

## Myxomycetes of Taiwan (XVIII): The Family Enteridiaceae

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**ABSTRACT:** Ten species of four genera in the family Enteridiaceae have been reported from Taiwan. In this paper a new record of the genus *Enteridium*, *E. intermedium* (Nann.-Bremek.) Farr, and the species *Lycogala exiguum* Morgan are described and illustrated. Keys to the genera of Enteridiaceae and to species of each genus from Taiwan, and synonyms of each species are also provided.

**KEY WORDS:** *Dictydiaethalium*, Enteridiaceae, *Enteridium*, *Lycogala*, Myxomycetes, Taiwan, True slime molds, *Tubifera*.

### INTRODUCTION

Enteridiaceae, one of the families of Liceales, is established by Farr (1982) due to the genus *Reticularia* has been replaced by *Enteridium* (Farr, 1976). Members in this family are a group of Myxomycetes with fructifications often large and conspicuous, and in the form of aethalium or pseudoaethalium except *Tubifera bombarda* which is a sporangiate form. Other distinct characters of this family are the presence of pseudocapillitium in various forms, and the absence of true capillitium. The lacking of dictydine granules is a character separating this family from Cribrariaceae. Four genera are generally accepted in this family although one of them, *Dictydiaethalium*, was removed (Nannenga-Bremekamp, 1985).

According to the records in Taiwan, up to the present, there are eleven known species in this family, among them ten have been reported (Nakazawa, 1929; Liu, 1980, 1981, 1982; Wang et al., 1981; Chen et al., 2005). In this paper we report one new record of *Enteridium*. The voucher specimens are deposited at the herbarium of National Museum of Natural Science, Taichung, Taiwan (TNM).

### TAXONOMIC TREATMENT

**Enteridiaceae** Farr, Mycologia 74: 339. 1982.

Reticulariaceae Chev., Fl. Gen. Env. Paris 1: 341. 1826.

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### Key to the genera of Enteridiaceae from Taiwan (inspired by Martin and Alexopoulos, 1969)

1. Fructification sporangiate; sporangia clustered or united into a pseudoaethalium ..... 2
1. Fructification aethaliate ..... 2
2. Fructification sporangiate or pseudoaethaliate with persistent peridium; hypothallus massive, fibrous or spongy ..... *Tubifera*
2. Fructification pseudoaethaliate; peridia evanescent at maturity except for thickened strands at the angles, which persist as pseudocapillitial threads depending from the lids; hypothallus not massive or spongy ..... *Dictydiaethalium*
3. Aethalium subglobose to conical or pulvinate, often on a restricted base; pseudocapillitium of colorless, ornamented tubes; spores in mass pinkish, then pallid ..... *Lycogala*
3. Aethalium pulvinate on a broad base; pseudocapillitium of frayed or perforated membranes; spores in mass brown, yellow or olivaceous ..... *Enteridium*

***Dictydiaethalium plumbeum*** (Schumach.) Rostaf., in Lister, Mycet. 157. 1894.

*Fuligo plumbea* Schumach., Enum. Pl. Saell. 2: 193. 1803.

*Reticularia plumbea* (Schumach.) Fr., Syst. Mycol. 3: 88. 1829.

*Ostracoderma spadiceum* Schw., Trans. Am. Phil. Soc. II. 4: 262. 1832.

*Licea rugulosa* Wallr., Fl. Crypt. Germ. 2: 345. 1833.

*Licea applanata* Berk., London J. Bot. 4: 67. 1845.

*Lycogala lenticulare* Dur. & Mont., in Dur., Expl. Sci. Alger. Bot. 1: 401. 1848.

*Reticularia entoxantha* Berk., J. Bot. & Kew Misc. 3: 201. 1851.

*Dictydiaethalium applanatum* (Berk.) Rostaf., in Fuckel, Jahrb. Nass. Ver. Nat. 27-28: 69. 1873.

*Reticularia lurida* Berk. & Broome, J. Linn. Soc. Bot. 14: 82. 1873.

*Licea cinnabarina* Berk. & Broome, J. Linn. Soc., Bot. 14: 86. 1873.

