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**Materials for Pythium Flora of Japan (V)**  
**Three species of *Pythium* from soil of a vegetable garden in winter**

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**Abstract**

In winter, 1991, one hundred eighty-seven isolates of *Pythium* were obtained from soil of a vegetable garden and from damped-off spinach (King of Denmark) seedlings sown in the soil. Three species (*P.rostratum* Butler, *P.spiniosum* Sawada, *P.ultimum* Trow var. *ultimum*) are selected to be described and illustrated.

During a survey of pathogenic and non-pathogenic *Pythium* spp. in soil of a vegetable garden of our University Farm in winter, 1991, one hundred eighty-seven isolates were obtained<sup>1)</sup> and maintained as described previously<sup>2)</sup>. Among these isolates, one isolate of *P.rostratum* Butler, two isolates of *P.spiniosum* Sawada and three isolates of *P.ultimum* Trow var. *ultimum* were described and illustrated, following methods described previously<sup>3)</sup>.

*Pythium rostratum* (Plates I-III)

This fungus was first reported in Japan by Watanabe<sup>4,5)</sup>, but no detailed description was provided. A full description follows.

Colonies showing a chrysanthemum pattern without aerial mycelium, thin on Bacto-CMA, thick on Bacto-PDA (Plate I). Main hyphae up to 7  $\mu$ m wide, septate when old. Appressoria irregular, often catenulate. Hyphal swellings or sporangia limoniform, globose, up to 32  $\mu$ m, intercalary or terminal. Zoospores not formed, germination by germ tube. Oogonia smooth, subglobose, often in chains, mostly intercalary, 25-30  $\mu$ m, average 28  $\mu$ m, provided with 1, rarely 2 projections. Antheridia 2(-4) per oogonium, crook-necked, hypogynous, sometimes lateral, monoclinal, sessile, occasionally stalked, rarely branched, persisting after fertilization. Oospores plerotic, 22-29  $\mu$ m, average 25  $\mu$ m diam.; wall less than 2.0  $\mu$ m; oosphere rarely abortive.

Cardinal temperatures: minimum about 7°C, optimum 25-28°C, maximum 31°C. Daily mycelial growth on Bacto-CMA at 25°C 10 mm.

Description: based on UOP 383 (=IFO 32421, MAFF 02-35796).

Isolation: on VP<sub>3</sub> medium<sup>6)</sup> selectively from soil of a vegetable garden, University Farm, University of Osaka Prefecture, Mozu-umemachi, Sakai, Osaka, Feb.20, 1991, by E. Nakazono.

Host range: not examined.

*Pythium spiniosum* (Plates I, IV-V)

This fungus was originally described by Sawada and Chen<sup>7)</sup> in Taiwan, and has since occurred very commonly in Japan<sup>8-15)</sup>. A detailed description is as follows.

Colonies showing a radiate pattern with aerial mycelium, thin on Bacto-CMA, thick on Bacto-PDA (Plate I). Main hyphae up to 10  $\mu\text{m}$  wide, septate when old. Hyphal swellings or sporangia usually limoniform, rarely globose, up to 28  $\mu\text{m}$  diam., usually germinating by a germ tube, spherical hyphal swellings or sporangia with projections sometimes germinating, intercalary, rarely terminal. Oogonia globose, rarely fusiform, intercalary, rarely terminal, 23–29  $\mu\text{m}$ , average 25  $\mu\text{m}$  diam., provided with a varying number of blunt, digitate projections, 2.0–13.0  $\mu\text{m}$  long and 2.0–4.5  $\mu\text{m}$  diam. at the base. Antheridia usually 1, sometimes 2 per oogonium, originating at various distances from the oogonium, clavate, crook-necked, making apical contact with the oogonium, predominantly monoclinal, sometimes declinal, soon disappearing after fertilization. Oospores plerotic, 20–26  $\mu\text{m}$ , average 22  $\mu\text{m}$  diam.; wall up to 2.0  $\mu\text{m}$  thick.

Cardinal temperatures: minimum 4–7°C, optimum 31°C, maximum 34°C. Daily mycelial growth on Bacto-CMA at 25°C 23 mm.

Description: based on UOP 384 (=IFO 32422, MAFF 02-35797), UOP 385 (=IFO 32423, MAFF 02-35798).

