

THE COPROPHILOUS DISCOMYCETES OF TAIWAN

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ABSTRACT - After a series of investigations of Taiwanese coprophilous discomycetes, a total 46 species within 11 genera were identified. Descriptions of five newly recorded species, illustrations, drawings, SEM graphs of ornamented ascospores, and keys to genera and species are provided.

KEY WORDS: Coprophilous, Discomycetes, Pezizales, Taiwan.

INTRODUCTION

Coprophilous discomycetes is a group of fungi specially growing on animal dung, which has been widely studied in various countries (Bell 1983, Cacialli et al. 1998, Otani 1973, Otani & Kanzawa 1970a, 1970b, Richardson & Watling 1968). In Taiwan, Sawada (1931) was the first to describe a coprophilous species, *Aleurina nigrodisca* Sawada, which was growing on buffalo dung from Taipei Chu. According to his description (in Japanese) and illustration, it seems to be a species of *Ascobolus*. Liou & Chen (1977) collecting from Taipei and Yangmei County, reported 20 species of discomycetes, including six species of *Ascobolus*, five species of *Saccobolus*, four species of *Ascodesmis*, two species of *Iodophanus*, one *Coprobria* species, and one *Coprotus* species. Starting from 1992, investigations of coprophilous ascomycetes were initiated in Taiwan (Wang 1993, 1995, 1996). Since then, four new species of discomycetes were published (Wang 1994, Wang & Brummelen 1997, Wang & Kimbrough 1993). This is a

conclusive report of these investigations, containing 46 species of coprophilous discomycetes collected in Taiwan. Among these, five species, *Ascobolus amoenus*, *A. carbonarius*, *Cheilymenia fimicola*, *Coprotus marginatus*, and *Thelebolus stercoreus* are newly recorded. Descriptions, illustrations, SEM graphs of ornamented ascospores and keys of these species are provided. All specimens are deposited in the herbarium of the National Museum of Natural Science, Taiwan (TNM).

MATERIALS AND METHODS

All specimens were collected from dung of herbivores in Taiwan, except for those of *Ascobolus carbonarius*, which were found on burnt wood. Fresh or dry samples of dung were collected in the field and carried in sealed plastic bags to the laboratory. A piece of dung was placed on moist filter paper in a Petri dish and kept at room temperature. Following incubation, samples were examined with a dissecting microscope, and fresh apothecia were collected when mature. Some

specimens were collected directly from dung in the field. Microscopic structures were examined under a light microscope in fresh condition, and measurements were made when mounted in distilled water. Ornamented ascospores were spread on a small piece of cover glass, air dried, coated with gold, and then observed under a scanning electron microscope (Hitachi S570).

Key to genera of coprophilous discomycetes of Taiwan

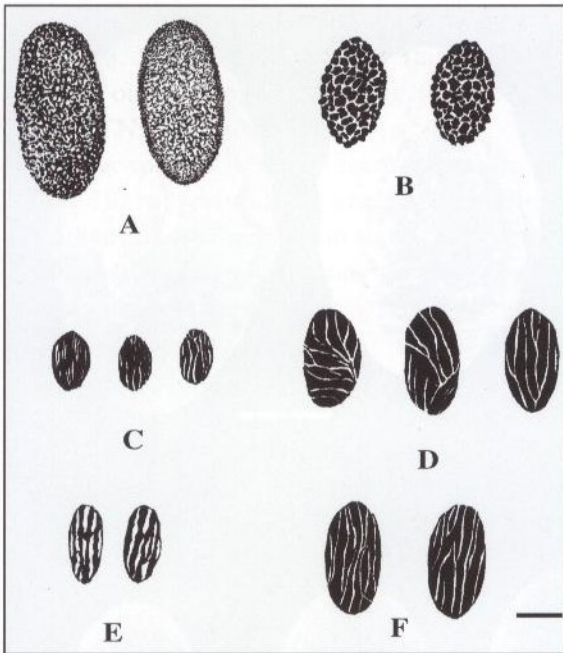
This key is inspired by Bell (1983) and Richardson & Watling (1968).

- 1a. Ascospores with purplish brown or brown ornamentation..... 2
- 1b. Ascospores hyaline, and smooth or ornamented..... 4
- 2a. Ascospores firmly attached together in a package..... *Saccobolus* p.65
- 2b. Ascospores separate..... 3
- 3a. Apothecia small, without excipulum.....
..... *Ascodesmis* p.57
- 3b. Apothecia greenish or brown, excipulum well developed..... *Ascobolus* p.50
- 4a. Apothecia containing only one ascus 5
- 4b. Apothecia containing more than a single ascus 6
- 5a. Apothecia white, cylindrical.....
..... *Leptokalpion albicans* p.65
- 5b. Apothecia brown, globular.....
..... *Thelebolus stercoreus* p.71
- 6a. Apothecia with a fringe of hairs 7
- 6b. Apothecia without a fringe of hairs 8
- 7a. Hairs brown, apothecia orange.....
..... *Cheilymenia fimicola* p.59
- 7b. Hairs hyaline, apothecia hyaline or pale yellowish *Lasiobolus* p.64
- 8a. Ascus wall turning blue in Melzer's reagent 9
- 8b. Ascus wall not turning blue in Melzer's reagent.....10

- 9a. Apothecia pale orange or reddish, ascospores verrucose ... *Iodophanus* p.62
- 9b. Apothecia white to grayish tan
..... *Thecotheus* p.70
- 10a. Ascospores smooth, each with a de Bary bubble *Coprotus* p.60
- 10b. Ascospores with minute longitudinal striations, without a de Bary bubble, paraphyses enlarged at the tips.....
..... *Coprobria striata* p.60

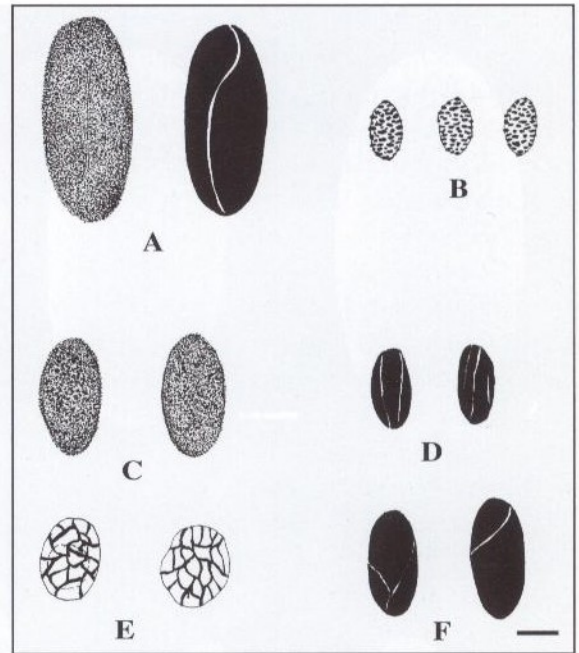
Key to species of *Ascobolus* found in Taiwan

- 1a. Growing on burnt material, ascospores warty, 19-23 x 13-15 μm ... *A. carbonarius*
- 1b. Growing on dung..... 2
- 2a. Apothecia large, up to 1 cm wide, margin covered with white hyphoid hairs, ascospores ellipsoid, 22-26 x 11-13 μm ...
..... *A. scatigenus*
- 2b. Apothecia less than 1 cm wide, not covered with white hairs 3
- 3a. Ascospores large, oblong ellipsoid, 38-60 x 19-34 μm *A. immersus*
- 3b. Ascospores less than 30 μm 4
- 4a. Ascospores reticulate, broadly ellipsoid, 15-20 x 12-15 μm *A. reticulatus*
- 4b. Ascospores smooth, granulate or striated 5
- 5a. Ascospores smooth to granulate.....
..... 6
- 5b. Ascospores striated 7
- 6a. Ascospores granulate, 33-36 x 16-18 μm
..... *A. amoenus*
- 6b. Ascospores finely granulate, 20-25 x 11-12.5 μm *A. mancus*
- 7a. Ascospores broadly fusiform, 11-15 x 7.5-9 μm , with transverse striae or ridges.....
..... *A. lineolatus*
- 7b. Ascospores with lines longitudinal or oblique, sometimes anastomosing.....8
- 8a. Ascospores small, 11-14 x 6-8 μm
..... *A. crenulatus*
- 8b. Ascospores larger than 14 μm
..... 9



Text-figure 1

Ascospores of *A. Ascobolus amoenus*. B. *A. carbonarius*. C. *A. crenulatus*. D. *A. denudatus*. E. *A. fushanus*. F. *A. furfuraceus*. Bar = 10 μm .



Text-figure 2

Ascospores of *A. Ascobolus immersus*. B. *A. lineolatus*. C. *A. mancus*. D. *A. michaudii*. E. *A. reticulatus*. F. *A. scatigenus*. Bar = 10 μm .

- 9a. Ascospores narrowly ellipsoid, 15-18 x 7-8 μm , with 4-6 longitudinal wide lines.....*A. fushanus*
 9b. Ascospore width $\geq 8 \mu\text{m}$ 10
 10a. Apothecia short-stalked, ascospores with 3-4 widely spaced lines, 16-19 x 8-9.5 μm *A. michaudii*
 10b. Apothecia sessile 11
 11a. Young ascus wall turning very pale blue in Melzer's reagent, ascospores with various longitudinal and transverse lines, 17- 21 x 9-11 μm *A. denudatus*
 11b. Ascus wall turning blue in Melzer's reagent, ascospores with many closely spaced lines, 20-24 x 11-12 μm *A. furfuraceus*

Ascobolus amoenus Oudemans, Hedwigia 21: 165, 1882. Figs. 1A, 3A.

Apothecia gregarious, greenish yellow,

ochraceous, globose then open to cupulate, 0.2-0.6 mm wide, 0.4-0.8 mm high, top with far protruding asci, receptacle with yellow granules. Ectal-excipulum yellowish, globose to polygonal cells, cells 5-30 μm in diam., layer 40-50 μm thick. Medullary excipulum of a *textura globulosa*, cells 5-17.5 μm wide, layer 50-75 μm thick. Asci 8-spored, young ascus wall turning blue in Melzer's reagent, broadly clavate, 395-475 x 33-47 μm , elongated when mature. Ascospores ellipsoid, 33-36 x 16-18 μm , with unilateral or all-sided sheath, hyaline at first, then purple to brown, with fine granules. Paraphyses filiform, not enlarged at tips, 2-3 μm wide, embedded in greenish yellow mucus.

Specimens examined: Taiwan. Penghu: Paisha, on goat dung, *Y. Z. Wang* 9719, May 26, 1997 (TNM F7411); Paisha, on ox dung, *Y. Z. Wang* 9720, May 26, 1997 (TNM F7412). Taipei:



Text-figure 3

(SEM) Ascospores of A. *Ascobolus amoenus*. B. *A. carbonarius*. C. *A. crenulatus*. D. *A. denudatus*. E. *A. fushanus*. F. *A. furfuraceus*. Bars = 5 μm .