*Licea tenuissima* Berk. & Broome, J. Linn. Soc. Bot. 14: 86. 1873.

*Clathroptychium rugulosum* (Wallr.) Rostaf., Mon. 225. 1875.

- Dictydiaethalium dissiliens* (Hazsl.) ed., in Just. Bot. Jahresber. 5: 156. 1877.  
*Ophiuridium dissiliens* Hazsl., Oesterr. Bot. Zeits. 27: 85. 1877.  
*Clathroptichium cinnabarinum* (Berk. & Broome) Sacc., Michelia 1: 545. 1879.  
*Clathroptichium dissiliens* (Hazsl.) Berl., in Saccardo, Syll. Fung. 7: 409. 1888.  
*Clathroptichium berkeleyi* Massee, Mon. 53. 1892.  
*Dictydiaethalium plumbeum* var. *entoxanthum* (Berk.) G. Lister, J. Linn. Soc. Bot. 46: 95. 1922.  
*Dictydiaethalium plumbeum* var. *cinnabarinum* (Berk. & Broome) Hiranuma, in Shirai & Hara, List Jpn. Fungi ed. 3. 119. 1927.  
*Dictydiaethalium ferrugineum* Nann.-Bremek., Proc. Kon. Ned. Akad. Wetensch., Ser. C. 69: 345. 1966.  
*Dictydiaethalium cinnabarinum* (Berk. & Broome) H. Neubert, Nowotny & K. Baumann, Myxom. Deutschl. 1: 122. 1993.  
*Enteridium japonicum* Nann.-Bremek. & Y. Yamam., in Yamamoto & Nann.-Bremek., Proc. Kon. Ned. Akad. Wetensch., Ser. C. 98: 321. 1995.  
*Dictydiaethalium plumbeum* f. *cinnabarinum* (Berk. & Broome) Y. Yamam., Myxomycetes Biota Japan 106. 1998.  
*Dictydiaethalium plumbeum* var. *japonicum* (Nann.-Bremek. & Y. Yamam.) Y. Yamam., Myxomycetes Biota Japan 105. 1998.  
*Dictydiaethalium plumbeum* var. *ferrugineum* (Nann.-Bremek.) L. G. Krieglst., Regensburger Mykologische Schriften 9: 116. 1999.

Description and illustration: C.-H. Liu, in *Taiwania* 26: 58-59, 60-61 (1981).

Distribution: Cosmopolitan.

**Key to the species of *Enteridium* from Taiwan**  
 (inspired by Martin and Alexopoulos, 1969)

1. Pseudocapillitium membranous at base (but not perforated), fraying out into dendroid columns of flexuous threads; peridium persistent; aethalia often large, up to 3 cm or more in extent ..... *E. lycoperdon*
1. Pseudocapillitium composed entirely of dendroid columns; peridium thin, brittle, evanescent; aethalia rarely exceeding 2 cm in extent ..... *E. intermedium*

***Enteridium intermedium* (Nann.-Bremek.) Farr,**  
 Taxon 25: 514. 1976. Figs. 1A-D

*Reticularia intermedia* Nann.-Bremek., Med. Bot. Mus. Utrecht 149: 773. 1958.

Aethalia solitary, pulvinate, pale brown tinted with pink, about 1.5 cm in diameter and 0.5 cm in height. Hypothallus white, irrediscent. Peridium thin, fragile, evanescent. Pseudocapillitium profuse, yellowish brown, dendroid, with very small and membranous plates at the base, extending throughout the aethalium, broken and collapsed with dispersal of spores. Spores free, pinkish brown in mass, pale yellow by transmitted light, delicately reticulate over most of the surface, smooth on the small remaining area, globose to subglobose, (6.5-)7-9  $\mu$ m in diameter including the reticulate border. Plasmodium not observed.

Specimens examined: Taipei: National Taiwan University campus, on bark of *Melaleuca leucadendron*, CHL B1201 (TNM F18562), June 19, 1997.

Distribution: Bahamas, Doorwerth, Great Britain, Greece, Netherlands, Taiwan.

