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**A SPECIES OF ARTHROBOTRYS THAT
CAPTURES SPRINGTAILS**

A SPECIES OF ARTHROBOTRYS THAT CAPTURES SPRINGTAILS

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(WITH 6 FIGURES)

Of the predaceous fungi, numbering about 61, that have been made known both with respect to the vegetative stage active in capture of animals, and with respect to at least one reproductive phase sufficiently distinctive to provide a basis for identification, 3 are recognized as preying mainly on rotifers, 5 as preying habitually on testaceous rhizopods, 24 as preying habitually on *Amoebae*, and 29 as preying habitually on nematodes. Although offering an obvious analogy with the insectivorous phanerogams, the fungi hitherto reported to subsist through capture of motile animals have in no instance been found specially adapted for preying on insects. Such adaptation might, indeed, seem hardly possible, since even the smallest of the more familiar insects appear rather large in comparison with organisms of truly microscopic dimensions. Nevertheless, a hyphomycete has recently been observed, which, though no more robust than the several nematode-capturing forms closely related to it, is unmistakably adapted to prey primarily on insects, and under natural conditions presumably is given wholly to a predaceous mode of life.

The hyphomycete in question made its appearance in 14 Petri plate cultures planted on Sept. 18, 1943, with discolored rootlets of *Polygonum pennsylvanicum* L. freshly collected from moist ground near a brook in Arlington, Va. Most of the cultures had previously been used in growing *Pythium ultimum* Trow and *P. vexans* de Bary, and thus were thoroughly permeated with oomycetous mycelium when the final planting was made. The few cultures

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wherein sterile medium—maizemeal agar of rather soft consistency—was used soon became permeated likewise with pythiaceus mycelium, as *P. palingenesis* Drechsl. promptly grew out from each of the discolored rootlets. Development of bacteria in moderate quantity permitted gradual multiplication of rhizopods and eelworms, which, in turn, led to development of fungi subsisting on these animals. Examinations made at weekly intervals during the month of October revealed the 3 widespread nematode-capturing species *Arthrobotrys oligospora* Fres., *Dactylella ellipsospora* Grove, and *Dactylaria candida* (Nees) Sacc., variously intermixed with the 7 allied nematode-capturing forms I have described (2) under the binomials *A. conoides*, *A. musiformis*, *A. dactyloides*, *Dactylella bembicoides*, *Dactylella geophyropaga*, *Dactylaria brochopaga*, and *Dactylaria thaumasia*. Except that their conidiophores occasionally interfered with pedestrian locomotion, these fungi did not harmfully affect the concomitant development of a minute species of springtail often encountered on decaying plant materials that have been kept for some time under moist conditions. This springtail, whose length was usually found varying from 125 μ in small individuals to 350 μ in large individuals, and whose width was equivalent generally to one-third or two-fifths of its length, has been identified as a member of the genus *Sminthurides* (subgenus *Sphaeridia*) very similar to *Sminthurides* (*Sphaeridia*) *serratus* Folsom and Mills (6); it belongs, therefore, in the family Sminthuridae of the order Collembola.² If the earlier examinations gave no evidence that the insect was suffering any mishap, an examination made on November 1, when in most cultures it had attained numbers ranging from 50 to 100, showed many dead specimens grouped in small areas near the decaying roots added 44 days previously. A somewhat clustered arrangement of the dead insects and the constant proximity of many erect columnar processes (FIG. 1-4) indicated a predaceous fungus as the agent of destruction.

² For identification of this difficult insect, I am greatly indebted to Miss Grace Glance of the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, Washington, D. C. A general idea of its appearance may be gained from illustrations of related springtails given by Comstock (1: p. 229, fig. 236), by Folsom and Mills (6: figs. 19, 84), and by Mills (8: p. 123, fig. 13).

During the ensuing 10 days numerous additional groups of columnar processes appeared; the new groups being produced, for the most part, at increasingly greater distances from the root material whence the first groups had originated. This more widespread development was accomplished by radial extension of rather narrow, straightforward, hyaline, septate, prostrate hyphae that for relatively long distances showed only meager branching of commonplace character. However, at intervals these long hyphae would widen perceptibly and would give off several branches close together and at angles approaching a right angle. Not far from their respective origins, the branches, which in the beginning ran parallel with one another, would abruptly change their direction of growth to anastomose with one of their fellows, or would give off one or more secondary branches to accomplish a similar end; thereby forming a hyphal network prostrate on the surface of the substratum. Many of the segments composing the network then would send up, individually, an erect process consisting of a stout stalk-like basal cell together with a wider distal cell, ovoid or prolate ellipsoidal in shape (FIG. 5, *A*; *B*, *a-f*; *C*, *a-g*; FIG. 6, *A*, *a-p*). The distal cell, in all instances, soon secreted a relatively large quantity of a colorless adhesive liquid. In cultures well protected against evaporation for a few days, the adhesive liquid often appeared as a glistening globular droplet between 15 and 20 μ in diameter (FIG. 5, *A*, *a-m*); and it may be presumed that a guttular form is generally characteristic of the newly elaborated adhesive mass. However, more usually the body of adhesive exudate appeared as a rather strongly collapsed, irregularly lobate envelope surrounding the distal cell (FIG. 5, *A*, *n, o, s, t, v, x, z*; *B*, *a-f*; *C*, *a-g*; FIG. 6, *A*, *b, c, f, g, i, j, k, n, o, p*). When the columnar process was brought into a prostrate position, as frequently happened, the adhesive envelope would flatten out over the substratum and reveal a very thin peripheral film (FIG. 5, *A*, *n, p*; FIG. 6, *A*, *a, d, e, h, l, m*). Through secondary development a new erect process was often sent up from the base of a procumbent stalk (FIG. 5, *A*, *o, q*) or from a prostrate distal cell (FIG. 5, *A*, *u, v*); or a new adhesive process would arise not only from an older prostrate stalk but also from the glandular cell originally surmounting it (FIG. 5, *A*, *r, s, t*); or two new adhesive processes would arise from a

