

ANOTHER NEMATODE-STRANGULATING DACTYLELLA AND SOME RELATED HYPHOMYCETES

CHARLES DRECHSLER¹

(WITH 6 FIGURES)

Among the clampless hyphomycetes subsisting by capture of motile eelworms the species that hold and subdue their prey through constriction of hyphal rings invite special interest since they possess mechanically active organs analogous to the trapping devices of such remarkable carnivorous phanerogamic plants as *Dionaea muscipula* Ellis and *Aldrovanda vesiculosa* L. In earlier papers I described nine nematode-strangulating species, assigning them to four form genera in accordance with the commonplace diagnostic features of their conidial apparatus: *Trichothecium polybrochum* (2: 535-538) being distinguished by solitary uniseptate conidia; *Arthrobotrys dactyloides* (2: 482-487) by clustered uniseptate conidia; *Dactylella doedycoides* (4: 448-456), *Dactylella heterospora* (6: 339-349), and *Dactylella stenobrocha* (10: 2-12) by solitary biseptate conidia; *Dactylella bembicodes* (2: 487-492) by mostly solitary triseptate conidia; *Dactylaria brochopaga* (2: 514-518) by clustered triseptate conidia; and *Dactylella coelobrocha* (9), as well as *Dactylella aphrobrocha* (10: 12-22), by solitary quadrisepate conidia. The nematode-strangulating *Dactylaria gracilis*, which Duddington (11) recently described in England, produces conidial apparatus much resembling that of *D. brochopaga*—the resemblance being especially close if the spore dimension shown in the figure of the British form are considered. A strangulating species clearly different from any hitherto made known came to light in several maize-meal-agar plate cultures which after being overgrown by mycelium of *Pythium debaryanum* Hesse had been further planted with pinches of leaf mold taken up in deciduous woods

¹ Pathologist, United States Department of Agriculture, Plant Industry Station, Beltsville, Maryland.

near Cumberland, Maryland, on February 6, 1951.² It was first noticed 17 days after the forest detritus had been added, an ample food supply having meanwhile become available through multiplication of several species of nematodes introduced with the partly decayed material.

When growing in nematode-infested agar plate cultures the new fungus extends its mycelium rather sparsely. The hyphae pursue relatively straightforward courses, often elongating on or close under the surface. They give rise at intervals to predacious rings which like the similar organs of all other actively strangulating forms consist of three arcuate cells and are borne on stalks usually composed of two segments. In its original position the individual ring is commonly oriented in a plane perpendicular to the parent hypha as well as to the surface of the ambient (FIG. 1, *A*; *B*, *a*; FIG. 2, *A*, *a*), and consequently is directed edgewise to the observer when it is being examined under a microscope in slabs taken from an agar plate culture. Some rings, when busted by large nematodes, are pushed sideways into oblique (FIG. 1, *C-E*; FIG. 2, *B*, *a*) or horizontal positions (FIG. 1, *B*, *b*; *F-H*; *I*, *a*, *b*; *J-R*; FIG. 2, *C*, *a*, *b*; *D-J*) in which their cellular make-up and their attachment to the stalk are better revealed. Their formative stages (FIG. 1, *T*, *a*, *b*; FIG. 2, *K*, *L*) show a sequence of development generally similar to that illustrated in *Dactylella aphrobrocha* (10: Fig. 5, *I*, *a-e*). Fully developed rings of the new fungus most closely resemble the homologous organs of *D. doedycoides* and *D. heterospora*, for as in these species the component arcuate cells have a noticeable median protrusion on their concave inner side that gives the aperture an outline suggestive of trefoil ornamentation. As in *D. doedycoides* and *D. heterospora*, again, the supporting stalks are comparatively long and somewhat slender, and the two cells composing them seem usually to differ little in size. This rangy type of stalk differs markedly from the short stout type exemplified in *D. bembicodes*, where the proximal cell most often is conspicuously shorter than the distal cell, its length, indeed, being frequently equal to only half of its own width.

² I am greatly indebted to Professor Walter F. Jeffers of the University of Maryland for his kindness in obtaining this material.

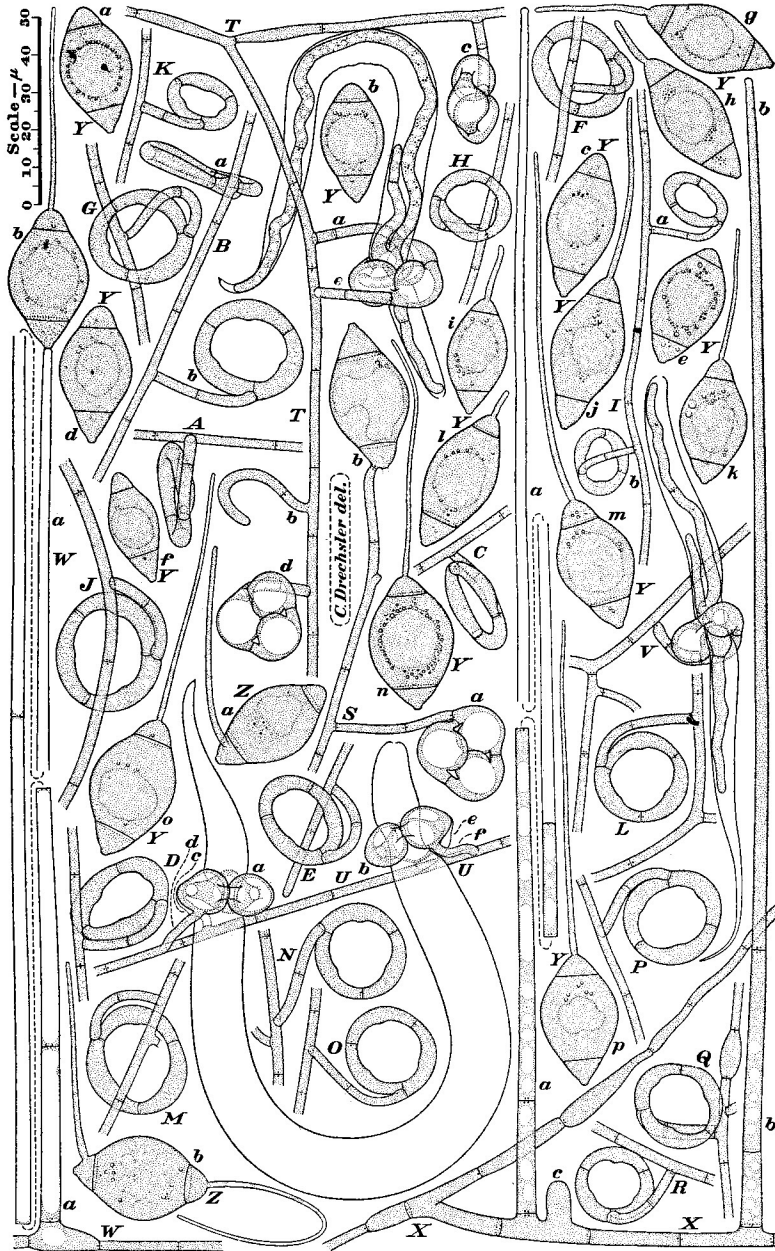


FIG. 1.

