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A NEW NEMATODE-CAPTURING DACTYLELLA AND SEVERAL RELATED HYPHOMYCETES

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(WITH 4 FIGURES)

In two earlier papers (**2**, **3**) descriptive accounts were given of twenty-one interrelated mucedinaceous fungi observed capturing and consuming actively motile eelworms in transparent agar plate cultures planted with softened discolored rootlets or, at times, with various other decaying materials. A twenty-second mucedinaceous fungus of similar predaceous character and having taxonomic kinship in the same intimate series is described herein as a new species. Occasion is taken to describe likewise as new species three hyphomycetous forms which together with a fourth form identified as *Dactylaria pulchra* Linder (**7**) apparently also belong in the series, though so far none of the four have been demonstrated either to capture microscopic animals or to subsist habitually as parasites.

ANOTHER CONSTRICTING DACTYLELLA WITH BROAD BISEPTATE CONIDIA

A maizemeal-agar plate culture that after being permeated with mycelium of *Pythium ultimum* Trow had received on May 13, 1941, some addition of decaying bluegrass leaves taken three days earlier from a heap of lawn clippings in Arlington, Va., revealed on May 27 a sparse array of tall colorless conidiophores, each bearing terminally a single large biseptate colorless conidium of distinctive prolate ellipsoidal shape. In accordance with expectations suggested by their general resemblance to the fertile hyphae more especially of the nematode-capturing species I presented earlier as *Dactylella bembicodes* (**2**) and *D. doedycoides* (**3**), the tall conidiophores were found arising from a mycelium that manifestly was nourished on the fleshy contents of eelworms held fast and strangled by it. During the ensuing two weeks the predaceous mycelium spread throughout the Petri plate culture, giving rise here and there to additional conidial apparatus in quantity commensurate with the somewhat meager supply of living prey. Since this prolonged development took place at laboratory temperatures ranging between 28° and 32° C.—at temperatures mostly too high for abundant predaceous development of any large-spored *Dactylella* then known to capture eelworms—it was evident that the fungus here concerned differed from familiar allied species in its thermal adaptations as well as in the outward form of its conidia. Pure cultures obtained through removal of the conidia to sterile agar media soon brought to light accessory reproductive bodies expressive of further distinctiveness.

In pure culture on maizemeal agar the fungus grows with moderate rapidity to produce a colorless mycelium composed of branching hyphae divided by cross-walls into segments of moderate lengths. Owing to a somewhat promiscuous arrangement of the hyphae the mycelium in the transparent medium has a dull appearance without the luster usual in mycelia of such species as *Arthrobotrys dactyloides* Drechsl. and *Dactylaria brochopaga* Drechsl. (**2**), both of which extend their filaments in more nearly parallel arrangement. The younger hyphae contain clear homogeneous protoplasm wherein granules of variable size are distributed rather sparingly. During the younger stages of hyphal development, no less than during the later increasingly vacuolate stages, the pore of each septum is guarded on both sides by granules of the type discussed by Buller (**1**: p. 128) as "Woronin bodies." Ordinarily when maizemeal-agar cultures are kept free of alien organisms and protected against mechanical disturbances they show no development of special apparatus for capture of prey.

Nematode-infested agar cultures afford only rather sparse mycelial development of the fungus. Along the straightforward rangy hyphae creeping over the infested substratum, or lying horizontally submerged under its surface, predaceous organs are produced which, as in *Arthrobotrys dactyloides*, *Dactylella bembicodes*, *D. doedycoides*, *Dactylaria brochopaga*, and *Trichothecium polybrochum* Drechsl. (**2**), consist of three-celled constricting rings, each attached by a curving two-celled stalk. Although these rings commonly originate in positions beneath the parent filament and in planes approximately at right angles to it, they often are jostled by passing nematodes into more nearly horizontal postures, so that their cellular make-up may then conveniently be viewed flatwise (FIG. 1, *A*, *a*, *b;* *B*, *a*, *b;* *C–F*). When a ring is thus viewed the aperture framed by the inner contour of its three arcuate segments is not smoothly circular or smoothly elliptical like the outer contour, but appears in some degree scalloped, owing to the presence of a median thickening on the inner side of each segment. Usually, as in other species, the arcuate segment of distal origin anastomoses somewhat more broadly with the arcuate segment of proximal origin than with the adjacent distal cell of the stalk. The stalk itself most closely resembles that of *D. doedycoides*, being perceptibly longer and slenderer than the homologous part of any of the four other species so far made known as capturing eelworms by means of constricting rings. Naturally the somewhat greater length of the stalk entails no difference in the manner in which the remarkable annular trap closes upon an intruding animal. The three arcuate cells here, just as in the short-stalked species, swell and contract abruptly to hold the hapless animal and at the same time to bring about its disablement promptly, so that the assimilative hyphae may the sooner be extended into its fleshy body. In some instances, especially where the prey is relatively small and weak, subsequent development likewise follows the same course as in the short-stalked forms—the fungus protoplasm elaborated by the assimilative hyphae at the expense of the animal's substance, being transferred to the parent mycelium by way of the stalk (FIG. 1, *G*). However, in other instances, especially where a comparatively large and vigorous captive has been taken, the stalk suffers injury from the animal's struggles. To remedy such injury a new hyphal connection is established. If, for example, the proximal cell of the stalk has been damaged severely enough to require evacuation of its contents, the distal cell may extend a short branch obliquely backward to anastomose with the parent filament (FIG. 1, *H*), thereby opening a new avenue for movement of elaborated protoplasm. If the stalk as a whole has been subject to severe wrenching, a new hyphal connection may be formed to unite the parent filament with the swollen distal segment of the ring (FIG. 1, *I, a*). It seems probable moreover, that even where the stalk has not been perceptibly damaged an additional hyphal communication is frequently formed merely to furnish a supplementary channel for transfer of the materials elaborated in the expropriation of a large captive. Replacement of an injured stalk, or on occasion, presumably, development of a supplementary connection, occurs likewise in *D. doedycoides;* the published figure of that species showing a ring that after having functioned in the capture of a nematode had established a second connection between its proximal swollen cell and the parent filament (**3**: p. 455, FIG. 1, *H*).

After the mycelium in a nematode-infested culture has been active for some time in destroying prey, it gives rise here and there to erect conidiophores (FIG. 1, *J, a, b; K*) generally similar to those of *Dactylella bembicodes*. They resemble, with respect to stature and septation, also the conidiophores of *D. doedycoides*, but as a rule lack the bulbous apical modification which suggested the epithet of that species. Like the tall conidiophores of *D. doedycoides*, again, they bear large, predominantly biseptate, solitary conidia (FIG. 1, *J, a; L, a–u*), consisting typically of a small basal cell, a large median cell, and a small apical cell. When its primary function has been served, a conidiophore usually falls over on to the substratum, and then often sends up from one or another of its wider basal segments a new conidiophore of similar stature. Occasionally, indeed, an old conidiophore may by lateral branching from a basal segment give rise to a new one even while it is still maintaining a more or less erect posture.

