

Two new species of *Syncephalis* from Taiwan, with a key to the *Syncephalis* species found in Taiwan

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ABSTRACT. Two new species of *Syncephalis* from Taiwan are described and illustrated. *Syncephalis clavata* differs from other taxa by the formation of branched merosporangia, a clavate sporangiophore apex, and larger, doliiform merospores. *Syncephalis formosana* is distinguished from other species by the production of branched merosporangia, the height of sporangiophores, the relatively large merospores, and the number of spores per merosporangium. These new taxa are compared with other species of *Syncephalis*. A key to the nine species of *Syncephalis* known in Taiwan is provided.

Keywords: Dung; Soil; *Syncephalis clavata*; *Syncephalis formosana*; Zygomycetes.

INTRODUCTION

Species of the genus *Syncephalis* (Piptocephalidaceae, Zoopagales, Zygomycetes) are common inhabitants of soil and dung. They are small, often inconspicuous mycoparasites, mainly of members of the Mucorales. *Syncephalis* are distinguished by the formation of simple, straight, or recurved sporangiophores, cylindrical merosporangia born on terminal vesicles, basal rhizoids, and spores released into droplets of fluid at maturity (Benjamin, 1959). Fifty-seven species of *Syncephalis* have been described (Benjamin, 1985; Gruhn and Petzold, 1991; Kirk et al., 2001; Patil and Patil, 1994; Zycha et al., 1969), and seven of them (*S. cornu* Tiegh. & G. Le Monn., *S. depressa* Tiegh. & G. Le Monn., *S. obconica* Indoh, *S. parvula* Gruhn, *S. sphaerica* Tiegh., *S. tenuis* Thaxter, *S. cf. ventricosa* Tiegh.) have been found in Taiwan (Ho, 2000, 2001, 2002, 2003). During a continuing investigation of merosporangiferous Zygomycetes in Taiwan, two new species of *Syncephalis* were discovered, and they are described in this paper.

Materials and Methods

Species of *Syncephalis* were isolated from soil or dung in Taiwan. Soil samples were collected by the roadside or in forests and brought to the laboratory in plastic bags. Two to three milligrams of soil particles were placed on

the surface of BBL™ corn meal agar (Becton Dickinson 211132) plates. For the dung samples, dung of herbivores, small omnivorous rodents or amphibians were collected from forests, national parks, school campuses, and houses and then carried back to the laboratory in clean containers. Each sample was placed on a moist filter paper in a Petri dish. The plates were left on a bench at room temperature, incubated for nearly one week, and then observed using a dissecting microscope. Sporangiophores of *Syncephalis*, along with the host, were transferred to a fresh corn meal agar plate and incubated as described above. Microscope slides were prepared from one-week-old cultures using tap water or lactic acid-cotton blue (cotton blue, 0.5 g; 90% lactic acid, 1L) as mounting media (Kurihara et al., 2001). Specimens were observed and photographed using a Leica MPS32 light microscope (LM).

TAXONOMY

Syncephalis clavata H. M. Ho et Benny, sp. nov.

Figures 1A-F, 2A-E

Hyphae vegetativae 1-2 µm diam. Sporangiophora recta, simplicia, (75)-124-155(-163) µm alta, basi 11.3-13.8 µm crassa, apice 7.5-10 µm crassa. Rhizoidei crassa, simple vel 2-3 lobati, nonseptati. Vesiculae obovatae, 9-14(-15) µm diam, cum 8 merosporangiis superiorem vesiculae. Merosporangia dichotomosin ramose, 3 merosporas gignentia. Merospora doliiformis, 8-9 µm longa, 4.0-4.2 µm crassa. Zygosporae ignotae. (Typus: TNMF19552).