Although as in other strangulating species the rings of the new hyphomycete are found here and there to have closed emptily (FIG. 1, *S, a; T, c, d*; FIG. 2, *M, a, b*), they ordinarily operate by closing on the body of an intruding eelworm (FIG. 1, *U, a, b*; FIG. 2, *A, b, c; C, c, d*). After the struggling animal has been brought into submission through the pronounced constriction effected by the ring, its integument is penetrated and assimilative hyphae are extended forward and backward throughout its length (FIG. 1, *T, e; V*; FIG. 2, *B, b*). At first the invading hyphae are obscured badly owing to the globuliferous degeneration of musculature and organs that marks their advance. They become more clearly visible when the fleshy materials have been largely appropriated by them. As the nutrients are depleted more and more, the assimilative hyphae show increasing vacuolization. Eventually when the digestible substance of the captive has vanished entirely, leaving only the empty integument and, in males, the spicula, the assimilative hyphae likewise are evacuated of all living contents through gradual withdrawal of protoplasm backward into the parent hypha. The backward withdrawal of protoplasm takes place by way of the stalk originally supporting the ring (FIG. 1, *T, e; V*; FIG. 2, *A, b, c; B, b*) wherever this longish two-celled connection has not been seriously damaged by the struggles of the animal. In the frequent instances where the original stalk incurred severe injury it degenerates internally (FIG. 1, *U, c, e*; FIG. 2, *C, e*) and a new hyphal connection (FIG. 1, *U, d, f*; FIG. 2, *C, f*) is formed between the parent mycelial filament and one of the three swollen cells. This secondary connection continues to serve as a passageway when in their turn the three swollen cells are progressively emptied of their protoplasm.

Thus nourished through capture and destruction of eelworms the fungus gives rise from its prostrate hyphae to scattered erect conidiophores mostly 0.3 to 0.45 mm. in height (FIG. 1, *W, a; X, a, b*; FIG. 2, *N, a*). Some hyphal segments will put forth two conidiophores, either simultaneously (FIG. 2, *O, a, b*) or successively (FIG. 1, *X, a, c*). Each conidiophore bears at its tip, which sometimes is slightly inflated, a single bisepitate conidium (FIG. 1, *W, b*; FIG. 2, *N, b*) most closely resembling the conidia of *Dactylella*

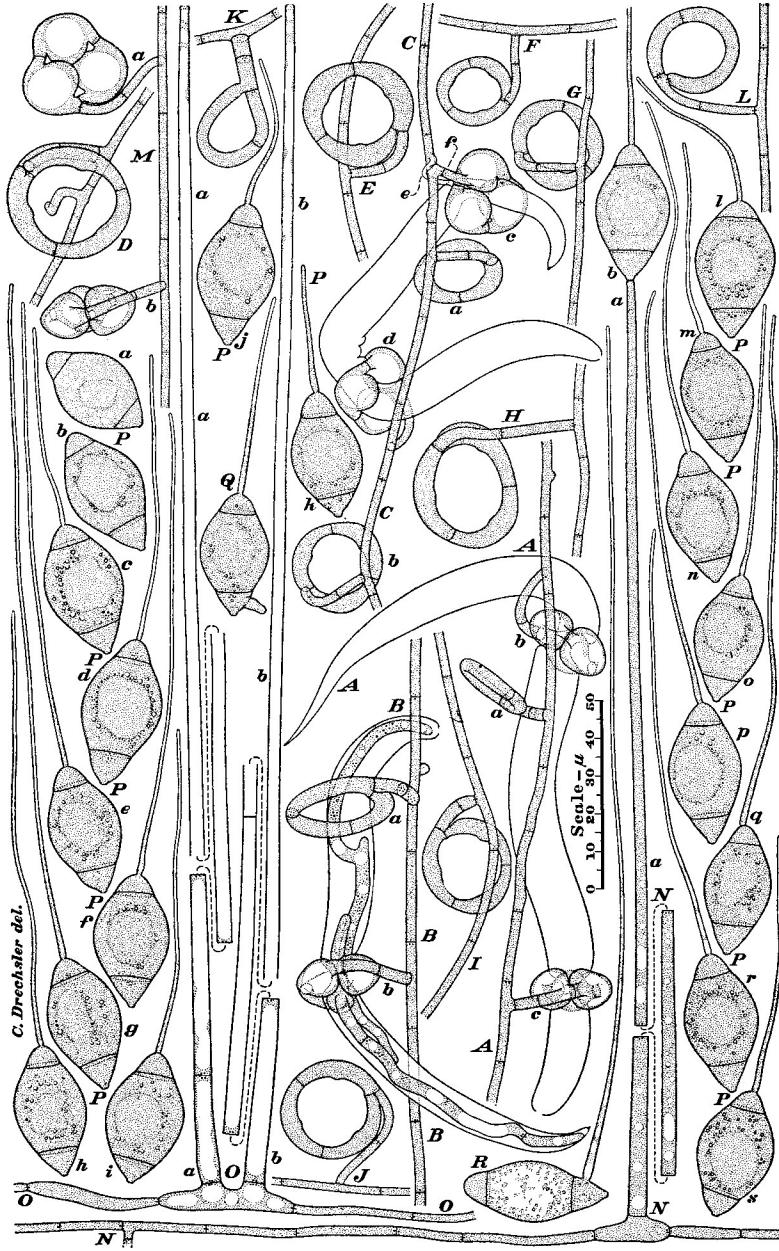


FIG. 2.

doedycoides in that it is of broadly turbinate shape and has its cross-walls placed so as to delimit a large barrel-shaped middle cell from a small basal and a small apical cell. The basal end of the detached conidium, which as a rule protrudes perceptibly from the rounded contour of the proximal segment, appears bluntly or somewhat convexly truncate in the small area of disjunction, and therefore differs rather markedly from the concave basal end in conidia of *D. doedycoides*. When sporulating tracts in nematode-infested agar plate cultures are examined under a dry objective, some of the conidia seen held aloft on conidiophores show no distal outgrowth of any kind; and such distally unmodified conidia (FIG. 1, *Y, a-f*; FIG. 2, *P, a, b*) may be found detached in moist preparations under a cover glass. However, by far the greater number of conidia produced in nematode-infested cultures have a narrow, slightly flexuous filamentous appendage that is attached at or very near the tip of the distal cell and is directed in prolongation of the spore axis (FIG. 1, *Y, g-p*; FIG. 2, *P, c-s*). Once a conidium has fallen on a moist substratum it may germinate vegetatively, it may anastomose with a mycelial hypha (FIG. 1, *S, b*), or it may put forth a filamentous outgrowth from its proximal cell (FIG. 1, *Z, a, b*; FIG. 2, *Q, R*). Although in *D. coelobrocha* conidia will often extend filamentous outgrowths liberally from positions below the large middle cell even while they are still borne aloft on their supporting hyphae, in the present fungus the individual conidium will apparently produce only its single apical appendage previous to disjunction. It seems probable that conidia lacking an apical outgrowth are still in some degree immature.

Pure cultures of the fungus are readily obtained when sterile maize meal agar is planted with conidia removed from the tall conidiophores by means of a sterile slab of agar held on a flamed platinum spatula. The conidia germinate promptly, soon giving rise to a vegetative mycelium of radiating appearance. As in many related forms hyphal anastomoses take place abundantly. After about 5 days conidiophores and conidia begin to develop. In 15 days they are usually visible to the naked eye as a somewhat extensive downy turf. While many conidiophores produced in pure culture (FIG. 3, *A, B*) are fully as tall as those found on nematode-