Although the large conidia of the present fungus resemble the homologous spores of *Dactylella doedycoides* with respect to septation, they are distinguished from the latter not only by their generally greater length and lesser diameter, but also by their prolate ellipsoidal rather than broadly turbinate shape. Viewed at an angle perpendicular to its axis, the detached conidium, like that of *D. doedycoides*, presents at its base a sharply truncate outline along the plane of disarticulation. A minute but distinct basal protrusion, absent in *D. doedycoides*, removes the truncate portion of profile from alignment with the main elliptical profile of the spore. After falling on moist agar substratum the detached conidia germinate readily, often putting forth one (FIG. 1, *M*) or two (FIG. 1, *N*) germ tubes from the basal segment, or emitting a germ tube from both the basal and the terminal cell (FIG. 1, *O*). Frequently, again, germination takes place by the production of a germ conidiophore on which is borne a secondary conidium similar to the primary one except in its noticeably smaller dimensions (FIG. 1, *P*).

Erect aerial conidiophores of the same type as those produced sparingly by the fungus in nematode-infested cultures are formed more abundantly in pure cultures prepared with maizemeal agar (FIG. 2, *A*, *B*). Some little tendency toward reduced height is often recognizable here in an increased proportion of moderately short conidiophores. Often, too, the conidiophores formed in pure culture appear less markedly differentiated from mycelial hyphae than in eelworm-infested cultures; the lesser differentiation coming to light in smaller basal diameter, reduced tapering, greater apical width, and more frequent haphazard flexures. This obliteration of structural features ordinarily distinguishing filaments given over to production of the large conidia is even accompanied now and then by loss of the erect aerial habit; for in pure cultures some conidiophores are produced completely submerged under the surface of the maizemeal-agar medium and in positions parallel with this surface. Such intramatrical development of conidiophores has not hitherto been observed in any other member of the predaceous series of hyphomycetes, though several hyphomycetes parasitic on nematodes, including *Harposporium anguillulae* Lohde and the species I described (4) under the binomials *H. helicoides*, *H. oxycoracum*, *H. diceraeum*, and *Meria coniospora* readily form their conidia within a soft agar medium, especially in instances where the animal host has succumbed well below the surface.

The large conidia borne intramatrically on submerged hyphae, as also the similar conidia (FIG. 2, *C*, *a–z*) produced in pure culture on the tall erect hyphae, show no marked difference with respect to size, shape, septation, or germination (FIG. 2, *D*, *a*, *b*), from those formed in nematode-infested cultures. In mounts made from actively sporulating cultures, a small proportion of the conidia referable to the type under consideration contain only a single cross-wall (FIG. 1, *L*, *a*, *b*, *c;* FIG. 2, *C*, *b*, *h*, *q*, *r*, *s*, *w*) which nearly always corresponds in position to the basal cross-wall of the preponderant biseptate specimens. Since, for the most part, absence of a second cross-wall would seem attributable here to immaturity, it was deemed advisable not to include either uniseptate or unseptate specimens of the large conidia in making the measurements utilized in drawing up the diagnosis. The relevant metric data submitted in the diagnosis are thus based wholly on measurements of biseptate specimens, 100 in number, whereof 50 were taken at random from a pure culture, and 50 from a nematode-infested culture. The 100 values for length, expressed to the nearest integral number of microns, are distributable as follows: 35 μ, 1; 36 μ, 6; 37 μ, 9; 38 μ, 10; 39 μ, 12; 40 μ, 20; 41 μ, 17; 42 μ, 10; 43 μ, 6; 44 μ, 5; 45 μ, 2; 46 μ, 1; 47 μ, 1; while the values for width are distributable thus: 13μ, 4; 14 μ, 3; 15 μ, 16; 16 μ, 27; 17 μ, 28; 18 μ, 13; 19 μ, 5; 20 μ, 4.

After development of large conidia is well under way, the fungus in pure culture on maizemeal-agar plates gives rise at the tips of prostrate filaments (FIG. 2, *E*, *a*) and more especially at the tips of short lateral branches (FIG. 2, *E*, *b–e*) borne at intervals on such filaments, to smaller, elongated, somewhat curved, regularly uniseptate conidia (FIG. 2, *F*, *a–z*). The individual filament or branch, having formed one of these smaller conidia, continues development by growing out laterally a short distance below its tip, and on the tip of the spur thus produced forms a second, similarly uniseptate, elongated, curved conidium. With repetition of the process additional conidia are formed, and the sporiferous element is prolonged into a rather crooked, prominently spurred rachis. The elongating rachis soon comes to lie in large part prostrate on the surface of the substratum, although the two or three youngest spurs retain usually an erect or ascending posture, and as a result the young conidia attached to or being produced on them are commonly found extending into the air. Disarticulation evidently takes place very readily, for the mature conidia are mostly found strewn about on the substratum near the denuded rachis from which they came.

Detached conidia of the smaller type are not sharply truncate at the base like the larger conidia, but usually have a profile that is only a little less smoothly rounded at the proximal end than at the distal end. The single cross-wall dividing them is most often laid down somewhat below the middle, though its insertion in an approximately median position is not infrequent (FIG. 2, *F*, *a*, *e*, *h*, *s*, *t*, *y*). Now and then it is placed slightly above the middle (FIG. 2, *F*, *c*, *i*), or, again, so far below the middle that the distal segment may be nearly three times as long as the proximal segment (FIG. 2, *F*, *v*). Whatever the position of its cross-wall the small conidium germinates without difficulty, often by putting forth a germ tube from the basal end (FIG. 2, *G*, *a*, *b*) or from both the basal and the apical end (FIG. 2, *G*, *c*). Germ tubes of such origin, much like ordinary hyphae, anastomose freely with mycelial filaments (FIG. 2, *G*, *d*).

The smaller conidia are filled with protoplasm which though often somewhat more granular than the protoplasm of the larger conidia is otherwise apparently of similar character. The contrast of outward shape is therefore not associated here by any pronounced difference in internal organization, such as is evident in *Dactylella doedycoides*, where the elongated conidioid bodies produced sparingly on short erect branches contain numerous globules in curiously distinctive arrangement. Often the contrast in outward shape is impaired to some degree through the occasional production on the tall conidiophores—perhaps, more especially, on germ conidiophores (FIG. 1, *P*)—of rather narrow, straight or curved conidia (FIG. 1, *L*, *b*, *d*, *e;* FIG. 2, *C*, *x*) intergrading variously with conidia formed on the short prostrate branches. However, the distinction between the two types of spores is here not as badly obscured by intergradation as in *Arthrobotrys dactyloides*, where biseptate swollen conidia, if formed at all, are borne on tall conidiophores of the same kind as those bearing the uniseptate elongated conidia, and, indeed, are often borne promiscuously intermingled in the same head with the uniseptate conidia.

In pure culture on maizemeal agar the fungus also produces, mainly under the surface of the substratum, numerous resting bodies consisting frequently of a simple intercalary chain of ten to twenty inflated hyphal segments filled with globuliferous contents (FIG. 2, *H*). Very often, again, they are more complex in their makeup and include, in addition to the segments derived by modification of an axial filament, an equal or even larger number of segments derived from proximal portions of several branches (FIG. 2, *I*). Both in simple and in branched resting bodies the median segments are more strongly distended and contain larger globules than the more remote segments, which usually show gradual transition toward the unmodified character of the outlying mycelium. The distended cells have a faintly yellowish coloration, and are provided with walls noticeably thicker than the membranes surrounding ordinary hyphae, though the thickening is not pronounced.

