



## Myxomycetes of Taiwan XXIII. The Genera *Diachea* and *Didymium*

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**ABSTRACT:** Species of *Diachea* and *Didymium* reported from Taiwan are critically revised. Two newly recorded species, *Didymium floccoides* and *Didymium leptotrichum*, are described and illustrated in this paper. Keys to the *Diachea* and *Didymium* species of Taiwan are also provided.

**KEY WORDS:** *Diachea*, Didymiaceae, *Didymium*, Myxomycetes, Taiwan, taxonomy.

### INTRODUCTION

The genera *Diachea* and *Didymium* (Didymiaceae, Physarales) have common characteristics in having limeless capillitium and dark-colored spore mass. The peridium of *Diachea* is also limeless and often with a metallic shine, while that of *Didymium* is limy, with lime crystals either compactly covering the peridium as an outer layer, or scattering loosely over the surface in various forms.

To date, three species of *Diachea*, and nineteen species of *Didymium* have been recorded in Taiwan (Nakazawa, 1929; Shi, 1981; Wang et al., 1981; Liu, 1982, 1983, 1989; Chung and Liu, 1995, 1996a, 1996b, 1997; Liu and Chen, 1998, 1999). In this paper two newly recorded species, *Didymium floccoides* Nann.-Bremek. & Y. Yamam. and *Didymium leptotrichum* (Racib.) Masee are described and illustrated. Characteristic examination for the fruiting bodies of these specimens were made by light and scanning electron microscopy as described previously (Liu et al., 2002).

### TAXONOMIC TREATMENTS

#### Key to the species of *Diachea* from Taiwan

- 1a. Sporangia cylindrical to ovate, rarely subglobose .....  
 ..... *Diachea leucopodia*  
 1b. Sporangia globose or nearly so .....2  
 2a. Stalk length at least 1/2 of total height; spores sparsely but  
 prominently warted ..... *Diachea bulbillosa*  
 2b. Stalk shorter and conic; spores warted subreticulate .....  
 ..... *Diachea subsessilis*

*Diachea bulbillosa* (Berk. & Broome) Lister, in Penzig,  
 Myxomyc. Fl. Buitenzorg 45. 1898.

It was reported in a list by Nakazawa (1929), but no specimens were deposited in Taiwan.

*Diachea leucopodia* (Bull.) Rostaf., Sluzowce Monogr.  
 190. 1874. Fig. 1

Description and illustration: C.H. Liu, in *Taiwania*  
 27: 68, 70, 84 (1982).

Specimens examined: Taipei City: main campus of National  
 Taiwan Univ., on wall of a plastic flower pot, *CHL M394*, Nov. 18,  
 1981; Peitou, Yangmingshan National Park, on fallen leaves of  
*Liquidambar formosana*, *CHL B2359*, Dec. 16, 2000. Nantou Co.:  
 Yuchih Hsiang, Lianhua Pond, on decaying leaves, *CHL M381*, Oct.  
 25, 1981.

It is a very striking species and easily recognized in  
 the field by the white calcareous stalk, the dark-colored,  
 and metallic shining conical sporangia.

*Diachea subsessilis* Peck, Annual Rep. New York State  
 Mus. 31: 41. 1879.

Description and illustration: C.H. Liu and Y.F. Chen,  
 in *Taiwania* 44: 369-371 (1999).

#### Key to the species of *Didymium* from Taiwan

- 1a. Fructification sessile ..... 2  
 1b. Fructification stipitate ..... 8  
 2a. Peridium white and smooth as egg-shell ..... 3  
 2b. Lime crystals of peridium, loosely scattered or compacted, with  
 rough surface layer not as egg-shell ..... 4  
 3a. Capillitial threads rigid and profuse, quite long with transverse  
 connections between two neighboring threads; spores 9-11 µm in  
 diameter ..... *Didymium listeri*  
 3b. Capillitial threads not as above, usually short and sparse; spores  
 11.0-12.5 µm in diameter ..... *Didymium difforme*  
 4a. With large vesicles intermixed with spore ..... 5  
 4b. Vesicles absent ..... 6  
 5a. Plasmodiocarps branching and anastomosing to form an intricate  
 net; columella rising to about half of the height of plasmodiocarps;  
 spores subglobose or polygonaled with ridges on the  
 surface ..... *Didymium flexuosum*  
 5b. Plasmodiocarps broadly effused, depressed; columella absent .....  
 ..... *Didymium serpula*  
 6a. Spores 12-16 µm in diameter ..... *Didymium leptotrichum*  
 6b. Spores smaller than 11 µm in diameter .....7