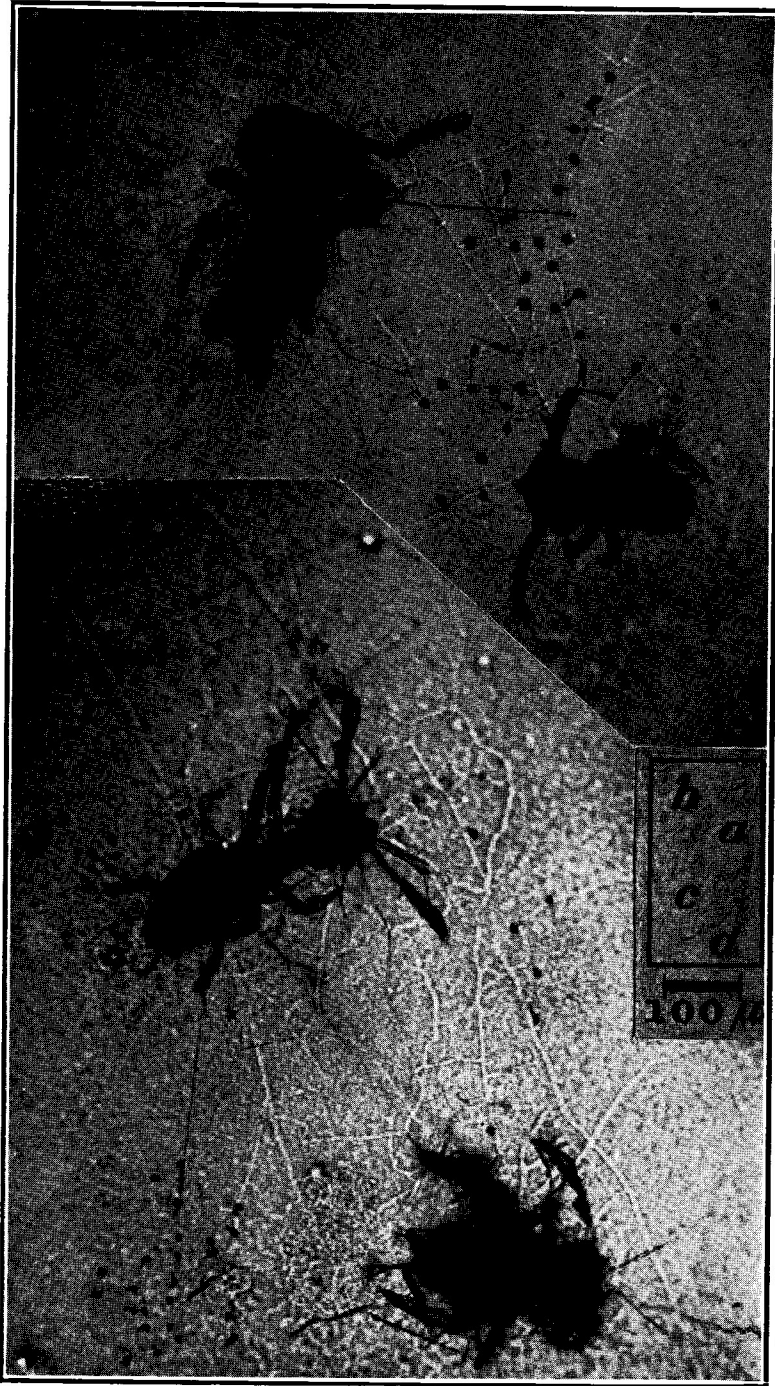


FIG. 1. *Arthrobotrys entomopaga*.

prostrate glandular cell (FIG. 5, *A*, *w*, *x*, *y*), one or the other, perchance, eventually in turn giving rise from its distal cell to an adhesive process of tertiary origin (FIG. 5, *A*, *z*).

The manner in which the erect processes operate as predaceous organs in the capture of springtails was immediately obvious from their general similarity to the intramatrix predaceous processes of *Dactylella ellipsospora* and of the two allied nematode-capturing hyphomycetes I have described as *Dactylella asthenopaga* (2) and *Dactylaria haptospora* (3).³ Borne aloft at a height usually of 10 to 15 μ the distal glandular cell is well placed for adhering to the ventral side of the low-bodied prey, or to its legs. The abundant elaboration of sticky exudate beforehand would seem important in assuring, at the very outset, such extensive adhesion that the effort of the insect to free itself by immediate use, more especially, of its powerful spring, will prove ineffectual. Owing to the close arrangement of the erect processes in groups, several of them probably often adhere to the animal at the same time, thereby fastening it down all the more securely.

