

THERMOPHILIC AND THERMOTOLERANT FUNGI IN TAIWAN (II)

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Abstract: Additional thermophilic fungus, *Rhizomucor miehei* (Cooney and Emerson) Schipper and thermotolerant fungus, *Rhizopus microsporus* v. Tiegh. var. *rhizopodiformis* (Cohn) Schipper and Stalpers isolated from the paddy soil of Tai-Tung area of Taiwan are reported in this paper. Both species are new record to Fungal Flora of Taiwan.

In the previous paper, six species of thermophilic and two species of thermotolerant fungi were reported from Taiwan. In recent collection of soil samples from the eastern part of this island, additional species of thermophilic and thermotolerant fungi are isolated. The research method applied in this investigation are followed the procedures described in the previous paper (Chen and Chen, 1988). All cultures described in this report have been deposited in the Mycological laboratory, Department of Botany, National Taiwan University.

1. *Rhizopus microsporus* v. Tiegh. var. *rhizopodiformis* (Cohn) Schipper and Stalpers. *Stud. Mycol.* 25: 30, 1984. Figure 1 & Plate 1

Colonies on PDA growing all plates in 3 days at 40°C, white, gray-black; erect hyphae with sporangiophores reached to the cover of plate, with grayish black sporangia; reverse maize yellow. Sporangioophores arising from the stolons, wall smooth, brown, gradually turning to pale brown, hyaline from the base to the tip, some have septa, mostly 1-3 together, rarely 4, 364 (-400) × 7.8 (-9) μm, with simple rhizoids, some without rhizoid; rhizoids brown, gradually turning to pale color, or colorless and hyaline till the apex. Sporangia smooth, globose, pale grayish green, turning to brown at maturity, 53.2-92.4 × 54.6-86.8 μm, the smallest up to 36 μm in diam. the largest up to 105 μm in diam. Columellae wall smooth, pyriform to ellipsoid, globose, subglobose, some have collars, pale gray to hyaline, 33.6-51.8 × 36.4-68.6 μm; columellae of single sporangiophore usually larger than those of 2-3 together. Sporangiospores globose, subglobose or polygonal, possessing spine structure on the surface, pale green, up to 4.5 (-5.5) μm in diam. Chlamydospores thick walled, globose, ovate or irregular in shape, pale green, 33-36.4 μm in diam. Zygosporangia not observed.

Habitat: Field soils of Taitung area of Taiwan (TAI-14T55).

Temperature: Temperature range for the mycelial growth of this fungus is very wide, 16-50°C show good growth. At 25-40°C, sporangia are produced abundantly. It is a thermotolerant fungus.

