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## SOME NEW SPECIES OF PYTHIUM

BOTANY.—*Some new species of Pythium.*<sup>1</sup> CHARLES DRECHSLER,  
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Although the fungi to be described herein are all referable to *Pythium* in the broader sense in which that genus has generally been understood, they include members of groups rather diverse in their more intimately distinctive morphological tendencies. *Pythium disotocum* in its small degree of outward sporangial differentiation, approximates more closely than any of the others the condition described by Pringsheim (9) for *P. monospermum* Pringsh., which with the subsequent transfer of his *P. entophytum* to *Lagenidium*, remains as the obvious type of the genus. It therefore also comes closer than any of the others in conforming to the requirements for Schröter's (10) definition of his genus *Nematosporangium* which stipulates filamentous sporangia not wider than the mycelial hyphae. That in the choice of the generic name the one introduced in its present meaning by Pringsheim (9) was adopted, is to be attributed, however, less to the production by the fungus of slightly swollen dactyloid elements evidently essentially sporangial in nature, than to the unsoundness of Schröter's dispositions historically. For whatever may have been the propriety of Pringsheim's followers in bringing forms differing considerably from *P. monospermum* into the same fold, and whatever the utility of Fischer's (5) subdivision of the enlarged genus into three subgenera, there can be little doubt that Schröter's elevation to generic rank of the one of these subgenera to which had been assigned the very species that had originally formed the basis of the genus *Pythium*, was flagrantly in contravention of nomenclatorial stability. Nor apparently have the ill-advised dispositions of Schröter been sanctioned by use, as most authors of the past four decades have continued to

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include species having other than subspherical sporangia among the members of the older genus.

In *Pythium peritulum* and *P. myriotylum* are represented departures from the outwardly completely undifferentiated filamentous form of sporangium demanded by Schröter's definition of Nematosporangium wider than in *P. dissotocum*, as in these two fungi swollen lobulate elements occur more freely and constitute a larger proportion of the volume of the parts concerned in asexual reproduction. In *P. periplocum* the sporangia consist very largely of moriform aggregations of lobulate elements in comparison with which the undifferentiated mycelial parts are often altogether insignificant in volume. Assignment of a fungus having a sporangium consisting of distended elements in intricate arrangement to a genus of which the chief distinctive feature is by definition a filamentous sporangium not wider than the mycelial hyphae would seem rather obviously out of question.

The sporangia of *Pythium paroecandrum* and of *P. salpingophorum* are of typically subspherical form, those of the former species resembling in general the sporangia of *P. debaryanum* Hesse, while those of the latter are noteworthy mainly because of the conspicuous distal widening of their individual evacuation tubes. The sporangia of *P. acanthicum* and *P. oligandrum* likewise are often simply subspherical, but frequently, again, a filamentous part of varying length is included, or more especially in *P. oligandrum*, several subspherical elements communicate by connecting portions of filament, so that structures more or less transitional between subspherical and filamentous sporangia and between subspherical and lobulate sporangia, respectively, are brought about.

The sexual apparatus of *Pythium dissotocum* invites comparison with that of *P. debaryanum* inasmuch as it exhibits monoclinal antheridia both in proximate and in more distant mycelial relationship to the oogonium, while the regularly proximate origin of the monoclinal antheridia of *P. paroecandrum* provides a parallelism with *P. ultimum* Trow. In *P. peritulum* the antheridia and the branching filaments supporting them are wrapped extensively and intimately about the oogonium in a manner suggestive of various species of *Aphanomyces*. Envelopment of the oogonium is effected also in *P. myriotylum*, though usually less extensively than in *P. peritulum*, and never quite as intimately. However, the oogonia of *P. periplocum* are invested often fully as extensively as those of *P. peritulum*, owing here, to be sure, more to the rangy lobate antheridia spreading over the female organ as closely as the spiny configuration permits, than to the rather moder-

ately developed antheridial branches creeping closely between the spines.

The frequently somewhat lobate shape of the antheridium, the longitudinal application of the male organ to the oogonium, and the creeping of the antheridial stalk between the spiny protuberances of the female organ, prevalent in *P. oligandrum*, are indicative of a somewhat close relationship to *P. periplocum*, which, it may be admitted, the frequent parthenogenesis and the simpler construction of sporangium distinctive of the former species do little to sustain. A certain degree of relationship to *P. periplocum* is evidenced also by *P. acanthicum* in the production of a frequently lobate antheridium and its application lengthwise to the spiny oogonium. Accordingly, *P. periplocum*, *P. oligandrum* and *P. acanthicum* might perhaps well be regarded as members of a group articulating with *P. artotrogus* de Bary. It must be mentioned, however, that the very usual origin of the antheridial branch in *P. acanthicum* from the hypha bearing the oogonium and at a variable but mostly small distance from the female organ, provides a similarity with the arrangement of the sex organs in *P. debaryanum* and its allies, *P. mamillatum* Meurs and *P. spinosum* Sawada, which especially in the case of the latter two forms, would seem to be further sustained by the presence of numerous protuberances on the oogonium. However in *P. acanthicum* as in *P. periplocum* and *P. oligandrum*, the more delicate hyphae are much more extensively developed relative to the stouter hyphae than in members of the *debaryanum* series, and the oogonial protuberances usually taper noticeably from base toward apex instead of maintaining approximately the same diameter.

The sexual stage of *Pythium salpingophorum* is noteworthy chiefly because of the frequency of parthenogenetic development manifested by it. In regard to such development as well as to the frequent moniliform arrangement of its oogonia and the usual complete filling of the latter structures by their individual oospores, the species shows a striking resemblance to *P. papillatum* Mathews (7).

Although the fungus now to be described under the binomial *Pythium anandrum* was cited in an earlier note (3) as apparently having an intercalary antheridium in the frequently contorted distal portion of the oogonial stalk, it is now evident that the oogonial stalk serves no direct sexual function, and that the development of the oospore is consistently parthenogenetic. The spiny oogonial protuberances of this fungus are longer and more acutely pointed than those of any congeneric form hitherto described. In some instances an individual spine has been observed to have developed into a process measuring

30 to 40 $\mu$  in length and widening midway to the tip into an expansion provided with secondary spiny protuberances and bearing internally a secondary oospore approximately 10 to 11 $\mu$  in diameter. The combination of a sexual stage so unusual with a sporangium resembling that of a proliferous species of *Phytophthora* in all details except in that the zoospores are fashioned entirely in accordance with the asexual development characteristic of *Pythium*, makes *P. anandrum* one of the most anomalous members of the genus.

*Pythium mastophorum* and *P. polymastum*, in spite of the absence of any indication of a proliferous sporangial habit, represent species apparently most directly related to *P. megalacanthum* De Bary. In both fungi the mycelium is conspicuous for its haphazard disposition, and the sporangia are unusually tardy of development. The large oogonial protuberances that have suggested the specific terms submitted are perhaps even more distinctive because of the thickness of wall they exhibit and because of the mammiform shape they frequently assume than because of their extraordinary size.

*Pythium helicoides*, *P. oedochilum*, *P. polytylum* and *P. palingenes* are representatives of the group of species to which reference was made earlier in a brief abstract (4). The terminally borne, subspherical, proliferous sporangium with mostly apical evacuation tube which is characteristic of each of these representatives, corresponds well to that described and figured by various authors for *Pythium proliferum* De Bary. However in De Bary's account (1) of the sexual apparatus of the latter species, the antheridia were set forth in text and in figures as essentially similar to those of his *P. debaryanum* (i.e., *P. ultimum*) in shape as well as in relationship to mycelium and oogonium. In the four species under consideration the antheridium is a terminal, long, curved cylindrical structure applied lengthwise very tightly to the oogonium, and producing an evacuation tube from a navel rather than from an apical position. And the oospore is distinguished not only by an unusually thick wall, but also by an organization of contents different from that of the oospores of the generality of forms assigned to *Pythium*, a half dozen to a score of reserve globules and a few to a dozen of refringent bodies being distributed with some uniformity through a densely granular matrix. Protrusion of the oogonium where in contact with antheridia, involvement of hyphal elements supporting the oogonium by those supporting an antheridium, occurrence of granular residues between ripe oospore and oospore wall, and pronounced yellow coloration of oogonium and oospore, are among the

additional features displayed in varying measure by one or another of the species.