Except for a frequently abnormal posture of body and appendages, which was obviously attributable to their struggles to escape, captured springtails for several days offered no marked departure in outward appearance when viewed under a microscope of low magnification; though closer examination at this time invariably showed the insects being permeated throughout with mycelium. Apparently, as in the 3 nematode-capturing hyphomycetes provided with similar predaceous organs, penetration is accomplished by the glandular cells most directly operative in effecting capture. Entrance of the fungus on the ventral side of prey was not brought under observation successfully. In instances where the fungus entered by way of an outstretched leg or sprawling antenna (FIG. 6, *B*, *a*) appearances indicated that the adhering glandular cell thrusts a narrow outgrowth through the thin integument, and then gives rise inside to a number of short swollen cells. From these swollen cells filamentous hyphae somewhat wider even than the hyphae

³ In view of their passive operation the predaceous organs here concerned invite comparison also with the stalked glands employed for capturing insects by 3 carnivorous phanerogamic plants (7), *Byblis linifolia* Salisb., *B. gigantea* Lindl., and *Drosophyllum lusitanicum* Lk.



FIG. 2. *Arthrobotrys entomopaga*.

making up the prostrate network outside are extended to permeate the fleshy interior with a copiously ramifying assimilative mycelium. Rather marked irregularities in thickness of hyphae may appear at articulations between joints of the appendages (FIG. 6, *B*, *b*; *C*).

The assimilative hyphae are distinguished by greater width not only when they are found in captured springtails but also when they occur in nematodes. Invasion of nematodes came under observation with some frequency in several cultures in which mites had borne down many newly developed predaceous processes, thereby bringing numerous adhesive cells into prostrate positions where eelworms might readily brush against them. Division of the assimilative hyphae into rather short and often somewhat inflated segments gave the mycelium formed within invaded specimens of *Plectus parvus* Bastian, the species most frequently found serving as prey, a curiously knotted appearance (FIG. 5, *D*) not hitherto noted in any fungus habitually given to capture of eelworms. When assimilative mycelium developed within eelworms gave rise to predaceous apparatus, it produced erect columnar stalks (FIG. 5, *D*, *a-h*), each bearing aloft a glandular cell,—in fine, it produced apparatus primarily suitable for capturing springtails rather than for capturing nematodes.

Although in all hyphomycetes now known to prey habitually on nematodes the assimilative hyphae transfer their protoplasmic contents backward into the external mycelium by way of the channel of invasion, those of the present fungus were sometimes found erupting through the integument of an eelworm to extend new mycelial filaments externally without reference to the path of ingress (FIG. 5, *D*). Apparently eruption may likewise take place through the integument of a captured springtail, for not infrequently long aerial filaments were seen festooned from the dorsal surface of an immobilized insect like threads of a very scant cobweb (FIG. 1, *b*, *c*, *d*). However, as many captured springtails never showed any arachnoid development, there is reason to believe that the protoplasm elaborated by the fungus from the fleshy materials of its usual prey is for the most part withdrawn backward into the external mycelium. The elaborated protoplasm, in any case, makes possible continued growth of long filaments ex-

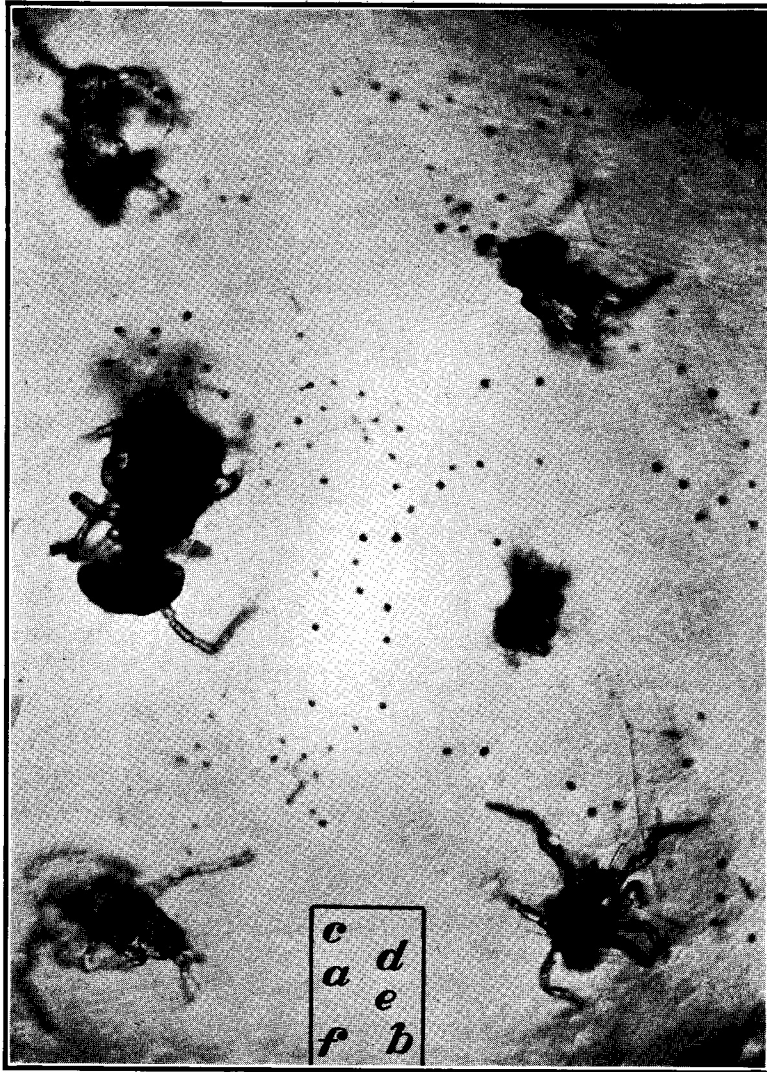


FIG. 3. *Arthrobotrys entomopaga*.

ternally and development on these filaments of additional groups of predaceous organs in the manner already described.

