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The Nervous System of Phylloxera.

While engaged in studies on the anatomy of the Coccidae¹ there were not at my command specimens of the grape-vine pest — *Phylloxera vastatrix* Planch., so that, very naturally, my first concern, on returning from Europe in the summer of 1876, was to submit the grape-vine louse to a hasty scrutiny, principally with the view of ascertaining whether it agreed with other plant-lice in the possession of salivary glands. That question was soon settled in the affirmative, but, inasmuch as the glands did not present peculiarities strikingly different from those already described at length for *Aspidiotus*, there seemed no reasonable grounds for publishing the results of my short studies. Although some other points in the anatomy of *Phylloxera* seemed to me of interest, I hesitated to make any announcement of them, thinking that the great amount of attention recently bestowed upon these insects had probably, at that time, already led to a very thorough acquaintance with their anatomy. Being at the time without access to the literature on *Phylloxera*, it therefore seemed best to defer any statement till such time as I might have the opportunity to learn what had already been written by others.

Investigations of another sort have enticed me from the further study of the plant-lice. But for an inquiry from Mr. J. Duncan Putnam, of Davenport, Iowa, it is likely I should not have ventured to offer anything on this subject to the readers of *PSYCHE*. Late in January 1878, Mr. Putnam wrote to me :

¹ Mark: Beiträge zur Anatomie und Histologie der Pflanzenläuse, insbesondere der Cocciden ; in Archiv für mikroskopische Anatomie, Bd. 13, S. 31-86, Taf. 4-6.

“Riley in his 8th Report, page 159, has described similar tracheae in the *Phylloxera* as *nerve* chords. Is he right?” On turning to Prof. Riley’s Reports¹ I was not a little surprised at the description of the nervous system. It seems to me that it is not only not quite accurate for that insect, but also that it hardly corresponds to the nervous system of any animal.

Although I have not studied the *sexual* individuals — which are the ones described by Prof. Riley,—I have not the least doubt that the objects very carefully drawn by him as nerves are nothing other than the tracheae, as suspected by Mr. Putnam. The nervous system will certainly be found to present other peculiarities than those figured by Prof. Riley, and probably will differ only slightly from the same system as observed in the sexless individuals.

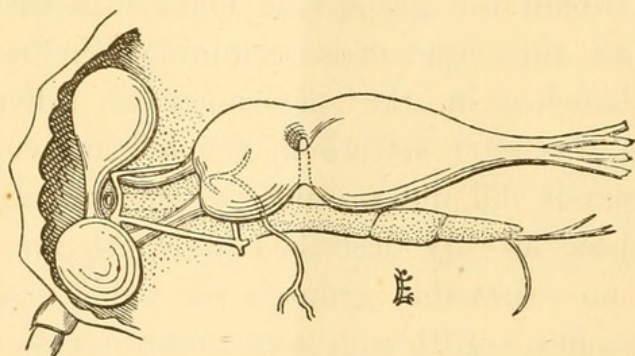


Fig. 9 — *Phylloxera vastatrix* Planch.—*radicicola*, winged.

An oblique view of the upper left surface of the central portion of the nervous system, as seen after cutting away the dorsal wall of the body, and the oesophagus where it ascends from the level of the brain-commissure. Magnified about 100 diameters.

The following observations were all made on sexless root-infesting individuals in the month of August 1876. The central portion of the nervous system, in both winged and wingless forms, came under observation. The accompanying figure represents the ganglia in a pupa of a winged form in which the tip of the wing-pads reached backward to near the middle of the abdomen.

¹ Seventh annual report on the noxious, beneficial and other insects of the state of Missouri, . . . 1875, p. 99, fig. 19, and foot note.

Eighth annual report on the noxious, beneficial and other insects of the state of Missouri, . . . 1876, p. 158, fig. 48 *b* and *e* ; p. 159.

Trans. St. Louis Acad. Sci., v. 3, p. 283, fig. 22; p. 284.

That which first strikes one's attention, in dissecting out the nervous system, is the absence of so marked a consolidation of the ventral chain of ganglia as characterizes most of that group of insects. Instead of the single oval ganglionic mass, which in the near relatives of Phylloxera represents the concentrated ventral chain of ganglia found in most arthropods, the Phylloxera presents *two* distinct ganglionic masses below the front end of the digestive canal; or, to be more exact, two pairs of ganglionic enlargements. The component lateral halves of each of the two masses are so consolidated as to leave only slight external indication of the fusion. This fusion of the lateral halves is, however, like the antero-posterior consolidation, not so pronounced as in many of the plant-lice. These two nervous masses are joined to each other by a pair of stout, short, longitudinal commissures. The anterior, in turn, is joined to the superoesophageal pair of nerve-centres by a pair of much longer and more slender commissures.

