (Homrich & Wright, 1973; Kreisel, 1994) until further study of the latter is made. The only sample of *L. wahlbergii* studied by us (Natal, South Africa, IX.1923, PREM 46086) has spores with spines larger than those of *C. bicolor*, as observed with SEM.



Figs. 11, 12. *Calvatia bicolor* from Sonora (AH 31714). Spores under SEM. Scale bars: 1 µm.

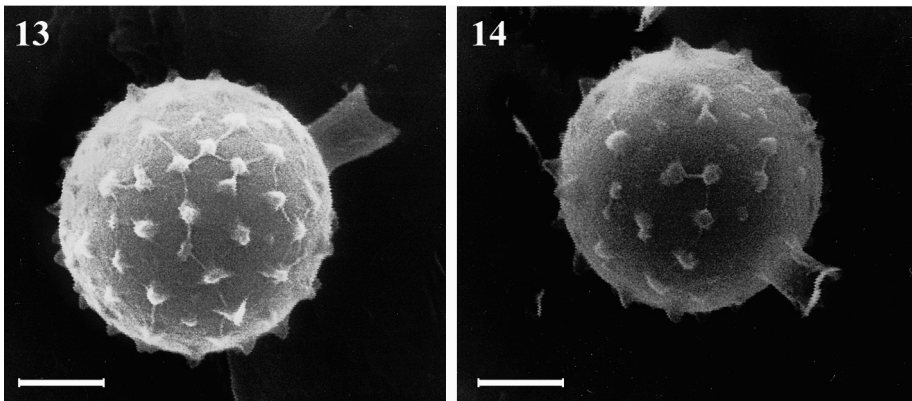
*Calvatia bicolor* is known from Argentina, Brazil, Ecuador, Cuba, St. Kitts (West Indies), India, Indonesia (Lloyd, 1904a; Kreisel, 1994). It has also been cited from South Africa and the former Belgian Congo by Bottomley (1948). We maintain our doubts about some identifications cited as *L. wahlbergii* until further information is acquired. The first reference (and illustration) of this species in Mexico was made by Lloyd (1902) as *B. lateritia* Berk., and corrected later by the author (Lloyd, 1904a). Guzmán & Herrera (1969) cited *L. wahlbergii* from the Mexican state of Morelos. Ochoa (1993) included two collections of *L. bicolor* from Baja California Sur in his doctoral thesis (unpublished). The material studied for the present work is the first record of *C. bicolor* for Sonoran mycobiota.

*Specimens examined.* MEXICO: Sonora, Baviácora municipality, near Baviácora town, leg. M. Esqueda & R. Ramírez, 26.III.1993, CESUES 1220, duplo in AH 31714; Ónavas municipality, Km 204.5 Hermosillo to Yécora road, oak-pine forest, leg. M. Esqueda, A. Armenta, A. Núñez & R. Santos, 6.X.1995, CESUES 2108, duplo in MEXU 24540; ibidem, leg. E. Pérez-Silva, T. Herrera, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 13.IX.1996, CESUES 2973; San Javier municipality, Km 151 Hermosillo to Yécora road, tropical thorn forest, leg. M. Esqueda, A. Armenta, A. Núñez & R. Santos, 14.X.1995, CESUES 2147.

#### 4. *Calvatia craniiformis* (Schwein.) Fr. ex De Toni — Figs. 13, 14

*Calvatia craniiformis* (Schwein.) Fr. ex De Toni in Saccardo, Syll. Fung. 7 (1888) 106.  
*Bovista craniiformis* Schwein., Trans. Amer. Philos. Soc., ser. 2, 4 (1832) 256.

The type species of *Calvatia* is characterized by a cellular and well-developed subgleba, resembling *C. cyathiformis* (Bosc) Morgan and *H. utrififormis* (Bull.: Pers.) Kreisel. *Calvatia craniiformis* differs from the former by the olivaceous, not lilacineous gleba, and by the smaller spores (3–4  $\mu\text{m}$  in diameter), semi smooth with LM but with small and regularly distributed verrucae-spines as observed with SEM. The capillitium is conspicuously pitted, with holes up to 3  $\mu\text{m}$  in diameter, whereas the European species *H. utrififormis* has the characteristic capillitium of genus *Handkea* (Kreisel, 1989) with elongated, slit-like pits. In addition, even when the spores of the latter are semi smooth under LM, the ornamentation under SEM appears more dense with rounded verrucae.



Figs. 13, 14. *Calvatia craniiformis* from Sonora (AH 31715). Spores under SEM. Scale bars: 1  $\mu\text{m}$ .