- 7a. Plasmodiocarps forming a perforated layer; peridium with large, yellowish lime crystals ..... *Didymium perforatum*
- 7b. Plasmodiocarps not forming a perforated layer; peridium with small, colorless lime crystals ..... *Didymium anellus*
- 8a. Stalk calcareous ..... 9
- 8b. Stalk not calcareous ..... 12
- 9a. Stalk smooth, filled with amorphous lime; peridium areolate; columella dark brownish, clavate ..... *Didymium floccosum*
- 9b. Stalk rough, with lime crystals ..... 11
- 10a. Peridium cartilaginous, orange yellow, with thinner pale lines of dehiscence, loosely covered by white or pale ochraceous lime crystals; spores not forming clustered warts ..... *Didymium leoninum*
- 10b. Spores with conspicuous clusters of warts ..... 11
- 11a. Sporangia discoid; columella absent; stalk tapering above ..... *Didymium lenticulare*
- 11b. Sporangia globose to subglobose, with a small umbilicus below; columella present, white; stalk stout, the top extending into the sporangia ..... *Didymium squamulosum*
- 12a. Sporangia discoid, umbilicate below; spores 7.0-8.0  $\mu\text{m}$  in diameter ..... *Didymium clavus*
- 12b. Sporangia not discoid ..... 13
- 13a. Columella whitish ..... 14
- 13b. Columella brownish ..... 17
- 14a. Sporangia usually erect ..... 15
- 14b. Sporangia nodding ..... 16
- 15a. Stalk narrowing upward; columella globose; spores 8.5-10.0  $\mu\text{m}$  in diameter ..... *Didymium iridis*
- 15b. Stalk uniform in width; columella stalked as goblet in shape; spores 10.0-11.5  $\mu\text{m}$  in diameter ..... *Didymium megalosporum*
- 16a. Columella globose ..... *Didymium verrucosporum*
- 16b. Columella discoid or depressed globose, up to 0.30 mm in diameter ..... *Didymium bahiense*
- 17a. Spores larger than 10  $\mu\text{m}$  in diameter ..... *Didymium melanospermum*
- 17b. Spores smaller ..... 18
- 18a. Columella large, globose, calcareous, up to 0.2 mm in diameter ..... *Didymium minus*
- 18b. Columella smaller ..... 19
- 19a. Columella small, conical, up to 0.11 mm in height ..... *Didymium floccoides*
- 19b. Columella not as above ..... 20
- 20a. Peridium dark; columella dark; stalk usually black ..... *Didymium nigripes*
- 20b. Peridium pale; columella paler, yellowish; stalk reddish brown ..... *Didymium ovoideum*

*Didymium anellus* Morgan, J. Cincinnati Soc. Nat. Hist. 16: 148. 1894.

Description and illustration: S.M. Wang et al., in Biol. Bull. Nat. Taiwan Normal Uni. 16: 8 (1981).

*Didymium bahiense* Gottsb., Nova Hedwigia 15: 365. 1968.

Description and illustration: C.H. Chung and C.H. Liu, in Fung. Sci. 11: 123-124, 126 (1996a).

Specimens examined: Taipei City: farm of National Taiwan University, on leaves and fallen twigs, *CHL B359*, Apr. 3, 1984. Changhua City: main campus of National Changhua Normal University, on fallen leaves, *J.H. Wu 46*, Mar. 6, 1995. Nantou Co.: Huisun Forestry Station, on fallen leaves, *CHL B498c*, Apr. 1, 1985.

This species is difficult to distinguish from *Didymium megalosporum* and *Didymium eximium*.

They all have white sporangia with long stalks, columella-like pseudocolumella and deep umbilici. To compare with the other two species, *Didymium bahiense* have much tapering stalk and darker spores which are warted or spinulose with distinct groups of larger warts instead of evenly warted in *Didymium megalosporum* or minutely and evenly warted in *Didymium eximium*. In specimen *CHL B359*, lime crystals in small swollen capillitial threads are observed. Our spore size is exactly same as that found in Tanzania (Härkönen and Saarimäki, 1991).

*Didymium clavus* (Alb. & Schwein.) Rabenh., Deutschl. Krypt.-Fl. 1: 280. 1844.

Description and illustration: C.H. Liu, in *Taiwania* 28: 103, 109, 112-113 (1983).

Specimens examined: Taipei City: Main campus of National Taiwan Univ., on bark of *Bischofia javanica*, *CHL B94a*, June 14, 1982; on bark, *CHL B1266*, Aug. 21, 1997. Tainan City on decayed wood, *CHL B612*, Aug. 4, 1986. Hualien County: Tayuling, Hohuanshan, on twigs, *CHL B130*, June 28, 1982.

