Myxomycetes of Taiwan XXI. The genus *Diderma*

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ABSTRACT: Species of the genus *Diderma* collected from Taiwan were critically reviewed. In this paper, we described and illustrated two new records of Taiwan: *D. cinereum* and *D. deplanatum*. A key to the *Diderma* species of Taiwan is also provided.

KEY WORDS: *Diderma*, Didymiaceae, Myxomycetes, Taiwan, taxonomy.

INTRODUCTION

Diderma, one of the genera in Didymiaceae (Physarales) is characterized by having fruiting bodies with typically double-layered peridium. The peidium is either calcareous or cartilaginous and impregnated by lime granules. Other characters include the usually well-developed and calcareous columella, the limeless capillitial threads and dark-colored spores (Martin and Alexopoulos, 1969; Nannega-Bremekamp, 1991).

To the present, more than 75 species are known. In Taiwan, only 11 species and one variety were collected and identified. Among them *Diderma cinereum* Morgan and *D. deplanatum* Fr. are new to Taiwan. *D. rimosum* Eliasson & Nann.-Bremek. and *D. saundersii* (Berk. & Broome ex Massee) Lado are two recently reconfirmed and recognized species (Lado et al., 2003). Fruiting bodies and their microscopic structures of the species reported in this paper were examined by light and scanning electron microscopy as described previously (Liu et al., 2002).

TAXONOMIC TREATMENTS

Key to the species of *Diderma* from Taiwan

1a. Fructification stalked ……..……..…..…… 2
1b. Fructification sessile, rarely with a constricted stem-like base, varying to subplasmodiocarpous or broadly expanded …....…… 3
2a. Peridium double, outer peridium calcareous; sporangia white, flattened, discoid, umbilicate below; stalk stout, rarely lacking … …… *D. hemisphaericum*
2b. Peridium single, wrinkled reticulate, breaking into preformed platelets ……..……..…… *D. rugosum*
3a. Peridium single or appearing so; dehiscence irregular …… ……..……..……..…… *D. cinereum*
3b. Peridium clearly double; dehiscence irregular or stellate …..…….. ……..…… 4
4a. Outer peridium cartilaginous, tough; dehiscence stellate ……..…..……..……..…… *D. floriforme*
4b. Outer peridium calcareous, fragile, dehiscence mostly irregular … ……..……..……..…… 5
5a. Spore surface markings subreticulate or banded reticulate with a band of 2 µm high ……..……..…… *D. subdictyospermum*
5b. Spore surface markings not as above ……..…….. 6
6a. Hypothallus profuse, sporangia embedded; outer peridium chalky, and rough; columella reduced to a broad base with pinkish tint ….....……..……..……..…… *D. spumarioides*
6b. Hypothallus not as above; outer peridium smooth and crustose ……..……..……..…….. 7
7a. Fructification plasmodiocarpous, often reticulate, effused, or ring-shaped ……..……..…… 8
7b. Fructification sporangiate, if plasmodiocarpous then never as above, always short to moderately long, curved ……..…… 11
8a. Fructification forming ring-shaped, curved or reticulate plasmodiocarps ……..……..……..…… *D. deplanatum*
8b. Fructification never forming ring-shaped plasmodiocarps …….. 9
9a. Fructification always plasmodiocarpoous, very thin and perforated ..……..……..*D. saundersii*
9b. Sporangia usually distinct and closely appressed, often effused forming reticulate plasmodiocarps ……..……..…… 10
10a. Capillitial threads thin and hyaline ……..……. *D. effusum*
10b. Capillitial threads dark reddish brown, with swollen nodules ……..……..……..…… *D. effusum* var. *pachytrichon*
11a. Sporangia polygonally ridged; columella globose; spores 9-9.5 µm in diam., with a pale line around the spore surface ……..... ……..... *D. rimosum*
11b. Sporangia not as above; spores 10-13 µm in diam., without a pale line around the surface; capillitial threads coarse ……..... ……..……..……..……..……. *D. chondrioderma*