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Vegetative hyphae slender, creeping on the host, 1-2 μm wide. Sporangioophores hyaline, erect, simple, arising singly or in groups of two, (75-)124-155(-163) μm height, 11.3-13.8 μm diameter at the broadest portion near the base, slightly tapering gradually upwards reaching 7.5-10 μm just below the vesicle, with a septum near the base. Rhizoids stout, short, 2-3 lobed. Vesicle not distinct, club-shaped, 9-14(-15) μm diameter, slightly rounded above, attenuated below gradually, bearing about eight branched merosporangia on the top of the vesicle. Merosporangia branched once, forming V-shaped arms, each containing 3 spores, basal cells cordate, symmetrical or asymmetrical, 8-10 \times 4-5 μm , detached when mature, leaving warts on

top of the fertile vesicle. Merospores doliiform, 8-9 \times 4-4.2 μm , hyaline. Zygosporangia not observed.

Holotype. TAIWAN. Miaoli City: parasitizing *Thamnostylum piriforme* (Bainier) Arx & H. P. Upadhyay growing on mouse dung collected April 2002 by H.-M. Ho DMML0101. A slide deposited in the National Museum of Natural Science, Taichung, Taiwan (TNM F19552).

Etymology. Clavatus (L); referring to the clavate sporangiophore apex.

Notes. Several species of *Syncephalis* produce branched merosporangia and doliiform merospores. Among the species, *S. clavata* most closely resembles