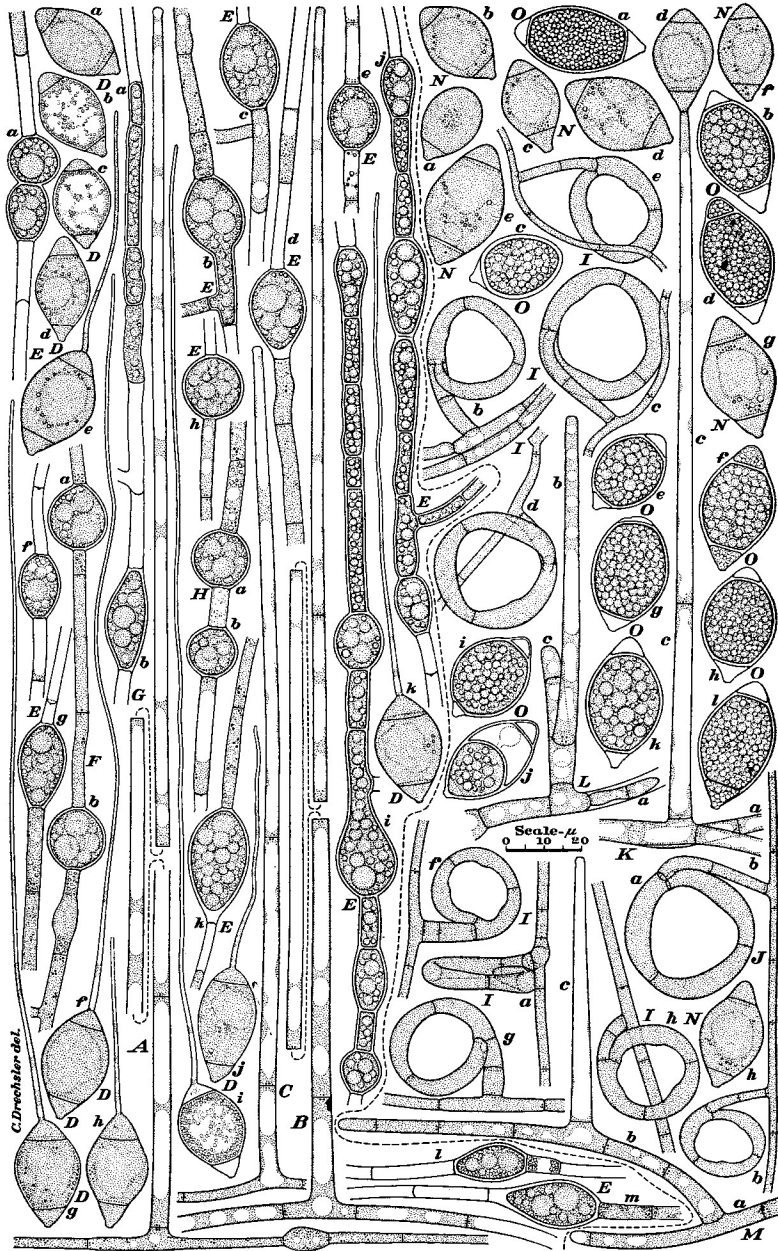


FIG. 3.

infested substratum, many others measure only 0.2 to 0.3 mm. in height, and thus may be considered of less than normal stature (FIG. 3, C). A similar tendency toward smaller dimensions is noticeable also in the conidia formed in pure culture (FIG. 3, D, a-k), yet numerous specimens here have approximately the same dimensions and cellular make-up as conidia nourished through destruction of eelworms. Some conidia have no filamentous outgrowth (FIG. 3, D, a-d), though usually the larger number are provided with an apical appendage of moderate (FIG. 3, D, e, h, j, k) or of impressive length (FIG. 3, D, f, g, i). Conidia in pure cultures 15 days old often begin to show internal modification. The less transparent contents of the broad middle segment become disposed in a thin parietal layer of granular or minutely globuliferous texture (FIG. 3, D, b, c). In some conidia the basal and apical segments undergo similar internal reorganization, but in other conidia either or both of these smaller cells suffer gradual loss of all their protoplasm (FIG. 3, D, i).

Meanwhile, more pronounced changes in texture of cellular contents have been proceeding in the subjacent mycelium, with resultant development of numerous chlamyospores (FIG. 3, E, a-m). These durable reproductive bodies are frequently composed, as in the very familiar *Arthrotrrys oligospora* Fres., of one or two somewhat thick-walled, distended intercalary cells densely filled with globuliferous contents (FIG. 3, E, a-h, k-m), but frequently, again, they consist of a more numerous chain of indurated hyphal segments (FIG. 3, E, i, j). In the longer chains some segments may be of cylindrical shape and only slightly wider than the unmodified portions of the parent hypha. Chlamyospores are sometimes separated from their nearest neighbors in the same mycelial filament by ordinary vegetative hyphal cells (FIG. 3, F, a, b), sometimes by empty cells (FIG. 3, G, a, b), and sometimes by one or more slightly indurated cells (FIG. 3, H, a, b). When fully differentiated they have a deeper yellowish coloration than the usually rather extensive complexes of inflated globuliferous cells produced in pure cultures of *Dactylella heterospora*, and more tardily also in some pure cultures of *D. doedycoides*.

The new fungus ordinarily forms no constricting rings when it grows undisturbed on maize meal agar without admixture of any

other organism. However, if a Petri plate culture is allowed to become well infested with mites predacious rings are produced abundantly (FIG. 3, *I, a-h; J, a, b*) though in the absence of nematodes these organs have no scope for profitable functioning. Conidiophores formed in mite-infested cultures (FIG. 3, *K, c; L, b; M, c*) are conspicuously shorter than those produced in nematode-infested cultures, their height commonly varying between 75 and 200 μ . After falling over on moist substratum they give rise freely to secondary and tertiary conidiophores (FIG. 3, *K-M, a-c*). The conidia borne on them (FIG. 3, *K, d; N, a-h*) seem somewhat more often undersized and deficient in normal septation than conidia produced on nematode-infested material. They very commonly lack the distal appendage so frequently present in pure cultures and in nematode-infested ones. In many instances they are converted largely or wholly into chlamydospores (FIG. 3, *O, a-l*). Most often the large middle cell alone undergoes thickening of its wall and becomes densely filled with globuliferous contents as the smaller basal and terminal cells are emptied of protoplasm (FIG. 3, *O, a, b, e, g, h, i, k*). Sometimes either the basal cell (FIG. 3, *O, l*) or the apical cell (FIG. 3, *O, c, d*) is included with the middle cell to form a bilocular chlamydospore. Occasionally all three segments of the conidium are included in the chlamydospore (FIG. 3, *N, f*), though the middle cell then, as a rule, shows more pronounced induration than the end cells. Somewhat rarely only an upper or a lower portion of the middle cell together perhaps with the adjoining end cell (FIG. 3, *O, j*) is found indurated.

A term compounded of two words, *ἀκρᾶ* and *χαίτη*, meaning "tip" and "hair," respectively, may serve as an appropriate epithet for the fungus.

***Dactylella acrochaeta* sp. nov.**

Mycelium sparsum; hyphis hyalinis, ramosis, mediocriter septatis, plerumque 1.8-4.5 μ crassis, hic illic ex ramulis bilocularibus (raro trilocularibus) 12-38 μ (vulgo 18-28 μ) longis 1.8-6 μ (plerumque 2-3.5 μ) crassis laqueos circulares 18-35 μ latos proferentibus qui in 3 cellulis arcuatis consistunt et foramen rotundum vel rotundo-triangulum vel rotundo-trifoveolatum 11-25 μ latum circumdant; cellulis arcuatis 15-30 μ longis, extremo 2.5-4.5 μ crassis, medio 4-7 μ crassis, saepius medio in latere foramen juxta gibbo praeditis; vermiculo nematoideo in laqueum apertum errato omnibus tribus cellulis

abrupte se contrahentibus, animal magnopere comprimentibus, id ita necantibus, integumentum ejus perforantibus, hyphas intus evolventibus quae carnem exhauriunt; hyphis assumentibus mox mediocriter septatis, saepius aliquid ramosis, maximam partem 2.3–4 μ crassis. Hyphae fertiles incoloratae, erectae, 75–475 μ (vulgo 325–450 μ) altae, basi 4–6.5 μ crassae, sursum leniter attenuatae, apice vulgo 2–2.5 μ crassae, interdum leviter tuberantes, ibi unum conidium ferentes; conidiis incoloratis, plerumque late fusiformibus, apice appendice filiformi praeditis, sine appendice vulgo biseptatis, plerumque 30–42 μ (saepius circa 35.3 μ) longis, 13.2–22.6 μ (saepius circa 19.5 μ) crassis, cellula infima eorum plerumque 5–9.2 μ (saepius circa 7.1 μ) longa, cellula media 17.2–26.2 μ (saepius circa 23 μ) longa, cellula summa 4–8.8 μ (saepius circa 5.2 μ) longa; appendice aliquid flexuosa, 25–250 μ (vulgo 50–150 μ) longa, basi 1.2–2 μ crassa, sursum 0.6–0.8 μ crassa. Chlamydosporae flavidae, valde globuliferae, quandoque ex 1–12 cellulis hyphae mycelii aliis globosis et usque 18 μ crassis aliis cylindraccis et 4–6 μ latis constantes, quandoque in 1–3 cellulis conidii praecipue in cellula conidii media consistentes.