In the literature only Dissmann's (2) figures of the elongated antheridium of his *Pythium proliferum* shows unmistakable evidence of affinity with the group of proliferous forms under consideration. Examination of the fungus investigated by Kanouse (6) under the name *Pythiomorpha gonapodioides* Petersen reveals it as similarly a member of the same series, although her publication, except for its description of the clasping antheridium, gives the impression of having been based on a proliferous species of *Phytophthora*. It is to be noted that the illustrated description of the sexual stage given by Minden (8) for his *Pythiomorpha gonapodioides* sets forth a clavate or ellipsoidal antheridium making apical contact with the base of the oogonium—a relationship unlike that found in members of the *helicoides* series as well as unlike that mentioned by Kanouse. Indeed Minden's account of the sexual apparatus of *Pythiomorpha gonapodioides* rather supports the conclusion to be drawn from his statement of mycelial characters and his description of sporangial development, that under the binomial mentioned, he, like Petersen before him, dealt with a proliferous species of *Phytophthora*.

Of the species herein described, three at least are definitely known to be of economic importance as parasites of cultivated plants. *Pythium periplocum* is responsible for some very small loss in destroying watermelon fruits. *P. acanthicum* is often energetically destructive of watermelon fruits, causing on the whole several times as much damage to this particular product ~~than~~<sup>as</sup> all other species of *Pythium* combined. *P. myriotylum* though apparently not closely related to *P. butleri* Subr. exhibits the same sort of aerial parasitism, and like the latter species is to be reckoned among the most destructive members of the genus. During periods of high humidity it similarly puts forth a profuse growth of aerial mycelium that through the production of an extraordinary number of appressoria, fastens upon and penetrates into any host structures it may chance to encounter. The fungus would seem however to have a more limited range than *P. butleri*, in the United States being encountered frequently only in the more southern latitudes.

***Pythium dissotocum* sp. nov.**

Intramatrical mycelium somewhat lustrous, capable of approximately 18 mm. radial extension in 24 hours at 24°C., the relatively straight axial hyphae mostly 3.5 to 6 $\mu$ , more rarely up to 7 $\mu$  in diameter, the branching elements of more irregular course, mostly 2 to 4 $\mu$  in diameter; under aquatic

conditions extramatrical mycelium meager, the hyphae sometimes as narrow as  $1.5\mu$ . Appressoria borne terminally on more delicate intramatrical branches in moderate number, often curved clavate, the distal part about  $7\mu$  in diameter. Aerial mycelium usually absent though sometimes very sparingly present.

Sporangia usually consisting entirely of undifferentiated mycelial filaments, but at times including somewhat swollen dactyloid lateral elements, simple or sparingly branched,  $5$  to  $8\mu$  in diameter. Evacuation tube sometimes more than 1 mm. in length,  $1.5$  to  $4\mu$  in diameter, widening at the refringent tip to a diameter of  $2.5$  to  $9\mu$ . Zoospores usually 10 to 75 in a vesicle, but sometimes in excess of 100, after rounding up usually  $8$  to  $9\mu$  in diameter, germinating usually by a single germ tube  $1.5$  to  $2\mu$  in diameter, or diplanetis through production of an evacuation tube  $1$  to  $1.5\mu$  in diameter, and up to  $12\mu$  in length.

Oogonia terminal, intercalary or laterally intercalary, provided with a smooth sturdy wall approximately  $0.8\mu$  in thickness, subspherical, measuring  $12$  to  $32\mu$ , usually  $17$  to  $25\mu$  (average  $20.7\mu$ ) in diameter, the delimiting septum or septa frequently inserted somewhat beyond the spherical contour, so as to include at either or both ends a cylindrical part up to  $8\mu$  in length. Antheridia usually crook-necked, mostly  $5$  to  $8\mu$  in diameter near apex, measuring individually  $6$  to  $16\mu$  along curved axis from apex to basal septum, the apical end often somewhat flattened and thus making broad contact with oogonium about a short fertilization tube approximately  $1.4\mu$  in diameter; varying in number usually from 1 to 3, 4 or 5 rarely present; when plural, each usually autonomous in origin; often sessile on the oogonial filament immediately adjacent to oogonium, or borne terminally on branches arising from a neighboring filament or from the oogonial filament often in immediate proximity to oogonium or at a variable distance from it. Oospore smooth, colorless or slightly yellowish, usually very largely though not completely filling oogonium,  $11$  to  $27\mu$ , mostly  $15$  to  $21\mu$  (average  $17.6\mu$ ) in diameter, with a wall  $1.0$  to  $2.2\mu$ , mostly  $1.3$  to  $1.8\mu$  (average  $1.5\mu$ ) in thickness, a reserve globule  $5$  to  $17\mu$ , mostly  $7$  to  $10\mu$  (average  $8.4\mu$ ) in diameter, and a refringent body oblate ellipsoidal or subspherical in shape, in latter case mostly  $3.5$  to  $5\mu$  in diameter.

Type culture isolated from diseased rootlets of *Saccharum officinarum* L. collected near Thibodaux, La., April, 1927.

#### *Pythium periilum* sp. nov.

Intramatrical mycelium often of lustrous, cumulous appearance, capable of approximately 18 mm. radial extension in 24 hours at  $24^{\circ}\text{C}$ ., the relatively straight axial hyphae mostly  $3.5$  to  $5\mu$ , rarely up to  $6\mu$  in diameter, the branching elements of more irregular course mostly  $2$  to  $3.5\mu$  in diameter; extramatrical mycelium under aquatic conditions meager, the hyphae sometimes as narrow as  $1.5\mu$ . Appressoria knob-like, borne terminally on finer intramatrical branches in moderate number or more abundantly, often  $7\mu$  in width and  $7$  to  $10\mu$  in length. Aerial mycelium absent, or on richer substrata present in small quantity as a shallow felty layer that collapses with age.

Sporangium consisting sometimes entirely of undifferentiated mycelial elements, but generally composed in part of sparingly distributed inflated dactyloid elements usually  $6$  to  $8\mu$ , rarely  $8$  to  $12\mu$  in diameter, and sometimes constituted in larger part of such inflated elements, which then are often concentrated in closely arranged branching systems though not in intricate complexes. Evacuation tube often  $0.1$  to  $0.5$  mm. in length, mostly

about  $3\mu$  in diameter, but in the distal part widening to a diameter of 5 to  $6\mu$ . Zoospores up to 75 in a vesicle, after rounding up usually 8 to  $9\mu$  in diameter, germinating usually by a single germ tube  $1.5$  to  $2\mu$  in diameter.

Oogonium terminal or more often intercalary, provided with a smooth wall approximately  $0.5\mu$  in thickness, subspherical, measuring usually 16 to  $22\mu$  (average  $18.8\mu$ ) in diameter, the delimiting septum or septa frequently inserted somewhat beyond the spherical contour, so as to include at either or both poles a cylindrical part up to  $4\mu$  in length. Antheridia crook-necked, mostly 4 to  $5\mu$  in diameter in median or distal part, measuring individually 7 to  $14\mu$  along curved axis from apex to basal septum, the bluntly rounded apical end making narrow contact with oogonium about a very short fertilization tube approximately  $1\mu$  in diameter, the proximal part usually tapering somewhat more gradually toward delimiting septum to diameter of supporting filament; varying in number usually from 2 to 5, borne terminally or less frequently laterally, all on branching prolongations of a single hypha originating sometimes from the oogonial hypha at some distance, rarely less than  $50\mu$ , from the oogonium, or more frequently from a neighboring filament; the branching prolongations bearing the antheridia together usually with several similar vegetative prolongations being wrapped rather extensively and rather closely about the oogonium, and very frequently though not always as closely, about the adjacent portions of the oogonial filament. Oospore colorless or somewhat yellowish, smooth, completely or nearly completely filling the oogonium, 14 to  $20\mu$  (average  $17.3\mu$ ) in diameter, with a wall  $1.1$  to  $1.8\mu$  (average  $1.5\mu$ ) in thickness, a reserve globule usually 7 to  $11\mu$  (average  $8.9\mu$ ) in diameter, and a refringent body oblate ellipsoidal or subspherical in shape, in latter case measuring on the average  $4.2\mu$  in diameter.

Isolated from diseased rootlets of *Saccharum officinarum* L. collected near Thibodaux, La., April, 1927.