Yangmingshan, on ox dung, *Y. Z. Wang* 9724, Nov. 26, 1997 (TNM F7960). Taitung: Green Island, on ox dung, *Y. Z. Wang* 9624, Apr. 1, 1996 (TNM F4546).

This species is newly recorded in Taiwan. It is characterized by greenish turbinate apothecia and finely granulated ascospores. *Ascobolus mancus* also has these characters but ascospores are smaller.

Ascobolus carbonarius P. Karst. Notis. Sallsk. Fauna Fl. Forh. II: 202, 1870. Figs. 1B, 3B, 18A.

Apothecia scattered, 2-3 mm wide, sessile, discoid, with a short base, receptacle dark brown, bottom entangled with brown, thick-walled hyphae, 3-5 μm wide, disc greenish brown, dotted with protruding asci. Excipulum of a *textura globulosa*, cells 8-20 μm wide. Asci clavate, 245-250 x 15-21 μm , wall not turning to blue in Melzer's reagent. Ascospores broadly ellipsoid, 19-23 x 13-15 μm , including warts, 16-18 x 10-11 μm without ornamentation, purplish brown, warty; warts irregularly shaped, 1-2 x 1-3 μm . Paraphyses filiform, septate, tips 2-3 μm , branched near the base, rarely enlarged at the tips up to 5 μm , embedded in greenish-brown mucus.

Specimens examined: Taiwan. Nantou: Meifeng, on burnt charcoal, *Y. Z. Wang*, WAN 160, June 14, 1995 (TNM F3423); WAN 646, Dec. 3, 1998 (TNM F9956).

This species is newly recorded from Taiwan. It is distinguished by its habitat and the warty ascospores. *Ascobolus archeri* Berk. also grows on charcoal but with smaller ascospores (17.5-22 x 9-11.5 μm , van Brummelen 1967). The polar thickening on the ascospores is not prominent in Taiwanese collections as described by van Brummelen (1967), and Paulsen & Dissing (1979).

Ascobolus crenulatus P. Karst., Fungi Fenn. Exs. No. 763, 1868. Figs. 1C, 3C.

Specimens examined: Taiwan. Hualien: Juisui, on cow dung, *Y. Z. Wang* 9455, Oct. 11, 1994 (TNM F2570). Kaohsiung: Liukuei, on monkey dung, *Y. Z. Wang* 93111, Nov. 30, 1993 (TNM F1417). Miaoli: Provincial Miaoli Agri-industrial Vocational High School, on horse dung, *Y. Z. Wang* 9602, Jan. 9, 1996 (TNM F4460); *Y. Z. Wang* 9605, Jan. 10, 1996 (TNM F4463). Nantou: Huisun Forestry Station, elev. 1200 m, on dung of unknown animal, *Y. Z. Wang* 9650, Dec. 27, 1996 (TNM F5708).

This species is characterized by greenish apothecia with prominent margins, and small striated ascospores. It was previously reported by Liou & Chen (1977).

Ascobolus denudatus Fr., Syst. Mycol. 2: 162, 1822. Figs. 1D, 3D.

Specimens examined: Taiwan. Hualien: Juisui, on cow dung, *Y. Z. Wang* 9456, Oct. 11, 1994 (TNM F2571). Miaoli: Provincial Miaoli Agri-industrial Vocational High School, on horse dung, *Y. Z. Wang* 9603, Jan. 9, 1996 (TNM F4461); on goat dung, *Y. Z. Wang* 9604, Jan. 10, 1996 (TNM F4462); on ox dung, *Y. Z. Wang* 9611, Jan. 16, 1996 (TNM F4468). Nantou: Chingching Farm, on cow dung, *Y. Z. Wang* 92151, Dec. 30, 1992 (TNM F0697); *Y. Z. Wang* 9415, Apr. 7, 1994 (TNM F1930), on sheep dung, *Y. Z. Wang* 9701, Jan. 3, 1997 (TNM F5709), *Y. Z. Wang* 9814, Feb. 5, 1998 (TNM F7974); on sheep dung, *Y. Z. Wang* 9329, Feb. 27, 1993 (TNM F0718). Taichung: Tunghai Univ., on cow dung, *Y. Z. Wang* 9480, Dec. 28, 1994 (TNM F2928); *Y. Z. Wang* 9229, May 19, 1992 (TNM F0177), *Y. Z. Wang* 9339, Mar. 23, 1993 (TNM F0723); Chunghsing Univ., on rabbit dung, *Y. Z. Wang* 9251, June 24, 1992 (TNM F0199); *Y. Z. Wang* 9253, June 25, 1992 (TNM F0201). Taipei: Mucha, Taipei City Zoo, on horse dung, *Y. Z. Wang* 9202, Feb. 28, 1992 (TNM F0151), *Z. C. Chen & Y. Z. Wang* 9211, Apr. 10, 1992 (TNM F0160); on zebra dung,

Y. Z. Wang 9637, May 21, 1996 (TNM F4722). Taitung: Orchid Island, on goat dung, *Y. Z. Wang 9713*, May 07, 1997 (TNM F5721). Fujian. Chinmen: on deer dung, *Y. Z. Wang 9429*, May 30, 1994 (TNM F2106); on sheep dung, *Y. Z. Wang 9430*, Aug. 7, 1994 (TNM F2495).

The ascospores of Taiwanese collections have various parallel to oblique lines. Van Brummelen (1967) described the ascospores also with warts or lumps. This character was not observed in Taiwanese collections. This species usually grows on filter paper during incubation and fruits very well on artificial medium.

Ascobolus furfuraceus Pers: Fr., Sys. Mycol. 2: 163. 1822.
Figs. 1F, 3F.

Specimens examined: Taiwan. Taoyuan: Puhsin, on horse dung, *Y. Z. Wang 9312*, Feb. 5, 1993 (TNM F0707).

Brummelen (1967) stated that this species is very common and extremely variable, and Paulsen & Dissing (1979) also mentioned that it is the most common *Ascobolus* species in Denmark. However, only one collection has been found in these investigations.

Ascobolus fushanus Y. Z. Wang & Brumm. Mycotaxon 65: 443-446, 1997. Figs. 1E, 3E.

Specimens examined: Ilan: Fushan Botanical Garden, on muntjac dung, *Y. Z. Wang 9646*, Oct. 29, 1996 (Holotype, TNM); *Y. Z. Wang 9703*, Feb. 3, 1997 (TNM F5711).

This species is characterized by the narrowly ellipsoid ascospores and the pattern of spore ornamentation. It is closely related to *A. crenulatus*, *A. michaudii*, and *A. denudatus*.

Ascobolus immersus Pers.: Fr., Sys. Mycol. 2: 164. 1822.
Figs. 2A, 4A, 18B.

Specimens examined: Taiwan. Changhua:

Yinhangshan, on cow dung, *Y. Z. Wang 9515*, June 7, 1995 (TNM F3438). Hualien: Yuli, on cow dung, *Y. Z. Wang 9286*, Aug. 26, 1992 (TNM F0675). Kaohsiung: Luchu, on cow dung, *Y. Z. Wang 93113*, Nov. 29, 1993 (TNM F1428). Nantou: Chingching Farm, on cow dung, *Y. Z. Wang 92152*, Dec. 30, 1992 (TNM F0585); on sheep dung, *Y. Z. Wang 9507*, Jan. 28, 1995 (TNM F2935); on sheep dung, *Y. Z. Wang 9813*, Feb. 4, 1998 (TNM F7973). Pingtung: Kenting, on cow dung, *Y. Z. Wang 9349*, Apr. 12, 1993 (TNM F0599). Taichung: Shengkang, on cow dung, *Y. Z. Wang 92137*, Dec. 7, 1992 (TNM F0581). Taitung: Chihshang, on cow dung, *Y. Z. Wang 9437*, July 17, 1994 (TNM F2238); Paoli, on goat dung, *Y. Z. Wang 9640*, July 19, 1996 (TNM F5300); Orchid Island, on goat dung, *Y. Z. Wang 9712*, May 7, 1997 (TNM F5720). Taoyuan: Puhsin, on cow dung, *Y. Z. Wang 9382*, July 19, 1993 (TNM F1017). Yunlin: Taihsi, on ox dung, *Y. Z. Wang 9466*, Oct. 27, 1994 (TNM F2581). Fujian. Chinmen: Chinmen, on cow dung, *Y. Z. Wang 9421*, May 7, 1994 (TNM F5711).

This species is easily recognized by the large asci and ascospores. It is the most common species of *Ascobolus* in Taiwan. Most collections were found on dry cow dung (Wang 1993).

Ascobolus lineolatus Brumm. Persoonia Suppl. 1: 120, 1967. Figs. 2B, 4B.

Specimens examined: Taiwan. Kaohsiung: Fengshan, on deer dung, *Y. Z. Wang 9315*, Feb. 26, 1992 (TNM F0675); Liukuei, on monkey dung, *Y. Z. Wang 93112*, Nov. 30, 1993 (TNM F1416). Nantou: Lienhuachih, on rabbit dung, *Y. Z. Wang 9601*, Jan. 9, 1996 (TNM F4459).

This species is easily recognized by the transverse or oblique ridges on the spore surface. It was previously reported by Liou & Chen (1977).



Text-figure 4

(SEM) Ascospores of A. *Ascobolus immersus*. B. *A. lineolatus*. C. *A. mancus*. D. *A. michaudii*. E. *A. reticulatus*. F. *A. scatigenus*. Bars = 5 μm .

Ascobolus mancus (Rehm) Brumm. Persoonia Suppl. 1: 84, 1967. Figs. 2C, 4C.

Specimens examined: Taiwan. Hsinchu: Liufutsun Zoo, on dung of unknown animal, Y. Z. Wang 93122, Dec. 30, 1993 (TNM F1445). Hualien: Cholu, on sheep dung, Y. Z. Wang 94042, July 21, 1994 (TNM F2243). Kaohsiung: Chiahsien, on cow dung, Y. Z. Wang 9385, July 20, 1993 (TNM F0995). Miaoli: Provincial Miaoli Agri-industrial Vocational High School, on horse dung, Y. Z. Wang 9606, Jan. 10, 1996 (TNM F4464). Taichung: Tunghai Univ., on cow dung, Y. Z. Wang 9458, Oct. 18, 1994 (TNM F2573). Tainan: Coastal Highway, on cow dung, Y. Z. Wang 93115, Dec. 2, 1993 (TNM F 1438). Taipei: Mucha, Taipei City Zoo, on antelope dung, Z.C. Chen & Y. Z. Wang 9212, Mar. 17, 1992 (TNM F0161). Taoyuan: Yangmei, on horse dung, Y. Z. Wang 93006, Feb. 3, 1993 (TNM F0704).

