THE ENDOGONACEAE OF TAIWAN
I. A PRELIMINARY INVESTIGATION ON ENDOGONACEAE OF BAMBOO VEGETATION AT CHI-TOU AREAS, CENTRAL TAIWAN.[1]

by

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ABSTRACT.

In this investigaion, 14 species are discovered, namely **Acaulospora foveata* Trappe & Janos, *A. laevis* Gerdemann & Trappe, *A. scrobiculata* Trappe, *A. trappei* Ames & Linderman, **Entrophospora infrequens* (Hall) Ames & Schneider, *Gigaspora gigantea* (Nicol. & Gerd.) Gerdemann & Trappe, **Glomus caledonicum* (Nicol. & Gerd.) Trappe & Gerdemann, *G. etunicatum* Becker and Gerdemann, *G. fasciculatum* (Thaxter sensu Gerdemann) Gerdemann and Trappe, *G. formosanum* sp. nov., **Sclerocystis coremioides* Berk & Broome, **S. pakistanica* Iqbal & Bushra, *S. rubiformis* Gerdemann & Trappe, **S. pachycaulis* sp nov. Among these mentioned as above, 7 species (with * mark) are previously unreported from Taiwan, and 2 new species (*G. formosanum*; *S. pachycaulis*) are described. Additionally, 6 unidentified species (3 in *Acaulospora*, 1 in *Glomus*, 1 in *Modicella*, and 1 pyriform spore type) are also described.

INTRODUTION.

The taxonomy of Endogonaceae, after the revision made by Gerdemann and Trappe (1974) followed by Ames and Schneider (1979), Hall (1979), Gibson (1984), Koske and Walker (1984), Morton and Walker (1984), Schenck et al (1984), Rothwell and Victor (1984), Trappe (1982), Trappe et al (1984), Walker et al (1984), Yang and Wilcox (1984), at present comprise with 7 genera v.s. *Acaulospora*, *Endogone*, *Entrophospora*, *Gigaspora*, *Glomus*, *Modicella*, and *Sclerocystis*.

The investigation of this family in Taiwan was started from late 1970's and up to date 29 species distributing into 4 genera: *Acaulospora*, *Gigaspora*, *Glomus*, *Sclerocystis* were reported. The infected host species were mainly in the economic crops or plants such as fruit trees, grains and forest tree etc. (Chen, Y. L. 1981; Chen, Z. C. 1981; Hu, 1978; Kuo and Huang, 1982; Toun, 1982; Tzean and Huang, 1980; Wang, 1982; Wong, 1981; Chang, 1984; Chao, 1984)

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1. This paper is based partly on a M. S. thesis of the first author submitted to the Research Institute of Botany, National Taiwan University under the guidance of the second author.
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During the survey of distribution of the Endogonaceae in bamboo vegetation about 20 species of mycorrhizal fungi distributed into 6 genera were recovered from the soil of rhizosphere of each plant species. The description and distribution in Taiwan of each fungal species are presented in this paper.

1. *Acaulospora foveata* Trappe & Janos, Mycotaxon 15: 515-522, 1982 Fig. 1.

Sporocarps unknown. Spores formed singly in the soil, sessile, yellowbrown, to dark reddish brown, globose to subglobose, 200-280 μm diam. Spore surface evenly pitted with round to oblong or irregular depressions 7.5-10 X 7.5-12.5 μm, 2-3 μm deep, with rounded bottoms, separated by ridges 1-12 μm thick. Outer wall yellow-brown to reddish brown, 12-13 μm thick, with a separable, hyaline inner wall 3 μm thick.

COLLECTIONS EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. From the rhizosphere of *Phyllostachys pubescens* Mazel, Oct. 23, 1982, Wu-003 (TAI) (SEM specimen); from the rhizosphere of *Pratia nummularia* (Lam.) A. Br. & Arch, Oct. 23, 1982, Wu-004 (slide).

DISTRIBUTION AND HABITAT IN TAIWAN: Found in the rhizosphere of ground cover of bamboo vegetation in central Taiwan (Wu, 1983).

NOTES: This species was a new record from Taiwan, but spores found in the in vestigation were rare. *A. foveata* is easily distinguished from *A. scrobiculata* Trappe by its larger pits (7.5-10 X 7.5-12.5 μm vs 1-4 X 1-3.5 μm).

2. *Acaulospora laevis* Gerdemann & Trappe, Mycologia Memoir No. 5. 33-34, 1974.

Sporocarps unknown. Spores formed singly in soil, sessile, yellow to yellowbrown; surface smooth, 90-205 X 95-205 μm, globose to subglobose or ellipsoid. Spore wall consisting of three layers: a rigid yellow to yellow-brown outer wall 2.5-7.5 μm thick, and two hyaline, thin inner walls; the innermost sometimes minutely rough-ened; in older specimens, wall frequently perforate and filled with microorganisms.

COLLECTIONS EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. From the rhizosphere of *Asplenium normale* Don, Oct. 23, 1982, Wu-005 (TAI) (slide), from the rhizosphere of *Pratia nummularia* (Lam.) A. Br. & Asch., Oct. 23, 1982, Wu-006 (TAI) (slide), and from the rhizosphere of *Phyllo-stachys pubescens* Mazel, Oct. 23, 1982, Wu-007 (TAI) (slide).

DISTRIBUTION AND HABITAT IN TAIWAN: From the rhizosphere of *Chama-ecyparis formosensis* Matsum. (Hu, 1978; Wong, 1981), *Taiwaniana crytomerioides* Hayata (Wong, 1981) and ground cover of bamboo forest (Wu, 1983) in Taiwan.

NOTES: The spores found in this investigation are identical to *A. laevis* described by Gerdemann & Trappe (1974). However, our collection have thicker wall than those of types (2.5-7.5 μm vs 2-4 μm).

3. *Acaulospora scrobiculata* Trappe, Mycotaxon 6(2): 363-366, 1977. Fig. 2-3.