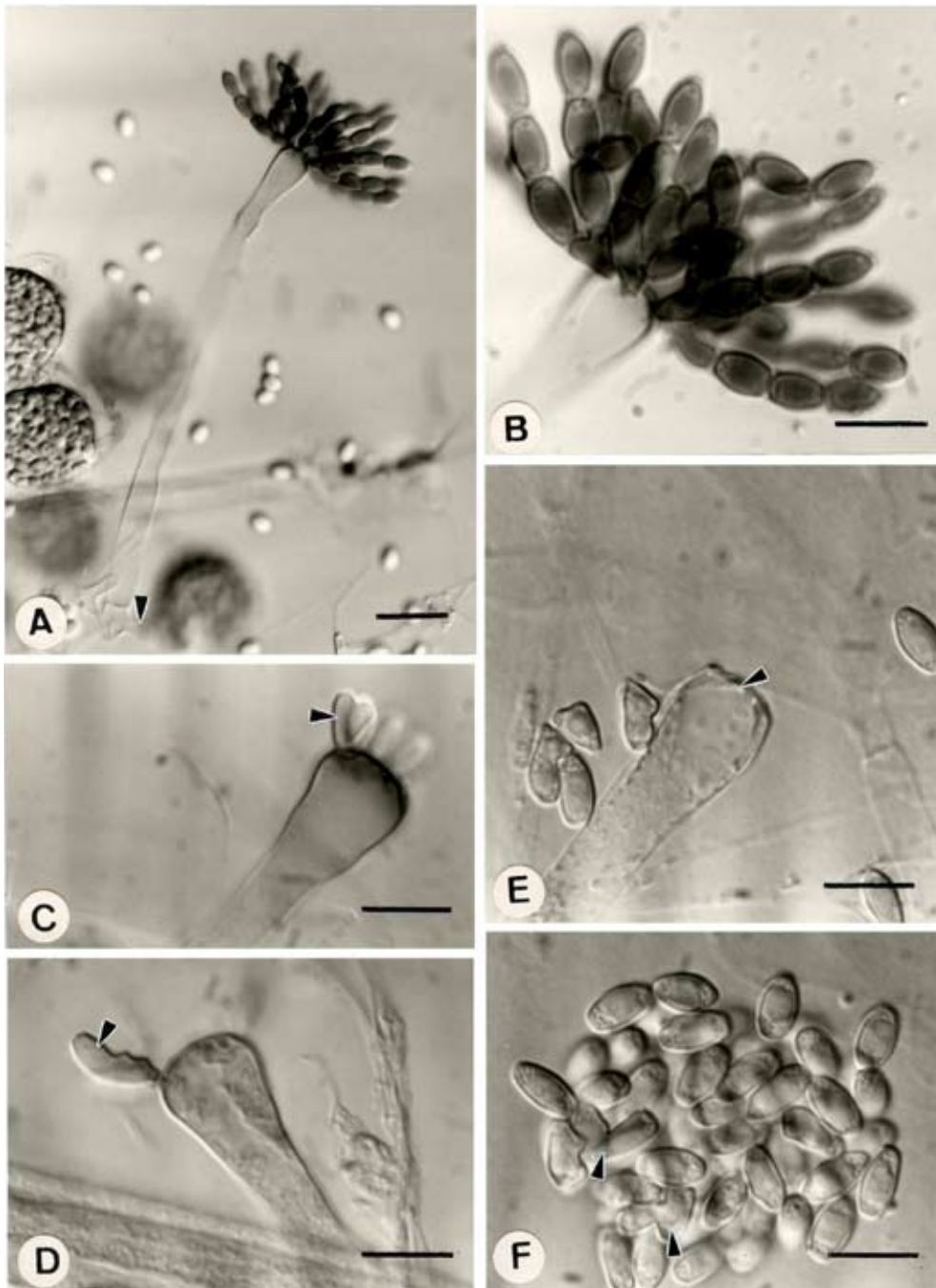


Figure 1. *Syncephalis clavata* (TNM F19552). A-F, LM (DIC). A, Sporophore with a fertile vesicle bearing merosporangia and the basal rhizoid (arrowhead) on base; B, Dichotomously branched merosporangia on a fertile vesicle; C, Symmetrical cordate basal cell on a fertile vesicle (arrowhead); D, Asymmetrical basal cell (arrowhead) on a fertile vesicle; E, Prominent warts (arrowhead) left on a fertile vesicle after merosporangial detachment; F, Doliiform merospores and basal cells (arrowheads). Bars: A = 20 μm ; B-F = 10 μm .

S. pygmae M. S. Patil & B. J. Patil, which also has clavate sporangiophores without a distinct vesicle. *Syncephalis pygmae*, however, has shorter (25-30 μm) and apically narrower (7-8 μm wide) sporangiophores, smaller merospores (4-6 \times 1-2 μm), and more spores per merosporangium (4-6) (Patil and Patil, 1994). These differences merit the establishment of a new species.

Syncephalis formosana H. M. Ho et Benny, sp. nov.

Figures 3A-F, 4A-E

Hyphae vegetativae graciles, 1 μm diam. Sporangiophora recta, simplicia, 700-790 μm alta, basi (28-)30-47 μm diam, apice 14-33 μm crassa, aureaxanthinus. Rhizoidei irregulariter ramosae, septati. Vesiculae ovatae,

(33-)40-58(-65) μm diam, (38-)50-70(-83) μm alta, cum pleuribus merosporangiis supra partem superiorem vesiculae. Merosporangia dichotomosin ramosae, 55-70 \times 7.5 μm , 4-5 merosporas gignentia. Merospora cylindracea, 13-15(-17) μm longa, 5-6 μm crassa. Paries merosporangii persistens, potius crassus. Zygosporae ignotae. (Typus: TNM F19551).

Vegetative hyphae slender, 1 μm diameter. Sporangiophores simple, 700-790 μm high, (28-)30-47 μm diameter at the broadest part near the base, gradually attenuated upward, 14-33 μm diameter just below the vesicle, golden yellow. Rhizoids branched irregularly, with several septa. Vesicles ovoid, (33-)40-58(-65) μm diameter at the broadest part, (38-)50-70(-83) μm high, bearing

