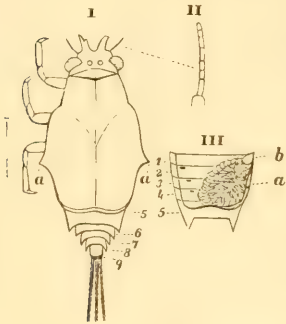


On the Pupa of the Ephemerinous genus *BÆTISCA* Walsh.

BY BENJ. D. WALSH, M. A.

The pupa that forms the subject of the present Article, and of the female of which a figure is annexed, has been known to me for four

years; but it was not till the present year that I succeeded in breeding the subimago from it. It differs from all described Ephemerinous pupæ in the antennæ being eight-jointed or thereabouts, not multiarticulate, and also in the branchiæ being internal and not used for locomotive purposes; and from all known larvæ and pupæ, and indeed from all known hexapod insects in any of their states, in the pro-meso- and meta-notum being connate and confluent and extending



ing over one-half of the abdomen in the form of a large, dilated, convex carapace or shield, thus giving the insect a very Crustacean appearance. In the Orthopterous genus *Tetrix* and the Homopterous *Membracidæ*, as is well known, it is by a prolongation of the prothorax alone that the body of the insect is almost entirely concealed and covered above. In certain of the Heteropterous *Scutelleridæ* and in the foreign Chalcididous genera *Thoracantha* and *Gulearia* (Hymenoptera), and the Indian Muscidous genus *Celyphus* (Diptera), it is by a prolongation of the mesoscutellum that the abdomen is almost entirely concealed above. But in all these cases the other thoracic segments are clearly distinguishable.

I had sent a ♀ specimen of the above pupa to Dr. Hagen in 1863, and subjoin his remarks on it, translating from the original French MS. :—

The larva No. 66 is the most extraordinary animal that I have seen, so that I asked myself whether it really belonged to Insecta. But there is no doubt of the fact of its being the larva of a hexapod insect. The large compound eyes determine at once its position as belonging to those insects which have an incomplete metamorphosis, and therefore to Orthoptera,* or Hemiptera.

* According to Erichson's and Sieboldt's views Dr. Hagen refers Pseudoneu-

As to Hemiptera, its mandibulate mouth excludes that Order. There remains therefore only the order Orthoptera, of which there are only three families with aquatic larvæ—Odonata, Perlina, and Ephemerina. The larvæ of Odonata always have the labium transformed into a well-known species of mask, which is not found here. It cannot therefore belong to Odonata. Perlina have only two caudal setæ, instead of three. There remains Ephemerina, and I believe that it belongs there, in spite of the antennæ being, as you observe, eight-jointed, and the absence of branchiæ. Possibly, however, there are branchiæ to the four basal segments of the abdomen, for I see something under the carapace, but do not choose to ruin a unique specimen by a more violent examination.

On inspecting the beautiful Ephemerina previously received from you, my eyes accidentally fell upon *Bætisca obesa*. Its robust form strikingly resembles that of this larva, when viewed at a distance. After a minute examination I believe that I am sure that this larva belongs to the genus *Bætisca*, and probably to *Bætisca obesa*; that is to say so far as one can be sure without actually breeding the imago. The head and the oviparous lamina are alike, and the carapace is represented in the imago, and even the groove on the dorsum of the abdomen that fits into the tip of the carapace.* But there is a sort of enigma here; for according to physiological and anatomical laws, we cannot understand how the pro- meso- and meta-thorax can be all soldered together in the larva. On the whole, it is about the most extraordinary larva known to science.

Those who are aware of the practical difficulty of correlating an insect, known only in the larva or pupa state, with its imago, will appreciate the successful acumen of the above analysis. One additional feature, by which the imago strikingly recalls the larva and pupa, is not referred to by Dr. Hagen. In the characters of the genus *Bætisca*, I noticed that "the fifth abdominal joint is twice as long as any of the

roptera to Orthoptera. See *Monogr. Coleopt.* p. 1, note, and *Monogr. Gomphin.* p. 1, note; also LeConte's *Introd. Class. Coleopt.* p. viii, note. It is not quite true, as suggested in the last passage by Baron Osten Sacken, that Pseudoneuroptera, as contradistinguished from Orthoptera, are "essentially aerial, passing the greater portion of the time on the wing." In Odonata, indeed, this is the case, but Perlina and Psocina, and especially Psocina, to say nothing of Termitina, pass the greater portion of their time on trees, like the Orthopterous Catydids and tree-crickets.