Sporocarps unknown. Spores formed singly in the soil, sessile, yellew to yellow-brown, globose to subglobose, 100-182.5 X 135-195 μm. Spore surface evenly pitted with depressions 1-4 X 1-3.5 μm, separated by ridges, 0.5-(2)-4 μm thick, the mouths of the depression circular to elliptical or irregular. Spore wall consisting

of four layers: the rigid, pitted light yellow brown outer layer, 2-7.5 μm thick, and three separable, thin (<1 μm thick), hyaline, inner walls.
Reaction to Melzer's reagent: outer three wall layers yellow, innermost layer quickly becoming deep red on contact.

COLLECTIONS EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. From the rhizosphere of *Phyllostachys pubescens* Mazel, Oct. 9, 1982, Wu-008 (TAI) (slide); from the rhizosphere of *Colocasia formosana* Hayata, Oct. 23, 1982, Wu-009 (TAI) (slide).

DISTRIBUTION AND HABITAT IN TAIWAN: From the rhizosphere of corn (Tzean and Huang, 1980). *Chamaecyparis formosensis* (Hu, 1978), ground cover of bamboo forest (Wu, 1983), and AVRDC cultivated fields (Kuo and Huang, 1982) in Taiwan.

NOTES: Spores found in this investigation were rare. The innermost wall layer of *A. scrobiculata* is not easily observed under microscope, except using Melzer's reagent to react with it and make it distinguishable.

4. *Acaulospora trappei* Ames & Linderman, Mycotaxon 3(3): 565-569, 1976.

Sporocarps unknown. Spores formed singly in the soil or within the roots, sessiles, borne laterally on a smooth, unbranched hyphal cell that terminate in a globose or subglobose vesicle; vesicle approximately the same size as the spore. Spores 30-54 X 40-63 μm, subglobose to obovoid, colorless, wall single, 3 μm thick.

COLLECTIONS EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. From the rhizosphere of *Pratia nummularia* (Lam.) A. Br. & Asch., Oct. 23, 1982, Wu-010 (slide); from the cortical tissue of *Gonostegia hirta* (Blume) Miq., Oct. 23, 1982, Wu-011 (slide).

DISTRIBUTION AND HABITAT IN TAIWAN: Found in the rhizosphere of *Chamaecyparis formosensis* (Hu, 1978), and ground cover of bamboo forest (Wu, 1983) in Taiwan.

NOTS: Based on the evidences that the presence of spore of *A. trappei* and sporeforming vesicle within the root of *Gonostegia hirta*, *A. trappei* seems to be able to form VA mycorrhizae with *G. hirta* in Taiwan.

5. *Acaulospora* sp-1 Fig. 4-5.

Sporocarp unknown. Spore formed singly in soil, hyaline, or subhyaline, 62.5 X 75 μm, obovoid. Spore surface ornamented with crowded hyaline spins tapering to 0.5 μm diam. and loosely separated. Base of the spins 1-2 μm diam. Reticulum lacking. Base of spins separated by distance about 2-4 μm long.

COLLECTION EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. From the rhizosphere of *Phyllostachys pubescens* Mazel., Oct. 23, 1982, Wu-012 (slide).

DISTRIBUTION AND HABITAT IN TAIWAN: From the rhizosphere of ground cover of bamboo forest in central Taiwan (Wu, 1983).

NOTES: Only one spore was found in this investigation. The outer morphology of this spore resemble to *A. elegans* Trappe & Gerdemann and *A. spinosa* Walker & Trappe. However, the spore size is smalller than those of *A. elegans* and *A. spinosa* (62.5 X 75 μm vs 140-285 X 145-230 μm and 100-298 X 100-235 μm respectively). Additionally, hyaline spore with loosely arranged hyaline spins is also distinguishable from those of *A. elegans* and *A. spinosa*.

6. *Acaulospora* sp-2 Fig. 6-8.

Sporocarps unknown. Spore globose, hyaline or white, 125 μm diam. Spore surface ornamented with cerebriform ridges. Spore wall consisting of an outer layer 4 μm thick, and a slight roughened inner layer 2.5 μm thick.

COLLECTION EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. From the rhizosphere of *Asplenium normale* Don., Oct. 23, 1982, Wu-013 (slide).

DISTRIBUTION AND HABITAT IN TAIWAN: From the rhizosphere of ground cover of bamboo forest in central Taiwan (Wu, 1983).

NOTES: Only one spore was found in this investigation. Owing to the lacking of attached hypha and with ring-like attachment, the spore was tentatively put in the genus *Acaulospora*. The spore of *A.* sp-2 resemble to *A. gerdemannii* Schenck & Nicolson by its cerebriformly ridged outer wall, but differs by hyaline spore and roughened wall.

7. *Acaulospora* sp-3 Fig. 9-10.

Sporocarp unknown. Spore formed singly in the soil, sessile, hyaline, 70 X 80 μm, obovoid. Spore wall consisting of two layers: outer layer hyaline 2-2.5 μm thick, inner layer hyaline, ornamented with polygonal reticulum; the ridges 2 μm thick. The thickness of inner wall difficult to determine. Spore with oil contents.

COLLECTION EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. From the rhizosphere of *Selaginella doederleinii* Hieron, Oct. 23, 1982, Wu-014 (slide).

DISTRIBUTION AND HABITAT IN TAIWAN: From rhizosphere of ground cover of bamboo forest in central Taiwan (Wu, 1983).

NOTES: Only one spore was found in this investigation. This spore resembles slightly to *A. bireticulata* Rothwell & Trappe by its polygonal reticulate inner wall. Additionally, the lacking of ornamentation in polygonal reticulum and double walls of *A.* sp-3 are apparently different from those of *A. bireticulata*.

8. *Entrophospora infreqnens* (Hall) Ames & Schneider Mycotaxon 8(2): 347-352, 1979 Fig. 13-14.

Azygospore formed singly in the soil, globose, yellow brown, 185 μm diam. Spore walls double, with one dull yellow outer layer, 4-6 μm thick, and yellow brown inner layer 3 μm thick. The outer surface of inner layer ornamented with crowded

spins, 4 μm tall, tapering to 0.5 μm diam.; reticulum 1 μm diam. Attached hypha, funnel shaped, with thick wall, 14 μm diam, at the attachment.