Despite their conspicuously multicellular make-up and only moderate induration the rangy resting bodies appear homologous with the chlamydospores of *Arthrobotrys oligospora* Fres. and of the three allied nematode-capturing species I described (**2**) under the binomials *A. conoides*, *A. musiformis*, and *Dactylaria thaumasia*. These chlamydospores, it is true, are predominantly unicellular, yet cultures of *A. oligospora* sometimes reveal a fairly generous admixture of two-celled specimens, while cultures of *A. conoides* may contain not only a liberal admixture of both two-celled and three-celled specimens, but also occasional specimens composed of four or even five cells. Owing to their thicker walls and deeper yellowish coloration, the chlamydospores of the four species mentioned offer an appearance more strongly suggestive of endurance under unfavorable conditions than is offered by the rangier resting bodies. With respect to desiccation, at least, this hardier appearance may not be unwarranted. Cultures of *A. oligospora*, *A. conoides*, and *D. thaumasia*, which were planted in tubes of maizemeal agar in March 1938, and which fifteen months later were removed from a refrigerator to be kept in the laboratory without protection from evaporation, produced an abundance of new conidia following addition of sterile water in April, 1942, though the agar substratum had then for fully thirty months been in a completely air-dry state, with the hardness and consistency of horn. However *A. musiformis*, tested in parallel cultures with the other forms, failed to revive; so that its chlamydospores would seem to be of somewhat lesser endurance.

As the fungus forming the rangy resting bodies appears not to have been described hitherto, it is presented here as a new species under a name having reference to its production of two kinds of conidia.

Dactylella heterospora sp. nov.

Mycelium effusum; hyphis hyalinis, septatis, plerumque 1.7–5 μ crassis, hic illic ex ramulis bilocularibus vulgo 12–25 μ longis et 2.5–3.5 μ crassis laqueos circulares 20–30 μ latos proferentibus qui in 3 cellulis arcuatis 15–25 μ longis medio 4–5.5 μ extremo 2.5–4 μ crassis consistunt; vermiculo nematoideo in laqueum apertum errato, tribus cellulis arcuatis abrupte se contrahentibus tumentibusque, ita animal captivum magnopere comprimentibus, mox id trucidentibus, integumentum ejus perforantibus, hyphas intus evolventibus quae carnem exhauriunt. Hyphae generis vulgaris fertiles hyalinae, erectae, simplices vel rarenter parvulum ramosae, plerumque 200–500 μ altae, basi 5–8 μ crassae, sursum leviter attenuatae, apice 2–4 μ crassae, conidia singula ferentes, quandoque recrescentes denique 1–2 alia conidia gerentes; his conidiis hyalinis, vulgo speciose ellipsoideis, fere rectis rarius curvatis, basi minute prominulis attamen abrupte truncatis, plerumque 35–47 μ (saepe circa 40 μ) longis, 13–20 (saepe circa 16.5 μ) crassis, biseptatis, loculo infimo 5–10 μ (saepe circa 7.3 μ) longo, loculo medio 21–30 (saepe circa 25.6 μ) longo, loculo summo 5–9.5 μ (saepe circa 7.1 μ) longo. Hyphae generis alterius fertiles hyalinae, saepius solos 15–25 μ longae, basi 2.5–4 μ crassae, sursum 1.5–2 μ crassae, apice singula conidia ferentes, denique identidem subter apicem repullulantes saepe 5–15 alia conidia deinceps gerentes, ita postea vulgo procumbentes vel ascendentes, irregulariter geniculatae, aliquot ramulis 1–10 μ longis instructae; conidiis hic abjunctis hyalinis, cylindraceis, utrimque rotundatis, plerumque curvatis vel allantoideis, 23–40 μ (saepe circa 31.3 μ) longis, 5.3–8 μ (saepe circa 6.8 μ) crassis, uniseptatis, loculo infero 7.5–17.5 μ (saepe circa 12.7 μ) longo, loculo supero 12–26 μ (saepe circa 18.6 μ) longo. Corpora perdurantia intra matricem orta, flavida, protoplasmatis valde guttulosi repleta, saepius intercalaria, modo simplicia, moniliformia, 100–250 μ longa, in 10–20 cellulis consistentia, modo ramosa denique ex 15–45 cellulis constantia; cellulis in medio corporis saepe 15–30 μ longis et 15–20 μ crassis, eis ad extremos angustioribus gradatim in hyphas mycelii transeuntibus.

Plectum parvum et alios vermiculos nematodeos capiens consumensque habitat in foliis Poae pratensis putrescentibus in Arlington, Virginia.

Mycelium spreading; vegetative hyphae hyaline, septate, 1.7 to 5 μ wide, often especially in presence of nematodes producing mostly underneath and in perpendicular positions approximately circular rings 20 to 30 μ in outside diameter, composed individually of 3 arcuate cells 15 to 25 μ long, 4 to 5.5 μ wide in the middle and 2.5 to 4 μ wide at the ends—the first and third of the cells being united to each other as well as to the distal end of a somewhat curved, 2-celled supporting stalk 12 to 25 μ long and 2.5 to 3.5 μ wide; following ensnarement of a nematode, the individual