Vermiculos nematoideos varios capiens consumensque habitat in humo silvestri prope Cumberland, Maryland.

Mycelium scanty, spreading; vegetative hyphae colorless, branched at moderate intervals, mostly 1.8 to 4.5 μ wide, often, especially in the presence of nematodes, giving rise on curving stalks to circular rings in usually perpendicular positions: the stalks 12 to 38 μ (commonly 18 to 28 μ) long, 1.8 to 6 μ (commonly 2 to 3.5 μ) wide, usually composed of 2 approximately equal cells, but occasionally of 3 cells; the rings, measuring 18 to 35 μ in diameter and surrounding a circular or rounded triangular or rounded trifoveolate aperture 11 to 25 μ wide, being regularly composed of 3 arcuate segments; the arcuate segments 15 to 30 μ long, 2.5 to 4.5 μ wide at the ends, 4 to 7 μ wide at the middle, very often having a protuberance in the middle on the concave side bordering the aperture—the first and third segments being united to one another as well as to the end of the stalk; on entrance of a nematode into the aperture the arcuate cells contracting abruptly, all three indenting the animal broadly and deeply, thereby strongly constricting it and soon disabling it, then perforating its integument and extending through its body assimilative hyphae mostly 2.3 to 4 μ wide, which appropriate the fleshy contents. Conidiophores colorless, erect, 75 to 475 μ (mostly 325 to 450 μ) high, 4 to 6.5 μ wide at the base, tapering gradually upward, 2 to 2.5 μ wide distally though sometimes slightly inflated at the tip, there bearing a single conidium. Conidia colorless, usually broadly spindle-shaped, bearing distally an appendage in approximate alignment with the spore axis, measuring (exclusive of the appendage) 30 to 42 μ (average 35.3 μ) in length and 13.2 to 22.6 μ (average 19.5 μ) in greatest width, commonly divided by 2 cross-walls into a small basal cell 5 to 9.2 μ (average 7.1 μ) long, a large barrel-shaped middle cell

17.2 to 26.2 μ (average 23 μ) long, and a small apical cell 4 to 8.8 μ (average 5.2 μ) long; the appendage colorless, filamentous, somewhat flexuous, continuous or meagerly septate, eventually empty or nearly empty of protoplasm, 25 to 250 μ (commonly 50 to 150 μ) long, 1.2 to 2 μ wide at the base, 0.6 to 0.8 μ wide toward the tip. Chlamydozoospores yellowish, filled with globuliferous contents, formed through induration of 1 to 12 (rarely more) hyphal cells or of 1 to 3 conidial cells; the indurated hyphal cells sometimes of cylindrical shape and measuring 7 to 35 μ in length and 4 to 6 μ in width, sometimes of subspherical or prolate ellipsoidal shape and measuring 10 to 18 μ in greatest width, but most often of intermediate shapes and dimensions; the chlamydozoospores of conidial origin consisting of the indurated middle cell together sometimes with either end cell or more rarely with both end cells.

Capturing and consuming different species of nematodes it occurs in leaf mold in deciduous woods near Cumberland, Maryland.

ACTIVITY OF DACTYLELLA HETEROSPORA IN DECAYING
GRASS REFUSE DURING WINTER

Dactylella heterospora was first obtained, though only in small quantity, from decaying grass leaves taken from a heap of lawn clippings in Arlington, Va., early in May, 1941. In my cultures other kinds of decaying plant detritus did not yield this easily recognizable fungus during the preceding 8 years or during the ensuing 10 years. The species developed in unexpected abundance in dozens of maize-meal-agar plate cultures planted with decaying grass taken at different times during January and February, 1950, from old weed piles near Beltsville, Md., and from heaps of lawn clippings in College Park, Md. Judging from the fragments of inflorescences found mixed with disintegrating leaves and culms, the weed piles contained mainly crab-grass (*Digitaria sanguinalis* (L.) Scop.), goose-grass (*Eleusine indica* (L.) Gaertn.), foxtail (*Setaria* sp.), and Bermuda grass (*Cynodon dactylon* (L.) Pers.), while the lawn clippings included chiefly Kentucky bluegrass (*Poa pratensis* L.) and crab-grass. As some portions of the decaying grass were badly infested with mites, many of the cultures were ruined within 15 or 20 days after they had been planted, but even in these short-lived cultures *D. heterospora* often developed extensively. Its generally prompt development indicated strongly that the fungus was present in the decaying material in an active state,

and that, consequently, it was operative in the destruction of nematodes during the longer periods of mild winter weather.

The conidiophores (FIG. 4, *A*) arising from prostrate hyphae in the cultures prepared with Maryland material, as well as the characteristically biseptate conidia (FIG. 4, *A, b; B-J*) borne on them, showed no noteworthy departure from the description based on

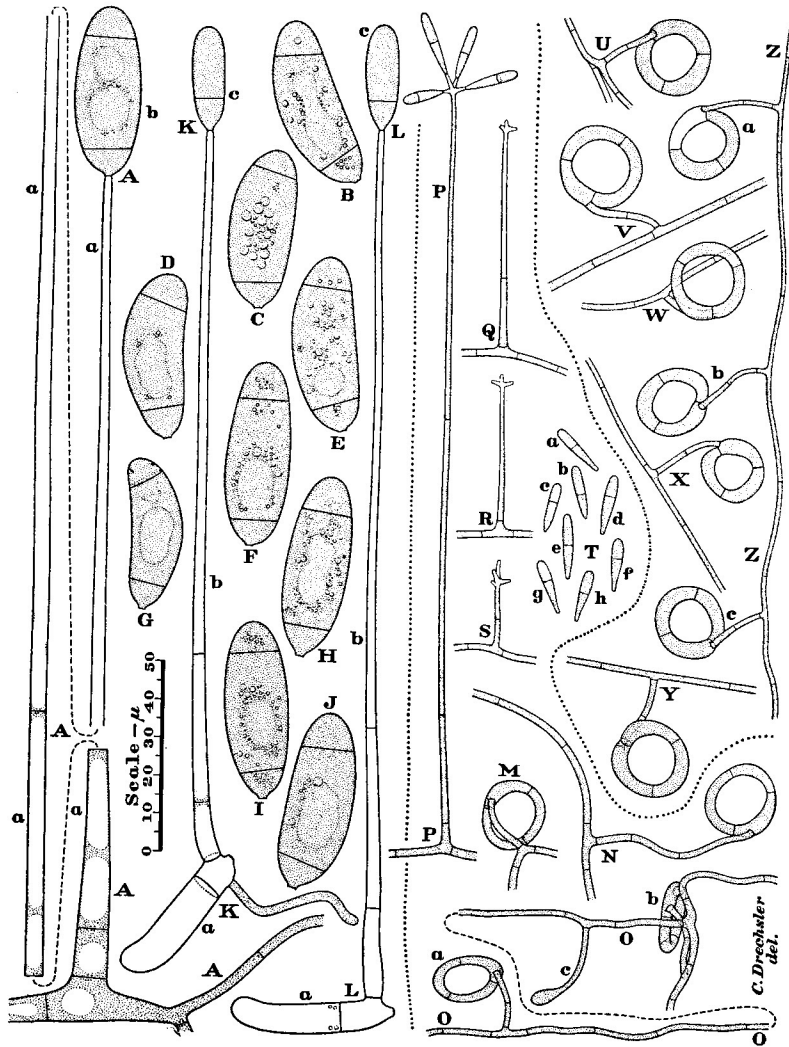


FIG. 4.

the Virginia fungus. Some of the nematode-infested cultures that were free of mites permitted repetitional development of conidia over a period of nearly 2 months. The secondary conidia formed on conidiophores sent up from fallen primary conidia were usually biseptate. Conidia of the third order (FIG. 4, *K, a*; *L, a*) appeared very frequently to be divided by only one septum, and when in their turn they gave rise individually to an erect conidiophore (FIG. 4, *K, b*; *L, b*) the small conidia of the fourth order (FIG. 4, *K, c*; *L, c*) likewise had only one cross-wall. The reduced septation and size made for closer similarity to the somewhat allantoid, regularly uniseptate conidia that in pure culture are formed on short rachiform, procumbent hyphal branches.