COLLECTION EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. From the rhizosphere of *Phyllostachys pubescens* Mazel, Oct. 9, 1982, Wu-028 (slide)

NOTES: This genus is characterized by its azygospore formed within the stalk of the mother vesicle and this species is also easily identified by its wall structure-inner layer covered with crowded spins protruding toward the outer layer. This genus and species are new records from Taiwan, but only one spore was found in this investigation. The spore of present collection slightly differs with the original description by having a thick-walled funnel-shaped attached hypha, smaller size of reticulum, and a colored outer wall.

9. *Gigaspora gigantea* (Nicol. & Gerd.) Gerdemann & Trappe, Mycologia Memoir No. 5: 29-30,1974.

Endogone gigantea Nicol. & Gerd., Mycologia 60: 321, 1968.

Azygospore formed singly in the soil, 400 μm diam, yellow, with a thin outer wall (±1 μm thick) covering an inner wall; the inner wall 8.5 μm thick. The suspensor-like cell bulbous, 54-58 μm diam, giving rise to dichotomous branch hypha that projects to the spore. Attached hypha 14 μm diam.

DISTRIBUTION AND HABITAT IN TAIWAN: Found in the rhizosphere of *Chamaecyparis formosensis* (Wong, 1981), and *Phyllostachys pubescens* (Wu, 1983) in Taiwan.

COLLECTION EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. From the rhizosphere of *Phyllostachys pubescens* Mazel, Oct. 9, 1982, Wu-021 (slide)

NOTES: Although many different types of spores of *Gigaspora* were found in this investigation among the rhizosphere of *Phyllostachys pubescens*, most of these were too seriously deteriorated by hyperparasitic fungi to be identified, and only one cultivated on agar plate for germination was iden-tified as *G. gigantea*.

10. *Glomus caledonicum* (Nicol. & Gerd.) Trappe & Gerdemann, Mycologia Memoir No 5: 56-57, 1974. Fig. 15-17.

Endogone macrocarpa var. *caledonia* Nicol. & Gerd., Mycologia 60: 318, 1968.

Chlamydospores formed singly in soil. Spore dull yellow to brown or reddish brown, 125 X 130 μm, subglobose. Spore wall double: outer wall hyaline or subhyaline, 2-4 μm thick and inner wall yellow brow, 7 μm thick; outer wall thickened at the hyphal attachment, extending along the attached hypha for some distance; inner wall thickening extending into the attached hypha a short distance. Spore contents separated from attached hypha by a thin, curved septum at the hyphal attachment. Attached hypha 13 μm diam at the attachment.

COLLECTION EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. From the rhizosphere of *Asplenium normale* Don, Oct. 23, 1982, Wu-022 (slide).

DISTRIBUTION AND HABITAT IN TAIWAN: In the rhizosphere of ground cover of bamboo forest in high lands of central Taiwan.

NOTES: This species was a new record from Taiwan. Among the other confused spores, only one of this species is identified in the rhizosphere of *Asplenium normale*. The spore of *G. caledonicum* resemble to those formed by *G. etunicatum* Becker and Gerdemann, and *G. macrocarpum* Tul. & Tul. *Glomus etunicatnm* has, however, smaller spores (68-144 μm diam) and separable hyaline, outer wall and *G. macrocarpum* has a thick-walled attached hypha along which a thin outer wall extend for some distance. According to the Gerdemann and Trappe (1974), that the outer wall of *G. caledonicum* is easily separable, is not coincident with the description by Becker and Gerdemann (1977), that the outer wall of *G. caledonicum* is usually persistent. This species has spores with persistent but separable outer wall.

11. *Glomus etunicatum* Becker & Gerdemann, Mycotaxon 6: 29-32, 1977.

Chlamydospore formed singly in the soil, globose, 100 μm diam. Spore wall composed of a ephemeral hyaline outer wall, 2.5-3 μm thick, and a persistent yellow to yellow brown inner wall, 4 μm thick. Outer wall extending down attached hypha for a short distance. Spore contents separated from attached hypha by a thin, curved septum.

COLLECTION EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. From the rhizosphere of *Colocasia formosana* Hayata, Oct. 23, 1982, Wu-023 (TAI) (slide).

DISTRIBUTION AND HABITAT IN TAIWAN: From the cultivated fields (Kuo and Huang, 1982) and high lands of Taiwan (Wu, 1983).

NOTES: Among the other confused spores, only one of this species is identified in the rhizosphere of *Colocasia formosana*. The spore of *Glomus etunicatum* resembles to those formed by *G. caledonicum*. *G. caledonicum* has, however, considerably larger spores (130-279 X 120-272 μm) and a hyaline outer wall which usually is persistent.

12. *Glomus fasciculatum* (Thaxter sensu Gerdemann) Gerdemann & Trappe, Myclologia Memoir No. 5: 52-53, 1974.

Endogone macrocarpa f. media Tul. & Tul., Fungi Hypogaei, P. 182, 1851.
E. fasciculata Thaxter, Proc. Am. Acad. Arts Sci. 57. 308-309, 1922. Emend. Gerdemann, Mycologia 57: 562-575, 1965.
E. arenacea Thaxter, Proc. Am. Acad. Arts Sci. 57: 317, 1922
Rhizophagites butleri Rosend, Bull. Torrey Bot. Club 70: 131, 1943.

Chlamydospores formed free in the soil, yellow to yellow brown, 80-100 X 87.5 -127.5 μm, globose, obovoid or ellipsoid. Spore wall singie, with varialbe thickness, 2.5-14 μm, yellow to yellow brown; the thicker wall often perforate with thickened inward projections. Hyphal attachment 10-15 μm diam, nearly occluded by wall thickness; wall of attached hypha often thickened to 1-4 μm near the spore.

COLLECTIONS EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental

Forest. From the rhizosphere of *Gonostegia hirta* (Blume) Miq., Oct. 23, 1982, Wu-024 (TAI); from the rhizosphere of *Pratia nummularia* (Lam.) A. Br. & Asch, Oct. 23, 1982, Wu-025 (TAI); from the rhizosphere of *Phyllostachys pubescens* Mazel, Oct. 23, 1982, Wu-026 (TAI); from the rhizosphere of *Sellaginella doederleinii* Hieron, Oct. 23, 1982, Wu-027 (TAI).