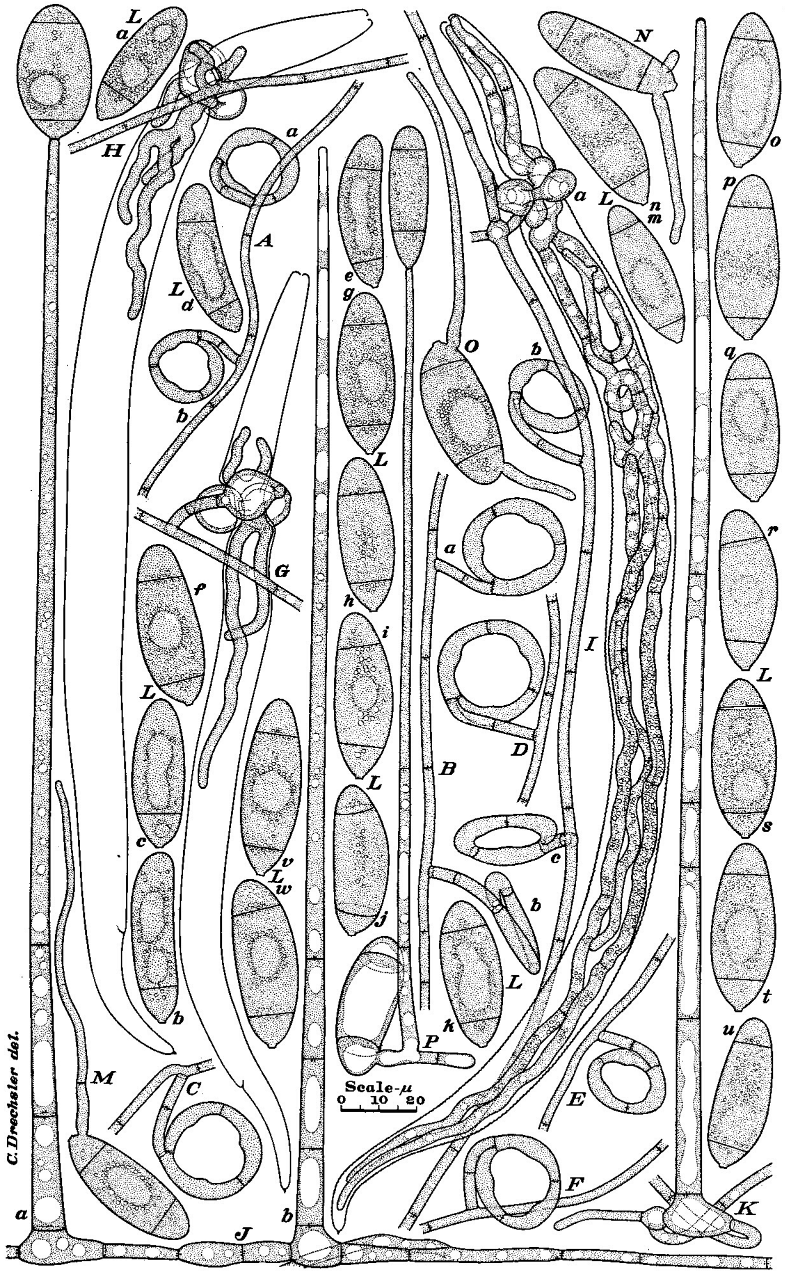

FIG. 1. *Dactylella heterospora* from nematode-infested cultures.

ring through inflation and contraction of the 3 arcuate cells constricting the animal to death or disabling it, then perforating the integument and extending lengthwise through the body assimilative hyphae that appropriate the fleshy contents. Conidiophores of the taller and more frequent type hyaline, erect, usually simple but occasionally branched, mostly 200 to 500 μ high, 5 to 8 μ wide at the base, tapering gradually upward, 2 to 4 μ wide at the apex, there bearing a single conidium, and sometimes, following repeated elongation, 1 or 2 additional conidia; the conidia thus produced being mostly handsomely prolate ellipsoidal, slightly protuberant at the abruptly truncate base, 35 to 47 μ (average 40 μ) long, 13 to 20 μ (average 16.5 μ) wide, divided by 2 cross-walls into 3 cells, the basal cell measuring 5 to 10 μ (average 7.3 μ) in length, the middle cell 21 to 30 μ (average 25.6 μ), and the apical cell 5 to 9.5 μ (average 7.1 μ). Conidiophores of the smaller type hyaline, often only 15 to 25 μ long, 2.5 to 4 μ wide at the base, 1.5 to 2 μ wide at the tip, after production of one conidium growing out repeatedly somewhat below the apices of successive spurs to abjoint often 5 to 15 additional conidia one after another, and thereby forming a strongly geniculate rachiform prolongation, often bearing several branches 1 to 10 μ long; the conidia abjointed here being hyaline, cylindrical with rounded ends, mostly curved and somewhat allantoid, 23 to 40 μ (average 31.3 μ) long, 5.3–8 μ (average 6.8 μ) wide, divided by a single cross-wall into a basal cell 7.5 to 17.5 μ (average 12.7 μ) long and a distal cell 12 to 26 μ (average 18.6 μ) long. Resting bodies regularly formed in the substratum, yellowish, filled with pronouncedly globuliferous protoplasm, most often intercalary, sometimes unbranched, moniliform, 100 to 250 μ long and composed of 10 to 20 cells, at other times branched and then often consisting of 15 to 45 cells; the median cells often 15 to 30 μ long and 15 to 20 μ wide, those at the ends narrower and gradually intergrading with contiguous unmodified mycelial segments.

Capturing and consuming *Plectus parvus* Bastian and various other nematodes it occurs in decaying leaves of *Poa pratensis* L. in Arlington, Va.

DACTYLARIA PULCHRA Linder

In an assortment of fungus cultures received from Dr. M. B. Linford late in 1937 and for the most part representing nematode-capturing hyphomycetes isolated by him from Hawaiian soils (**8**) was included a mucedinaceous form which he considered comparable biologically with my *Dactylella tenuis* (**2**: p. 538–539); for

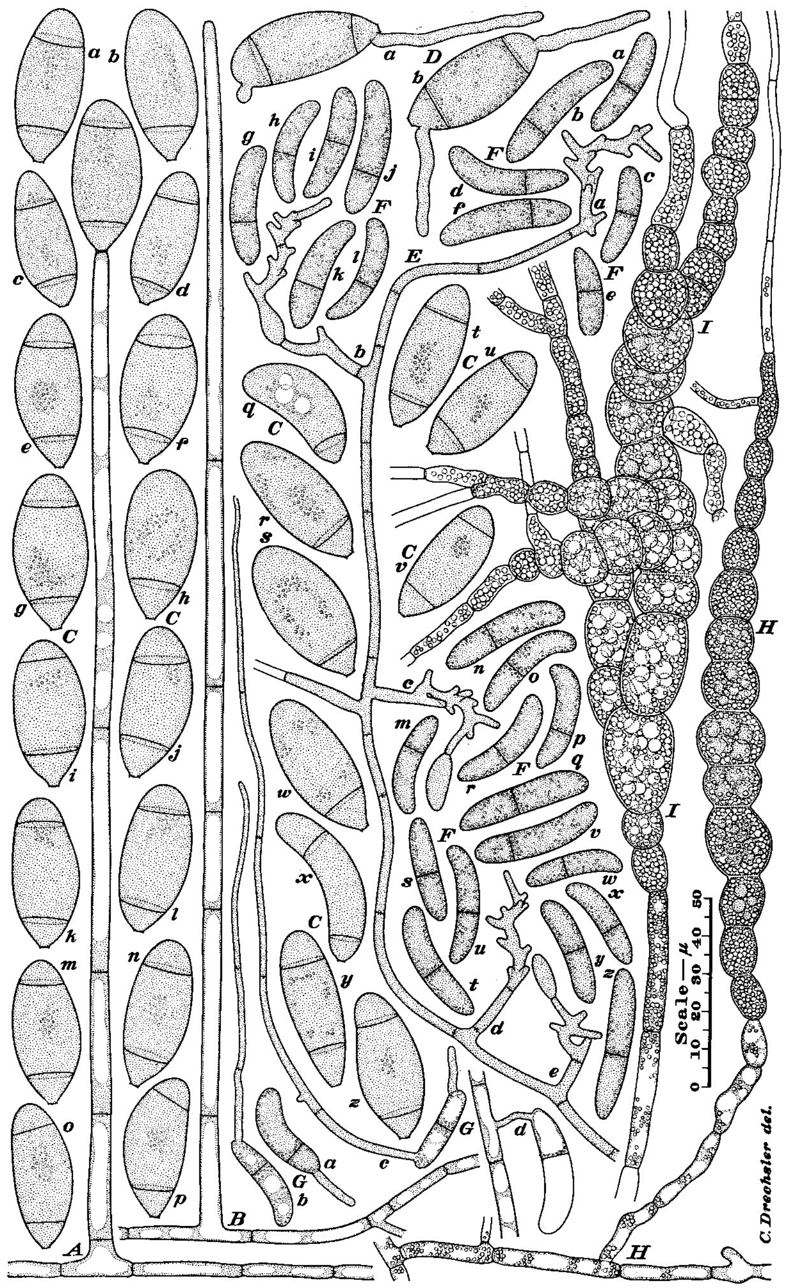

FIG. 2. *Dactylella heterospora* from pure Petri-plate cultures.

although it had come to light in his cultures under the same conditions that favored development of aggressively predaceous related forms, it had failed to show any predaceous behavior. The erect conidiophores (FIG. 3, *A*, *a–c; B*, *a–c*) formed very abundantly when this fungus was grown on Petri plates of maizemeal agar agreed well with those described and figured by Linder (7) in the original account of his *Dactylaria pulchra;* similarity being evident in dimensions and in a close arrangement of sterigmatic spurs along the irregularly rachiform tip. Since the conidia (FIG. 3, *C*, *a–q*) borne on the spurs likewise agreed in size, as also in shape and septation, to Linder's description, the Hawaiian fungus was held referable to *Dactylaria pulchra*, though owing to loss of all cultures derived from the material on which this species was based an actual comparison could not be made.