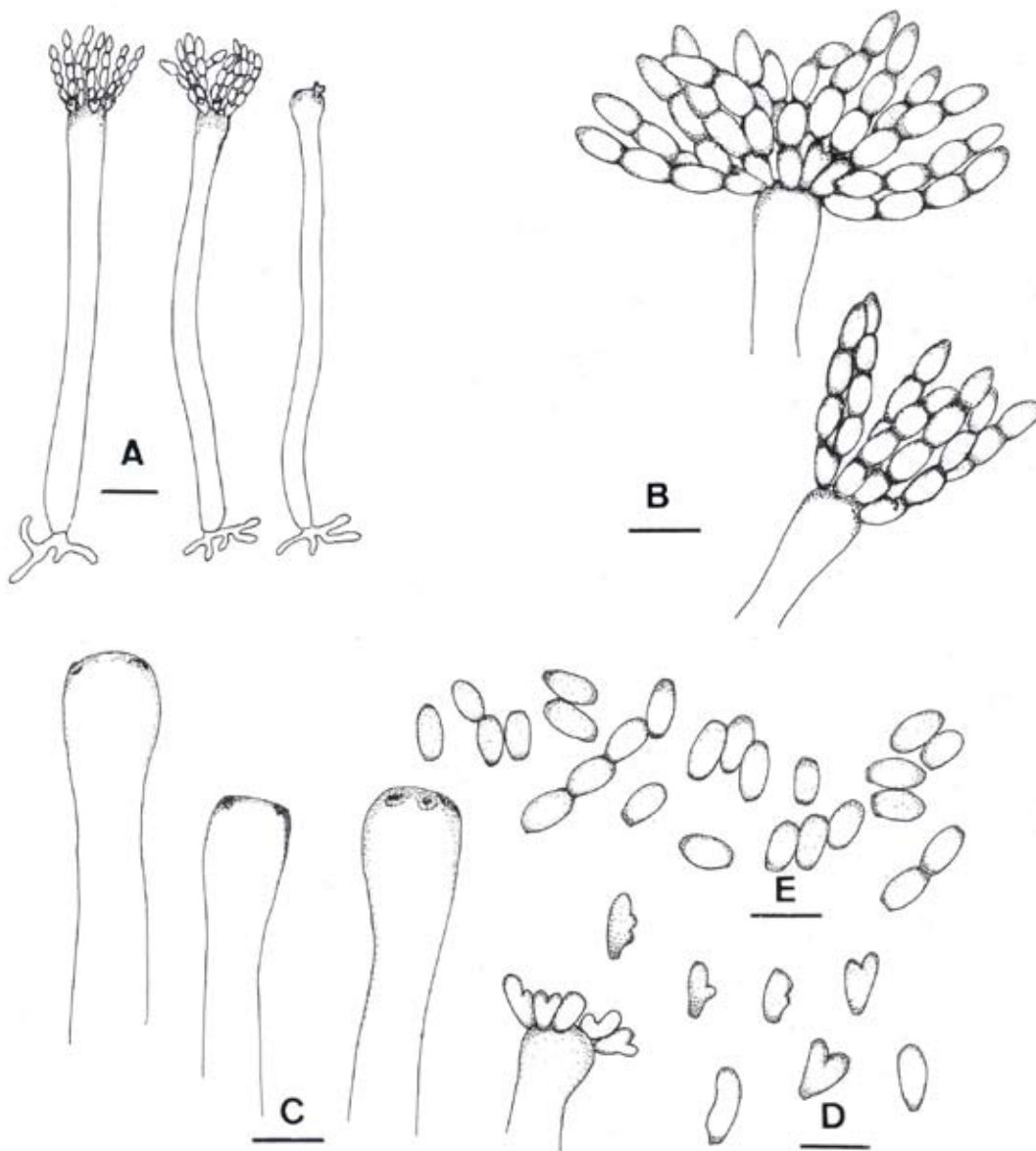


Figure 2. *Syncephalis clavata* (TNM F19552). A, Whole sporangiophores, showing merosporangia and basal cells; B, Apices of sporangiophores bearing nearly mature merosporangia; C, Apices of sporangiophores with or without basal cells after merosporangial detachment; D, Basal cells; E, Spores. Bars: A = 20 μm ; B-E = 10 μm .

merosporangia on the upper one third of the vesicle. Merosporangia branched dichotomously once or rarely twice at the base; the branches cylindrical, $55-70 \times 7.5 \mu\text{m}$, containing 4-5 spores; basal cells cordate, symmetrical or asymmetrical, $7.5-12.5 \mu\text{m}$ diameter, $12.5-15 \mu\text{m}$ long, tending to remain on the fertile vesicle after merosporangia detached. Merospores cylindrical, $13-15(-17) \times 5-6 \mu\text{m}$, surrounded by a wrinkled merosporangial wall remnant when mature. Zygosporangia not observed.

Holotype. TAIWAN. Nantou County: Hsiao-chilai, host unknown, isolated from soil collected Dec 2002 by H.-M.

