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FIVE NEW ZOOPAGACEAE DESTRUCTIVE TO RHIZOPODS AND NEMATODES

FIVE NEW ZOOPAGACEAE DESTRUCTIVE TO RHIZOPODS AND NEMATODES

CHARLES DRECHSLER

(WITH 5 FIGURES)

Five fungi referable to the Zoopagaceae are herein described as new, increasing the number of species presented as members of that family to thirty-eight. A sexual stage has so far been observed in only one of the five forms. As the form in question appears most closely allied to *Stylopage araea* Drechsl. (4) occasion is taken to submit also a brief account dealing with the sexual stage of the latter species, supplementing the earlier characterization based on its vegetative and asexual reproductive phases. Among the new fungi not known to produce zygospores is included a species that in adaptation to an endoparasitic development within nematodes, gives rise to conidial apparatus which differs markedly from any hitherto represented in the group and thus makes necessary the erection of a new genus.

STYLOPAGE SCOLIOSPORA

Watersoaked portions of submerged leaves and stems of water cress, *Radicula Nasturtium-aquaticum* (L.) Britten & Rendle, collected on May 13, 1938, from an extensive bed of declining productiveness near Woodstock, Va., gave rise, after being excised and planted on maizemeal agar in Petri dishes, to mycelia of several species of *Pythium*. The mycelia in many of the isolation cultures soon became copiously overgrown with bacteria and infested with rhizopods in immense numbers. Later, some of the protozoan forms in the thriving microfauna, including a few that had appeared especially successful in establishing themselves, were virtually if not wholly exterminated through the activity of various members of the Zoopagaceae.

Perhaps not any of the ill-fated animals were more consistently visited by disaster than was an *Amoeba* measuring mostly from 13

to 22 μ in diameter when drawn into its usual somewhat rounded shape, with contours curving sinuously about numerous delicate pseudopodial protrusions. Despite the small dimensions of the rhizopod, its enveloping pellicle was clearly visible in normal specimens, and persisted in recognizable condition for some time after removal of the protoplasm. In the slightly murky, dispersedly granular sarcode was imbedded a globose or somewhat ellipsoidal nucleus, mostly 3 to 4.5 μ in diameter, inside the clear outer layer of which was regularly discernible a slightly darker roundish central part, or "Binnenkörper," 1.8 to 2.8 μ in diameter. A contractile vacuole and a small number of less conspicuous vacuoles, possibly digestive in function, provided additional though less distinctive structural features.

The *Amoeba* in question was captured through adhesion to the hyphae of a delicate aseptate branching mycelium (FIG. 1, *A; B; C; D, a–d; E, a–c; F, a, b; G, a–c*). Contact of little extent sufficed usually for the intrusion of a haustorium from the hypha into the animal (FIG. 1, *B; C; D, a, c, d; E, a, b; F, b; G, a–c*); somewhat lengthier contact permitting intrusion of two haustoria (FIG. 1, *A; D, b; E, c; F, a*). Whether single or plural, the absorptive organ was of the pedicellate type, consisting of narrow stalk and thickish dichotomously branched assimilative elements, exemplified in various species described earlier, as, for example, *Stylopage rhabdospora* Drechsl. (**7**) and *S. cephalote* Drechsl. (**10**). After serving in the appropriation of all protoplasmic materials within the rhizopod, the haustorium was itself evacuated by the withdrawal of contents into the parent filament, its empty envelope thereupon becoming wholly invisible.

Asexual reproduction of the fungus took place abundantly through the development of conidia terminally, either on relatively short branches (FIG. 1, *H–K*), or sometimes on longer filaments (FIG. 1, *L*). Following the abscission of one spore, the sporophoric axis continued growth, usually somewhat obliquely, to give rise a short distance farther on to a second, the place of attachment of the first conidium being marked by a perceptible or often a pronounced geniculation. Repetition of the process, a familiar one in many groups of fungi, and already reported in several species of *Stylopage,* here resulted often in extraordinarily prolonged

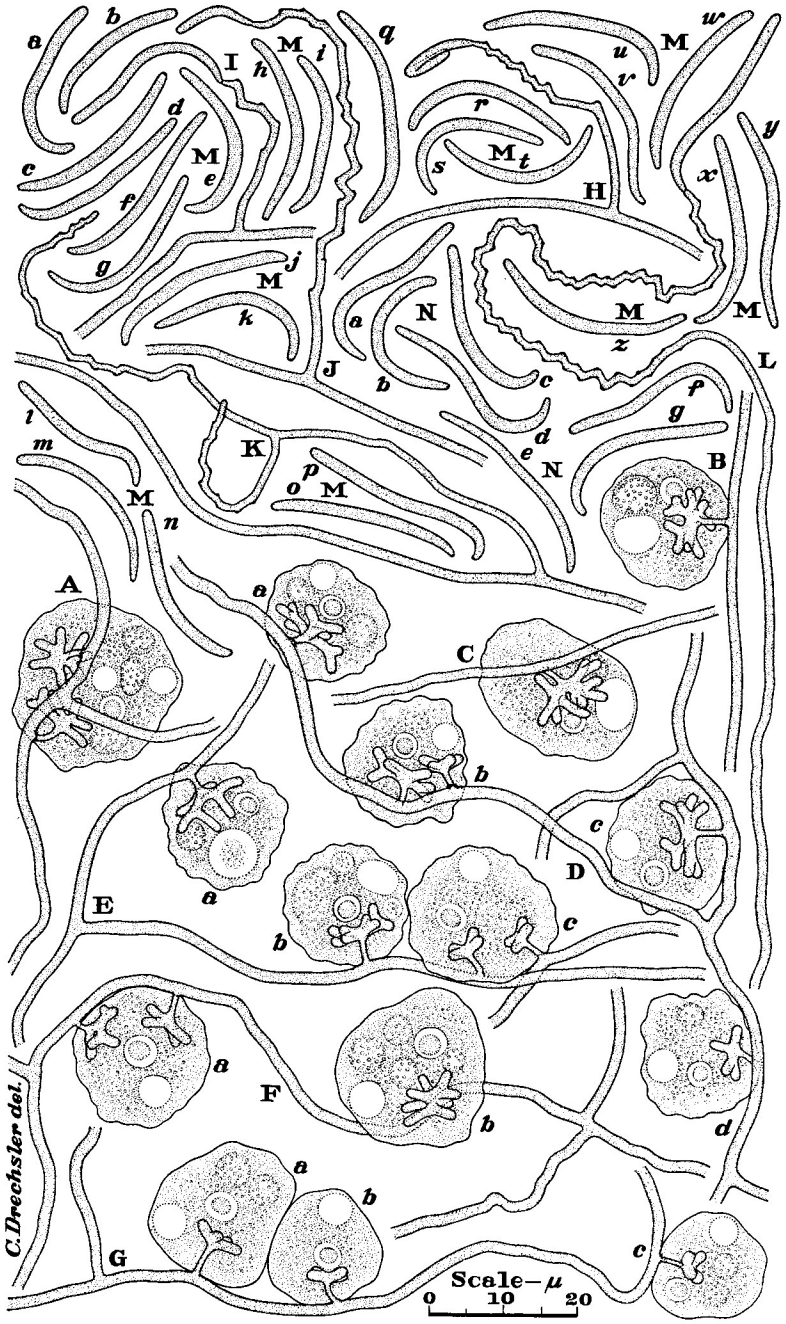

FIG. 1. *Stylopage scoliospora.*

fertile elements, showing from 50 to 75 slightly scarred geniculations, from each of which a conidium had been disarticulated. In the agar plate cultures studied, the conidiophorous branches were always found developing in prostrate positions on the surface of the substratum, never in erect positions. Though the possibility is not to be ignored that the recumbent posture may have been due to jostling by numerous nematodes, the obvious frailness of the sporiferous elements would seem in itself to have precluded an erect habit. As the material from which the fungus grew out was of aquatic origin, it seems reasonable to presume that in nature the frail elements are normally submerged. Their homology with the erect aerial conidiophores of terrestrial forms seems, however, sufficiently clear to permit assignment of the fungus to the genus *Stylopage*.

While the conidiophorous branches as a rule were perceptibly narrower than the predaceous filaments, the conidia borne on them approximated the vegetative hyphae in width; so that when strewn about on the substratum they presented an appearance as if they consisted of disarticulated mycelial segments (FIG. 1, *M, a–z; N, a–g*). Regarding such misleading appearance they invite comparison more particularly with the conidia of *Zoopage nematospora* Drechsl. (7), and as in that species the deceptive effect is heightened by the random curvatures that persist after disarticulation. Indeed, a term compounded of words meaning "crooked" and "seed," respectively, suggests itself as a fairly appropriate name for the fungus.

Stylopage scoliospora sp. nov.