#### *Pythium myriotylum* sp. nov.

Intramaterial mycelium somewhat diffuse in appearance, capable of approximately 34 mm. radial extension in 24 hours at  $24^{\circ}\text{C}$ ., the younger actively growing hyphae  $2.5$  to  $4\mu$ , mostly 3 to  $4\mu$  in diameter, the older axial hyphae often up to  $7\mu$  in diameter, and occasionally attaining a diameter of  $8.5\mu$  previous to degeneration; provided with numerous appressoria in the form of swollen clavate or knob-like terminations 7 to  $11\mu$  in diameter at the adhering apex. Under aquatic conditions extramaterial mycelium copious, often with numerous appressoria. Aerial mycelium under humid conditions very copious, adhering to solid bodies through the production of very numerous appressoria usually in large densely branching clusters or brush-like groups, each cluster or group including frequently 10 to 75 or more appressoria.

Sporangia terminal or intercalary, consisting sometimes of portions of outwardly undifferentiated filaments, delimited by septa or more massive plugs, the portions measuring 0.1 to 0.3 mm. in length and 3 to  $7\mu$  in diameter; but more often including a number of swollen lobulate or digitate elements attached laterally in open arrangement, or sometimes consisting for the most part of swollen elements which then are usually present in denser branching arrangements; the swollen elements highly variable in size, measuring 10 to  $175\mu$  in length and 7 to  $17\mu$  in diameter, though mostly not exceeding  $50\mu$  in length and  $12\mu$  in diameter. Evacuation tube often a prolongation of undifferentiated sporangial filament, but frequently arising as a special structure from swollen element or laterally from filamentous part; measuring 10 to  $100\mu$  or more in length and 2 to  $3.5\mu$  in diameter at base, widening usually

only slightly to a diameter of 4 to 6 $\mu$  below somewhat expanded refringent apex; often failing to function effectively, then becoming set off in whole or in part by septum or plug, followed by production of another tube. Zoospores formed 3 to 40 in a vesicle, longitudinally grooved, broadly reniform, biciliate, 9 to 16 $\mu$ , mostly 10 to 12 $\mu$  (average 11 $\mu$ ) in diameter, germinating usually by a single germ tube, 2.5 to 3 $\mu$  in diameter.

Oogonia terminal or intercalary, smooth, provided with a wall 0.5 to 1 $\mu$ , mostly 0.7 to 0.8 $\mu$  in thickness, subspherical, 15 to 44 $\mu$  in diameter, when most abundantly and normally developed 15 to 33 $\mu$ , mostly 23 to 30 $\mu$  (average 26.5 $\mu$ ) in diameter. Antheridia up to 10, usually 3 to 6 to an oogonium; terminally expanded, clavate, often crook-necked or arched, the proximal end of the individual male organ frequently in contact with oogonium, the middle part upcurved, the broadened rounded apex rather narrowly applied and bearing the usually short (1 to 3 $\mu$  long), narrow (1 to 1.5 $\mu$  wide) fertilization tube; measuring 4 to 8 $\mu$  in diameter and 8 to 30 $\mu$  in length, but more normally mostly 4.5 to 7 $\mu$  in diameter and 8 to 16 $\mu$  in length; borne terminally or somewhat laterally on branches often loosely or more intimately enveloping the oogonium, and supplied from 1 to 3 parent hyphae not demonstrably connected with the oogonial filament or connected with the latter at a distance usually in excess of 100 $\mu$  from the oogonium. Oospore colorless or yellowish; subspherical, 12 to 37 $\mu$  in diameter with a wall up to 2 $\mu$  in thickness and a reserve globule up to 18 $\mu$  in diameter, but when most abundantly and normally developed, 12 to 26 $\mu$ , mostly 18 to 24 $\mu$  (average 20.8 $\mu$ ) in diameter, provided with a wall 1.3 to 1.9 $\mu$  (average 1.6 $\mu$ ) in thickness, and containing a reserve globule 6 to 12 $\mu$  (average 9.8 $\mu$ ) in diameter, and a refringent body, subspherical or sometimes strongly flattened, measuring when subspherical mostly 3.5 to 5 $\mu$  in diameter.

Causing a decay of fruits of *Cucumis sativus* L. in South Carolina, of fruits of *Citrullus vulgaris* Schrad. in Florida and Georgia, of fruits of *Solanum melongena* L. in Florida; and isolated from discolored rootlets of *Lycopersicum esculentum* Mill. in South Carolina.

#### **Pythium periplocum** sp. nov.

Intramaterial mycelium somewhat lustrous, capable of approximately 25 mm. radial extension in 24 hours at 24°C., consisting while in active growth of filaments 1.2 to 4.8 $\mu$ , mostly 1.8 to 4.2 $\mu$  in diameter, later including somewhat larger hyphae with thicker walls, measuring up to 8.5 or 9 $\mu$  in diameter; the more delicate ramifications very irregular in course, often present as luxuriantly and densely branching systems. Under aquatic conditions extramaterial development rather meager. Aerial mycelium usually scanty, though on rich substrata present in some quantity.

Zoosporangia appearing promptly and in moderate abundance; mostly intercalary though often terminal or lateral; consisting usually very largely of branching digitate or lobulate elements, measuring 10 to 30 $\mu$  in length and 8 to 20 $\mu$ , mostly 10 to 15 $\mu$ , in diameter,—these elements frequently assembled in numbers up to 20 or 25 in an intricate moriform arrangement together with 1 or several contiguous filamentous parts usually not exceeding 75 $\mu$  in combined length; larger moriform complexes composed of more than 30 or 40 swollen elements, frequently becoming evacuated through 2 or 3 tubes, constituting compound or plural sporangia. Evacuation tube 50 to 500 $\mu$  in length, arising from inflated element or less frequently from undifferentiated filamentous part, measuring 2 to 4.5 $\mu$  in diameter at the base, widening usually to a diameter of 3 to 8 $\mu$  below the refringent apex; after discharge the tip

sometimes reflexed. Zoospores formed usually up to 125 in a vesicle, longitudinally grooved, broadly reniform, biciliate, briskly active, measuring 8 to 11 $\mu$ , mostly 9 to 10 $\mu$  in diameter after rounding up.

Oogonia terminal or intercalary; subspherical, measuring 13 to 32 $\mu$ , mostly 22 to 28 $\mu$  (average 24.6 $\mu$ ) in diameter, not including the spiny protuberances of which 25 to 65 are usually visible in upper and equatorial aspects and which measure 2 to 4 $\mu$  (average 2.8 $\mu$ ) in length and 1.4 to 3 $\mu$  (average 1.8 $\mu$ ) at the base from which they taper somewhat toward the rounded apex; provided with a wall approximately 0.6 $\mu$  in thickness that becomes attenuated to approximately 0.3 $\mu$  in the protuberances. Antheridia usually 1 to 4 in number, usually supplied from 1 or from 2 hyphae not closely connected with the oogonial hypha; sometimes consisting of a simple clavate part, but more regularly longer, measuring 15 to 30 $\mu$  or more in length, markedly lobed, the several lobes mostly 5 to 10 $\mu$  in length and 5 to 8 $\mu$  in diameter, disposed either in series or in branching arrangement, but in any case each making contact ventrally with the oogonium, the rangy male organs together frequently with distal portions of the branching hyphal elements supporting them thus rather intricately and extensively wrapped about the oogonium,—each antheridium giving rise usually to only a single, narrow, rather short, inconspicuous fertilization tube. Oospores smooth, colorless or yellowish, not filling oogonium completely; subspherical, measuring 11.5 to 27 $\mu$  mostly 18 to 24 $\mu$  (average 21.2 $\mu$ ) in diameter; provided with a wall 0.7 to 1.9 $\mu$  (average 1.4 $\mu$ ) in thickness, and containing a reserve globule 6.2 to 13.6 $\mu$  (average 10.7 $\mu$ ) in diameter and a refringent body, subspherical or somewhat flattened, measuring when subspherical usually 4 to 5 $\mu$  in diameter.

Causing occasional instances of blossom-end decay of fruits of *Citrullus vulgaris* L., manifested outwardly by a dark brown or bluish brown discoloration, in Virginia and Maryland.

#### ***Pythium paroecandrum* sp. nov.**

Intramatrix mycelium somewhat lustrous, of radiating aspect, capable of approximately 15 mm. radial extension in 24 hours at 24°C., composed of hyphae 2.7 to 9 $\mu$  in diameter, the relatively straight axial ones well supplied with sturdy branches, which may bear appressoria in moderate or more considerable number as curved clavate terminations 8 to 11 $\mu$  in diameter, often developing into systems of connected sickle-shaped structures. Aerial mycelium often absent or present only in moderate or in meager quantity; under aquatic conditions, extramatrix growth rather scanty.