The distribution of *C. craniiformis* includes North America and areas as remote as China and Japan (Kreisel, 1994). This species is well known in the United States, as proven by the numerous specimens kept in the Herbarium NY. However, the records from that country are rather scarce: North Carolina (type), Michigan (Kreisel, 1994), Oklahoma, Texas (Zeller & Smith, 1964). On the other hand, it is not a common species in Mexico, cited only from the northern states of Nuevo León, Coahuila (Urista et al., 1985) and Sonora (the two collections studied here).

Recently, Coetzee & Van Wyk (2003) wrote a note explaining the problem related to the authority of the name *C. craniiformis*.

*Specimens examined.* MEXICO: Sonora, Yécora municipality, Km 251 Hermosillo to Yécora road, oak forest, leg. M. Esqueda & R. Rodríguez, 10.IX.1995, CESUES 1922; ibidem, leg. E. Pérez-Silva, T. Herrera, M. Esqueda, A. Armenta & R. Santos, 13.IX.1996, CESUES 2977, duplo in AH 31715.

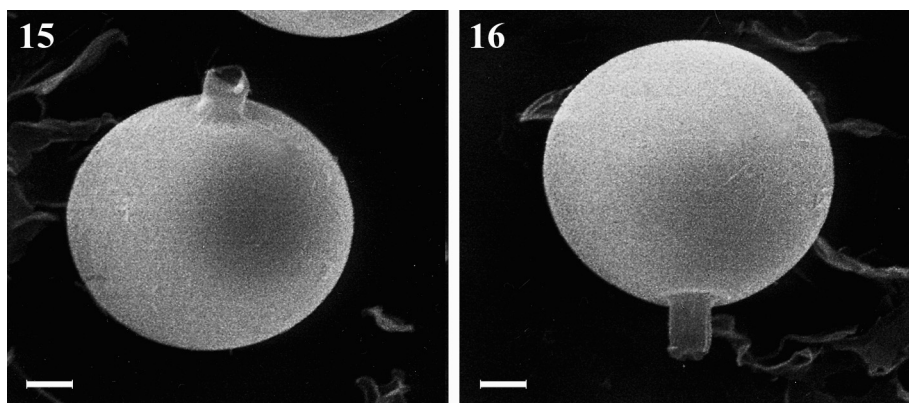
5. *Calvatia pygmaea* (R.E. Fr.) Kreisel, G. Moreno, C. Ochoa & Altés — Figs. 15, 16

*Calvatia pygmaea* (R.E. Fr.) Kreisel, G. Moreno, C. Ochoa & Altés, Cryptog. Mycol. 19 (1998) 132.

*Lanopila pygmaea* R.E. Fr., Ark. Bot. 8 (1909) 16–17.

*Calvatia pygmaea* is an interesting xerophilous bovistoid species, which was practically unnoticed until recently. Very few records are available: the two collections from Argentina and Bolivia which allowed Fries (1909) to describe it, and another two samples collected by Ochoa et al. (1998) in Baja California Sur, Mexico. The first record from Sonora of *C. pygmaea* is hereby presented, where it appears to be a relatively frequent species in sandy basic soils under *Bursera*, *Cercidium*, and *Olneya*.

*Calvatia pygmaea* belongs to *Calvatia* section *Lanopila* (Fr.) Kreisel, but it is the only species in the section showing smooth spores with both LM and SEM. The collections from Sonora have globose to subglobose basidiocarps with a diameter of 10–25 mm and without subgleba. Its features, including the size of spores 6.5–8 µm in diameter, fit very well the original description and the above-mentioned collections (Ochoa et al., 1998).



Figs. 15, 16. *Calvatia pygmaea* from Sonora (AH 31717). Spores under SEM. Scale bars: 1 µm.

*Specimens examined.* MEXICO: Sonora, Hermosillo municipality, Km 115 36N St. to Puerto Libertad road, microphyllous desert scrub, leg. M. Esqueda, A. Armenta, M. Coronado & A. Sánchez, 7.III.1998, CESUES 3953, duplo in AH 31717; ibidem, 29.VIII.1998, CESUES 4373, duplo in AH 31718; Km 125 36N St. to Puerto Libertad road, microphyllous desert scrub, leg. M. Esqueda, A. Armenta, M. Coronado & A. Sánchez, 29.VIII.1998, CESUES 4401, duplo in AH 31716; Ejido 6 de Diciembre, leg. G. Yanez, 27.VII.1994, CESUES 3257, duplo in AH 31719; Puerto Peñasco municipality, Pinacate and Grand Desert Biosphere Reserve, Ejido Los Norteños, leg. A. Sánchez, I. Encinas & J. Miranda, 12.VIII.2004, CESUES 5248; Sonoyta municipality, Pinacate and Grand Desert Biosphere Reserve, Ejido Punta Peñasco, leg. A. Sánchez, I. Encinas & J. Miranda, 16.I.2004, CESUES 5102; ibidem, 28.IV.2004, CESUES 5187; ibidem, 12.VIII.2004, CESUES 5213.

