

In rare cases pairs of spores that had not completely separated were seen, but evidently mature, as in each one the two nuclei were demonstrable (figure 16). Sometimes, in strong and rapidly developing tubes which had attained considerable length, the intine of the pollen-spore seemed to be pulled away from the extine, or as though it had fallen in or was pushed in by external pressure which the more rigid extine resisted, as shown in figures 12 and 13, and finally became knotted up at the tube end of the spore.

In conclusion, then, the results intended to be presented in this paper are:

1. That in *Tradescantia Virginica*, by using the simplest appliances, and in a very brief time, the two nuclei of the pollen-spore, and their descent into the pollen-tube, can be demonstrated.

2. That in this species the generative nucleus is a large worm-like spindle, and precedes the vegetative nucleus into the pollen-tube.

A New Larval *Entomophthora*.

BY J. C. ARTHUR.

(WITH PLATE II.)

The clover-leaf weevil, *Phytonomus punctatus* Fabr., is a comparatively new insect in this country. It was first brought to public notice in 1881¹ as very destructive to clover in Yates county, N. Y. It has now extended considerably, being abundant at Buffalo, and in the adjacent part of Canada, and is also reported from Indiana. It is supposed to have been introduced from Europe, where it is common, but looked upon as innoxious.

In last of May and first of June of this year, the larvæ were found in a clover field at Geneva, N. Y., dying in vast numbers of some parasitic fungus. Again, in October and November, they appeared in the same manner over a large lawn. At the latter date as full a study of the fungus was made as limited time would permit. It proves to be an undescribed species of *Entomophthora*, and may be characterized as follows:

Entomophthora Phytonomi (n. sp.)—Mycelium abundant, branched, non-septate, colorless, 9–12 μ in diameter, on the ventral surface of the insect growing out in form of rhizoids to act as holdfasts; hymenium over the whole surface except the head, 35–45 μ deep; conidiophores branched at the base, as thick as the mycelium; spores oblong, colorless, 24–28 μ long by 7–10 μ thick. Resting spores not seen.

In the larvæ of *Phytonomus punctatus* Fabr. Geneva, N. Y., May—June and October—November, 1885.

¹ Riley, Amer. Nat., xv, p. 751; Rep. U. S. Dep't Agric., 1881-2, p. 172; Lintner, First Ann. Rep. Insects of N. Y., p. 252.

The habit of the larvæ is to feed during the night and remain concealed during the daytime, but when attacked by the fungus they crawl as high as possible before daylight, coil around the edge of the object, usually horizontally (figure 1), and do not again descend. Until ten o'clock in the morning most of them are still able to crawl about when disturbed, but are sluggish. By noon the insect dies, and the rhizoids fasten it firmly to the support. Some hours afterwards the normal yellowish or pea-green color is changed to a dull gray by the appearance of the hymenium. The spores are produced late in the afternoon, and during the night they are discharged; by morning only a small shriveled and blackened mass remains, while the objects beneath are powdered with the colorless and evanescent spores. If the dead insect be placed on a pane of glass over night, the body will be surrounded in the morning by a halo of spores nearly two centimeters in diameter. When the atmosphere is damp enough during the night, the mycelium grows out over the whole body as a white pubescence. This is the usual course of development.

A larva dissected an hour or two before its death shows a mass of interlacing hyphæ (figure 9) among the muscles which line the outer wall of the body; the viscera are still unaffected. The hyphæ are quite uniform in size, with finely granular contents and vacuoles of various sizes, and are extensively branched. As the mycelium grows it encroaches upon the internal organs, and eventually fills up the whole cavity of the body, except that it does not enter the alimentary tract or the tracheæ. The internal organs, except the two just named, together with the fluids of the body are entirely consumed by the fungus. The larva when now cut across presents a firm interior traversed by the cavity of the alimentary tract (figure 5). In some cases, however, certain bacteria, and occasionally yeast, have become so abundant before this stage is reached that the tissues are converted into a slate-colored liquid, and the growth of the fungus is checked.