Mycelium sparsum, ramosum; hyphis hyalinis, aliquantum irregulariter flexuosis, 1–2 μ crassis, ad animalcula inhaerentibus, pelliculam eorum perforantibus, haustoria singula vel subinde bina in ea introtrudentibus quae carnem exhauriunt; haustoriis pedicellatis, pedicello saepius 1–4 μ longo, 0.6–0.9 μ crasso, abrupte latescente, apice vulgo semel vel ter repetite bifurco, ita 2–8 rarius 10 ramos divaricatos 1–6 μ longos, 1–1.5 μ crassos ferente. Hyphae fertiles procumbentes, foris probabiliter in aqua immersae, modo 10–100 μ sed quandoque usque ad 500 μ longae, 0.8–1.6 μ crassae, ex apice conidium ferentes, deinde identidem repullulantes et multa alia (subinde 50–75) conidia deinceps gerentes, ita mox crebre geniculatae; conidiis hyalinis, filiformibus, 20–32 μ longis, 1.3–1.9 μ crassis, saepius plus minusve curvatis.

Amoebas vulgo 13–22 μ latas capiens consumensque habitat in foliis caulibusque languidis *Radiculae Nasturtii-aquatici* prope Woodstock, Virginia.

Mycelium sparse, branching; vegetative hyphae colorless, somewhat irregularly flexuous, 1 to 2 μ (mostly about 1.5 μ) wide, adhering to minute rhizopods, perforating the integument of each captive, and developing 1 or 2 haustoria inside to appropriate the fleshy contents; haustoria pedicellate, the pedicel often 1 to 4 μ long and 0.6 to 0.9 μ thick, abruptly widening and successively bifurcating at wide angles 1 to 3 times to terminate in 2 to 8 or more rarely in as many as 10 branches, 1 to 6 μ long and 1 to 1.5 μ wide. Conidiophorous hyphae prostrate, under natural conditions probably submerse, often 10 to 100 μ and sometimes up to 500 μ long, 0.8 to 1.6 μ wide, after producing a conidium singly at its tip often repeatedly elongating from below the spore to give rise successively to many (sometimes 50 or 75) more conidia, whose places of origin after their disarticulation remain marked by geniculations mostly between 1.5 to 5 μ apart. Conidia hyaline, filiform, 20 to 32 μ (average 26 μ) long, 1.3 to 1.9 μ (average 1.6 μ) wide, often more or less irregularly curved.

Capturing and consuming a species of *Amoeba* commonly 13 to 22 μ in length and width, it occurs in moribund leaves and stems of *Radicula Nasturtium-aquaticum* near Woodstock, Va.

The apparent adaptation of the fungus to an aquatic existence, submerged or floating, would seem to strengthen the likelihood discussed in an earlier paper (**3**: p. 33–34), that the filamentous outgrowths noted by Leidy (**13**) on *Ouramoeba vorax* Leidy and *O. botulicauda* Leidy, by Korotneff (**12**) on *Longicauda amoebina* Kor., by Penard (**14**) on *Amoeba nobilis* Pen. and *A. vespertilio* Pen., as well as by Dangeard (**1**) on *Pelomyxa vorax* Dang., may prove to be referable to the Zoopagaceae. Geitler (**11**), in a recent and somewhat more detailed paper on the morphology and development of similar appendages found attached to *Amoeba proteus* Leidy, concluded that the fungus with which he was dealing unquestionably belonged in the Phycomycetes; though holding further that its position within that class, despite some similarities in outward habit to the Leptomitaceae, was presumptively in the Chytridiales, or more precisely, in the family Cladochytriaceae. An inspection of Geitler's figures, however, would seem to reveal not only a suggestive resemblance between the haustoria of his fungus and the haustoria more particularly of *Zoopage phanera* Drechsl. (**3**), but also an even more provoking similarity between the repeatedly constricted filaments shown attached to *A. proteus,*

on the one hand and immature or growing conidial filaments of *Zoopage atractospora* Drechsl. (**7**) on the other. If Geitler's illustrations pertaining to the development of resting spores show little evidence of hyphal conjugation, the relationship of parts in one of them (**11**: *fig. 3, r*) yet invites comparison with immature sexual apparatus of *Z. cladosperma* Drechsl. (**5**).

It must be admitted, of course, that the consistently aseptate condition imputed to the filamentous outgrowths by Geitler, as also by earlier writers, and the absence of any massive vegetative part comparable either to the spiral hyphae in the endoparasitic genera *Endocochlus* and *Cochlonema,* or to the greatly swollen conidia of the ectoparasitic genus *Bdellospora,* provide objections to a ready affiliation with the Zoopagaceae; yet these objections may perhaps be subject to abatement when they are considered in relation to the less exigent conditions attending development of *Amoeba* parasites in an aquatic as contrasted with a terrestrial environment. The spiral or globose vegetative thalli familiar in terricolous conidial parasites seemingly have as their special function the accumulation of protoplasmic masses in sturdy, compact bodies, little subject to injury from physical violence during the protracted period when the host remains capable of energetic locomotion. Delicate sporiferous filaments thrust out from an *Amoeba* briskly moving about among solid particles of harsh texture could hardly avoid suffering severe injury, if, indeed, they escaped being shorn off outright, perhaps at a relatively early stage. In a substratum of soil or decaying vegetable detritus, development of such filaments must accordingly be postponed until the animal has been disabled as a result of protoplasmic depletion brought on by the parasite itself. In a water medium, however, the danger from physical injury manifestly is so insignificant that external filaments can be produced from the beginning with complete safety; wherefore the need of rather massive storage structures in the form of obese vegetative thalli is wholly obviated. There is reason to presume, moreover, that while the slight disturbances usual in a water medium may be insufficient to injure a continuous filament destined for conversion into a conidial chain, they might readily suffice to bring about disarticulation of all conidia very soon after they became delimited by the deposition of septa at the constrictions;

in which event intercalary cross-walls would not often be encountered in the portions of filaments left attached, and their normal development in the filaments might therefore long remain unsuspected. As *Stylopage scoliospora* is a predacious mycelial form rather than an infective or parasitic one, and as it produces conidia separately rather than in chains, its usefulness in helping to interpret the problematical outgrowths reported by protozoölogists is less than might be desired.

STYLOPAGE RHYNCHOSPORA

A fungus with a reproductive habit most similar to that of *Stylopage araea* was observed in an old maizemeal agar plate culture, which, after having been occupied by mycelium of *Pythium ultimum* Trow, had received the addition of some pinches of decaying vegetable rubbish collected on October 24, 1936, from a roadside ditch in Arlington, Va. On the hyphae making up its sparse mycelium Amoebae varying considerably in size were found attached (FIG. 2, *A, a–e; L*), some measuring as little in width as 5 μ (FIG. 2, *A, a*), others as much as 30 μ (FIG. 2, *A, d*). The contents of the smallest animals were assimilated by means of a simple haustorial branch, while expropriation of the larger specimens was accomplished through branched bush-like haustoria of the type represented in *S. araea* and *Zoopage mitospora* Drechsl. (**10**). With the depletion of protoplasm in each captured rhizopod, the haustorium was itself soon evacuated by withdrawal of its contents into the parent filament, leaving only the collapsed pellicle to supply visible evidence on the fate of the animal (FIG. 2, *A, b, c*).

As has been intimated, the conidiophores of the fungus, which were found sparsely distributed over the substratum, resemble the fertile hyphae of *Stylopage araea* in general stature; but whereas the latter arise abruptly from the parent mycelial filaments as narrow, only slightly tapering, erect stalks, the former branch off as relatively thick, mostly prostrate elements that become erect some distance from their respectively attachments and taper markedly from wide base to narrow apex (FIG. 2, *B, a, b; C; D*). The sturdier development of the conidiophore would seem required here to support aloft a conidium of noticeably larger dimensions