DISTRIBUTION AND HABITAT IN TAIWAN: Found in the rhizosphere of corn (Tzean and Huang, 1980), citrus (Tzean and Huang, 1980), *Chamaecyparis formosensis* Matsum (Wong, 1981), asparagus (Chen, 1981), AVRDC cultivated fields (Kuo & Huang, 1982), and from the rhizosphere of ground covers in bamboo forest of central Taiwan (Wu, 1983).

NOTES: Wall thickness of *G. fasciculatum* sometimes extending into the attached hypha for a short distance, and this is similar to the description of Thaxter (1922).

13. *Glomus formosanum* Wu & Chen sp. nov. Fig. 18-20.

Sporocarpia luteobrunnea vel rubribrunnea, globosa, subglobosa, vel asymmetrica, 360-500 X 450-500 μm, cum peridio sporocarpia includenti, e hyphis septatis, tenuitunicatis, laxe intertextis, 2.5-10 μm diam, composito. Chlamydosporae, plerumque connexae una, sine peridio in humo, luteobruneae vel rubribrunneae, globosae vel subglobosae, si globosae, 65-117.5 μm diam, si subglobosae, 82-125× 95-135μm, cum una-quatuor hyphis affixis interdum ramosis. Hypha affixa, 7-17.5 μm diam, cum orificio ad afficionem prope occluso ab tunica sporae incrassata; cum pariete crasso, 5-6μm ad afficionem. Tunica chlamydosporae solitaria, luteobrunnea vel rubribrunnea, 5.5-12.5 μm crassa, autem crassissima ad afficionem, usque ad 20μm. Pagina chlamydosporae levigata. Holotypus Wu-029 (TAI).

Sporocarps yellow-brown or reddish brown, globose, subglobose, or irregular, 360-500×450-500μm, with peridium enclosing sporocarps, composed of septate, thin-walled, loosely interwoven hyphae, 2.5-10μm diam. Chlamydospores usually formed in aggregates without peridium in soil, yellow-brown, to reddish brown, globose to subglobose, if globose, 65-117.5μm diam, if subglobose, 82-125×95-135 μm, with 1-4, sometimes branched, attached hyphae. Frequently, two nearby attached hyphae fused together or closely separated at attachment. Attached hyphae 7-17.5 μm diam, with opening at attachment nearly occluded by spore wall thickness, with thick wall, 5-6μm at attachment. Chlamydospore wall single, yellow-brown or reddish brown, 5.5-12.5μm thick, but thickest at attachment up to 20μm. Chlamydospore surface smooth.

COLLECTION EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. TYPE: from the rhizosphere of *Pratia nummularia* (lam.) A. Br. & Asch., Oct. 23, 1982, Wu-029 (TAI). PARATYPE: from the rhizosphere of *Colocasia formosana* Hayata, Oct. 23, 1982, Wu-030 (TAI); from the rhizosphere of *Asplenium normale* Don, Oct. 23, 1982, Wu-031 (TAI); from the rhizosphere of *Phyllostachys pubescens* Mazel, Oct. 23, 1982, Wu-032 (TAI).

DISTRIBUTION AND HABITAT IN TAIWAN: High lands in the central Taiwan.

NOTES: The spores of *Glomus multicaule* Gerdemann & Bakish (1976) are ellipsoid or broadly ellipsoidal with rounded wall protuberances in contrast to our

specimen which forms sporocarps and has globose or subglobose spores with smooth wall. That two closely separated attached hyphae of *Glomus formosanum* fused at the attachment of chlamydospore suggestes that the chlamydospores in question may be a zygospore.

14. *Glomus* sp-1 Fig. 11-12.

Chlamydospore formed singly in soil, yellow to yellow brown, obovoid, 92.5-100 μm, with a hyaline attached hypha. Spore wall single layered, 2-2.5 μm thick; non-reaction to Melzer's reagent. An attached hypha 2 μm diam at the attachment, growing through wall protrusion, and tapering to 1 μm diam.

COLLECTION EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. From the rhizosphere of *Phyllostachys pubescens* Mazel, Oct. 9, 1982.

DISTRIBUTION AND HABITAT INTAIWAN: High lands in the central Taiwan.

NOTES: Only one spore was found in this investigation. It is distinguished by having a simple, hyaline, thin-walled collar-like neck, probably a septum at the spore base.

15. *Modicella* sp. Fig. 21-24.

Sporocarp dark brown to black brown, 300 μm diam, with peridium, 10 μm thick. Lower portion of sporocarp consisting of hyphae, vesicles, and sporangia. Sporangia 37.5-62.5 X 42.5-65 μm, globose to subglobose, ellipsoid, hyaline, and with a thin wall ($\pm$ 1 μm thick). Sporagiophore, pale yellow brown, septate, with a "lateral projection", 5 μm diam at the base of attachment; 7.5 μm diam at the "lateral projection". Spore 8.5-10 X 8.5-12 μm, globose or subglobose, hyaline, and thin-walled. Vesicles accompanied with sporangia, hyaline, thin-walled, 1 μm thick; attached by a slightly funnel-shaped attached hypha, hyaline, 5 μm diam.

COLLECTION EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. From the rhizosphere of *Phyllostachys pubescens* Mazel, March 10, 1983, Wu-034 (TAI) (slide).

DISTRIBUTION AND HABITAT IN TAIWAN: In the rhizosphere of bamboo (*Phyllostachys pubescens* Mazel) in the central Talwan.

NOTES: Only one sporocarp was found in this investigation. *M.* sp. is apparently distinguished from other species of *Modicella* by its thick-walled peridium, vesicles intermingled with sporangia in sporocarp and the "lateral projection" whic his on the sporangiophore and similar to unilateral projection on external mycelium of VAM.

16. Pyriform spore type Fig. 25-30.

Sporocarps unknown. Spores borne singly in soil, pyriform, 82.5-150 X 117.5-185 μm, yellow brown to dark brown. Spore wall three layers: outer and middle layers tightly adhered, up to 15 μm thick, not easily separated; middle layer hyaline, minutely roughened, 6 μm thick, and an inner layer, hyaline, separable, 1.5-2 μm

thick, extending into the lower terminal part of spore. Attached hypha abscent. The pore opening in the lower terminal part of spore 7.5-12 μm diam.