Indeed, in the cultures studied, almost all of the nourishment obtained from captured animals must have been expended in production of mycelial hyphae and predaceous organs—an expenditure

that might have been more profitable if the meager supply of available insects had not soon become exhausted. Only 3 of the 14 cultures showed any reproductive development, and in these 3 cultures only 10 conidiophores could be found, half of which were used in preparing drawings (FIG. 6, D-G). Owing to early evanescence of the long hyphal connections it was impossible in most instances to make out with certainty whether the conidiophores belonged to the same fungus as the clustered adhesive organs, though from the beginning both the conidial and the insect-capturing apparatus could be recognized as pertaining to some member of the predaceous series of hyphomycetes. In one instance, fortunately, hyphal anastomoses in proximity to membranous remains of several adhesive cells (FIG. 6, D, a-f) permitted easy recognition of the subjacent mycelium as consisting of an old insect-capturing hyphal network; a swollen living cell (FIG. 6, D, g) from which the solitary conidiophore arose being very clearly distinguishable as a glandular cell of the kind operative in capture of springtails.

The reproductive apparatus thus revealed in its proper connection did not conform at all closely to expectations suggested by the morphology of the predaceous parts. Among the nematode-capturing hyphomycetes now known, the closest approximation to the hyphal networks of the present fungus is found in the more or less scalariform networks of *Dactylella gephyrophaga*, a species producing large pluriseptate conidia on robust conidiophores. Pluriseptate conidia are likewise produced by the 3 nematode-capturing species, already enumerated, whose predaceous organs show most resemblance to those employed in capture of springtails. Then, too, somewhat robust dimensions of reproductive parts might be inferred from the relatively large size of the prey; for though the species of springtail captured may be small in comparison with the more familiar types of insects, it is large in comparison with the rhizopods and eelworms habitually taken by other terricolous fungi of predaceous habit. Contrary to all presupposition founded on analogy, both the conidiophores and the regularly uniseptate conidia borne on them in clusters were of decidedly modest proportions,—the whole apparatus, indeed, having dimensions not greatly different from those of the congeneric form which I re-

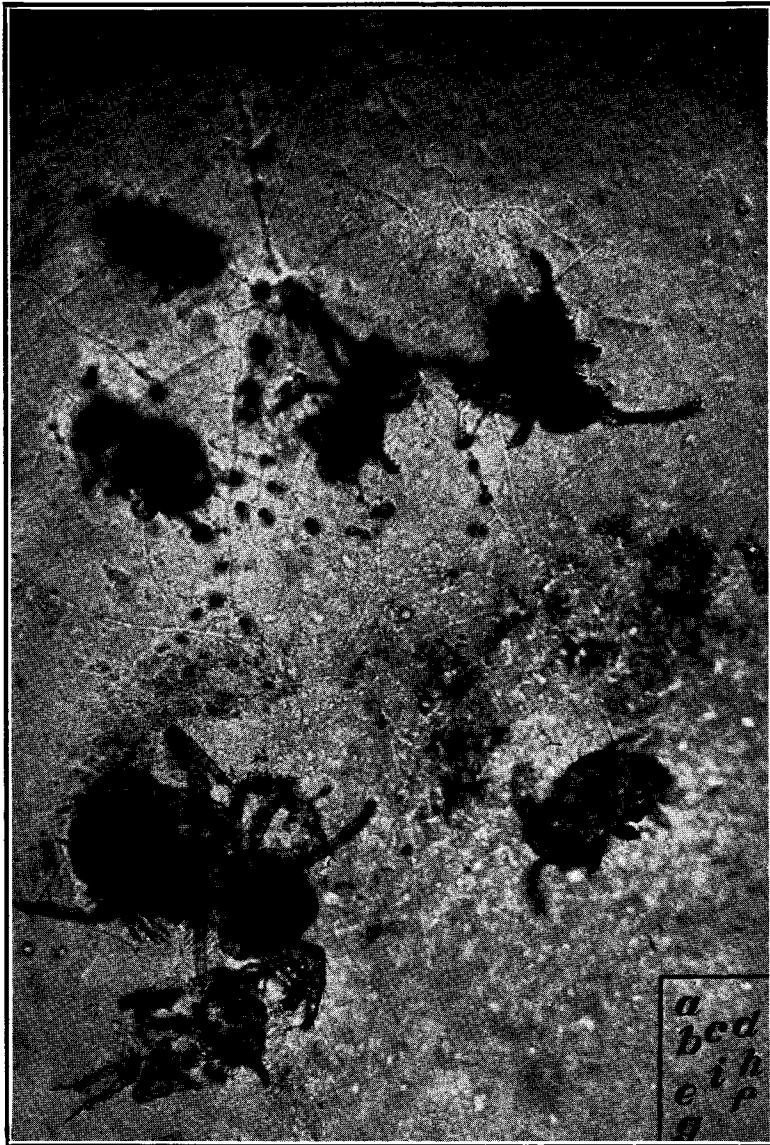


FIG. 4. *Arthrobotrys entomopaga*.