Isolation: on VP<sub>3</sub> medium<sup>6)</sup> selectively from soil of a vegetable garden, University Farm, University of Osaka Prefecture, Mozu-umemachi, Sakai, Osaka, Feb. 20, 1991, by K. Hotta.

Host range: not examined.

#### *Pythium ultimum* Trow var. *ultimum* (Plates I, VI-VII)

This fungus was first reported in Japan by Kusakari and Tanaka<sup>16)</sup>, followed by Ichitani *et al.*<sup>17)</sup>, but no detailed description was given<sup>16,17)</sup>. It is now described as follows.

Colonies showing a radiate pattern with aerial mycelium, thin on Bacto-CMA, thick on Bacto-PDA (Plate I). Main hyphae up to 11  $\mu\text{m}$  wide, septate when old. Appressoria sickle-shaped. Hyphal swellings or sporangia globose, limoniform, terminal, rarely intercalary and lateral, up to 30  $\mu\text{m}$  diam., sometimes germinating by a germ tube. Zoospores not formed at room temperature, or even at 5°C. Oogonia usually terminal, sometimes intercalary, globose, smooth-walled, occasionally with 1 projection, 21–29  $\mu\text{m}$ , average 25  $\mu\text{m}$  diam.; antheridia 1(–2) per oogonium, sac-like, sessile, mostly monoclinal, some hypogynous, persisting after fertilization. Oospores eccentric, aplerotic, globose, 18–24  $\mu\text{m}$ , average 21  $\mu\text{m}$  diam.; wall 1.8  $\mu\text{m}$  or more thick.

Cardinal temperatures: minimum 4–7°C, optimum 25–28°C, maximum 31°C. Daily mycelial growth on Bacto-CMA at 25°C 20 mm.

Description: based on UOP 386 (=IFO 32424, MAFF 02-35799), UOP 387 (=IFO 32425, MAFF 02-35800), UOP 388 (IFO 32426, MAFF 02-35801).

Isolation: on VP<sub>3</sub><sup>6)</sup> medium selectively from soil of a vegetable garden and from damped-off spinach (King of Denmark) seedlings sown in the soil, University Farm, University of Osaka Prefecture, Mozu-umemachi, Sakai, Osaka, Mar. 14, 1991, by M. Tojo.

Host range: The isolates were parasitic on spinach (King of Denmark) seedlings under winter conditions (10°C) (Ichitani, unpublished data).

*Pythium ultimum* Trow var. *ultimum* differs from var. *sporangiiferum* mainly by its failure to produce zoospores at room temperature<sup>18)</sup>. The fungus used in this experiment produced no zoospores, even at 5°C, a temperature at which they have been reported<sup>18)</sup>. Although no experiment was done under special conditions<sup>19)</sup> or in relation to the newly proposed keys<sup>20)</sup>, this fungus is considered to *P. ultimum* Trow var. *ultimum*.

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### Explanation of Plates

**Plate I** Growth habits of *P. rostratum* UOP 383 (right), *P. spinosum* UOP 384 (center) and *P. ultimum* Trow var. *ultimum* UOP 386 (left) on Bacto-CMA (upper) and Bacto-PDA (lower) incubated at 25°C for 1 day (1), 2 days (2) and 5 days (3).

**Plate II** Morphology of *P. rostratum*.

4, 5: Mycelia. 6: Appressoria. 7-10: Hyphal swellings or sporangia. 11, 12: Germinating hyphal swellings or sporangia. 13: Oogonium with 1 projection. 14, 15: Young oogonia and antheridia. 16-25: Oogonia and antheridia. 26, 27: Oogonia in chains. 28: Oospore.

Bars (10  $\mu$ m) below figs. 4 and 28 are applicable to figs. 5, 6, 49-51 and 94-96; and the rest of figures on plates II, IV and VI, respectively.

**Plate III** Morphology of *P. rostratum*.

29, 30: Mycelia. 31: Appressoria. 32, 33: Hyphal swellings or sporangia. 34: Germinating hyphal swelling or sporangium. 35: Oogonium with 1 projection. 36, 37: Young oogonia and antheridium. 38-43: Oogonia and antheridia. 44, 45: Oogonia in chains. 46-48: Propagules in leaf tissues of bentgrass (46: hyphae extending through cell wall; 47: hyphal swelling or oogonium; 48: oospore).