## 6. *Disciseda hyalothrix* (Cooke & Masee) Hollós — Figs. 17, 18

*Disciseda hyalothrix* (Cooke & Masee) Hollós, Növényt. Közlem. 1 (1902) 107.

*Bovista hyalothrix* Cooke & Masee, Grevillea 16 (1888) 73.

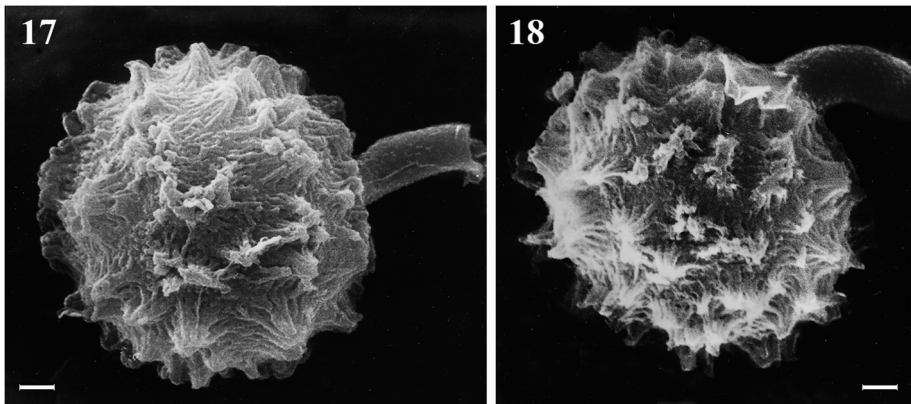
*Catastoma hyalothrix* (Cooke & Masee) Lloyd, The Lycopodaceae of Australia, New Zealand and Neighbouring Islands (1905) 27.

*Catastoma pedicellatum* Morgan, J. Cincinnati Soc. Nat. Hist. 14 (1892) 143–144.

*Disciseda pedicellata* (Morgan) Hollós, Természetrázi Füz. 25 (1902) 103.

The Sonoran specimens of *D. hyalothrix* have basidiocarps up to 20 mm in diameter. This species is characterized by ochraceous spores of a variable size (8.5–13  $\mu\text{m}$  in diameter), with conspicuous ornamentation formed by spines fused at the apex, forming processes with a flat tip. The spores maintain pedicels not as often as in the collections studied by Moreno et al. (2003), with a length of 5  $\mu\text{m}$ , which in some cases reaches up to 12  $\mu\text{m}$ . We believe that it is the grade of maturity and conservation of the gleba that determines such a condition, and that the spore ornamentation is much more important for the characterization of the species.

Recently, a comparative study of the type collections of *D. hyalothrix* and *D. pedicellata* (Moreno et al., 2003) showed their conspecificity. Unfortunately, the name to be given priority is the least known: the name *D. hyalothrix* has been applied only to specimens from some Australian localities. Previously, Grgurinovic (1997) established the synonymy of *B. irregularis* Berk. and *D. pedicellata* and proposed a new species at the same time, *D. errurraga*, which Grgurinovic identified earlier as *D. hyalothrix*, based



Figs. 17, 18. *Disciseda hyalothrix* from Sonora (AH 31722). Spores under SEM. Scale bars: 1  $\mu\text{m}$ .



on Australian collections. In both cases, the descriptions emphasize some differences in spore size and pedicel length, just the characters that are now considered to be the most variable. To date, we have had no access to the type collections of *B. irregularis* or *D. errurraga*, but we believe that study of their spore ornamentation could lead to the conclusion that these names are additional synonyms of *D. hyalothrix*. In case this is confirmed, the name *D. hyalothrix* would be correct because its basionym, *B. hyalothrix*, was published earlier (March 1888) than *B. irregularis* (May 1888).

