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Three New Records of Thermophilic Fungi from Taiwan

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ABSTRACT: Three species of thermophilic imperfect fungi isolated from farm soils of Taiwan are described and illustrated. Three species, *Humicola insolens* (Cooney & Emerson) var. *thermoidea* (Cooney & Emerson) Ellis, *Myceliophthora fergusii* (Klopotek) van Oorschot, *M. hinnulea* Awao & Udagawa are new records from Taiwan.

KEYWORDS: Thermophilic fungus, Deuteromycotina, *Humicola insolens* var. *thermoidea*, *Myceliophthora fergusii*, *Myceliophthora hinnulea*, Soil fungus.

In the course of a floristic survey of thermophilic and thermotolerant fungi of Taiwan, eight species of thermophilic and four species of thermotolerant fungi have been reported (Chen & Chen, 1988, 1990, 1991). In recent collection of soil samples from the southern part of this island, additional species of thermophilic fungi are isolated. The research methods applied in this investigation are those described in the previous paper (Chen & Chen, 1988). All cultures described in this report have been deposited in the Mycological Laboratory, Department of Botany, National Taiwan University.

1. **Humicola insolens** (Cooney & Emerson) var. **thermoidea** (Cooney & Emerson) Ellis, Trans. Br. mycol. Soc. 78: 129-139 (1982).

Humicola grisea (Traaen) var. *thermoidea* Cooney & Emerson, Thermophilic Fungi: 79 (1964) Fig. 1 and 2

Colonies on YpSs (Yeast Starch Agar: Yeast extract 4g, Soluble starch 15g, K_2HPO_4 1g, $MgSO_4 \cdot 7H_2O$ 0.5g Agar 20g, Dist. H_2O 1000 ml) grow very rapidly and attain full plate in 6 days at 40 °C. Mostly prostrate mycelia, grow radiately, undulate zonation. By spores maturation, the color at first White, Mouse Gray, Deep Mouse Gray and Dark Mouse Gray; reverse Colonial Buff, Dark Heliotropes-Slate. (The color based on Ridgway, 1912)

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Conidia single or a short chain of 2-3 spores, with stalk or without. Stalk hyaline, unbranched, 1.7-4.0 x 3.4-20.0 μm. Occasionally intercalary spores were founded on aerial and substrate mycelia, mostly on substrate mycelia. Spores smooth, mostly globose or fusiform (7.5-12 x 11.4-20 μm), pale yellow at first, becoming brown then turning to dark brown with age. The falling spores possess apicula on the area of connection with stalk.

