

INTERNAL ORGANIZATION OF *HESPERIA ETHLIUS* CRAM., AS OBSERVED IN THE LIVING ANIMAL.

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[*With editorial annotations.*]

THE larva of *Hesperia ethlius* may be found on the *Canna* or Indian-shot plant. This larva being somewhat diaphanous, and thus affording facilities for an examination of its internal organization, I have made of it a careful study.

The egg, when first laid on a leaf, is pinkish, smooth, biscuit-shaped, and with a central depression on its upper, convex side. As it matures it grows white. The larva emerges in six days, and eats up the upper third of its shell, which is detached like a lid, leaving a cup still adhering to the plant. At this time it is 1.6 mm. long, dull whitish; head very large, black, glossy, and bilobed. True feet and anal tip black. In a few hours it sheds its skin.

Having eaten a small portion of the leaf, and thus prepared a section of it for its use, the larva folds this over and confines it to its place with a few stitches of silk, enlarging this temporary retreat, or folding a new section, as it grows, and just before the pupal change lining it with silk. It feeds from this tubular case, just along its edges, retreating within when alarmed. It forcibly ejects all excrement from the upper, free end, together with all exuviae, so that, although it evidently sheds its skin several times, these cast skins cannot be found.

The larva increases more rapidly in size at its early stages than later, and doubles its length in 24 hours. It is cylindrical, flattened on the venter and

presents rather a large upper surface. At this time a transverse band is seen on dorsum of the 11th segment, connecting the posterior pair of stigmata which are faintly visible. Under a microscope of 75 diameters may also be seen the dorsal vessel lying over and contiguous to the alimentary canal, and a pair of small bodies between these and the pleura, situated in the 9th segment, on each side [testes in ♂, ovaries in ♀].

With its further development the body becomes more opaque, from the presence of food in the alimentary canal. When it is 6 mm. long the small organs in the 9th segment are well defined, being four-chambered, with the divisions suboval, the extreme ones terminating sometimes [in the ♀] in an acute point, the anterior one longest. These vessels are about the size round of a broom-straw and about twice as long as wide; of a pale yellow, and opaque.

Lying over the alimentary canal, and seemingly formed of a fold of it, are the two longitudinal tubular bodies, a little flattened, which are interrupted but not obliterated at the intersection of the segments [dorsal vessel, with its valves]. This tubular fold seems to recede from and approach the median line, each time apparently opening and closing on the posterior half of its length for the admission of fluid. There is a vermicular motion throughout these parts, but no fluid can actually be seen flowing through them.

The larva transforms in ten days and is, when fully grown, 44 mm. long. As it approaches maturity the four-chambered vessels [ovaries] become cylindrical, and twice their original length, and with points on the lower sides from the constricted parts. The fuller development of the alimentary canal and the longitudinal tubular fold [dorsal vessel] causes these smaller vessels [ovaries] to recede more from the dorsal median line and approach nearer to the pleura in the comparatively free space occupied only by the ramifications of the tracheae. Here they seem to be balanced upon and permeated by fine tracheae from the spiracle of the 9th segment, and move synchronously with the general impulse received through the series of spiracles on the pleura but begun in the pair on the 11th segment. This pair of spiracles, connected by a short transverse band or spiracular tube, gives rise to two sets of tracheae: one penetrating no farther than into the subcutaneous enveloping membrane, ramifies there, giving no signs of activity; the other responds to, if it does not originate, every impulse of the larva.

Each of the spiracles has a similar double set of tracheae acting in the same way. The air tubes of the passive set just referred to, are inclined a little backward, transversely, at their free ends, while those of the active set, ramifying within the inner parts of the body, tend forward. A part of them, meeting on the middle of the venter, arch over a small, misty, suboval dot [nervous ganglion] which has a faint sympathetic movement with the tracheae touching it.

One of these misty, white bodies is situated on each segment, beginning, from behind, at the 10th, where it seems to be a double, oval dot, and is presumably composed of the ganglion of the 11th and 10th. The next four anterior to this are single. The fifth and fourth are near each other and nearer the 3rd segment, showing a forward tendency. Each of the three thoracic segments has its separate ganglion, equidistant from each other, and nearer together than the series posterior to them. Each of these ganglionic nuclei is situated in the anterior angle of a triangle of white filaments whose base line is almost straight across the segment.

On the dorsum and ending on the venter are long tubes (malpighian vessels) one on each side, first traceable near the 10th spiracle, with which they are connected by a bent tubular line. Following a direct course forward from this as far as the 6th, these tubes recurve and return to the 9th, going forward once more at an acute angle and losing themselves in the 5th, but becoming again visible just below the third segment. These tubes are of the same size and appearance as the tracheae, with which they come in frequent contact. At the posterior end of the third segment, are the blunt ends of a pair of tubes [silk vessels]. These may be faintly traced almost to their position on the head as the spinnerets.

At times when the larva is undisturbed, there seems to be an almost total suspension of motion in the spiracles and in all the parts affected by them. With the entrance of air into the system of spiracles

there is a regular pulsating movement in the dorsal vessel, and in the small four-chambered bodies in the 9th segment [ovaries]. The entrance of air into the posterior pair of spiracles seems to give the initial impulse which travels so rapidly along the series and its ramifications that almost immediately the head of the insect begins to move from side to side as if affected by the same influences which affected the other parts. This occurs when the leafy covering of the larva is cut open and light and air admitted.

The first conscious effort of the larva when its sheath [nest] is opened is directed toward the elaboration of silk fluid with which to enclose itself once more within its case. With this purpose it eats rapidly and the silk fluid is seen at the same time accumulating in and near the thoracic segments. The larva uses its short, black, front pair of feet to unite the threads which it spins back

and forth, forming a cord of 50 to 75 threads, as may suit its purposes.

The pupa exhibits no specially interesting features. It is pale green, with faint traces of the outer set of tracheae still visible; broad at anterior end, with a sharp black spine from its extremity, by which it is attached to a mass of fine white silk. Body cylindrical, tapering at anal end. A loose girdle of silk passes around its body, and its entire length rests against a delicate layer of white silk. If disturbed it moves with great rapidity. It transforms in ten days. The motions of the imago of this hesperian are very rapid.

I have not sufficient data to make this an exhaustive monograph, but other students may have added what I have omitted. If not, we may leave to time and diligence the further discovery of such facts as are yet unknown.

CIRCULATION OF BLOOD IN THE LARVA OF *HYDROPHILUS*.

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EXAMINATION of living larvae of *Hydrophilus* under the microscope, the past summer, revealed the circulation of blood in their antennae and trophi, which is so distinctly visible and so curious in its directions as to be worthy of notice.

The blood of the larva of *Hydrophilus*, after leaving the anterior extremity of the dorsal vessel or heart and entering the head, divides itself into two lateral branches, one of which descends on each side of the oesophagus, the two branches reuniting beneath the oesophagus, a little anterior to their division on its upper side, to form a median

stream. Between the point where the streams separate and reunite, each stream gives off three branches, all of which flow in the same direction as the middle stream formed by the reunion of the two lateral streams, that is, toward the anterior part of the head. The median stream formed by the reunion of the two lateral streams, which is, of course, more ventral in position than the six other streams, enters the middle of the labium, and passes along the dorsal half of that organ until it nearly reaches the bases of the labial palpi. Here the stream turns back laterally and ventrally,