AN ARTHROBOTRYS-LIKE HYPHOMYCETE CAPTURING EELWORMS
IN DELICATE NON-CONSTRICTING RINGS

A maize-meal-agar plate culture which after being overgrown with mycelium of *Pythium irregulare* Buisman had been further planted with a small quantity of leaf mold taken from deciduous woods near Chester, Pa., on Feb. 14, 1950, showed 15 days later a delicate hyphomycete subsisting evidently through capture of nematodes by means of 3-celled non-constricting rings very similar to those earlier observed in my *Dactylella lysipaga* (2: 499-504), in my *Dactylella leptospora* (2: 504-508), in *Dactylaria candida* (Nees) Saccardo (2: 523-527), and in *Anulospodium nematogenum* Sherbakoff (12). The rings commonly measured 18 to 20 μ in diameter and inclosed an aperture 12 to 14 μ wide. Although occasionally supported on a 1-celled (FIG. 4, *M*) or 3-celled (FIG. 4, *N*) stalk, they were more usually borne on a 2-celled stalk (FIG. 4, *O, a, b*) measuring 15 to 25 μ in length and about 1.7 μ in width. The rather scanty mycelium, which occupied an area not exceeding 25 square millimeters, revealed no stalked adhesive knobs of the type accompanying similar predacious rings in other species. In an early stage of development the ring, much as in related forms, had somewhat the appearance of a stalked knob (FIG. 4, *O, c*).

The delicate mycelium gave rise from procumbent hyphae to sparsely scattered, erect or ascending, colorless conidiophores (FIG. 4, *P-S*) which measured 25 to 200 μ in length, 1.5 to 2.3 μ in basal

diameter and 1 to 1.2 μ in apical width. Near the tip these conidiophores commonly gave off 2 or 3 lateral spurs usually measuring 2 to 3 μ in length. Each spur as well as the axial tip bore a conidium, so that 3 or 4 conidia were held aloft in loose capitate arrangement (FIG. 4, *P*). The conidia (FIG. 4, *T*, *a-h*) were colorless, uniseptate, and of generally clavate shape. They measured mostly 13 to 17 μ in length and 1.5 to 2 μ in greatest width. Their single cross-wall was more often placed a little above the middle (FIG. 4, *T*, *a, c, d, f, g, h*) than at the middle (FIG. 4, *T*, *e*) or below the middle (FIG. 4, *T*, *b*). Many of the taller conidiophores, though at first erect, later gradually sank into a reclining position, and would then frequently put forth much shorter secondary conidiophores.

My attempts to isolate the fungus by removing its conidia to sterile agar were all unsuccessful, owing to the unfortunate circumstances that the area occupied by it was occupied also by several other predacious hyphomycetes with more robust and taller conidiophores. Consequently I was unable to determine whether the delicate *Arthrotrix*-like conidial apparatus represented a main asexual reproductive phase like that of my *A. entomopaga* (8) or a subsidiary sporulating stage comparable to the secondary conidial stage found in my *Dactylaria psychrophila* (7) and my *Dactylaria eudermata* (10). Similar difficulty was encountered earlier in a nematode-capturing hyphomycete that employed short-stalked adhesive knobs as predacious organs and gave rise to conidial apparatus best referable to *Trichothecium* (7: 166-168).

ANOTHER FUNGUS ENSNARING NEMATODES IN THICKISH
NON-CONSTRICTING RINGS

A maize-meal-agar plate culture which after being overgrown by *Pythium spinosum* Sawada had been further planted with a pinch of leaf mold taken from deciduous woods near Cumberland, Md., on Feb. 6, 1951, showed on examination 38 days later a somewhat extensive mycelium that subsisted evidently through capture of nematodes in non-constricting rings (FIG. 4, *U-Y*; *Z*, *a-c*). These rings, borne on 2-celled stalks mostly 13 to 20 μ long and 1.2 to 2.1 μ wide, measured 17 to 22 μ in outside diameter and had a

round aperture 9.5 to 15 μ wide. The three arcuate cells composing them varied in width between 2.8 and 4.8 μ , and thus were noticeably stouter than the corresponding cells in *Dactylella lysi-paga*, *Dactylella leptospora* and *Dactylaria candida*. In their more massive conformation the predacious organs here resembled the stout non-constricting rings observed earlier (10: 58-60) in agar plate cultures planted with leaf mold from Greensboro, N. C. With respect to the outside diameter of its predacious rings, however, the fungus from western Maryland agreed much more closely with the three nematode-ensnaring species to which binomials have been given than with the unnamed form occurring in North Carolina.

ANOTHER SMALL TRICHOHECIUM PARASITIZING
PYTHIUM OOSPORES

In earlier papers (3, 5) *Trinacrium subtile* Riess and two species of hyphomycetes that I described under the binomials *Dactylella spermatophaga* and *Trichothecium arrhenopum* were set forth as developing parasitically on *Pythium oospores*. Despite their commonplace appearance these fungi are of considerable interest not only because of their efficacy in destroying the resting bodies by which important plant pathogens live over in soil from year to year, but also because of their apparently close taxonomic relationship to the clamless nematode-capturing hyphomycetes. Another species of similar destructive capacity and similar kinship came to light in some maize-meal-agar plate cultures which after being overgrown by *Pythium spinosum* had been further planted with a small quantity of leaf mold taken up near Hermiston, Ore., on Aug. 20, 1947. Numerous oospores of *P. spinosum* were found occupied by relatively massive assimilative branches coming from a delicate septate mycelium (FIG. 5, A-C) that permeated the agar sparingly yet extensively. Often an expanded portion of hypha, or appressorium, was broadly in contact with the oogonial wall where this wall had been penetrated (FIG. 5, B, C) but sometimes no pronounced external enlargement of the invading hypha could be observed (FIG. 5, A). Wherever external appressoria could be recognized, they were generally found in nearly straight alignment with their supporting hyphae, and thus did not show the curious