Diderma chondrioderma (de Bary & Rostaf.) G. Lister, Monogr. Mycetozoa, 3rd ed. (London): 258. 1925.
Figs. 1 A-C

Fructification sporangiate or plasmodiocarpous, scattered, gregarious or crowded in small groups. Sporangia white, sessile, depressed globose, pulvinate, or rarely plasmodiocarpous, about 0.2 mm in thickness, 0.6-1.1 mm in diam., up to 2.3 mm long. Peridium doubles, the outer layer white, calcareous, more or less smooth, fragile, the inner layer membranous, grayish or brownish white, covered with a thin layer of lime granules, distinctly separated from the outer layer. Columella flat-pulvinate, calcareous, pale brownish. Capillitium of brownish, sparely branched and anastomosing threads. Spores blackish brown in mass, dark brown by transmitted light, globose or subglobose, 10-13(-15) µm in diameter, delicately warted, indistinctly decorated with clustered warts in places. Plasmodium not observed.

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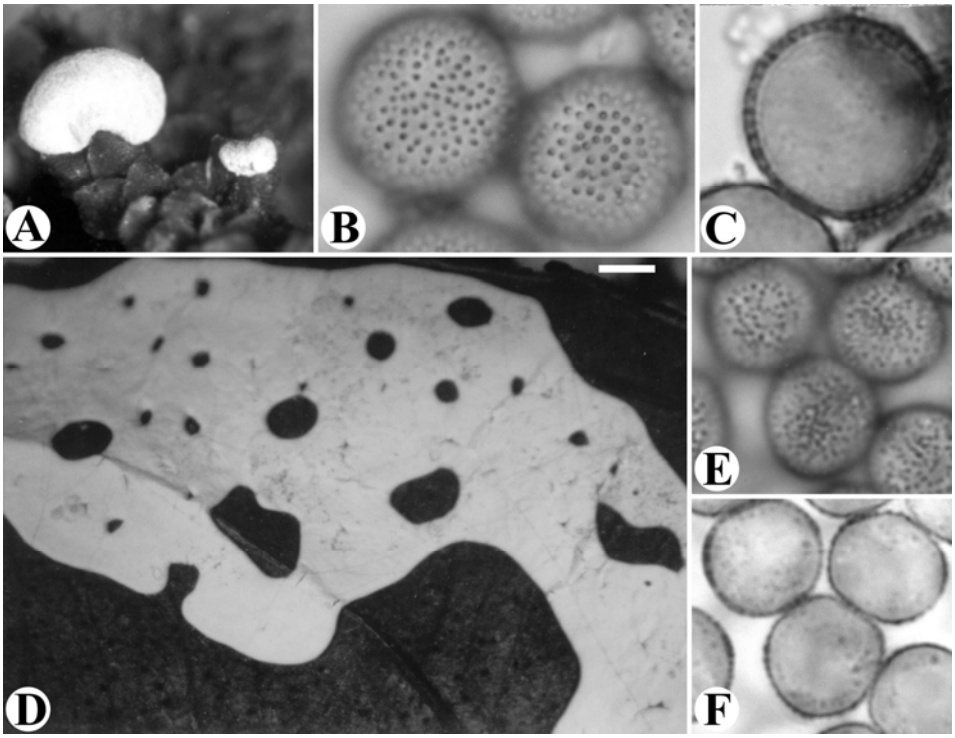


Fig. 1. A-C. *Diderma chondrioderma*. A: Fruiting bodies. B: Spores, surface view. C: One spore, marginal view. D-F. *Diderma saundersii*. D: A fruiting body. E: Spores, surface view. F: Spores, marginal view. Scale bar: A = 300 µm; B-C = 4 µm; D = 750 µm; E-F = 5 µm.