The distinctive feature of this species is the white discoid sporangium with a thickened, basal umbilicus which is limeless and brown in color. It resembles *Diderma hemisphericum* in size and shape. But the stellate lime crystals covering the peridium make the sporangium of this species apparently not smooth in outer appearance, while in *Diderma hemisphericum*, it appears smooth as a white crust of lime granules.

*Didymium difforme* (Pers.) S. F. Gray, Nat. Arr. Brit. Pl. 1: 571. 1821.

Description and illustration: C.H. Liu and Y.F. Chen, in *Taiwania* 43: 177-180 (1998).

*Didymium flexuosum* Yamashiro, J. Sci. Hiroshima Univ., Ser. B. II, Bot. 3: 31. 1936.

Description and illustration: C.H. Liu and Y.F. Chen, in *Taiwania* 43: 178-179, 181 (1998).

*Didymium floccoides* Nann.-Bremek. & Y. Yamam., Proc. K. Ned. Akad. Wet., Ser. C, Biol. Med. Sci. 90: 323. 1987. Fig. 2

Fructification scattered, stipitate, (0.27-) 0.51-0.85 mm in total height. Sporangia hemispherical or flattened globose, white and rough except at the base around the stalk attachment, 0.18-0.38 mm in diameter. Stalk dark, blackish, wrinkled, erect or slightly curved, attenuate, limeless on the surface, filled with rounded debris matter, up to 2/3 or more of the total height. Peridium membranous, hyaline, densely covered by