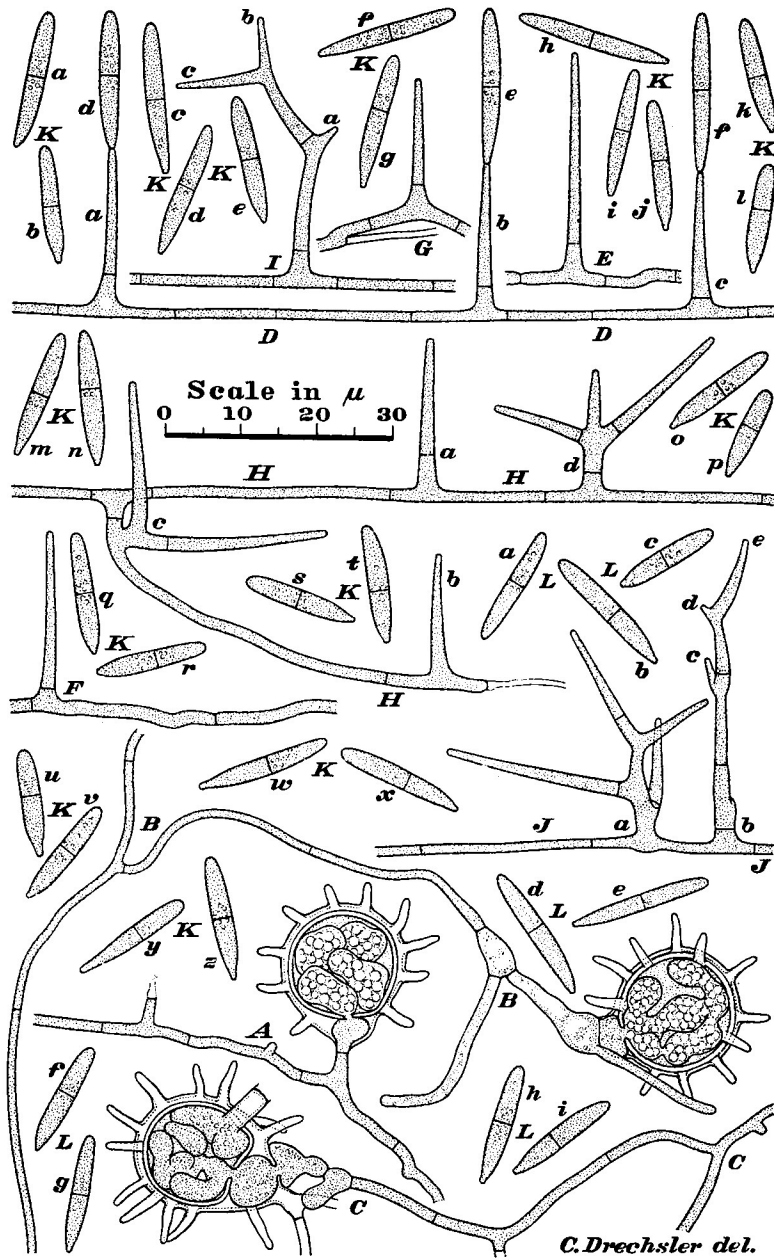


FIG. 5.

crook-necked antheridium-like conformation usual in appressoria of *Trichothecium arrhenopum*. Intimate enwrapment of the oogonium by the hypha bearing the appressorium, a characteristic feature in the parasitism of *Trichothecium arrhenopum*, was wholly absent in the Oregon fungus. In the space between the oogonial envelope and the oospore the invading hypha often showed an enlargement, which very probably represented an appressorium that had served in penetrating the oospore wall. The massive, somewhat lobulated assimilative branches contained globuliferous protoplasm while the host contents were being absorbed, but later this protoplasm was gradually withdrawn backward into the external mycelium, until in the end only the empty hyphal membrane remained within the empty envelopes of oospore and oogonium.

In the same agar plate cultures the Oregon fungus was found also parasitizing scattered individuals of the testaceous rhizopod *Arcella vulgaris* Ehrenb. and clustered cysts of a species of *Polyangium*. Although parasitism of fungi on bacteria might seem an unlikely biological relationship, cysts of Myxobacteriales produced on or under the surface of agar substratum have so often been found invaded by hyphomycetes of the predacious series that in nature they must almost certainly suffer widespread destruction from such attack. Invasion of *A. vulgaris* by the present fungus is hardly to be considered anomalous, since related hyphomycetes similarly subsisting for the most part on oospores will likewise destroy many individuals of suitable testaceous rhizopods encountered by them. Conversely, my *Dactylella passalopaga* (1) and other hyphomycetes subsisting mainly through capture of testaceous rhizopods are often abundantly destructive to oospores of such common damping-off parasites as *Pythium debaryanum*, *P. ultimum* Trow, and *P. irregulare*.

The fungus from Oregon gave rise at intervals along its procumbent hyphae to erect conidiophores (FIG. 5, *D*, *a-c*; *E-G*; *H*, *a*, *b*) generally somewhat shorter than those of *Trichothecium arrhenopum*. On each conidiophore a single conidium was produced (FIG. 5, *D*, *d-f*). Many conidiophores, in addition, gave off one (FIG. 5, *H*, *c*) or two (FIG. 5, *H*, *d*) or three (FIG. 5, *J*, *a*) branches, each of which likewise bore a terminal conidium. In

some ramified conidiophores (FIG. 5, *I*; *J*, *b*) the several sporiferous parts (FIG. 5, *I*, *a-c*; *J*, *c-e*) evidently were formed through successive branching. The conidia (FIG. 5, *K*, *a-z*; *L*, *a-i*) seemed generally shorter and narrower than those of *T. arrhenopum*, which in most other respects they resembled rather closely.

As its more commonplace manner of attacking oospores makes the fungus easily distinguishable from *Trichothecium arrhenopum* it is described as a separate species. Its assignment to the form genus typified by *T. roseum* Link is not intended to imply any intimate taxonomic kinship with that very familiar mold. The wide scope of its parasitism may perhaps be helpfully suggested in an epithet meaning "much slaying."

Trichothecium polyclonum sp. nov.

Mycelium ramosum, saepe aliquid sparsum; hyphis sterilibus incoloratis, mediocriter septatis, plerumque 1.2-1.8 μ crassis, hic illic appressoria clavata vulgo 4-6 μ crassa ad oosporas *Pythii* et rhizopoda crustosa et corpora perdurantia myxobacteriacearum apponentibus, murum perforantibus, hyphas asumentes lobosas 3-5 μ crassas intrudentibus; hyphis fertilibus erectis, incoloratis, primo simplicibus, vulgo pauce septatis, saepius 15-30 μ altis, basi 2-3 μ crassis, apice 0.6-1 μ crassis, unum conidium ferentibus, postea saepe aliquid ramosis denique 1-3 alia conidia gerentibus; conidiis incoloratis, clavulatis vel elongato-ellipticis, basi saepius aliquid attenuatis et abrupte truncatis, apice rotundatis, medio uniseptatis, plerumque 12.7-21 μ (saepe circa 16.9 μ) longis, 2.3-2.8 μ (saepe circa 2.6 μ) crassis.

Arcellam vulgarem et oosporas *Pythii spinosi* et corpora perdurantia *Polyangii* enecans habitat in humo silvestri prope Hermiston, Oregon.

Mycelium branched, often rather scanty. Vegetative hyphae colorless, septate at moderate intervals, mostly 1.2 to 1.8 μ wide, on encountering suitable hosts often forming clavate appressoria 4 to 6 μ wide, then narrowly perforating the host wall and intruding lobulated assimilative branches 3 to 5 μ wide. Conidiophores erect, colorless, at first unbranched, meagerly septate, often with only one cross-wall near the base, 15 to 30 μ high, 2 to 3 μ wide at the base, 0.6 to 1 μ wide at the tip and there bearing a single conidium, later often producing 1 to 3 branches, and on each branch bearing an additional conidium. Conidia colorless, somewhat clavate or of elongate elliptical outline, often narrowing at the abruptly truncate base, rounded at the tip, regularly divided by a cross-wall at the middle, mostly 12.7 to 21 μ (average 16.9 μ) long and 2.3 to 2.8 μ (average 2.6 μ) wide.