This species is close to *Ascobolus amoenus* and *A. elegans*, which are characterized by greenish cupulate apothecia and granulate ascospores. The main difference within this group is the size of the ascospores. *Ascobolus amoenus* has the largest ascospores, *A. mancus* the smallest, and those of *A. elegans* are intermediate in size. However, the ascospores of the Taiwanese collections are slightly larger than those of the typical material (19-23 x 10-12 μ m, Brummelen 1967), hence the distinction between *A. elegans* and *A. mancus* is not very clear. Japanese collections of *A. elegans* are reported with ascospores 22.4-25.0 x 11.0-12.5 μ m (Otani & Kanzawa 1970a).

Ascobolus michaudii Boud., Hist. Class. Discom. Eur. 71, 1907. Figs. 2D, 4D.

Specimens examined: Taiwan. Hsinchu: Liufutsun Zoo, on unknown animal dung, Y. Z. Wang 93124, Dec. 31, 1993 (TNM F1658). Nantou: Chingching Farm, on sheep dung, Y.

Z. Wang 9327, Feb. 27, 1993 (TNM F0717). Pingtung: Tsaopu, Y. Z. Wang 9345, Apr. 12, 1993 (TNM F0597). Taichung: Tunghai Univ., on cow dung, Y. Z. Wang 9228, May 19, 1992 (TNM F0176). Taipei: Mucha, Taipei City Zoo, on horse dung, Y. Z. Wang 9635, May 15, 1996 (TNM F4721).

This species is characterized by short-stalked yellowish apothecia and ascospores ornamented with widely spaced lines.

Ascobolus reticulatus Brumm. Persoonia Suppl. 1: 153, 1967. Figs. 2E, 4E.

Specimen examined: Fujian. Chinmen: Chinmen National Park, on deer dung, Y. Z. Wang 9452, June 1, 1994 (TNM F2495).

This is a rare species. It is characterized by a dark brown reticulation on the hyaline ascospores.

Ascobolus scatigenus (Berk.) Brumm., Persoonia Suppl. 1:159, 1967. Figs.2F, 4F, 18C.

Specimens examined: Hualien: Hualien, on cow dung, Y. Z. Wang 9431, June 23, 1994 (TNM F2121). Pingtung: Kenting, on cow dung, coll. G. C. Wu, Wang 9214, Apr. 14, 1992 (TNM F0163); Chufengshan, on cow dung, Y. Z. Wang 9239, June 16, 1992 (TNM F0187); Paoli, on ox dung, Y. Z. Wang 9641, July 29, 1996 (TNM F5301). Tainan: Coastal Highway, on cow dung, Y. Z. Wang 93115, Dec. 2, 1993 (TNM F1438). Taipei: Yangmingshan, on ox dung, Y. Z. Wang 9725, Nov. 26, 1997 (TNM F7961).

This species has the largest apothecia within the genus *Ascobolus*. It is characterized by the large green apothecia covered with white hyphoid hairs. Apothecia collected in the field usually grow larger than those grown in a moist chamber. According to Sawada's (1931) description and illustration, *Aleurina nigrodisca* Sawada with large yellow apothecia and brown ascospores growing on

buffalo dung should be a collection of *Ascobolus scatigenus*.

Key to species of *Ascodesmis* found in Taiwan

- 1a. Ascospores reticulate 2
 1b. Ascospores with short spines or ridges 3
 2a. Ascospores globose or subglobose, reticulate *A. sphaerospora*
 2b. Ascospores broadly ellipsoid, irregularly reticulate, 19-21 x 14-18 μm *A. macrospora*
 3a. Ascospores with spines and short ridges *A. nigricans*
 3b. Ascospores with a long prominent ridge *A. porcina*

Ascodesmis macrospora Obrist, Can. J. Bot. 39: 951, 1961. Figs. 5A, 6A.

Specimen examined: Kaohsiung: Fengshan, on goat dung, Y. Z. Wang 93035, Mar. 5, 1993 (TNM F0722).

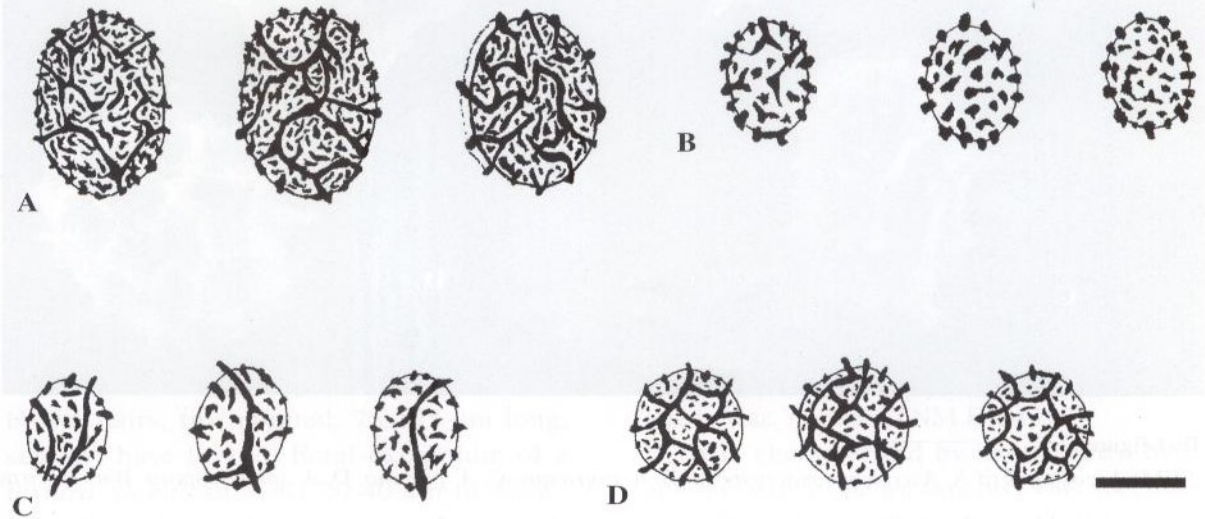
It is characterized by the large reticulate ascospores. It differs from *A. microscopica* (Crouan) Le Gal mainly by the larger

ascospores (Brummelen 1981). Liou & Chen (1977) reported *A. microscopica* with ascospores sizes of 13.5-17 x 11-13 μm .

Ascodesmis nigricans van Tieghem, Bull. Soc. Bot. Fr. 23: 275, 1907. Figs. 5B, 6B.

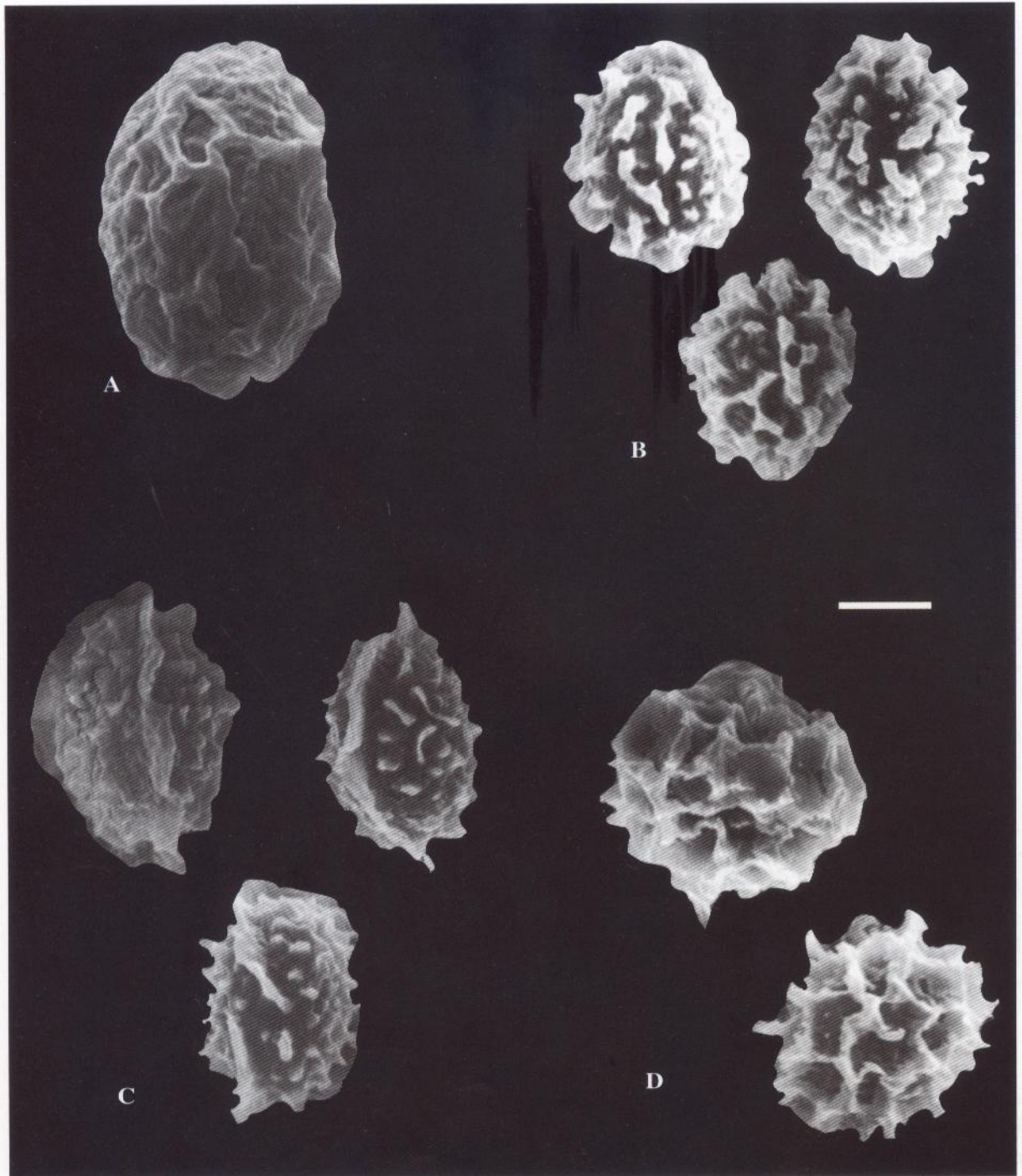
Specimens examined: Changhua: Peitou, on cow dung, Y. Z. Wang 93103, Sep. 27, 1993 (TNM F1185). Hualien: Yuli, on deer dung, Y. Z. Wang 9272, July 27, 1992 (TNM F0664). Kaohsiung: Fengshan, on deer dung, Y. Z. Wang 93014, Feb. 9, 1993 (TNM F0709). Miaoli: Taiwan Provincial Miaoli Agricultural Vocational High School, on cattle dung, Y. Z. Wang 9608, Jan. 15, 1996 (TNM F4466). Nantou: Lienhuachih, on cow dung, Y. Z. Wang 93088, Aug. 1, 1993 (TNM F1001). Pingtung: Kenting Farm, on cow dung, Y. Z. Wang 92135, Dec. 7, 1992 (TNM F0696). Taipei: National Taiwan Univ., on mouse dung, Y. Z. Wang 9608, Jul. 29, 1993 (TNM F4466). Yunlin: Taihsi, on cow dung, Y. Z. Wang 93090, Jan. 11, 1995 (TNM F1010); on sheep dung, Y. Z. Wang 9501, Jan. 11, 1995 (TNM F2929).