This species has been collected in almost all the continents, usually under the name of *D. pedicellata*. Even though the number of published records is not very significant, we cite here: USA (Coker & Couch, 1928), Argentina (Spegazzini, 1912; Domínguez de Toledo, 1989), Australia (Cunningham, 1942; Grgurinovic, 1997), Mozambique, South Africa (Bottomley, 1948), and a very doubtful citation from Sweden (Rydberg, 1949; Eckblad, 1955). Some records of this species are from xeric areas in several states of northern Mexico: Chihuahua (Laferrrière & Gilbertson, 1992), Sonora (Esqueda et al., 1995), and Baja California (Ochoa & Moreno, 1996; Ochoa et al., 2000).

*Specimens examined.* MEXICO: Sonora, Hermosillo municipality, Centro Ecológico de Sonora, leg. M. Esqueda & R.E. Villegas, 7.V.1993, CESUES 1581, duplo in AH 31721; Km 125 Hermosillo to Puerto Libertad road, leg. M. Esqueda, A. Armenta, A. Núñez & A. Sánchez, 29.VIII.1998, CESUES 4402, duplo in AH 31720; La Colorada municipality, Km 100 Hermosillo to Yécora road, leg. E. Pérez-Silva, M. Esqueda, A. Armenta, A. Núñez & R. Santos, 11.IX.1996, CESUES 2842; San Javier municipality, Km 137.5 Hermosillo to Yécora road, tropical deciduous forest, leg. M. Esqueda, A. Armenta, A. Núñez & R. Santos, 9.VI.1996, CESUES 2768, duplo in AH 31722.

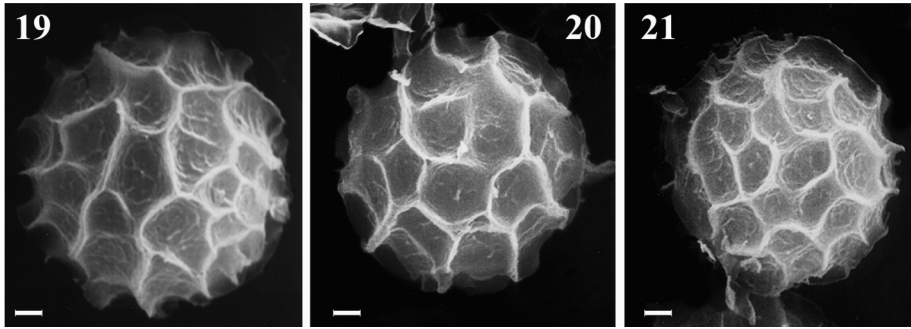
7. ***Disciseda stuckertii*** (Speg.) G. Moreno, Esqueda, Altés, *comb. nov.* — Figs. 19–21

*Bovista stuckertii* ('*stuckerti*') Speg., Anales Mus. Nac. Buenos Aires 8 (1902) 56.

*Abstoma stuckertii* (Speg.) J.E. Wright & V.L. Suárez, Cryptog. Bot. 1 (1990) 377.

The genus *Abstoma* was proposed by Cunningham (1926) for Lycopodaceae resembling *Bovista* or *Disciseda*, basidiocarps with an irregular dehiscence, without a definite stoma, wavy capillitium without pits and reticulate spores. Later, it was emended by Wright & Suárez (1990), including smooth and ornamented spores. Finally, it was corrected by Moreno et al. (1992) to include the new species *A. friabile* ('*friabilis*') G. Moreno et al. with a distinctive pitted capillitium. According to Wright & Suárez (1990) there are four species with reticulate spores: *A. purpureum* (Lloyd) G. Cunn. (New Zealand), *A. townei* (Lloyd) Zeller (West and Southwest United States, West Argentina), *A. stuckertii* (Argentina) and *A. reticulatum* G. Cunn. (Australia, West and Southwest United States). Among these species, the size and ornamentation of spores are so similar that clear limits are difficult to set. On this basis, Domínguez de Toledo (1989) established in her doctoral thesis the conspecificity of *A. stuckertii* and *A. reticulatum*.

The Mexican collections studied met all the characteristics in this group of *Abstoma* species, especially those from the center of the country which were identified as *D. muelleri* (Berk.) G. Cunn. by Guzmán & Herrera (1969). Spores in the collections from Sonora are slightly smaller (7–10  $\mu\text{m}$  in diameter) and meshes per hemisphere are less numerous, but do not exceed the ranges observed in such species. Pending a solution to the possible synonymy of these species with reticulate spores, our initial plan was to classify the Mexican material as *A. stuckertii*, the name with priority.