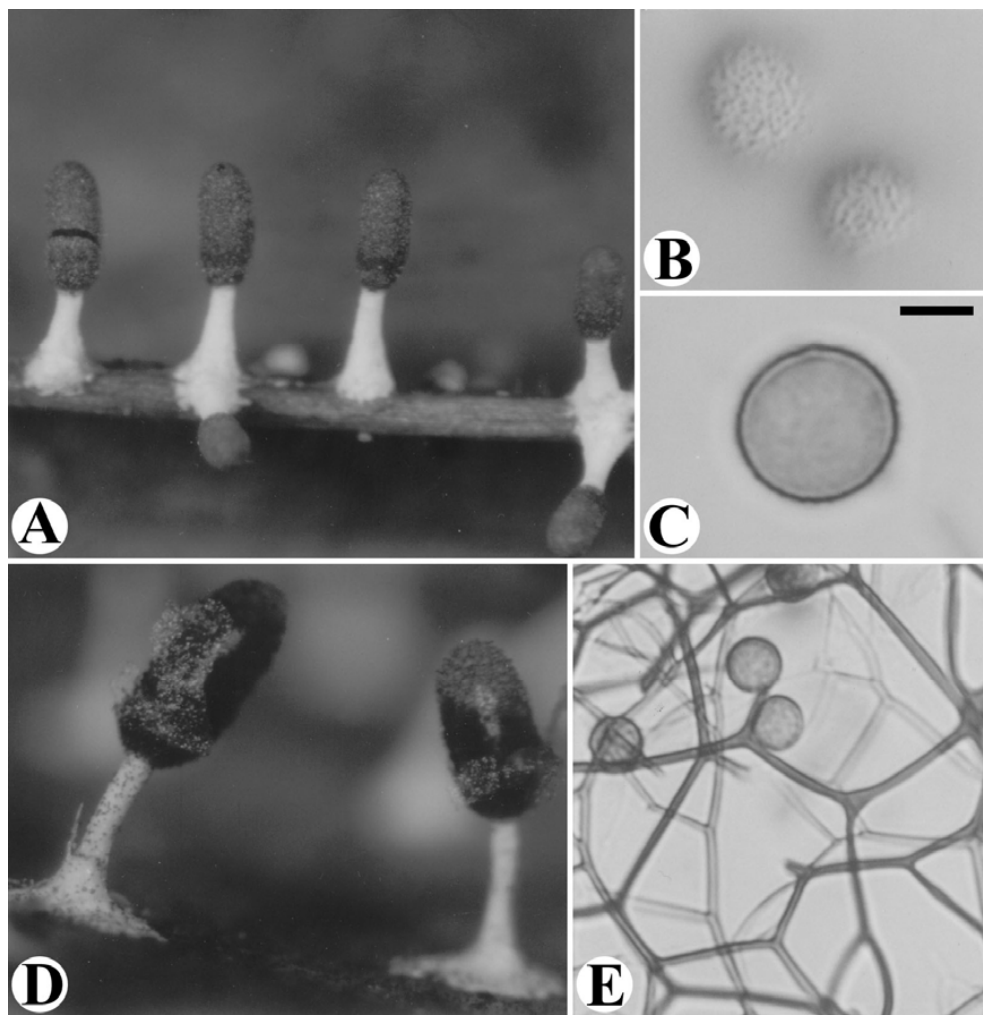


Fig 1. *Diachea leucopodia*. A: Fruiting bodies. B: Spores, surface view. C: One spore, marginal view. D: Dehiscent fruiting bodies. E: Capillitial threads and spores. Scale bar: A = 350  $\mu\text{m}$ ; B-C = 4  $\mu\text{m}$ ; D = 230  $\mu\text{m}$ ; E = 14  $\mu\text{m}$ .

white lime crystals. Hypothallus discoid, black brown. Columella dark brown, conical, small, up to 0.11 mm in height. Capillitium pale brown, slender, scarcely branching and anastomosing, with small nodules. Spores dark brown in mass, pale violaceous brown by transmitted light, globose, 7.5-9.0 (-10.0)  $\mu\text{m}$  in diameter, mostly 7.5-8.0  $\mu\text{m}$ , minutely warted, warts often clustered. Plasmodium not observed.

Specimens examined: Taipei City: Peitou, Yangmingshan National Park, on fallen leaves, *Jong* 39, June 26, 2001 (moist-chamber culture: Mar. 18-June 26, 2001), *Jong* 67, July 18, 2001 (moist-chamber culture: June 26-July 18, 2001), *Jong* 71, Apr. 4, 2002 (moist-chamber culture: Feb. 15-Apr. 4, 2002).

This species is characterized by the white sporangia (hemispherical or flattened globose, rough), the long, wrinkled and dark stalk, and the small, conical columella. It differs from *Didymium floccosum* in the much smaller and shorter fruiting bodies, the non-umbilicate sporangia, and smaller spores with warts

not as distinct.

*Didymium floccosum* G.W. Martin, K.S. Thind & Rehill, *Mycologia* 51: 160. 1959.

Description and illustration: C.H. Chung and C.H. Liu, in *Taiwania* 41: 175-178 (1996b).

*Didymium iridis* (Ditmar) Fr., *Syst. mycol.* 3: 120. 1829.

Description and illustration: C.H. Liu, in *Taiwania* 27: 69, 71, 74, 83 (1982).

*Didymium lenticulare* K.S. Thind & T.N. Lakh., *Mycologia* 60: 1083. 1968.

Description and illustration: C.H. Chung and C.H. Liu, in *Taiwania* 40: 375-379 (1995).