COLLECTION EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimeotal Forest. From the rhizosphere of ***Gonostegia hirta*** (Blume) Miq., Oct. 23, 1982, Wu-015 (TAI); from the rhizosphere of ***Asplenium normale*** Don, Oct. 23, 1982, Wu-016 (TAI); from the rhizosphere of ***Phyllostachys pubescens*** Mazel, Oct. 23, 1982, Wu-017 (TAI); from the rhizosphere of ***Plantago asiatica L.***, Oct. 23, 1982, Wu-018 (TAI); from the rhizosphere of ***Pratia nummularia*** (Lam.) A. Br. & Asch., Oct. 23, 1982, Wu-019 (TAI); from the rhizosphere of ***Sellaginella doederleinii*** Hieron, Oct. 23, 1982, Wu-020 (TAI).

DISTRIBUTION AND HABITAT IN TAIWAN: In abundance in the rhizosphere of ground cover of bamboo forest in central Taiwan.

NOTES: Based upon the outer morphology, the pyriform spores resemble to those formed by ***Complexipes moniliformis*** Walker. However, ***C. moniliformis*** has small spore size (55-110 μm diam), hyaline to pale yellow cup-shaped attached hypha readily detaching from the spore base, and papillate outer wall. The inner wall of pyriform spore extends through an opening, frequently two in the middle layer, into the lower terminal part, and the outer wall of lower terminal part seems to be continuous with the main spore body. Consequently, the wall of lower terminal part consists of two layers. Owing to the outer wall of pyriform spore is not readily separated from middle wall and also continuous with lower terminal part, the outer wall is suggested to be secreted by middle mayer as ***C. moniliformis*** by Walker (1979). The outer wall of pyriform spore ornamented with angularly cerebriform folds and with little papillae.

17. ***Sclerocystis coremioides*** Berk & Broome, J. Linn. Soc. London 14: 137. 1875. Fig. 31.

Xenomyces ochraceus Cesati, Atti R. Acad. Sci. Fische e Math. Napoli 8 (No. 4): 26. 1879.

SPhaerocreas javanicum von Höhn., Sitzungsber. Kaiserl. Akad. Wiss. Wein Math.-Naturwiss. Kl. Abt. I. 117: 1014. 1908.

Endogone minutissima Beeli, Bull. Soc. Roy. Belg. 56: 57. 1923.

Sporocarp found imperfect. Chlamydospores pale yellow to yellew brown, 42.5-70 X 55-177.5 μm, obovoid-ellipsoid, often but not always cut off from attached hyphae by septa just below spore base. Chlamydospore wall up to 10 μm thick near the base and 2.5-4.5 μm thick at apex. Attached hypae 10-17.5 μm diam.

COLLECTION EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. From the rhizosphere of ***Phyllostachys pubescens*** Mazel, March 10, 1983, Wu-035 (TAI); from the rhizosphere of ***Asplenium normale*** Don, March 14, 1983, Wu-036 (TAI); from the rhizosphere of ***Colocasia formosana*** Hayata, March 18, 1983, Wu-037 (TAI); from the rhizosphere of ***Gonostegia hirta*** (Blume) Miq., March 2, 1983, Wu-038 (TAI); from the rhizosphere of ***Oplismenus compositus*** (L.) Beauv., March 9, 1983, Wu-039 (TAI).

DISTRIBUTION AND HABITAT IN TAIWAN: From the bamboo forest in central Taiwan. It was also reported from USA (Gerd. & Trappe, 1974) and New Zealand (Hall, 1977).

NOTES: This species was a new record from Taiwan. The largest spore of *S. coremioides* found in this investigation is singly in the rhizosphere of *A. normale*, and its size is 57.5 X 177.5 μm. The spores of *S. coremioides* resemble to those formed by *S. dussii* (Pot.) von Höhn. However,, *S. dussii* has smaller spore size (32-54 X 50-80 μm), thinner spore wall, and forming vesicles upon the surface of crust of sporocarps.

18. ***Sclerocystis pakistanica*** Iqbal & Bushra. Trans. Mycol. Soc. Japan 21(1): 57-63. 1980. Fig. 36-40.

Sporocarps dark brown, globose to subglobose, 550-900 (-1000) μm, consisting of a single layer of chlamydospore surrounding a central plexus of hyphae. Hyphal wall of plexus, 0.5 μm thick. Sporocarp covered with a loosely interwoven peridium. Chlamydospores brown to dark brown, 31-70 X 65-137 μm, cylindro-clavate to clavate, elongated. Paraphyses-like structures hyaline, intermingled with chlamydospores, clavate, sometimes with lateral branch. Walls of chlamydospores pale brown to dark brown, laminate, 2-2.5 μm thick, generally thickest at base up to 4 μm thick.

COLLECTION EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. From the rhizosphere of *Phyllostachys pubescens* Mazel, Oct. 9, 1982, Wu-040 (TAI).

DISTRIBUTION AND HABITAT IN TAIWAN: In the rhizosphere of bamboo in central Taiwan.

NOTES: Most of the specimens examined in this investigation has paraphyseslike structures intermingled with chlamydospores, although this structure was not described by Iqbal and Perveen (1980). This species was a new record from Taiwan.

19. ***Sclerocystis pachycaulis*** Wu & Chen sp. nov Fig. 32-34.

Sporocarpia lutea vel luteo-brunnea, globosa vel subglobosa 170-230×175-270 μm, e chlamydosporis terminatricis radialiter in intertexta centrali hypharum dispositis constantia. Peridium ignotum. Chlamydosporae luteae vel luteo-brunneae obovoideae vel ellipsoideae, interdum irregulares, 27.5-60×37.5-87.5μm. Tunica chlamydosporae luteo-brunnea, 1-5μm crassa, cum strato extremo hyalino, separabili, 0.5-1 μm crasso. Plerumque contentum chlamydosporae ad unum-duo septa adventitia infra afficionem hyphae affixae separatum. Hyphae affixae 7.5-15 μm diam, cum pariete crasso usque ad 7.5 μm. Crassities tunicae hyphae affixae extensa deorsum per distantiam nonnullam, plerumque quam tunica chlamydosporae crassior. Holotypus Wu-043 (TAI).