Bars (20  $\mu$ m) on figs. 29, 32 are applicable to figs. 30, 31, 74-76 and 120-122; and the rest of figures on plates III, V and VII, respectively.

**Plate IV** Morphology of *P. spinosum*.

49, 50: Mycelia. 51: Appressoria. 52, 53: Hyphal swellings or sporangia. 54, 55: Germinating hyphal swellings or sporangia. 56: Young oogonium and antheridia. 57: Young oogonium (?). 58-69: Oogonia and antheridia. 70-72: Oospores. 73: Abnormal-shaped oospores.

**Plate V** Morphology of *P. spinosum*.

74, 75: Mycelia. 76: Appressoria. 77, 78: Hyphal swellings or sporangia. 79, 80: Germinating hyphal swellings or sporangia. 81: Young oogonium and antheridia. 82: Young oogonium (?). 83-87: Oogonia and antheridia. 88-90: Oospores. 91: Abnormal-shaped oospores. 92, 93: Propagules in leaf tissues of bentgrass (92: hyphae extending through cell wall; 93: oospores).

**Plate VI** Morphology of *P. ultimum* Trow var. *ultimum*.

94, 95: Mycelia. 96: Appressoria. 97-99: Hyphal swellings or sporangia. 100-102: Germinating hyphal swellings or sporangia. 103: Oogonium with 1 projection. 104, 105: Young oogonia and antheridia. 106-113: Oogonia and antheridia. 114-119: Oospores.

**Plate VII** Morphology of *P. ultimum* Trow var. *ultimum*.

120, 121: Mycelia. 122: Appressoria. 123-125: Hyphal swellings or sporangia. 126, 127: Germinating hyphal swellings or sporangia. 128: Oogonium with 1 projection. 129: Young oogonium and antheridium. 130-133: Oogonia and antheridia. 134-137: Oospores. 138, 139: Propagules in leaf tissues of bentgrass (138: hyphae extending through cell wall; 139: oospores).