What would seem to be the same fungus appeared early in 1938 in some Petri plate cultures that had been started from discolored pieces of some lettuce (*Lactuca sativa* L.) seedlings found succumbing to damping-off in a greenhouse at the Bureau of Plant Industry Station near Beltsville, Md. The Maryland strain, though in the end no less prolific than the Hawaiian strain, was slower to begin sporulating. Two weeks after planting its conidial apparatus would, as a rule, hardly be visible to the naked eye anywhere within the area occupied by its pale submerged mycelium. After two additional weeks, however, the surface would usually be covered with a dense, somewhat pulverulent, almost crustose, markedly zonate, faintly yellowish layer, composed of conidiophores and conidia in extraordinary quantity, many of them present only as empty collapsed membranes. The predominance of conidia tapering almost equally toward both ends (FIG. 3, *C*, *c*, *h*, *i*) over those with a thicker, rather broadly rounded tip (FIG. 3, *C*, *a*, *b*) appeared often somewhat more pronounced in the Maryland strain than in the Hawaiian strain.

All the tests hitherto made to uncover predaceous or parasitic characteristics in the two strains have given negative results. Sizable slabs well permeated with vigorous young mycelium of the fungus were excised from maizemeal-agar plate cultures and transferred to agar plate cultures infested with saprophilous eelworms of such genera as *Rhabditis*, *Plectus*, *Cephalobus*, *Acrobeloides*, *Diploscapter*, *Wilsonema* and *Bunonema*. No predaceous organs were ever formed in consequence of this procedure, and no eelworms were ever captured or parasitized. Nor were any of the various amoebae and testaceous rhizopods likewise present in the infested cultures ever observed undergoing attack by the fungus.

A DACTYLELLA BEARING SIX-SEPTATE FUSIFORM CONIDIA IN OPEN RACEMOSE ARRANGEMENT

Three weeks after a pinch of leaf mold taken from deciduous woods near Beltsville, Md., in February 1938, had been added to a maizemeal-agar culture thoroughly permeated with mycelium of *Pythium ultimum* Trow, delicate submerged hyphae bearing small globose knobs and non-constricting rings were found developing in a tract of substratum adjoining the deposit of forest refuse. As the adhesive knobs and more especially the non-constricting rings served effectively in the destruction of eelworms present in the culture, it was apparent that the hyphae obtained their nourishment mainly, if not solely, from the animals they consumed. In manner of operation, as also in morphology, the predaceous organs offered a close parallelism with those of *Dactylella lysipaga* Drechsl. (**2**: p. 499–504) and *Dactylaria candida* (Nees) Sacc. (**2**: p. 523–527). Reproductive apparatus likewise recalling these two species subsequently came to light in a sparse array of conidiophores that bore hyaline, septate, fusiform conidia singly or, at times, in groups of two or three. Rather unexpectedly, however, most of the conidia were found divided by six cross-walls—a number not hitherto observed in *D. lysipaga*, and only occasionally seen in *D. candida*. In order that the departure in septation might be studied better, the meager sporulating material was removed to facilitate aseptic transfer of the conidia to sterile maizemeal agar.

The fungus thus obtained free of alien organisms grows with moderate rapidity in pure culture to produce a pale colorless submerged mycelium of fairly close texture. After several days a few conidiophores may often be discovered under the microscope, though two or three weeks usually elapse before their increasing numbers become visible to the naked eye as a delicate turf. At this later stage of development they frequently bear in rather open racemose arrangement more than half a dozen conidia (FIG. 3, *D*), which, judging from the positional relationships of the supporting spurs (FIG. 3, *E; F*, *a*, *b*), have obviously been formed one after another on successive subapical prolongations. The six-septate condition most characteristic of the spores formed in the original nematode-infested culture predominates also in those produced in pure culture (FIG. 3, *G*, *a–n*). Among 100 conidia selected at random in a mount prepared from a maizemeal-agar plate culture 16 days after planting, 3 were found divided by 7 septa, 55 by 6 septa, 35 by 5 septa, 6 by 4 septa, and 1 by 3 septa. Measurements of the same 100 spores gave values for length, expressed to the nearest integral number of microns, distributable as follows: 29 μ, 1; 34 μ, 1; 35 μ, 1; 36 μ, 2; 37 μ, 1; 38 μ, 3; 39 μ, 3; 40 μ, 7; 41 μ, 6; 42 μ, 9; 43 μ, 11; 44 μ, 8; 45 μ, 7; 46 μ, 11; 47 μ, 10; 48 μ, 4; 49 μ, 5; 50 μ, 4; 51 μ, 4; 52 μ, 1; 54 μ, 1; and values for width with the following distribution: 8 μ, 4; 9 μ, 55; 10 μ, 38; 11 μ, 3. Most of the relatively few conidia that contained only 3 or 4 cross-walls were clavate in shape, while the much more numerous and more perfectly developed spores that contained 5, 6, or 7 cross-walls were, as a rule, rather symmetrically fusiform.

Sizable slabs of maizemeal agar newly permeated with mycelium of the fungus have at various times been placed on agar cultures well infested with eelworms. In no instance, however, has this procedure led to development of predaceous organs, or provoked predaceous activity. Perhaps the fungus is adapted to capture animals only under rather special environal conditions, which may have been lacking in all the tests hitherto made. On the other hand, it is about equally possible that the conidia originally used in starting the pure culture had no connection with the submerged hyphae bearing adhesive knobs and constricting rings in proximity to them.

The fungus provides another example of the troublesome intergradation between *Dactylella* and *Dactylaria* discussed in a previous paper (**3**: p. 467). It is referred to the former genus partly because on nematode-infested agar, where members of the predaceous series commonly show the same sporulating habit as on their natural substrata, its production of plural conidia was hardly on a scale to permit capitate arrangement. To bring into relief one of the features setting it apart from several closely related forms, it is described under a specific name having reference to the frequent division of its conidia into seven segments.

Dactylella heptameres sp. nov.

Mycelium effusum; hyphis sterilibus hyalinis, septatis, ramosis, plerumque 1.5–3 μ crassis; hyphis fertilibus hyalinis, septatis, primum erectis, vulgo 50–150 μ altis, basi 2.5–3.5 μ crassis, sursum 1.5–2 μ crassis, apice uno conidio genito aliquando 1–10 μ subter apicem a latere identidem repullulantibus et ex incrementis saepius 5–35 μ longis 5–10 alia conidia deinceps gerentibus, itaque postea in parte supera plus minusve ramosis et aliquid degravatis; conidiis hyalinis, plerumque fusoideis, subinde clavatis, 3–7-septatis plerumque 6-septatis, 29–52 μ (saepe circa 44 μ) longis, 8–10.8 μ (saepe circa 9.3 μ) crassis.