This is the most common *Ascodesmis*



Text-figure 5

Ascospore of A. *Ascodesmis macrospora*. B. *A. nigricans*. C. *A. porcina*. D. *A. sphaerospora*. Bar = 10 μm .



Text-figure 6

(SEM) Ascospores of A. *Ascodemis macrospora*. B. *A. nigricans*. C. *A. porcina*. D. *A. sphaerospora*. Bars = 5 μ m.

species in Taiwan. It is characterized by small ascospores with short spines and ridges.

Ascodesmis porcina Seaver, Mycologia 8: 3, 1916. Figs. 5C, 6C.

Specimens examined: Taichung: Tunghai Univ., on deer dung, Y. Z. Wang 9237, June 12, 1992 (TNM F0185). Yunlin: Taihsi; on sheep dung, Y. Z. Wang 9503, Jan. 16, 1995 (TNM F2931); on cow dung, Y. Z. Wang 9644, Aug. 31, 1996 (TNM F5304).

This species is easily recognized by ascospores with a prominent ridge extending over a great part of the spore surface.

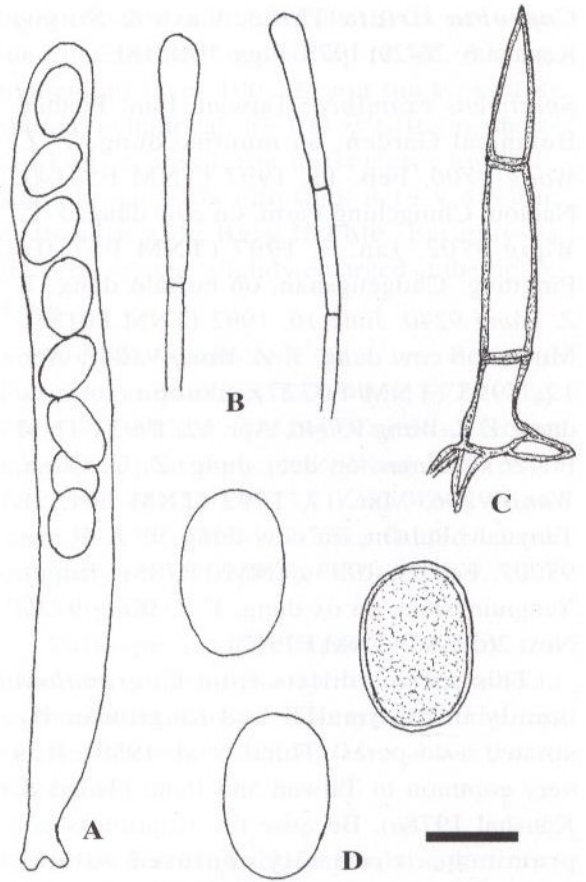
Ascodesmis sphaerospora Obrist, Can. J. Bot. 39: 948, 1961. Figs. 5D, 6D.

Specimen examined: Ilan: Fushan Botanical Garden, on monkey dung, Y. Z. Wang 9708, Mar. 11, 1997 (TNM F5716). Kaohsiung: Fengshan, on goat dung, Y. Z. Wang 93034, Mar. 5, 1993 (TNM F0721). Nantou: Lienhuachih, on rabbit dung, Y. Z. Wang 9615, Jan. 30, 1996 (TNM F4472). Taichung: Kaomei, on goat dung, Y. Z. Wang 9406, Mar. 18, 1994 (TNM F1921).

This species is distinguished by its globose or subglobose ascospores with a reticulate ornamentation. *Ascodesmis microscopica* also has reticulate ascospores which are, however broadly ellipsoid with an irregular reticulation (Brummelen 1981).

Cheilymenia fimicola (De Not. & Bagl.) Dennis, British Ascomycetes p. 45, 1968. Figs. 7, 10A.

Apothecia scattered, discoid, orange-red, 0.7-2.0 mm, receptacle yellowish brown, with brown hairs, tips pointed, 75-175 μm long, septate, base forked. Ectal-excipulum of a *textura globulosa*, cells 20-40 μm in diam., medullary excipulum composed of small polygonal cells 10-15 μm . Asci 8-spored, clavate, 171-208 x 15-18 μm . Ascospores



Text-figure 7

Cheilymenia fimicola A. Ascus; B. Paraphyses tips; C. hair; D. Ascospores. Bar = 25 (μm for A, B, C. and 10 μm for D).

ellipsoid, 17-20 x 10-12 μm , smooth, hyaline. Paraphyses filiform, base 3-4 μm , expanded at tips, 5-11 μm , filled with red granules, turning green in Melzer's reagent.

Specimen examined: Taiwan. Taipei: Yangmingshan, on buffalo dung, Y. Z. Wang 9621, Mar. 7, 1996 (TNM F4543).

It is characterized by short brown hairs and the size of the ascospores. This specimen was collected directly in the field. It is a new record from Taiwan.

Coprobia striata Thind, Cash & Singh, Kavaka 6: 26-29, 1978. Figs. 10B, 18E.

Specimens examined: Taiwan. Iilan: Fushan Botanical Garden, on muntjac dung, Y. Z. Wang 9706, Feb. 11, 1997 (TNM F5714). Nantou: Chingching Farm, on cow dung, Y. Z. Wang 9702, Jan. 3, 1997 (TNM F5710). Pingtung: Chugengshan, on buffalo dung, Y. Z. Wang 9240, June 16, 1992 (TNM F0188); Mutan, on cow dung, Y. Z. Wang 93047, Apr. 12, 1993 (TNM F0727); Tsaopu, on cow dung, Y. Z. Wang 93046, Apr. 12, 1993 (TNM F0726). Tainan: on deer dung, Z. C. Chen; Wang 9206, Mar. 17, 1992 (TNM F0155). Taoyuan: Puhsin, on cow dung, Y. Z. Wang, 93007, Feb. 3, 1993 (TNM F0705). Taipei: Yangmingshan, on ox dung, Y. Z. Wang 9726, Nov. 26, 1997 (TNM F7962).

This species differs from *C. granulata* mainly in the smaller and longitudinally striated ascospores (Thind et al. 1959). It is very common in Taiwan and India (Thind & Kaushal 1978a). Because the striation is not prominent, it is easily confused with *C. granulata*. Moravec (1990) transferred *Coprobia* to *Cheilymenia*, because both genera have hairy apothecia and smooth ascospores. But I retain this species in *Coprobia*.

Key to species of *Coprotus* found in Taiwan

- 1a. Apothecia white to yellowish 2
- 1b. Apothecia pale yellow to orange
..... *C. ochraceus*
- 2a. Asci 8-spored 4
- 2b. Asci more than 8-spored 3
- 3a. Asci 16-spored *C. sexdecimsporus*
- 3b. Asci 64-spored *C. niveus*
- 4a. Paraphyses branched and hooked at the tips 5
- 4b. Paraphyses not hooked at the tips 6
- 5a. Ascospores 14-16 x 7.5-10 μm
..... *C. uncinatus*
- 5b. Ascospores 8-9 x 4-4.5 μm
..... *C. glaucellus*

- 6a. Apothecial margin prominent, ascospores 8-13 x 4-6 μm *C. marginatus*
- 6b. Apothecial margin not prominent 7
- 7a. Ascospores 16-18 x 10-12 μm
..... *C. leucopocillum*
- 7b. Ascospores 11-14 x 6-7.8 μm
..... *C. disculus*

Coprotus disculus Kimbrough, Luck-Allen & Cain, Can. J. Bot. 50: 962, 1972. Fig. 8A.

Specimens examined: Taiwan. Pingtung: Kangtzu, on cow dung, Y. Z. Wang 93075, June 7, 1993 (TNM F0741); Kenting, on goat dung, Y. Z. Wang 9812, Jan. 18, 1998 (TNM F7972). Taipei: Mucha, Taipei Zoo, on goat dung, Y. Z. Wang 9204, Mar. 11, 1992 (TNM F0153). Taoyuan: Puhsin, on horse dung, Y. Z. Wang 93031, Mar. 1, 1993 (TNM F0591); Yangmei, on horse dung, Y. Z. Wang 93033, Mar. 4, 1993 (TNM F0720).

This species is close to *C. leucopocillum* but can be distinguished by smaller ascospores.

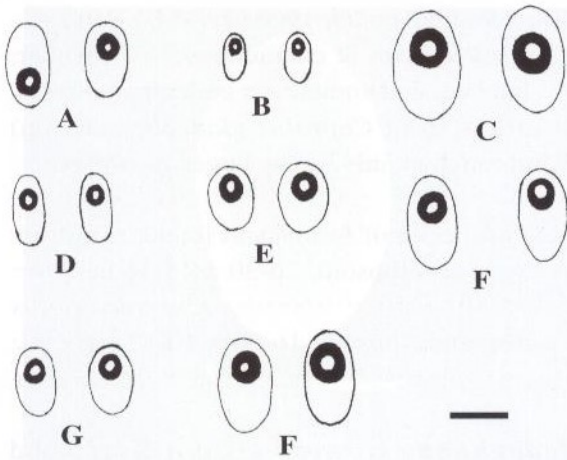
Coprotus glaucellus (Rehm) Kimbrough, Amer. J. Bot. 54: 22, 1967. Fig. 8B.

Specimen examined: Iilan: Fushan Botanical Garden, on Formosan muntjac dung, Y. Z. Wang 9619, Feb. 9, 1996 (TNM F4458); Y. Z. Wang 9647, Nov. 13, 1996 (TNM F5306).

This species has the smallest asci and ascospores among all species of the genus *Coprotus* having white apothecia. *Coprotus uncinatus* Wang also has hooked paraphyses, however the asci and ascospores are larger.

Coprotus leucopocillum Kimbrough, Luck-Allen & Cain, Can. J. Bot. 50: 965, 1972. Fig. 8C.