* In the imago, as is usual in Ephemerina, the pro- and meso-thorax are separated by a free suture, and the meso- and meta-thorax by a connate suture, but the meso-scutellum extends over the abdomen to the tip of the *first*, or what some would call the *second* abdominal joint, thus simulating the carapace of the larva. The transverse, medial, sinuate carina on the 5th abdominal dorsal is remarkably distinct and strongly recalls that found in the pupa, though it is not nearly so much elevated.

others, which are subequal." (*Proc. Acad. Nat. Sci. Philad.*, Sept. 1862, p. 378.) This is not known to be the case, so far as I am aware, in any other Ephemeropterous imago. We can understand now why it should be so here. In the pupa this joint is abnormally developed to receive the tip of the carapace, and therefore, as is not unfrequently the case, traces of the same arrangement are found in the imago, though there are no longer the same special functions performed by the part. There is a feature, too, in the ornamentation of its legs which indicates that it belongs to Ephemera, and not to Odonata as I had myself originally suspected. They are fasciate, not vittate; and I have already observed that Odonata never have fasciate legs, and might have added that, so far as known to me, Ephemera never have vittate legs. (See *Proc. Acad. Nat. Sci. Philad.*, Sept. 1862, p. 383.)

It will have been noticed that Dr. Hagen calls the insect which I sent him, and which was identical in every respect with the one figured above, a *larva* and not a *pupa*. Authors generally tell us that in Insecta the pupa is distinguishable from the larva by having rudimentary wings, with the exception of course of those genera (*Diapheromera*, *Rhaphidophora*, &c.) which have no wings whatever in the imago state. Probably from the fact of there being no external wings in this insect, as in all other known Pseudoneuropterous pupæ, Dr. Hagen supposed it to be in the larva state. The above, however, is only another anomaly in this most anomalous creature. I have a specimen in alcohol from which the subimago has partly emerged, and which must necessarily therefore be in the pupa state; yet it has no external wings and the subimaginal wings lie flatly under the interior surface of the carapace; neither indeed had any of my other specimens any external wings. It is, I think, a mistake to suppose that in Insecta the possession of rudimentary wings is peculiar to the pupa as distinguished from the larva. Many insects that I have bred, e. g. a Psyllade inhabiting a gall on the hackberry (*Celtis occidentalis*), exhibit distinct rudimentary wings before their final moult into the pupa state; and I believe it is generally so with Pseudoneuroptera and Orthoptera, and probably in all those Orders which have an active pupa. Unless, indeed, which is contrary to all analogy, we choose to believe that an insect can moult after assuming the pupa and before assuming the imago state, and so consider it as a pupa as soon as the rudimentary wings begin to be

developed, which in many Orthoptera saltatoria is at a very early period. The rule, however, seems to be, that in the larva state an insect moults about four times, and after assuming the pupa state not at all, until its final moult into the subimago or imago state. And this is shown clearly in those Orders (Coleoptera, the true Neuroptera, Hymenoptera, Lepidoptera and Diptera) which have a quiescent pupa, and where consequently the line of demarcation between the larva and pupa states is clearly drawn. Consequently, if this be a correct view of the case, just as in *Perlina*, *Ephemerina*, *Odonata*, &c., both the mature larva and the pupa have distinct external rudimental wings, so in the genus *Bætisca* neither the mature larva nor the pupa has them. And if the above considerations are correct, in none of these instances can the mature larva be distinguished from the pupa, except by ascertaining whether it has undergone its final moult before assuming the subimago or imago states. As regards *Bætisca obesa*, none of my specimens moulted while in my possession, and therefore those from which I bred the subimago must have been pupæ when I obtained them. The others, some of which were much smaller and might have been larvæ, after I had kept them in water alive for six or seven days, were either dissected or placed in alcohol, without awaiting their further development.

If any additional proof was required to establish the validity of my genus *Bætisca*, which is itself sufficiently remarkable in its characters, all drawn from the imago, the discovery of the very anomalous characters of its pupa would amply supply the deficiency.

GENUS BÆTISCA—PUPA.

Head freely moveable and connected with the thorax by membrane, with two horizontally porrect horns springing from above the anterior edge of the front, which are sometimes simply elongate-triangular, sometimes both of them deeply emarginate on the interior edge so as to present the appearance of a long exterior and a short interior horn, sometimes only one of them thus emarginate (as shown in Fig. I.) Anterior edge of front strongly carinate, deeply and widely emarginate in the middle opposite the labrum and less deeply so on each side. Epistoma scarcely extending forwards beyond the central emargination of the front, and separated from the labrum by a very distinct and deep transverse suture. Labrum moderate, transverse. Mandibles

