Reprinted from JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES
Vol. 27, No. 9, September 15, 1937

BOTANY.—*A species of* Tridentaria *preying on* Difflugia constricta.[1]

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In earlier papers I described four fungi that subsist by the destruction of testaceous rhizopods inhabiting different vegetable materials undergoing decomposition in contact with the soil. Two of the fungi (4), *Cochlonema cylindricum*, endoparasitic on *Euglypha denticulata* Brown, and *Zoopage tryphera*, predacious on *Geococcus vulgaris* Francé, belong in the Zoopagaceae, a family of conidial Phycomycetes living for the most part on terricolous amoebae. The other two fungi both belong in an interrelated series of Hyphomycetes which has become known more especially, perhaps, through some widely distributed and comparatively robust members variously adapted for the capture of free-living nematodes. One of the two mucedinous forms in question (3), *Dactylella passalopaga*, preys on *G. vulgaris* and *E. laevis* Perty; while the other (2), *Pedilospora dactylopaga*, is predacious in *Difflugia globulosa* Duj. and *Trinema enchelys* Ehrenb.

A fungus strongly reminiscent of *Pedilospora dactylopaga* appeared recently in some old maizemeal agar plate cultures of *Pythium Butleri* Subr. to each of which had been added a small quantity of leaf mold collected in deciduous woods with an undergrowth of coarse herbaceous weeds. No special organs of capture could be discovered on the slender hyphae that made up its scanty mycelium. Nevertheless, when filaments on the surface of the agar substratum were traced for any considerable distance, they were found here and there to pass along the oral end of a shelled rhizopod, through the mouth of

[1] Received June 20, 1937.