Specimens examined: Taiwan. Pingtung: Kangtzu, on cow dung, Y. Z. Wang 93076, June 7, 1993 (TNM F0742); Nanjenhu, on buffalo dung, Y. Z. Wang 9271, July 17, 1992



Text-figure 8

Ascospores of A. *Coprotus disculus*. B. *C. glaucellus*. C. *C. leucopocillum*. D. *C. marginatus*. E. *C. niveus*. F. *C. ochraceus*. G. *C. sexdecimsporus*. H. *C. uncinatus*. Bars = 10 μm .

(TNM F0663); Oluanpi, on goat dung, Y. Z. Wang 93098, Sep. 8, 1993 (TNM F1124); Tsaopu, on cow dung, Y. Z. Wang 93048, Apr. 12, 1993 (TNM F0598). Taichung: Chunhui Farm, on cow dung, Y. Z. Wang 95020, Aug. 1, 1995 (TNM F3444); Shengkang, on cow dung, Y. Z. Wang 9292, Sept. 18, 1992 (TNM F0680); Tunghai Univ., on cow dung, Y. Z. Wang 9231, May 22, 1992 (TNM F0179); Y. Z. Wang 93037, Mar. 22, 1993 (TNM F0594); Y. Z. Wang 94033, June 27, 1994 (TNM F2123). Yunlin, Taihsi, on ox dung, Y. Z. Wang 94062, Oct. 26, 1994 (TNM F2577).

It is the most common species within this genus collected in Taiwan. All collections were found from cow dung. The Norwegian collections have smaller ascospores (13-16.5 x 7-9.5 μm), according to Aas (1983).

Coprotus marginatus Kimbrough, Luck-Allen & Cain, Can. J. Bot. 50: 967, 1972. Fig. 8D.

Apothecia scattered, white to yellowish, lenticular to discoid, 0.3-1.2 mm, margin inrolled. Excipulum of a *textura globulosa*,

layer 150-200 μm thick, cells 10-25 μm wide, marginal cells elongated, up to 50 μm long, hymenium layer 100-125 μm thick. Asci 8-spored, cylindrical, 87-100 x 9-10 μm , short-stalked. Ascospores uniseriate, hyaline, smooth, narrowly ellipsoid, 8-13 x 4-6 μm , each with a de Bary bubble. Paraphyses filiform, septate, slightly enlarged at the tip, 3-4 μm .

Specimens examined: Taiwan. Penghu: Paishan, on ox dung, Y. Z. Wang 9722, May 29, 1997 (TNM F7414). Taitung: Green Island, on goat dung, Y. Z. Wang 9630, Apr. 18, 1996 (TNM F4573); Y. Z. Wang 9634, Apr. 23, 1996 (TNM F4720); Orchid Island, on goat dung, Y. Z. Wang 9714, May 9, 1997 (TNM F5722).

This species is characterized by the narrowly ellipsoid ascospores and apothecia with inrolled margins. The type material has smaller ascospores (8.5-10.0 x 4.0-5.0 μm , Kimbrough et al. 1972).

Coprotus niveus (Fuckel) Kimbrough, Luck-Allen & Cain, Can. J. Bot. 50: 967, 1972. Fig. 8E.

Specimens examined: Taiwan. Hualien: Yuli, on cow dung, Y. Z. Wang 9283, Aug. 10, 1992 (TNM F0672). Pingtung: Kangtzu, on cow dung, Y. Z. Wang 94048, July 28, 1994 (TNM F2248); Nanjenhu, on buffalo dung, Y. Z. Wang 9270, July 6, 1992 (TNM F0238); Nanjenshan, on cow dung, Y. Z. Wang 93058, Apr. 20, 1993 (TNM F0607); Paoli, on goat dung, Y. Z. Wang 9642, July 29, 1996 (TNM F5302); Sheting Park, on cow dung, Y. Z. Wang 9262, June 30, 1992 (TNM F0230); Tsaopu, on cow dung, Y. Z. Wang 93055, Apr. 20, 1993 (TNM F0604). Taitung: Chihshang, on ox dung, Y. Z. Wang 94061, Oct. 22, 1994 (TNM F2576). Yunlin: Taihsi, on ox dung, Y. Z. Wang 94065, Oct. 27, 1994 (TNM F2580). Fujian. Chinmen: Chinmen, on cow dung, Y. Z. Wang 94024, May 12, 1994 (TNM F1980).

This species is characterized by the small white apothecia and multisporous asci, which are very obvious under a dissecting microscope.

Coprotus ochraceus (Cr. & Cr.) Larsen, Dan. Bot. Tidsskr. 66: 1-32, 1971. Fig. 8F.

Specimens examined: Taiwan. Penghu: Huhsi, on goat dung, *Y. Z. Wang* 93092, Aug. 3, 1993 (TNM F0998). Pingtung: Chufengshan, on buffalo dung, *Y. Z. Wang* 9241, June 16, 1992 (TNM F0189); Kenting, on cow dung, *Y. Z. Wang* 93071, May 18, 1993 (TNM F0743). Tainan: Coastal Highway, on ox dung, *Y. Z. Wang* 93116, Dec. 6, 1993 (TNM F1439). Taipei: Mucha, Taipei Zoo, on antelope dung, *Z. C. Chen & Y. Z. Wang* 9213, Apr. 18, 1992 (TNM F0162).

This is the only species of *Coprotus* with orange apothecia found in Taiwan. It has also been recorded from India (Thind et al. 1978) and in Norway (Aas 1983).

Coprotus sexdecimsporus (Cr. & Cr.) Kimbrough, Amer. J. Bot. 54: 22, 1967. Fig. 8G.

Specimen examined: Taiwan. Taoyuan: Yangmei, on horse dung, *Y. Z. Wang* 93023, Feb. 19, 1993 (TNM F0716).

This species is easily recognized by the 16-spored asci. It was also recorded from Norway (Aas 1983).

Coprotus uncinatus *Y. Z. Wang*, Mycotaxon 62: 84, 1994. Fig. 8H.

Specimens examined: Taiwan. Hualien: Hualien, on cow dung, *Y. Z. Wang* 94035, July 2, 1994 (TNM F2125). Ilan: Shuanglienpi, on buffalo dung, *Y. Z. Wang* 94014, Mar. 31, 1994 (TNM F1929). Pingtung: Kangtzu, on cow dung, *Y. Z. Wang* 93074, June 3, 1993 (Holotype, TNM F0740). Taitung: Green Island, on goat dung, *Y. Z. Wang* 9631, Apr. 18, 1996 (TNM F4717); on buffalo dung, *Y. Z.*

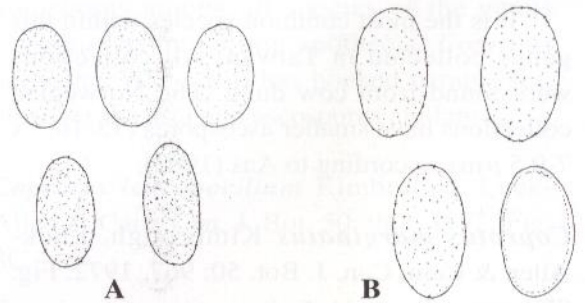
Wang 9633, Apr. 29, 1996 (TNM F4719).

This species is characterized by slender, tip-hooked, and sometimes coiled paraphyses. It differs from *Coprotus glaucellus* (Rehm) Kimbrough mainly by the larger ascospores.

Key to species of *Iodophanus* found in Taiwan
Ascospores ellipsoid, 26-30 x 15-18 μ m
..... *I. verrucosporus*
Ascospores ellipsoid, 16-20 x 10-12 μ m
..... *I. carneus*

Iodophanus carneus (Pers.) Korf apud Kimbrough & Korf, Amer. J. Bot. 54: 19, 1967. Figs. 9A, 10C.

Specimens examined: Taiwan. Changhua: Yinhangshan, on cow dung, *Y. Z. Wang* 95017, June 22, 1995 (TNM F3440); Changhua, on goat dung, *Y. Z. Wang* 9636, May 20, 1996 (TNM F4723). Hualin: Juisui, on cow dung, *Y. Z. Wang* 94071, Nov. 04, 1994 (TNM F2585). Kaohsiung: Chiahhsien, on cow dung, *Y. Z. Wang* 94004, Jan. 27, 1994 (TNM F1661). Nantou: Chingching Farm, on sheep dung, *Y. Z. Wang* 93001, Jan. 05, 1993 (TNM F0702); Chushan, on goat dung, *Y. Z. Wang* 9236, June 10, 1992 (TNM F0184). Pingtung: Tsaopu, on cow dung, *Y. Z. Wang* 93052, Apr. 20, 1993 (TNM F0601). Taichung: Tunghai Univ., on cow dung, *Y. Z. Wang* 93043, Mar. 26, 1993 (TNMF0596); on cow dung, *Y. Z. Wang* 94005, Mar. 18, 1994 (TNM F1920). Taipei:



Text-figure 9

Ascospores of A. *Iodophanus carneus*. B. *I. verrucosporus*. Bar = 10 μ m.



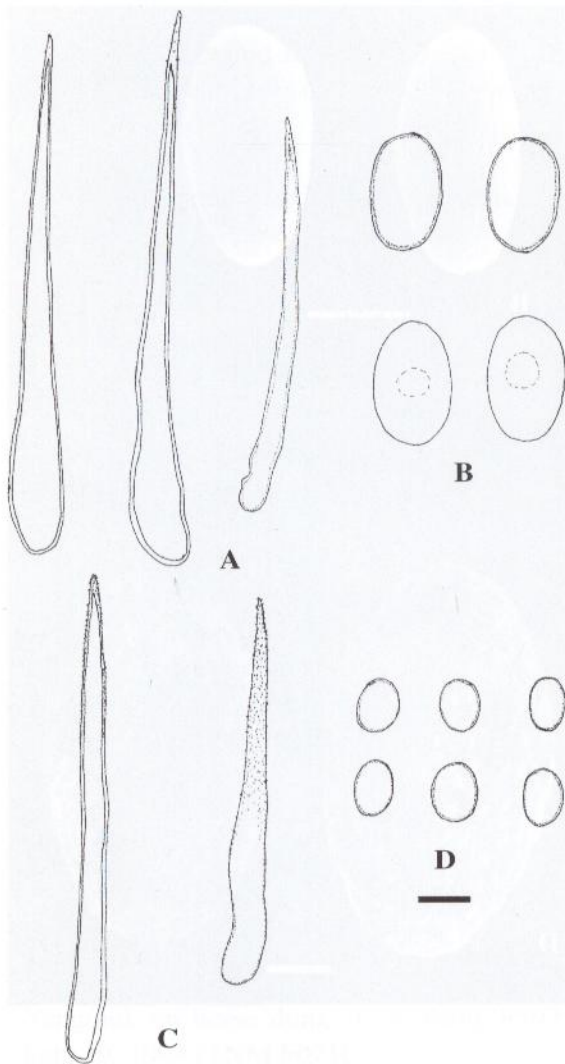
Text-figure 10

(SEM) Ascospores of A. *Cheilymenia fimicola*. B. *Coprobria striata*. C. *Iodaphanus carneus*. D. *I. verrucosporus*. Bars = 5 μ m.