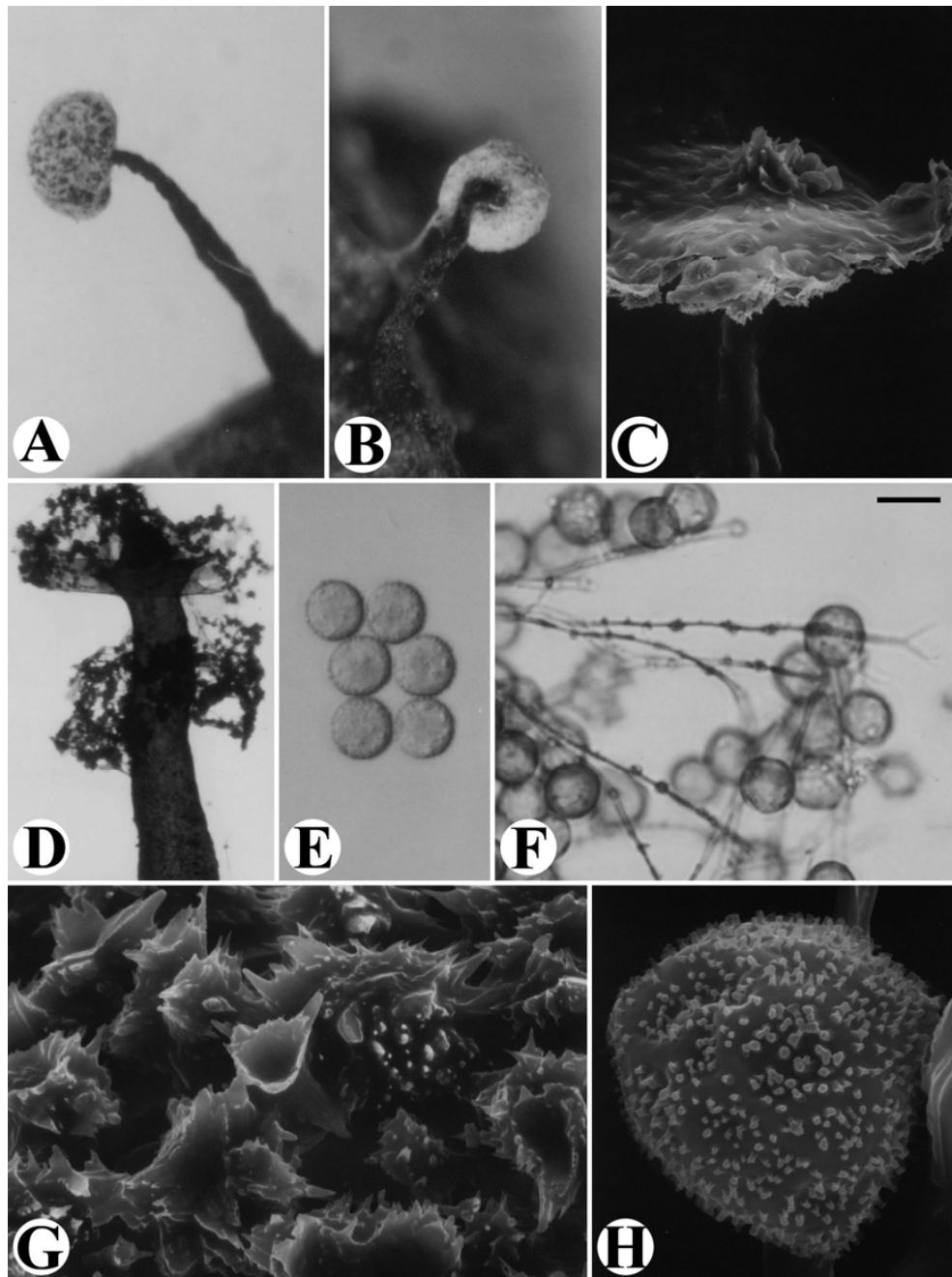


Fig. 2. *Didymium floccoides*. A-B: Fruiting bodies. C: Columella, by SEM. D: Columella surrounded by remaining peridium. E: Spores. F: Capillitial threads and spores. G: Lime crystals on the outer surface of peridium, by SEM. H: Surface markings of spore, by SEM. Scale bar: A-B = 150  $\mu$ m; C = 18.5  $\mu$ m; D = 75  $\mu$ m; E-F = 9.5  $\mu$ m; G = 3.6  $\mu$ m; H = 1.4  $\mu$ m.

*Didymium leoninum* Berk. & Broome, J. Linn. Soc., Bot. 14: 83. 1873.

Description and illustration: C.H. Liu, in *Taiwania* 34: 6-8 (1989).

*Didymium leptotrichum* (Racib.) Masee, Monogr. Myxogastr. 243. 1892. Fig. 3

Fructification plasmodiocarpous, scattered to gregarious, 0.33-1.92 mm long, up to 4.15 mm in their longer dimension, accompanied by sessile, sporangiate forms. Sporangia usually flat-pulvinate, whitish, 0.27-0.44 mm in diameter, dehiscent circumscissile; plasmodiocarps curved, irregular or nodular, grayish white, appearing thicker in height than the sporangiate