Ho *SHCL0101*. A dried culture deposited in the National Museum of Natural Science, Taichung, Taiwan (TNM F19551).

Etymology. Formosanus (L); referring to the place of collection.

Notes. *Synccephalis formosana* resembles *S. asymmetrica* Tiegh. & G. Le Monn., *S. cordata* Tiegh. & G. Le Monn., *S. intermedia* Tiegh. and *S. ramosa* Tiegh. in having simple, yellow, straight sporangiophores, V-shaped branching merosporangia over the upper surface of the vesicle, and heart-shaped basal cells of the

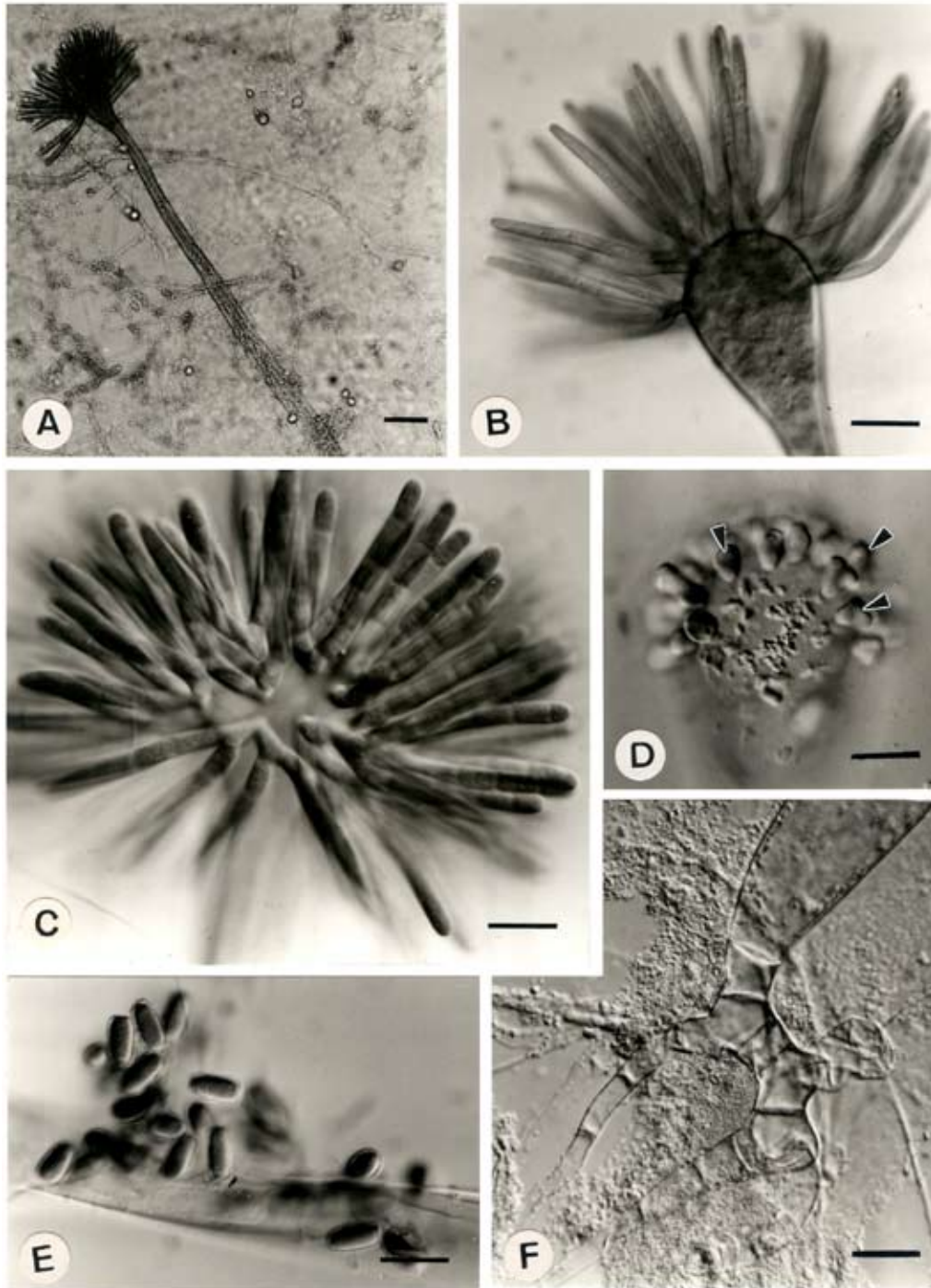


Figure 3. *Synccephalis formosana* (TNM F19551). A-F, LM (DIC). A, Sporangiophore with merosporangia on a fertile vesicle; B, Immature, dichotomously branched merosporangia on a fertile vesicle; C, Nearly mature branched merosporangia segmented into spores; D, Cordate basal cells (arrowheads) of merosporangia remaining on a fertile vesicle after merosporangial detachment; E, Detached merosporangia with wrinkled merosporangial wall remnants; F, Branching rhizoids with septa. Bars: A = $50 \mu\text{m}$; B-F = $20 \mu\text{m}$.

branching merosporangia. However, *S. formosana* has larger merospores ($13\text{--}15\text{--}17 \times 5\text{--}6 \mu\text{m}$) than all these species ($4\text{--}8 \times 2\text{--}4 \mu\text{m}$ in *S. asymmetrica*; $8\text{--}10 \times 6 \mu\text{m}$ in *S. cordata*; $6\text{--}13 \times 6 \mu\text{m}$ in *S. intermedia* and $6\text{--}12 \mu\text{m}$ in *S. ramosa*). Also, sporangiophores of *S. formosana* ($700\text{--}790 \mu\text{m}$) are longer than those of *S. intermedia* ($400\text{--}600 \mu\text{m}$) or *S. ramosa* ($500\text{--}600 \mu\text{m}$) and shorter than those of *S. cordata* (up to 3 mm). In addition, spore number per merosporangial branch is also different, being 4–6 in *S. formosana* and 10 and 5–7 in *S. cordata* and *S. intermedia*, respectively. The present fungus can be easily distinguished from *S. ramosa* because in the latter species, merosporangia have various branching forms, either simple, bifurcate, or trifurcate at the base, bearing many branches at various heights along its length, and spore shape is oval or globose. Finally, unlike *S. formosana*, *S. asymmetrica* and *S. intermedia* lack secondary branches (Indoh, 1962; Van Tieghem and Le Monnier, 1873; Van Tieghem, 1875; Zycha et al., 1969). We thus propose *S. formosana* as a new species.

DISCUSSION

The two species of *Syncephalis* described here present some characters that are common to other taxa. Several other members of the genus *Syncephalis* produce merosporangia that are basally branched. In *S.*

asymmetrica, *S. cordata* and *S. intermedia*, the spores formed at the branching point are noticeably different in morphology (cordate, symmetrical, asymmetrical) from those in the other portions (cylindrical to doliiform with rounded apices) of the merosporangium (Van Tieghem and Le Monnier, 1873; Van Tieghem, 1875). The aforementioned taxa also exhibit the same range of variation in spore morphology and ornamentation observed in *S. clavata* and *S. formosana*.

KEY TO THE SPECIES OF SYNCEPHALIS KNOWN FROM TAIWAN

- A. Sporangiophore curved up to 270° *S. cornu*
- AA. Sporangiophore straight B
- B. Fertile vesicles more or less globose C
- BB. Fertile vesicles obovoid to clavate E
- C. Sporangiophores less than $200 \mu\text{m}$ high D
- CC. Sporangiophores more than $200 \mu\text{m}$ high
..... *S. sphaerica*
- D. Sporangiophores more than $80 \mu\text{m}$ high; vesicle at base *S. cf. ventricosa*
- DD. Sporangiophores more than $80 \mu\text{m}$ high; no vesicle at base *S. parvula*
- E. Merosporangia simple, 2-spored *S. tenuis*

