A nematode-destroying species of Cephalosporiopsis

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With Figures 1—10.

Among the clampless Hyphomycetes that attack free-living nematodes after the usual manner of fungous parasites (that is, by the germination of adhering or ingested conidia) are included several species generally resembling the many insectivorous fungi of the *Verticillium-Acrostalagmus-Cephalosporium* series. Another nematode-destroying fungus of generally similar reproductive habit (but producing conidia that frequently become divided by a median cross-wall) recently came to light in a maizemeal-agar plate culture earlier inoculated with a pinch of leaf mold taken from upland woods about 2 kilometers north of Bass Lake, near Park Falls, Wisconsin, on October 11, 1968. While the presence of the median conidial partition presumably does not cast serious doubt on the natural kinship of the Wisconsin fungus to the 4 nematode-destroying parasites I described before (Drechsler, 1941, 1946) under the binomials *Cephalosporium balanoides*, *Acrostalagmus bactrosporus*, *A. abovatus*, and *zeosporus*, the uniseptate spore, of course, necessitates assignment to the somewhat unfamiliar genus *Cephalosporiopsis* Peyronel. Because the fungus differs notably from the several known congeneric forms, it merits description as a new species.

Cephalosporiopsis carnivora sp. nov.

Hyphae assumentes filiformes, incoloratae, intra vermiculos nematoideos vivos crescentes, in animalibus parvis exiguae et parce ramosae sed in animalibus grandiculis abundanter evolventes, mediocriter septatae, plerumque 1.5—2.2 μ crassae. Hyphae fertiles extra animal emortuum evolutae, interdum in materia animal ambienti immersae interdum omnino vel partim procumbentes vel in aerem ascendentes, semper hyalinae, vulgo simplices sed quandoque ramosae, aliquando 75—300 μ longae tum magnam partem circa 1 μ crassae, sed plerumque 12—75 μ longae, 1.2—2.6 μ crassae, in cellulis vulgo 5—12 μ longis consistentes, plerisque cellulis 1—2 ramulos conidiferos ferentes; ramulis conidiferis atque cellulis terminalibus continuis, lageniformibus, 5—12 μ longis, 1.5—2.7 μ crassis, plerumque sursum in sterigmate 0.5—0.7 μ crasso

abeuntibus, 3—15 conidia apice gignentibus, quandoque aliud sterigma ex ventre proferentibus. Conidia primo conglutinata, deinde secedentia, incolorata, ellipsoidea vel obovoidea, primo interdum continua et medio non constricta, postremo saepius medio constricta et uniseptata, plerumque 3—4.2 μ longa, 1.7—2.2 μ crassa.

Vermiculos nematoideos (*Rhabditis* sp.) necans habitat in humo silvestri (magnam partem in foliis Betulae et Aceris et Ulmi putrescentibus consistente) prope Park Falls, Wisconsin. Typus: Figurae 1—10.

Assimilative hyphae filamentous, colorless, developing within living nematodes, often rather scanty and only meagerly branched in small host animals but formed abundantly in larger host animals, moderately septate, mostly 1.5—2.2 μ wide. Conidiophores produced outside the dead host nematode, sometimes immersed in material surrounding the animal's body, sometimes partly or wholly procumbent, or, again, ascending partly or wholly into the air, always hyaline, occassionally having but more commonly lacking sterile branches, sometimes 75—300 μ in length inclusive of a conspicously attenuated subapical prolongation, but much more usually 12—75 μ long, 1.2—2.6 μ wide, divided into segments 5—12 μ long; the apical segment, and the 1 or 2 fertile branches borne laterally on most segments lower down, constituting flask-shaped conidiiferous cells (phialides), mostly 5—12 μ long, 1.5—2.7 μ wide, tapering distally into a sterigma usually 0.5—0.7 μ wide, and sometimes extending a second sterigma from a median position on the venter. Conidia colorless, mostly 3—4.2 μ long and 1.7—2.2 μ wide, at first cohering in a cluster of 3 to 15 at the tip of the sterigma but later separating, elongate-ellipsoid or somewhat obovoid, sometimes continous and not constricted at the middle but more often becoming divided by a cross-wall at a median constriction.