Mucha, Taipei Zoo, on antelope dung, Y. Z. Wang 9217, Apr. 28, 1992 (TNMF0166); on buffalo dung, Y. Z. Wang 9203, Mar. 4, 1992 (TNM F0152); Yangmingshan, Chingtien-kang, on ox dung, Y. Z. Wang 9802, Jan. 5, 1998 (TNM F7965). Taitung: Orchid Island, on goat dung, Y. Z. Wang 9716, May 9, 1997 (TNM F5724). Taoyuan: Puhsin, on horse dung, Y. Z. Wang 93011, Feb. 05, 1993 (TNM F0706); Y. Z. Wang 93013, Feb. 05, 1993 (TNM F0708). Fujian. Chinmen: Chinmen National Park, on deer dung, Y. Z. Wang

94027, May 18, 1994 (TNM F2104); on cow dung, Y. Z. Wang 94028, May 18, 1994 (TNM F2105).

This is the most common coprophilous discomycete found in Taiwan. The pigment of the apothecia becomes pale orange when inoculated indoors. Kimbrough et al. (1969) treated the non-coprophilous collections under *I. testaceus* (Moug.) Korf. But *I. carneus* can also grow on filter paper inoculated with dung, hence I followed Thind & Kaushal (1978b) and assigned all collections to *I.*



Text-figure 11

Lasiobolus cuniculi; A. Hairs. B. Ascospores. *L. microsporus*; C. Hairs. D. Ascospores. Bar = 25 μm for A, C. and 10 μm for B, D.

carneus.

Iodophanus verrucosporus Kimbrough, Luck-Allen & Cain, Can. J. Bot. 56: 1201, 1969. Figs. 9B, 10D.

Specimens examined: Taiwan. Ilan: Shuanglienpi, on buffalo dung, Y. Z. Wang 94013, Apr. 2, 1994 (TNM F1928). Nantou:

Mingchien, on goat dung, Y. Z. Wang 93105, Sept. 27, 1993 (TNM F1186); Aowanta, on cow dung, Y. Z. Wang 94045, July 26, 1994 (TNM F2245). Penghu: Wuni, on cow dung, Y. Z. Wang 93079, July 6, 1993 (TNM F0758); Huhsi, on goat dung, Y. Z. Wang 93078, July 6, 1993 (TNMF0760). Taichung: Chunghsing Univ., on sheep dung, Y. Z. Wang 9265, July 2, 1992 (TNM F0233); Shengkang, on cow dung, Y. Z. Wang 9289, Sept. 18, 1992 (TNM F0677); Tunghai Univ., on cow dung, Y. Z. Wang 94073, Nov. 4, 1994 (TNM F2587).

This species is recognized by the large verrucose ascospores. Kimbrough et al. (1969) described this species with smaller ascospores (22-27 x 14-16.5 μm). The ascospores are usually collapsed when dry, but easily swollen to normal shape when mounted in water.

Key to species of *Lasiobolus* found in Taiwan
 Ascospores 16-23 x 11-15 μm
 *L. cuniculi*
 Ascospores 8-13 x 6-10 μm , setae with fine markings*L. microsporus*

Lasiobolus cuniculi Vel., Monogr. Discom. Bohem. 1: 413, 1934. Fig. 11A, B.

Specimens examined: Taiwan. Nantou: Chinching Farm, on cow dung, Y. Z. Wang 93030, Mar. 1, 1993 (TNM F0719); Y. Z. Wang 94011, Mar. 25, 1994 (TNM F1926). Taoyuan: Yangmei, on horse dung, Y. Z. Wang 93026, Feb. 19, 1993 (TNM F0715).

This species is close to *L. ciliatus*, which also has short seta and similarly sized ascospores, but the setae of the last have a broader base. (20 - 42 μm , Bezerra & Kimbrough 1975).

Lasibolus microsporus Bezerra & Kimbrough, Can. J. Bot. 53: 1221, 1975. Fig. 11C, D.

Specimens examined: Taiwan. Hualien: Yuli,

on deer dung, *Y. Z. Wang* 9274, July 28, 1992 (TNM F0667). Kaohsiung: Liukuei, Shanping, on monkey dung, *Y. Z. Wang* 93107, Nov. 16, 1993 (TNM F1412); *Y. Z. Wang* 93108, Nov. 16, 1993 (TNM F1413). Miaoli: Taiwan Provincial Miaoli Agri-industrial Vocational High School, on horse dung, *Y. Z. Wang* 9607, Jan. 15, 1996 (TNM F4465). Nantou: Huisun Forestry Station, on dung of unknown animal, *Y. Z. Wang* 9649, Dec. 27, 1996 (TNM F5707). Pingtung: Nanjenshan, on goat dung, *Y. Z. Wang* 9256, June 26, 1992 (TNM F0204); on cow dung, *Y. Z. Wang* 93056, Apr. 20, 1993 (TNM F0605); Yingta Farm, on horse dung, *Y. Z. Wang* 95013, Mar. 21, 1995 (TNM F3068). Taichung: Kaomei, on goat dung, *Y. Z. Wang* 94010, Mar. 22, 1994 (TNM F1925); Hsuehshan, on Formosan muntjac dung, *Y. Z. Wang* 9639, June 27, 1996 (TNM F5299).

This species is characterized by the small ascospores and setae with cyanophilic markings. The type material has smaller ascospores (9-11 x 6-6.8 μm , Bezerra & Kimbrough 1975).

Leptokalpion albicans Brumm., Kew Bull. 31: 617, 1977. Fig. 18F.

Specimen examined: Ilan: Fushan Botanical Garden, on formosan muntjac dung, *Y. Z. Wang* 9618, Feb. 5, 1996 (TNM F4457).

This is a rare species, and probably restricted to southeastern Asia. Van Brummelen (1977) first reported it from Thailand.

Key to species of *Saccobolus* found in Taiwan

- 1a. Apothecia yellowish 4
- 1b. Apothecia white to pink 2
- 2a. Ascospores arranged in two rows
..... *S. infestans*
- 2b. Ascospores not arranged in two rows
..... 3
- 3a. Ascospores warty *S. verrucisporus*
- 3b. Ascospores smooth *S. depauperatus*

- 4a. Ascospores free at maturity 5
- 4b. Ascospores attached together at maturity 6
- 5a. Ascospores smooth, 14-16 x 7-8 μm
..... *S. michiganensis*
- 5b. Ascospores finely granulate, 15-18 x 8-10
 μm *S. saccoboloides*
- 6a. Ascospores small, 10-14 x 4-6 μm
..... *S. minimus*
- 6b. Ascospores larger than 14 μm 7
- 7a. Ascospores 22-25 x 8-11 μm
..... *S. glaber*
- 7b. Ascospores smaller than 22 μm 8
- 8a. Apothecia pale yellow, ascospores smooth
to finely granulate, 14-17 x 7-10 μm ,
truncated at two ends
..... *S. truncatus*
- 8b. Apothecia bright yellow or amber yellow,
ascospores with isolated warts 9
- 9a. Apothecia lemon yellow, ascospores with
truncated ends, 18-20 x 8-9 μm
..... *S. citrinus*
- 9b. Apothecia amber yellow, ascospores
finely dotted, 18-21 x 9-11 μm
..... *S. succineus*

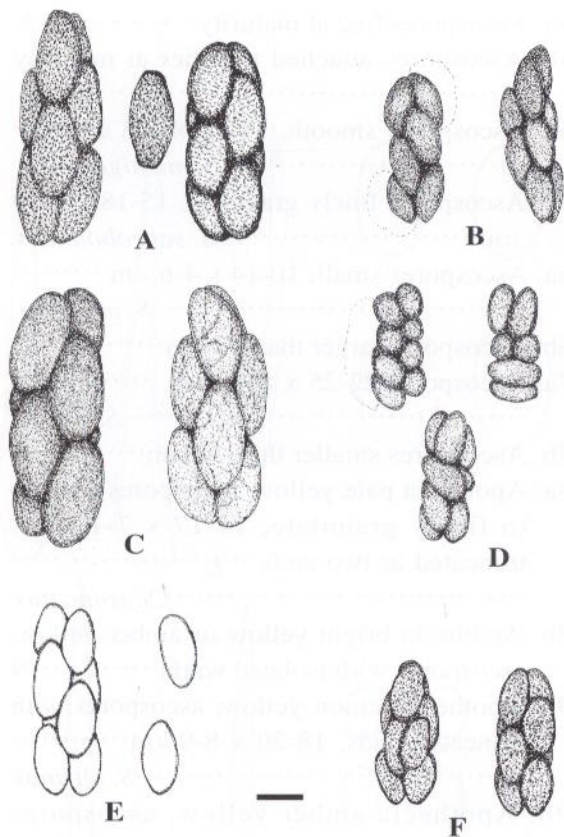
Saccobolus citrinus Boud. & Torrend, Bull. Soc. Mycol. Fr. 27: 131, 1911, Figs. 12A, 14A.

Specimens examined: Taiwan. Pingtung: Paisha, on cow dung, *Y. Z. Wang* 93072, May 8, 1993 (TNM F0738). Taichung: Chunghsing Univ., on cow dung, *Y. Z. Wang* 9250, June 22, 1992 (TNM F0198).

This species is close to *S. succineus*, but can be distinguished by the lemon-yellow apothecia and truncated ascospores. The ascospores of the former are narrower and more verrucose (Brummelen 1969).

Saccobolus depauperatus (Berk. & Broome) E. C. Hansen, Vid. Medd. Dansk Naturh. Foren. 1876: 87, 1876. Figs. 12B, 14B.

Specimens examined: Taiwan. Hsinchu:



Text-figure 12

Ascospores of A. *Saccobolus citrinus*. B. *S. depauperatus*. C. *S. glaber*. D. *S. infestans*. E. *S. minimus*. F. *S. michiganensis*. Bar = 10 μm .

Liufutsun Zoo, on herbivore dung, *Y. Z. Wang* 93123, Dec. 30, 1993 (TNM F1446). Nantou: Chingching Farm, on sheep dung, *Y. Z. Wang* 93028, Feb. 27, 1993 (TNM F0590). Nantou: Yingta Farm, on sheep dung, *Y. Z. Wang* 9509, Feb. 9, 1995 (TNM F3014). Taipei: Mucha, Taipei Zoo, on horse dung, *Y. Z. Wang* 9201, Feb. 22, 1992.

This species is recognized by the ascospore arrangement and the small, smooth, dark brown ascospores.

Saccobolus glaber (Pers.) Lamb., Fl. Mycol. Belg. Suppl. 1: 284, 1887. Figs. 12C, 14C.