Habitat in humo silvestri prope Beltsville, Maryland.

Mycelium spreading; vegetative hyphae colorless, septate, branched mostly 1.5 to 3 μ wide; conidiophores colorless, septate, at first erect, commonly 50 to 150 μ high, 2.5 to 3.5 μ wide at the base, 1.5 to 2 μ wide at the tip, sometimes after producing one conidium repeatedly growing out 1 to 10 μ below the apex to produce 5 to 10 additional conidia on the apices of successive prolongations mostly 5 to 35 μ in length, thereby often becoming somewhat branched and weighed down distally; conidia colorless, mostly spindle-shaped, occasionally club-shaped, divided by 3 to 7 cross-walls, most often divided by 6 cross-walls, 29 to 52 μ (average 44 μ) long, 8 to 10.8 μ (average 9.3 μ) wide.

Occurring in leaf mold near Beltsville, Md.

A DACTYLELLA BEARING SEVEN-SEPTATE CONIDIA IN OPEN ARRANGEMENT

Fifteen days after some pinches of leaf mold from a supply collected in deciduous woods near Beltsville, Md., in January 1938, were planted on a maizemeal-agar culture newly permeated with mycelium of *Pythium Butleri* Subr., slender erect unbranched conidiophores (FIG. 3, *II*, *a*, *b*) were found scattered sparsely in a tract of substratum adjoining one of the deposits of decaying material. Each of these conidiophores produced at its tip only a single conidium, though frequently after falling over on the agar medium, now abundantly infested with nematodes, amoebae, and bacteria, it continued to serve a reproductive function by giving rise from one of its proximal segments to a second conidiophore; the same process being repeated, in some instances, half a dozen times. The conidia here produced (FIG. 3, *I*, *a–k*) were clavate in shape and contained usually 7 cross-walls. They varied mostly between 42 μ and 60 μ in length, and between 7.6 μ and 9.6 μ in width; measurements of the two dimensions gave average values of 52.7 μ and 8.6 μ, respectively.

By aseptic removal of the conidia from their supporting hyphae, the fungus was readily obtained free of alien microorganisms. Growing in pure culture on maizemeal agar it ordinarily advances more than 2 mm. a day to produce a pale mycelium of rather close texture. From the superficial hyphae conidiophores are sent up, which like the conidiophores of *Dactylella heptameres* formed in pure culture, eventually often produce 5 to 10 conidia in loose arrangement (FIG. 3, *J*). The first conidium is borne commonly at a height between 75 μ and 100 μ; the others being formed singly on branches that sometimes come directly from the main axis (FIG. 3, *K*), but more often are put forth one after another in a zigzag series (FIG. 3, *L–N*). When sporulation takes place abundantly in pure culture the conidia (FIG. 3, *O*, *a–t*) have been found to vary in length mostly between 36 μ and 53 μ, and in width between 6.7 μ and 9 μ; measurements of the two dimensions yielding averages of 44.5 μ and 8.1 μ respectively. The 7-septate condition predominates here hardly less strongly than in the original nematode-infested culture. Conidia with 8, 9, or 10 cross-walls are formed in relatively small numbers.

The fungus appears to differ rather markedly from the several related species that have been described as producing clavate spores. Its conidia, on the one hand, are decisively wider than those of *Monacrosporium subtile*, which according to Oudemans' (**10**) account measure 45 to 70 μ in length and 5 to 7 μ in width; while, on the other hand, they are decisively narrower than the massive spores of *Dactylella minuta* that were set forth by Grove (**5**) as ranging in length from 60 to 70 μ, and in width from 14 to 15 μ. When comparison is extended to *M. sarcopodioides* (Harz) Berl. et Vogl. (**11**: p. 552) whose clavate spores, 35 to 38 μ long, are divided by only 3 to 5 cross-walls, a pronounced dif-

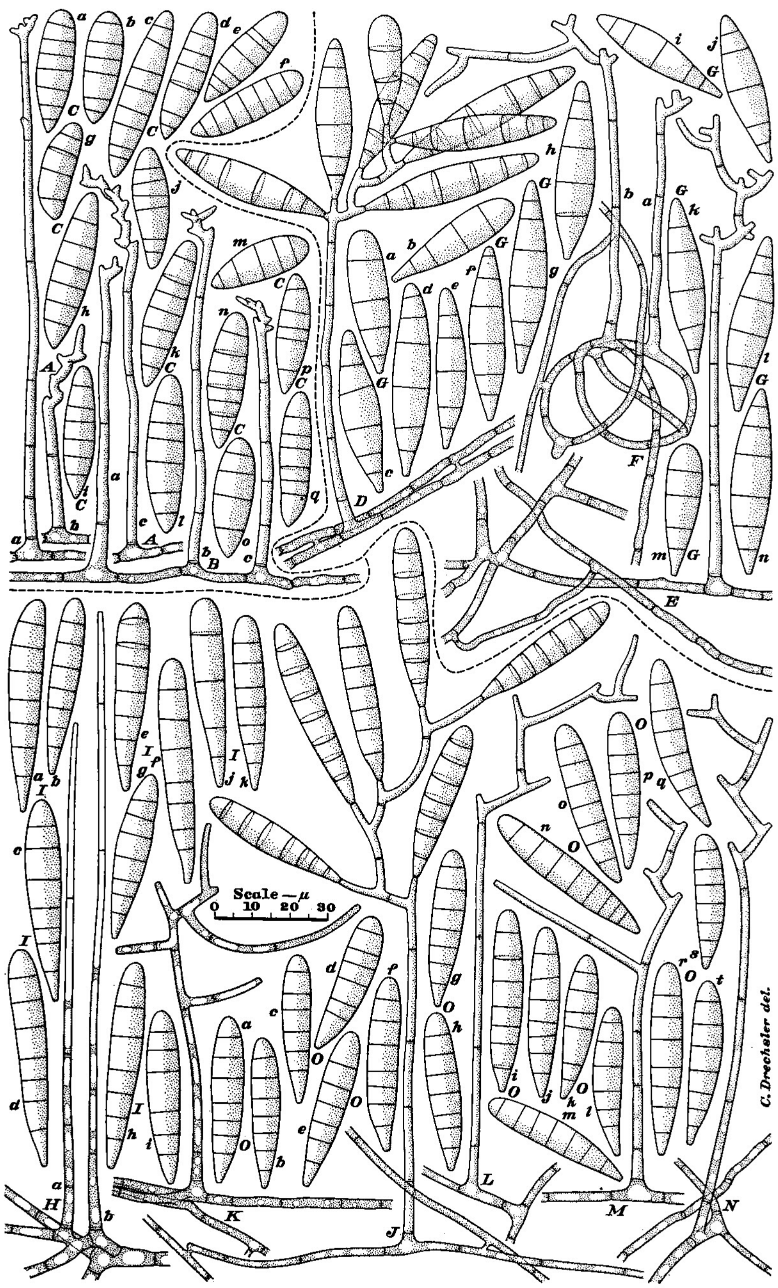

FIG. 3. *A–C, Dactylaria pulchra; D–G, Dactylella heptameres; H–O, Dactylella rhopalota.*

ference in conidial septation comes to light. The fungus manifestly is not to be identified with any form producing mostly spindle-shaped conidia. It is accordingly described as a new species under a name meaning "club-shaped."