Specimens examined: Taipei City: Main campus of National Taiwan University, on bark of *Liquidambar formosana*, *C.-H. Chung M1173*, Apr. 1, 1996. Taipei Co.: Hsintien, Kueishan, on mosses growing on the concrete wall along the roadside, *C.-H. Chung M995*, June 2, 1996; Wu-Lai Hsiang, on mosses growing bark of trees, *CHL B1272*, *CHL B1296*, Aug. 23, 1997.

Distribution: Cosmopolitans.

This species is macroscopically similar with *D. effusum*. Spores of the later species, however, are constantly pale brown in color and smaller in diameter (7-9 µm) It is also similar with the sessile form of *D. hemisphaericum*, but different in having quite larger spores (8-9 µm in *D. hemisphaericum*).

Our specimens are mostly from mosses growing either on roadside wall or on bark of trees, a distinct habitat of this species. The double-layered peridium which are distinctly separated and the dark-colored spore mass in our specimen are characters not as described for this species (Martin and Alexopoulos, 1969; Ing, 1999). Specimen reported as *D. chondrioderma* from Costa Rica (Farr, 1976), and Belgium (Buyck, 1982) however, are similar with our specimen in having well-separated double-layered peridium.

Diderma cinereum Morgan, J. Cincinnati Soc. Nat. Hist. 16: 154. 1894. Fig. 2

Fructification scattered, sporangiate. Sporangia rounded or pulvinate, 0.24-0.33 mm in diameter, white, sessile. Peridium appearing single, crustose, thin, limy. Columella reduced to a thickened base. Capillitial threads brown or dark brown, slender, sparsely branched and anastomosing. Spores dark brown in mass, brown in transmitted light, globose, 10-11 µm in diameter, minutely and unevenly warted. Plasmodium not observed.

Specimen examined: Taipei City: Peitou, Yangmingshan National Park, on mosses, *CHL B2380*, Nov. 9, 2001 (moist-chamber culture: Oct, 17- Nov. 9, 2001).

Distribution: China, Europe, Japan, New Zealand, North America, Taiwan.

Our specimen is from a moist-chamber culture and the sporangia appeared scattered instead of gregarious, and smaller in size.

Diderma deplanatum Fr., Syst. Mycol. (Lundae) 3: 110. 1829. Fig. 3

Fructification plasmodiocarpous, scattered, white, 450-600 µm in diameter, up to 5.5 mm in length, about 200 µm thick. Peridium double, dehiscence irregular; the outer layer white, smooth as egg-shell, the inner layer membranous, translucent. Columella pulvinate,

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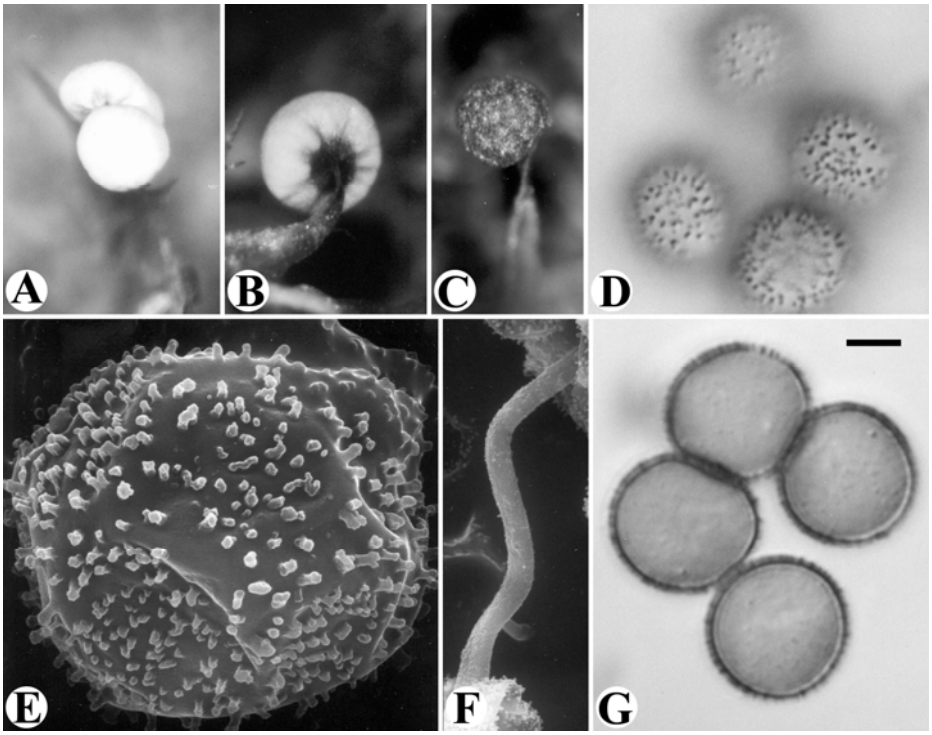