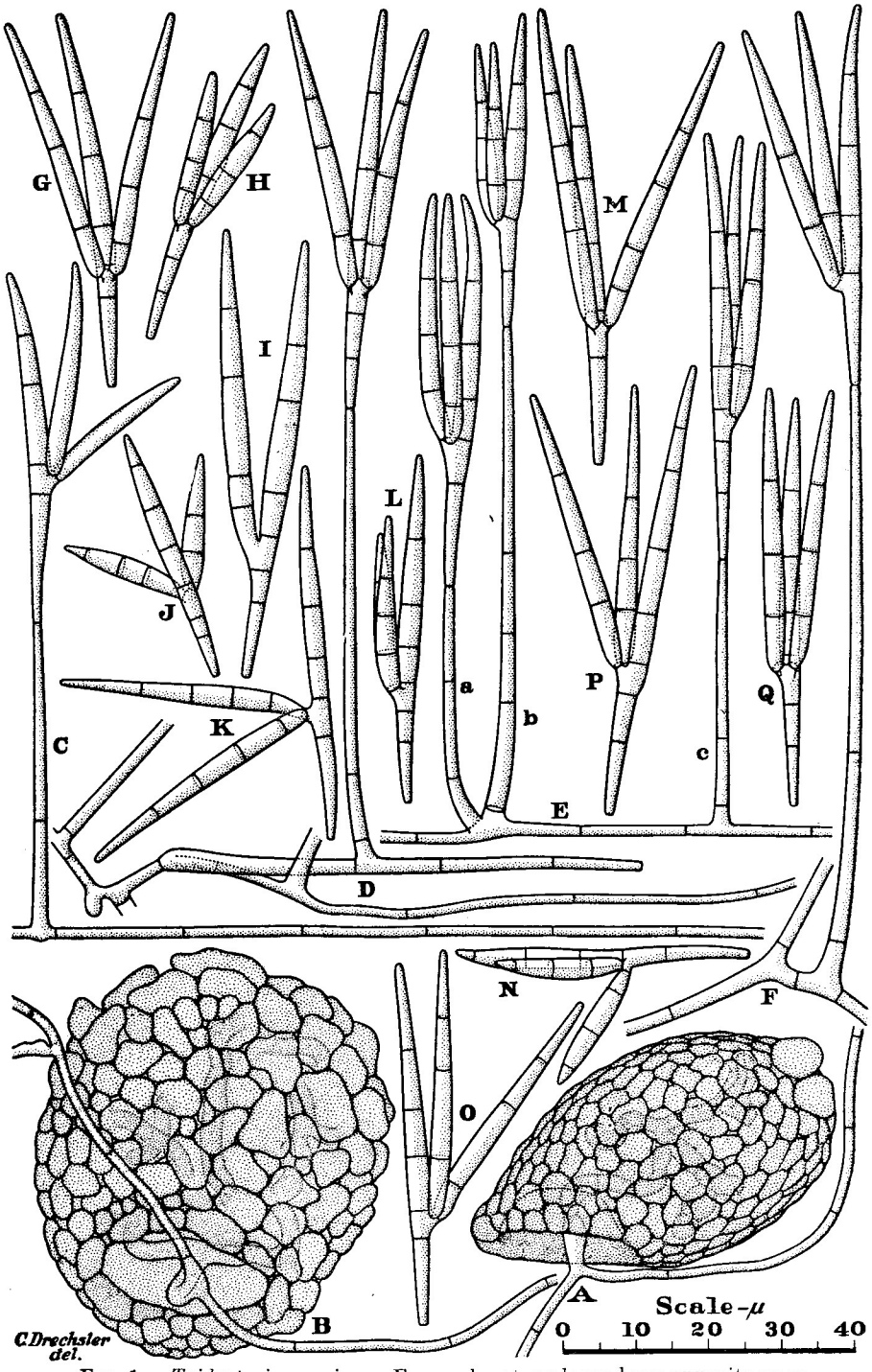

FIG. 1.—*Tridentaria carnivora*. For explanatory legend see opposite page

which invariably a branch entered to ramify irregularly within the protoplasmic interior (Fig. 1, A, B). Manifestly the ramifying elements functioned in assimilating the fleshy contents since some of the invaded animals had been depleted to such an extent that nothing remained but the more or less crusty tests. Despite the sluggishness of their locomotion the animals presumably endured invasion and appropriation of their digestible substance only because they were prevented from escaping. Appearances indicated that capture very probably was effected through adhesion of the hypha to the extruded sarcode, although direct optical evidence of an adhesive secretion on the mycelial filaments has not yet been obtained.

In view of its normally slanting posture, much like that of *Trinema enchelys*, of its usually brownish or light brownish coloration, of its compressed ovoid shape, its inflexed mouth and its somewhat protruded anterior lip, the rhizopod destroyed by the fungus is clearly referable to the widespread *Difflugia constricta* (Ehrenb.) Leidy. Most of the specimens encountered measured about 55μ in length from anterior lip to fundus (Fig. 1, A), about 45 μ in width as viewed flatways from above or below (Fig. 1, B), and about 30 μ in thickness from front to rear at a right angle to the inclined axis (Fig. 1, A). In dimensions, therefore, they were comparable to the smaller spineless individuals of *D. constricta* figured by Leidy (11: plate 18, figs. 12, 14, 17, 18, 19,), by Penard (14: page 212, fig. 37), and by Cash (1: plate 19, figs. 14–16).

The conidiophores (Fig. 1, C; D; E, *a-c;* F) produced by the fungus in small numbers, show general similarity to those of *Pedilospora dactylopaga* with respect to stature, and like them also, bear curiously forked solitary conidia. A very pronounced difference however is at once apparent in that the spores terminate regularly in three rather than in two prongs. One of the prongs represents merely a prolongation of the basal portion of the conidium, with which portion it continues the axis of the conidiophore and forms an element analogous

FIG. 1.—*Tridentaria carnivora*, drawn from material developed in mixed culture on maizemeal agar, with the aid of a camera lucida, at a uniform magnification; ×1000 throughout. A.—Portion of hypha with a captured specimen of *Difflugia constricta* in lateral view. B.—Portion of hypha with a captured specimen of *D. constricta* in oral-posterior aspect. C.—Portion of hypha bearing a conidiophore with conidium attached. D.—Portion of mycelium with an old conidiophore that has declined to the substratum; from the prostrate conidiophore has arisen a secondary conidiophore whereon is borne a conidium. E.—Portion of hypha with three conidiophores, each bearing a conidium. F.—Portion of mycelium from which has arisen a relatively tall conidiophore whereon a conidium has been produced. G–Q.—Conidia, showing variations in size, shape and arrangement of component elements; all being of the usual three-pronged type except the two-pronged specimen I.

to the entire conidium of *Dactylella passalopaga*. At a distance from its base often equal to about one-third of its length, this axial element bears laterally a broad process that immediately divides dichotomously in a transverse plane to provide the other two prongs. Though the paired prongs are sometimes rather widely divaricate especially in conidia that have been in contact with the substratum for some time (Fig. 1, J, K, N, O), they are more usually directed upward at narrowly divergent angles to one another as well as to the axial prong (Fig. 1, D; E, *a-c;* F, G-I; L; M; P; Q).