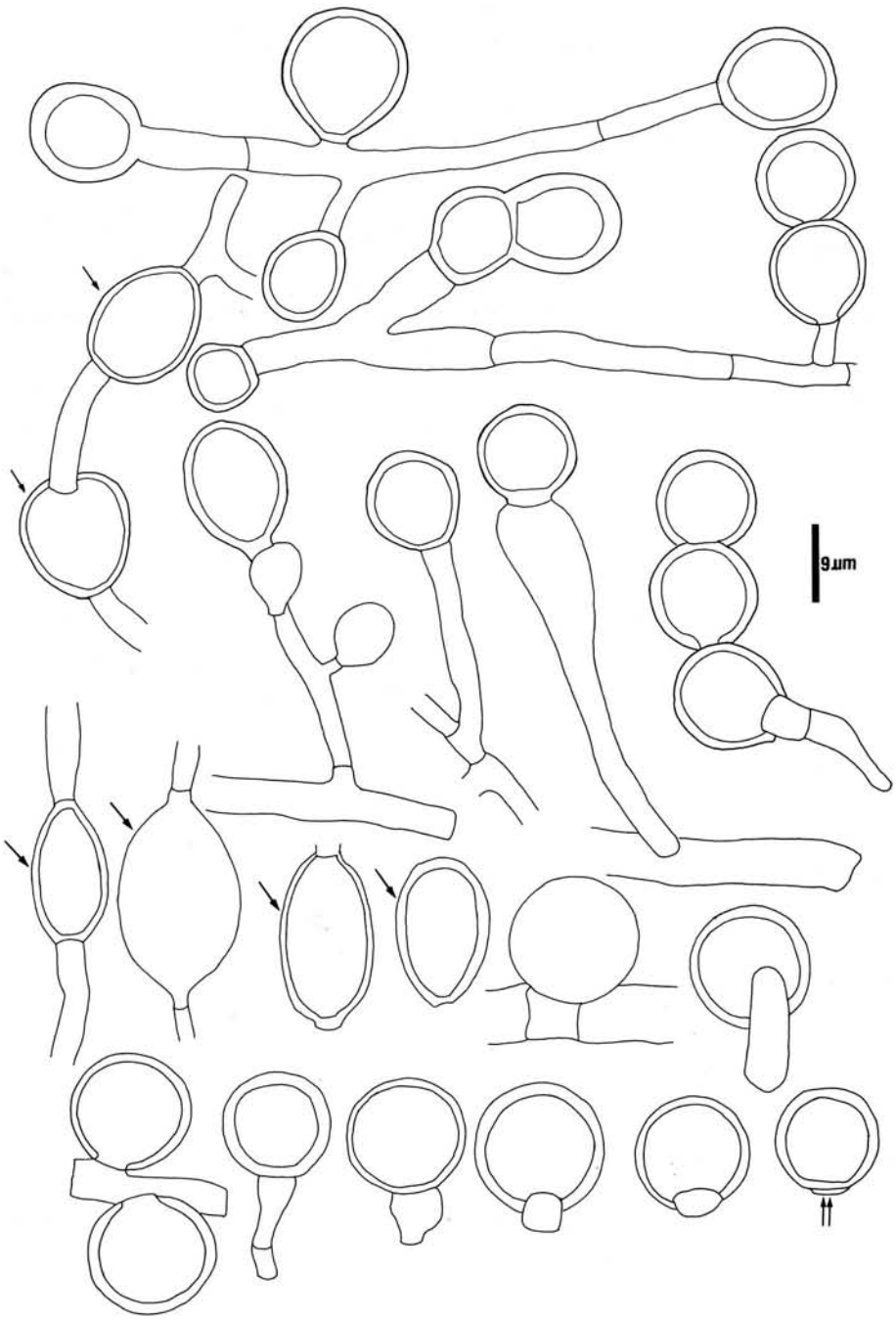

Fig. 1. *Humicola insolens* var. *thermoidea* (Chen 8608-37). Conidia and chlamydospores (arrow). Apiculum (double arrow).

Specimen examined: Corn field soils (low land) at Che-Cherng Hsiang, Pingtung County, Taiwan, 10.VIII.1986, K-Y Chen 8608-37.

Temperature tests: The optimum temperature of growth is between 30℃ and 50℃. The same temperature range is for sporulation (Table 1)