moderate, normal, appressed to the mouth and not extending forwards in the form of a horn. No palpi visible externally. Labium large, subquadrate, rather wider than long and not emarginate. Eyes ♂ large and almost contiguous; eyes ♀ much smaller and separated by a space equal to one-half the diameter of the head, with distinct rudiments of the two posterior ocelli between them. Antennæ (Fig. II.) inserted in a large but shallow cavity before the eyes, eight-jointed or thereabouts, the joints rather indistinct with appearances in some specimens of a 9th long and slender setiform joint. *Thorax* with the pro- meso- and meta-notum confluent soldered together in the form of a large convex shield, which has an inflected lateral flange for its entire length like the epipleura of the Coleopterous elytrum, and the tip of which fits accurately into a transversely sinuate medial groove on the fifth dorsal joint of the abdomen, immediately behind which groove runs a transverse carina. On the lateral edge of this shield about $\frac{2}{3}$ of the way to its tip, and also on the side of its dorsum about $\frac{3}{4}$ of the way to its tip, there projects a large flattened triangular tooth, the lateral teeth (Fig. I. a) directed outwards, the dorsal teeth directed outwards and upwards and prolonged both forwards and backwards in an acute carina or elevated and angulated ridge. From the central point of the dorsum of this shield there extends obliquely forwards on each side a wide, shallow, ill-defined stria or depression which terminates before it reaches the lateral edge, the two striæ forming with each other from their origin an angle of about 99° . These striæ probably represent the suture between the pro- and meso-notum. Along the whole length of this shield, but obscurely interrupted before its middle and again just before its tip, extends a not very acute dorsal carina. Prosternum divided throughout by a suture, which is apparently connate, from the meso-sternum. Meso- and meta-sterna confluent with each other, as well as all the episterna and epimera. Central piece of sternum truncate in front, about as wide between the front legs as the anterior acetabulum, with the suture behind the front legs transverse, thence gradually widening to double its former width a little behind the middle legs, thence to its posterior edge, which is squarely truncate, with its sides nearly parallel. *Abdomen* 9-jointed dorsally, 8-jointed ventrally, joints 8 and 9 being ventrally confluent. The dorsal joints 1—4 and the anterior $\frac{1}{2}$ of 5 soft and membranous, except a narrow lateral piece.

Joint 1 has attached to its lateral base a large, pale, fleshy branchia (Fig. III. *a*) full of dark-colored interlacing vessels, above the origin of which lies a much smaller flap-like piece (Fig. III. *b*) apparently devoid of vessels. Joints 2—4 have on each side a very distinct spiracle, to exhibit which in Fig. III, the left branchia is removed. Joint 5 is twice as long as any of the others, which are subequal, and rises upwards abruptly and almost vertically from its hind margin into a transversely sinuate carina to receive the tip of the thoracic shield, whence it is suddenly depressed downwards and forwards so as to leave a cavity under the tip of the shield for the two branchiæ to work in, the shield being attached by membrane to the inferior portion of the thorax, but only in front of the abdomen. *Caudal setæ* three, equal in length and diameter, multiarticulate and very finely pilose, the pilosity indistinct except when the insect is alive and in the water, when it is very obvious. *Legs* with the tarsi one-jointed and bearing a single robust claw, the tibiæ exceedingly short and connate with the tarsus. No external wings. The ♂ differs from the ♀, not only in its much larger eyes, but in being considerably slenderer.

In the only known species belonging to this genus (*B. obesa* Say, Walsh) the general color of the pupa is dull brown, variably marked above and below with luteous. The legs are luteous with the tarsus, tibia and femur each medially but irregularly fasciate with brown, and the femur with also a superior basal brown spot. Its general consistence is pretty firm.

The habits of this species are to frequent clear, rapidly-running rivers, and to attach themselves in repose to the under surface of submerged stones. Their food must consist almost exclusively of minute particles of matter floating in the water, for of two which I bred to the subimago state and two which partially attained that state—making four in all—three lived for over five and one for six or seven days in a glass vessel in clear but unfiltered cistern water, changed every twenty-four hours and containing no solid substance whatever but a piece of floating cork. I had originally placed a specimen in water containing several dead aquatic larvæ and some jelly-like masses, probably confervæ, which occurred in its natural station; but on noticing that it repeatedly crawled over such substances in an unconcerned manner, I placed them all in simple water. It is singular that, neither in

the water nor out of the water, did I ever observe the antennæ to be disengaged from the lower surface of the breast and thrust forwards. They crawl quite slowly, but swim very rapidly, the caudal setæ being the chief organ of motion in swimming, and the legs being only used occasionally to direct their course. When swimming the caudal setæ and the tip of the abdomen are directed upwards and backwards at an angle of 45° with the body, and with this as the axis of oscillation are vibrated vigorously and rapidly up and down. When desirous of rapidly changing their course, they have the power of elevating the tip of the abdomen and setæ so as to lie along the dorsum of the shield, and then suddenly lashing out with them. I noticed that in repose they sometimes adhered to the under surface of the floating cork for hours together, and sometimes to its side, so that their body would be half in and half out of the water. When they were taken out of the water the tip of the notal shield generally after a few seconds gaped apart from the fifth dorsal joint of the abdomen, and the palpitations and structure of the branchiæ became plainly visible under the shield. The reason is obvious. They were then compelled to breathe through their spiracles, instead of through their branchiæ.

The pupa crawls out of the water to assume the subimago state, which process is performed by the notal shield splitting open dorsally in a straight line from end to end, and the head being disengaged backwards from the pupal head without splitting it. Described from 8 specimens, some living, some alcoholic, procured in the Mississippi Rapids, June 5—11; the first subimago appeared June 13, from a specimen obtained June 5. Length ♂ (one specimen) 7 millimetres. ♀ (one specimen) $7\frac{1}{2}$ mill. Breadth ♂ $3\frac{1}{4}$ mill. ♀ 4 mill. Setæ ♂ $2\frac{1}{4}$ mill. ♀ $2\frac{1}{2}$ mill.

ROCK ISLAND, ILLINOIS, July 1, 1864.