Sporangia formed promptly, mostly intercalary though occasionally lateral or terminal, subspherical or often prolate ellipsoidal 12 to 30 $\mu$  in transverse diameter. Evacuation tube arising indiscriminately from any part, generally 3 to 30 $\mu$  in length, and 2 to 5 $\mu$  in diameter at the base, frequently widening toward the apex and thus attaining a diameter of 2.5 to 7 $\mu$  below refringent tip. Zoospores usually 3 to 25 in a vesicle, biciliate, reniform, measuring 9 to 11 $\mu$  in diameter after rounding up.

Oogonia usually intercalary, smooth; subspherical, though often prolonged at either end or both ends; measuring 11 to 28 $\mu$ , mostly 18 to 25 $\mu$  (average 21.4 $\mu$ ) in transverse diameter; with a wall 0.4 to 0.9 $\mu$ , mostly 0.6 to 0.7 $\mu$  thick, not readily collapsing after maturity. Antheridia 1 to 5 to an oogonium, of monoclinous or diclinous origin: When of monoclinous origin sometimes consisting of an outwardly undifferentiated segment of hypha adjacent to the oogonium, mostly 7 to 15 $\mu$  in length and 4 to 7 $\mu$  in diameter; sometimes of a somewhat swollen adjacent segment; sometimes of an adjacent segment

together with a bulbous lateral outgrowth from which the fertilization tube is produced; sometimes of a sessile pouch-like or crook-necked structure, measuring mostly 7 to 15 $\mu$  in length and 6 to 8 $\mu$  in diameter, arising proximate to the oogonium; sometimes of an inflated and often crook-necked terminal structure borne on a branch arising in proximate relation to the oogonium, together often with a proximal or distal cylindrical part; sometimes of an intercalary portion of an antheridial process arising in such proximate relationship, and including generally a cylindrical part in addition to an inflated part; a sessile antheridium or antheridial branch or antheridial process occasionally arising from a functional adjacent antheridium; an antheridial process occasionally composed of two antheridia in series; and when two or more oogonia are formed adjacent to one another on the same hypha, the sessile antheridium or antheridial stalk or antheridial process supplying one oogonium often coming to have origin from the juxtaposed (and presumably younger) oogonium. Antheridia of declinous origin mostly terminal expanded structures, often crook-necked, resembling branch antheridia of monoclinous origin, measuring mostly 6 to 8 $\mu$  in diameter at the distal expanded part, and 10 to 20 $\mu$  in length; rarely consisting of an intercalary portion of hypha bearing a broad protuberant part. Contact of antheridium with oogonial wall other than at delimiting septum usually moderately narrow, the oogonial membrane often lipped about the fertilization tube, which latter measures mostly 1 to 4 $\mu$  in length and 1.2 to 3 $\mu$  in diameter. Oospores colorless or yellowish, smooth, subspherical, 10 to 22 $\mu$ , mostly 16 to 21 $\mu$  (average 18.3 $\mu$ ) in diameter, provided with a wall 0.6 to 1.6 $\mu$ , mostly 1.1 to 1.5 $\mu$  (average 1.3 $\mu$ ) in thickness, containing a reserve globule 6 to 14 $\mu$ , mostly 10 to 13 (average 11.5 $\mu$ ) in diameter, and a refringent body, subspherical, with a diameter of 3.5 to 4.5 $\mu$ , or often more or less flattened.

Isolated from discolored root of *Allium vineale* L. collected near McLean, Va., May, 1925.

#### ***Pythium salpingophorum* sp. nov.**

Intramatrical mycelium somewhat lustrous, of pronounced radial appearance, capable of approximately 22 mm. radial extension in 24 hours at 24°C., composed of hyphae 1.5 to 7 $\mu$ , mostly 2 to 5.5 $\mu$  in diameter, bearing appressoria in moderate number as clavate terminations mostly 7 to 8.5 $\mu$  at the adhering apex, often developing into systems of connected sickle-shaped elements. Under aquatic conditions extramatrical mycelium meager or of moderate quantity. Aerial mycelium usually absent.

Sporangia formed promptly and in great numbers; sometimes terminal but mostly intercalary often only a short distance from the tip of the supporting filament, the short distal element of the latter, often 5 to 15 $\mu$  in length, thus frequently borne as an apical appendage; subspherical, 17 to 33 $\mu$ , mostly 21 to 29 $\mu$  (average about 24 $\mu$ ) in diameter; occasionally though not regularly proliferous, the secondary sporangium being borne within the primary one. Evacuation tube arising from any part of sporangium but especially frequently in proximate relation to one or the other of the delimiting septa; generally 3 to 4.5 $\mu$  in length and 1.5 to 3 $\mu$  in diameter at base, but widening often up to a diameter of 11 $\mu$  toward the apex, the membrane of the frequently pestle-like apical enlargement often flaring backward after discharge. Zoospores formed usually 15 to 40 in a vesicle; longitudinally grooved, broadly reniform, biciliate; often very sluggish in movement and soon coming to rest; after rounding up, measuring usually 7.5 to 9.2 $\mu$  (average 8.5 $\mu$ ) in diameter.

Oogonia borne on hyphae usually 2 to 3 $\mu$ , rarely up to 4 $\mu$  in diameter;

terminal or intercalary, often laterally or tangentially intercalary; subspherical, measuring 11 to  $22\mu$ , mostly 13 to  $19\mu$  (average  $15.8\mu$ ) in transverse diameter, delimited by septa or irregular plugs inserted sometimes at a distance from juncture of subspherical part with cylindrical filament and thus often including a portion of latter at one or two ends up to  $15\mu$ , usually 2 to  $5\mu$ , in length; often occurring adjacent to one another in series of 2 to 5 individuals, then sometimes without separating partitions; developing parthenogenetically in most (approximately 3 out of 4) instances, in other instances supplied with 1 or more rarely 2 antheridia. Antheridia arising sometimes from a filament not closely related to the oogonial hypha, then often lateral, sessile and straight; but more often arising from the oogonial hypha proximate to the oogonium, then usually strongly crook-necked; in either case measuring mostly 10 to  $20\mu$  in length and 3.5 to  $6\mu$  in diameter, individually usually producing a short, narrow fertilization tube, though sometimes without delimiting septum, without fertilization tube, non-functional. Oospore colorless or yellowish, subspherical, usually filling completely the spherical part of oogonium and fusing indistinguishably with the portion of oogonial wall in contact with it, measuring 10 to  $19\mu$ , mostly 12 to  $18\mu$  (average  $14.6\mu$ ) in diameter, provided with a wall mostly 0.8 to  $1.5\mu$  (average  $1.2\mu$ ) in thickness, a reserve globule 4.5 to  $10\mu$  (average  $6.3\mu$ ) in diameter and a refringent body subspherical or somewhat flattened which when subspherical measures mostly 3 to  $4\mu$  in diameter.

Isolated from decaying roots of *Pisum sativum* L. collected near Eden, N. Y., June, 1924.

***Pythium acanthicum* sp. nov.**

Intramaterial mycelium lustrous, often of cumulous appearance, though frequently highly diaphanous and therefore inconspicuous, capable of approximately 14 mm. radial extension in 24 hours at  $24^{\circ}\text{C}$ ., composed of hyphae 1.3 to  $5.6\mu$  in diameter, mostly 2 to  $4.5\mu$  while in actively growing condition, the more delicate of the filamentous elements of irregular course and abundantly developed. Extramaterial mycelium under aquatic conditions meager. Aerial mycelium usually absent, sometimes occurring in very small quantity.

Sporangia produced fairly promptly; sometimes terminal but more often intercalary in position; sometimes subspherical, 12 to  $43\mu$  in diameter, but as frequently consisting individually of a subspherical part together with a contiguous portion of filament that may be relatively short or up to  $75\mu$  or more in length, in latter case often including one or more branches; or consisting of 2 or more subspherical or irregularly swollen parts communicating by a filamentous part or parts. Evacuation tube arising from subspherical parts or from filamentous part, but especially frequently from near the junction of the two; measuring 10 to nearly  $200\mu$  (mostly 20 to  $60\mu$ ) in length, 2.5 to  $4\mu$  in diameter at the base, often widening somewhat toward the apex, the open termination after evacuation mostly 4 to  $6\mu$  in diameter, rarely as much as  $9\mu$ ; often marked by numerous irregularities in course. Zoospores produced 5 to 50, usually 15 to 30 in a vesicle, biciliate, longitudinally grooved, broadly reniform, decidedly active, after rounding up measuring usually 8 to  $9.5\mu$  in diameter.