Sporocarps yellow to yellow-brown, globose to subglobose, 170-230×175-270 μm, consisting of terminal chlamydospores radially arranged on a central plexus of hyphae. Peridium unknown. Chlamydospores yellow to yellow-brown, obovoid to ellipsoid, sometimes irregular, 27.5-60×37.5-87.5μm. Chlamydospore wall yellow-

brown, 1-5μm thick, with a hyaline, separable outer layer, 0.5-1μm thick. Usually chlamydospore contents separated by 1-2 advanture septa below the attachment of attached hypha. Attached hyphae 7.5-15μm diam, with thick wall up to 7.5μm. Wall thickness of attached hypha extending down for some distance, usually thicker than chlamydospore wall. Spores often perforated.

COLLECTIONS EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. TYPE: from the rhizosphere of *Gonostegia hirta* (Blume) Miq., Oct. 23, 1982, Wu-043 (TAI). PARATYPE: from the rhizosphere of *Polygonum hydropiper* L., Oct. 23, 1982, Wu-044 (TAI); from the rhizosphere of *Phyllostachys pubescens* Mazel Oct. 23, 1982, Wu-045 (TAI); from the rhizosphere of *Microstegium geniculatum* (Hayata) Honda, Oct. 23, 1982, Wu-046 (TAI); from the rhizosphere of *Asplenium normale* Don, Oct. 23, 1982, Wu-047 (TAI).

DISTRIBUTION AND HABITAT IN TAIWAN: Sporocarps found in the rhizosphere of *Gonostegia hirta* (Blume) Miq., *Polygonum hydropiper* L., *Phyllostachys pubescens* Mazel, *Microstegium geniculatum* (Hayata) Honda, and *Asplenium normale* Don, in the central Taiwan.

NOTES: *S. pachycaulis* closely resembles to *S. rubiformis* by spore size and gloss morphology, but differs by having a hyaline, separable outer layer and a short thick-walled attached hypha with very narrow lumen and having no complicated hyphal plexus as that of other species of *Sclerocystis*. The wall thickness of attached hypha is usually thicker than spore walls.

20. *Sclerocystis rubiformis* Gerdemann & Trappe, Mycologia Memoir No. 5: 60-63. Fig. 35.

Sporocarp yellow brown to brown, subglobose, 180 X 250 μm, consisting of a single layer of chlamydospores surrounding a central plexus of hyphae. Peridium absent. Chlamydospores yellow brown to red brown, obovoid to ellipsoid, 35-50 X 40-72.5 μm, with a small pore opening into the thick-walled attached hyphae. Attached hyphae 7.5-10 μm diam; wall of attached hyphae 2.5-7.5 μm thick at the base of attachment. Spore wall laminate, 3-4 μm thick up to 10 μm thick at the spore base; often perforated.

COLLECTIONS EXAMINED: TAIWAN-NANTOU: Chi-tou, NTU Experimental Forest. From the rhizosphere of *Asplenium normale* Don, Oct. 23, 1982, Wu-041 (TAI); from the rhizosphere of *Plantago asiatica* L., Oct. 23, 1982, Wu-042 (TAI).

DISTRIBUTION AND HABITAT IN TAIWAN: Found in the rhizosphere of *C. formosensis* (Hu, 1978; Wong, 1981), citrus (Tzean & Huang, 1980), and ground covers in bamboo forest (Wu, 1983) in Taiwan.

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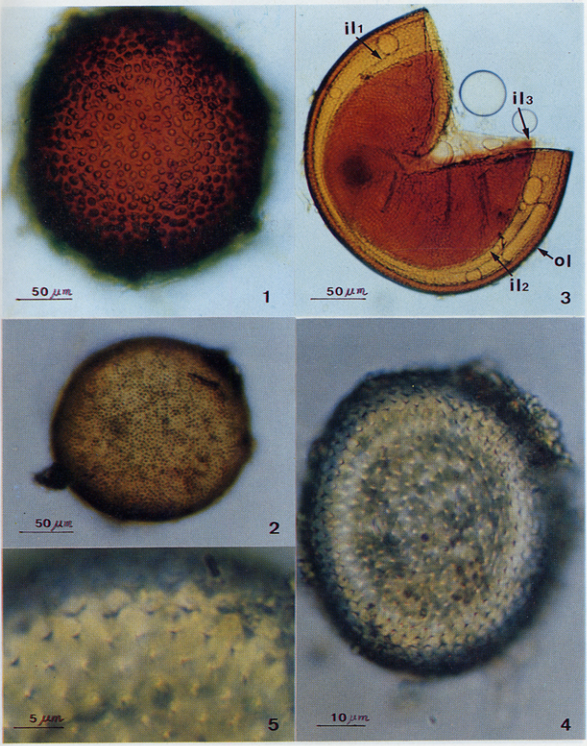
EXPLANATION OF FIGURES

Fig. 1. The azygospore of *Acaulospora foveata* with larger Pits.
Fig. 2. The azygospore of *A. scrobiculata*. with finer pits.
Fig. 3. The spore wall layers of *A. scrobiculata*. The innermost layer (il3) is easily distinguished with Melzer's reagent, when becoming deep red on contact. (ol: outer layer; il: inner layer)
Fig. 4. Spore surface of *A.* sp-1 covered with crowded spins.
Fig. 5. The spins of *A.* sp-1 loosely arranged.
Fig. 6. The azygospore of *A.* sp-2. The outer layer (ol) easily detached from inner layer (il).
Fig. 7. The outer layer of *A.* sp-2 with cerebriform ridges and showing its ring-like attachment. A: attachment.
Fig. 8. The spore of *A.* sp-2 with hyaline inner layer (il) and filled with oil contents.
Fig. 9. The spore of *A.* sp-3 accompanied with its oil contents.
Fig. 10. Two wall layers of *A.* sp-3. The inner layer is characterized with its polygonal reticular ridges. ol: outer layer.
Fig. 11. The spore of *Glomus*. sp-1.
Fig. 12. The spore of *G.* sp-1 showing the characteristic attached hypha and its collar-like neck attachment (CN).
Fig. 13. The outer surface of inner layer (IL) of *Entrophospora infrequens* ornamented with crowded spins. OL: outer layer, AH: attached hypha.
Fig. 14. The polygonal reticulum (R) viewed from the outer layer of *E. infrequens*.
Fig. 15-16. The spore of *G. caledonicum* with double-layered walls: a thin, ouer layer (OL) and a thick, inner layer (IL).
Fig. 17. The wall layers at attachment of *G. caledonicum*. The outer layer (OL) thickened and the inner layer (IL) thinned and extending downto the attached hypha.
Fig. 18. The spores of *G. formosanum* ornamented with multiple attached hyphae (AH). The lower splitted figure (18b) magnified 850 times.
Fig. 19. Sporocarps of *G. formosanum* (X65)
Fig. 20. The spore of *G. formosanum* with 3 attached hyphae showing its smooth outer layer.
Fig. 21. A crushed sporocarp of *Modicella* sp. showing its peridium (P), sporangium (S), and vesicle (V).
Fig. 22. The sporangium of *Modicella* sp. showing its characteristic lateral projection (SP) smilar to the unilateral projection on external mycelium of VAM.
Fig. 23. The vesicle (V) accompanied with the sporangium (S) of *Modicella* sp. with its sporangiophore on which an angular projection was indicated by arrow. AH: attached hypha of vesicle.