**Plate I**

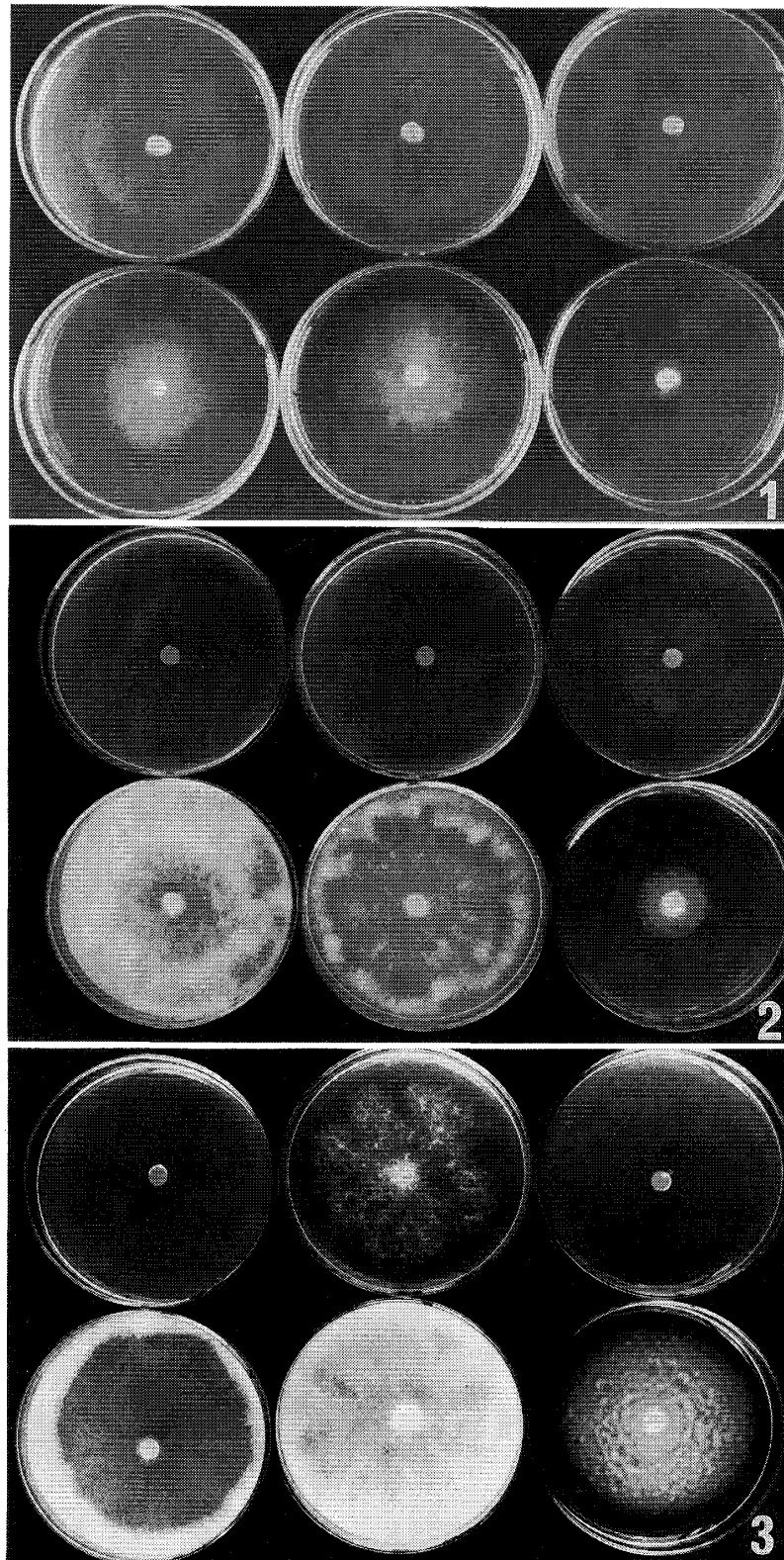
