SOUTH INDIAN PHYCOMYCETES—II

Some Little Known Species of Pythium Occurring in South India*

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The following account is a brief description of some species of Pythium collected by the author during the investigation of the Pythiacae under a scheme financed by the Indian Council of Agricultural Research. The descriptions given are based on the writer's own observations and vary slightly from the original descriptions of the species. For these the reader is referred to Middleton's (1943) excellent monograph of the genus and to Mathew's (1931) handbook "Studies on the genus Pythium".

I. Pythium carolinianum Mathews (loc. cit.), p. 71 (Text-Fig. 1)

Hyphae slender and delicate, measuring 1·5–4 µ in thickness, profusely branched. Sporangia terminal, rarely intercalary, spherical, elongate or limoniform, 15–30 µ in diameter, mostly 25 µ, with a small papilla, prolific, the secondary sporangia borne either inside or outside the primary sporangia. Zoospores 12 to numerous, delimited in a vesicle formed at the tip of a short evacuation tube, reniform, laterally biciliate, measuring 8–12 µ x 6–10 µ when swimming and 8–10 µ when encysted, germinating by the production of one to three germ tubes. Sporangia also capable of direct germination. Sexual reproduction not observed. In some 3–4 months' old cultures on slices of boiled carrots in distilled water resting spores (Text-Fig. 1, L, M.) similar to those described by Mathews could be observed.

Isolated from water containing vegetable debris, Coimbatore; inoculation trials proved that it could parasitize on Spirogyra spp. This species is recorded for the first time outside the United States of America.

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II. *Pythium paracandrum* Drechsler, *J. Wash. Acad. Sc.*, 20, 398-418, 1930
(Text-Fig. 2)

Hyphae 2.5-12 μ in diameter; curved and clavate appressoria developed in abundance on most culture media. Sporangia spherical, subspherical or ellipsoidal, when spherical 20–30 μ in diameter, when ellipsoidal 15–40 μ long and 10–30 μ wide, terminal or intercalary, germinating by one to several germ tubes. Formation of zoospores not observed. Oogonia subspherical, spherical or barrel-shaped, terminal or intercalary, 10–30 μ in diameter (mean 24 μ) smooth, occasionally with one or two papillate protuberances. Antheridia 1–4 per oogonium, usually 1–3, monoclinous or diclinous. When monoclinous they may be hypogynous, sessile and adjacent to the oogonium, often including the adjacent segment, pouch-like or crook-necked or rarely terminal on a stalk always arising very near the oogonium. When diclinous they are usually terminal, rarely intercalary, saccate, inflated, crook-necked and sessile or stalked. Oospores aplerotic with a wall upto 1.5 μ thick, containing a single reserve globule and a single refringent body. Oospores measuring 10–25 μ (mean 19 μ) in diameter.
This rare and interesting species has been reported so far only from *Allium vineale* L. (Drechsler, loc. cit.) *Impatiens pallida* Butt., *Sanguinaria canadensis* L. (Drechsler, 1940), *Aloe ciliaris* Haw, and *Aloe variegata* L. (Middleton, loc. cit.), all from the U.S.A. The writer isolated it from rotting pods of *Phaseolus vulgaris* L. collected in the New Market, Coimbatore. This is the first record of the species outside the U.S.A.