Fig. 24. The vesicle of *Modicella* sp.
Fig. 25. Outer feature of pyriform spore.
Fig. 26. After outer layer (O) of pyriform spore removed, a hyaline endospore (O) with two layers exposed.
Fig. 27. The outer layer of pyriform spore ornamented with angularly cerebriform folds and little papillae. (SEM).
Fig. 28. Pyriform spore with its oil contents.
Fig. 29. The endospore of pyriform spore showing two pores on the outer layer (ML) as indicated by arrows. IL: inner layer.
Fig. 30. An opening extending through the lower portion of spore body of pyriform spore. Opening indicated by double-headed arrow.
Fig. 31. The spore of *Sclerocystis coremioides*.
Fig. 32. The sporocarps of *S. pachycaulis*.
Fig. 33-34. The spores of *S. pachycaulis* with its shorter and thick-walled attached hyphae. (OL: hyaline, outer layer; S: Septum.)
Fig. 35. The spore of *S. rubiformis*.
Fig. 36. The cross section of sporocarp of *S. pakistanica*. (SEM)
Fig. 37. The spores of *S. pakistanica*.
Fig. 38. The paraphysis-like hypha accompanied with the spore of *S. pakistanica*.
Fig. 39. The spore of *S. pakistanica* showing its laminated wall layers. (SEM)
Fig. 40. Hypha (HP) protruding from the spore of *S. pakistanica*.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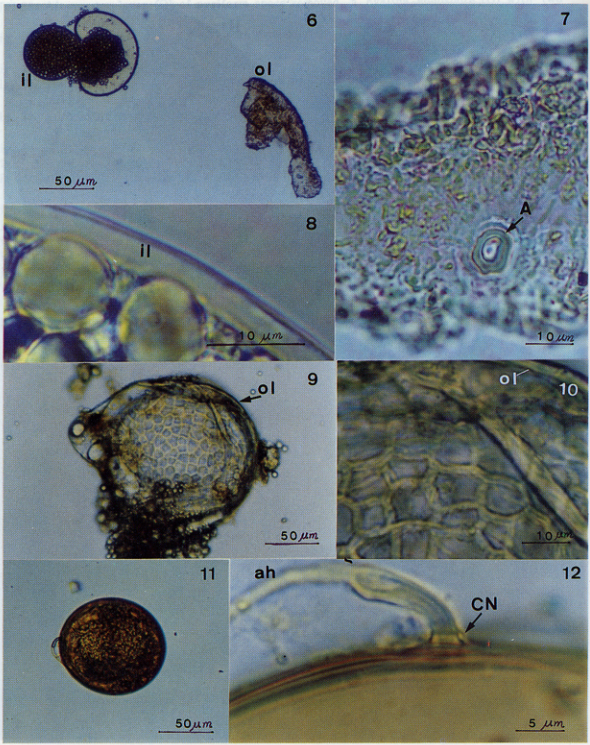