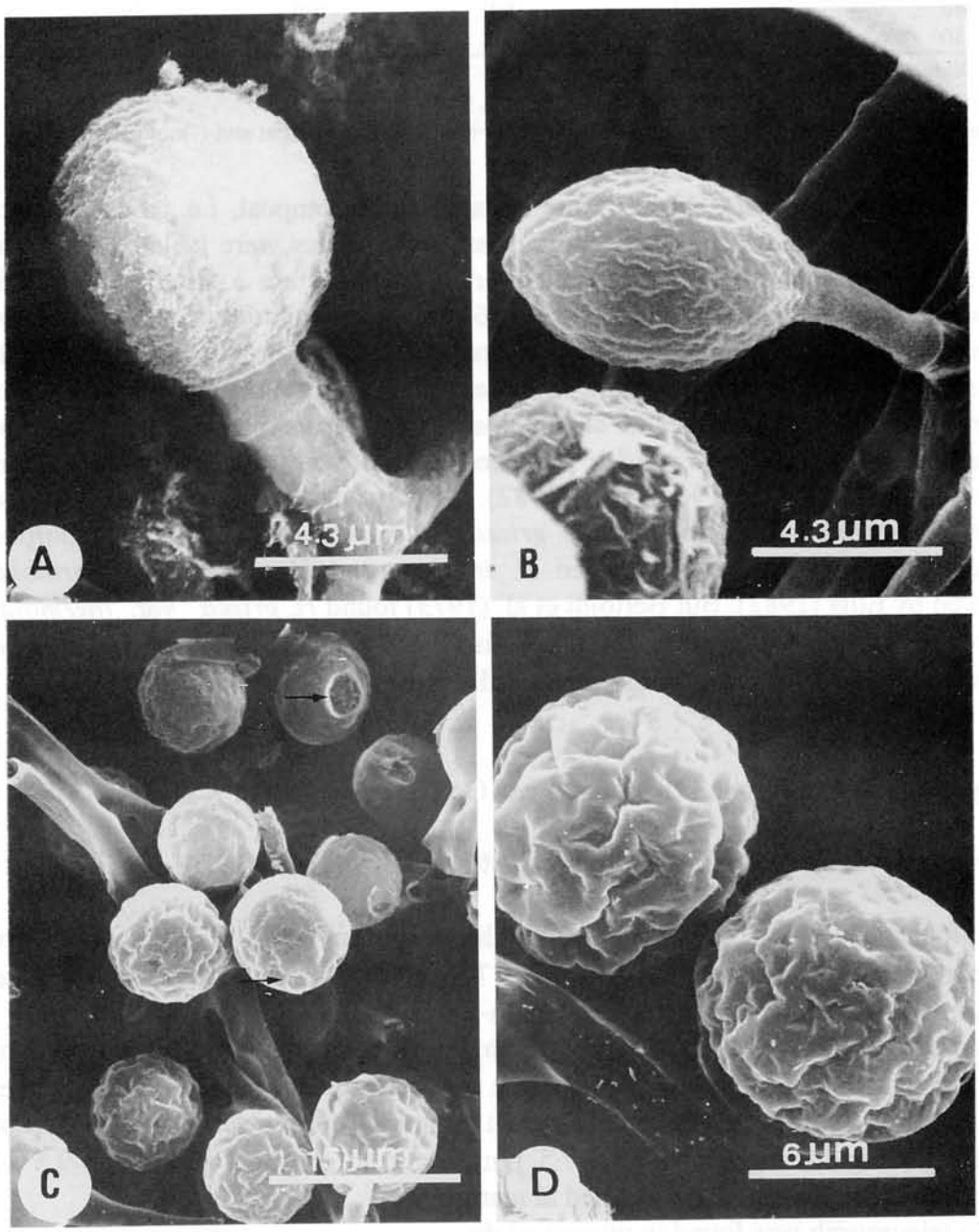

Fig. 2. *Humicola insolens* var. *thermoidea* (Chen 8608-37). A-D. Conidia. C. Detached scar (arrow). (A-D: Under SEM).

Table 1. Radial growth and conidia formation of *Humicola insolens* var. *thermoidea* (Chen 8608-37) on YpSs medium at various temperature.

Temperature	Mycelial growth (mm)			Conidia	
(°C)	3d	6d	9d	6d	9d
20	0	0	0	-	-
25	0	10	30	-	+
30	27	55	81	++	+++
35	43	82	full*	+++	++++
40	54	full	full	+++	++++
50	44	78	full	++	+++

*: Diameter of petri dish: 85mm

Mycelial growth: Colony diameter (mm) after 3, 6, 9 days (d).

Conidia: (++++)very abundant; (+++)abundant; (++)moderate; (+)slight and (-)not produced.

Note: Most of *Humicola* species were isolated from compost, i.e., mushroom compost, horse manure, waste compost, etc. In contrast, our isolates were isolated from corn field soils . Both *H. insolens* and *H. griseus* var. *thermoidea* are a similiar taxon. However, Cooney and Emerson (1964) and Fergus (1964) made distinction of both taxa by following characters: (1) distribiution of chlamydospores: *H. insolens* produces abundant chlamydospores on both aerial and substrate mycelia, and *H. grisea* var. *thermoidea*, mostly on substrate mycelia; (2) number of chlamydospores: *H. insolens* produce 15-30 spores, in contrast *H. grisea* var. *thermoidea* produced 2-4 spores in a short chain (Cooney and Emerson, 1964; Fergus, 1964; Ellis, 1982). But Awao and Otsuka (1974) suggested *H. insolens* was probably a synonym of *H. grisea* var. *thermoidea*. The obvious morphological and ultrastructural similarity between *H. insolens* and *H. grisea* var. *thermoidea* was observed by Ellis (1982). But Bertoldi et al. (1973) found *H. grisea* var. *thermoidea* have difference in GC content of up to 13%. Ellis (1982) changed *H. grisea* var. *thermoidea* to *H. insolens* var. *thermoidea*. In this study, Ellis' treatment was followed.

2. **Myceliophthora fergusii** (Klopotek) van Oorschot, Persoonia 9: 406 (1977).