From the manner of its development the three-pronged conidium obviously is symmetrical with respect to only one plane, that being the plane passing through the axial element and bisecting the angle between the paired prongs. When viewed lengthwise from this plane, the spore (Fig. 1, G, H, Q), especially if considered together with the hypha supporting it, presents an appearance suggestive of a trident. The similitude is of consequence in encouraging, or, perhaps, even necessitating assignment of the fungus to *Tridentaria*, a genus erected by Preuss (15) in 1852 on a single species found by him on moist disintegrating stems of *Brassica oleracea* L. and described very sketchily under the name *T. alba*. The diagnosis of the genus likewise is exceedingly brief, consisting of only a dozen words. There can be no question, at least, that the conidia were intended to be described as simple and as being united in the form of a trident, but whether the conidiophore was considered as being included in the union remains open to speculation.

Owing to its inadequate characterization the genus has not been at all kindly received by compilers. Saccardo (16), who set forth the conidiophores as terminating in simple conidia joined together in the form of a trident—an arrangement certainly not easy to relate to ordinary modes of development—added the comment that the genus had been imperfectly and obscurely described by Preuss, and hence was dubious. Lindau (12) in his first treatment of the genus characterized it in part as having very short conidiophores, and as bearing on these conidiophores solitary triradiate conidia. The portion of the description concerning the shortness of the conidiophores appears to have been based primarily on inference. On the other hand, the reference to production of solitary triradiate conidia instead of simple conidia joined in the form of a trident, is evidently to be explained as expressive of an interpretation—I believe a justifiable interpretation—whereby the individual spore was looked upon as a more inclusive unit than originally. One is tempted to submit, possibly, that

a structure held to resemble a trident might have been more accurately described by words meaning "three-pronged" or "three-tined" (as, for example "dreizackig" or "dreizinkig") than by the expression "3 strahlige"; since the proximal part corresponding to the shaft of a trident constitutes obviously a fourth radial and thus, strictly speaking, makes for a quadriradiate condition.

In his key to the genera of the Hyalostaurosporae in a later work (13: page 535) Lindau, indeed, referred to the conidia of *Tridentaria* as three-pronged and treated them as analogous in outward make-up to the two-pronged conidia of Pedilospora. Then, however, somewhat inconsistently, in defining the genus (13: page 543) he characterized the conidia as being simple and as concreted in the form of a trident,—exactly, therefore, as Saccardo had characterized them previously. Complaining, not without reason, that it was impossible to gather from Preuss' description how the conidia really look, he held that the genus might better have been rejected,—a course from which he was dissuaded by the small membership of the Mucedinaceae-Staurosporae, and the hope of arousing some profitable attention. Since its erection *Tridentaria* has had committed to it only one additional species, that being *T. setigera* published by Grove (8) in 1912. The original account of this species was accompanied by figures of compound branching structures which from the description were evidently considered as being composed individually of a three-celled conidiophore tapering toward its base and widening like a fan toward its apex, together with three conidia palmately united at their bases and collectively flanked on both sides by an acute seta. As Preuss made no mention of setae in his diagnosis of *Tridentaria,* the authors dealing with *T. setigera* in the "Sylloge fungorum" (17) quite properly raised the question whether the fungus might not perhaps better be regarded as a species of *Titaea.* The similarity of the branching structures to the conidia of *Tetracladium marchalianum* De Wild., especially as figured in a recent paper by Karling (10), suggests an alternative disposition, if, indeed, the distinction between *Titaea* and *Tetracladium* can still be maintained.

Undoubtedly the fungus preying on *Difflugia constricta* fits into *Tridentaria* better than does *T. setigera;* and better, too, than it fits into any other genus. Though its conidial prongs do not lie in one plane, and though the shoulders of its lateral prongs are comparatively narrow, yet the general resemblance of its reproductive apparatus to a trident seem more realistically suggestive than the resemblances underlying most of the names applied to fungi. The

structural design here is conspicuously different from the triradiate design that was set forth by Fresenius (6) as characteristic of the conidia of *Trinacrium subtle* Riess, and that accordingly may be held more or less typical of the genus erected on this species. To be sure, in application *Trinacrium* has not been strictly limited to triradiate forms, having been made to include *T. subtropicale* Speg. with quadriradiate conidia, as well as *T. tropicale* Speg. with conidia composed mostly of three or four radial elements whereof the proximal one is pedicelliform and shorter than the others. The former species differs markedly from the fungus destructive to *D. constricta* in the greater width (5 to 6μ) and cruciate arrangement of its conidial branches, while the latter presents equally decisive differences in its shorter ascending conidiophores and shorter conidial radiants. The genus *Tetracium* P. Henn. with quadriradiate, elongate-fusoid, pluriseptate conidia may be dismissed from consideration, for although originally described as presumably eligible for inclusion in the Mucedineae, Höhnel's study (9) of its type species, *T. Aurantii* P. Henn., refers it definitely to the Tuberculariaceae.