It resembles *Enteridium lycoperdon* in outer appearance, but this species is smaller in size range. They are remarkably different in the pseudocapillitium which in *E. lycoperdon* arises from the base as erect prominent plates ending in a mass of flexuous threads, and in *E. intermedium* is thread-like and dendroid with minute plates at the base (Nannenga-Bremekamp, 1991).

***Enteridium lycoperdon* (Bull.) Farr,** Taxon 25: 514. 1976.

- Mucor lycogalum* Bolton, Hist. Fung. 3: 133. 1789.  
*Reticularia lycoperdon* Bull., Hist. Champ. Fr. 95. 1791.  
*Lycogala argentea* Pers., Neues Mag. Bot. 1: 87. 1794.  
*Trichoderma fuliginoides* Pers., Syn. Fung. 236. 1801.  
*Lycogala punctata* Pers., Syn. Fung. 158. 1801.  
*Lycogala turbinata* Pers., Syn. Fung. 158. 1801.  
*Fuligo lycoperdon* Schum., Enum. Pl. Saell 2: 193. 1803.  
*Reticularia argentea* (Pers.) Poir., in Lam., Encyc. 6: 183. 1804.  
*Strongylium fuliginoides* (Pers.) Ditmar, Neues J. Bot. Schrad. 3: 55. 1809.  
*Reticularia umbrina* Fr., Syst. Mycol. 3: 87. 1829.  
*Reticularia lycoperdon* var. *americana* Nann.-Bremek., Med. Bot. Mus. Herb. Rijksuniv. Utrecht 7: 773. 1958.

Description and illustration: C.-H. Liu, in *Taiwania* 26: 59, 60-61 (1981).

Distribution: Cosmopolitan.

**Key to the species of *Lycogala* from Taiwan**  
 (inspired by Martin and Alexopoulos, 1969; Ing, 1999)

1. Aethalia large, 2 cm or more in diameter; peridium smooth or nearly so, without scales ..... *L. flavofuscum*
1. Aethalia less than 2 cm in diameter; peridium with scales or warts ..... 2
2. Aethalia conical, taller than broad ..... *L. conicum*
2. Aethalia subglobose or pulvinate, not notably taller than broad ..... 3
3. Aethalia pallid to yellow-brown, rarely blackish, mostly 3-15 mm in diameter; cortical scales neither strongly pustulate nor tessellate; pseudocapillitium strongly sculptured, 6-25  $\mu$ m in diameter ..... *L. epidendrum*
3. Aethalia brownish ochraceous to dark brown or black, mostly 2.5-5.5 mm in diameter, rarely larger; cortical scales pulvinate, prominent, dark, at first pustulate, tending to become tessellate; pseudocapillitium not strongly sculptured, 2-5  $\mu$ m in diameter ..... *L. exiguum*

***Lycogala conicum* Pers., Syn. Fung. 159. 1801.**

- Lycogala atropurpureum* Berk. & Broome, J. Linn. Soc., Bot. 14: 82. 1873.  
*Lycogala nitidum* Berk. & Broome, J. Linn. Soc., Bot. 14: 81. 1873.  
*Dermodium conicum* (Pers.) Rostaf., Mon. 385. 1874.  
*Antonigepia conica* (Pers.) O. Kuntze, Rev. Gen. Pl. 3: 443. 1898.  
*Lycogala conicum* var. *pustulatum* K.S. Thind, Indian Phytopathol. 78. 1977.

Description and illustration: C.-H. Liu, in *Taiwania* 27: 64, 80-81 (1982).

Distribution: Europe, North America, West Pakistan, China, India, Japan, Taiwan.

*Lycogala epidendrum* (L.) Fr., *Syst. Mycol.* 3: 80. 1829. Figs. 2A-B

*Lycoperdon epidendrum* L., *Sp. Pl.* 1184. 1753.

*Mucor lycogala* Scop., *Fl. Carn. ed. 2.* 2: 496. 1772.

*Mucor fragiformis* Schaeff., *Fung. Bavar.* 4: 132. 1774.

*Lycoperdon pisiforme* Jacq., *Misc. Austr.* 1: 137. 1778.