Specimens examined: Taiwan. Changhua:

Peitou, on horse dung, *Y. Z. Wang* 93104, Sept. 27, 1993 (TNM F1187). Hualien: Shoufeng, on cow dung, *Y. Z. Wang* 94038, July 17, 1994 (TNM F2239). Kaohsiung: Luchu, on cow dung, *Y. Z. Wang* 93117, Dec. 6, 1993 (TNM F1440). Nantou: Aowanta, on cow dung, *Y. Z. Wang* 94032, June 27, 1994 (TNM F2122). Pingtung: Nanjenhu, on buffalo dung, *Y. Z. Wang* 9257, June 26, 1992 (TNM F0205). Yunlin: Lintsoliao, on sheep dung, *Y. Z. Wang* 94076, Nov. 6, 1994 (TNM F2590).

This species is recognized by the large brown ascospores. It was previously reported by Liou & Chen (1977).

Saccobolus infestans (Batista & Pontual) Brumm., Persoonia Suppl. 1: 204, 1967. Figs. 12D, 14D.

Specimens examined: Taoyuan: Puhsin, on horse dung, *Y. Z. Wang* 93017, Feb. 12, 1993 (TNM F0711, F0712).

This species is recognized by its special ascospore arrangement. Brummelen (1967) described the paraphyses contents as being olive, but the paraphyses of this collection have white yellowish contents.

Saccobolus michiganensis O'Donnell, Mycologia 70: 191, 1978. Figs. 12F, 14F.

Specimens examined: Taiwan. Kaohsiung: Fengshan, on deer dung, *Y. Z. Wang* 93025, Feb. 12, 1993 (TNM F0714). Nantou: Lienhuachih, on rabbit dung, *Y. Z. Wang* 9610, Jan. 16, 1996 (TNM F4467). Penghu: Tungliang, on deer dung, *Y. Z. Wang* 93077, July 6, 1993 (TNM F0761). Pingtung: Yingta Farm, on sheep dung, *Y. Z. Wang* 95010, Feb. 9, 1995 (TNM F3015). Taichung: Chunhui Farm, on cow dung, *Y. Z. Wang* 95019, July 28, 1995 (TNM F3443); Houli, on horse dung, *Y. Z. Wang* 9290, Sept. 15, 1992 (TNM F0678). Taipei: Mucha, Taipei Zoo, on antelope dung, *Z. C. Chen & Y. Z. Wang* 9210,

Apr. 1, 1992 (TNM F0159). Yunlin: Lintsoliao, on ox dung, *Y. Z. Wang* 94067, Oct. 27, 1994 (TNM F2582).

This species is very similar to *S. saccoboloides* (Seaver) Brumm. Mature ascospores of the last are bright yellowish-brown, slightly larger (16-18 x 7-9 μm), and the surface is finely granulated.

Saccobolus minimus Vel., Mon. Discom. Boh. 1: 370, 1934. Figs. 12E, 14E.

Specimens examined: Hualien: Yuli, on goat dung, *Y. Z. Wang* 9281, Aug. 3, 1992 (TNM F0670). Ilan: Fushan Botanical Garden, on muntjac dung, *Y. Z. Wang* 9645, Oct. 29, 1996 (TNM F5305). Nantou: Sunlinsea, on deer dung, *Y. Z. Wang* 92134, Dec. 5, 1992 (TNM F0694). Penghu: Hushi, on goat dung, *Y. Z. Wang* 93087, Aug. 1, 1993 (TNM F1015). Pingtung: Nanjenshan, on goat dung, *Y. Z. Wang* 9723, Nov. 17, 1997 (TNM F7959). Taitung: Orchid Island, on goat dung, *Y. Z. Wang* 9718, May 9, 1997 (TNM F5726).

This species is characterized by yellow apothecia and small ascospores. It is occasionally confused with *S. depauperatus* because of the small ascospores.

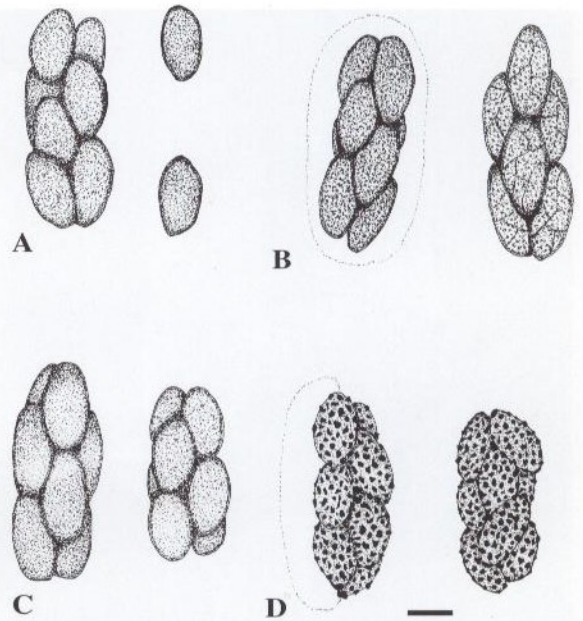
Saccobolus saccoboloides (Seaver) Brumm. Persoonia Suppl. 1: 168, 1967. Figs. 13A, 15A.

Specimens examined: Hualien: Cholu, on sheep dung, *Y. Z. Wang* 94043, July 21, 1994 (TNM F2244). Tainan: Jente, on cow dung, *Y. Z. Wang* 93114, Nov. 29, 1993 (TNM F1429).

It is characterized by the loosely attached and finely granulate brown ascospores.

Saccobolus succineus Brumm., Persoonia 5: 229, 1969. Figs. 13B, 15B, 18D.

Specimens examined: Taiwan. Hualien: Fenglin, on ox dung, *Y. Z. Wang* 94064, Oct. 19, 1994 (TNM F2579). Miaoli: Tunghsiao, on cow dung, *Y. Z. Wang* 9402, Jan. 5, 1994



Text-figure 13

Ascospores of A. *Saccobolus saccoboloides*. B. *S. succineus*. C. *S. truncatus*. D. *S. verrucisporus*. Bar = 10 μm .

(TNM F1662); *Y. Z. Wang* 93106, Oct. 27, 1993 (TNM F1433). Nantou: Chushan, on sheep dung, *Y. Z. Wang* 9235, June 8, 1992 (TNM F0183). Taichung: Chunghsing Univ., on cow dung, *Y. Z. Wang* 93012, Sept. 8, 1993 (TNM F1126); Shengkang, on cow dung, *Y. Z. Wang* 92136, Dec. 07, 1992 (TNM F0701); Tunghai Univ., on cow dung, *Y. Z. Wang* 93038, Mar. 22, 1993 (TNM F0724); *Y. Z. Wang* 9226, May 19, 1992 (TNM F0174); *Y. Z. Wang* 9227, May 19, 1992 (TNM F0175). Taitung: Chulu, on cow dung, *Y. Z. Wang* 94057, Oct. 17, 1994 (TNM F2572). Taoyuan: Yangmei, on cow dung, *Y. Z. Wang* 93084, July 19, 1993 (TNM F1012); Puhsin, on cow dung, *Y. Z. Wang* 93083, July 19, 1993 (TNM F1014).

This species is characterized by the amber-yellow apothecia and granulated ascospores. It is close to *S. citrinus*, but with broader ascospores and the granules on the



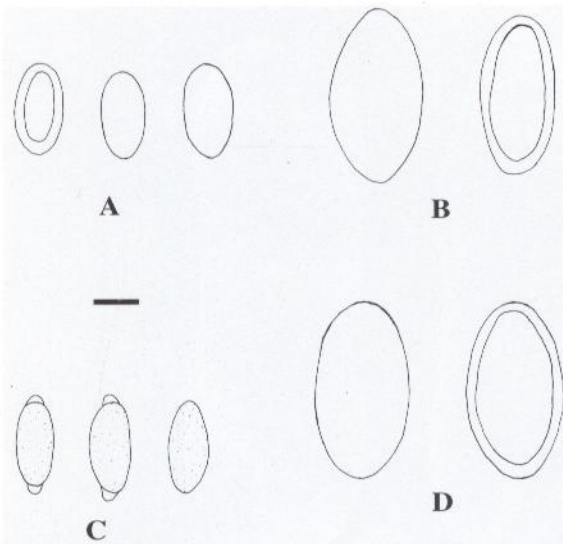
Text-figure 14

(SEM) Ascospores of A. *Saccobolus citrinus*. B. *S. depauperatus*. C. *S. glaber*. D. *S. infestans*. E. *S. minimus*. F. *S. michiganensis*. Bars = 5 μ m.



Text-figure 15

(SEM) Ascospores of A. *Saccobolus saccoboloides*. B. *S. succineus*. C. *S. truncatus*. D. *S. verrucisporus*. Bars = 5 μ m.



Text-figure 16

Ascospores of A. *Thecotheus agranulosus*. B. *T. flavidus*. C. *T. formosanus*. D. *T. pelletieri*. Bar = 1 μm .

spore surface are smaller (Brummelen 1969).

Saccobolus truncatus Vel., Monogr. Discom. Boh. 1: 370, 1934. Figs. 13C, 15C.

Specimens examined: Taiwan. Pingtung: Kangtzu, on cow dung, Y. Z. Wang 94047, July 28, 1994 (TNM F2247); Paisha, on cow dung, Y. Z. Wang 93054, Apr. 20, 1993 (TNM F0603). Taichung: Chunghsing Univ., on rabbit dung, Y. Z. Wang 9249, June 22, 1992 (TNM F0197); Houli, on horse dung, Y. Z. Wang 9291, Sept. 15, 1992 (TNM F0679).

This species is characterized by the arrangement and shape of the ascospores. It is close to *S. citrinus*, but with smaller ascospores and a finer spore surface (Brummelen 1969).

Saccobolus verrucisporus Brumm., Persoonia Suppl. 1:199, 1967. Figs 13D, 15D.

Specimens examined: Taiwan. Hualien: Yuli, on goat dung, Y. Z. Wang 9273, July 27, 1992 (TNM F0665); on deer dung, Y. Z. Wang

92147, Dec. 10, 1992 (TNM F0695). Ilan: Fushan Botanical Garden, on muntjac dung, Y. Z. Wang 9617, Jan. 30, 1996 (TNM F4474); Y. Z. Wang 9705, Feb. 11, 1997 (TNM F5713). Kaohsiung: Liukuei, Shan-ping, on monkey dung, Y. Z. Wang 94078, Dec. 12, 1994 (TNM F 2774). Pingtung: Kangtzu, on cow dung, Y. Z. Wang 94049, July 28, 1994 (TNM F2249); Oluanpi, on goat dung, Y. Z. Wang 93095, Aug. 30, 1993 (TNM F1127); Puting, on goat dung, Y. Z. Wang 93050, Apr. 12, 1993 (TNM F0728), Y. Z. Wang 93066, May 08, 1993 (TNM F0735); Sheting Park, on cow dung, Y. Z. Wang 9263, June 30, 1992 (TNM F0231). Taichung: Tunghai Univ., on goat dung, Y. Z. Wang 93040, Mar. 20, 1993 (TNM F0725); Y. Z. Wang 93096, Sept. 2, 1993 (TNM F1121). Taitung: Orchid Island, on goat dung, Y. Z. Wang 9717, May 9, 1997 (TNM F5725).