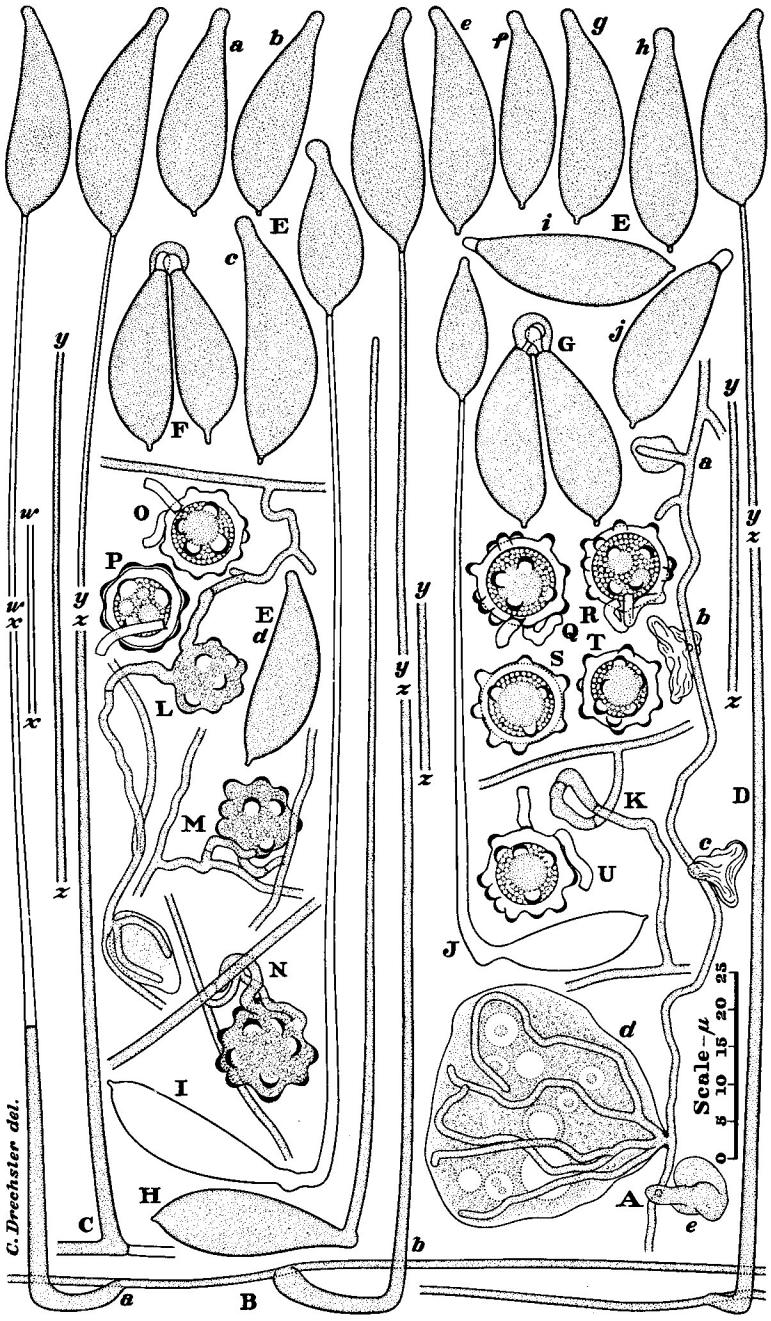

FIG. 2. *Stylopage rhynchospora.*

than that of *S. araea*. Apart from its greater size the asexual spore of the present species is distinguished further by having its tip drawn out in a bluntly rounded beak (FIG. 2, *E, a–h*) that sometimes is later evacuated of protoplasmic contents and then becomes walled off as an empty appendage (FIG. 2, *E, i, j*). Often when two conidia, on falling to the substratum, happen to make apical contact with one another, their beaks are emptied of contents in secreting a mass of yellow adhesive material; so that the spores are, as it were, soldered or cemented together (FIG. 2, *F, G*). Whether the curious union thus effected, the like of which has not been seen in any related form, serves any useful purpose remains uncertain.

Repetitional development of conidia by the production of secondary (FIG. 2, *H, I*) and apparently even of tertiary (FIG. 2, *J*) conidia on germ sporangiophores is of frequent occurrence in the species. Just as in instances of similar development in the coarser congeneric forms, *Stylopage hadra* Drechsl. (**5**) and *S. leiohypha* Drechsl. (**6**), both destructive to nematodes, each derived spore is appreciably smaller than its parent.

The fungus was observed to produce sexual apparatus in moderate quantity. Conjugating branches invariably arise from separate mycelial hyphae. They unite apically with very little entanglement of parts (FIG. 2, *K*). A cross-wall is laid down in each of the sexual elements at some distance from the union, to delimit the paired gametantia. The young zygosporangium now develops at the union as a globose intercalary body that during its later stages of enlargement becomes boldly sculptured with warty protuberances (FIG. 2, *L–N*). At full maturity there is revealed within the outer sporangial envelope and generally rather intimately fused with it a thick zygospore wall, which surrounds a parietal protoplasmic layer of coarsely granular texture disposed about a central reserve globule of homogeneous consistency (FIG. 2, *O–U*).

A term compounded of two words meaning "snout" and "seed" respectively, is deemed suitable as a specific name for the fungus.

Stylopage rhynchospora sp. nov.

Mycelium sparsum, ramosum; hyphis hyalinis, flexuosis, plerumque 1–1.8 μ crassis, ad animalcula inhaerentibus, pelliculam eorum perforantibus, haus-

torium laxe arbusculiforme intus evolventibus quod protoplasma exhaurit. Hyphae fertiles incoloratae, ad summam erectae etsi in parte infera saepius procumbentes, 170–220 μ longae, basi 2–3.5 μ crassae, sursum attenuatae, apice 0.7–0.8 μ crassae, unicum conidium ferentes. Conidia hyalina, elongato-ovoidea, basi pediculo 1–2 μ longo circa 0.8 μ crasso praedita, apice rostro rotundato 2–3.5 μ longo 1.6–2.8 μ crasso subinde vacuo instructa, ex toto vulgo 27–34 μ longa, 7.5–10 μ crassa, saepius ex hypha fertile germinationis circa 120 μ alta conidium ordinis secundi modo 24–28 μ longum, 7.5–9 μ crassum proferentia; conidiis ordinis secundi ex hypha fertile germinationis 75 μ alta conidium ordinis tertii circa 19 μ longum 6.5 μ crassum subinde item proferentibus. Hyphae zygosporiferae 10–35 μ longae, 1–1.5 μ crassae, septo saepius 6–10 μ ab junctione divisae, utraque ex alia hypha mycelii enata. Zygosporangia sphaeroidea, vulgo 10–12 μ crassa, maturitate 12–25 verrucis 0.8–2 μ altis 1.5–3 μ latis ornata, membrana cum membrana zygosporae flavidae quae cellulam viventem 7.5–9 μ crassam circumdat quasi concreta.

Amoebas vulgo 5–30 μ latas capiens consumensque habitat in reliquiis plantarum putrescentibus in Arlington, Virginia.

Mycelium branched, sparse; vegetative hyphae colorless, somewhat flexuous, mostly 1 to 1.8 μ wide, adhering to small rhizopods, perforating the pellicle of each captive and developing within it a bush-like branching haustorium to appropriate the protoplasmic contents. Conidiophores colorless, often procumbent at the base for a distance of 5 to 20 μ, then becoming erect, 170 to 220 μ in total length, mostly 2 to 3.5 μ wide in its proximal portion, tapering upward to a diameter of 0.7 to 0.8 μ at the apex, there bearing a single terminal conidium. Conidia colorless, elongated ovoid, 27 to 34 μ (average 30 μ) in total length, 7.5 to 10 μ (average 8.9 μ) in width, bearing basally a small pedicel usually 0.8 μ wide and 1 μ or rarely up to 2 μ long, distally drawn out into a bluntly rounded beak 2 to 3.5 μ long and 1.6 to 2.8 μ wide that may become evacuated, sometimes with secretion of yellow glutinous material causing cohesion in pairs tip to tip; often giving rise individually on a germ sporangiophore about 120 μ high to a secondary conidium usually 24 to 28 μ long and 7.5 to 9 μ wide; the secondary conidium in turn sometimes giving rise to a tertiary one, mostly about 19 μ long, and 6.5 μ wide, on a germ sporangiophore about 75 μ high. Zygophoric hyphae 10 to 35 μ long and 1 to 1.5 μ wide, those of a conjugating pair arising from separate mycelial filaments, each divided by a septum often placed 6 to 10 μ from the juncture. Zygosporangium intercalary, subspherical, at maturity boldly ornamented with 12 to 25 warty protuberances mostly 0.8 to 2 μ high and 1.5 to 3 μ wide, its wall often rather indistinguishably fused with the thicker wall of the yellowish zygospore, which incloses a subspherical protoplast 7.5 to 9 μ in diameter.

Capturing and consuming Amoebae mostly 5 to 30 μ wide, it occurs in decaying remains of herbaceous plants in Arlington, Va.