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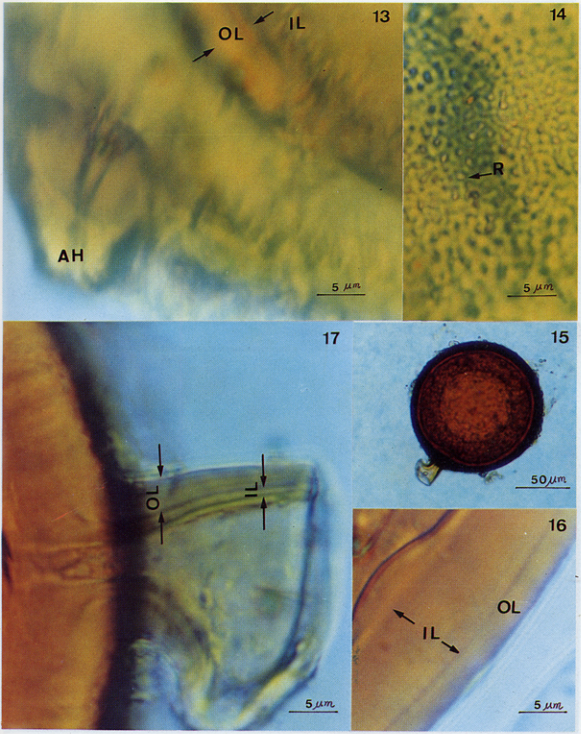
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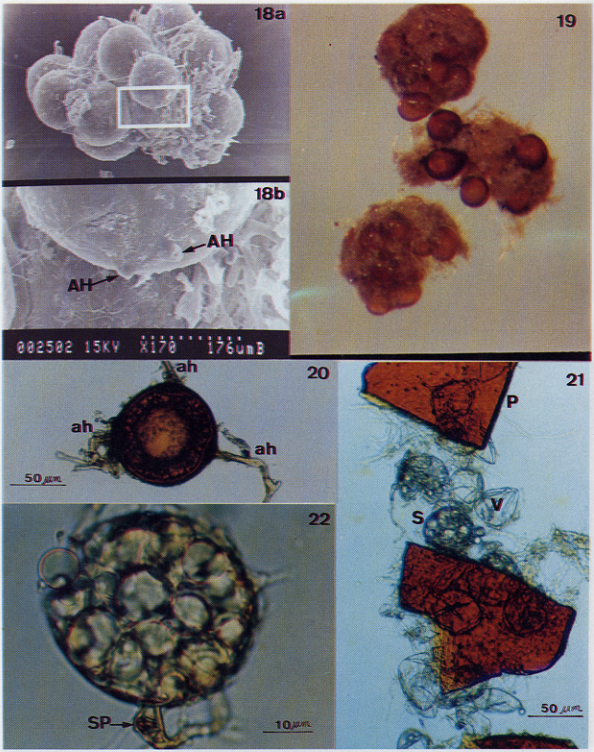
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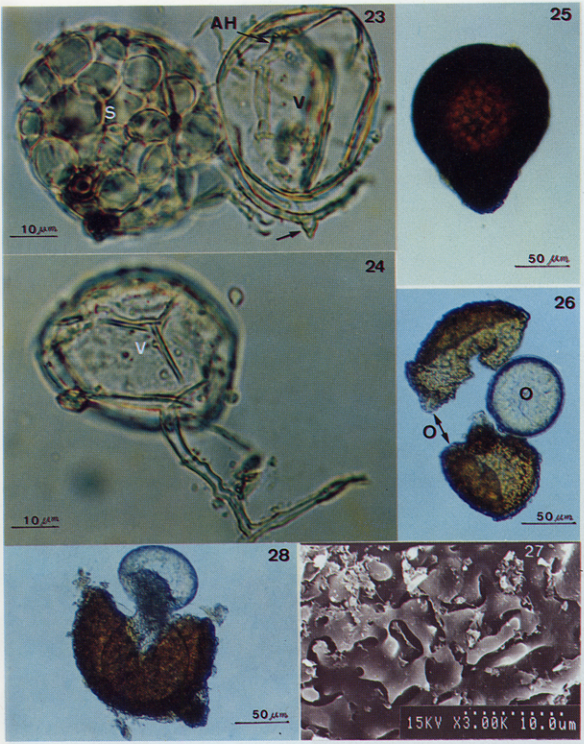
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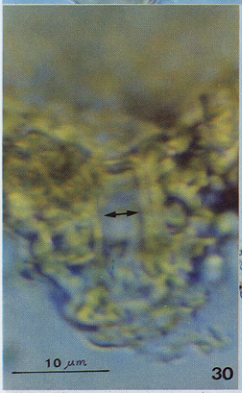
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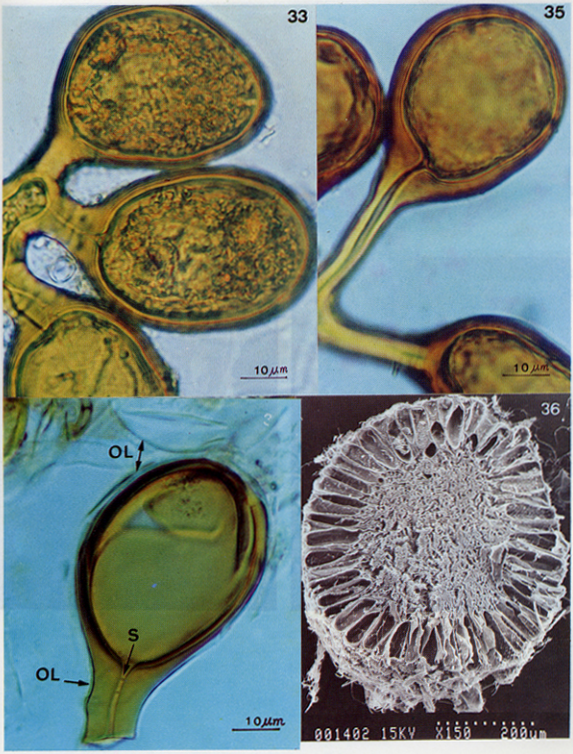
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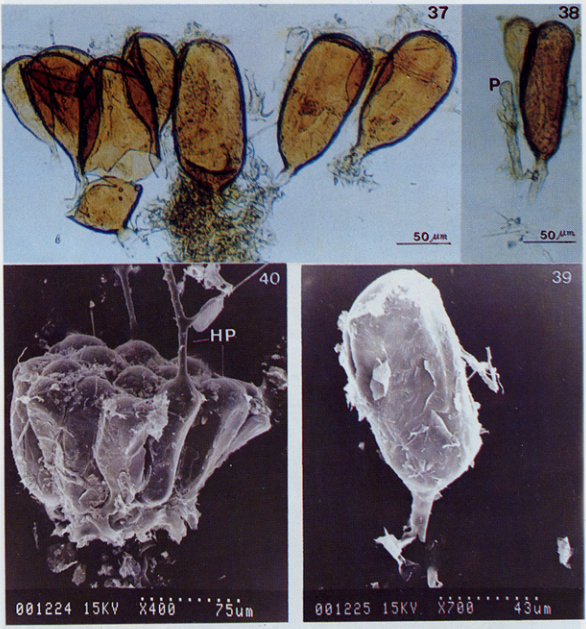
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39
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臺灣內生菌科之調查

(一) 溪頭地區孟宗竹林內生菌科之調查

吳繼光 陳瑞清

中 文 摘 要

在本調查中，有 14 種被發現，即 **Acaulospora foveata* Trappe & Janos, *A. laevis* Gerdemann & Trappe, *A. scrobiculata* Trappe, *A. trappei* Ames & Linderman, **Entrophospora infrequns* (Hall) Ames & Schneider, *Gigaspora gigantea* (Nicol. & Gerd.) Gerdemann & Trappe, **Glomus caledonicum* (Nicol. & Gerd.) Trappe & Gerdemann, *G. etunicatum* Becker and Gerdemann, *G. fasciculatum* (Thaxter sensu Gerdemann) Gerdemann and Trappe, **G. formosanum* sp. nov., **Sclerocystis coremioides* Berk & Broome, **S. pakistanica* Iqbal & Bushra, *S. rubiformis* Gerdemann & Trappe, **S. pachycaulis* sp. nov., 其中帶星號 (*) 者，係臺灣新記錄種，共7種，包括兩種新種 (*G. formosanum* 和 *S. pachycaulis*)。此外尚有六種未定名，在本文中一併描述。