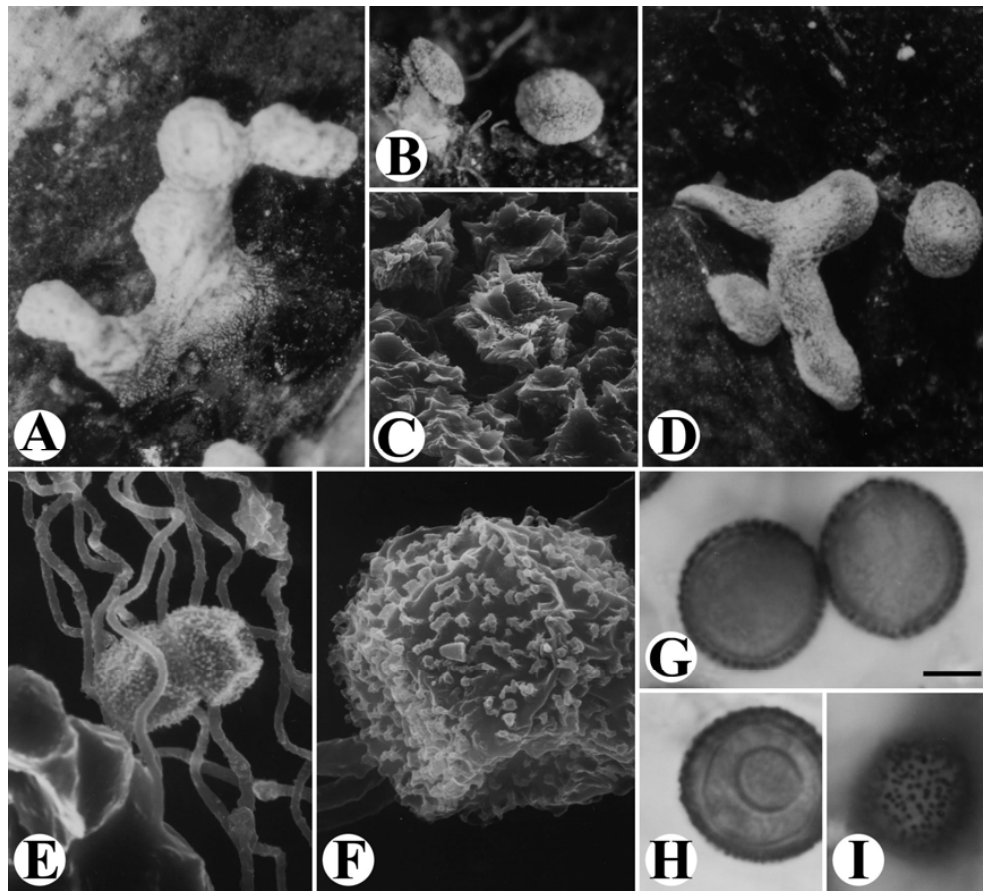


Fig. 3. *Didymium leptotrichum*. A-B & D: Fruiting bodies. C: Lime crystals on the outer surface of peridium. E: Capillitial threads, by SEM. F: Surface markings of spore, by SEM. G-H: Spores, marginal view. I: Spore, surface view. Scale bar: A-B & D = 200  $\mu$ m; C = 7.5  $\mu$ m; E = 5  $\mu$ m; F = 1.7  $\mu$ m; G-I = 6  $\mu$ m.

form. Peridium membranous, covered with a crumbly layer of minute lime crystals forming a rough crust, colorless in transmitted light. Hypothallus inconspicuous. Columella absent or represented by a thickened pale orange-brown base. Capillitium dense, threads slender, undulate, sparsely branched, with isolated swelling nodules, hyaline to pale brown. Spores black in mass, violaceous brown or reddish brown by transmitted light, coarsely and distinctly warted, the warts often arranged in an obscurely line pattern, globose or subglobose, 12-16  $\mu$ m in diameter. Plasmodium not observed.

Specimens examined: Taipei City: Peitou, Yangmingshan National Park, on moss, CHL B2280, CHL B2281, Sept. 16, 2000.

Our specimens with characteristics fulfill well with the descriptions for *Didymium leptotrichum* in the reference (Nannenga-Bremekamp, 1991). This species is almost identical with *Didymium nivicolum* Meylan in the flat plasmodiocarps with a rough and white crust on the peridium, the capillitial threads, and the dark, warted, large spores (Moreno et al., 2003).

*Didymium nivicolum* is a nivicolous species and known from either the snow bank or alpine area (Mitchel et al., 1980; Ing, 1999; Moreno et al., 2003). As listed in the reference (Nannenga-Bremekamp, 1991), it was under *Didymium leptotrichum* as a synonym and stated "Whether *Didymium nivicolum* and *Didymium leptotrichum* are really identical cannot be certain till the type material has been examined". We placed our specimen as *Didymium leptotrichum* since it has the priority and our collections are from lowland instead of alpine.

*Didymium listeri* Masee, Monograph of the Myxogastres: 244. 1892.

Description and illustration: C.H. Liu and Y.F. Chen, in *Taiwania* 43: 179-180, 182 (1998).

*Didymium megalosporum* Berk. & M.A. Curtis, *Grevillea* 2: 53. 1873.