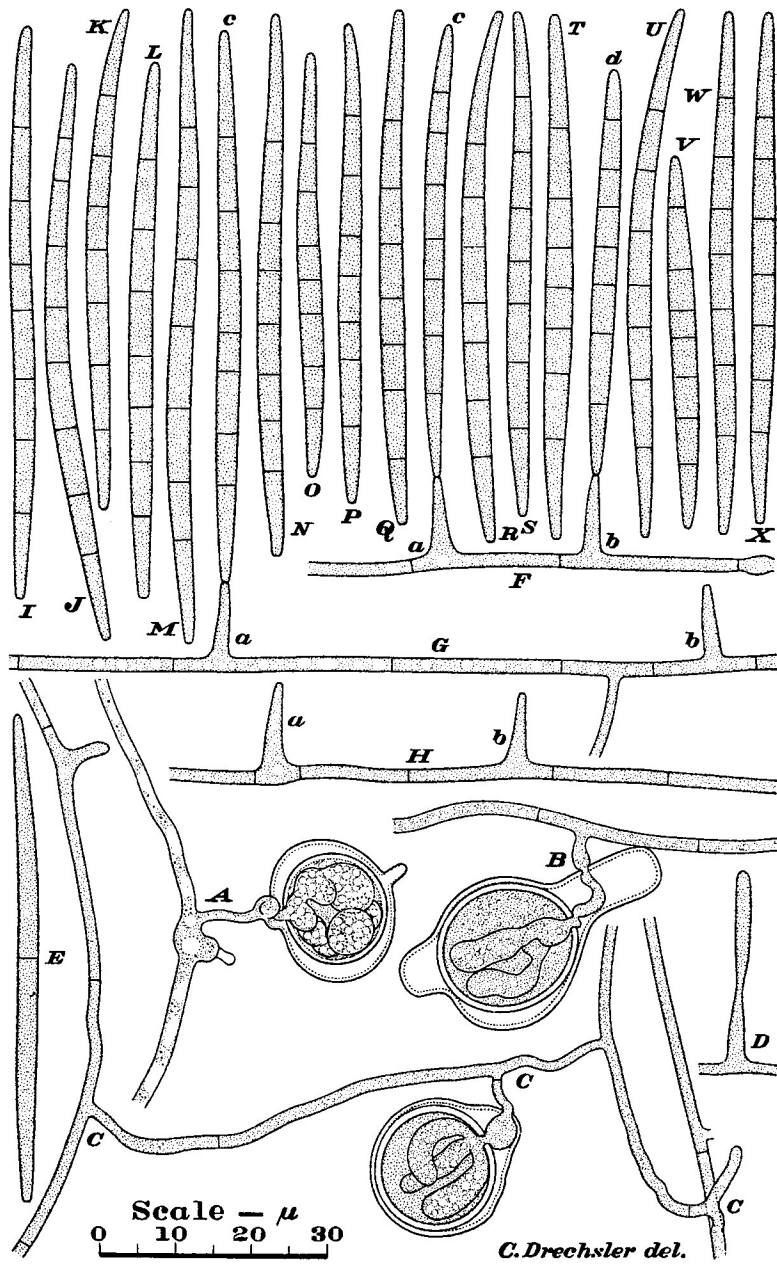


FIG. 6.

Parasitizing *Arcella vulgaris*, oospores of *Pythium spinosum*, and cysts of *Polyangium* sp., it occurs in leaf mold near Hermiston, Oregon.

A FUSARIUM-LIKE DACTYLELLA DESTRUCTIVE TO PYTHIUM OOSPORES

A maize meal-agar plate culture which after being overgrown by *Pythium debaryanum* had been further planted with leaf mold taken up near Provo, Utah, late in the summer of 1947, showed on examination 45 days later many oospores of the *Pythium* destroyed by a colorless septate mycelium generally similar to that of *Trichothecium polycitonum*. Penetration of the oogonial envelope was here usually accomplished with little (FIG. 6, A, B) or no external enlargement (FIG. 6, C) of the invading hypha. Within the oogonial chamber the invading hypha was in some instances modified very little before it penetrated the oospore wall (FIG. 6, A, B) but in other instances it showed a fairly large appressorium (FIG. 6, C). After the oospore wall was narrowly perforated assimilative branches of lobulate or broadly digitate shape were intruded into the protoplasmic interior. Gradual appropriation of the spore contents and withdrawal of all living material backward into the external mycelium followed much as in destruction of oospores by *T. polycitonum*. Zygosporangia of the zoopagaceous parasite *Cochlonema megalosomum* Drechsl. that were grouped here and there in the agar culture around collapsed pellicles of *Amoeba verrucosa* Ehrenb. were attacked and parasitized in the same way.

In initiating asexual reproduction prostrate hyphae of the fungus extended erect branches noticeably constricted about $10\ \mu$ above the base (FIG. 6, D). A cross-wall at the constriction soon delimited the longer distal portion as a conidium, which after being divided first by a median septum (FIG. 6, E) usually underwent further partitioning into 8 subequal cells. The procumbent filaments thus came eventually to support at intervals relatively short spurs (FIG. 6, F, a, b; G, a, b; H, a, b) each of which bore a slender 7-septate (FIG. 6, F, c, d; G, c; I; K-X) or occasionally 8-septate (FIG. 6, J) conidium rather suggestive of *Fusarium*, though lacking the curious basal modification frequent in that genus. In view of the

equally perplexing resemblance to *Fusarium* that is evident in conidia more particularly of the nematode-capturing *Dactylella leptospora* and the rhizopod-capturing *D. passalopaga*, the Utah fungus would seem, despite its ambiguous appearance, to belong taxonomically with the clampless predacious hyphomycetes. The epithet, meaning "like a worm," that is here applied to it, is intended to have reference to the conformation of its spores.

***Dactylella helminthodes* sp. nov.**

Mycelium sparsum, ramosum; hyphis sterilibus incoloratis, mediocriter septatis, plerumque 1-2.5 μ crassis, hic illic ramulos assumentes inflatos vel lobosos et vulgo 3-6 μ crassos in sporas perdurantes intrudentibus; hyphis fertilibus incoloratis, erectis, plerumque circa 10 μ altis, basi saepius 2-3 μ crassis, sursum attenuatis, apice circa 1 μ crassis, ibi unum conidium ferentibus; conidiis hyalinis, elongato-fusoideis, basi rotundo-truncatis, apice rotundatis, vulgo 7-septatis, rarius 8-septatis, plerumque 53-84 μ (saepe circa 67.3 μ) longis, 2.8-3.7 μ (saepe circa 3.1 μ) crassis.

Oosporas *Pythii debaryani* et zygosporas *Cochlonematis megalosomi* enecans habitat in humo silvestri prope Provo, Utah.

Mycelium sparse, branched; vegetative hyphae colorless, septate at moderate intervals, mostly 1 to 2.5 μ wide, here and there intruding into indurated resting spores inflated or lobulated assimilative branches commonly 3 to 6 μ wide; conidiophores colorless, erect, mostly about 10 μ high, 2 to 3 μ wide at the base, tapering upward, at the tip about 1 μ wide and there bearing a single conidium; conidia colorless, elongated fusiform, somewhat convexly truncate at the base, rounded at the tip, usually 7-septate and occasionally 8-septate, measuring mostly 53 to 84 μ (average 67.3 μ) in length and 2.8 to 3.7 μ (average 3.1 μ) in greatest width.

Parasitic on oospores of *Pythium debaryanum* and on zygosporas of *Cochlonema megalosomum* it occurs in leaf mold near Provo, Utah.

LITERATURE CITED

1. Drechsler, C. A *Fusarium*-like species of *Dactylella* capturing and consuming testaceous rhizopods. Jour. Washington Acad. Sci. 26: 397-404. 1936.
2. ——. Some hyphomycetes that prey on free-living terricolous nematodes. Mycologia 29: 447-552. 1937.
3. ——. Two hyphomycetes parasitic on oospores of root-rotting oomycetes. Phytopathology 28: 81-103. 1938.
4. ——. Three new hyphomycetes preying on free-living terricolous nematodes. Mycologia 32: 448-470. 1940.

5. —. Another hyphomycetous fungus parasitic on *Pythium* oospores. *Phytopathology* 33: 227-233. 1943.
6. —. A new nematode-capturing *Dactylella* and several related hyphomycetes. *Mycologia* 35: 339-362. 1943.
7. —. Three hyphomycetes that capture nematodes in adhesive networks. *Mycologia* 36: 138-171. 1944.
8. —. A species of *Arthrobotrys* that captures springtails. *Mycologia* 36: 382-399. 1944.
9. —. A nematode-strangling *Dactylella* with broad quadrisepate conidia. *Mycologia* 39: 5-20. 1947.
10. —. Several species of *Dactylella* and *Dactylaria* that capture free-living nematodes. *Mycologia* 42: 1-79. 1950.
11. **Duddington, C. L.** Further records of British predacious fungi. II. *Trans. Brit. Mycol. Soc.* 34: 194-209. 1951.
12. **Sherbakoff, C. D.** A new fungus parasitic on nematodes. *Mycologia* 25: 258-262. 1933.