The most characteristic feature of this species is the diversity of the antheridia in their position and relationship to the oogonium. When diclinous and of remote origin, an antheridium may be saccate, laterally sessile on an axial hypha (Fig. 2, D), intercalary (Fig. 2, E) or crook-necked, borne terminally on a stalk of varying length (Fig. 2, F, G, J, M). In neither instance, however, does it display such variety as when arising in close proximity to the oogonium. The simplest type of a monoclinous antheridium is hypogynous, *i.e.*, an outwardly undifferentiated segment adjacent to the oogonium thrusting its fertilization tube through the septum delimiting the oogonium (Text-Fig. 2, H, I). Further modification through the production of a lateral outgrowth always arising very near the oogonium permits the protrusion of the fertilization tube through the spherical wall of the oogonium. Here again the lateral portion which is clavate, inflated and crook-necked, may be small in comparison to the segment producing it (Text-Fig. 2, G) or when the cylindrical portion is much reduced, may constitute the main bulk of the antheridium (Text-Fig. 2, B). This condition approaches cases where the lateral outgrowth is cut off by a septum to function as a sessile antheridium (Text-Fig. 2, C, K, L). Often the antheridium is borne terminally on a stalk of varying length arising always near the oogonium, or a lateral outgrowth may be cut up by a septum to serve as two antheridia in a series. Antheridia thus varying considerably in the manner of origin and shape are found variously associated in many units of the sexual apparatus. This diversity is a characteristic feature of this species and helps to differentiate it from congeneric species such as *P. ultimum* Trow, *P. deBaryanum* Hesse, *P. rostratum* Butler and *P. pulchrum* von Minden.

In his key to species of *Pythium*, Middleton (loc. cit., p. 22) lists this species along with *P. ultimum* and *P. polymorphon* Sideris under the group with "antheridia monoclinous or diclinous but never hypogynous" as distinct from *P. pulchrum* with "typically hypogynous antheridia". As stated above, the simplest type of antheridium in *P. paraeandrum* is a hypogynous one, viz., an outwardly undifferentiated segment adjacent to the oogonium which thrusts its fertilization tube through the cross wall
FIG. 2. Asexual and sexual reproductive structures of *P. paroecandrum*

Drechsler: A × 480, the rest × 680.

between it and the oogonium. Middleton himself (*loc. cit.*, p. 6) says that "a hypogynous antheridium is one surmounted by an oogonium; the antheridium is formed within the oogonial stalk or at the apex of the oogonial stalk adjacent to the oogonium, never laterally disposed". Comparison of the figures given by Drechsler (1940) and Middleton (*loc. cit.*, p. 92A) with Text-Fig. 2, H and I and the "truly hypogynous" antheridia of *P. pulchrum* and *P. rostratum* is enough to show that the simplest types of antheridium in *P. paroecandrum* is also hypogynous. The writer, therefore, feels that *P. paroecandrum* should be considered a species with monoclinous, dicolinous and hypogynous antheridia and as such should be placed in a group distinct from *P. polymorphon* and *P. ultinum* which do not possess hypogynous antheridia. The following amendment to Middleton's key is suggested (*cf.*, Middleton, *loc. cit.*, p. 22, line 10).
**South Indian Phycomycetes—II**

Antheridium absent

... 39. *P. anguillulæ aceti*

Antheridium present—

Antheridium typically hypogynous, rarely monoclinous

... 40. *P. pulchrum*

Antheridium monoclinous or diclinous, frequently hypogynous, typically sessile originating near the oogonium

... 41. *P. paroecandrum*

Antheridium typically monoclinous or diclinous, never hypogynous

... 42. *P. polymorphon*

Antheridial branch falcate or sigmoid

... 43. *P. ultimum*, etc.

III. *Pythium periplocum* Drechsler var. *Coimbatorensis* var. nov. Text-Fig. 3.

Hyphae 2–9 μ in diameter, profusely branched, the submerged mycelium being distinguished by intricately ramifying short lateral branches on a straight axial hypha giving a characteristic appearance (Text-Fig. 3, A). Sporangia inflated, filamentous, intercalary, rarely terminal, digitate, often aggregated into massive complexes. Zoospores 50–150, delimited within a vesicle formed at the tip of a long evacuation tube, reniform, laterally biciliate, 8–11 μ × 9–10 μ when swimming and 8–10 μ when encysted, germinating after encystment by one to several germ tubes. In older agar cultures, contents of sporangia retract, forming resting spores with a thin wall and containing several reserve globules and refractive bodies (Text-Fig. 3, B, C) oogonia spherical or subspherical, echinulate, the spines tapering slightly to a blunt apex, terminal, occasionally intercalary, 25–40 μ (mean 33 μ) in diameter, excluding the spines. Antheridia diclinous, one or more, usually one to three, per oogonium; antheridia usually originating on a single stalk, rarely on two stalks. The antheridial cell is oblong clavate, markedly lobed, making ventral contact with the oogonial wall. The antheridia and distal portions of the antheridial stalks extensively and intricately wrapped about the oogonium making it very difficult to trace the relationship of the sexual organs. Oospores aplerotic, spherical, smooth walled, measuring 20–34 μ (av. 29.5 μ) in diameter, with a single reserve globule and a single refractive body.