Figs. 19–21. *Disciseda stuckertii* from Sonora (AH 31709). Spores under SEM. Scale bars: 1  $\mu\text{m}$ .

On the other hand, the suitability of maintaining the genus *Abstoma* should be reconsidered given the similarities with other close genera, especially *Disciseda* (absence of subgleba, sinuous-spiraled capillitium, similar size and spore morphology). The main difference between these two genera is reduced to the type of dehiscence, by a more or less defined stoma in *Disciseda*, and by an apical irregular fracture of the spore sac in *Abstoma*. But this character is very variable in the collections of *Abstoma* studied by us, probably determined by the age and conservation of the material. Molecular data will most likely provide accurate information leading to a more adequate placement of some species of *Abstoma* in the genus *Disciseda*, as we do here, and perhaps some other species (i.e. *A. friabile*) can better be placed in *Calvatia*.

Regarding *A. stuckertii*, in both the Mexican material and the Argentinian collection BAFC 31871, it was proven that dehiscence is produced by a more or less defined stoma. Given the sand case of exoperidium, added to the most distinctive characteristic of *Disciseda*, we deem reasonable to propose a new combination: *D. stuckertii*. However, the link between *A. stuckertii* and *Disciseda* is not new at all. The species was originally classified by Spegazzini (1902) as *B. stuckerti*, but years later (Spegazzini, 1912) he reconsidered that position and placed that name in the synonymy of *D. pampeana* (Speg.) Speg. (= *B. pampeana* Speg.). Now we know that such synonymy is inaccurate because of the obvious differences in spore ornamentation of the two species (cf. Wright & Suárez, 1990), but the sand case that we mentioned before seems to us to be an outstanding character. Later, Wright & Suárez (1990) proposed the new combination of this species as *A. stuckertii* after revising genus *Abstoma* in South America, and accepted the synonymy of *D. pila* R.E. Fr., which was suggested earlier by Spegazzini himself (1912).

Wright & Suárez (1990) reported *Disciseda stuckertii* from several provinces of Argentina: Chaco, Córdoba (type of *Bovista stuckertii*), Jujuy (type of *Disciseda pila*), and Santiago del Estero. These authors also included the only non-Argentinian record, that is from New Zealand. Therefore, the material studied here represents the first record of *D. stuckertii* for Mexico.

*Specimens examined.* MEXICO: Sonora, Hermosillo municipality, Centro Ecológico de Sonora, microphyllous desert scrub, R.E. Villegas & M. Esqueda, 7.V.1993, CESUES 1290; ibidem,

20.VII.1993, CESUES 1587; La Colorada municipality, Km 100 Hermosillo to Yécora road, open areas in tropical thorn forest, leg. A. Armenta, A. Núñez & R. Santos, 16.II.1996, CESUES 2363, duplo in AH 31709; Baviácora municipality, Km 72 Mazocahui to Hermosillo road, leg. E. Pérez-Silva, T. Herrera & M. Esqueda, 30.VIII.2001, CESUES 4842; Sonoyta municipality, Pinacate and Grand Desert Biosphere Reserve, Papatote, leg. A. Sánchez, I. Encinas & J. Miranda, 12.VIII.2004, CESUES 5232; Distrito Federal, Tranvia way, Xochimilco to Manantiales, leg. G. Guzmán 293, 13.IX.1955, ENCB, duplo in AH 31710; Estado de México, Zumpango, edge of big drainage channel, leg. G. Guzmán 316, 18.IX.1955, ENCB, duplo in AH 31711.

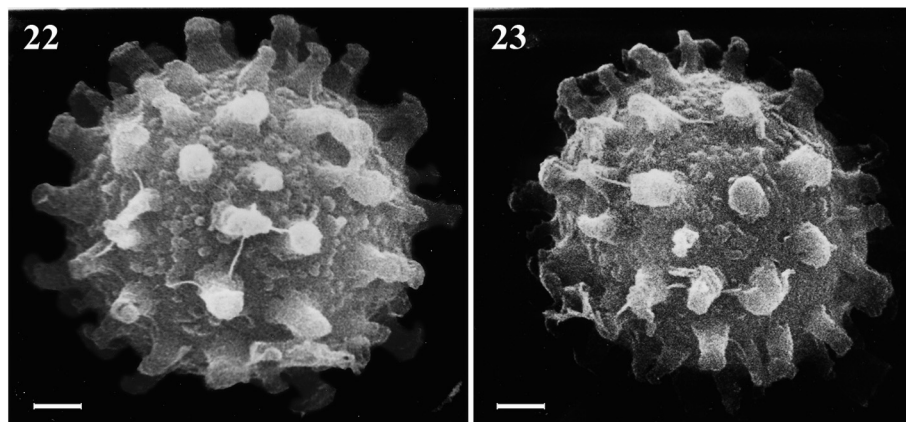
### 8. *Disciseda verrucosa* G. Cunn. — Figs. 22, 23

*Disciseda verrucosa* G. Cunn., Trans. & Proc. New Zealand Inst. 57 (1926) 205.