Chrysosporium fergusii Klopotek, Arch. Mikrobiol. 98: 366. (1974). Fig. 3 and 4

Colonies on YpSs grow rapidly, reaching 76 mm at 40 °C in 3 days; irregularly scattering in groups, floccose or powdery; The color shows white at first, Seashell Pink, then turn to Pinkish Buff; reverse Cinnamon-Buff.

Hyphae smooth-walled, septate. Fertile hyhpae unbranched or irregularly side branched up to 5.8 μm in width. Blastic conidia pale yellowish green, born terminal or laterally on fertile hyphae, sessile or 1-3 conidia grown on ampulliform swelling on short protrusions; conidia globose to subglobose, (4.5-7.5 μm), ovoid to elliptical (5-8 x 5.6-9.5 μm) with smooth at young, few slightly roughed at maturity.

No teleomorph was found in present study.

Specimen examined: Legume field soils (low land) at Yunlin Hsien, Yunlin County, Taiwan, 4.IV.1985, K-Y Chen 8504-11.

Temperature tests: The optimum temperature of growth and conidium production is between 35°C and 50°C. The minimun temperature is 25°C (Table 2).

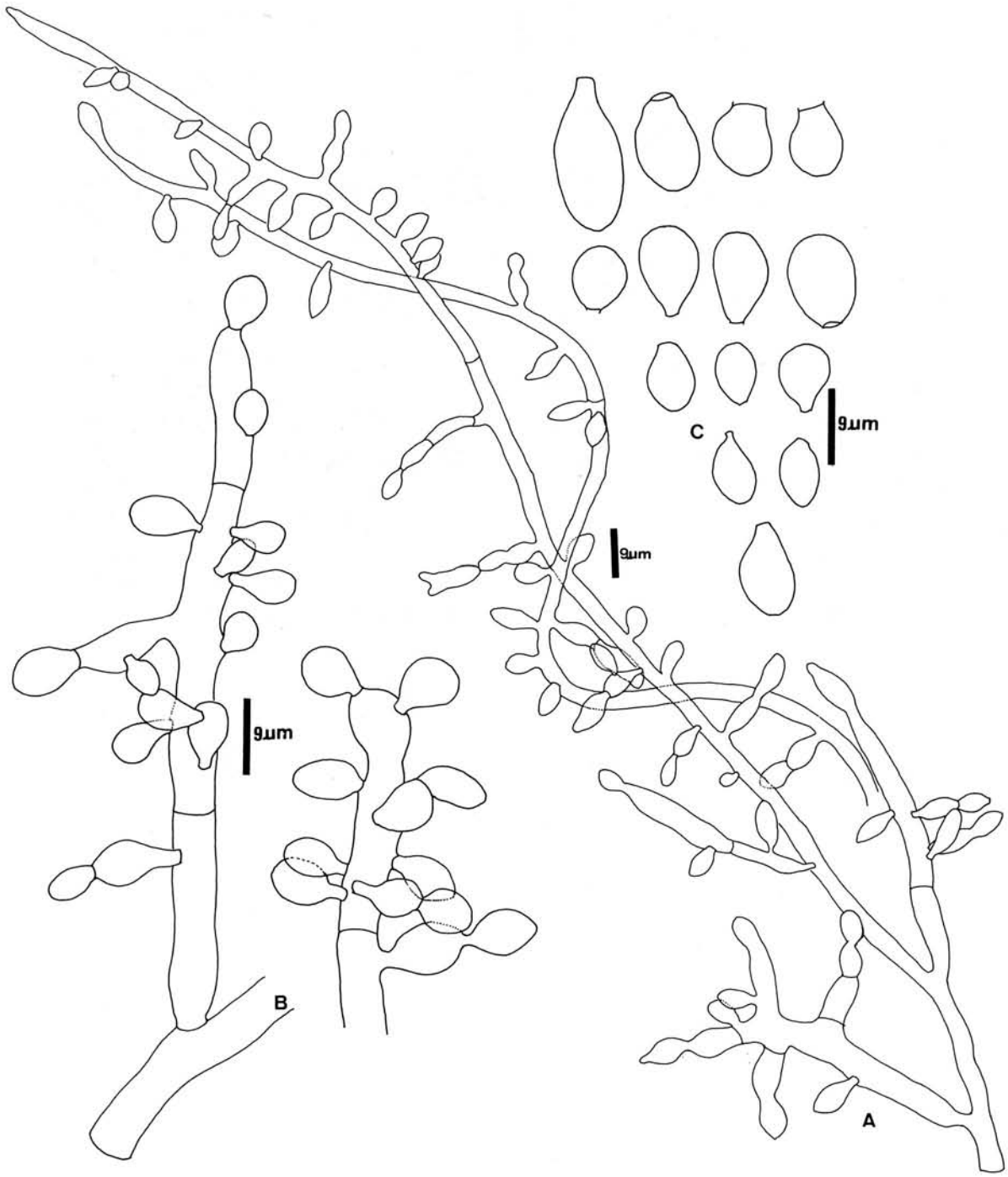

Fig. 3. ***Myceliophthora fergusii*** (Chen 8504-11). A and B. Conidiophores. C. Conidia.

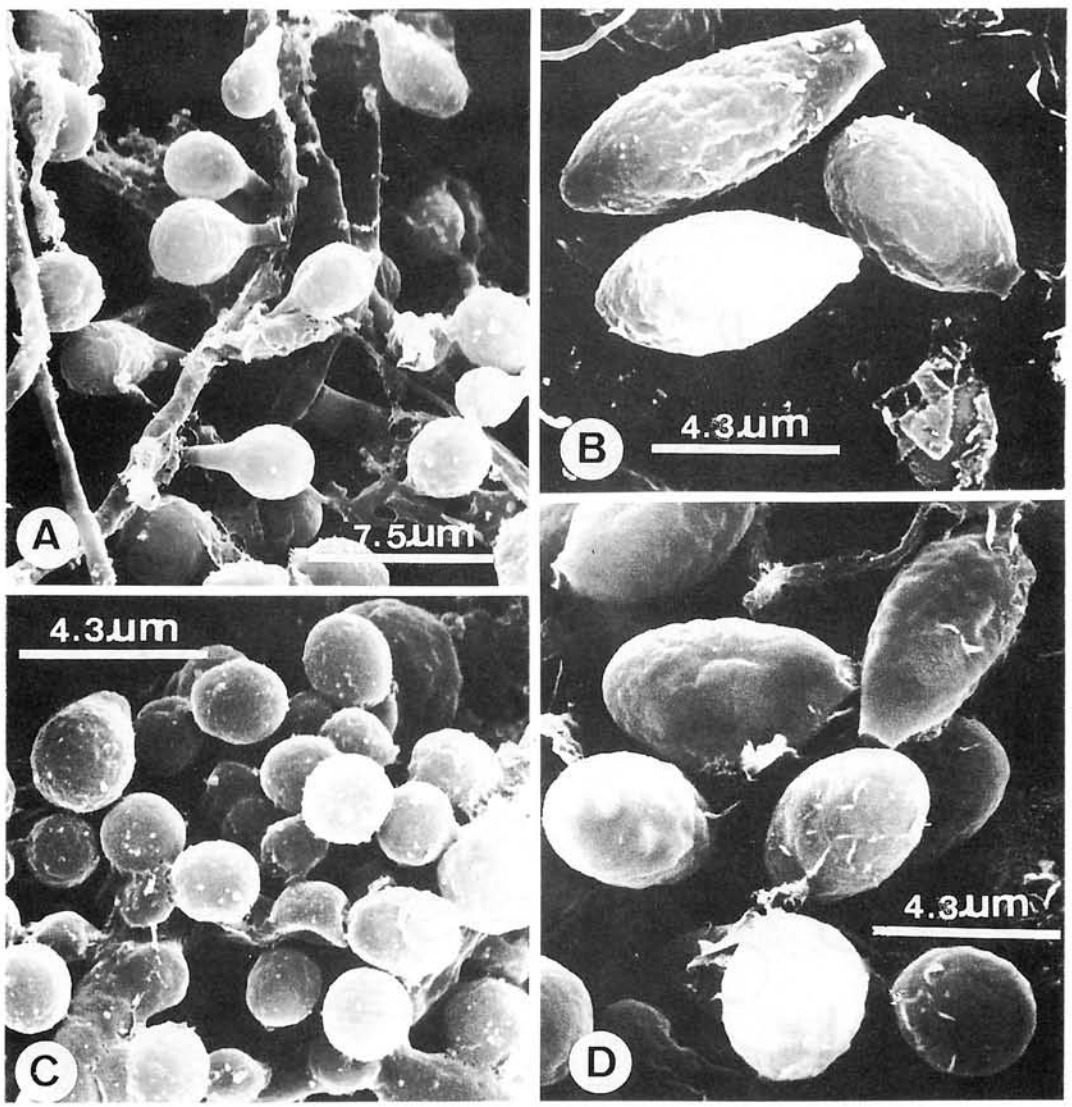

Fig. 4. ***Myceliophthora fergusii*** (Chen 8504-11). A-D. Conidiogenous cell and conidia (Under SEM).