Dactylella rhopalota sp. nov.

Mycelium effusum; hyphis sterilibus hyalinis, septatis, ramosis, plerumque 1–3 μ crassis; hyphis fertilibus hyalinis, septatis, primum erectis, plerumque 50–200 μ altis, basi 2.5–4 μ crassis, sursum attenuatis, apice 1–2 μ crassis, uno conidio genito saepe procidentibus denique hypham fertilem ordinis secundi prope basin proferentibus, saepe stantibus et 1–20 μ subter apicem a latere identidem repullulantibus et ex incrementis vulgo 10–50 μ longis 5–10 alia conidia gerentibus itaque postea in parte supera ramosis et aliquid degravatis; conidiis hyalinis, plerumque clavatis subinde paene cylindraceis, 3–10-septatis plerumque 7-septatis, 36–60 μ longis, 6.7–9.6 μ crassis.

Habitat in humo silvestri prope Beltsville, Maryland.

Mycelium spreading; vegetative hyphae colorless, septate, branched, mostly 1 to 3 μ wide; conidiophores colorless, septate, at first erect, mostly 50 to 200 μ high, 2.5 to 4 μ wide at the base, tapering upward, 1 to 2 μ wide at the tip, after forming a single terminal conidium sometimes falling over on the substratum and giving rise near the base to a second conidiophore, sometimes remaining standing and repeatedly growing out 1 to 20 μ below the apex to produce 5 to 10 additional conidia on the apices of branches or of successive prolongations mostly 10 to 50 μ in length, thereby becoming somewhat ramified and weighed down distally; conidia colorless, mostly clavate, occasionally more nearly cylindrical, 36 to 60 μ long, 6.7 to 9.6 μ wide.

Occurring in leaf mold near Beltsville, Md.

A DACTYLELLA BEARING TEN-SEPTATE CONIDIA IN LOOSE RACEMOSE ARRANGEMENT

A very prolific species of *Dactylella* has repeatedly made its appearance in maizemeal-agar plate cultures which after being permeated with *Pythium* mycelium had been further planted with small quantities of partly decayed tomato leaves collected in winter from greenhouse beds. The filaments of its sparse mycelium have never been observed attacking any of the various nematodes and protozoans that multiplied in the cultures after the decaying material was added.

The fungus shows greater tolerance toward bacteria than most other members of the predaceous series of hyphomycetes. Even in the heavily contaminated original cultures its conidiophores often grew so luxuriantly that here and there groups of them became visible to the naked eye as minute white aerial tufts. When conidia were transferred from these tufts to sterile maize-meal agar, pure cultures were promptly obtained; the mycelium extended in the absence of alien organisms being pale, colorless, and of close texture. In Petri plate cultures conidiophores are ordinarily sent up within a few days and continue to develop usually for about a month; so that eventually they often make up a felty layer, which sometimes is white, and at other times has a faint pinkish or yellowish coloration. The extraordinarily copious sporulation revealed in such a layer is achieved in large part through repeated branching and subapical prolongation of the individual conidiophore, which as a result often comes to bear more than a score of conidia (FIG. 4, *A*). Owing to pronounced irregularity in the manner of branching (FIG. 4, *B–G*) the arrangement of the conidia can be designated only rather approximately as loosely racemose.

By far the greater proportion of conidia (FIG. 4, *H–Z*) are spindle-shaped, and show little difference in conformation between their proximal and distal ends. A clavate shape, much as in *Dactylella heptameres*, often distinguishes the shorter, undersized specimens (FIG. 4, *H*, *M*, *Q*, *X*), which contain mostly from 3 to 7 cross-walls. In the fusiform specimens, where the number of cross-walls varies from 7 to 13, the 10-septate condition predominates strongly. Clavate and fusiform specimens were taken indiscriminately in selecting at random the 100 conidia whose measurements were used in preparing the statement on conidial dimensions given in the diagnosis. The 100 measurements for length gave values distributable in classes as follows: 26–30 μ, 3; 31–35 μ, 1; 36–40 μ, 1; 41–45 μ, 2; 46–50 μ, 1; 51–55 μ, 5; 56–60 μ, 12; 61–65 μ, 43; 66–70 μ, 25; 71–75 μ, 6; 76–80 μ, 1; while the measurements for width gave values, expressed to the nearest integral number of microns, distributable thus: 7 μ, 4; 8 μ, 18; 9 μ, 61; 10 μ, 17

Although the fungus recalls *Monacrosporium oxysporum* Sacc. et March., described from excrement of caterpillars in Brussels (**9**), its conidia are not only considerably shorter than those of

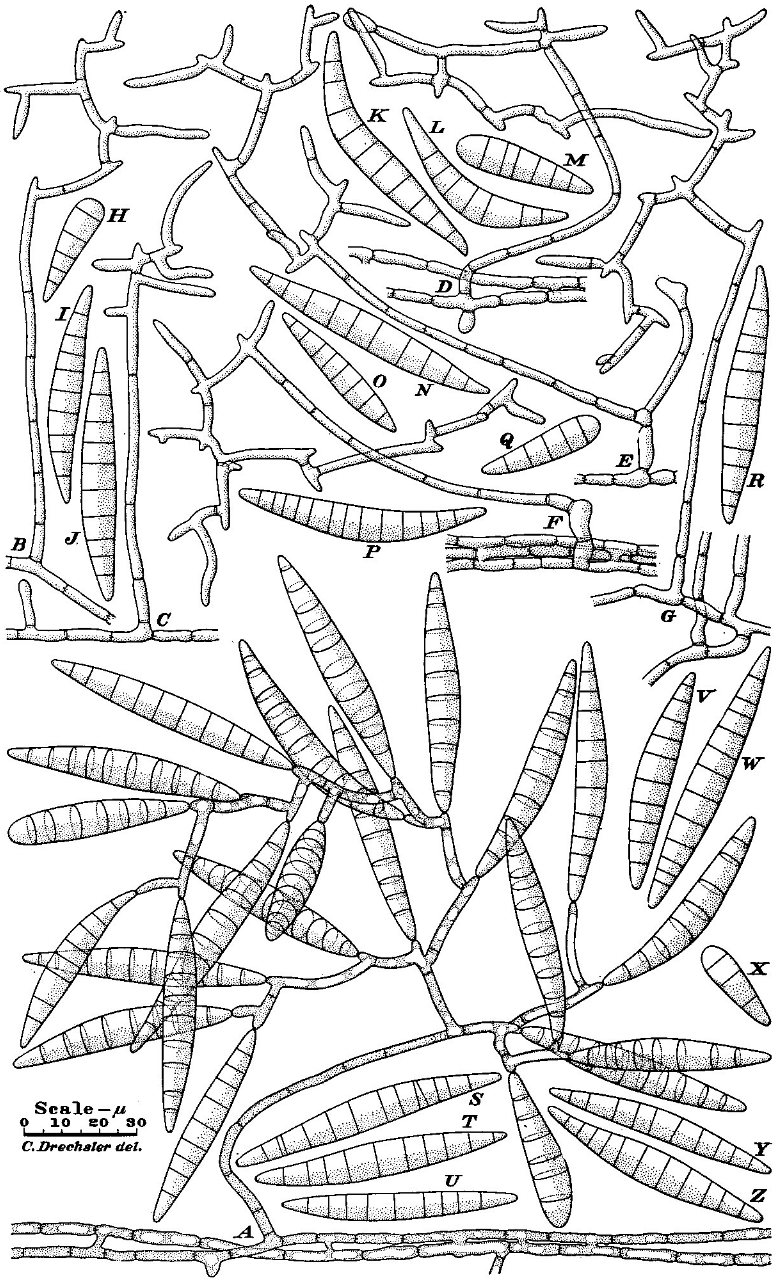

FIG. 4. *Dactylella atractoides*.