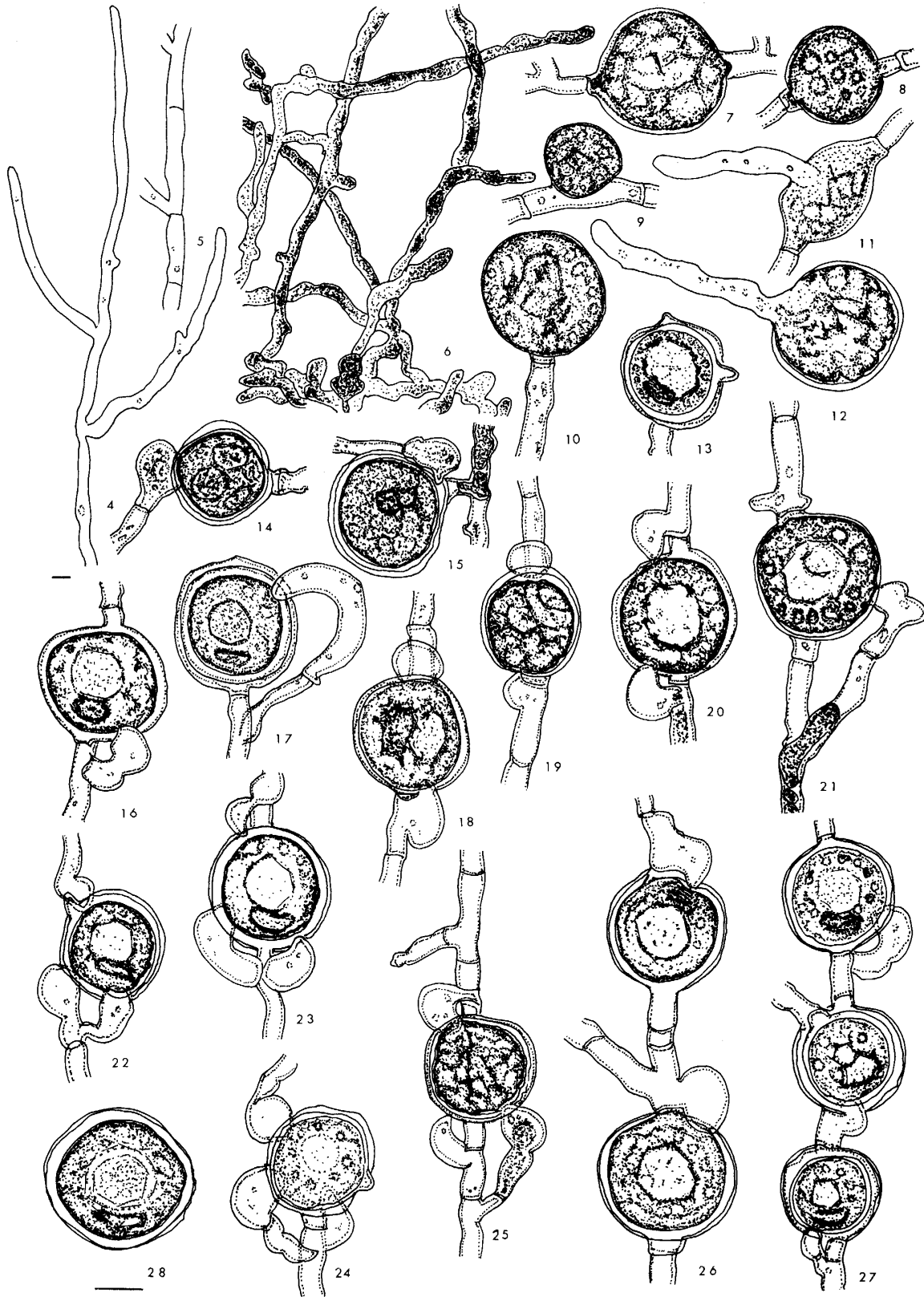