Table 2. Radial growth and conidia formation of *Myceliophthora fergusii* (Chen 8504-11) on YpSs medium at various temperature.

Temperature	Mycelial growth (mm)			Conidia	
(°C)	3d	6d	9d	6d	9d
20	0	0	0	-	-
25	0	3	12	-	+
30	13	47	67	+	++
35	43	81	full*	+++	++++
40	76	full	full	+++	++++
50	45	75	full	++	++

*: Diameter of petri dish: 85 mm.

Mycelial growth: Colony diameter (mm) after 3, 6, 9 days (d).

Conidia: (++++) very abundant; (++) abundant; (++) moderate; (+) slight and (-) not produced.

Note: It is a thermophilic fungus (Table 2) and new record from Taiwan. *M. fergusii* has a known teleomorph: *Corynascus thermophilus* (Fergus & Sinden) Klopotek, but teleomorph stage of this isolate has not been observed. Morphology of *M. fergusii* is similar to *M. thermophila,* but have the following differences: (1) conidial wall of *M. fergusii* are smooth (van Oorschot, 1980), while *M. thermophila* are smooth at young, and predominately warty structure at maturity. (2) the fertile hyphae of *M. fergusii* are wider than those of *M. thermophila. M. fergusii* are up to 6 μm and *M. thermophila* are < 4 μm (Klopotek,1974, 1976; van Oorschot, 1980).

3. **Myceliophthora hinnulea** Awao & Udagawa, Mycotaxon 15: 436-440 (1983).
Fig. 5 and 6

Colonies on YpSs grow very well attaining 80 ㎜ at 40℃ in 6 days, dense, floccose, convolate at the center with abundant conidia on the aerial and basal hyphae. The color white at first, Buff Pink, Vinaceous Tawny, turning to Cinnamon-Brown by spores maturation; reverse Vinaceous Russet, Terra Cotta, Onion-Skin Pink, then turn to Neutral red with black spot. Exudate small droplets, adhere to the surface of mycelia, mainly at the center.

Hyphae smooth walled, hyaline or pale green, 2.5-5 μm, the site of septa or branch appear turning to dark. Conidia borne terminally or laterally on fertile hyphae, short or long pedicel 2.0-5 x (2.2-) 5.5-28 (-38) μm.

Blastic conidia solitary or 1-3 growing on an ampulliform swelling, hyaline at first, pale yellow, pale brown, brown, then turning to black brown, rough, thick-walled conidia. Conidia globose to subglobose or pyriform, smooth, hyaline at young, becoming spiny, hyaline, then turning to irregular and conspicuous spinulose-verrucose wall.

Specimen examined: Soybean field soils (low land) at Taitung Hsien, Taitung county, Taiwan, 5.IV.1987, K-Y Chen 8709-1.

Temperature tests: It is a thermophilic fungus. The optimum temperature is between 40℃ and 50℃, no growth at 25℃. Sporulation is very abundant between 40℃ and 50℃ (Table 3).

Table 3. Radial growth and conidia formation of *Myceliophthora hinnulea* (Chen 8709-1) on YpSs medium at various temperatures.

Temperature	Mycelial growth (㎜)			Conidia	
(℃)	3d	6d	9d	6d	9d
20	0	0	0	-	-
25	0	0	0	-	-
30	0	0	19	-	++
35	20	46	77	+	++++
40	37	68	full*	++	++++
50	47	80	full	++	++++

*: Diameter of petri dish: 85 mm.
Mycelial growth: Colony diameter (mm) after 3, 6, 9 days (d).