Description and illustration: H. Shi, in *Bull.*

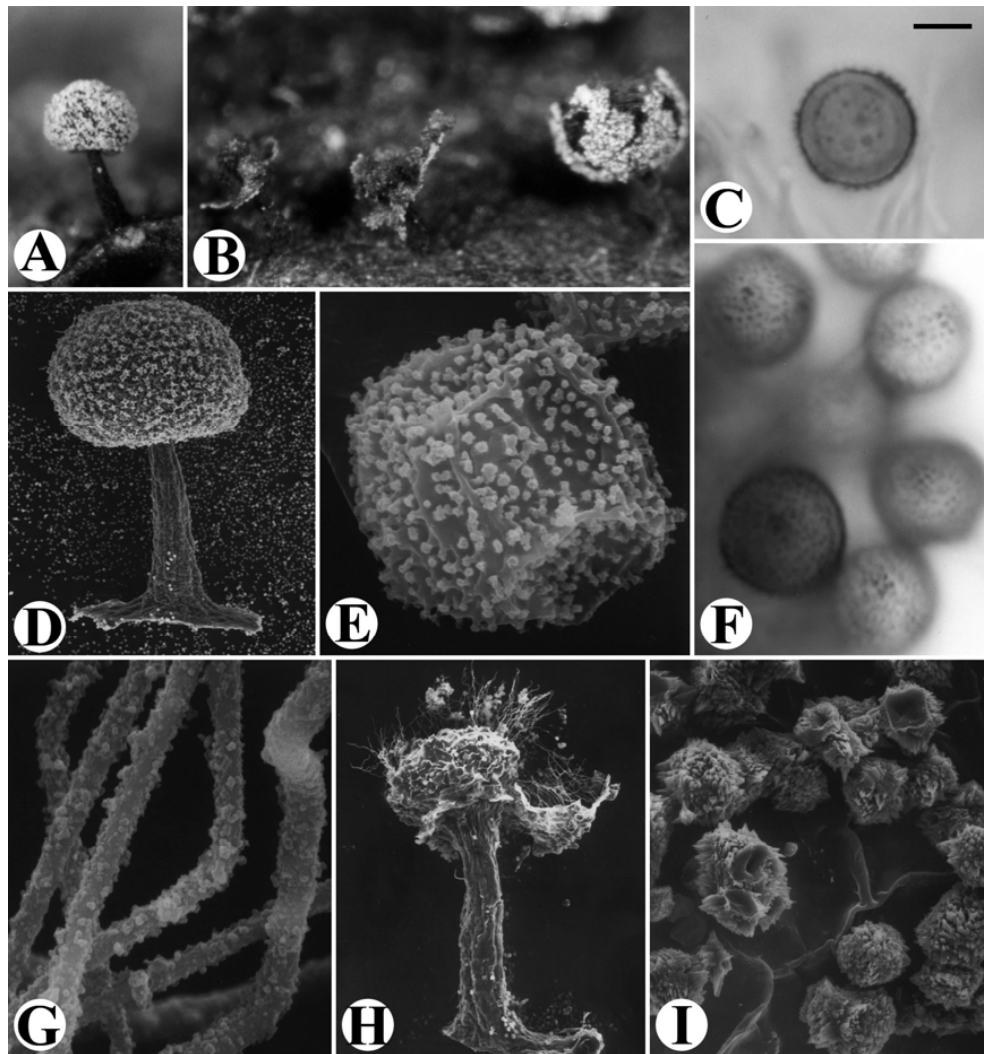


Fig. 4. *Didymium minus*. A: Fruiting body. B: Dehiscent sporangia. C: Spore, marginal view. D: Fruiting body, by SEM. E: Surface markings of spore, by SEM. F: Spores, surface view. G: Capillitial threads, by SEM. H: Dehiscent sporangium, showing columella, by SEM. I: Lime crystals on outer surface of peridium, by SEM. Scale bar: A-B = 250  $\mu$ m; C, F = 4.5  $\mu$ m; D = 120  $\mu$ m; E, G = 1.4  $\mu$ m; H = 85  $\mu$ m; I = 10.5  $\mu$ m.

Hsin-Chu Teacher's College 7: 396-397 (1981).

Specimens examined: Taipei City: farm of National Taiwan University, on fallen leaves, *CHL B500*, Apr. 11, 1985. Taipei County: Shiding, Wenshan Botanical Gardens of National Taiwan Univ., on fallen leaves and twigs, *Yang 99-12 C5L1*, Dec. 25, 1999.

The distinct characters of this species are the erect, white sporangium on a limeless brown stalk, the prominent stalked, whitish columella, and the large spores of 10-12  $\mu$ m in diameter. Our specimens resemble *Didymium nigripes* in outer appearance of the white sporangia and the spore surface markings. They are different, however, in columella and capillitial threads. In *Didymium nigripes*, the columella are brown and subglobose, the capillitial threads bear dark thickenings, while in *Didymium megalosporum* the

columella are whitish and stalked as goblet in shape, the dark thickenings of the capillitial threads are not found.

*Didymium melanospermum* (Pers.) T. Macbr., N. Amer. Slime-Moulds 88. 1899.