Fig. 2. ***Diderma cinereum*****. A-B: Fruiting bodies. C: A young fruiting body. D: Spores, surface view. E: One spore, showing surface markings, by SEM. F: A part of capillitium, by SEM. G: Spores, marginal view. Scale bar: A-C = 150 μm; D, G = 4 μm; E = 1 μm; F = 3 μm.**

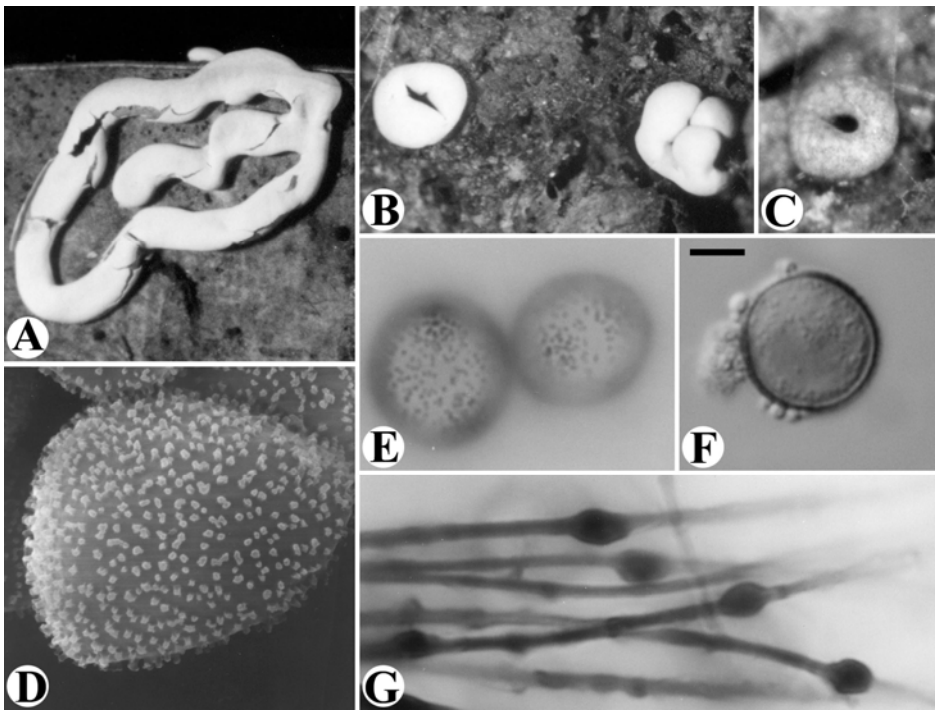


Fig. 3. ***Diderma deplanatum*****. A-B: Fruiting bodies. C: A ring-shaped young fruiting body. D: One spore, showing surface markings, by SEM. E: Spores, surface view. F: A spore, marginal view. G: Dark brown capillitial threads with nodular enlargements. Scale bar: A = 750 μm; B-C = 320 μm; D = 1.3 μm; E-G = 4.5 μm.**

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paler yellow. Capillitium tufted, sparsely branched with swollen nodules along the length, yellowish brown to dark brown. Spores dark brown in mass, paler brown in transmitter light, globose to subglobose, 9.0-11.0 µm in diameter, minutely warted with clustered warts on the surface. Plasmodium not observed.