cently described (5) as *Arthrobotrys cladodes* var. *macroides*, and which with respect to its aerial reproductive structures must be reckoned among the smallest of the nematode-capturing hyphomy-

cetes. As the conidia were attached on rather long sterigmata their arrangement in clusters resembled the loose capitulate arrangement prevalent in *A. musiformis*, whose much sturdier conidiophore likewise is abruptly subramose at its tip. Resemblance to *A. musiformis* was especially manifest during early stages of development, when only a single conidial cluster was present (FIG. 6, *E*, *a*, *x*). In most of the 10 conidiophores that came under observation, production of the first conidial cluster had obviously been followed by renewed apical growth and repeated sporulation, since they bore aloft 2 (FIG. 6, *D*, *h*, *y*, *z*; *E*, *b*, *y*, *z*; *F*, *a*, *b*) or 3 (FIG. 6, *G*, *a-c*) spore clusters and thus offered marked contrast to the strictly monocephalous condition characteristic of *A. musiformis*. As this repeated production of conidia took place when sporulation was exceedingly scanty—so scanty that under comparable circumstances neither *A. superba* Corda nor *A. oligospora* nor *A. conoides* would ordinarily have formed more than a single cluster of spores—there is excellent reason to presume that the fungus has a very strong tendency toward repeated elongation of its conidiophores with concomitant development of conidial heads in prolonged succession. The merit of this presumption has not been confirmed so far by observations on pure cultures, as my attempts to isolate the fungus by aseptic transfer of conidia directly from the conidiophore to a sterile agar medium were all unsuccessful. Yet even without further knowledge of more prolonged development, the reproductive apparatus here discussed appears different from that of any species of *Arthrobotrys* hitherto made known. It seems appropriate, therefore, to present the insectivorous fungus as a new member of that genus, under a specific name compounded of two words meaning, respectively, “insect” and “trap.”

***Arthrobotrys entomopaga* sp. nov.**

Mycelium effusum; hyphae steriles generis vulgaris longae, filiformes, incoloratae, mediocriter septatae, 2–3 μ crassae, saepe repentes et magna ex parte parvulum ramosae sed hic illic aliquantulum latescentes et ramos repentes 3–6 μ crassos crebre emittentes qui in rete coeunt et ramusculos tenaces erectos ferunt; ramusculis tenacibus vulgo bilocularibus, cellula inferiore cylindrata vel sursum attenuata, plerumque 7–17 μ longa, 2–5 μ crassa, cellula superiore quasi ovoidea, 8–13 μ longa, 4.5–8 μ crassa, involucro glutinis primum sphaerali mox collapsio circumdata, itaque ad insectum

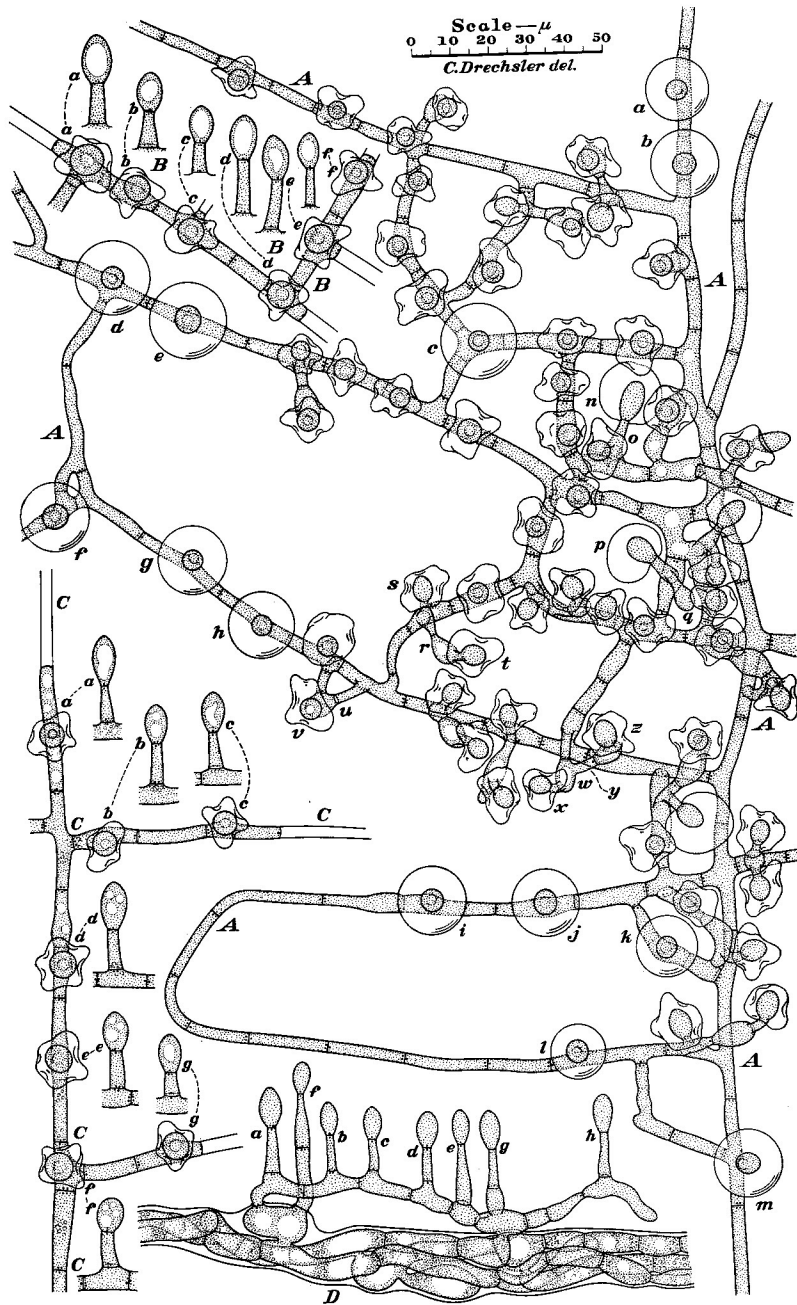
minutum inhaerente, hyphas ramosas $4-8\mu$ crassas in animal captivum intrudente quae carnem exhauriunt. Hyphae fertiles erectae, incoloratae, pauciseptatae, $75-175\mu$ altae, basi $3-4.5\mu$ crassae, sursum circa 2.5μ crassae, apice paulum inflatae, ibi $3-8$ sterigmatibus simplicibus vel furcatis $2-7\mu$ longis instructae, itaque $3-10$ conidia in capitulum laxum ferentes, denique identidem apice repullulantes alia capitula sporarum deinceps gerentes; conidiis hyalinis, cylindratis vel clavatis, apice rotundatis, basi vulgo aliquid attenuatis et minute pedicellatis, $15-28\mu$ longis, $4.5-5.5\mu$ crassis, uniseptatis, cellulis ferme quasi aequalibus tamen cellula inferiore saepe paulo longiore quam cellula superiore.