THE SEXUAL STAGE OF STYLOPAGE ARAEA

During the several years that have intervened since it was first described, *Stylopage araea* has been observed from time to time in old plate cultures planted with decaying vegetable materials collected in Virginia and Maryland. Its mycelium and conidial apparatus were associated in some of these later cultures with sexual apparatus distinctive of the species. As in *S. rhynchospora*, and, indeed, in most allied forms whose sexual stage has come under observation, the zygophoric hyphae destined for conjugation with each other arise as branches, outwardly little differentiated, from separate mycelial filaments. On making contact the two branches wind about one another, each describing approximately two complete turns before apical fusion takes place (FIG. 3, *A*). A septum now is laid down in each of the intertwined branches, most often at a distance of 7 to 15 μ from the union; and the young zygosporangium begins to develop as a globose body, now virtually sessile (FIG. 3, *B, D, E*), now terminal on a stalk up to 10 μ long that may arise from near the union, or at a distance of 5 to 10 μ from it (FIG. 3, *C, F*). When the growing zygosporangium has attained or nearly attained a definitive diameter of 9 to 12 μ, it thrusts out 20 to 35 warty protuberances mostly about 0.7 μ high and 1.5 μ wide. It is then cut off by a basal septum (FIG. 3, *G, a*), and a zygospore wall is laid down, usually so close to the sporangial envelope that demarcation between the two membranes is little evident (FIG. 3, *G, b–j*). Reorganization of the living contents proceeds with gradual enlargement of two or three vacuole-like inclusions (FIG. 3, *G, b–e, g–i*) that eventually may coalesce into one; so that in its fully mature state the sexual body, always distinctly yellowish in color, incloses a subspherical protoplast 6 to 8.5 μ in diameter, composed of a parietal coarsely granular layer and a central reserve globule (FIG. 3, *G, f*).

COCHLONEMA PUMILUM

A fungus rather closely similar morphologically to *Cochlonema cylindricum* Drechsl. (**9**) appeared in a few old maizemeal-agar plate cultures on which had been planted some pinches of leaf mold collected on April 26, 1937, in deciduous woods in Arlington,

Va. It subsisted exclusively on testaceous rhizopods referable to the genus *Euglypha,* the animals utilized for food being, however, markedly smaller than *E. denticulata,* the species parasitized by *C. cylindricum,* measuring, as they did, only about 11 μ in thickness, 13 to 19 μ in width, and 22 to 30 μ in length (FIG. 3, *H–U*). The elliptical scales making up the testae measured about 5.5 μ in length and about 2.5 μ in width; those bordering the mouth, usually 6 to 8 in number, being modified at the projecting end by very narrow marginal thickening and frequently, too, by some inconspicuous serrulation. A subspherical nucleus about 5 μ in diameter and containing a globose body about 1.3 μ wide frequently remained distinguishable during the earlier stages of infection (FIG. 3, *H, K*). From their morphology the animals, all very obviously conspecific, would seem best referable to *E. levis* (Ehrenb.) Perty as that species is set forth by Wailes (**15**), though I am inclined to doubt their identity with the rhizopod earlier and perhaps more correctly recorded under that binomial as being captured and consumed by *Dactylella passalopaga* Drechsl. (**8**). The specimens of *Euglypha* destroyed by the predaceous hyphomycete were uniformly of considerably larger dimensions, and showed generally a somewhat larger number of oral scales which individually appeared more heavily and more extensively thickened at the smooth projecting end. However, a similarity in general outward habit, certainly not shared by *E. denticulata* with its smoothly ovoid shape and very obscurely delimited mouth, would seem to sustain in some degree the application of one binomial to the two forms, encouraged, whether rightly or wrongly, by the broad species concept pervading much protozoölogical literature.

Infection of the small shelled rhizopod results from ingestion usually of a single rod-shaped conidium (FIG. 3, *H*). This conidium germinates by putting forth from one of its ends, often somewhat obliquely, a delicate germ-tube that soon widens into a thallodic hypha (FIG. 3, *I–M, T, U*). In continuing growth the hypha becomes recurved, and thus acquires a strongly arched bail-like shape (FIG. 3, *K, L, N, O, R, S*), or even a convolute or circinate shape (FIG. 3, *I, J, M, P, Q, T*), depnding on the measure of elongation. Apparently while the animal is still capable of locomotion, the thallus gives off a single reproductive filament from

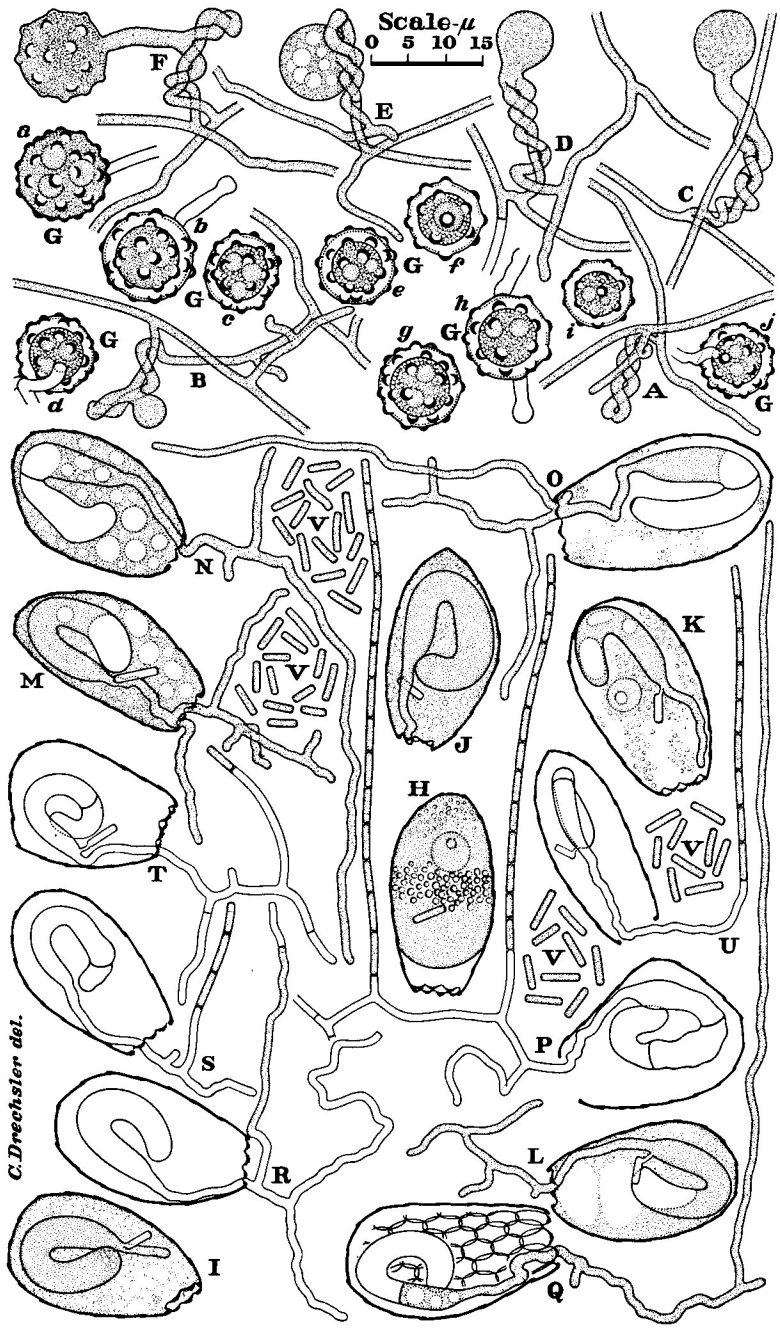

FIG. 3. *A–G. Stylopage araea; H–V, Cochlonema pumilum.*

its proximal end, close to the attachment of the empty conidium (FIG. 3, *I–K*). After the animal is disabled this filament grows out through the oral opening, sends a few short branches into the substratum for anchorage (FIG. 3, *L, M*), and gives rise to one, two, or more rarely three aerial hyphae (FIG. 3, *N, O, Q*). These aerial hyphae elongate as protoplasm from the underlying parts of the fungus is transferred to them; but as the amount of nourishment available is always relatively small, their combined lengths ordinarily do not exceed 350 μ or 400 μ. Segmentation of the aerial hyphae converts them into chains of closely arranged rod-shaped conidia. In these chains the individual conidium is often very narrowly in contact with its neighbors by its slightly convex end-walls (FIG. 3, *P, S, U*). Disintegration of the conidial chains from slight disturbances leaves the spores strewn about on the substratum, ready to infect any specimen of the protozoan host that may unhappily ingest one of them. The somewhat shrunken, empty, curved thallodic envelopes remaining inside the empty testae are usually rather inconspicuous (FIG. 3, *R*), but may often be discerned with less difficulty when they contain one or two cross-walls laid down in the course of their evacuation (FIG. 3, *P, S, T, U*).

The fungus, manifestly belonging to the genus *Cochlonema,* is held to be specifically distinct from *C. cylindricum;* the distinction being based more on the smaller dimensions of its conidia than on the dwarfish proportions of its thallus, wherein, to be sure, might merely be reflected the small bulk of the host animal.

Cochlonema pumilum sp. nov.

Hyphae alitae incoloratae, 20–40 μ longae, 3–5 μ crassae, simplices, plerumque semel circulatim convolutae, ex basi per os animalis hypham genitabilem 1–1.5 μ crassam proferentes, quae paucos brevis ramulos in materiam subjacentem intromittit et 1–3 hyphas fertilis erectas vulgo 100–300 μ longas, 0.9–1.1 μ crassas in aera emittit. Conidia hyalina, cylindrata, vulgo 3–6 μ longa, 0.9–1.1 μ crassa, utrimque leviter rotundata, in catenulas crebre digesta.