Oogonium sometimes terminal especially on shorter branches, but much more frequently intercalary, often laterally or tangentially intercalary; provided with a wall usually 0.4 to  $0.6\mu$  in thickness; subspherical, 13 to  $30\mu$ , mostly 19 to  $28\mu$  (average  $23.7\mu$ ) in diameter, not including the spiny protuberances of which 20 to 55 are usually visible in upper and equatorial

aspects; the protuberances with a wall approximately  $0.3\mu$  thick, measuring  $1.5$  to  $5\mu$  (average  $2.7\mu$ ) in length and  $1$  to  $3\mu$  (average  $1.9\mu$ ) in diameter at the base from which they usually taper rather slightly toward the bluntly rounded apex. Antheridium, except in occasional cases when 2 male organs are present, occurring singly; borne terminally on a branch occasionally arising from a hypha other than the oogonial hypha and without close mycelial connection with the latter, but much more frequently arising from the oogonial hypha at variable distances usually not exceeding  $25\mu$  and mostly not exceeding  $10$  or  $15\mu$  from the septum delimiting the oogonium, the stalk then frequently of somewhat irregular course, measuring mostly  $0.5$  to  $3\mu$  in diameter and  $6$  to  $33\mu$  in length; inflated clavate, straight or crook-necked, measuring mostly  $8$  to  $17\mu$  in length and  $5$  to  $9\mu$  in diameter; the longer ones often with 1 or 2 transverse constrictions and therefore somewhat lobate; sometimes applied rather broadly by the apex, but more often, especially the longer ones applied frequently together with a short distal portion of the supporting stalk lengthwise to the oogonium. Oospore smooth, colorless or often yellowish; usually occupying the oogonial cavity almost completely, though without adhering to oogonial wall; subspherical, measuring  $12$  to  $27\mu$ , mostly  $17$  to  $26\mu$  (average  $21.7\mu$ ) in diameter; provided with a wall  $1.3$  to  $2\mu$  (average  $1.6\mu$ ) in thickness; often remaining for extended period with 6 to 12 reserve globules, but in more fully matured condition revealing a single reserve globule,  $5.5$  to  $12\mu$  (average  $9\mu$ ) in diameter, and a single refringent body, subspherical or flattened, when subspherical measuring  $3.5$  to  $5\mu$  in diameter; germinating by the production of several germ tubes, or often without extended resting period developing as a sporangium by discharge of contents through an evacuation tube.

Causing a blossom-end rot of the fruit of *Citrullus vulgaris* L. manifested outwardly by a dark brown or bluish brown discoloration, in Florida, Georgia, Missouri, Indiana, and with greater destructiveness in Maryland and Virginia.

#### *Pythium oligandrum* sp. nov.

Intramatrical mycelium somewhat lustrous, sometimes of somewhat cumulous appearance, capable of approximately 27 mm. radial extension in 24 hours at  $24^{\circ}\text{C}$ .; composed of hyphae  $1.5$  to  $6.8\mu$  in diameter, the more delicate elements ramifying freely and developing extensively though not usually occurring in excessively compact branching systems. Under aquatic conditions extramatrical development rather profuse. Aerial mycelium usually present in some quantity, on richer substrata in moderate abundance.

Sporangia formed promptly and abundantly; terminal or more often intercalary; mostly subspherical,  $25$  to  $45\mu$  in diameter, but often consisting of a subspherical element together with a variable length usually up to  $50$  or  $75\mu$ , of filament modified little if at all, or consisting of 2 to 5 subspherical elements sometimes fused into a somewhat irregular structure, and sometimes connected by undifferentiated filamentous portions either in a series or in branching arrangement. Evacuation tube arising from any part of sporangium but especially frequently from near juncture of subspherical part with filamentous part, usually up to  $35\mu$  or more in length, mostly  $2$  to  $4\mu$  in diameter at base, generally widening to a diameter of  $3.5$  to  $6.5\mu$  toward the expanded apex. Zoospores formed mostly 20 to 50 in a vesicle, longitudinally grooved, broadly reniform, biciliate, moderately active, measuring usually  $9$  to  $10\mu$  (average  $9.4\mu$ ) after rounding up.

Oogonia terminal or intercalary, often intercalary close to tip of the supporting filament, and often laterally or tangentially intercalary; provided

with a wall approximately 0.5 to 0.7 $\mu$  in thickness; subspherical, measuring 17 to 35 $\mu$ , mostly 22 to 31 $\mu$  (average 26.4 $\mu$ ) in diameter, not including the spiny protuberances of which from 15 to 125, mostly 35 to 75, are visible in upper and equatorial aspects,—the spiny protuberances mostly 3 to 7 $\mu$  (average 3.9 $\mu$ ) in length and 1.5 to 3.5 $\mu$  (average 2.2 $\mu$ ) in diameter at base, tapering usually markedly toward the rather sharply pointed apex, sometimes somewhat irregular and jagged in profile, with membrane usually approximately 0.3 $\mu$  in thickness; in most (approximately 4 out of 5) cases developing parthenogenetically, in other cases supplied with 1 or less often 2 antheridia. Antheridium borne terminally on branch arising usually from a hypha other than the one bearing oogonium, the branch in distal portion for length of 5 to 25 $\mu$  usually closely applied to oogonium; measuring 12 to 25 $\mu$  (usually approximately 18 $\mu$ ) in length and 5.5 to 8 $\mu$  in diameter in the more inflated distal part; when relatively short usually clavate and somewhat crook-necked, when longer often divided into 2 or 3 lobes by transverse constrictions; in any case applied lengthwise closely to the oogonium, the short fertilization tube produced from near the apex. Oospore colorless or yellowish; subspherical, 15 to 30 $\mu$ , mostly 19 to 27 $\mu$  (average 23.1 $\mu$ ) in diameter; provided with a wall 0.9 to 2.2 $\mu$  (average 1.5 $\mu$ ) in thickness and containing a reserve globule 6 to 14.5 $\mu$  (average 9.6 $\mu$ ) in diameter; refringent body often not clearly in evidence, when visible often subspherical, 3 to 4.5 $\mu$  in diameter.

Isolated from discolored rootlet of *Pisum sativum* L. collected near Eden, N. Y., June, 1924.

#### **Pythium anandrum** sp. nov.

Intramatrix mycelium of radiating aspect, only slightly lustrous, capable of approximately 22 mm. radial extension in 24 hours at 24°C., composed of relatively straight axial hyphae mostly 5 to 8.3 $\mu$  in diameter, bearing shorter, more irregularly disposed ramifying branches usually 3.5 to 5 $\mu$  in diameter. Extramatrix mycelium under aquatic conditions rather meager, delicate, the hyphae often as narrow as 2 $\mu$ . Aerial mycelium absent or when present, scanty and loosely arachnoid.

Sporangia borne terminally on simple or sparingly branched filaments which measure, except in the frequently expanding distal portion, 2 to 3 $\mu$  in diameter and often up to 2 or 3 mm. in length, or later through continuation of growth by the supporting filament from immediately below the delimiting septum, sometimes occupying a lateral position; elongated, prolate ellipsoidal, measuring 18 to 40 $\mu$  (average 25.3 $\mu$ ) in diameter by 32 to 85 $\mu$  (average 50.4 $\mu$ ) in length exclusive of the usually sessile papilla of dehiscence mostly 6 to 8 $\mu$  in basal diameter and 3 to 5 $\mu$  in length; occasionally proliferous, mostly by the sporangiophore growing through the empty sporangium to produce another sporangium farther on. Vesicle usually sessile on the sporangium, developing 8 to 30 zoospores; the latter biciliate, reniform, somewhat sluggish in movement, measuring mostly 12 to 14 $\mu$  (average 13 $\mu$ ) in diameter on rounding up.