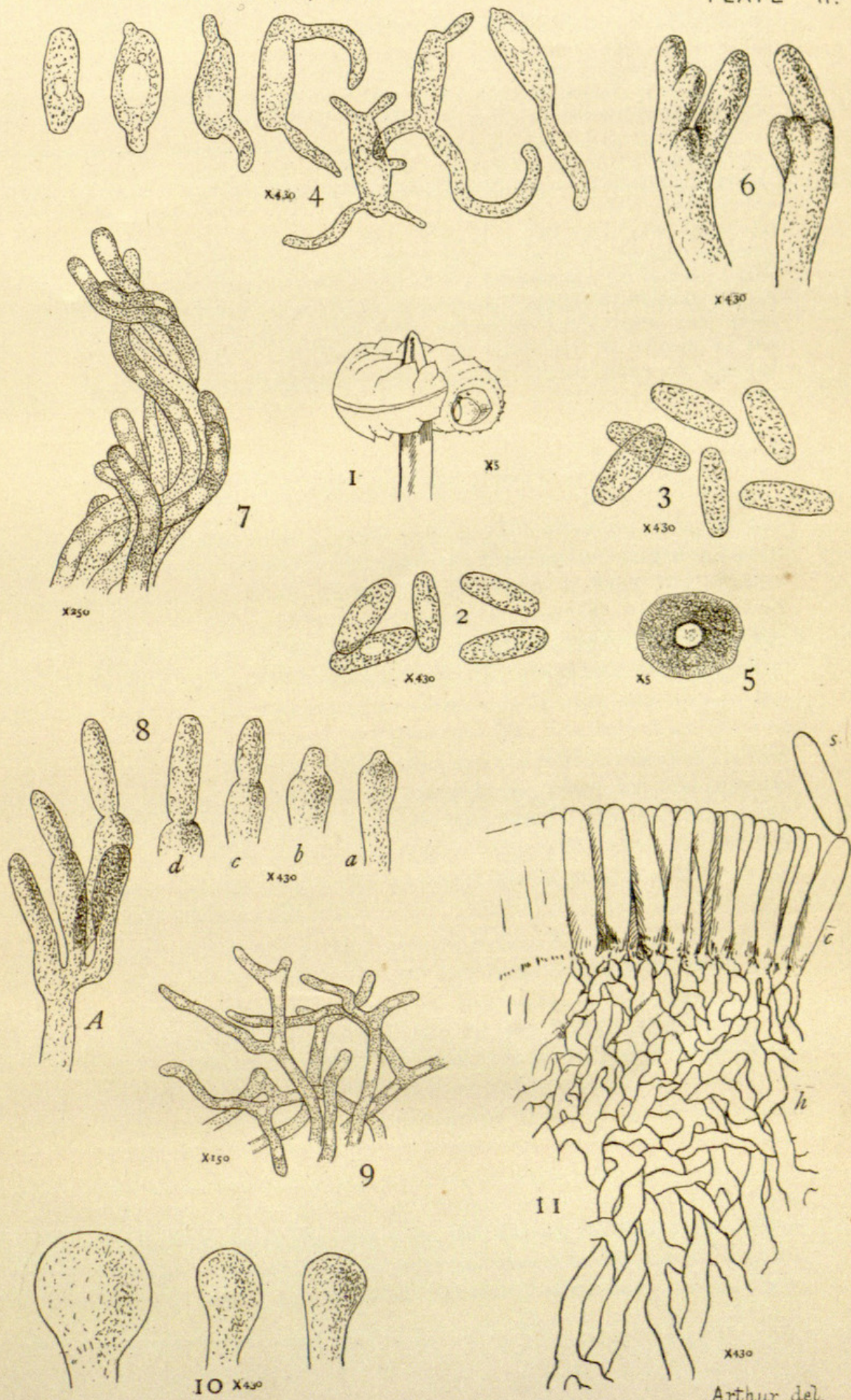
The rhizoids appear before the hymenium is formed, but whether before the insect is dead or not was not determined; nor was it ascertained on just what portions of the ventral surface they occur. They will extend a full millimeter in length when the insect is removed from the supporting object and placed in a damp atmosphere. They consist of straight colorless hyphæ, with walls much distorted and ends somewhat flattened.

The hymenium, which surrounds the whole body, presents a uniform thickness when not grown in a very moist atmosphere (figure 11). The conidiophores branch at their base (figures 6 and 8),

and each bears a spore, formed by abstriction (figure 8). I was unable to see, either in fresh or alcoholic preparations, any partition wall between the conidiophores and the hyphæ from which they arise, but do not feel entirely convinced in regard to the matter, as I found it difficult to separate them well, owing to the compact interlocking of the branches. Swollen hyphæ with granular contents (figure 10) were a few times seen among the conidiophores, but they could hardly have been paraphyses. No sterile hyphæ projected beyond the hymenium under ordinary circumstances. When the dead larvæ are placed in a damp atmosphere over night, the mycelium grows out a millimeter or so beyond the surface of the body in straight or somewhat coiled hyphæ (figure 7); these do not appear to be elongated conidiophores, or true paraphyses, but a luxuriant growth of the mycelium.

The spores are very regular and uniform in size (figure 3). When mature they are projected from the body of the larva, as in the common house-fly fungus, and like those adhere to whatever they touch. Spores gathered in May and kept dry till November measured, when examined in water, a little less than fresh ones, $21-27\mu$ by $6-8\mu$, had one end slightly pointed, and exhibited a central non-granular spot (figure 2). Fresh spores are uniformly granular, and both ends are the same shape. They germinate in water in two to six hours by pushing out one to several tubes which grow irregularly and to indefinite length (figure 4). The protoplasm is filled with vacuoles, but does not all collect at the advancing ends of the hyphæ nor are there septa formed as in the closely related *E. sphærosperma* Fres. Their behavior when germinated in moist air was not observed. Spores kept upon glass in the laboratory gave but a small per cent. of germinations after five days.

This fungus is intimately related to *E. sphærosperma* Fres. (*E. radicans* Brefeld), the habit of growth being the same so far as investigated, but differs in ultimate shape of spores, septation of hyphæ, the various measurements, etc. Although observed as late as Nov. 20, when cold weather set in, no mummified larvæ containing resting spores were found. This could hardly have been because they were overlooked, for the sick larvæ are conspicuous by their position, and up to the date mentioned were dying by thousands. The disease appears to extend readily into an epidemic of economic importance; whether it could be propagated at will is yet to be determined by experiment.



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