Euglypham levem forma minore enecans habitat in humo silvestri in Arlington, Virginia.

Vegetative hyphae colorless, 20 to 40 μ long, 3 to 5 μ wide, circularly or often circinately convolved in approximately one (0.7 to 1.3) turn, each extending from its base and through the mouth of the host animal a reproductive filament 1 to 1.5 μ wide, which sends a few short branches into the substratum outside and thrusts into

the air 1 to 3 conidiiferous hyphae 100 to 300 μ long, 0.9 to 1.1 μ wide; these hyphae collectively yielding in close catenulate arrangement often about 50 to 75 conidia of cylindrical shape with slightly convexed ends, measuring mostly 3 to 6 μ (average 4.6 μ) in length and 0.9 to 1.1 μ (average 1.05 μ) in width.

Destroying a small form of *Euglypha levis* it occurs in leaf mold in Arlington, Va.

COCHLONEMA FUSISPORUM

Including the fungus just described, three species of *Cochlonema* with rod-shaped conidia comprise all the members of the Zoopagaceae that have so far been set forth as developing endoparasitically in testaceous rhizipods. Several other congeneric forms, also producing rod-shaped conidia and likewise subsisting on testaceous rhizopods have been observed, even if as yet not in sufficient detail to allow an adequate discussion of them. Parasitism on shelled protozoans is, however, not limited to members of the series with cylindrical conidia, being shared unquestionably by a congeneric fungus with spindle-shaped conidia that appeared in an old maizemeal-agar plate culture two months after the addition of some pinches of leaf mold collected on November 22, 1937, in deciduous woods in Arlington, Va.

The fungus in question consistently parasitized an ovoid animal measuring usually 45 to 52 μ in length and 25 to 28 μ in width, which was covered with imbricated broadly elliptical scales often 7 to 8.5 μ long and 6 to 7 μ wide (FIG. 4, *A, B*). At the circular mouth the testa was fringed with a sharply dentate honey-colored band; near the fundus was contained a large spherical nucleus often 13 to 15 μ in diameter, within which a loose central assemblage of slightly darker oblong parts was discernible. Since the rhizopod thus conforms closely to the description of *Sphenoderia dentata* Pen. as given by Penard (**14**) and by Wailes (**15**), it may confidently be referred to that species. Apparently because of a rather dense texture of the animal's protoplasmic contents the thallus of the parasite was very often badly obscured, and consequently for the most part escaped notice until some development of hyphae outside betrayed its presence (FIG. 4, *C–E*). In specimens of the host containing numerous scales preparatory to divi-

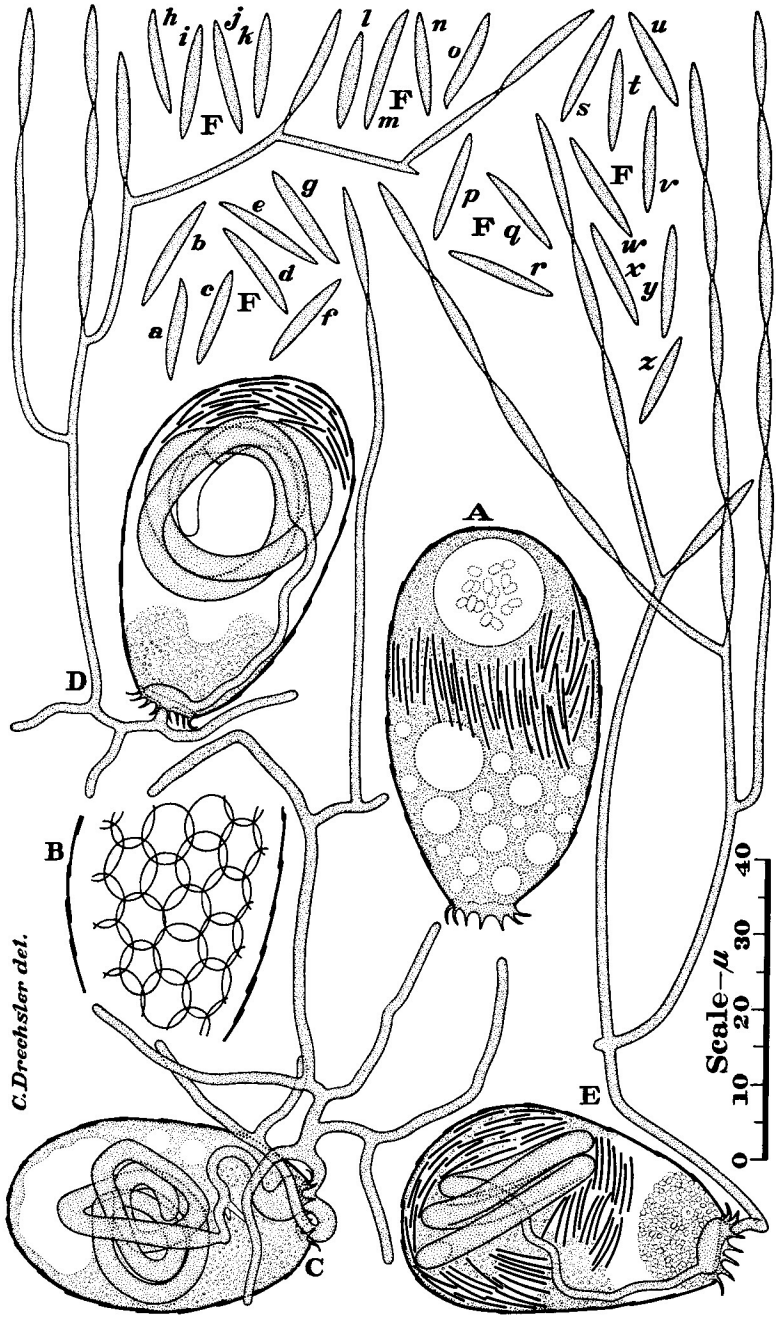

FIG. 4. *Cochlonema fusisporum.*

sion, the fungus could usually be detected earlier through conspicuous displacement of the plates from their normal position in a well ordered equatorial layer (FIG. 4, *D, E*).

The thallus appears usually of a bulk scarcely commensurate with the size of the parasitized animal. In the few instances where the vegetative body could be followed with certainty throughout its length, it was found to consist of an unbranched hypha, only moderately swollen, and coiled sometimes irregularly (FIG. 4, *C*), but more often with fair geometrical symmetry (FIG. 4, *D, E*), in only two, three, or four simple turns. The relatively small volume of the convolved structure is necessarily associated with comparatively early development of external parts; for only through such earlier development could the thallus be enabled after a brief initial period to function essentially after the manner of a haustorium in transmitting assimilated materials to conidial apparatus outside the host, instead of retaining them to augment its own volume. Now, as development of external parts requires the infected animal to be incapable of further locomotion, it follows that the fungus must somehow bring about early disablement of its host. A probable means by which such a result might be accomplished is to be recognized in a conspicuous gag-like enlargement of the reproductive hypha immediately within the animal's mouth (FIG. 4, *C–E*)—a curious modification not observable in allied forms, and assuredly well placed to interfere with or to disrupt the pseudopodial equipment of the rhizopod.

For the rest, the reproductive filament follows a usual course of development. It arises always singly from the proximal end of the thallus, reaches the oral opening of its host often by a somewhat circuitous path, and after emerging therefrom and in some instances sending a few short branches into the substratum, gives rise to erect or ascending aerial hyphae constricted at regular intervals. Through evacuation of protoplasm from the constrictions, and deposition of end-walls by the separated protoplasts, the aerial hyphae become converted into chains of spindle-shaped conidia, that, except for the absence of all sculpturing, recall the catenulate conidia of *Zoopage tryphera* Drechsl. (**9**). After the production of one chain of asexual spores, the supporting hypha often grows out somewhat obliquely from a point just below its

sharply tapered apex, to give rise a little farther on to a second conidial chain (FIG. 4, *E*), and frequently, by successive repetition of the process, to additional chains (FIG. 4, *D*). Apart from subterminal elongation, some increase in sporiferous hyphae is provided for through lateral branching (FIG. 4, *D, E*).

The shape of its conidium suggests for the fungus a name compounded of two words meaning "spindle" and "seed," respectively:

Cochlonema fusisporum sp. nov.