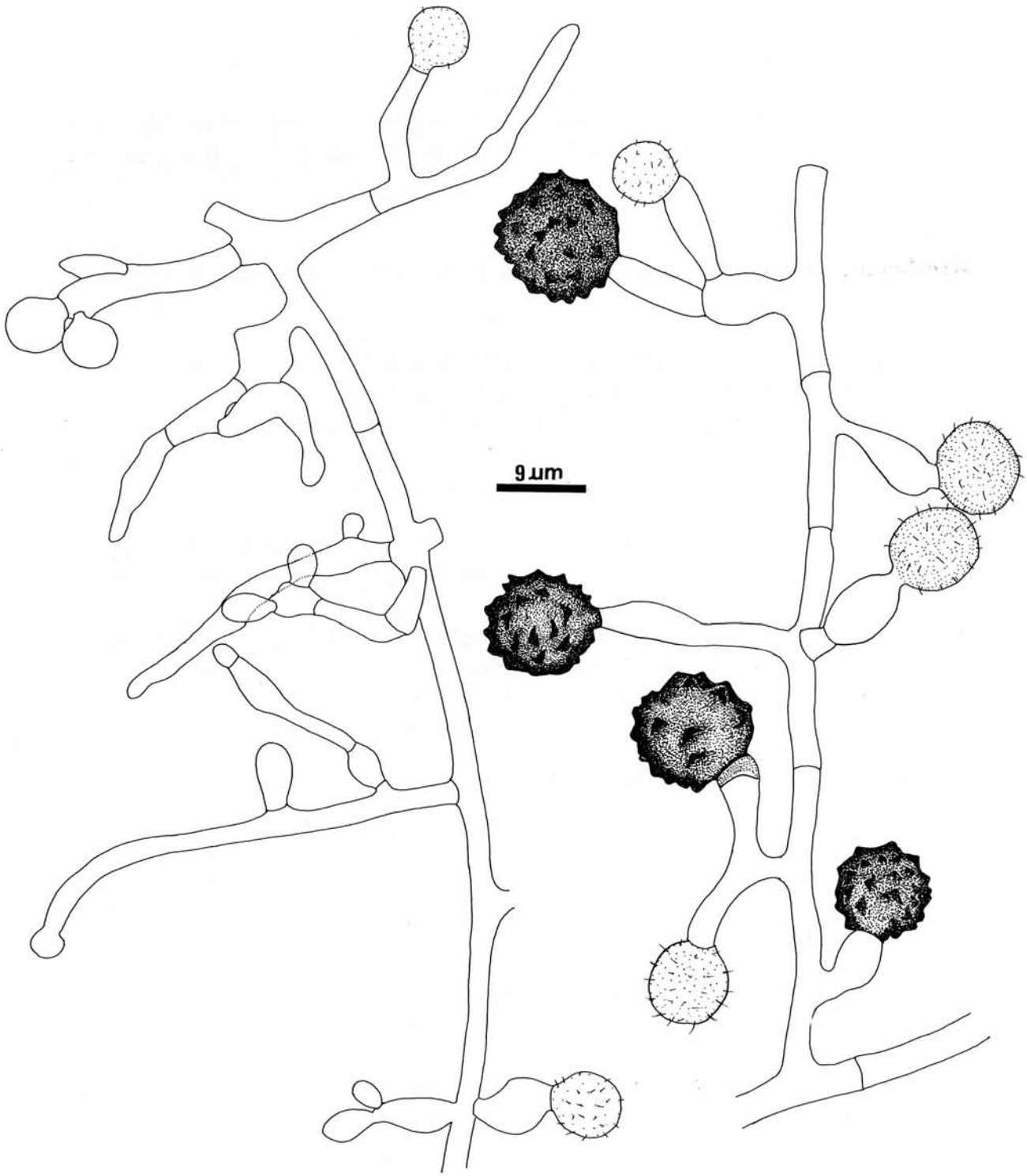

Fig. 5. *Myceliophthora hinnulea* (Chen 8709-1). Conidiophores and conidia.