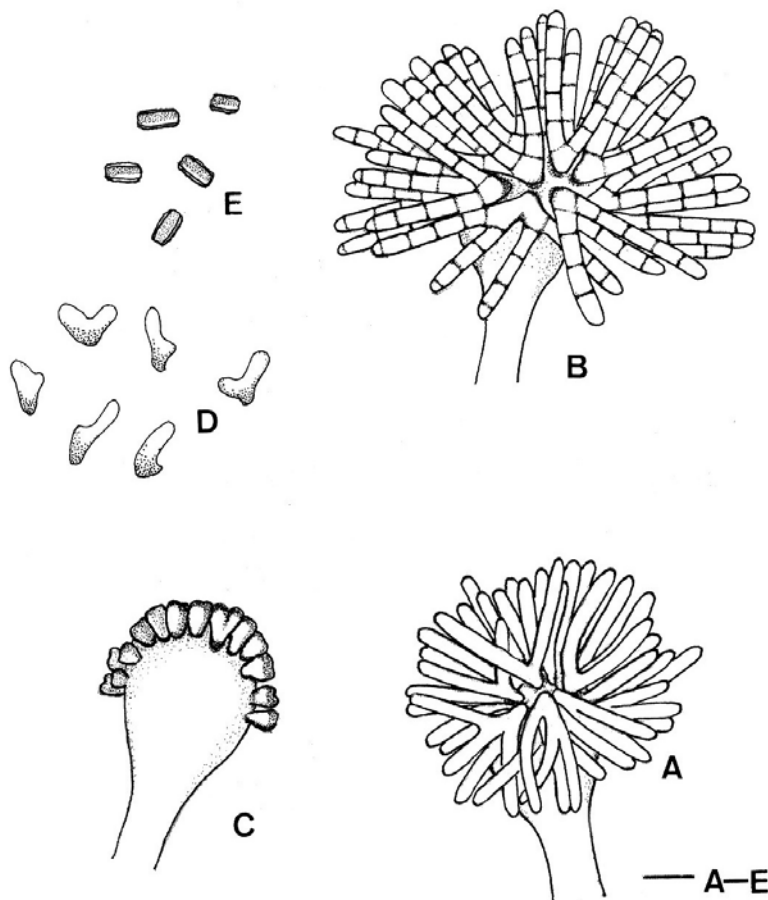


Figure 4. *Syncephalis formosana* (TNM F19551). A, Terminal vesicle of a sporangiophore bearing young merosporangia; B, Terminal vesicle of sporangiophore showing nearly mature merosporangia; C, Vesicle with basal cells after merosporangial detachment; D, Basal cells; E, Spores. Bar: A–E = $20 \mu\text{m}$.

- EE. Merosporengia branched, with more than 2 spores ..F
 F. Fertile vesicle apex truncate; merosporengia arising in a circle on the upper edge of the vesicle G
 FF. Fertile vesicle apex convex; merosporengia formed over the upper portion of the vesicle..... H
 G. Merosporengia initially developing horizontally and then forming several vertical branches *S. depressa*
 GG. Merosporengia initially developing more or less vertically, with a single branch.....*S. obconica*
 H. Merosporengia with one branch; spore at branching point cordate to irregular in shape, other spores doliiiform.....*S. clavata*
 HH. Merosporengia with one or, less commonly, two branches; spore at basal branching point cordate, other spores cylindrical*S. formosana*

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台灣產兩新種集珠黴菌及台灣產集珠黴屬真菌之檢索表

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本文描述與圖示了兩新種集珠黴菌 *Syncephalis clavata* (棒狀集珠黴) 及 *Syncephalis formosana* (台灣集珠黴)，分別由鼠糞及土壤分離得到。前者的特徵為形成有分枝之管狀孢子囊，孢子囊柄末端常無明顯膨大頭狀構造，呈棒狀，以及具較大之桶狀孢子。後者的特徵包括形成有分枝之管狀孢子囊，孢子囊柄長度、孢子大小及管狀孢子囊中孢子數目與相近種類不同。文中比較此兩種與相近種類之異同點並提供台灣九種集珠黴屬真菌之檢索表。

關鍵詞：糞物、土壤、棒狀集珠黴、台灣集珠黴、接合菌綱。