In newly invaded nematodes the rather slender assimilative hyphae of *Cephalosporiopsis carnivora* are often seriously obscured through the granulose degeneration of the fleshy tissues surrounding them, so that their cross-walls usually cannot be distinguished (Fig. 1). Later, when the softer organs and musculature have been largely absorbed — the firm oesophagus and bulb yield only very slowly to dissolution — the septation of the vegetative mycelium is more clearly revealed (Fig. 2, 3). With continued expropriation of the animal's substance, and concomitant movement of fungous protoplasm into the conidiophores, both the host integument and the assimilative hyphae become entirely emptied, and thereupon gradually vanish.

The fertile hyphae, or conidiophores, produced by *Cephalosporiopsis carnivora* outside the dead host animal, are in some instances (Fig. 2, A) noticeably stouter than the assimilative hyphae from which they originate; but often (Fig. 2, B, C; Fig. 3; Fig. 5—7) they seem about equal in width to the latter. Occasionally, a very small conidiophore (Fig. 8), bearing only a single phialide, may be slenderer than its assimilative

parent. In the exceptionally long conidiophores that arise mostly from host nematodes which have succumbed in rather deeply submerged positions, a pronounced change with respect to width is revealed (Fig. 4). They begin their development much like ordinary conidiophores, but after putting forth a number of phialides (Fig. 4, a—b) they taper markedly and then continue growth at a width of approximately 1 μ, usually pushing upward through overlying material. When the slender prolongation reaches the surface, it gives rise terminally to a single phialide (Fig. 4, C), so that the conidia formed by phialides in submerged positions are supplemented with some conidia more favorably placed for distribution by aerial agents.

The conidia produced successively by the individual phialides of *Cephalosporiopsis carnivora* remain cohering in a cluster attached to the tip of the sterigma. On moist agar substratum the cluster often remains intact for some time after it has become detached. When the cluster disintegrates, the prevalent bicellular condition of the spores (Fig. 9—10) is at once recognizable; though here, as in *C. imperfecta* Moreau & Moreau (1941), some conidia have no septum, and, besides, lack the slight median constriction usually associated with the presence of a cross-wall.

Frequently 1 or 2 conidia of *Cephalosporiopsis carnivora* were seen adhering to the forward profile of an actively motile eelworm, or of a dead eelworm that had succumbed to infection (Fig. 2, D). In some infected animals a cylindrical body (Fig. 2, E) was found tightly affixed to the head. Because of dimensional similarities to conidia of the parasite, there was reason to believe that the affixed protuberances might well have represented the empty envelopes of spores from which infections had originated.

From the several species hitherto assigned to the genus *Cephalosporiopsis*, the Wisconsin fungus is readily distinguishable by its smaller conidia. Thus the spores of *C. carnivora* appear only about one-third as long as those of *C. alpina* (Peyr.) Peyr., which, according to the diagnosis given by Saccardo (1931), measure 9—12 × 2—2.5 μ. They are clearly shorter, and also somewhat narrower, than the ovoid, ellipsoid or cylindrical spores of *C. imperfecta*, which were set forth by Moreau and Moreau as ranging from 5 to 11 μ in length and from 2.5 to 3 μ in width. Likewise they appear markedly shorter and somewhat narrower than the fusoid conidia of *C. parasitica* Hansford (1946), which measure 13—16 × 2.5—3.5 μ. Manifestly, too, they are shorter and narrower than the fusoid conidia of *C. asterinicola* Batista and Nascimento (1956), which are stated to measure 10—13.5 × 3—3.5 μ. In *C. carnivora*, much as in *C. imperfecta*, the bicellular spores intermingled with the unicellular spores are constricted at the median cross-wall; whereas in *C. parasitica* and *C. asterinicola* the conidia, though regularly bicellular, are without any constriction.