Insecta minuta specie *Sminthuridarum* (Collembola) etiam vermiculos nematodeos praecipue *Plectum parvum* capiens consumensque habitat in radicibus putrescentibus *Polygoni pennsylvanici* in Arlington, Virginia.

Mycelium spreading; the ordinary vegetative hyphae long, filamentous, colorless, septate at moderate intervals, mostly $2-3\mu$ wide, often creeping on the surface of the substratum and over rather long distances only sparsely branched, but at intervals widening locally and from the widened portions giving off prostrate branches, mostly 3 to 6μ wide and spaced 10 to 40μ apart, which unite by anastomosis into a network and thereupon give rise to numerous erect aerial predaceous organs; these organs usually uniseptate, the lower cell stalk-like, cylindrical, or tapering upward, mostly 7 to 17μ long and 2 to 5μ wide, supporting aloft an ovoid or prolate ellipsoidal distal cell usually measuring 8 to 13μ in length by 4.5 to 8μ in width and soon becoming surrounded by an envelope of adhesive secretion effective in holding any suitable roaming springtail, which then is invaded throughout by branching assimilative hyphae 4 to 8μ wide. Conidiophores erect, colorless, meagerly septate, 75 to 175μ tall, 3 to 4.5μ wide at the base, about 2.5μ wide farther upward, often somewhat inflated at the top from which are given off 3 to 8 simple or branched sterigmata, 2 to 7μ long, whereon are borne collectively 3 to 10 conidia in loose capitulate arrangement; additional conidial clusters often being produced following renewed axial elongation. Conidia colorless, cylindrical or somewhat clavate, 15 to 28μ long, 4.5 to 5.5μ wide, broadly rounded at the tip, often minutely pedicellate below, uniseptate, the 2 cells not pronouncedly unequal as a rule even though the lower cell is often slightly longer than the upper one.