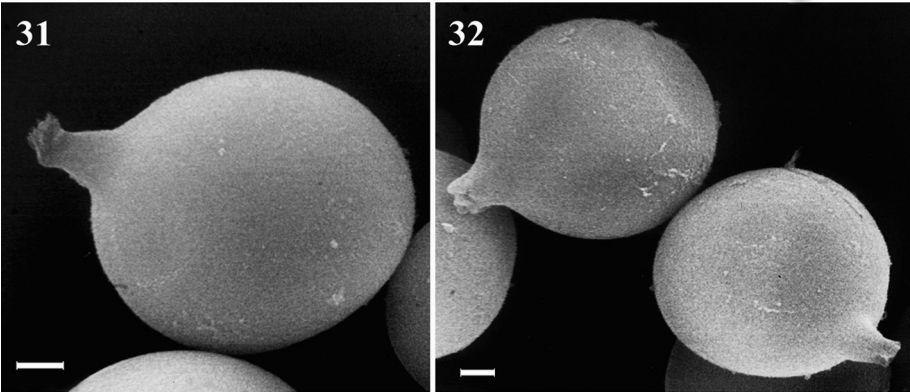
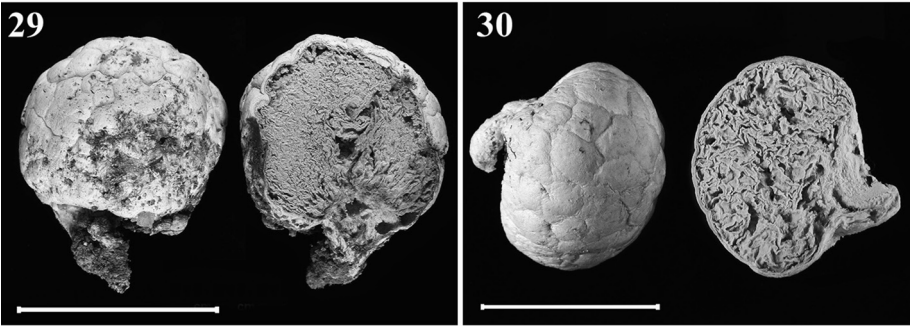
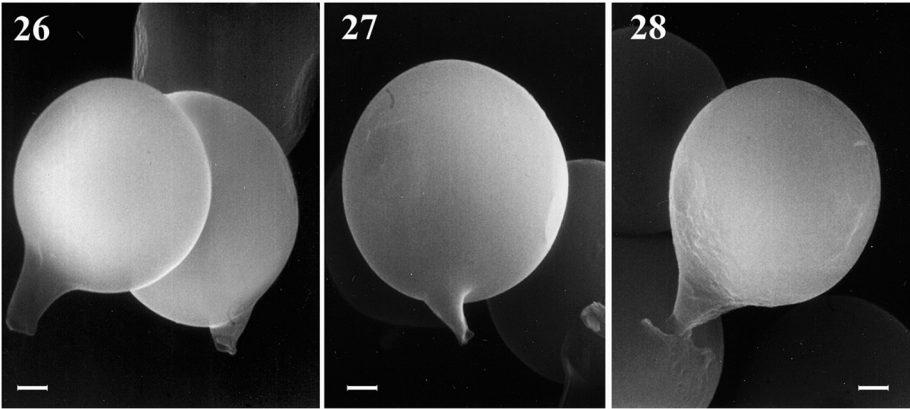
*Disciseda arida* Velen., Novit. Mycol. (1939) 169.

*Disciseda verrucosa* is clearly characterized by its sparsely pedicellate spores conspicuously ornamented by obtuse finger-like processes, usually curved at the apex. Recently, Moreno et al. (2003) studied the type material of *D. verrucosa* and *D. arida*, and proposed them as conspecific. Even considering this previous study, this taxon has been scarcely cited up to present; some records are known from New Zealand and Australia (Cunningham, 1942), South Africa (Bottomley, 1948), from the former Czechoslovakia (Moravec, 1958), and Spain (Moreno et al., 2003). Sonora is the only site in Mexico from which *D. verrucosa* is reported. The material studied adds to the previous records by Aparicio-Navarro et al. (1994) and Pérez-Silva et al. (2000).