This species is characterized by pinkish apothecia and warty ascospores. It is close to *S. thaxteri* Brumm. but with larger warts.

Key to species of *Thecotheus* found in Taiwan

- 1a. Asci 8-spored.....2
- 1b. Asci 32-spored, 28-37 x 15.5-19 μm
..... *T. pelletieri*
- 2a. Ascospores with apiculi, 18-20 x 7.5-9 μm
..... *T. formosanus*
- 2b. Ascospores without apiculi.....
..... 3
- 3a. Ascospores 17-20 x 10-11 μm
..... *T. agranulosus*
- 3b. Ascospores 28-32 x 14-16 μm
..... *T. flavidus*

Thecotheus agranulosus Kimbrough, Mycologia 61: 112, 1969. Fig. 16A.

Specimen examined: Pingtung: Tsaopu, on cow dung, Y. Z. Wang 93067, May 8, 1993 (TNM F0746).

This species is recognized by the smooth ascospores. *Thecotheus formosanus* has similarly sized ascospores but with apiculi.

Thecotheus flavidus Y. Z. Wang & Kimbrough, *Mycologia* 85: 1020-1022, 1993. Fig. 16B.

Specimens examined: Taichung: Shengkang, Y. Z. Wang 92131, Sept. 25, 1992 (Holotype, TNM F0661); Y. Z. Wang 92132, Nov. 19, 1992 (TNM F0662); Tunghai Univ., on cow dung, Y. Z. Wang 94046, July 26, 1994 (TNM F2246).

This species is characterized by smooth, yellowish ascospores and two types of paraphyses. It is similar to *T. phycophilus* Pfister in having smooth ascospores and two types of paraphyses.

Thecotheus formosanus Y. Z. Wang, *Mycotaxon* 62: 86, 1994. Fig. 16C.

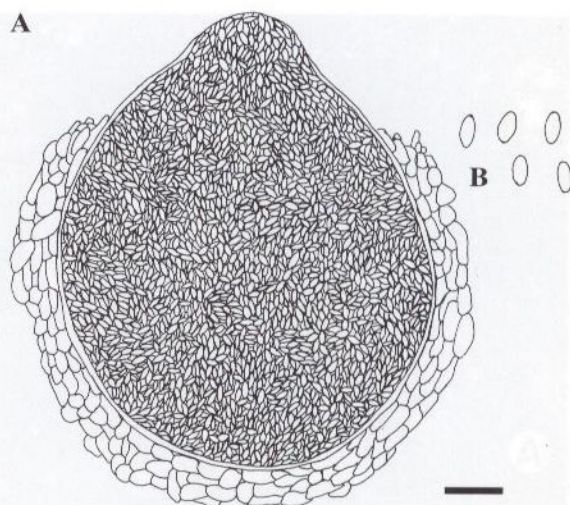
Specimens examined: Taiwan. Pingtung: Kangtzu, on cow dung, Y. Z. Wang 93070, May 11, 1993 (Holotype, TNM F0744); Y. Z. Wang 93073, June 8, 1993 (TNM F0739); Kenting, on goat dung, Y. Z. Wang 9810, Jan. 18, 1998 (TNM F7970). Taitung: Green Island, on goat dung, Y. Z. Wang 9629, Apr. 16, 1996 (TNM F4572); Orchid Island, on goat dung, Y. Z. Wang 9715, May 9, 1997 (TNM F5723).

It is characterized by apiculate and verruculose ascospores. *Thecotheus apiculatus* Kimbrough and *T. harasisus* Gene et al. (1993) also have apiculate ascospores, but the former has smooth ascospores with narrow apiculi (Kimbrough 1969), while the latter has more warty ascospores with broad apiculi.

Thecotheus pelletieri (Cr. & Cr.) Boud., *Ann. Sci. Nat.* V 10: 236, 1869. Fig. 16D.

Specimens examined: Taiwan. Taipei: Yangmingshan, on cow dung, coll. Z. C. Chang, Y. Z. Wang 9205, Mar. 6, 1992 (TNM F0154). Pingtung: Mutan, on cow dung, Y. Z. Wang 93053, Apr. 20, 1993 (TNM F0602).

This species is characterized by the



Text-figure 17

Thelebolus stercorus A. Apothecium. Bar = 25 μ m.

B. Ascospores. Bar = 10 μ m.

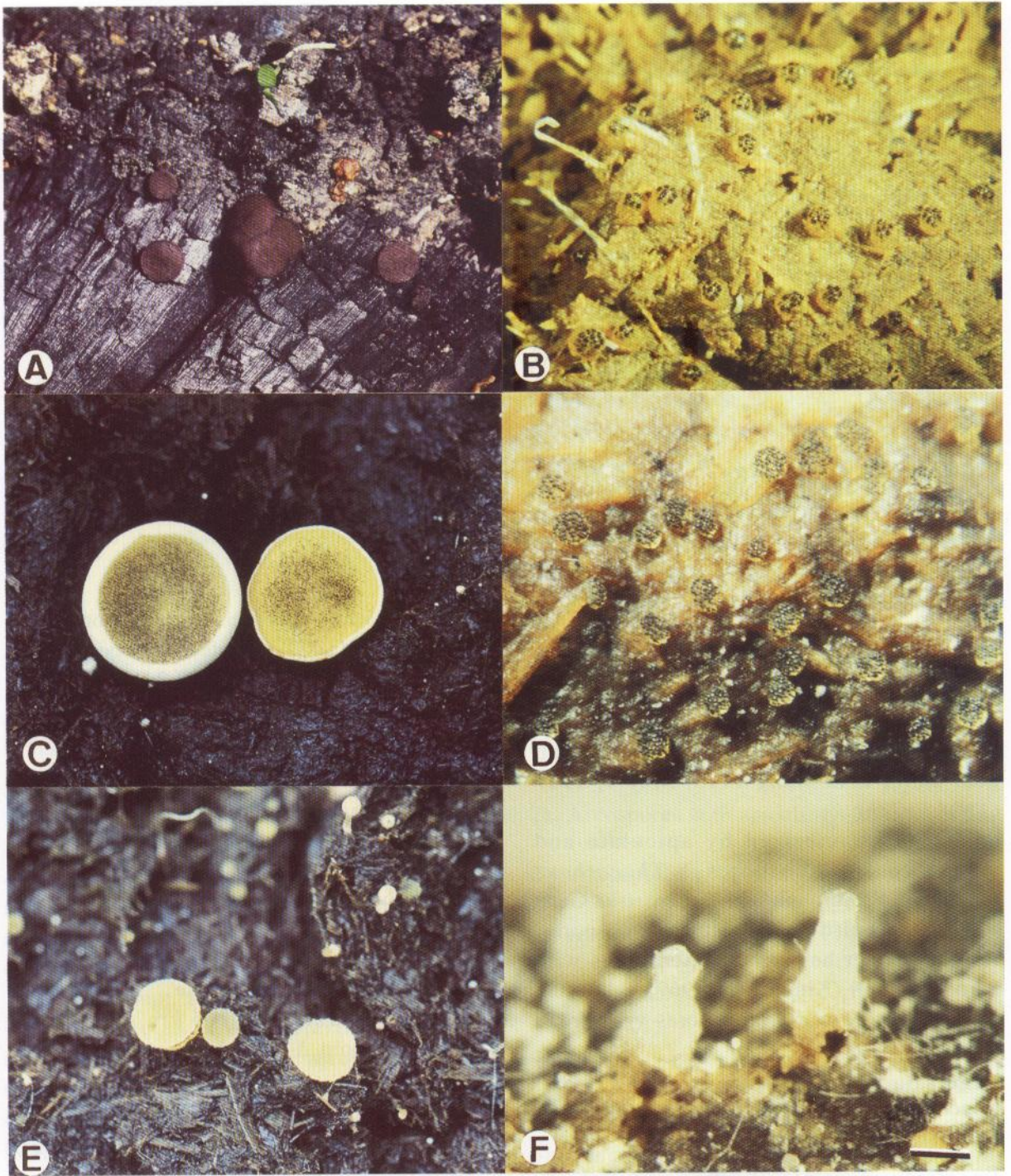
turbinate white apothecia and 32-spored asci. Kimbrough (1969) reported this species with larger ascospores (32-40 x 20-24 μ m).

Thelebolus stercorus Tode : Fr., *Syst. Mycol.* 2: 306, 1823. Fig. 17.

Apothecia scattered, subimmersed, yellowish to brown, globose, transparent, 125-200 μ m in diam. with a single ascus, remaining cleistocarpous until spore mature. Excipulum layer 15-25 μ m thick, composed of polygonal cells 12-20 x 8-10 μ m. Ascus multispored, subglobose, filled with ascospores, 125 x 90-105 μ m. Ascospores small, ellipsoid, 5-8 x 3-3.5 μ m, smooth.

Specimen examined: Taiwan. Ilan: Fushan Botanical Garden, on Formosan muntjac dung, Y. Z. Wang 9709, Apr. 2, 1997 (TNM F5717).

The apothecia of this species are very minute, hence easily neglected. It is characterized by globose, monascial apothecia and small ascospores. This is a new record for Taiwan.



Text-figure 17

Habitat of A. *Ascobolus carbonarius*, bar = 3 mm. B. *A. immersus*, bar = 12 mm. C. *A. scatigenus*, bar = 4 mm. D. *Saccobolus succineus*, bar = 0.8mm. E. *Coprobia striata*, bar = 8 mm. F. *Leptokalpion albicans*, bar = 0.4 mm.

ACKNOWLEDGEMENTS

The author thanks Drs. J. van Brummelen at Rijksherbarium, The Netherlands, C.-Y. Chien at National Taiwan Normal University, R.O.C., and J. W. Kimbrough at University of Florida, USA for reviewing the manuscript and all the people who helped in collecting samples of dung for the use in this study.

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- Manuscript received December 17, 1999
Revised manuscript accepted December 30, 1999

台灣的糞生盤菌

王也珍

摘要

本篇將台灣產糞生的盤菌目作一總整理，共記錄有11屬46種。其中有5個為台灣新記錄種。文中提供各種菌的形態描述，孢子描圖，電子掃描照片，標本產地和各屬與種的檢索表。

關鍵字：糞生，盤菌綱，盤菌目，台灣。