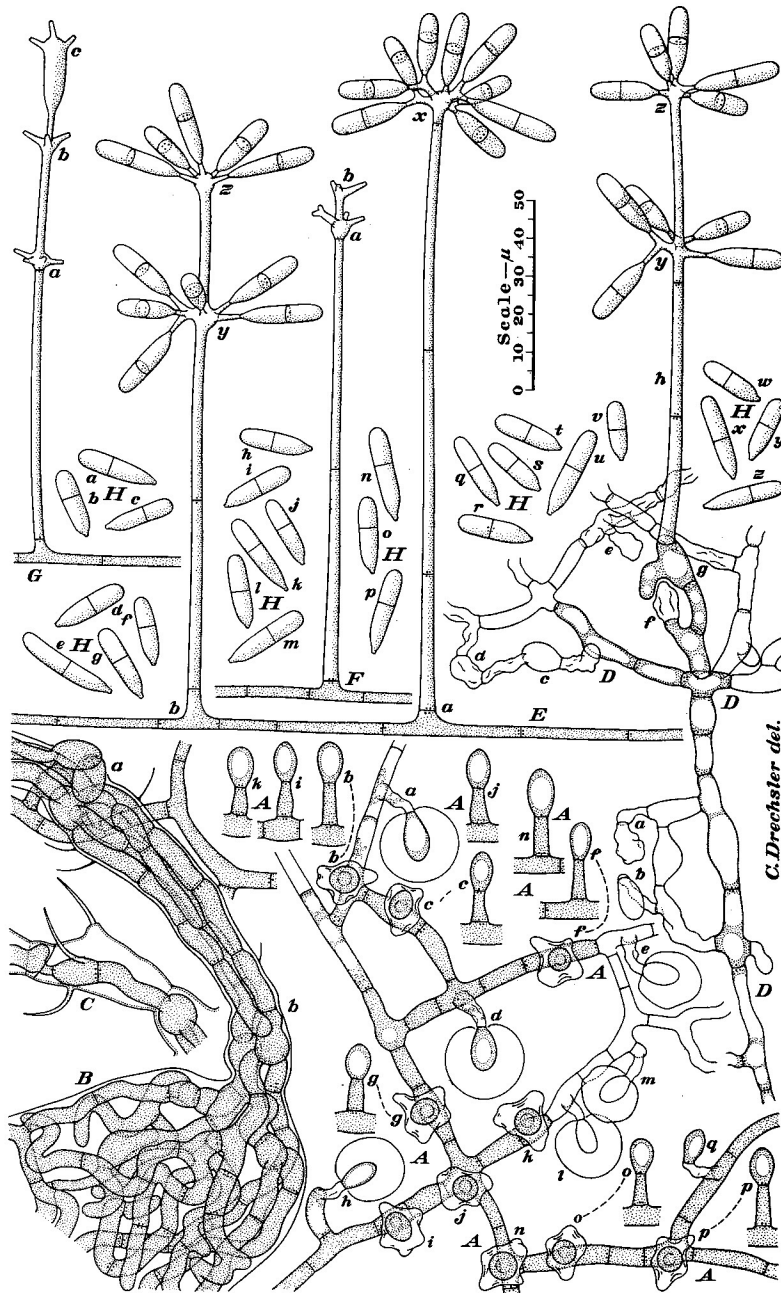
Capturing and consuming minute springtails referable to a species of *Sminthurides* very similar to *S. (Sphaeridia) serratus*, and occasionally also destroying various nematodes including *Plectus parvus*, it occurs in decaying roots of *Polygonum pennsylvanicum* in Arlington, Va.

The specific epithet in the new binomial is not intended to con-

FIG. 5. *Arthrobotrys entomopaga*.

vey the impression that *Arthrobotrys entomopaga* is considered to be probably the only fungus subsisting by capture of insects. On the contrary the close resemblance of the new species to familiar nematode-capturing forms gives reason to suspect that similar biotic adaptation may perhaps be uncovered in some of the various hyphomycetes which despite striking similarity and intimate relationship to species habitually preying on nematodes have under experimental conditions puzzlingly failed to capture eelworms or to form organs suitable for laying hold on minute animals of any kind (2: p. 538-540; 4: p. 349-360). In agar plate cultures planted with diseased rootlets or with leaf mold, these perplexing hyphomycetes ordinarily begin growing out of the vegetable detritus in much the same way as nematode-capturing forms, but, unlike the latter they cease developing after putting forth a scant display of conidiophores and conidia. Such discontinuance of growth might not unreasonably be expected in a predaceous fungus that after being introduced into a culture with some captured animals but without an escort of actively motile living prey, would need to conclude its production of mycelial hyphae and conidiophores as soon as the nutrient in the dead captives was exhausted. The different behavior of nematodes and springtails when material harboring them is used in planting agar cultures—the former little heeding the disturbance, the latter briskly springing away—would, from the start, tend to give the fungi predaceous on the two types of animals very unequal opportunity for visible extension into the transparent substratum. Later on, the slower hatching of springtail eggs as compared with nematode eggs, and the frequent failure of springtails to multiply well in agar cultures, must naturally operate to the further disadvantage of fungi subsisting on them. If adaptation for capture of insects may thus, perhaps, account in part for the meager development and unaggressive behavior of several fungi repeatedly tried out in the presence of nematodes and protozoans, it may, perhaps, likewise account for the fact that of the long-established hyphomycetous species manifestly belonging in the predaceous series only a small number have been recognized among the forms found preying on nematodes and protozoans.

At all events, the more minute of the terrestrial springtails ap-

FIG. 6. *Arthrobotrys entomopaga*.

pear well suited for extensive predaceous attack by mucedinous fungi. In their thoroughgoing infestation of decaying porous materials they roam the minute interstices and deeply ramifying passages along which predaceous hyphomycetes can put forth adhesive organs under circumstances affording some protection against desiccation. The low position of their bodies relative to the floor on which they walk must facilitate ample contact with adhesive organs encountered by them. Their legs, though adequate for unobstructed walking, do not seem strong enough to overcome stubborn adhesion, nor are they attached in a manner favorable for effective traction. Once a minute springtail is securely held, its very thin integument could hardly be expected to offer much more resistance to hyphal penetration than is offered by the integument of a nematode.

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EXPLANATION OF FIGURES

FIG. 1. Predaceous mycelium of *Arthrobotrys entomopaga* with 4 captured springtails, *a-d*; one of the insects, *a*, seems little changed externally, having evidently been captured later than the 3 others, *b-d*, which not only look badly shrunken and collapsed, but offer a tousled appearance, owing to the several long aerial hyphae that extend for some distance above the substratum; the aerial hypha directed downward from insect *c* has given rise to the group of predaceous organs to the left of insect *d*. Unretouched photomicrographs taken with the microscope focussed on the surface of the substratum, and therefore showing the numerous adhesive bodies somewhat less distinctly than the underlying hyphal network; approximately $\times 100$.