*Specimens examined.* MEXICO: Sonora, Hermosillo municipality, Las Dunas, close to Puerto Libertad town, leg. A. Armenta, A. Núñez & A. Sánchez, 29.VIII.1998, CESUES 4484; La Colorada municipality, Km 100 Hermosillo to Yécora road, leg. M. Esqueda, A. Armenta, A. Núñez & R. Santos, 17.III.1996, CESUES 2615a; *ibidem*, 2.VII.1997, CESUES 3299, duplo in AH 31648; San Javier municipality, Km 151 Hermosillo to Yécora road, leg. A. Armenta, A. Núñez & R. Santos, 31.V.1996, CESUES 2711; Yécora municipality, 3.4 km Yécora to Las Cabañas way, leg. M. Esqueda & R. Rodríguez, 8.IX.1995, CESUES 1778; Sonoyta municipality, Pinacate and Grand Desert Biosphere Reserve, Papatote, leg. A. Sánchez, I. Encinas & J. Miranda, 12.VIII.2004, CESUES 5226.



Figs. 22, 23. *Disciseda verrucosa* from Sonora (AH 31648). Spores under SEM. Scale bars: 1  $\mu$ m.



9. **Endoptychum arizonicum** (Shear & Griffiths) Singer & A.H. Sm. — Figs. 24–32

*Endoptychum arizonicum* (Shear & Griffiths) Singer & A.H. Sm., *Brittonia* 10 (1958) 221.

*Secotium arizonicum* Shear & Griffiths in Shear, *Bull. Torrey Bot. Club* 29 (1902) 450–451.

This taxon is frequently observed in the xerophilous areas of Sonora. It produces solitary to scattered, small basidiocarps (10–13 mm in diameter in our collections), resembling an immature *Bovista*. *Endoptychum arizonicum* is characterized by a membranous, rather thin, smooth, yellowish exoperidium, fragile when dry; the stipe is very short or practically absent, continued by a not fully developed columella; the gleba is sublamar, consisting of closely anastomosed, thin, yellowish tramal plates; the spores are smooth, thick walled, subhyaline, globose, 7–12  $\mu\text{m}$  in diameter, with a short pedicel, and germ pore absent. The presence of clamp-connections in this species (specially in the columella), pointed out only by Vellinga et al. (2003) was confirmed.

Except for the rather smaller basidiocarps, the characteristics of the Mexican material match those we observed in various collections from Tucson (Arizona, USA), including the type and isotype specimens, *Griffiths 1630* and *West American Fungi 323*, respectively (Shear, 1902). Amongst the materials from Arizona that we have studied, there are two other samples (*Lloyd 30824* and *Griffiths 205*) mislabelled as type.

*Endoptychum arizonicum* was first considered to be very close to *E. agaricoides* Czern. (Shear, 1902; Lloyd, 1903). There are actually many differences between the two species: *E. agaricoides* has larger, scaly basidiocarps; a percurrent, well-developed columella; ellipsoidal spores not larger than 10  $\mu\text{m}$  in diameter, greenish to yellowish brown, with germ pore. Some other species, with obvious differences such as darker spores, have been erroneously included in this genus, i.e. *E. depressum* Singer & A.H. Sm. from North America, and *E. melanosporum* (Berk.) Singer & A.H. Sm. (= *S. melanosporum* Berk.) from Australia. In 1997, Grgurinovic proposed three new species from the Australian material: *E. wariatodes* Grgur., *E. kolya* Grgur., and *E. moongum* Grgur.).

The molecular data of *Endoptychum* lead us to believe that some of the species recorded under this genus should be classified elsewhere. Vellinga et al. (2003) demonstrated a close relationship between *E. agaricoides*, *C. molybdites* (G. Mey.: Fr.) Masee, and some species of *Macrolepiota*; Singer & Smith (1958) had suggested this based on the greenish colour of their spores. Vellinga et al. (2003) proposed to group these taxa in the genus *Chlorophyllum*. That would entail conserving the name *Chlorophyllum* over *Endoptychum* (Vellinga & de Kok, 2002), in spite of the latter being much older; a solution from the Committee for Fungi is still pending. During the process of reviewing and publishing of this paper, the Committee for Fungi has accepted the proposal by Vellinga & de Kok (2002) and recommends to conserve *Chlorophyllum* over *Endoptychum*