*Lycoperdon variolosum* Huds., *Fl. Angl. ed. 2.* 645. 1778.

*Galeperdon epidendrum* (L.) Wiggers, *Prim. Fl. Holsat.* 109. 1780.

*Lycoperdon chalybeum* Batsch, *Elench. Fung.* 155. 1783.

*Lycogala minutum* Pers., *Neues Mag. Bot.* 1: 87. 1794.

*Reticularia rosea* DC., *Bull. Soc. Philom.* 1: 105. 1798.

*Lycogala ferruginea* Schum., *Enum. Pl. Saell.* 2: 192. 1803.

*Reticularia miniata* (Pers.) Poir., in *Lam., Encyc.* 6: 184. 1804.

*Reticularia punctata* Poir., in *Lam., Encyc.* 6: 184. 1804.

*Lycogala terrestre* Fr., *Sym. Gast.* 10. 1817.

*Lycogala affine* Berk. & Broome, *J. Linn. Soc.* 14: 81. 1873.

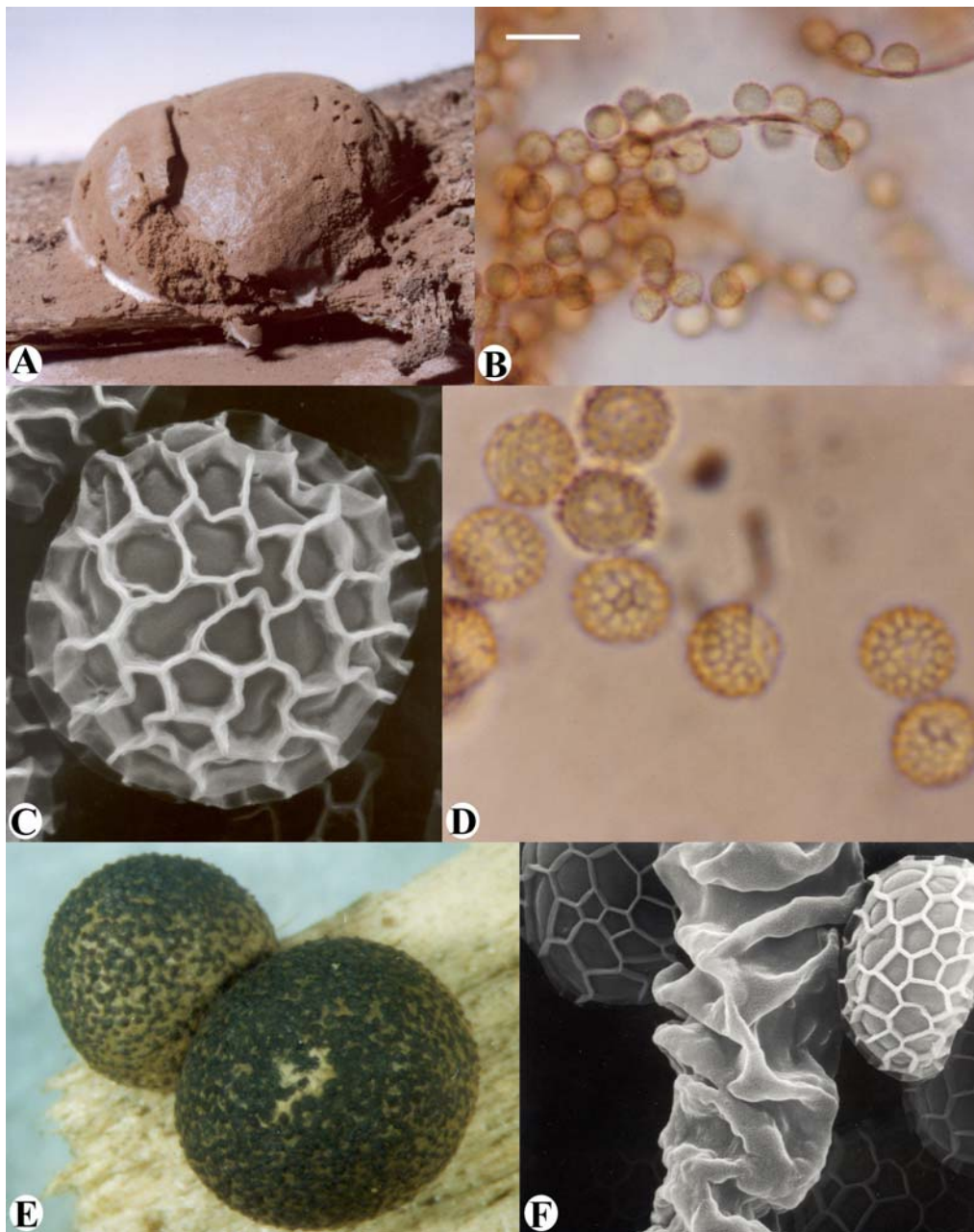


Fig. 1. A-D. *Enteridium intermedium*. A: Aethalium. B: Pseudocapillitium and spores. C: Surface markings of spore, SEM. D: Spores, showing the surface reticulation and the smooth area. E-F. *Lycogala exiguum*. E: Aethalia. F: SEM of pseudocapillitium and spores. Scale bars: A = 250  $\mu$ m, B = 18  $\mu$ m, C = 1  $\mu$ m, D = 7.5  $\mu$ m, E = 1 mm, F = 1.5  $\mu$ m.

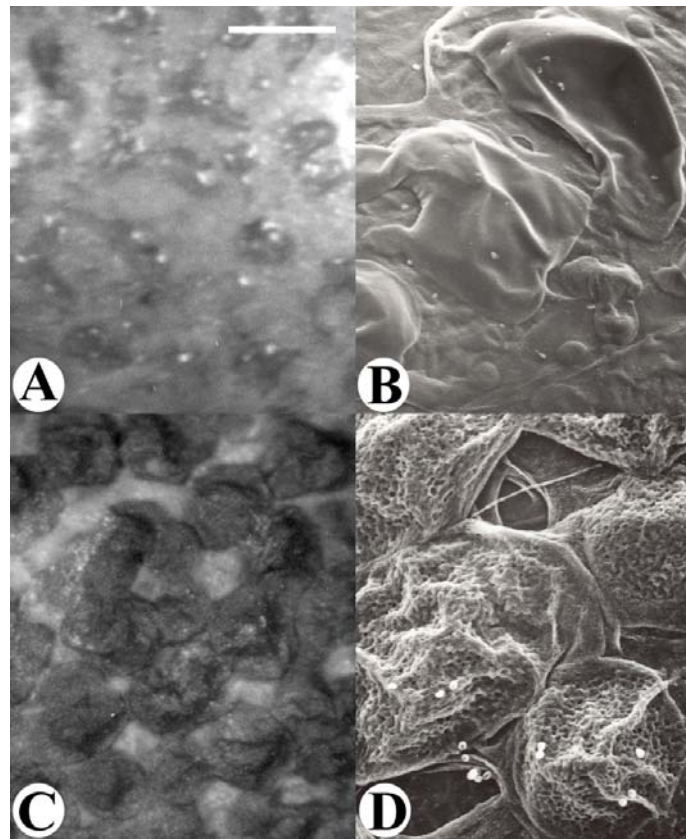


Fig. 2. A-B. *Lycogala epidendrum*, showing the detail of peridium under LM (A) and SEM (B) respectively. C-D: *L. exiguum*, showing the detail of peridium under LM (C) and SEM (D) respectively. Scale bars: A, C = 400  $\mu$ m, B, D = 100  $\mu$ m

*Lycogala miniatum* var. *tessellatum* Lister, in Penzig, Myxom. Buitenz. 77. 1898.

*Lycogala* cf. *epidendrum* var. *tessellatum* (Lister) G. Lister, in Lister, Mycet. ed. 2. 203. 1911.

*Lycogala nigricans* Lloyd, Mycol. Writ. 7:1184. 1923.

*Lycogala miniatum* var. *cristatum* Flatau & Schir., Zeit. Mykol. 60: 256. 1994.

*Lycogala epidendrum* var. *terrestre* (Fr.) Y. Yamam., Myxomycetes Biota Japan 118. 1998.