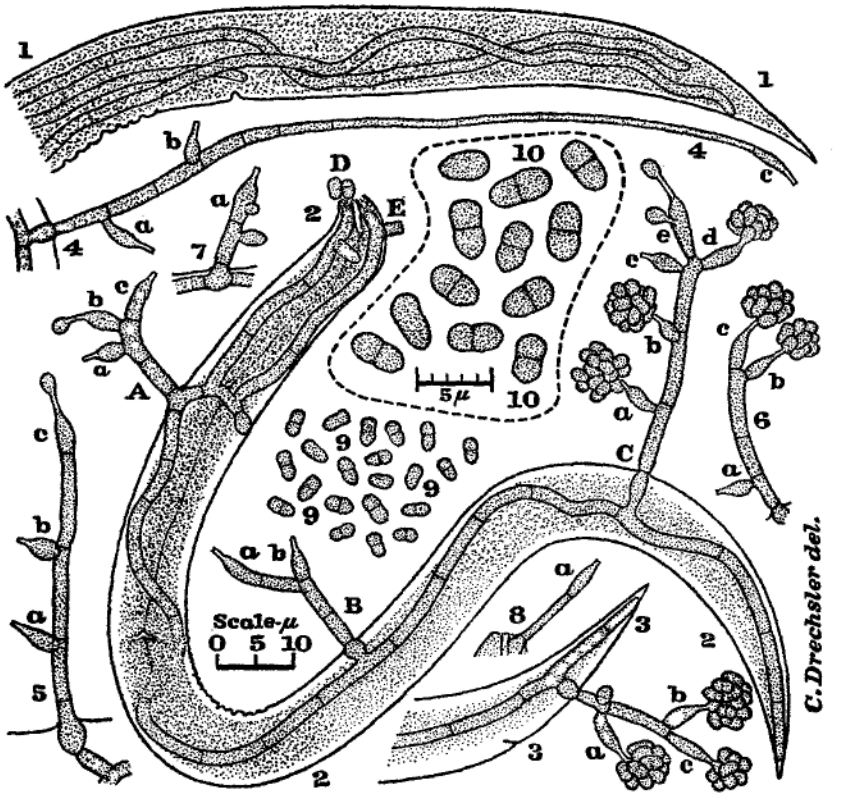

Fig. 1—10. *Cephalosporiopsis carnivora* as found developing through parasitism on eelworms (Rhabditis sp.) in a maizemeal-agar plate culture at temperatures near 19° C. Fig. 1. Posterior portion of host nematode newly invaded by 3 assimilative hyphae in which cross-walls have not yet become discernible, ×1000. Fig. 2. Small host nematode invaded by a meagerly branched, visibly septate assimilative hypha that has put forth 3 conidiophores, A—C; on A are borne 2 lateral phialides, a—b, and a terminal phialide, c; on B are borne 2 phialides, of which one, a, is terminal on a subapical branch, while the other, b, is terminal on the axial hypha; on C are borne 4 lateral phialides, a—d, and terminal phialide, e, provided with 2 sterigmata; on the animal's head are shown 2 adhering conidia, D, and an affixed protuberance, E, possibly representing the empty membrane of the conidium from which infection proceeded; ×1000. Fig. 3. Posterior portion of small host nematode, showing a septate assimilative hypha which has put forth a conidiophore bearing 2 lateral phialides, a—b, and a terminal phialide, c; ×1000. Fig. 4. Conidiophore composed of a sturdy proximal portion with 2 lateral phialides, a—b, and a slender distal portion with a terminal phialide, c; ×1000. Fig. 5, 6. Conidiophores, each with 2 lateral phialides, a—b, and a terminal phialide, c; ×1000. Fig. 7, 8. A stout and a slender conidiophore, respectively, each with a terminal phialide, a; ×1000. Fig. 9. A random assortment of conidia, showing usual variations in size and shape, and in presence or absence of a median constriction and cross-wall; ×1000. Fig. 10. A similarly random assortment of conidia more highly magnified; ×2000.

The phialides of *Cephalosporiopsis carnivora* (Fig. 2, A, a—c; B, a—b; C, a—e; Fig. 3—6: a—c; Fig. 7—8: a) are shorter and slenderer than the homologous conidiiferous cells, or conidiophores, of *C. alpina,* which according to Saccardo measure 15—30 × 2.5—5 μ. They are shorter, but certainly not narrower, than the conidiophores, or phialides, of *C. parasitica,* described as being continuous, hyaline, smooth, usually straight, 30—40 μ long, 1.5 μ wide at the base, and slightly attenuated upwards. The conidiophores of *C. imperfecta* seem much more variable in their make-up than the corresponding reproductive parts of *C. carnivora.* Although the conidiophores of *C. asterinicola,* which measure 56—100 × 2.5—3.5 μ, are multiseptate, they bear no phialides laterally. Their terminal segments that alone seem directly concerned in spore production, would appear, in the 2 specimens figured, to be filiform rather than flask-shaped, and, therewith, proportionally slenderer than the phialides of *C. carnivora.*

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