Isolated from vegetable debris in water, Coimbatore. The species is recorded here for the first time in India. While agreeing in all essential details with the type described by Drechsler, the Coimbatore form differed from the former in one particular, *viz.*, the formation of resting
spores in old agar cultures. These spores (Text-Fig. 3, B, C) were spherical or irregular in shape and appeared to be formed out of sporangia by the retraction of their contents. Mature resting spores did not germinate at all when transferred to distilled water or soil leachate while immature ones readily formed zoospores. The internal organisation of these spores showed a marked similarity to that described for another species of *Pythium*, *P. undulatum* Petersen, by both Dissmann (1927) and Drechsler (1946), though in this case the wall is not quite as thick as that of the resting spores of *P. undulatum*. It is interesting to note that such resting spores have so far been reported for only one species, *P. undulatum*, which like the present form is aquatic. As Drechsler (1946) has remarked, the possibility cannot be ignored that similar reproductive structures may be produced by other species of *Pythium*, especially aquatic forms.

Although the present form differs from the type in the production of resting spores, the writer feels that the formation of these spores is to be considered the result of its aquatic habitat and is not a sufficient basis for
considering it specifically distinct from Drechsler's fungus. It is, therefore, presented as a new variety.

*P. periplocum* is at present the only known species of *Pythium* which possesses filamentous sporangia and echinulate oogonia.

IV. *Pythium catenulatum* Mathews (*loc. cit.*), p. 47 (Text-Fig. 4).

Hyphae slender, 2-5 μ in diameter, profusely branched. Sporangia composed of somewhat inflated hyphae in conjunction with irregularly swollen outgrowths forming simple or complex aggregations; zoospores 8-100 in a vesicle depending on the size of the sporangium, reniform, biciliate, 8-10 μ x 6-7 μ when swimming and 8-10 μ when encysted, germinating by 1-3 germ tubes. In addition to sporangia numerous spherical or pyriform asexual reproductive bodies also present; these are terminal or intercalary, single or several in a chain, germinating by germ tubes. Sexual reproduction not observed.

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*Fig. 4. Aseuxal reproductive structures of *P. catenulatum* Mathews. A-E × 480; F and G × 680.*
Parasitic on *Spirogyra* spp. in rice fields, Vedapatti, Coimbatore; saprophytic on decaying vegetable matter in water, Coimbatore.

Though all three isolates of this organism collected by the writer did not produce any sexual organs, it is considered identical with *P. catenulatum* on account of the inflated nature of its sporangia which are made up of inflated elements with bud-like lateral outgrowths. In the other two congeneric species which possess spherical asexual reproductive bodies along with filamentous sporangia—*P. perniciosum* Serbinow and *P. cfertile* Kanouse and Humphrey—the sporangium is unbranched and not thicker than the parent hypha.

*Pythium catenulatum* has been isolated from vegetable debris in water by Mathews (1931) and Middleton (1943). It is here recorded for the first time outside the United States.

**Summary**

Four species of *Pythium*—*P. carolinianum*, *P. paracandrum*, *P. periplocum* and *P. catenulatum* are reported for the first time in India. The isolate of *P. periplocum* obtained is considered a new variety as it produces resting spores and is named *P. periplocum* var. *Coimbatorensis* var. nov. The morphological features and peculiarities of each species are described and discussed.

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