Oogonia borne terminally on branches often somewhat irregular or contorted and frequently widening toward the rather broad, usually convexly protruding delimiting septum; subspherical 12 to 33 $\mu$ , mostly 23 to 32 $\mu$  (average 28.3 $\mu$ ) in diameter exclusive of the conically spiny protuberances, of which 35 to 65 are usually visible in upper and equatorial aspects, and which on firm substrata measure mostly 2 to 4 $\mu$  (average 2.8 $\mu$ ) in basal diameter and 3 to 11 $\mu$  (average 7.1 $\mu$ ) in length, though under aquatic conditions often not exceeding 1 $\mu$  in basal diameter and 2 $\mu$  in length; provided with a

wall of moderate thickness, this thickness usually between  $0.5$  and  $0.8\mu$  becoming reduced somewhat in the spiny protuberances; constantly parthenogenetic, developing in the absence of any recognizable antheridia. Oospore colorless or yellowish, largely filling oogonium, smooth, subspherical,  $11$  to  $28\mu$ , mostly  $21$  to  $27\mu$  (average  $24.4\mu$ ) in diameter, provided with a wall  $0.8$  to  $2.1\mu$ , mostly  $1.2$  to  $1.8\mu$  (average  $1.6\mu$ ) in thickness, the reserve globule measuring  $7$  to  $16\mu$ , mostly  $10$  to  $14\mu$  (average  $12.8\mu$ ) in diameter, and the refringent body when subspherical measuring mostly  $4$  to  $5\mu$  in diameter, though frequently somewhat flattened.

Isolated from softened underground bud of *Rheum rhaponticum* L. collected near Brentwood, Md., June 13, 1924.

***Pythium mastophorum* sp. nov.**

Intramatrix mycelium without pronounced luster or radiating aspect, capable of approximately  $20$  mm. radial extension in  $24$  hours at  $24^{\circ}\text{C}$ ., consisting of hyphae  $2$  to  $7.8\mu$  in diameter, often somewhat contorted and typically disposed in haphazard, irregular course, bearing in moderate number appressoria mostly knob-shaped,  $8$  to  $12\mu$  in diameter, or less often sickle-shaped. Extramatrix growth under aquatic conditions sparse. Aerial mycelium absent or scantily developed.

Sporangia not known to be proliferous, subspherical, usually  $17$  to  $38\mu$  (average  $29.3\mu$ ) in diameter, somewhat darkly opaque, terminal or intercalary, in latter case often near tip of supporting hypha. Evacuation tube arising indiscriminately from any portion of sporangium, mostly  $15$  to  $125\mu$  in length and  $2.5$  to  $8\mu$  in diameter, often more or less contorted, sometimes bearing  $1$  or several short diverticulations, the apical portion below refringent tip widening little, if at all; frequently ineffective for discharge and then often  $0.2$  or  $0.3$  mm. in length. Zoospores formed  $3$  to  $14$  or sometimes more in a vesicle, biciliate, broadly reniform, usually somewhat sluggish in movement, after rounding up measuring  $12$  to  $14\mu$  in diameter.

Oogonium when primary in origin borne usually terminally on a branch commonly  $5$  to  $25\mu$  long, subspherical,  $24$  to  $48\mu$ , mostly  $30$  to  $41\mu$  (average  $35\mu$ ) in diameter exclusive of the spiny protuberances that number usually  $25$  to  $75$  in upper and equatorial aspects; the spiny protuberance conical or often mammiform, measuring on firm substrata  $2$  to  $8\mu$  (average  $5.2\mu$ ) in length and  $2$  to  $6\mu$  (average  $4.3\mu$ ) in diameter at the base, where its wall is often approximately  $1\mu$  in thickness to become usually noticeably attenuated toward the frequently papillate apex at which the lumen yet often becomes very narrow; under aquatic conditions protuberances more minute, often not exceeding  $2\mu$  in length and  $1\mu$  in diameter. Antheridium usually single; borne usually terminally or more rarely in intercalary position on a hypha without close connection with the oogonial branch; variously shaped, often somewhat lobate,  $7$  to  $15\mu$  (usually approximately  $12\mu$ ) in diameter and  $16$  to  $28\mu$  (usually approximately  $20\mu$ ) in length; making broad apical contact with the oogonium about the origin of a fertilization tube generally measuring  $1.5$  to  $4\mu$  in diameter and  $1.5$  to  $3\mu$  in length; the antheridium and the distal part of its supporting hypha often though not always closely engaging the oogonial stalk and the basal portion of the oogonium, the engagement sometimes made more intimate through the presence of diverticulations. Oospore colorless or somewhat yellowish; smooth, subspherical, when primary in origin measuring  $20$  to  $44\mu$ , mostly  $24$  to  $36\mu$  (average  $28.9\mu$ ) in diameter, provided with a wall  $1.4$  to  $2.3\mu$  (average  $1.8\mu$ ) in thickness, containing a re-

serve globule 12 to  $18\mu$  (average  $15.5\mu$ ) in diameter, and a refringent body subspherical or oblate ellipsoidal in shape, measuring when subspherical usually 4 to  $6\mu$  in diameter, germinating by the production of a germ tube, or under aquatic conditions, often developing as a sporangium with the discharge of contents through an evacuation tube.

Primary oogonium under some conditions frequently producing instead of an oospore, an endogenous secondary oogonium which is often similarly though usually more sparingly provided with protuberances, but is of inferior size, the smaller ones often little more than  $20\mu$  in diameter, and produces a proportionately smaller oospore, the diameter of the latter sometimes little exceeding  $15\mu$ , or occasionally gives rise to an endogenous tertiary oogonium within which the small oospore is produced.

Isolated from discolored root of *Bellis perennis* L. collected in Washington, D. C., June, 1927.

#### *Pythium polymastum* sp. nov.

Intramatrical mycelium of diffuse appearance, capable of approximately 19 mm. radial extension in 24 hours at  $24^{\circ}\text{C}$ ., consisting of hyphae 2.5 to  $9.5\mu$  in diameter, haphazard in disposition and branching habit, usually devoid of recognizable appressoria. Under aquatic conditions extramatrical mycelium sparse or nearly moderate in quantity. Aerial mycelium absent, or if present, rather scanty and floccose.

Sporangia not known to be proliferous; somewhat darkly opaque; borne on extramatrical hyphae, sometimes formed terminally, though then later often coming to have a lateral position through continuation of growth of the supporting filament, or somewhat more often originating in intercalary position frequently a short distance from tip of supporting hypha, the distal element of latter then present as an apical appendage; usually subspherical, often noticeably oblate measuring 20 to  $36\mu$  (average approximately  $30\mu$ ) in diameter, but sometimes of rather irregular shape through presence of 1 or more dome-shaped protuberances, or even composed of 2 or 3 subspherical parts fused into a lobate structure. Evacuation tube arising indiscriminately from any portion of sporangium, measuring mostly 14 to  $55\mu$  (average approximately  $30\mu$ ) in length and 4.5 to  $7.5\mu$  in diameter. Zoospores formed 2 to 12 or sometimes more in a vesicle, longitudinally grooved, biciliate, broadly bean-shaped, usually somewhat sluggish in movement, often  $18\mu$  in length and  $13\mu$  in diameter, after rounding up measuring usually 14 to  $17\mu$  in diameter.

Oogonia usually borne terminally on branches infrequently more than  $100\mu$ , usually less than  $50\mu$  and often less than  $10\mu$  long, though sometimes lateral and sessile on the parent filament; subspherical, measuring 29 to  $67\mu$ , mostly 29 to  $58\mu$  (average  $45.6\mu$ ) in diameter, exclusive of the spiny protuberances of which usually from 10 to 125 (average approximately 55) are visible in upper and equatorial aspects; the spiny protuberance conical or often characteristically mammiform, measuring 1 to  $10\mu$  (average  $5.5\mu$ ) in length and 2.5 to  $6.5\mu$  (average  $4.5\mu$ ) in diameter at the base, where its wall is 0.8 to  $1.4\mu$  in thickness to become usually noticeably attenuated toward the frequently narrowed papillate apex at which the lumen yet often becomes very narrow. Antheridia 1 to 4 in number; usually terminal on branches without close mycelial connection with the oogonium, or sometimes intercalary, then mostly intercalary a short distance from tip of supporting hypha, or sometimes lateral and sessile on the parent filament; variously shaped, broadly saccate

or cylindrical or barrel-shaped, often with diverticulate or cupulate protuberances, or sometimes markedly lobate; measuring mostly 20 to 43 $\mu$  (average approximately 27 $\mu$ ) in length and 12 to 21 $\mu$  (average approximately 15 $\mu$ ) in diameter; making broad apical contact with the oogonium about the origin of a fertilization tube sometimes approximately 4 $\mu$  long and 2.5 to 3.5 $\mu$  in diameter; 1 antheridium and the distal part of its supporting stalk sometimes closely engaging the oogonial stalk and the basal part of the oogonium. Oospore nearly colorless or somewhat yellowish, smooth, subspherical, mostly 25 to 42 $\mu$  (average 35.3 $\mu$ ) in diameter, provided with a wall 1.2 to 2.2 $\mu$  (average 1.6 $\mu$ ) in thickness, containing a reserve globule 16 to 28 $\mu$  (average 21.3 $\mu$ ) in diameter, and a refringent body, subspherical or strongly flattened, when subspherical measuring usually 4.5 to 5.5 $\mu$  in diameter.