Hyphae alitae incoloratae, circa 150–175 μ longae, 2.2–3.8 μ crassae, simplices, bis vel quater circulatim convolutae, ex basi hypham genitabilem proferentes: hypha genitabili magnam partem 1–1.6 μ crassa sed in ore vel prope os animalis aliquantum inflata, ultra os in ramos fertilis erectos vel ascendentis 1.2–1.6 μ crassos abeunte; conidiis hyalins, levibus, fusiformibus, plerumque 12–17 μ longis, 1.5–2 μ crassis, in catenulas 15–35 sporas assurgentis digestis; ramo fertili deinde tum aliquotiens identidem repullulante aliquot additicias cantenulas conidiorum deinceps fere gerente.

Sphenoderiam dentata enecans habitat in terra silvestri in Arlington, Virginia.

Vegetative hypha colorless, often 150 to 175 μ long, 2.2 to 3.8 μ wide, simple, coiled in 2 to 4 circular turns 15 to 28 μ in diameter, from its proximal end emitting a reproductive filament; the reproductive filament mostly 1 to 1.6 μ wide except for an inflated part at the mouth of the host animal, outside of which orifice it terminates always in erect or ascending conidiiferous branches, besides sometimes giving off one or more short sterile branches into the substratum. Conidia colorless, smooth, spindle-shaped, mostly 12 to 17 μ (average 14.3 μ) long, 1.5 to 2 μ (average 1.76 μ) wide, formed in numbers of 15 to 35 in chains resulting from segmentation of the fertile branches; the basal part bearing a conidial chain often growing out repeatedly from below the pointed sterigmatic tip to give rise successively to additional conidial chains.

Destroying *Sphenoderia dentata* it occurs in leaf mold in Arlington, Va.

In the agar plate culture where *Cochlonema fusisporum* was found subsisting on *Sphenoderia dentata,* the rhizopod at the same time was being captured and consumed by the predaceous hyphomycetous form that I described earlier (2) as *Pedilospora dactylopaga.* Perhaps because the phycomycetous parasite rather quickly disables an infected animal, only one specimen of the rhizopod was seen undergoing simultaneous expropriation by both

fungi. Neither of the carnivorous species showed any ill effects from their close positional relationship.

EURYANCALE SACCIOSPORA

Nematodes from their sculpturing obviously referable to a species of *Bunonema* were found being destroyed in considerable numbers on an old maizemeal-agar plate culture 4 weeks after it had been planted with some pinches of leaf mold gathered from deciduous woods in Arlington, Va., on March 25, 1938. The distinctive conidial apparatus growing out from the dead animals over the surface of the substratum indicated as the cause of the destruction an endoparasitic fungus comparable in reproductive habit and presumably, too, in biological relationship, to various species of *Harposporium* and *Verticillium* often exterminating large populations of eelworms. Previous to the death of affected nematodes and for some time thereafter, the oily or lumpy degeneration of all fleshy parts largely obscured the organism causing the pathological changes—a difficulty encountered, of course, in virtually all instances where nematodes are invaded by fungi. Later, on advanced depletion of the animal's degenerating contents, the vegetative thallus of the parasite was revealed as a branching filamentous mycelium disposed lengthwise within the sculptured integument, from blunt head to pointed tail. In the earlier observable stages the hyphae were found consistently devoid of septa; so that with respect to structure as well as with respect to dimensions, branching habit and texture of protoplasmic contents, they resembled the haustorial filaments of *Stylopage hadra* and *S. leiohypha*. In subsequent stages cross-walls were often present, having manifestly been laid down at intervals as retaining partitions to delimit living portions of hypha from empty portions. Evacuation of the mycelium was found to begin in the outlying elements, the dense finely granular protoplasm being utilized in extending a number of prostrate reproductive filaments over the substratum in various directions (FIG. 5, *A*).

These filaments originate as delicate branches from the endozoic mycelium, reaching the exterior by narrowly perforating the animal's integument. On attaining a certain length each gives rise some distance back from its tip and usually at an angle approxi-

mating a right angle, to a single prostrate branch (FIG. 5, *A, v, u*), or often to a pair of opposite prostrate branches. For a distance of 5 to 10 μ each branch maintains about the same width as the parent filament; then, however, while extending itself about 10 μ farther, still as a prostrate structure, it widens to a diameter three times greater (FIG. 5, *A, t*). Thereupon it abruptly changes its direction of growth to curve upward and thus to thrust into the air a narrowing beak at the end of which a small but readily noticeable bulbous enlargement is produced (FIG. 5, *A, s*). Sometimes from the adaxial side of this enlargement (FIG. 5, *A, j*), sometimes from its abaxial side (FIG. 5, *A, r*), yet as far as can be determined always approximately in the plane of the upcurved supporting branch, there is put forth a delicate filamentous outgrowth about 15 μ long, often bent rather abruptly about 2 μ from its attachment, and gently curved from the bend to the bluntly rounded tip. A cross-wall is now laid down immediately below the bulbous enlargement; and the enlargement, together with the short adjacent portion of outgrowth up to the abrupt bend, is evacuated by the migration of its protoplasm upward into the longer gently curved distal portion, which thereupon is set off by a retaining septum. Meanwhile the narrow vertical beak-like support below the bulbous enlargement likewise becomes evacuated through withdrawal of its contents back into the stouter portion of the upcurved branch, and a retaining septum is laid down to wall off the empty part (FIG. 5, *C*). When disarticulation then takes place at the partition immediately below the bulbous enlargement, a conidium is released, curiously made up of a slender curved cylindrical living cell together with an empty basal appendage that looks preposteriously like a little pouch attached by a longish neck (FIG. 5, *I*).

After one conidium has been produced, the upcurved inflated branch grows out on its adaxial side a short distance below the septum delimiting it from its empty beak, to form a new beak on which after the same elaborate development already described (FIG. 5, *A, h, i*) another conidium is borne. Repetition of the process gives rise successively to a third conidium (FIG. 5, *A, g*), to a fourth, to a fifth (FIG. 5, *B, b*), to a sixth (FIG. 5, *B, d*), and sometimes even to a tenth (FIG. 5, *F*). With each successive elongation the blunt stump of the preceding sterigmatic beak is displaced,

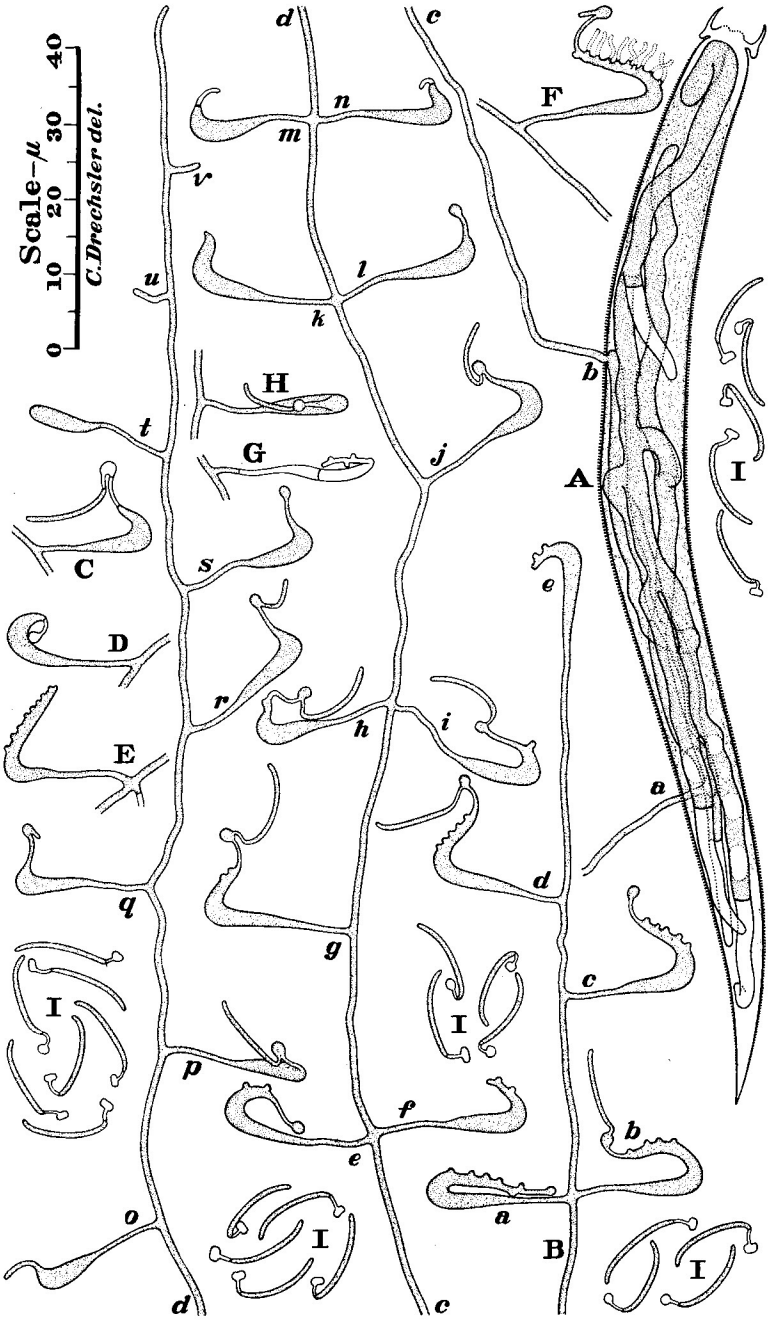

FIG. 5. *Euryancale sacciospora.*

in most instances being pushed into an abaxial position (FIG. 5, *A, e–i; B, b–e; E; F*). Thus in the end the distal limb of the upcurved inflated branch, which may come to equal (FIG. 5, *B, a–d*) or even to exceed (FIG. 5, *E, F*) the proximal limb with respect to length, is usually revealed with a series of small dentate protuberances along its upper or abaxial side; the very delicate empty sterigmatic processes borne thereon (FIG. 5, *F*) having become almost indiscernible.