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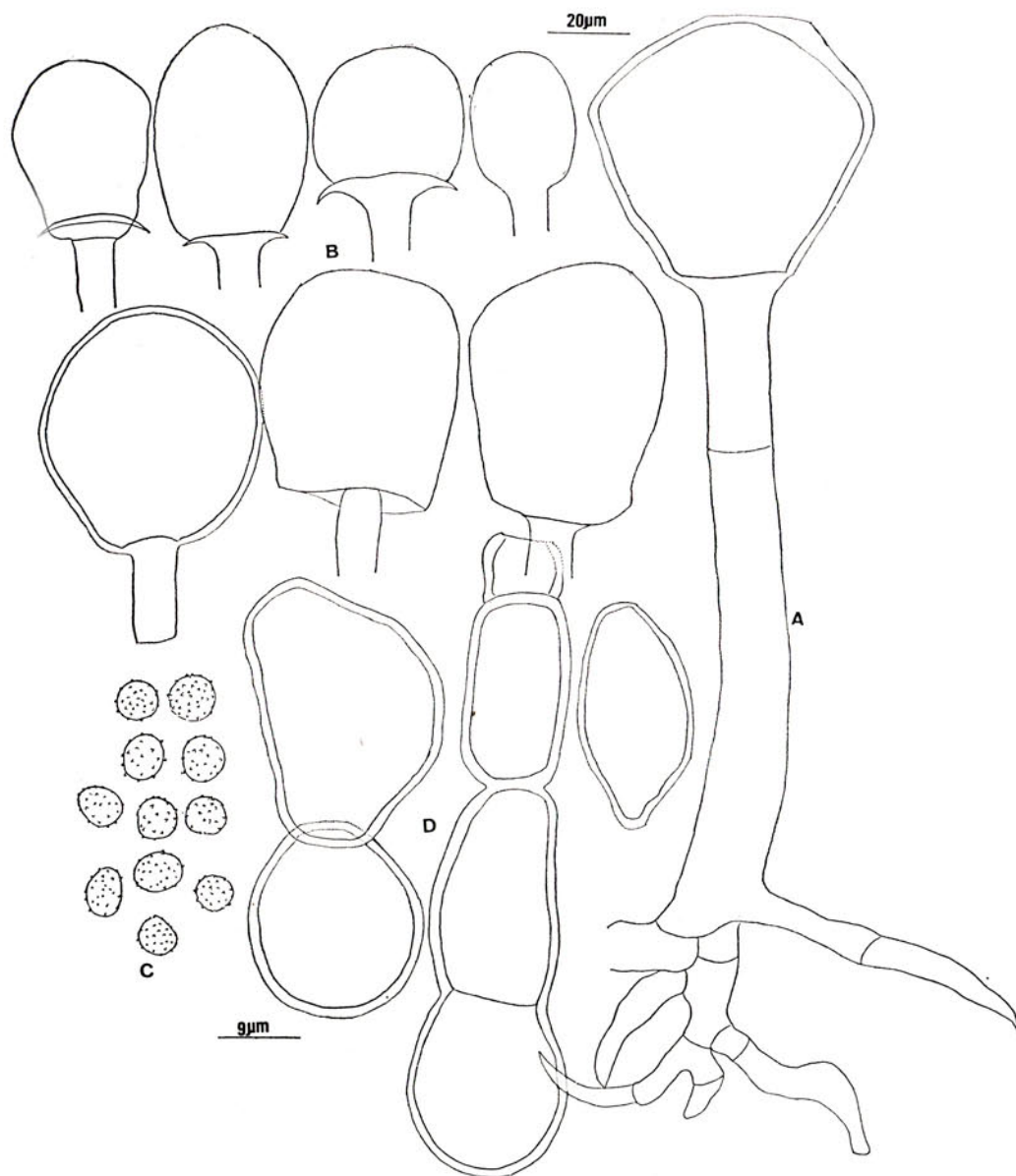


Fig. 1. *Rhizopus microsporus* v. Tiegh. var. *rhizopodiformis* (TAI-14T55).
 A. Sporangiphore with simple rhizoids; B. Columellae;
 C. Sporangiospores; D. Chlamyospores.

The rate of growth on PDA:

Day	Temp. (°C)	Diameter of mycelial colony (in mm)						
		16	20	25	30	35	40	50
2	—		20	34	44	71	73	18
3	14		37	54	68	85	85	26
6	36		full*	full	full	full	full	74

*: Diameter of plate: 85 mm.