Isolated from *Lactuca sativa* L. in Connecticut, April, 1921.

***Pythium helicoides* sp. nov.**

Intramatrical mycelium diffuse in appearance, capable of approximately 29 mm. radial extension in 24 hours at 24°C., consisting of axial hyphae measuring in actively vegetative condition 4 to 8 $\mu$  in diameter, later sometimes attaining a diameter of 9.5 $\mu$ , and of branching elements mostly 2 to 4 $\mu$  in diameter usually very extensively developed and bearing a moderately abundant supply of appressoria as clavate or knob-like terminations measuring 6 to 8 $\mu$  toward the adhering apex. Under aquatic conditions intramatrical mycelium of moderately copious development, the most delicate elements sometimes only 1.5 $\mu$  in diameter. Aerial mycelium usually well and often profusely developed, under conditions not too humid persisting without collapsing.

Sporangia regularly formed terminally, generally on long extramatrical hyphae and on branches borne mostly on the distal portions of such hyphae often in racemose or cymoid arrangement; individually later often coming into a lateral position through continued elongation of the supporting filament from immediately below the delimiting septum; subspherical or more often obovoid; measuring mostly 9 to 40 $\mu$  (average approximately 28 $\mu$ ) in transverse diameter and 17 to 45 $\mu$  (average approximately 31 $\mu$ ) in length, not including an apical papillary protuberance, approximately 6 $\mu$  in basal diameter and 4 $\mu$  in length, often present during prolonged resting periods; regularly discharging through an evacuation tube mostly 3 to 40 $\mu$  long and 3 to 9.5 $\mu$  in diameter arising from the apex, or sometimes especially following frustration of an apical tube, from an equatorial or a basal position; very often once and sometimes twice proliferous, the secondary or tertiary sporangium being formed usually within the empty envelope of its predecessor, though sometimes borne externally on a prolongation of the sporangiophore passing out through the evacuation tube. Zoospores formed usually 2 to 40 in a vesicle, longitudinally grooved, bean-shaped, biciliate, after rounding up measuring 10 to 15 $\mu$  (average 12.3 $\mu$ ) in diameter; occasionally giving rise to a secondary swimming spore through the production of an evacuation tube measuring approximately 2.8 $\mu$  in diameter and 8 $\mu$  or more in length.

Oogonium borne terminally sometimes on longer branch and sometimes on branch less than 5 $\mu$  in length, but especially often through further shortening of such branches, borne laterally as a structure sessile on the parent filament; subspherical, often broadly protruding toward the antheridium; measuring mostly 26 to 40 $\mu$  (average approximately 33 $\mu$ ) in diameter; pro-

vided with a sturdy wall approximately  $0.7\mu$  in thickness; and often retaining at maturity considerable granular residues outside of the oospore. Antheridia 1 to 4 in number; when plural, sometimes each of origin independent of the other or others, and sometimes 2, rarely more, supplied by the same branching filamentous element; in any case borne terminally on branches not closely connected with oogonial hypha, one of the branches, or its parent filament or a short vegetative branch from the parent filament or two of such elements collectively regularly winding about the oogonial hypha or the parent filament of the latter in 2 to 4 close helical turns, and occasionally, in addition, a filament closely connected with a second antheridium similarly involving a hyphal element having close mycelial relationship to oogonium; elongated, curved, cylindrical; measuring 20 to  $42\mu$  in length and 6 to  $9\mu$  in diameter; very intimately applied lengthwise to oogonium for entire length; producing a fertilization tube from navel position measuring usually 3 to  $7\mu$  in length and 2 to  $3\mu$  in diameter, occasionally widening to a diameter of  $5\mu$ . Oospore nearly colorless or more often decidedly yellowish; subspherical, measuring mostly 21 to  $32\mu$  (average approximately  $27.5\mu$ ) in diameter; provided with a wall mostly 2.5 to  $3.2\mu$  in thickness, and containing at maturity 6 to 20 reserve globules, mostly 4 to  $6\mu$  in diameter, and 2 to 4 refringent bodies, approximately  $3\mu$  in diameter.

Isolated from decaying roots of *Phaseolus vulgaris* L. collected near Pompano, Fla., March and April, 1926.

**Pythium oedochilum**<sup>\*</sup> sp. nov.

Intramatrix mycelium diffuse in appearance, capable of approximately 20 mm. radial extension in 24 hours at  $24^{\circ}\text{C}$ ., consisting of hyphae 1.8 to  $6.5\mu$  in diameter, bearing appressoria rather sparingly or often in moderate abundance as swollen clavate terminations usually curved and measuring 5 to  $7\mu$  at the adhering apex. Under aquatic conditions extramatrix mycelium of meager or sometimes of nearly moderate development. Aerial mycelium sparse, or moderately profuse, though even in latter case somewhat arachnoid; under conditions not too humid persisting without collapsing.

Sporangia regularly formed terminally on long, slender, extramatrix hyphae that measure 2 to  $4.5\mu$ , mostly about  $3\mu$ , in diameter, or terminally on branches from the distal portion of such hyphae, in either case individually later often coming to a lateral position through continued growth of the supporting hypha; in exceptional instances intercalary; subspherical, obovoid or more often ovoid, measuring mostly 17 to  $42\mu$  (average approximately  $30\mu$ ) in transverse diameter and 25 to  $48\mu$  (average approximately  $35\mu$ ) in length not including a papillary apical protuberance 6 to  $8\mu$  in basal diameter and in length, often present during resting periods; becoming discharged individually by means of an evacuation tube mostly 3 to  $32\mu$  (average approximately  $16\mu$ ) and 3.5 to  $8\mu$  (average approximately  $6\mu$ ) in diameter, arising usually from the apex but sometimes especially after functional frustration of apical tube from an equatorial or a basal position; sometimes proliferous though not abundantly so, most often once, somewhat rarely twice, usually by continuation of growth of the supporting hypha through the orifice of the evacuated membrane, and formation of another sporangium externally. Zoospores formed usually 10 to 35 in a vesicle, longitudinally grooved, bean-shaped, biciliate, after rounding up measuring 11 to  $15\mu$  in diameter.

Oogonium occasionally intercalary, but usually borne terminally on longer branch or less frequently terminally on branch less than  $5\mu$  in length, and

sometimes attached laterally to the parent filament as a sessile structure; subspherical, often with prominent protrusion directed toward antheridium and pierced centrally by the evacuation tube to yield a thick-lipped profile; measuring 19 to 39 $\mu$ , mostly 27 to 36 $\mu$  (average 31.5 $\mu$ ) in diameter; provided with a sturdy wall 0.4 to 1.1 $\mu$  (often 0.7 $\mu$ ) in thickness; sometimes retaining at maturity rather meager granular residues outside of the oospore. Antheridia 1 to 4, mostly 1 or 2, in number; borne terminally usually on branches not often exceeding 50 $\mu$  in length and generally arising from a filament not closely connected with the oogonial filament, yet occasionally arising from the oogonial hypha though at distances usually more than 40 $\mu$  from the oogonium, or sometimes sessile and borne laterally on the parent filament,—in any case involvement of a filamentous part supporting the oogonium by a filamentous part supporting an antheridium associated with that oogonium, of decidedly rare occurrence; curved, elongated cylindrical, often somewhat wavy in contour, measuring 13 to 30 $\mu$  in length and 4.5 to 8 $\mu$  in diameter; applied intimately to the oogonium lengthwise along its entire length; producing a fertilization tube usually 2 to 4 $\mu$  in length and 1.2 to 2.5 $\mu$  in diameter from a somewhat forward navel position. Oospore usually distinctly yellowish; subspherical, measuring 16 to 34 $\mu$ , mostly 23 to 32 $\mu$  (average 28.1 $\mu$ ) in diameter; provided with a wall 1.8 to 3.6 $\mu$ , mostly 2.1 to 3.2 $\mu$  (average 2.5 $\mu$ ) in thickness, and containing 5 to 20 reserve globules, mostly 4 to 6.5 $\mu$  in diameter, and refringent bodies 2.5 to 3.5 $\mu$  in diameter, numbering usually 3 to 4 at early maturity and 10 to 20 at later maturity.