= *Didymium melanospermum* var. *bicolor* G. Lister, Monogr. Mycetozoa, 3rd Edi. (London): 115. 1925.

It was reported in a list by Nakazawa (1929), but no specimens were deposited in Taiwan.

*Didymium minus* (Lister) Morgan, J. Cincinnati Soc. Nat. Hist. 16: 145. 1894. Fig. 4

Fructification gregarious, sporangiate, stalked,



0.42-0.80 (-1.0) mm in total height. Sporangia white, slightly depressed-globose, umbilicate below, (0.36-) 0.40-0.50 mm in diameter. Peridium membranous, covered with lime crystals, dehiscence irregular. Stalk erect or slightly curved, limeless, striate, brown to dull below, slightly narrowed and paler near the apex, 0.28-0.68 mm long. Columella large, globose, slightly depressed, rough, calcareous, brown, attaining to the center of the sporangium, 100-200  $\mu$ m in diameter. Capillitium of delicate, colorless to pale brown threads, scarcely branched and anastomosed, irregularly and densely marked by warts of various size on the surface under SEM. Hypothallus discoid, dark, membranous. Spores dark brown to nearly black in mass, brown to violaceous brown by transmitted light, globose, mostly 8.5  $\mu$ m, (7.5-) 8-10  $\mu$ m in diameter, minutely warted, the warts often in clusters on the surface. Plasmodium not observed.

Specimens examined: Taipei City: Peitou, Yangmingshan National Park, on fallen leaves, *CHL B1423c*, Apr. 1, 1998; *Jong 19*, June 28, 2001 (moist-chamber culture: June 4-28, 2001). Farm of National Taiwan University, on straw, *CHL B254*, Apr. 29, 1983. Nantou Co.: Huisun Forestry Station, on decaying twigs, *CHL B498*, Apr. 1, 1985.

The distinct characters of this species are the strongly umbilicate and stalked sporangia, and dark warted spores with warts often clustered on the surface. Our specimens with characters agree well in general with those of *Didymium minus* except that the surface of capillitial threads of ours is not smooth, a characteristic not found in the references (Martin and Alexopoulos, 1969; Nannenga-Bremekamp, 1991; Moreno et al., 2001).

*Didymium nigripes* (Link) Fr., Syst. Mycol. 3: 119. 1829.

Description and illustration: C.H. Liu, in *Taiwania* 27: 71-72, 74, 83 (1982).

*Didymium ovoideum* Nann.-Bremek., Med. Bot. Mus. Herb. Utrecht 150: 780. 1958.

Description and illustration: C.H. Liu, in *Taiwania* 27: 71-72, 83 (1982).

*Didymium perforatum* Yamashiro, Journal of Science of the Hiroshima University, B. II 3: 33. 1936.

Description and illustration: C.H. Chung and C.H. Liu, in *Taiwania* 42: 278-279 (1997).

Specimen examined: Taipei City: campus of Affiliated High School of the National Taiwan Normal University, on dead leaves of *Eucalyptus robusta*, C.-H. Chung *M1507*, Dec. 21, 1996.

The distinct characters of this species are the closely reticulate plasmodiocarps, the iridescent peridium sprinkled with yellowish lime crystals, the dark netted

capillitium, and capillitial threads with nodose thickenings.

*Didymium serpula* Fr., Syst. Mycol. 3: 126. 1829.

Description and illustration: C.H. Liu, in *Taiwania* 27: 72-73, 75, 82 (1982).

*Didymium squamulosum* (Alb. & Schwein.) Fr., Symb. Gasteromyc. 19. 1818.

Description and illustration: C.H. Liu, in *Taiwania* 27: 73, 75, 82 (1982).

*Didymium verrucosporum* A.L. Welden, Mycologia 46: 98. 1954.

Description and illustration: C.H. Liu, in *Taiwania* 27: 73, 76, 82 (1982).

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## 臺灣黏菌(二十三)：白柄黏菌屬和鈣皮黏菌屬

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**摘要：**本篇整理與訂正臺灣產白柄黏菌屬與鈣皮黏菌屬的成員，其中擬碎鈣皮黏菌 (*Didymium floccoides*) 和薄捲鈣皮黏菌 (*D. leptotrichum*) 為兩種臺灣新記錄之黏菌，內文並提供臺灣所有紀錄的白柄黏菌屬與鈣皮黏菌屬的物種檢索表。

**關鍵詞：**白柄黏菌屬、鈣皮黏菌科、鈣皮黏菌屬、真黏菌綱、臺灣、分類。