Plate II





**Plate III**

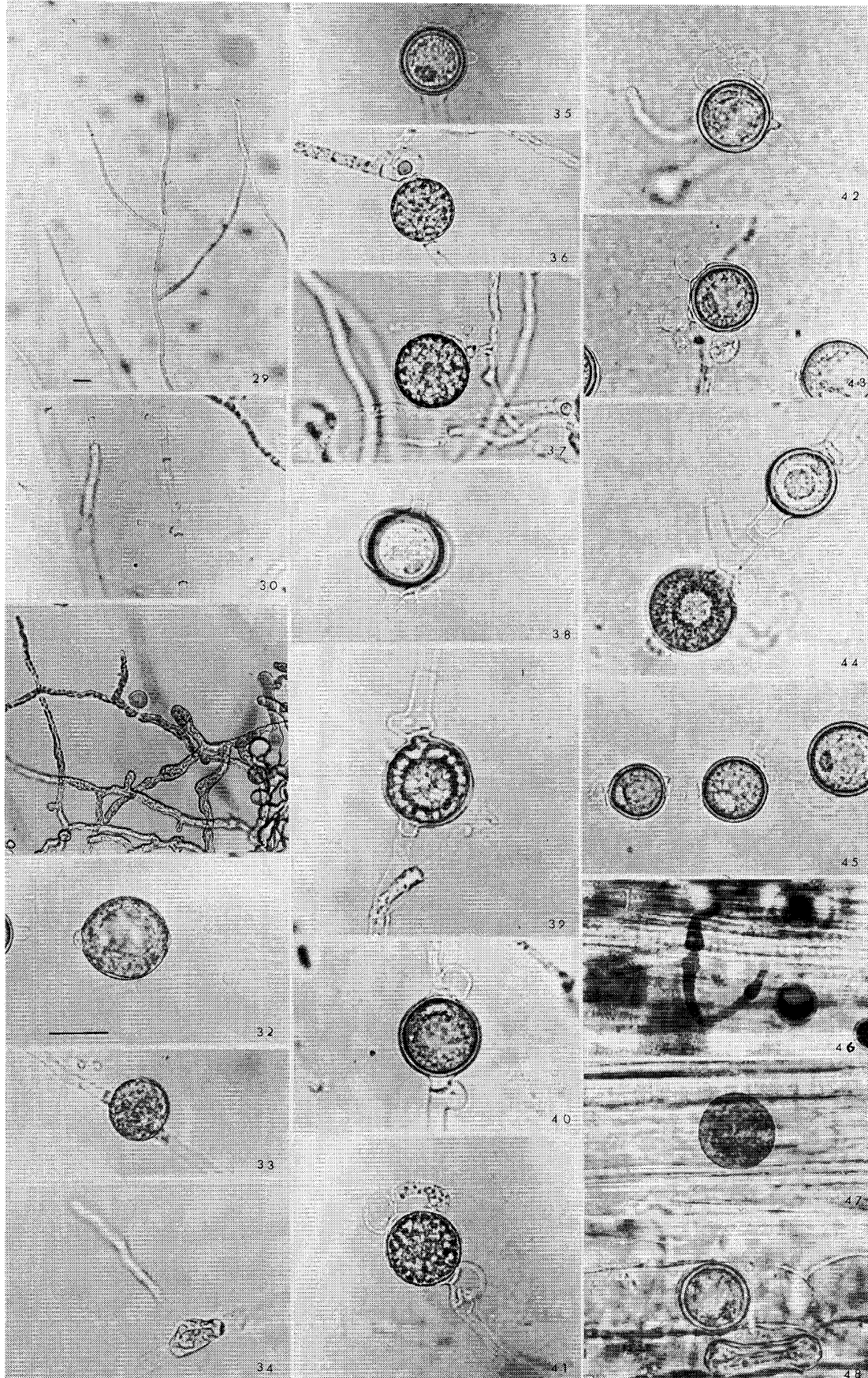




Plate IV