Specimens examined: Taipei Co.: Shihting, Wenshan Botanical Gardens of National Taiwan Univ., on leaf litter, *Yang99-11 C1L3-b*, Jan. 12, 2000 (moist-chamber culture: Nov. 17, 1999-Jan. 12, 2000). Pingtung Co.: the eastern edge of Mt. Wanlite, on bark of *Ilex aculeolata*, *Y.F. Chen360b*, Apr. 22, 1996 (moist-chamber culture: Apr. 8-22, 1996); on bark, *Y.F. Chen372b*, July 25, 1996 (moist-chamber culture: May 15-July 25, 1996).

Distribution: China, Europe, India, Japan, New Zealand, North America, Taiwan.

It resembles *D. effusum* in outer appearance, but is more plasmodiocarpous and has darker spores. Spores of this species are dark brown to blackish brown in mass, but spores in *D. effusum* are pale brown.

Diderma effusum (Schwein.) Morgan, J. Cincinnati Soc. Nat. Hist. 16: 155. 1894. Fig. 4

Description and illustration: C.H. Chung and C.H. Liu, in Taiwania 43: 14-15 (1998).

Specimens examined: Taipei City: Main campus of National Taiwan Univ., on dead angiospermous leaves, *C.-H. Chung M663*, Apr. 19, 1994; Peitou, Yangmingshan National Park, on fallen leaves of *Liquidambar formosana*, *CHL B2356*, Mar. 27, 1998; *Jong 150*, Sept. 19, 2001 (moist-chamber culture: July 19-Sept. 19, 2001). Changhua Co.: Chinshuiyen, on dead angiospermous leaves, *C.-H. Chung M603*, Apr. 27, 1996. Pingtung Co.: the eastern edge of Mt. Wanlite, on bark of *Castanopsis stellatospina*, *Y.F. Chen 86*, July 6, 1995; Kenting National Park, on dead angiospermous leaf, *CHL B146*, Feb. 15, 1982; on dead angiospermous leaves and twigs, *CHL B1109*, *CHL B1111*, Aug. 23, 1988.

D. effusum was described as possessing colorless capillitium, and var. *pachytrichon* are delimited from it by having completely dark capillitium. In our specimens, the hyaline capillitial threads may have brownish parts and decorated with brownish nodules. After reviewing the contents of the descriptions for the species in Chung and Liu (1998), we found these specimens: *CHL B146*, *CHL B1109*, *CHL B1111*, actually belong to *D. effusum* instead of *D. testaceum* (Schrad.) Pers. The sporangiate to plasmodiocarpous fructification and the characteristics of capillitial threads and columella are all identical to those of *D. effusum* (Nannenga-Bremekamp, 1991).

Diderma effusum var. ***pachytrichon*** Nann.-Bremek., Proc. Kon. Ned. Akad. Wetensch., Ser. C 76: 485. 1973. Fig. 5

Description and illustration: D.S. Wei and C.H. Liu, in Trans. Mycol. Soc. R.O.C. 4: 45-46, 49-51 (1989).

Specimens examined: Taipei City: main campus of National Taiwan Univ., on bark of *Celtis formosana*, *D.S. Wei 3866*, May 5, 1988; Peitou, Yangmingshan National Park, on fallen leaves of *Liquidambar formosana*, *CHL B2319*, Aug. 24, 2001 (moist-chamber culture: June 4 - Aug. 24, 2001). Hsinchu City: campus of Tungmen Elementary School, on bark of *Bombax malabarica*, *C.-H. Chung M1244a*, July 13, 1996.

In contrast to *D. effusum*, this taxon is less common in Taiwan, and is different from it by the dark and coarse capillitial threads.

Diderma floriforme (Bull.) Pers., Neues Mag. Bot. 1: 89. 1794.