EXPLANATION OF FIGURES

FIG. 1. *Dactylella acrochaeta*, drawn at a uniform magnification with the aid of a camera lucida from nematode-infested agar plate cultures; $\times 500$ throughout. *A*, Portion of hypha with a constricting ring in normal position. *B*, Portion of hypha with one ring, *a*, in normal position and another, *b*, turned flatwise. *C-E*, Portions of hyphae, each with a ring in oblique position. *F-H*, Portions of hyphae, each with a ring turned flatwise. *I*, Portion of hypha with two rings, *a* and *b*, turned flatwise. *J-R*, Portions of hyphae, each with a ring turned flatwise. *S*, Mycelial hypha that bears a closed ring, *a*, on an unusually long stalk and that has anastomosed with a conidium, *b*. *T*, Portion of mycelium with two rings, *a* and *b*, in early stages of development; with two rings, *c* and *d*, that have closed empty; and with one ring, *e*, that has killed and invaded an eelworm possibly referable to *Plectus* sp. *U*, Hypha with two rings, *a* and *b*, that have captured an eelworm; the stalk *c* of ring *a* having degenerated, a secondary connection, *d*, has been formed; the stalk *e* of ring *b* having also degenerated has been replaced by a secondary connection, *f*. *V*, Portion of mycelium bearing a ring on its original stalk; the ring has closed on an eelworm and extended assimilative branches into it. *W*, Portion of prostrate hypha with an erect conidiophore, *a*, bearing a conidium, *b*. *X*, Portion of prostrate hypha with two erect denuded conidiophores, *a* and *b*, and with a third, *c*, in very early stage of growth. *Y*, Conidia; some of them, *a-f*, without appendages; others, *g-p*, having each an apical appendage. *Z*, Conidia, *a* and *b*, that after falling on moist substratum are extending an outgrowth from the basal cell. (Owing to lack of space the conidiophores *W*, *a*, and *X*, *a*, are shown in parts whose proper connection is indicated by broken lines.)

FIG. 2. *Dactylella acrochaeta*, drawn at a uniform magnification with the aid of a camera lucida from nematode-infested agar plate cultures; $\times 500$ throughout. *A*, Portion of hypha with an open ring, *a*, in normal vertical position, and two closed rings, *b* and *c*, that have captured an eelworm. *B*, Portion of hypha with an open ring, *a*, turned slightly sideways, and a closed

ring, *b*, that has caught an eelworm and extended assimilative hyphae into it. *C*, Portion of hypha with two open rings, *a* and *b*, turned flatwise, and two closed rings, *c* and *d*, that have jointly captured a nematode; the stalk *e* of ring *c* having degenerated, a new connection, *f*, has been formed. *D-J*, Portions of hyphae, each with a ring turned flatwise. *K, L*, Incompletely developed rings. *M*, Portion of hypha with one closed ring, *a*, turned flatwise and with another, *b*, in normal position. *N*, Prostrate hypha with an erect conidiophore, *a*, bearing a conidium, *b*. *O*, Prostrate hypha with two denuded conidiophores, *a* and *b*. *P*, Conidia; some of them, *a* and *b*, without an appendage; others, *c-s*, having each an apical appendage. *Q, R*, Conidia, each with an outgrowth arising from its basal cell. (Owing to lack of space the conidiophores *N, a*, and *O, a* and *b*, are shown in parts whose proper connection is indicated by broken lines.)

FIG. 3. *Dactylella acrochaeta*, drawn at a uniform magnification with the aid of a camera lucida; $\times 500$ throughout. *A-H*, Parts developed in pure culture on maize-meal-agar plates: *A-C*, Portions of prostrate hyphae, each with a denuded conidiophore; owing to lack of space the conidiophores in *A* and *B* are shown in parts whose proper connection is indicated by broken lines. *D*, Conidia; some, *a-d*, without an appendage; others, *e-k*, bearing an apical appendage. *E*, Chlamydo-spores, *a-m*, consisting of a single indurated segment or of several such segments in a continuous series. *F-H*, Portions of hyphae in which two chlamydo-spores, *a* and *b*, are separated by one or more segments. *I-O*, Parts developed in maize-meal-agar plate cultures 40 to 45 days old and well infested with mites: *I*, Portions of hyphae, each with an open ring; one of the rings, *a*, shown in normal position; the others, *b-h*, turned flatwise. *J*, Portion of hypha with two open rings, *a* and *b*, turned flatwise. *K*, Portion of a primary conidiophore, *a*, with proximal portion of a secondary conidiophore, *b*, from which arises a tertiary conidiophore, *c*, bearing a conidium, *d*. *L*, Portion of a prostrate conidiophore, *a*, from which has arisen the denuded secondary conidiophore *b* that has begun putting forth a tertiary conidiophore, *c*. *M*, Distal portion of a prostrate primary conidiophore, *a*, from which was extended the secondary conidiophore *b* that supports a denuded tertiary conidiophore, *c*. *N*, Conidia, *a-h*, without any appendage. *O*, Conidia, *a-l*, partly or wholly converted into chlamydo-spores.

FIG. 4. Drawn at a uniform magnification with the aid of a camera lucida; $\times 500$ throughout. *A-L*, *Dactylella heterospora*: *A*, Portion of mycelium with a conidiophore, *a*, bearing a conidium, *b*. *B-J*, Conidia that were produced on conidiophores arising from prostrate hyphae. *K-L*, Conidia apparently of third order, *a*, each with an erect germ conidiophore, *b*, on which is borne a conidium of the fourth order, *c*. *M-T*, Unnamed *Arthrotrix*-like nematode-capturing hyphomycete: *M, N*, Portions of mycelial hyphae, each with a stalked non-constricting ring. *O*, Portion of mycelium with two completed rings, *a* and *b*, and a third, *c*, in an early stage of development. *P*, Tall conidiophore bearing four conidia. *Q-S*, Shorter conidiophores in denuded state. *T*, Detached conidia, *a-h*, showing variations in shape and position of cross-wall. *U-Z*, Unnamed nematode-capturing hyphomycete with thickish non-constricting rings: *U-Y*, Portions of hyphae, each bearing a ring. *Z*, Longer portion of hypha bearing three rings, *a-c*. (Owing to

lack of space the conidiophore *A*, *a*, and the mycelium *O* are shown in parts whose proper connection is indicated by broken lines.)

FIG. 5. *Trichothecium polyctonum*, drawn to a uniform magnification with the aid of a camera lucida; $\times 1000$ throughout. *A-C*, Portions of mycelium, each showing invasion of an oospore of *Pythium spinosum*. *D*, Portion of hypha with three simple conidiophores, *a-c*, bearing the conidia *d-f*, respectively. *E-G*, Portions of hyphae, each with a denuded simple conidiophore. *H*, Portion of hypha with two simple conidiophores, *a* and *b*, and two branched conidiophores, *c* and *d*. *I*, Portion of hypha bearing a branched conidiophore with three successively formed tips, *a-c*. *J*, Portion of hypha with one ramified conidiophore, *a*, that shows no obvious sequence of branching, and another conidiophore, *b*, that shows successive subapical branching in forming its three denuded tips, *c-e*. *K* (*a-z*), *L* (*a-i*), Detached conidia showing variations in size and shape.

FIG. 6. *Dactylella helminthodes*, drawn to a uniform magnification with the aid of a camera lucida; $\times 1000$ throughout. *A-C*, Portions of mycelium, each showing invasion of an oospore of *Pythium debaryanum*. *D*, Portion of prostrate hypha with a young conidiiferous branch. *E*, Detached immature conidium divided only by a single cross-wall. *F*, Portion of hypha with two conidiophores, *a* and *b*, bearing the conidia *c* and *d*, respectively. *G*, Portion of mycelium with two conidiophores *a* and *b*, the former bearing a conidium, *c*. *H*, Portion of hypha with two denuded conidiophores, *a* and *b*. *I-X*, Detached conidia showing usual variations in shape and size, all containing seven cross-walls except *J*, which contains eight.