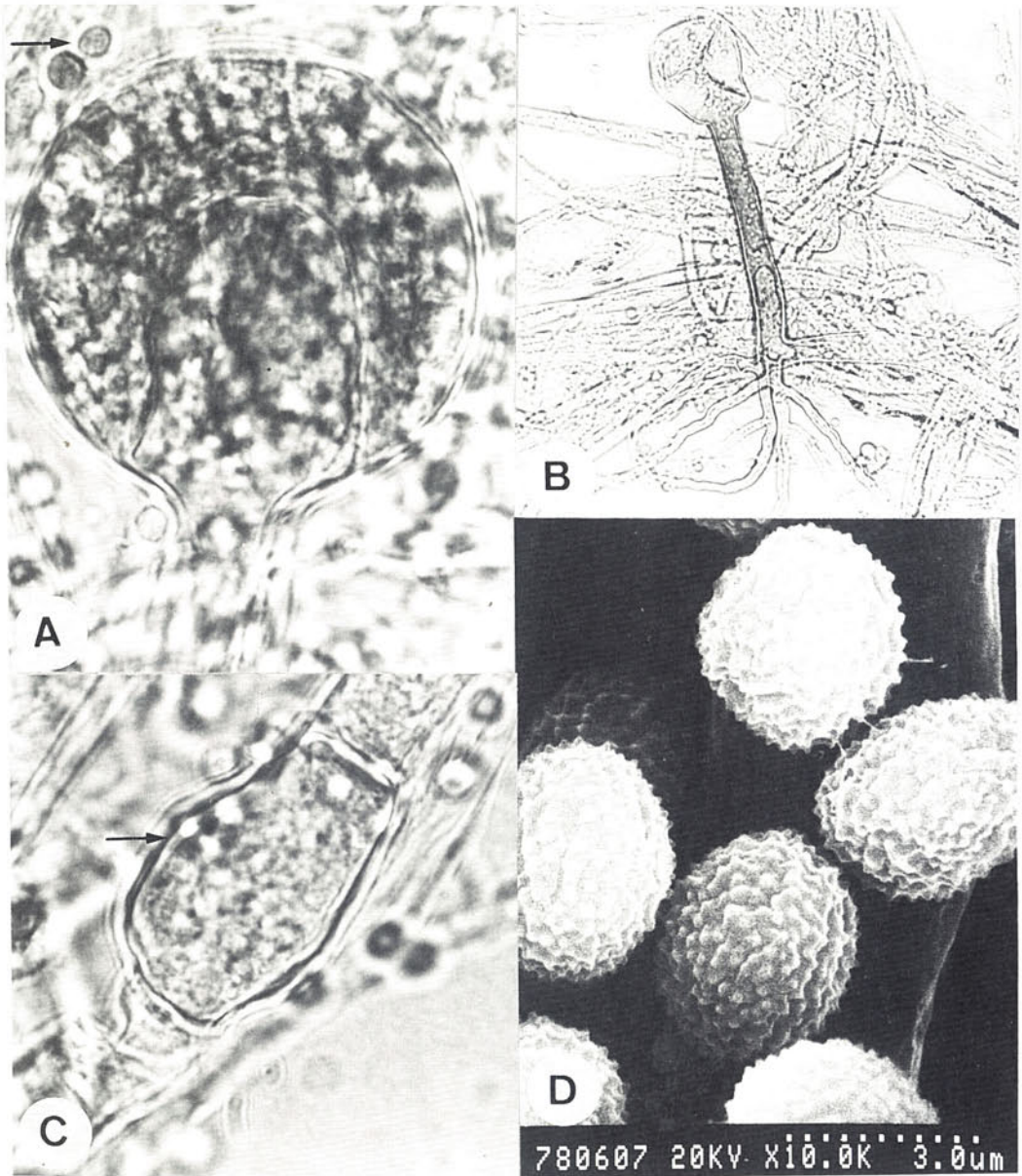


Plate 1: *Rhizopus microsporus* v. Tiegh. var. *rhizopodiformis*. (TAI-14T55).

- A. Sporangium with sporangiospores (arrow). ($\times 1000$)
- B. Sporangiophores with rhizoid. ($\times 200$)
- C. Chlamyospore (arrow).
- D. Sporangiospores (under SEM). ($\times 10000$)

Note: Ellis (1981) used the SEM to distinguish the spore ornamentation of the *Rhizopus* and related genera, such as *Rhizomucor*. The spore ornamentation of *Rhizopus microsporus* var. *rhizopodiformis* as shown in Plate 1-D, is with distinct fine protrusions which is identical to the description of *R. rhizopodiformis* by Ellis (1981).

2. *Rhizomucor miehei* (Cooney and Emerson) Schipper, Stud. Mycol. 17: 58, 1978.