Isolated from decaying roots of *Dahlia* sp. in Washington, D. C., August, 1926.

***Pythium polytylum* sp. nov.**

Intramaterial mycelium diffuse in appearance, capable of approximately 25 mm. radial extension in 24 hours at 24°C., consisting of hyphae measuring 1.9 to 7.5 $\mu$  in actively vegetative condition, later sometimes attaining a diameter of 8 $\mu$ ; the more delicate elements abundantly developed and bearing abundant appressoria as curved, swollen, clavate terminations, 6 to 8 $\mu$  in diameter at the adhering apex. Under aquatic conditions extramaterial mycelium of moderately abundant development. Aerial mycelium usually produced in moderate quantity or sometimes more copiously, and often persisting long without collapsing.

Sporangium appearing somewhat tardily; sometimes intercalary, especially laterally intercalary but usually formed terminally on long, slender extramaterial filament little given to branching, though later often coming to occupy a lateral position through continuation of growth of the supporting filament from immediately below the delimiting septum; subspherical, in case of larger examples often 28 to 33 $\mu$  in diameter not including the papillary protuberance of variable size sometimes present during resting periods; regularly discharging through an evacuation tube measuring mostly 8 to 20 $\mu$  in length and 7 to 9 $\mu$  in diameter and arising often from apex but sometimes from other positions, especially after functional frustration of apical tube; proliferous development infrequent and often absent. Zoospores formed usually 10 to 35 in a vesicle, longitudinally grooved, bean-shaped, biciliate, after rounding up measuring mostly 9.5 to 11.5 $\mu$  in diameter.

Oogonium sometimes terminal on branch generally less than 50 $\mu$ , rather often less than 5 $\mu$  in length, sometimes lateral and sessile on parent filament; subspherical, though frequently protruding broadly toward antheridia;

measuring 26 to 40 $\mu$ , mostly 29 to 37 $\mu$  (average 32.6 $\mu$ ) in diameter; provided with a wall 0.5 to 1 $\mu$  (average 0.7 $\mu$ ) in thickness. Antheridia 1 to 4, mostly 1 or 2 in number; sometimes lateral and sessile, but usually borne terminally on branches rarely more than 80 $\mu$ , mostly less than 50 $\mu$  and sometimes less than 5 $\mu$  (average approximately 25 $\mu$ ) in length, the branches arising mostly from hyphae not closely connected with oogonial filament, though sometimes arising from parent filament oogonial branch or its mycelial connections, the length of hypha intervening between the septa delimiting oogonium and antheridium usually exceeding 60 $\mu$ ,—in any case the filamentous elements supplying the sex organs only infrequently exhibiting helicoid involvement; curved, elongated cylindrical, often somewhat wavy in profile; measuring usually 15 to 40 $\mu$  (average approximately 30 $\mu$ ) in length, and 5 to 7.5 $\mu$  (average approximately 6 $\mu$ ) in diameter; intimately applied lengthwise to the oogonium, and except sometimes for a short proximal portion, applied throughout its length; producing from a navel position a fertilization tube often 3 to 4 $\mu$  in length and 2 $\mu$  in diameter. Oospore usually distinctly yellowish, subspherical, 23 to 35 $\mu$ , mostly 25 to 33 $\mu$  (average 28.8 $\mu$ ) in diameter, provided with a wall 2.1 to 3.4 $\mu$  (average 2.6 $\mu$ ) in thickness, and containing 6 to 20 reserve globules, mostly 4 to 6 $\mu$  in diameter, and 4 to 8 or more refringent bodies mostly 2.5 to 3.2 $\mu$  in diameter.

Isolated from decaying root of *Prunella vulgaris* L. collected near Delaplane, Va., August, 1926.

#### *Pythium palingenes* sp. nov.

Intramatrix mycelium diffuse in appearance, capable of approximately 26 mm. radial extension in 24 hours at 24°C., consisting of hyphae 2 to 7 $\mu$  in diameter, bearing appressoria in moderate abundance as distended, clavate or knob-like terminations mostly 5.5 to 7.5 $\mu$  in diameter toward adhering apex. Under aquatic conditions extramatrix mycelium of meager, sometimes of nearly moderate development. Aerial mycelium sometimes scanty, but more often of moderate or copious development; under conditions not too humid persisting long without collapsing.

Sporangia formed promptly and in large number; regularly formed terminally on long simple extramatrix filaments mostly 2 to 4 $\mu$  in diameter and mostly devoid of branches in the distal part, but often continuing growth from immediately below one sporangium to produce another farther on, the older one then coming to occupy a lateral position; subspherical or often somewhat ovoid, individually measuring mostly 24 to 42 $\mu$  (average approximately 33 $\mu$ ) in length and 18 to 36 $\mu$  (average approximately 29 $\mu$ ) in transverse diameter, the former dimension not including a sessile apical papilla often present during resting periods and measuring often approximately 6 $\mu$  in basal diameter and 4 $\mu$  in length; individually discharging often by means of the sessile apical papilla, but more frequently through an evacuation tube measuring exclusive of refringent tip usually 2 to 35 $\mu$  (average 8 $\mu$ ) in length and 5.5 to 10 $\mu$  (average 6.6 $\mu$ ) in diameter,—the tube arising usually from the apex, but occasionally, especially after failure of apical tube, from other positions; abundantly proliferous, both by formation of sessile or nearly sessile secondary and often tertiary sporangia within primary ones, and by growth of the supporting filaments through the orifices of the empty sporangial envelopes to produce sporangia externally,—the latter type of development frequently repeated 2 or 3 times, usually in conjunction with the former at any or all of

the serial sporangia. Zoospores produced 6 to 30 in a vesicle; longitudinally grooved, bean-shaped, biciliate, after rounding up measuring 11 to 17 $\mu$  (average 14 $\mu$ ) in diameter; individually germinating vegetatively by a germ tube usually 2 to 3 $\mu$  in diameter, or often giving rise without interposition of a vegetative phase to a secondary zoospore,—the repetitional development taking place either by direct discharge of contents through an evacuation tube 3 to 6 $\mu$  in diameter and 5 to 15 $\mu$  in length, or by the production terminally of an elongated miniature sporangium often 16 to 32 $\mu$  in length and 7 to 13 $\mu$  in transverse diameter on a germ sporangiophore mostly 2 $\mu$  in diameter and 40 to 285 $\mu$  in length. Conidia often borne in large numbers on aerial hyphae on dry substrata, generally similar to sporangia formed under aquatic conditions, though usually somewhat smaller, often intercalary as well as terminal, and usually germinating by the production of one or more germ tubes rather than giving rise to zoospores.

Oogonia sometimes borne terminally on branches up to 75 $\mu$  or more in length, more often on short stalks less than 5 $\mu$  in length, or frequently sessile on the parent filament, or intercalary, especially laterally or tangentially intercalary; nearly colorless or sometimes decidedly yellowish; subspherical, though often protruding toward antheridia; measuring 19 to 41 $\mu$ , mostly 28 to 40 $\mu$  (average 34 $\mu$ ) in diameter; provided individually with a wall 0.4 to 1 $\mu$ , mostly approximately 0.6 $\mu$  in thickness. Antheridia 1 to 4 (average 2) in number, sometimes borne laterally on hyphae as sessile structures, but more often borne terminally on branches sometimes less than 5 $\mu$ , and usually not more than 50 $\mu$  in length,—these supporting branches usually not closely connected with the oogonial filament though sometimes, like often also certain vegetative branches, wrapped about the latter in 2 or 3 close helical turns; curved cylindrical, often wavy or more markedly irregular in contour; measuring mostly 20 to 28 $\mu$  in length and 6 to 8 $\mu$  in diameter; intimately applied lengthwise to the oogonium, sometimes for entire length and sometimes only along anterior portion; producing individually an evacuation tube measuring often 2 to 4 $\mu$  in length and 2 $\mu$  in diameter, from a navel or often more forward position. Oospore usually yellowish; subspherical, measuring 18 to 37 $\mu$ , mostly 26 to 36 $\mu$  (average 31.3 $\mu$ ) in diameter; provided with a wall 1.5 to 3.5 $\mu$  (average 2.6 $\mu$ ) in thickness, and containing 5 to 30 reserve globules 3 to 6 $\mu$  in diameter, and 2 to 5 refringent bodies mostly 2.5 to 4 $\mu$  in diameter.

Isolated from roots of *Ambrosia trifida* L. collected near Delaplane, Va., August, 1926.

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