FIG. 2. Predaceous mycelium of *Arthrobotrys entomopaga* with 6 captured springtails, *a-f*; 3 of the insects, *a-c*, seem little changed externally, having manifestly been captured later than the other 3, which appear badly collapsed. Unretouched photomicrographs taken with the microscope focussed about 15μ above the agar substratum, and therefore showing the numerous adhesive bodies more clearly than the underlying hyphal network; approximately $\times 100$.

FIG. 3. Predaceous mycelium of *Arthrobotrys entomopaga* with 6 captured springtails, *a-f*; 3 of the insects, *a-c*, seem little changed externally, having apparently been captured later than the other 3 noticeably collapsed ones, *d-f*. Unretouched photomicrograph taken with the microscope focussed about 20μ above the surface of the substratum, so that the adhesive bodies are shown more clearly than the underlying hyphal network; approximately $\times 100$.

FIG. 4. Predaceous mycelium of *Arthrobotrys entomopaga* with 7 captured springtails, *a-g*, in a somewhat collapsed condition; further, the disorganized remnants of 2 other captives, *h* and *i*, are faintly discernible within the same area. Unretouched photomicrograph taken with the microscope focussed on the surface of the substratum, and therefore showing the adhesive bodies less clearly than the underlying hyphal network; approximately $\times 100$.

FIG. 5. *Arthrobotrys entomopaga* as found developing in Petri plate cultures infested with springtails; drawn to a uniform magnification with the aid of a camera lucida; $\times 500$ throughout. *A*, Hyphal network with many predaceous organs, some of them, *a-m*, newly formed under good protection against evaporation, showing each distal cell surrounded by a glistening droplet of adhesive liquid; *n*, a prostrate predaceous organ whose adhesive envelope is flattened out on the moist substratum, and from whose stalk has been sent up a new predaceous organ, *o*; *p*, a prostrate predaceous organ from the stalk of which a new predaceous organ, *q*, is growing out; *r*, a prostrate predaceous organ that from its base has given rise to one new predaceous organ, *s*, and from its distal cell has given rise to another predaceous organ, *t*; *u*, a prostrate predaceous organ whose terminal cell has given rise to the new predaceous organ, *v*, and besides has anastomosed with its parent hypha; *w*, a prostrate predaceous organ whose terminal cell has put forth 2 new predaceous organs, *x* and *y*, whereof one, *y*, on coming into a prostrate position has given rise to another predaceous organ, *z*. *B*, Portion of hyphal network bearing 6 predaceous organs, *a-f*, shown as seen when viewed from above, in their normal erect posture, and also shown lengthwise (without adhesive secretion) as seen when viewed after being pressed down strongly under a cover-glass. *C*, Portion of hyphal network with 7 predaceous organs, *a-g*, shown not only as seen from above in their normal erect posture, but also shown lengthwise (without adhesive secretion) as seen when pressed down strongly under a cover-glass. *D*, Portion of nematode, *Plectus parvus*, occupied by mycelium of the fungus; from this mycelium branches have been pushed through the integument to give rise externally to 8 predaceous organs, *a-h*, which have not yet secreted any adhesive material.

FIG. 6. *Arthrobotrys entomopaga*, as found developing in Petri plate cultures infested with springtails; drawn to a uniform magnification with the

aid of a camera lucida; $\times 500$ throughout. *A*, Portion of hyphal network bearing 17 predaceous organs, *a-q*, among which seven—*a*, *d*, *e*, *h*, *l*, *m*, *q*—are in prostrate positions, with their envelopes of adhesive material flattened out on the substratum; the other organs, younger and still functional, being shown not only as seen when viewed from above in their normal erect posture, but also shown lengthwise (without adhesive secretion) as seen when pressed down strongly under a cover-glass. *B*, Portion of captured female springtail, showing part of its head and the two proximal segments of one antenna occupied by assimilative mycelium; *a*, region near articulation between second and third segments, where adhesive cell of a predaceous organ effected penetration of the antenna to initiate invasion of animal; *b*, articulation between first and second segments of antenna. *C*, Single assimilative filament in two proximal segments of an antenna of a male springtail. *D*, An old hyphal network with 6 empty collapsed adhesive cells, *a-f*, and a seventh adhesive cell, *g*, which, after coming into a prostrate position, has given rise to a conidiophore, *h*, bearing 2 conidial clusters, each containing 5 conidia. *E*, Portion of prostrate hypha from which have been sent up 2 conidiophores, *a* and *b*; the former bearing 9 conidia in a single cluster, *x*, the latter bearing 2 conidial clusters, *y* and *z*, containing 6 conidia and 5 conidia, respectively. *F*, Portion of prostrate hypha with a denuded conidiophore bearing 2 whorls of sterigmata, *a* and *b*. *G*, Portion of prostrate hypha with a denuded conidiophore bearing 3 whorls of sterigmata, *a-c*. *H*, Random assortment of conidia, *a-z*, showing variations in shape, size, and position of cross-wall.