The posterior ganglionic pair is larger than either of the two remaining pairs. It is continuous behind with a single median nerve trunk, which promptly bifurcates. As seen from above it presents a somewhat elongated heart-shaped, symmetrical outline, its greatest breadth being considerably in front of its centre. In a lateral view it is also seen to present the greatest thickness a little in advance of its centre. Its outline from the latter point of view is, however, not quite symmetrical, the dorsal surface being considerably more flattened than the ventral. In their backward continuation, moreover, the dorsal and ventral outlines are quite unlike, inasmuch as the former passes with almost unnoticeable curvature into the dorsal outline of the main nerve-trunk, while the ventral outline suffers a conspicuous and rather prompt bending to bring its course into a line parallel with the dorsal outline of the main nerve.¹ At its anterior end, also, differences in the course of the dorsal and ventral outlines are noticeable. While the outline of the dorsal, in passing by means of the stout commissure into that of the first suboesophageal ganglion, presents only a very gentle

¹ Owing to the obliqueness of the view furnished by the figure this difference is not there made prominent.

curve, the ventral outline is very sharply curved, or may even form a cusp, thus reducing the ventral surface of the commissure to a minimum.

Both dorsal and ventral surfaces of this ganglion present longitudinal, shallow depressions, more conspicuous at the anterior than at the posterior end, and less pronounced above than below. Further traces of the real nature of this double ganglion are sometimes observed in the behavior of the main nerve-trunk which arises from its posterior end, inasmuch as this trunk may be reduced to zero by an early division into its lateral halves. Thus the notch at the anterior end becomes continuous with the dorsal and ventral furrows, and, through them, with the posterior notch which separates these two nerve stems. In this manner the consolidation of the lateral halves of the ganglion often appears far from complete. The lateral outlines of this ganglion pass, by a gentle curve, into those of the main nerve. The latter sooner or later bifurcates, the two branches diverge and undergo further sub-division, in their course backward, to be distributed to the organs of the posterior part of the abdomen. In addition to this main trunk there arise from the lateral margins of the posterior ganglion other nerves, which are not always symmetrically placed. As many as four such nerves, at least, may arise from each side of this ganglion. The commissures between this and the first suboesophageal ganglion are short, rounded cords, which are slightly flattened side-wise, and lie somewhat nearer the dorsal than the ventral surfaces of the ganglia which they connect. Their narrowest measurements indicate a thickness of about one-half or one-third that of the ganglion just described, and a breadth of one-fourth that of the same ganglion. As seen from above, the opening embraced by the commissures and the ganglia which they join is an oval with its antero-posterior diameter equal to the breadth of one of the commissures, and its transverse diameter about half as long.

The first suboesophageal pair presents a flattened, rounded mass, in width one-third less than the posterior ganglion, and of a length equal to its own breadth, and a thickness not varying much from three-fourths of the same. The longitud-

inal axes of the two suboesophageal ganglia do not form a continuous line, but are so directed as to form a very obtuse angle opening downward, as may be seen in the figure. This deflection in the nervous axis helps to increase the differences already noticed in the dorsal and ventral outlines connecting the ganglia. This ganglion also presents both anterior and posterior indentations, as well as slight longitudinal depressions in its dorsal and ventral surfaces, indicative of its origin from lateral halves. It is under the anterior end of this ganglion that the two ducts of the salivary glands unite and eventually open into the beginning of the oesophagus. (See figure.)

The circumoesophageal commissures are comparatively long and slender. Their direction from the lower anterior aspect of the first suboesophageal ganglion is — unlike that of most arthropods — obliquely *downward* and forward. In their course they pass beneath a chitinous frame-work,¹ and ultimately diverge to reach the infero-posterior surface of the two halves of the brain ganglion.

The ganglionic pair which constitutes the superoesophageal or brain-mass presents considerable variations, from a rather intimate union of the two halves² to such a condition as is represented in the accompanying figure, where the lateral halves are joined by a brain-commissure of considerable length and of not much greater thickness than that of the circumoesophageal commissures. Although my observations were not sufficiently extensive to exclude the possibility of an erroneous inference, I still think that these two forms of the brain-mass belong respectively to the wingless and winged individuals. So much, at least, is certain, that the figure here presented was made from one of the winged insects, and that all my drawings of the wingless forms show a much closer approximation of the two halves.