Description and illustration: C.H. Liu and Y.F. Chen, in Taiwania 44: 370-372 (1999).

Diderma hemisphaericum (Bull.) Hornem., Fl. Danic. 33: 13. 1829.

Description and illustration: C.H. Liu, in Taiwania 27: 68-70, 83 (1982).

Diderma rimosum Eliasson & Nann.-Bremek., Proc. Kon. Ned. Akad. Wetensch., Ser. C 86: 148. 1983.

≡ *Diderma cingulatum* var. *rimosum* (Eliasson & Nann.-Bremek.) Nann.-Bremek., Proc. Kon. Ned. Akad. Wetensch., Ser. C 98: 321. 1995.

Description and illustration: C.H. Liu and Y.F. Chen, in Taiwania 44: 369-370, 373 (1999).

Specimen examined: Pingtung Co.: Kenting National Park, on fallen twigs, *CHL B1105*, Aug. 23, 1988.

Our specimen matches the original description of this species (Eliasson and Nannenga-Bremekamp, 1983). The distinct characteristics which are different from *D. cingulatum* Nann.-Bremek. are the polygonally ridged sporangia, the globose columella and the densely warted spores with a pale line around the spore surface. The constancy and stability of the species characters has been confirmed (Lado et al., 2003), and thus the species are regarded as distinct from *D. cingulatum*.

Diderma rugosum (Rex) T. Macbr., N. Amer. Slime-Moulds 105. 1899.

Description and illustration: C.H. Chung and C.H. Liu, in Taiwania 43: 15, 20 (1998).

Diderma saundersii (Berk. & Broome ex Massee) Lado, Cuad. Trab. Fl. Micol. Iber. 35. 2001. Figs. 1 D-F

≡ *Chondrioderma saundersii* Berk. & Broome, ex Massee, Mon. 209. 1892.
= *Diderma platycarpum* Nann.-Bremek., Proc. Kon. Ned. Akad. Wetensch., Ser. C 69: 359. 1966.
= *Diderma platycarpum* var. *berkeleyanum* Nann.-Bremek., Proc. Kon. Ned. Akad. Wetensch., Ser. C 69: 359. 1966.