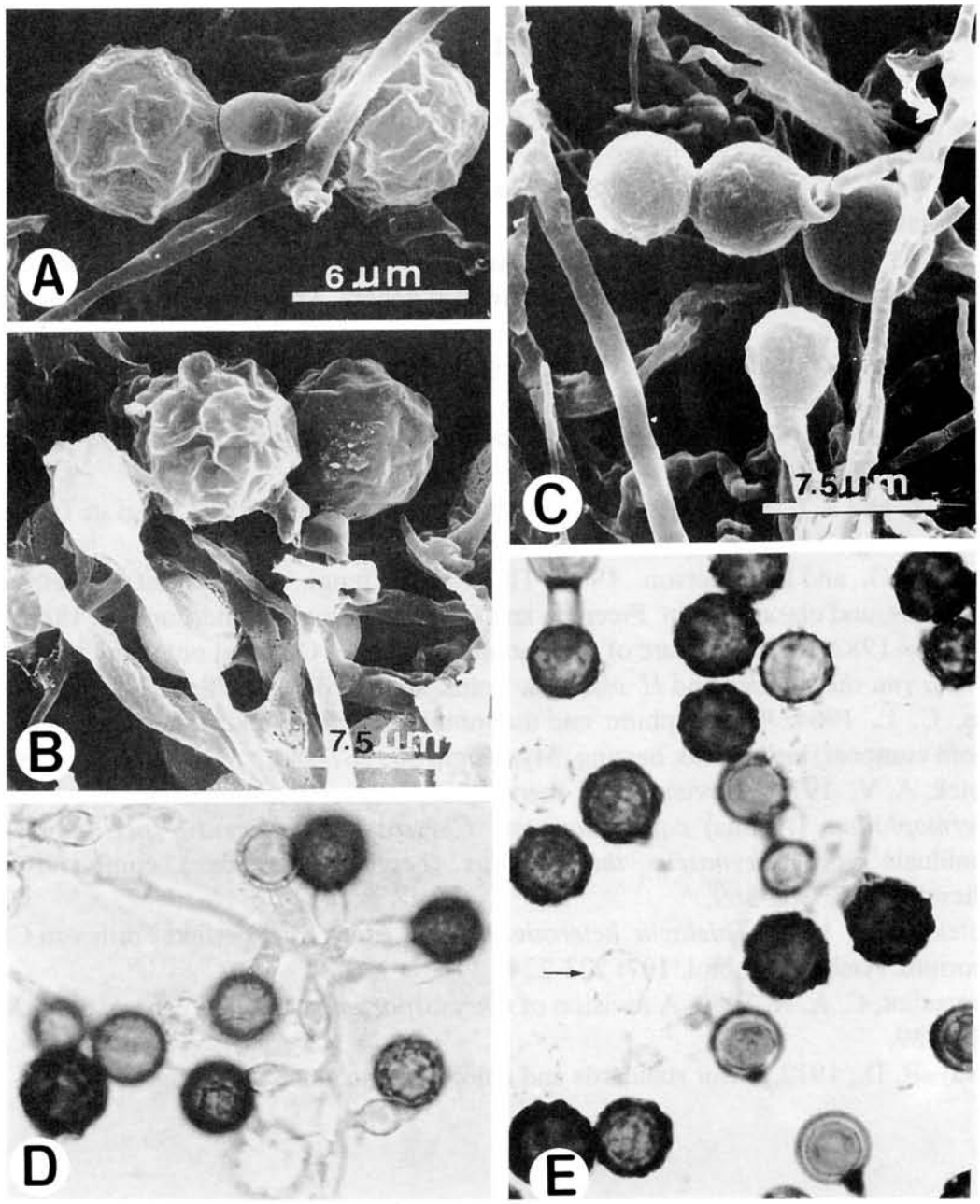

Fig. 6. *Myceliophthora hinnulea* (Chen 8709-1). A-E. Conidiogenous cell and conidia. E. Conidia with spine (arrow). (A-C: Under SEM; D-E: Under LM).

Note: It is a new record from Taiwan. Based on the morphology of colonies and conidia, such as color, shape and ornamentation. This isolate is identified as *M. hinnulea* Awao & Udagawa (1983). Additionally, two more species of *Myceliophthora* have been isolated from field soils, i.e. *M. thermophila* (Apinis) van Oorschot, the anamorph of *Thielavia heterothallica* and *M. fergusii* (Klopotek) van Oorschot. *M. hinnulea* differs from these two species by having black brown, conspicuous verrucose-spinulose conidia, and a narrower temperature range.

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三種臺灣新紀錄的嗜熱性眞菌

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摘　　要

分別從臺灣屏東、雲林、臺東地區之田土分離出三種嗜熱性眞菌，*Humicola insolens* (Cooney & Emerson) var. *thermoidea* (Cooney & Emerson) Ellis, *Myceliophthora fergusii* (Klopotek) van Oorschot 和 *Myceliophthora hinnulea* Awao & Udagawa, 皆爲臺灣菌類相之新紀錄種。

關鍵語：嗜熱性眞菌,不完全菌，*Humicola insolens* var. *thermoidea*，*Myceliophthora fergusii*，*Myceliophthora hinnulea*。

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