The axial reproductive filament develops after the manner of an indeterminate inflorescence (FIG. 5, *A*). As it continues to elongate it puts forth additional lateral branches at successive intervals, each branch emulating its older fellows in elaborating conidia one by one. Some dozens of sporiferous branches may be produced before axial growth is concluded with the development terminally of a broadened upcurved sporiferous part (FIG. 5, *B, e*) homologous with the lateral elements. Owing to the sequence of their formation, the older or proximal branches generally give rise to more conidia than the younger distal ones, though, to be sure, some branches outdistance others below them in productiveness, or, again, are exceeded in productiveness by branches above them. Elaboration of conidia naturally ceases when the vegetative thallus has yielded up all the protoplasmic materials resulting from appropriation of the animal's fleshy contents; the empty lateral branches (FIG. 5, *G*) then soon collapsing, and together with the evacuated envelopes of the other filamentous parts, becoming subject to disintegration.

Presumably the peculiarities of morphology and development embodied in its conidial apparatus, have a part in somehow adapting the fungus for parasitism on its host. The conidia in being formed a short distance above the substratum would seem favorably placed for making contact with the upper side of the habitually creeping animal, where adhesion, or perhaps other physical engagement, is facilitated by pronounced sculpturing of the integument. How the pouch-like conidial appendages may promote infection is more difficult to understand, unless through their flexibility they serve a useful purpose in entangling themselves, possibly with the somewhat rangy cephalic parts of the host, or possibly with its remarkable protuberances.

At all events the parasite manifestly differs so widely from all members of the Zoopagaceae hitherto described, that the erection of an additional genus within that family appears advisable. For this genus a name compounded of words meaning "wide" and "bent arm," respectively, is suggested by the swollen upcurving conidiiferous branches of the fungus; while the peculiar conidial appendages suggest a specific term made up from words meaning "small bag" and "seed," respectively.

Euryancale gen. nov.

Mycelium continuum, ramosum, hyalinum, intra vivens animal crescens, in hyphis filiformibus consistens, post mortem animalis hyphas genitabilis extra evolvens; hyphis genitabilibus continuis, longiusculis, ramulos fertilis identidem emittentibus; ramulis fertilibus continuis, plus minusve incrassatis, ex apice conidia continua hyalina deinceps gerentibus.

Mycelium developing within living animals, continuous, branched, hyaline, composed of filiform hyphae, and giving rise after the death or disablement of the animal, to external reproductive filaments; reproductive filaments continuous, rather long, producing conidiiferous branches one after another; conidiiferous branches continuous, more or less widened, bearing continuous hyaline conidia terminally and often successively.

Euryancale sacciospora sp. nov.

Mycelium in hyphis sterilibus leniter flexuosis plerumque 2–3.5 μ crassis consistens, 2–6 hyphas genitabilis emittens; hyphis genitabilibus repentibus, saepius 0.3–1 mm. longis, 0.8–1.2 μ crassis, quoque 15–45 ramulos fertilis ad pares angulos singulatim vel bifariam proferente; ramulis fertilibus inter se 10–35 μ distantibus, 18–30 μ longis, basi filiformibus repentibus 0.7–0.9 μ crassis, sursum in aera abrupte recurventibus 2.4–3 μ crassis, in sterigma plerumque 3–4 μ longum 0.7 μ crassum abeuntibus, ex eo unicum conidium gerentibus, deinde tum protoplasmate ex sterigmate identidem subducto in alia sterigmata deinceps recrescentibus et ex eis alia conidia deinceps gerentibus; conidiis hyalinis, in cellula viventi superiore et appendice inani inferiore consistentibus: cellula viventi filiformi, leviter curvata, 11–13 μ longa, circa 0.7 crassa; appendice basi ad instar sacculi inflata ibi saepius 1–2 μ lata, sursum cervice 1–2 μ longa, 0.3–0.4 crassa adjuncta.

Vermiculos generis *Bunonematis* enecans habitat in humo silvestri in Arlington, Virginia.

Mycelium composed of slightly flexuous hypha mostly 2 to 3.5 μ wide, putting forth in various directions from each infected animal usually 2 to 6 creeping reproductive hyphae 0.3 to 1 mm. long and 0.8 to 1.2 μ wide; each reproductive hypha giving rise at intervals of 10 to 35 μ and at angles approximating a right angle, either singly or oppositely in pairs, to 15 to 45 conidiiferous

branches, which, measuring 18 to 40 μ in total length, consist individually of a prostrate proximal filamentous part, 5 to 10 μ long and 0.7 to 0.9 μ wide, together with a more expanded distal part 2.4 to 3 μ wide that curves abruptly upward into the air to terminate in a tapering sterigma, mostly 3 to 4 μ long and 0.7 μ wide, whereon is produced an apical conidium; the conidiiferous branch after withdrawing the protoplasm from one sterigma, often growing out into a new sterigma to bear another conidium, and then through continued repetition of the process frequently giving rise successively to additional conidia; conidium composed of a continuous, slightly curved, filiform, distal living cell, 11 to 13 μ long and 0.7 μ wide, together with a proximal empty appendage expanded at its base into a pouch-like part, 1 to 2 μ wide, and attached by a slender neck 1 to 2 μ long and 0.3 to 0.4 μ wide.

Destroying nematodes belonging to a species of *Bunonema,* it occurs in leaf mold in Arlington, Va.

DIVISION OF FRUIT AND VEGETABLE CROPS AND DISEASES,
BUREAU OF PLANT INDUSTRY,
U. S. HORTICULTURAL STATION,
BELTSVILLE, MARYLAND

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EXPLANATION OF FIGURES

FIG. 1. *Stylopage scoliospora;* drawn with the aid of a camera lucida to a uniform magnification; × 1000 throughout. *A,* portion of a branching superficial hypha from which two haustoria have been intruded into a relatively large specimen of the susceptible *Amoeba;* within the animal are visible also, firstly, the single subspherical nucleus consisting of a light peripheral layer together with a somewhat darker central body, secondly, two conspicuous contractile vacuoles (unstippled), and, thirdly, three digestive vacuoles somewhat obscured by overlying granular material; the three kinds of cellular structures being drawn in a manner uniform for all captured Amoebae shown in *A–G. B, C,* portions of hypha from each of which one haustorium has been intruded into a captured *Amoeba. D,* portion of mycelium with four captured Amoebae, *a–d;* one haustorium having been intruded into each of the three captives, *a, c,* and *d,* while two have been intruded into captive *b. E,* portion of mycelium with three captured Amoebae, *a–c;* one haustorium having been intruded into captive *a* and into captive *b,* while two have been intruded into captive *c. F,* portion of mycelium with two captured Amoebae, *a* and *b;* two haustoria having grown into the former, and one into the latter. *G,* portion of mycelium from which a haustorium has been intruded into each of the three captured animals *a–c. H,* a hypha with a conidiophorous branch showing a young terminal conidium in place, and thirteen geniculations that mark the places of attachment of conidia successively formed. *I,* portion of hypha whereon is borne a conidiophorous branch showing five geniculations and a fully grown sixth conidium attached terminally. *J,* portion of hypha with a conidiophorous branch showing a young conidium at its tip, subsequent to the formation earlier of nineteen conidia at successive positions marked by geniculations. *K,* portion of hypha with a branched conidiophore, the two elements of which show respectively ten and eighteen scarred geniculations, marking places of conidial attachment. *L,* portion of a long filament with conidiophorous termination showing a fully grown sixty-sixth conidium beyond sixty-five scarred geniculations that mark places of former attachment of successively developed conidia. *M, a–z; N, a–g,* conidia, showing variations in dimensions and shape.