the Belgian species but differ further in that they are rounded at both ends rather than acutely pointed. Much greater similarity in conidial morphology is evident when comparison is made with *Dactylella minuta* var. *fusiformis* Grove (6), and the likelihood of identity with this variety cannot readily be dismissed. However as my fungus appears wholly alien to typical *D. minuta*, which produces decidedly wider conidia of clavate shape, I am describing it as a separate species, under an epithet different from the varietal name used by Grove, but of similar meaning.

Dactylella atractoides sp. nov.

Mycelium effusum; hyphis sterilibus hyalinis, septatis, ramosis, plerumque 1–4 μ crassis; hyphis fertilibus hyalinis, septatis, primum erectis, basi 3–5 μ crassis, sursum 2.5–3 μ crassis, uno conidio genito 2–20 μ subter apicem a latere identidem repullulantibus et ex incrementis 5–40 μ longis 5–25 alia conidia gerentibus itaque postea usque 300 μ longis aliquantum ramosis degravatisque; conidiis hyalinis, plerumque fusiformibus, subinde clavatis, rectis vel nonnihil curvatis, 3–13-septatis (septis saepius denis), 26–76 μ (saepius circa 62 μ) longis, 7.2–10.2 μ (saepius circa 8.8 μ) crassis.

Habitat in foliis Lycopersici esculenti putrescentibus prope Beltsville, Maryland.

Mycelium spreading; vegetative hyphae hyaline, septate, branched, mostly 1–4 μ wide; conidiophores hyaline, septate, at first erect, 3 to 5 μ wide at the base, 2.5 to 3 μ wide above, after attaining a length frequently of 100 to 125 μ and producing a terminal conidium repeatedly growing out laterally 2 to 20 μ below the apex to produce 5 to 25 additional conidia on the apices of branches or prolongations often 5 to 40 μ in length, thereby becoming rather extensively ramified; conidia colorless, mostly spindle-shaped, occasionally club-shaped, straight or somewhat curved, divided by 3 to 13 cross-walls, most often divided by 10 cross-walls, measuring 26 to 76 μ (average 62 μ) in length and 7.2 to 10.2 μ (average 8.8 μ) in width.

Occurring in decaying leaves of *Lycopersicon esculentum* Mill. near Beltsville, Md.

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EXPLANATION OF FIGURES

FIG. 1. *Dactylella heterospora* as found developing on nematode-infested maizemeal-agar plate cultures; drawn to a uniform magnification with the aid of a camera lucida, and reproduced at an enlargement of 500 diameters. *A*, *B*, Portions of hyphae, each bearing two open predaceous rings, *a* and *b*. *C–F*, Portions of hyphae, each bearing an open predaceous ring. *G*, *H*, Portions of hyphae, on each of which is borne a ring that after closing on a specimen of *Plectus parvus* has intruded several growing assimilative filaments into the fleshy interior of the captive. *I*, Portion of hypha bearing three predaceous rings, *a*, *b*, and *c*, of which *b* and *c* are open; the ring *a*, after closing on a specimen of *P. parvus*, has extended haustorial filaments lengthwise throughout the animal. *J*, Portion of prostrate hypha from which two tall conidiophores have originated; one of them, *a*, shown with the single large conidium attached; the other, *b*, shown in a denuded state. *K*, Small portion of mycelium with a denuded tall conidiophore. *L*, Random assortment of large conidia, *a–w*, showing variations in size, shape, and septation. *M*, Conidium of large type germinating by production of a single germ tube. *N*, *O*, Large conidia germinating by production of two germ tubes. *P*, Conidium of large type that has put forth a germ conidiophore bearing a secondary conidium.

FIG. 2. *Dactylella heterospora* as found developing in pure culture on maizemeal-agar plates; drawn to a uniform magnification with the aid of a camera lucida, and reproduced at an enlargement of 500 diameters. *A*, Portion of a prostrate hypha with a tall conidiophore to which is attached the single large conidium produced on it. *B*, Portion of a prostrate hypha with a tall conidiophore in denuded state. *C*, Random assortment of large conidia, *a–z*, showing variations in size, shape, and septation. *D*, Two large conidia, *a* and *b*, germinating by production of a germ tube from each end cell. *E*, Prostrate filament that has produced smaller conidia on the apices of rachiform prolongations extended from its tip, *a*, and from four lateral branches, *b–e*. F, Random assortment of conidia of the smaller type, *a–z*, showing variations

in size, shape, and septation. *H*, Unbranched resting body. *I*, Branched resting body.

FIG. 3. Drawn to a uniform magnification with the aid of a camera lucida; × 500 throughout.

A–C, Dactylaria pulchra: A, Portions of procumbent hypha, *a–c*, each with a denuded conidiophore. *B*, Portion of procumbent hypha with three erect conidiophores, *a–c*, in denuded condition. *C*, Random assortment of conidia, *a–q*, showing variations in size, shape, and septation.

D–G, Dactylella heptameres as found developing in pure culture on Petri plates of maizemeal agar sixteen days after planting: *D*, Portion of mycelium with a conidiophore bearing seven conidia. *E*, Portion of mycelium with a denuded conidiophore on which ten conidia were produced. *F*, Portion of mycelium with two conidiophores, *a* and *b*, which produced, respectively, three and six conidia. *G*, Detached conidia, *a–n*, showing variations in size, shape, and septation.

H, I, Dactylella rhopalota as found developing in a maizemeal-agar plate culture infested with nematodes, amoebae, and bacteria: *H*, Portion of mycelium with two denuded conidiophores, *a* and *b*, on each of which a single conidium was produced. *I*, Detached conidia, *a–k*, showing variations in size, shape, and septation.

J–O, Dactylella rhopalota as found developing in pure culture on Petri plates of maizemeal agar: *J*, Portion of mycelium with a conidiophore bearing six conidia. *K–N*, Portions of mycelium, each with a denuded conidiophore; in *K*, *L* and *N* six conidia were abjointed, in *M* five were abjointed. *O*, Detached conidia, *a–t*, showing variations in size, shape, and septation.

FIG. 4. *Dactylella atractoides* as found developing in pure culture on Petri plates of maizemeal agar; drawn to a uniform magnification with the aid of a camera lucida, and reproduced at an enlargement of 500 diameters. *A*, Portion of mycelium with a conidiophore bearing twenty-two conidia. *B–G*, Portions of mycelium, each with a denuded branching conidiophore; presumably nine conidia were abjointed in *B*, seven in *C*, nine in *D*, fourteen in *E*, eighteen in *F*, and eighteen in *G*. *H–Z*, Detached conidia showing variations in size, shape, and septation.