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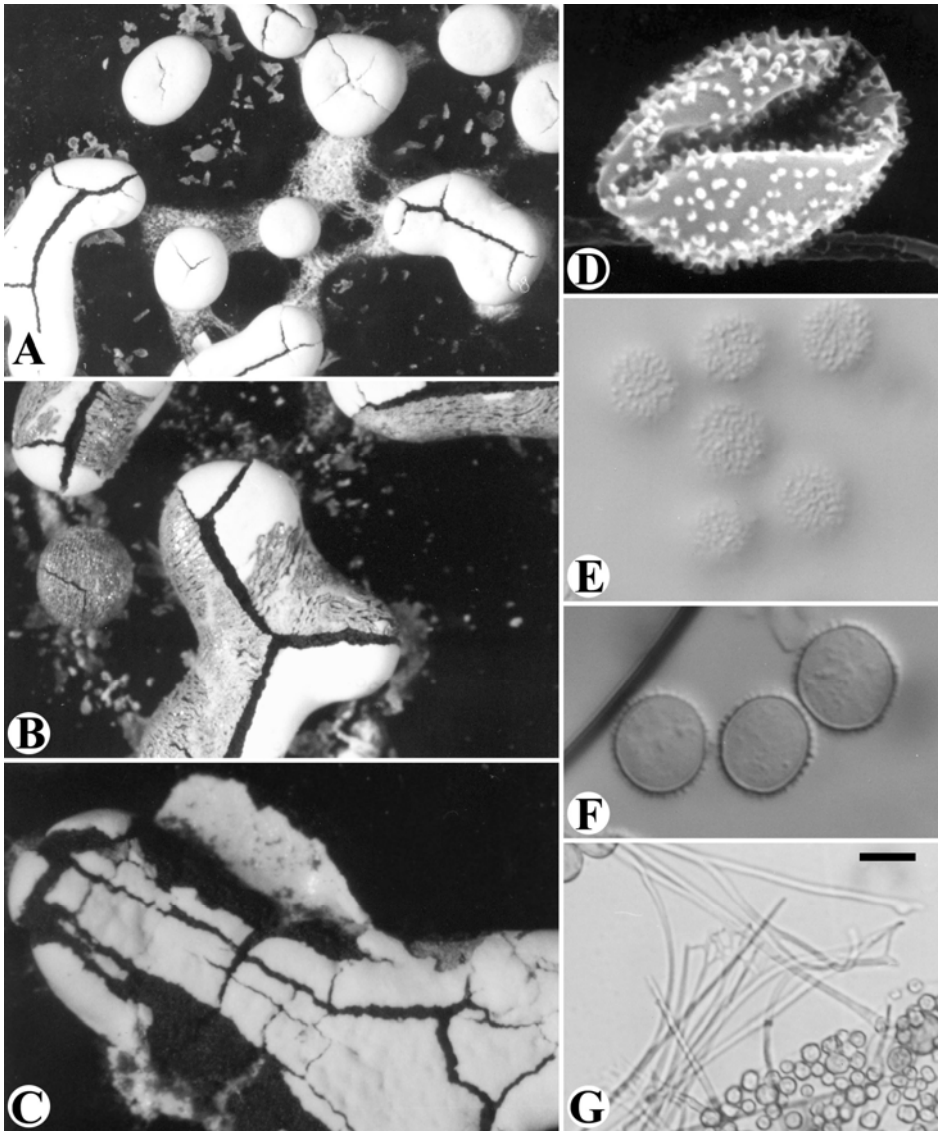


Fig. 4. *Diderma effusum*. A-B: Fruiting bodies. C: A dehiscent fruiting body. D: One spore, showing surface markings, by SEM. E: Spores, surface view. F: Spores, marginal view. G: Pale capillitial threads and lime granules. Scale bar: A = 340 µm; B = 230 µm; C = 155 µm; D = 1 µm; E-F = 5 µm; G = 10 µm.

Specimens examined: Taipei City: Main campus of National Taiwan Univ., on bark of *Bischofia javanica*, *CHL B87c*, *CHL B110*, *CHL B111a*, June 14, 1982; on bark of *Cinnamomum camphora*, *CHL B2047*, June 11, 1996; on bark of *Brainea insignis*, *CHL B1623*, June 23, 1999; Peitou, Yangmingshan National Park, on fallen leaves of *Liquidambar formosana*, *CHL B2317*, Aug. 24, 2001 (moist-chamber culture: June 4-Aug. 24, 2001). Pingtung Co.: Kenting Notional Park, on leaf litter, *CHL B15b*, Nov. 21, 1981 (moist-chamber culture: Oct. 8-Nov. 21, 1981).

D. saundersii has priority over *D. platycarpum* (Lado, 2001). Our specimens (*CHL B15b*, *CHL B87c*, *CHL B110*, *CHL B111a*) have characteristics of lacking columella, having large spores and yellow plasmodium (*CHL B15b*) which agree with Nannenga-Bremekamp's variety *platycarpum* (Nannenga-Bremekamp, 1991) very well. The specimens (*CHL B1623*, *CHL B2047*, *CHL B2317*) which were identified as *D. platycarpum* var. *berkleyanum* have much smaller spores of 6-8 µm in diameter.

Diderma spumarioides (Fries) Fries, Syst. Mycol. (Lundae) 3: 104. 1829.

Description and illustration: C.H. Chung and C.H. Liu, in Taiwania 43: 19-21 (1998).

Specimen examined: Taipei Co.: Wulai, around Miaohsin Temple, *C.H. Chung M836*, Dec. 6, 1994, on dead angiospermous leaf.