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Figs. 24, 25. *Endoptychum arizonicum* from Arizona (*D. Griffiths 205* in BPI 728601). 24. Label of the collection; 25. basidiomes. — Fig. 26. Holotype of *Endoptychum arizonicum* (*D. Griffiths 1630* in BPI 797001). Spore under SEM. — Figs. 27, 28. Isotype of *Endoptychum arizonicum* (*D. Griffiths 323* in BPI 728540). Spores under SEM. — Figs. 29–32. *Endoptychum arizonicum* from Sonora. 29. Sectioned basidiome (AH 31725); 30. basidiomes (AH 31723); 31, 32. spores under SEM (AH 31725). Scale bars: 25, 29, 30 = 10 mm; 26–28, 31, 32 = 1  $\mu\text{m}$ .

(Gams, 2005; Taxon 54: 520–522). This would result in combinations like *C. agaricoides* (Czern.) Vellinga (Vellinga, 2002). Following the same line, *E. depressum* is apparently related to *Agaricus arvensis* Schaeff., as Singer & Smith suggested (1958), and would be included in genus *Agaricus* as *A. inapertus* Vellinga (Vellinga et al., 2003). It will be interesting to include molecular data to solve the position of *E. arizonicum* and the other species of the genus.

*Endoptychum arizonicum* was found to be a characteristic species of the xerophilous areas between the United States and Mexico (Shear, 1902; Arora, 1986; Guzmán & Herrera, 1969; Esqueda et al., 1998). However, its distribution does not appear to be restricted to that region, considering the records from Argentina (Singer, 1962) and more recently from Italy (Sarasini & Contu, 2001).

*Specimens examined.* MEXICO: San Luis Potosí, Tanque Caballos, Km 34 San Luis Potosí to Antiguo Morelos road, leg. F. Medellín-Leal, 20.VI.1958, ENCB, duplo in AH 31726; Sonora, Altar municipality, Monte La Esperanza, 4 km NE Altar town, leg. H. Araiza, 18.IX.1968, ENCB, duplo in AH 31727; La Colorada municipality, Km 31 Hermosillo to Yécora road, microphyllous desert scrub, leg. M. Esqueda, A. Armenta, A. Núñez, R. Rodríguez & R. Santos, 14.X.1995, CESUES 2204, duplo in AH 31723; ibidem, 24.XI.1995, CESUES 2210; ibidem, 16.II.1996, CESUES 2351; ibidem, 29.IV.1996, CESUES 2707; ibidem, 11.IX.1996, CESUES 2789, duplo in AH 31724; Km 40 Hermosillo to Yécora road, microphyllous desert scrub, leg. M. Esqueda, A. Armenta, A. Núñez & R. Santos, 14.X.1995, CESUES 2176; ibidem, 24.XI.1995, CESUES 2221; ibidem, 29.IV.1996, CESUES 2705; ibidem, 11.IX.1996, CESUES 2843, duplo in AH 31725; ibidem, leg. M. Esqueda, 2.VII.1997, CESUES 3305; Km 100 Hermosillo to Yécora road, tropical thorn forest, leg. M. Esqueda, A. Armenta, A. Núñez & R. Santos, 29.IV.1996, CESUES 2696; Puerto Peñasco municipality, Pinacate and Grand Desert Biosphere Reserve, Ejido Los Norteños, leg. M. Esqueda, M. Coronado, A. Sánchez, J. Miranda & I. Encinas, 28.IV.2004, CESUES 5189; Sonoyta municipality, Pinacate and Grand Desert Biosphere Reserve, Ejido Punta Peñasco, leg. M. Esqueda, A. Sánchez, I. Encinas & J. Miranda, 28.IV.2004, CESUES 5193. — USA: ARIZONA, leg. D. Griffiths 205, X.1905, BPI 728601, 'type' in label (?); Tucson, leg. D. Griffiths, Herb. Lloyd 30824, BPI 718209, 'type' in label (?); ibidem, leg. D. Griffiths, IX.1930, Herb. Long 7895, BPI 728538; ibidem, leg. D. Griffiths 1630, IX.1900, BPI 797001, holotype; ibidem, leg. D. Griffiths 323, IX.1900, BPI 728540 & 796870, isotypes; Nogales-Tucson road, 7 miles from Tucson, 19.II.1934, Herb. Long 7629 (BR); Catlaw Flats, 4 miles from Sabino Canyon, near Tucson, 28.IX.1939, Herb. Long 8403 (BR); unknown locality, Herb. Long 7854 (BPI 728539).

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