It can be in no way a source of surprise that the brain-mass, in the wingless form, is, moreover, considerably smaller than in the winged form, when one reflects on the greater develop-

¹ The anterior portion, or cross-piece, of this frame work is what I have called *arcus superior*, and the lateral portions *costae superiores*, in the paper above referred to.

² Much as in *Aspidiotus nerii*. Vide *op. cit.*, Taf. VI, fig. 31, *gp.*

ment of the organs of special sense in the latter form. The distribution of the nerves to the special sense-organs, however, has not been followed out, save that, in some of my sketches of the wingless forms, I find a pair of nerves given off from the anterior end of the hemispheres, which I have no doubt supplies the eyes, and that another pair arises from the ventral aspect of the same hemispheres, and probably makes its way to the antennae. In the winged forms, the hemispheres lie in such close approximation to these organs that the nerves will certainly be found to be very short.

As may be seen from the accompanying figure, the oesophagus ascends in the space bounded by the *arcus superior* behind, and by the brain commissure in front. *E. L. Mark.*

Cambridge, Dec. 24, 1878.

NOTE. — After the preceding article was in type my attention was directed to an article by Targioni-Tozzetti¹ through a review of the same by P. Mayer in Hofmann u. Schwalbe's *Jahresberichte ueber die Fortschritte der Anatomie und Physiologie*. Bd. 6, Abth. 2 : *Entwicklungsgeschichte ; Anatomie der wirbellosen Thiere*. p. 185. 1878.

Inasmuch as the article alluded to contains a short statement with regard to the nervous system in a nearly related species of the same genus, I will take advantage of the opportunity here afforded to give its substance.

The author says (p. 237) : "The nervous system is composed, as far as regards the suboesophageal part, of two ganglia ; it is not possible to separate from the surrounding parts the superoesophageal ganglion so as to define it with accuracy. Of the two ganglia beneath the oesophagus, the anterior is the smaller, it is heart-shaped and joined by means of two thick and short divaricating commissures to the posterior ganglion, which is larger and pyriform. The latter gives rise to lateral nerves, and ends with a long, thick cord, which, having furnished some branches in its course, is divided into other branches and there terminates."

¹ Sommario di nuove osservazioni sulla Fillossera del Leccio e della Querce.—(*Phylloxera florentina*, *Ph. signoreti*) Targ. Bull. Soc. Ent. Italiana, v. 9, p. 236-239. 1877.

It will be seen that, so far as the description goes, it corresponds very closely with that which is given for *Phylloxera vastatrix*. The extreme difficulty of successful dissections with these minute insects is sufficient explanation of the failure of the accomplished Italian to make out satisfactorily the superoesophageal ganglion.

I will also avail myself of this opportunity to confirm for *Ph. vastatrix* the observation of Targioni-Tozzetti, made on an oak-infesting species, that the Malpighian vessels are absent; and finally to add that Targioni-Tozzetti has demonstrated the presence of a pair of salivary glands in the *Phylloxera* which he has studied.

E. L. M.

Jan. 9, 1879.

BIBLIOGRAPHICAL RECORD.

(Continued from page 200.)

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Nos. 1059 to 1135 are from **Can. Entom.**, v. 8.

* 1059. C: J. S. BETHUNE. Annual address of the President of the Entomological Society of Ontario, 1875. p. 1-4. [Mar., 1876.]

Progress of work; preparation for the Centennial Exhibition; meetings of the Entom. Club A. A. A. S.; remarks upon *Doryphora decemlineata*, *Pieris rapae* and its parasite *Pteromalus puparum*, *Caloptenus spretus*, *Leucania unipuncta*, *Clisiocampa americana*, *C. sylvatica*, *Bruchus pisi*.

* 1060. L. F. HARVEY. New Texan moths. p. 5-7. [Mar., 1876.]

Describes *Parasa incisa*, *Euerythra*, *E. phasma*, *Litodonta*, *L. hydromeli*, *Aletia hostia*, *Caradrina conviva*, *Mamestra brachiolum* = 2 n. gen., 6 n. spp. *Catocala belfragiana* Harv. = *C. jocaste* Streck.

* 1061. G: J. BOWLES. Notes on *Biston ursaria* Walker. p. 7-9. [Mar., 1876.]

Describes the imago, eggs, new-born larva and mature larva; abundance, habits; larva feeds on *Populus* and *Prunus*.

* 1062. G: M. DODGE. New species of Acridini from Nebraska. p. 9-12. [Mar., 1876.]

Describes *Pezotettix junius*, *P. autumnalis*, *P. alba*, *Caloptenus lurida*, *C. regalis* = 5 n. spp., natives of Glencoe, Dodge Co., Nebraska.



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