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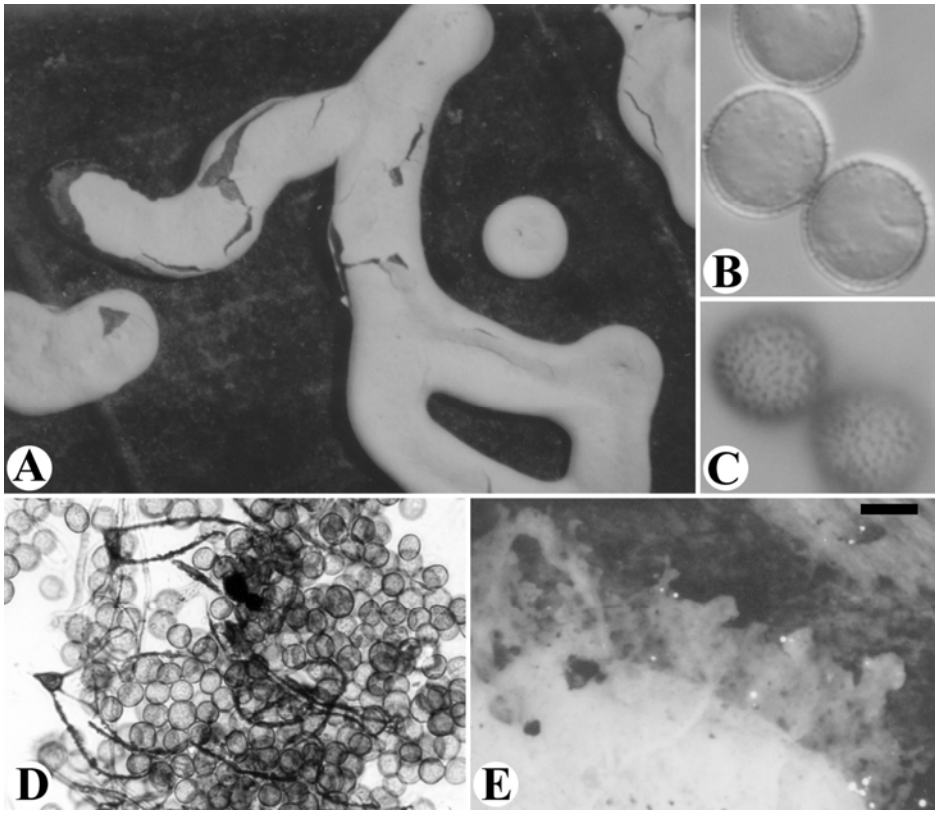


Fig. 5. *Diderma effusum* var. *pachytrichon*. A: Fruiting bodies. B: Spores, marginal view. C: Spores, surface view. D: Brownish capillitial threads and spores. E: White plasmodium. Scale bar: A, E = 500 µm; B-C = 4.5 µm; D = 20 µm.

Our specimen resembles *D. crustaceum* Peck in spores which are distinctly spiny and large in size, up to 15 µm in diameter, and in the crowded arrangement of the sporangia. In our specimen the outer peridium is rough and closely appressed to the inner peridium, which are distinct characteristics of *D. spumariodes* and are obviously different from the smooth outer peridium which apparently remote from the inner layer in *D. crustaceum*.

Diderma subdictyospermum (Rostaf.) G. Lister, Monogr. Mycetozoa, 2nd ed. 101. 1911.

Description and illustration: C.H. Liu and Y.F. Chen, in Taiwania 44: 370, 372-373 (1999).

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摘要：本篇整理與訂正臺灣產雙皮黏菌屬的成員，其中灰色雙皮黏菌(*Diderma cinereum*)與扁墊雙皮黏菌(*D. deplanatum*)為兩種臺灣新記錄之黏菌，內文並提供臺灣所有紀錄的雙皮黏菌屬的物種檢索表。

關鍵詞：雙皮黏菌屬、鈣皮黏菌科、真黏菌綱、臺灣、分類。

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