Description and illustration: C.-H. Liu, in *Taiwania* 25: 148 (1980).

Distribution: Cosmopolitan.

*Lycogala exiguum* Morgan, J. Cinc. Soc. Nat. Hist. 15: 134. 1893. Figs. 1E-F, 2C-D

*Lycogala epidendrum* var. *exiguum* (Morgan) G. Lister, in Lister, Mycet. ed. 3. 199. 1925.

Fructification aethaliolate, scattered or gregarious, subglobose, dark pinkish-buff to almost black, 2.5-5.5 mm in diameter. Peridium yellowish brown, covered with clusters of dark purplish brown or black scales which appeared dividing into compartments, dehiscent apically. Pseudocapillitium of colorless or yellow branching tubules smooth, roughened or transversely wrinkled, 2-5  $\mu$ m in

diameter. Spores pink in mass, colorless by transmitted light, globose, 5-5.5  $\mu$ m in diameter, banded reticulate under SEM.

Specimens examined: Taipei Co.: Shih-ting, Wenshan Botanical Gardens of National Taiwan University, on dead wood, *Yang A3-4* (TNM F18533), Mar. 27, 1999; *Yang A4-2-2* (TNM F18534), Feb. 24, 1999. Nantou Co.: Huisun Forestry Station, on dead wood, *CHL B1365* (TNM F18669), Dec. 20, 1997.

Distribution: Cosmopolitan.

The characters separating this species from *L. epidendrum* are the dark clustered cortical scales and the smooth, slender pseudocapillitium. This species has been reported as a new record without any description and illustration (Wang et al., 1981). It is described and illustrated here for the first time basing on the specimens collected in Taiwan.

*Lycogala flavofuscum* (Ehrenb.) Rostaf., in *Fuckel, Jahrb. Nass. Ver. Nat.* 27-28: 68. 1873.

*Diphtherium flavofuscum* Ehrenb., *Sylvae Myc. Berol.* 27. 1818.

*Reticularia flavofusca* (Ehrenb.) Fr., *Syst. Mycol.* 3: 88. 1829.

*Lycogala repletum* Morgan, J. Cinc. Soc. Nat. Hist. 18: 40. 1895.

- Lycogala flavofuscum* var. *argentea* Brandzã, Ann. Sci. Univ. Jassy 8: 265. 1914.  
*Verrucosia corticola* Teng, Contr. Biol. Lab. Sci. Soc. China 7: 124. 1932.  
*Lycogala corticolum* (Teng) Teng, Contr. Biol. Lab. Sci. Soc. China 8: 143. 1932.  
*Lycogala flavofuscum* var. *armeniicum* Wichansky, Ces. Mycol. 13: 224. 1959.  
*Lycogala flavofuscum* var. *albidum* Wichansky, Ces. Mycol. 13: 224. 1959.

Distribution: Europe, North America, South America, New Zealand, South Africa, China, Taiwan.

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

**Key to the species of *Tubifera* from Taiwan**  
 (inspired by Martin and Alexopoulos, 1969)

1. Pseudocapillitium columella-like, sometimes with branches which may reach the peridium ..... *T. casparyi*
1. Pseudocapillitium lacking ..... 2
2. Hypothallus expanded, not forming a stalk-like structure; spores usually larger than 6 µm in diameter ..... *T. ferruginosa*
2. Hypothallus contracted, forming a short thick stalk ..... 3
3. Hypothallus white, forming a stalk-like structure, densely covered by small sporangia ..... *T. dimorphotheca*
3. Hypothallus dark, raises slightly as a short and stout stalk without any sporangia on the rim, spores smaller than 6 µm in diameter ..... *T. microsperma*

***Tubifera casparyi*** (Rostaf.) T. Macbr., N. Am. Slime-Moulds 157. 1899.

*Siphoptychium casparyi* Rostaf., Mon. App. 32. 1876.

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

It was reported as a new record without any description and illustration (Wang et al., 1981).

***Tubifera dimorphotheca*** Nann.-Brem. & Loerak., Proc. K. Ned. Akad. Wet. C. 84: 237. 1981.

Description and illustration: Y.-F. Chen, et al., in Coll. and Res. 18: 18, 20-22 (2005).