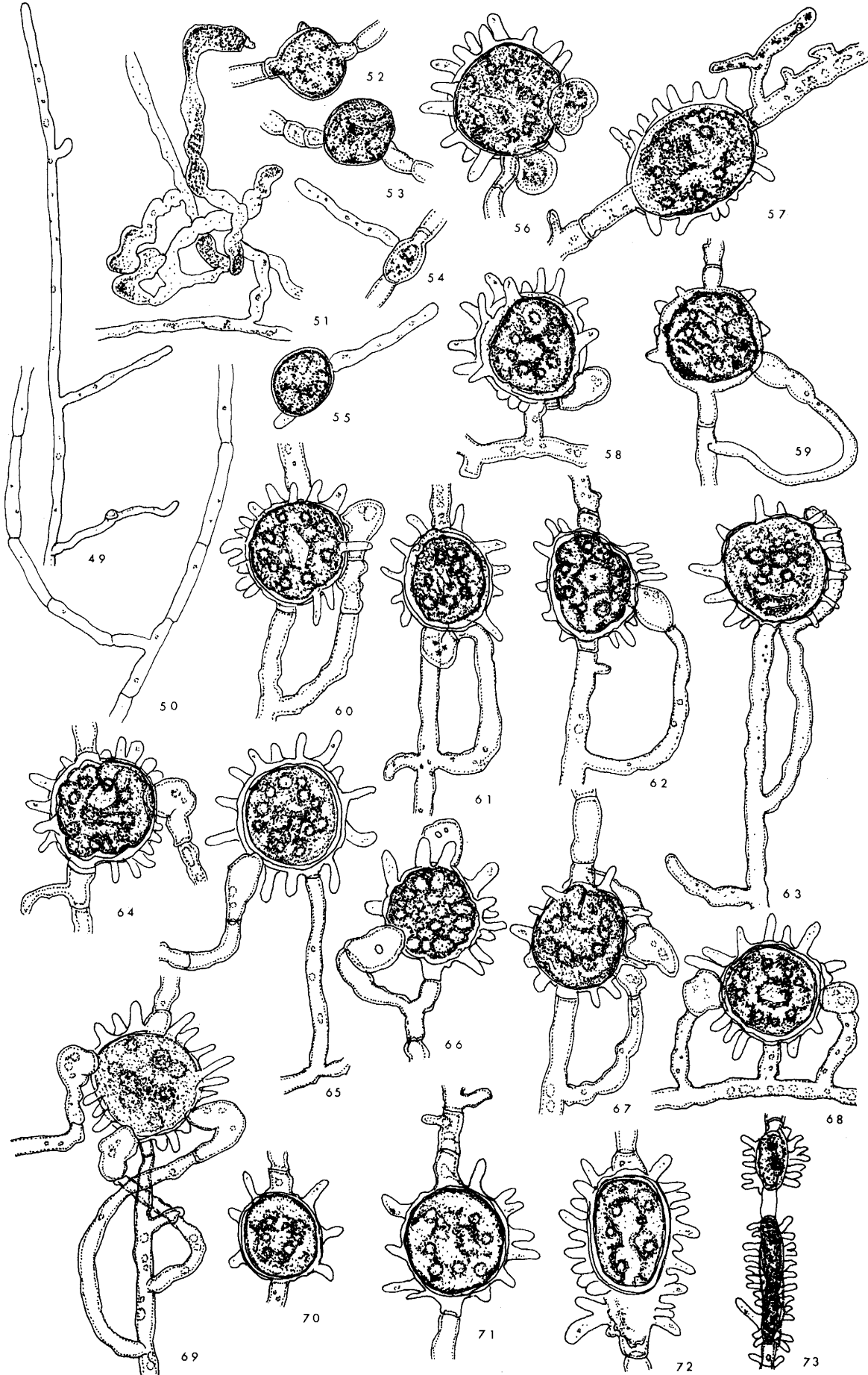


Plate V

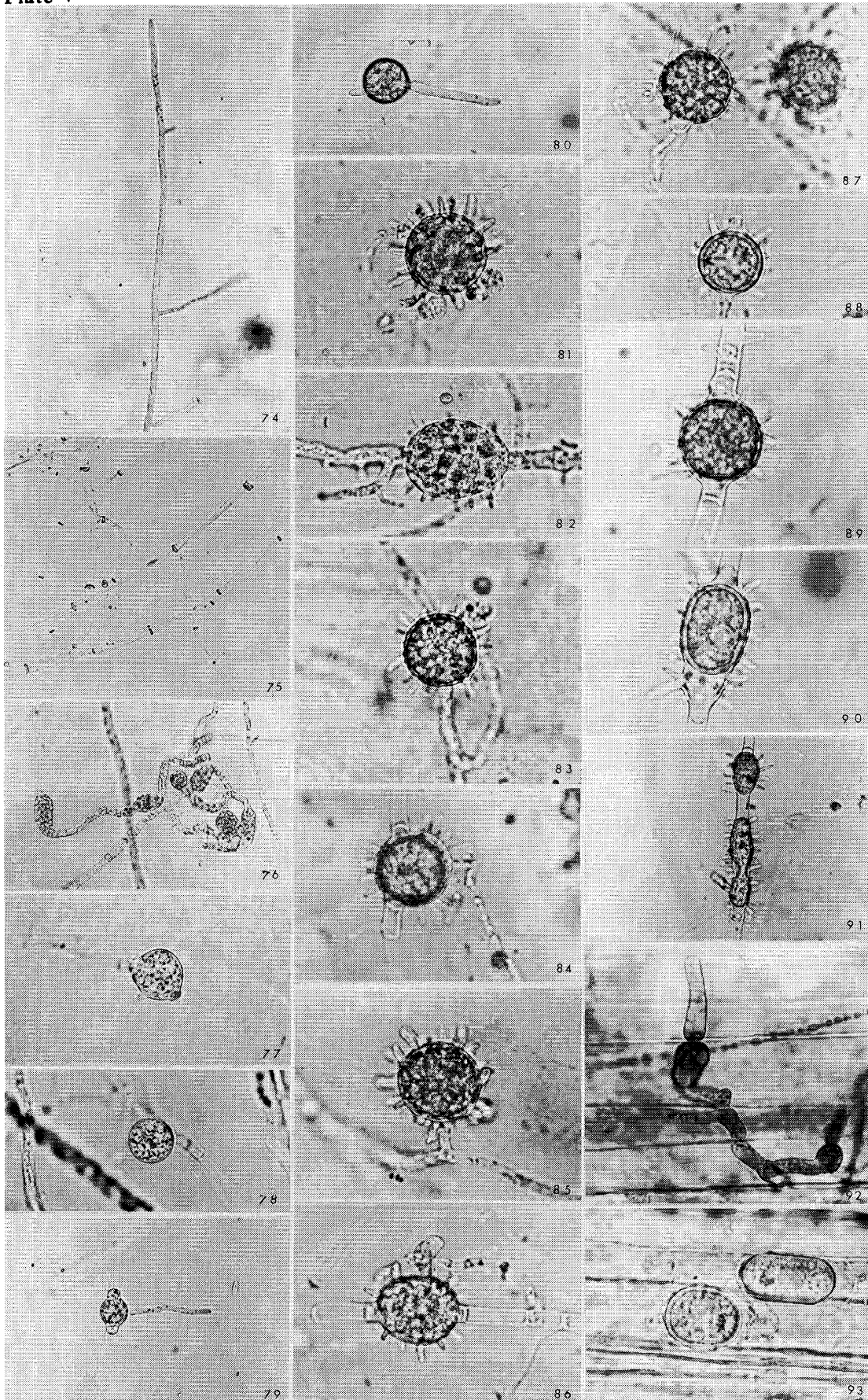