Figure 2 & Plate 2.

Colonies on PDA growing well, reaching all plates in 3 days at 40°C, white at first, turning to Pale Mouse Gray*, Olive-Gray*; reverse Marguerite Yellow*. At 50°C, white, margin irregularly undulate; reverse Empire Yellow* to Pale Yellow* or Marguerite Yellow. Vegetative hyphae have rhizoids but developed poorly, hyaline, not limited under the sporangiophores. Sporangiophores smooth, some have crystals, grown from any site of vegetative mycelia, branched loosely in sympodial, with or without septa. Sporangia are globose, subglobose, Pale Yellow-Green*, turning to pale brown, brown at maturity, 23-31×22-34 μm. At 30°C, sporangia slightly larger, 28-35.2 μm in diam. Columellae smooth, globose, subglobose, ellipsoid, rarely pyriform-ellipsoid or umbrella-shaped, 13.4-30.7×12.2-36.5 μm. Sporangiospores smooth, globose, subglobose, ellipsoid or irregular in shape, pale green, 3.8-5.1 μm in diam. Zygospores homothallic, globose, subglobose, first pale grayish green then to yellowish brown or dark brown, 25.6-42.9×27.5-44.8 μm. Suspensors equal, conical.

Habitat: Field soil of Taitung area of Taiwan (TAI-14T510).

Temperature: Growth and sporulation only at 25-50°C; at 20°C, extremely slow growth; at 40°C, abundant sporangia and zygospores; at 50°C, form sporangia sparsely. Zygospores are formed at 30°C, 35°C and 40°C.

The rate of growth on PDA:

Day	Temp. (°C)	Diameter of mycelial colony (in mm)						
		16	20	25	30	35	40	50
2	—	—	—	—	32	75	83	66
3	—	—	—	8	44	full*	full	80
6	—	—	7	27	full	full	full	82

*: Diameter of plate: 85 mm.

Note: The formation of zygospore is very similar to that of *Rhizopus stolonifer* (Ehrenb: Fr.) Vuill reported by Ho (1988). Two opposite zygophores contact, fuse and swell, accordingly their shape changed from cylindrical to globose. The suspensor also swell following the mating of gametangia. The outer wall of zygospores eventually cracking, the warts protruding and continuously enlarge until the shape of warts changing to blunt spines (Plate 2-F). According to Schipper and Stalper (1978), some strains of *Rhizomucor pusillus* and *Rh. miehei* are homothallic. Therefore the homothallism could not be used as the key character for distinguishing two species. Instead, the zygospore size should be regarded as a key character in distinguishing two species. In our previous report, *Rh. pusillus* was isolated from the San-Tzu area of Taiwan (Chen and Chen, 1988) but no

*: After Ridgway's (1912).