Distribution: Belgium, India, Japan, Netherlands, Taiwan.

***Tubifera ferruginosa*** (Batsch) J.F. Gmel., Syst. Nat. 2: 1472. 1792.

*Stemonitis ferruginosa* Batsch, Elench. Fung. Contin. 1: 261. 1786.

*Lycoperdon favaceum* Schrank, Baier. Fl. 2: 667. 1789.

*Sphaerocarpus cylindricus* Bull., Hist. Champ. Fr. 140. 1791.

*Sphaerocarpus fragiformis* Bull., Hist. Champ. Fr. 141. 1791.

*Tubifera cylindrica* (Bull.) J.F. Gmel., Syst. Nat. 2: 1472. 1791.

*Tubifera fragiformis* (Bull.) J.F. Gmel., Syst. Nat. 2: 1472. 1791.

*Tubulina fragiformis* (Bull.) Pers., Neues Mag. Bot. 1: 91. 1794.

*Tubulina coccinea* Trent., in Roth, Catalecta Bot. 1: 243. 1797.

*Licea tubulina* Schrad., Nov. Gen. Pl. 16. 1797.

*Licea clavata* Schrad., Nov. Gen. Pl. 16. 1797.

*Tubulina fallax* Pers., Obs. Myc. 2: 28. 1799.

*Tubulina cylindrica* (Bull.) DC., Fl. Fr. 2: 249. 1805.

*Tubulina fragifera* Poir., in Lam., Encyc. 8: 130. 1808.

*Licea fragiformis* (Bull.) Nees, Syst. Pilze Schw. 107. 1816.

*Licea effusa* Ehrenb., Sylv. Myc. Berol. 18. 1818.

*Licea cylindrica* (Bull.) Fr., Syst. Myc. 3: 195. 1829.

*Licea iricolor* Zoll., in Zoll. & Mor., Nat. Geneesk. Arch. Neerl.-Ind. 1: 376. 1844.

*Tubulina conglobata* Preuss, Linnaea 24: 140. 1851.

*Licea rubiformis* Berk. & Curt., Proc. Am. Ned. Acad. 4: 125. 1859.

*Tubulina nitidissima* Berk., J. Linn. Soc. 18: 387. 1881.

*Tubulina speciosa* Speg., Atti Soc. Critt Ital. 3: 62. 1881.

Distribution: Cosmopolitan.

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

***Tubifera microsperma*** (Berk. & Curt.) G.W. Martin, Mycologia 39: 461. 1947.

*Licea microsperma* Berk. & Curt., in Berk., Grevillea 2: 68. 1873.

*Licea stipitata* Berk. & Rav., in Berk. & Curt., Proc. Am. Acad. 4: 125. 1860.

*Tubulina stipitata* (Berk. & Rav.) Rostaf., Mon. 223. 1875.

*Tubifera stipitata* (Berk. & Rav.) T. Macbr., N. Am. Slime-Moulds 157. 1899.

*Tubifera ferruginosa* var. *stipitata* (Berk. & Rav. ex Rostaf.) Torrend, Broteria 7: 22. 1908.

Description and illustration: C.-H. Liu, in Taiwaniana 26: 58, 60-61 (1981).

Distribution: Hawaii, North America, South America, China, Japan, Taiwan.

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### 臺灣黏菌(十八): 孔膜黏菌科

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#### 摘 要

孔膜黏菌科在臺灣已紀錄有4屬10種, 本篇所報導的中間型孔膜黏菌 (*Enteridium intermedium* (Nann.-Bremek.) Farr) 為臺灣新紀錄之黏菌, 並進一步對小粉瘤黏菌 (*Lycogala exiguum* Morgan) 作描述與圖示; 另外內文並提供臺灣所紀錄的孔膜黏菌科內之各屬與屬內物種之檢索表及其同種異名。

關鍵詞: 網聚囊黏菌屬、孔膜黏菌科、孔膜黏菌屬、粉瘤黏菌屬、黏菌綱、臺灣、真黏菌、筒黏菌屬。

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