Plate VI

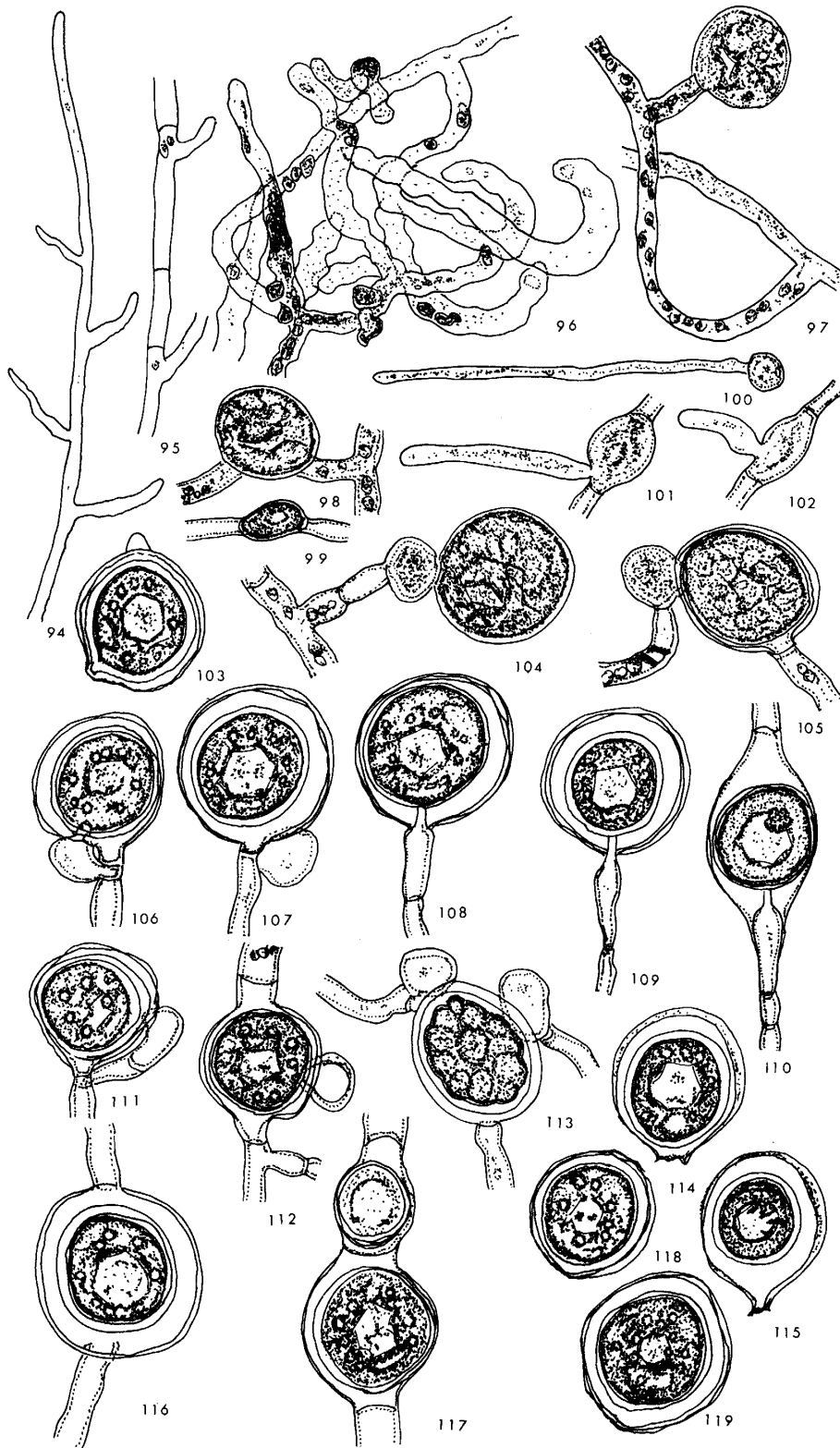




Plate VII