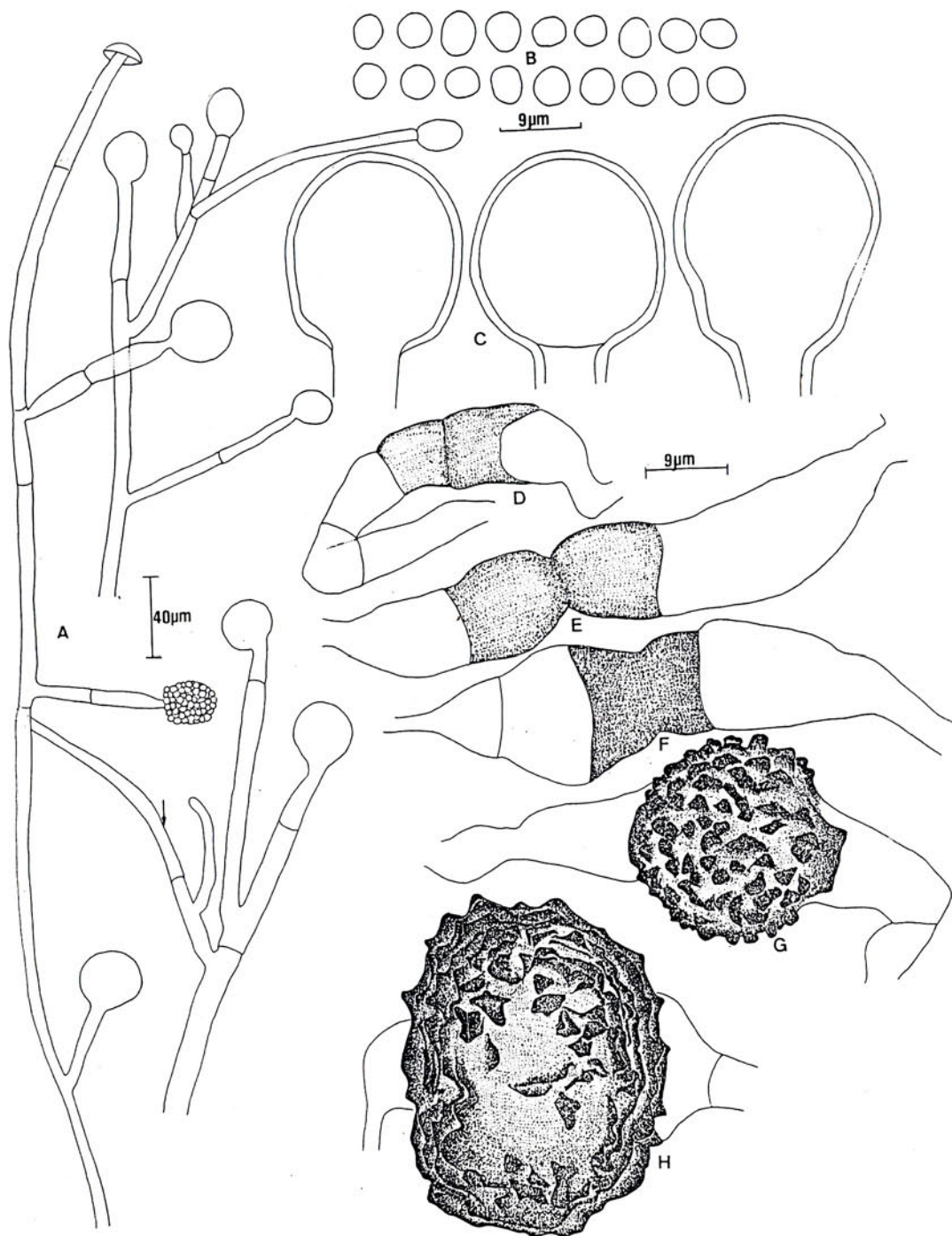
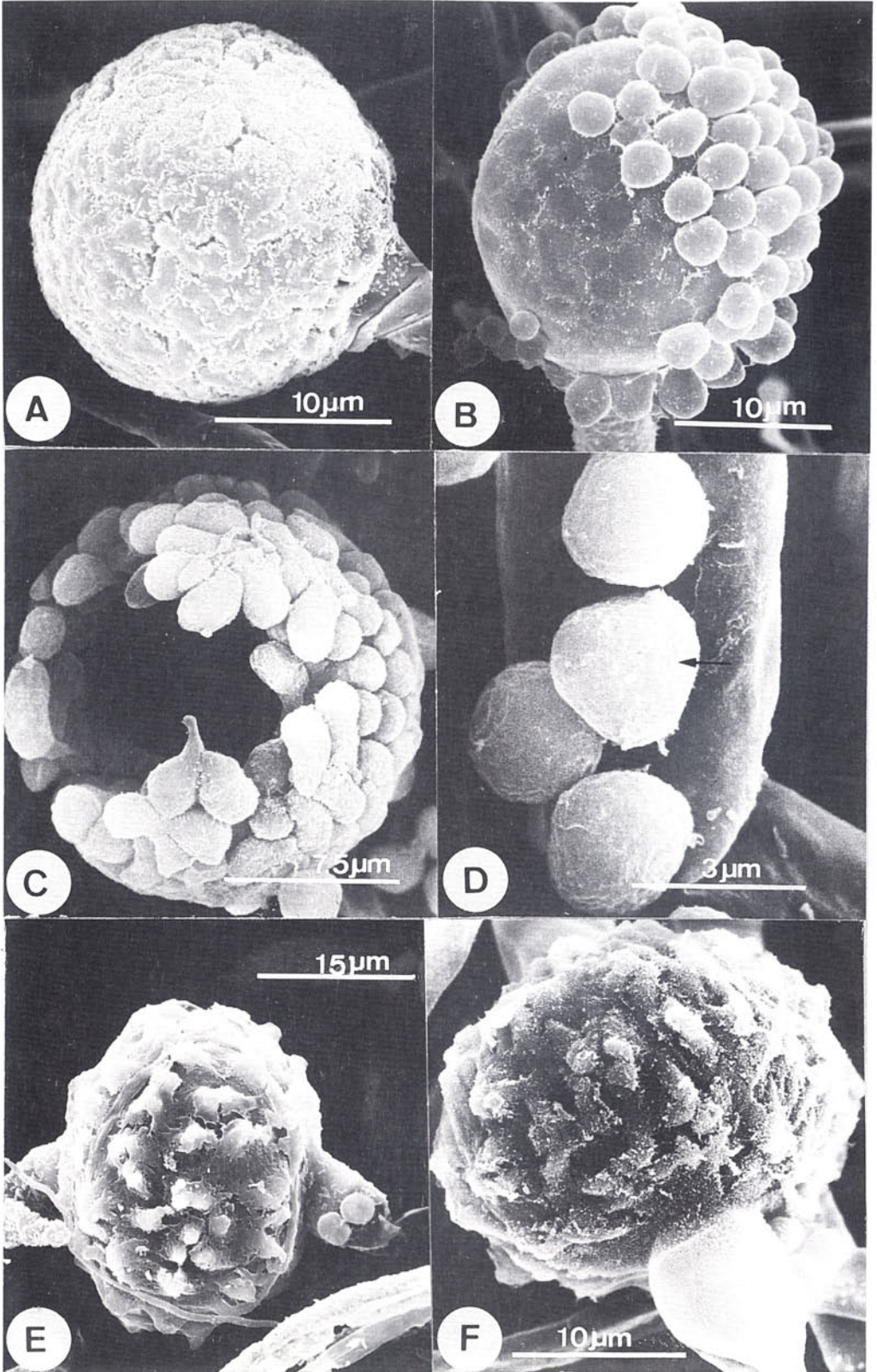


Fig. 2. *Rhizomucor miehei* (TAI-14T510).

A. Sporangiophore with rhizoids (arrow). B. Sporangiospores.
C. Columellae. D-H. The development of zygosporangium



zygospore was observed. The two species of *Rhizomucor* isolated from Taiwan are thus distinguished mainly by branching pattern of sporangiophores, sporangium size, and slightly different requirement of growth temperature. Although this species isolated from Taiwan can grow poorly at 20°C, it is still considered to be a thermophilic fungus.

ACKNOWLEDGEMENTS

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臺灣嗜熱性和耐熱性真菌之調查 (II)

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摘 要

從臺灣之臺東地區稻田土壤中分離出嗜熱性真菌一種，*Rhizomucor miehei* (Cooney and Emerson) Schipper，及耐熱性真菌一種，*Rhizopus microsporus* v. Tiegh. var. *rhizopodiformis* (Cohn) Schipper and Stalpers，皆為臺灣菌類相之新記錄。

Plate 2: *Rhizomucor miehei* (TAI-14T510).

- A. Sporangium with disrupted membrane.
- B. Columella with few spores adhesion.
- C. Group of sporangiospores.
- D. Sporangiospores (arrow).
- E-F. The development of zygosporangium. (A-F: under SEM)