FIG. 2. *Stylopage rhynchospora;* drawn with the aid of a camera lucida to a uniform magnification; × 1000 throughout. *A,* portion of mycelial hypha on which five individual Amoebae, *a–e,* are shown attached: one, *e,* having been captured so recently that penetration has not yet been effected;

two, *a* and *d*, having each been well invaded by a haustorium; the others, *b* and *c*, having each been wholly depleted of contents. *B*, a portion of superficial mycelial filament from which have arisen two conidiophores, *a* and *b*, each bearing a conidium; for want of space the conidiophores are shown in sections—*w* and *x* representing corresponding points on the sections of *a*; *y* and *z* representing corresponding points in the sections of *b*. *C*, a conidiophore bearing a conidium; from want of space shown in sections connecting at the points *y* and *z*. *D*, portion of mycelial hypha with a conidiophore bearing a conidium; from want of space shown in sections connecting at the points *y* and *z*. *E*, *a–j*, conidia, showing variations in size and shape. *F*, two conidia that have become united though cohesion of their glutinous beaks. *G*, two other conidia likewise united through cohesion of their glutinous beaks. *H*, a conidium germinating by the production of a conidiophore. *I*, a conidium that has given rise to a conidiophore whereon is borne fully developed a secondary conidium. *J*, a small conidium, presumably the product of repetitional development, that has in turn given rise to a conidiophore bearing a smaller and presumptively tertiary conidium. *K*, paired zygophoric branches immediately after apical fusion, showing in each one a septum at some distance from the union. *L*, *M*, *N*, three units of sexual apparatus showing successively later stages in enlargement and sculpturing of the zygosporangium; a filament from which one of the sexual branches in *L* is given off, has intruded a somewhat meager haustorium into a small animal captured by it. *O–U*, zygosporangia with zygospores in mature condition, illustrating variations in size and sculpturing; attached to them are shown portions of the empty sexual hyphae.

FIG. 3. Drawn with the aid of a camera lucida to a uniform magnification; × 1000 throughout. *A–G*, *Stylopage araea*: *A*, pair of intervolved sexual branches arising from separate hyphae and conjugating by apical fusion. *B*, pair of sexual branches apically united, from which a young zygosporangium has begun to develop laterally at some distance from the union; the septum delimiting one of the gametangia is shown. *C*, sexual apparatus showing the half-grown zygosporangium developing on a stalk arising close to the juncture of the two intervolved sexual branches, in each of which a cross-wall delimits a distal gametangium. *D*, sexual apparatus like the preceding, but with the zygosporangium being developed on a shorter stalk. *E*, sexual apparatus with the zygosporangium sessile at some distance from the union, and nearly fully grown. *F*, sexual apparatus with the zygosporangium terminal on a rather long stalk arising at some distance from the juncture of the sexual branches; attainment of definitive size by the zygosporangium is accompanied by the appearance of warty protuberances. *G*, *a*, zygosporangium after delimitation of a basal septum, but before deposition of a thick oospore wall; *b–j*, zygosporangia containing zygospores—the thin warty envelopes of the former being fused rather indistinguishably with the thicker walls of the latter; showing, moreover, variations of the sexual bodies in size, in shape, in organization of contents, and in number and distribution of their warty protuberances. *H–V*, *Cochlonema pumilum*: *H*, partly encysted specimen of *Euglypha levis*, showing the animal's nucleus posterior to the equatorial granular zone, and an ingested conidium of the parasite in an anterior positon. *I–K*, specimens of *E. levis*,

each containing a well developed thallus of the parasite; to the proximal end of each thallus is shown attached the empty envelope of the conidium from which it originated, together with the single reproductive hypha growing toward or through the animal's mouth. *L, M,* specimens of *E. levis,* each containing a thallus of the parasite that has given rise to a reproductive hypha, which after growing through the animal's mouth has ramified in the substratum outside; the development entailing evacuation of protoplasm from the distal portion of each thallus. *N, O,* specimens of *E. levis,* each containing a thallus of the parasite, from which has been produced a reproductive filament that after growing through the animal's mouth, has ramified outside to give rise to short sterile submerged elements and to longer aerial hyphae; evacuation of contents from the distal portion of each thallus having led to deposition of an approximately median septum. *P,* depleted testa of a specimen of *E. levis,* and within it the empty envelope of a thallus of the parasite, the protoplasmic contents of which were exhausted in the production of two conidial chains shown only in part from lack of space. *Q,* depleted testa of a specimen of *E. levis,* illustrating the dimensions and arrangement of its scales; within it is shown a thallus of the parasite that in large part has been evacuated of contents in giving rise to the reproductive filament with its lengthy aerial branch. *R–U,* exhausted testae of *E. levis,* each containing a thallus wholly depleted of contents in giving rise to conidial apparatus of which only the proximal parts are shown, owing to lack of space. *V,* conidia showing variations in dimensions and shape. (The testae of all animals in *H–T* are shown flatways; that in *U* is shown edgeways. Though the animals are mainly drawn in approximately median optical view, the oral profile is in most instances also shown, either wholly or partly; and in *Q,* besides, the testa is shown partly in surface view.)

FIG. 4. *Cochlonema fusisporum;* drawn with the aid of a camera lucida to a uniform magnification; × 1000 throughout. *A,* normal full-grown specimen of the host animal, *Sphenoderia dentata,* in a condition shortly preceding reproduction, showing the characteristically dentate oral fringe, the numerous scales for a new individual in the equatorial region, and the large nucleus in a posterior position. *B,* median portion of testa of *S. dentata,* illustrating the size and shape of its component scales, as well as their manner of imbrication. *C,* specimen of *S. dentata* containing a thallus of the parasite convolved in four turns; from its proximal end a reproductive filament has been produced; this filament, after widening markedly at the mouth of the host, resumed its original width on emerging therefrom to ramify outside; one of the resulting branches terminating in a chain of conidia, of which, from lack of space, only the basal member is shown. *D,* a specimen of *S. dentata* whose contents have been largely exhausted, and whose internal scales have been badly dislocated by the rather symmetrically convolved thallus of the parasite lying within, coiled in two and one-half turns; from the proximal end of the thallus has grown the single narrow reproductive filament, that, after swelling into a plug-like expansion at the animal's mouth, resumed its ordinary width on emerging therefrom, and gave rise outside to a few short submerged sterile branches as well as to a long aerial conidiiferous hypha; the latter, after producing a chain of conidia terminally, having grown out repeatedly four times from just below

each successive sterigmatic tip to produce in turn other chains of conidia farther on, exclusive of the one additional chain of spores produced on a lateral branch arising from the main axis some distance below its tip; the most distal of the chains not being shown at all from lack of space, the others being shown only in small part. *E*, specimen of *S. dentata* with protoplasm mostly exhausted and its scales inside badly displaced by a spiral thallus of the parasite consisting of two and one-third turns; from the proximal end of the thallus a single reproductive filament has been produced, which, after swelling into a plug-like distension at the animal's mouth resumed its ordinary width on issuing therefrom into the air, where, with two instances of lateral branching and two of subapical elongation, it gave rise to five chains of conidia, shown only in small part from lack of space. *F*, *a–z*, disarticulated conidia, showing variations in size and shape.

FIG. 5. *Euryancale sacciospora;* drawn with the aid of a camera lucida, to a uniform magnification; × 1000 throughout. *A*, specimen of *Bunonema* sp., permeated internally with a mycelium of the parasite; two reproductive hyphae, *a* and *b*, have been extended over the surface of the substratum—one of them, *b*, being shown from origin to growing tip, in three sections connecting at the points *c* and *d;* along the axial filament *b* are attached lateral conidiiferous branches, *e–v*, in early stages of development near the tip, and becoming progressively older toward the base. *B*, distal portion of a reproductive filament, showing four inflated upcurved lateral conidiiferous branches, *a–d*, on which sterigmatic stumps numbering six, four, five and five, respectively, indicate previous development and disarticulation of like numbers of conidia; the axial filament itself terminates in an expanded upcurved part, *e*, with two sterigmatic stumps on it implying disarticulation of two conidia. *C*, a swollen upcurving conidiiferous branch, with its first conidium shown in mature condition and attached to the empty slender sterigmatic prolongation. *D*, a conidiiferous branch from which its first conidium was detached somewhat abnormally, above rather than below the empty bulb-like part. *E*, a conidiiferous branch showing eight sterigmatic stumps. *F*, a conidiiferous branch supporting nine denuded sterigmata and terminating in a tenth sterigma on which a young conidium is being developed; the empty sterigmata, being only very indistinctly visible, are shown with dotted contours. *G*, an old conidiiferous branch from which the protoplasm has largely been withdrawn. *H*, upper view of conidiiferous branch in normal position, showing attached to it its first conidium still in somewhat immature condition. (Owing to some unavoidable disturbance incident to mounting material under a cover glass, nearly all other upcurved branches are shown as they appear when more or less flattened against the substratum; the unnatural postures, fortunately, revealing to advantage the actual relationship of parts.) *I*, conidia showing variations in size, in shape, and in disposition of the empty pouch-like basal appendages.