From its thoroughgoing similarity in biological relationship and reproductive habit to some of the Hyphomycetes known to prey on animals, the fungus under discussion must be regarded as unquestionably a member of the same predacious series. Its distinctive conidial apparatus is easily derived from that of the genus *Dactylella* Grove through branching of the solitary conidium; thereby offering an analogy to *Pedilospora dactylopaga* and to the nematode-capturing species I have described elsewhere (5) under the name *Triposporina aphanopaga.* In *P. dactylopaga* such derivation comes about through a single bifurcation of a narrow elongate conidium of the type found in *Dactylella passolopaga* and *D. leptospora* Drechsl. (5), provided that the distal elements or prongs be oriented parallel to one another; in the present fungus a similarly narrow elongate conidium bears a lateral branch that immediately bifurcates into two prongs usually diverging little from the axial prong; in *T. aphanopaga,* on the other hand, a swollen conidium of the type produced in *D. ellipsospora* Grove (7), *D. gephyropaga* Drechsl. (5) and *D. bembicodes* Drechsl. (5), bifurcates twice successively, the four distal apices diverging widely from one another. As Preuss attributed to *Tridentaria alba* "Sporis oblongis vel clavaeformibus" it may be inferred that what would now be regarded as the complete conidium of his species could be derived through appropriate branching of a clavate spore of the type represented, for example, in *D. asthenopaga* Drechsl. (5).

In any event the clavate elements ascribed to the type species of *Tridentaria* sets it apart from the fungus subsisting on *Difflugia constricta*. Since this fungus appears specifically distinct also from the few other quadriradiate species in the Mucedinaceae-Staurosporae, it is described as new under a name suggestive of its predacious character.

Tridentaria carnivora sp. nov.

Mycelium sparsum, effusum; hyphis sterilibus hyalinis, parce ramosis, mediocriter septatis, 1–2μ crassis, hac illac animalcula testacea adhaerendo capientibus, ramulum in orem cujusque intrudentibus, hyphas intus evolventibus quae carnem assumunt. Hyphae fertiles sparsae, hyalinae, septatae, erectae, simplices sed post maturitatem procidentes diende tum saepius hyphas fertilis ordinis secundi proferentes, plerumque 32–85μ altae, basi 1.7–3.3μ crassae, sursum leviter fastigatae, apice .9–1.4μ crassae, in unicum conidium abeuntes; conidiis hyalinis, vulgo ex tribus partibus ad instar fuscinae compositis,—parte longissima quae lineam hyphae fertilis producit elongato-fusoidea, recta vel leviter curvata, 5–8- loculari, 35–63μ longa, 2.8–3.8μ crassa, deorsum in hastili 1–3- loculari, 12–21μ longo, sursum in dente 3–5- loculari, 23–43μ longo consistente, inter hastile et dentem unum ramulum lateralem ferente; hoc ramulo infimo furcato atque in duos dentes 1–6- loculares 17–44μ longos apicem versus attenuatos vulgo abeunte, rarius simplici manente tum conidium bidens faciente.

Difflugiam constrictam capiens consumensque habitat in humo silvestri prope Beltsville, Maryland.

Mycelium scanty, spreading; the vegetative hyphae hyaline, sparingly branched, septate at moderate intervals, 1 to 2μ wide, here and there capturing testaceous rhizopods by adhesion, thrusting a branch into the mouth of each captive and giving rise inside to assimilative hyphae that appropriate the protoplasmic contents. Conidiophores sparsely scattered, hyaline, septate, erect, typically simple though after maturity declining to the substratum and then often putting forth secondary fertile hyphae, in any case mostly 32 to 85μ (average 60μ) high, 1.7 to 3.3μ (average 2.5μ) wide at the base, tapering slightly upward, .9 to 1.4μ (average 1.2μ) wide at the tip, terminating in a single conidium. Conidia hyaline, usually composed of three elements in trident-like arrangement,—the longest element elongate-fusoid, straight or slightly curved, divided by septa into 5 to 8 (average 6.4) cells, measuring 35 to 63μ (average 52μ) in length, 2.8 to 3.8μ (average 3.2μ) in width, its axis prolonging the axis of the supporting hypha, its proximal portion of 1 to 3 cells forming a shaft 12 to 21μ (average 18μ) long, its distal portion of 3 to 5 cells forming a somewhat tapering prong 23 to 43μ (average 34μ) long, between shaft and prong bearing a lateral spur; the spur usually bifurcating near its base into two prongs, each divided by septa into 1 to 6 (average 4) cells and measuring 17 to 44μ (average 34μ) in length; occasional elongation of spur directly into a simple branch leading to development of atypical two-pronged conidia.

Capturing and consuming *Difflugia constricta*, it occurs in leaf mold near Beltsville, Md.

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