

PSYCHE.

A NEW SEXUAL CHARACTER IN THE PUPAE OF SOME LEPIDOPTERA.

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The sexual characters of insects have always been an interesting study to the entomological student, the more so as they are the less apparent, and discoverable, if to be found at all, only as the result of close observation and comparison. In the larger proportion of insects, in the perfect stage, they are so marked as to leave no doubt of the sex when the male and female are compared. Thus, in the hymenoptera, we have the ovipositor in its varied forms, often quite conspicuous. In the lepidoptera, among the *heterocera*, there are usually the more fully developed antennae of the male, and the broader, conical and more capacious abdomen of the female—features attaining their maximum development in the family of *bombycidae*. In the diptera, there are the larger and more approximate eyes in the male, and conspicuous structural differences in the antennae and suctorial apparatus in some of the families. In the coleoptera, there are often, in the male, stouter legs, broader tarsi, greatly elongated mandibles and other horn-like capital and thoracic processes. In the hemiptera, the vocal organs in the *cicadidae*, the ovipositor in several of

the families, and the great sexual differences in size and in the presence or absence of wings are prominent features. In the orthoptera, there are the stridulating wing-nerves, the extended ovipositor, and a genital armature greatly varied in its adaptation to greatly differing habits. And in the neuroptera, distinctive male characters are found in clasping organs, in differences in color and in size, the long mandibles of *Corydalis*, the abnormal location of the intromittent organ in *libellulidae*, and in the elongated and forcipated genitalia of *Panorpa*.

In addition to such primary features as above noted, there are numerous secondary ones, which do not appear to be so dependent upon sex, and many of which seem almost to serve no higher purpose than that of ornamentation. Yet it is reasonable to believe that most of these differences have their use in the economy of nature, and that they aid in the continuance of the species.

Among such minor antigenetical features, may be mentioned, in the lepidoptera, the usually more angulated wings of the male; the simple frenulum of most of the male *heterocera* in con-

trast with the compound one in the female; the hairy anterior legs of *Grapta* and *Vanessa* in the *nymphalidae*; the long hairs between the costal and subcostal nervures, above the cell of the hind wings of *Argynnis*, appearing, when extended in the cabinet, like a long fringe to the inner margin of the front wings; the incrassated, black scale-patch upon the middle of vein 2 (the 1st median nervule) of the secondaries of *Danais*; the ovoid discal spot on the front wings of many of the *theclinae*; in the *hesperidae*, the reflexed costal margin in most of the *Nisoniades*, *Eudamus*, and *Pyrgus*, and the tibial epiphysis¹ of the anterior legs in all but one of our genera; the transverse discoidal stigma on the primaries of the larger portion of our pamphilas, the beautiful and peculiar microscopic (often concealed) scales, or androconia, of many of the butterflies; the usually concealed pair of extensile anal appendages found by Fritz Müller and others in certain *glaucopidae*, *bombycidae*, *noctuidae* and in a *Danais*;² each of these indicating the male sex. Features equally interesting, and alike serving no purpose so far as known, might be mentioned in each of the orders of insects.

In the earlier stages of insects (egg and larval), sexual features, as would naturally be expected, are less numer-

ous and less conspicuous. They rarely occur in the first stage—that of the egg, or more properly, they have not, in many instances, been recognized by us.³

It was for a long time believed that in the larva of one of our *sphingidae* not unfrequently met with—*Thyreus abbotii*—the sex was so clearly indicated by difference in color and pattern that it could be told at a glance. Of the two greatly differing forms, the one marked with a series of large yellow-green patches on the dorsum extending half-way down the sides, and with another row of smaller subtriangular similarly colored spots resting on the prolegs, was described by Clemens as the male; the female being reddish-brown throughout, with a dark brown subdorsal stripe and numerous short broken striae.⁴ This sexual determination of Clemens was accepted by me in my paper upon the larvae and pupae of this species in the 26th Report of the N. Y. state museum of natural history, p. 114-116, and has also been followed by other writers. That the two forms are indicative of sex, has since been denied,⁵ and it is to be presumed that the denials are based upon results obtained in rearing them to their perfect form. The green-spotted larva may therefore be accepted as a dimorphic form, comparatively

¹ Guenée: Hist. nat. ins., 1852—Lepid., v. — Noct., 1, p. xxxv. Speyer: in Canad. entomol., 1878, v. 10, p. 124. Edwards' Catal. lep. Amer., 1877, p. 64.

² Fritz Müller: Nature, 11 June 1874, v. 10, p. 102 (Psyche, Mch.-Apr. [9 July] 1877, v. 2, p. 24). Morrison: Psyche [9] Oct. 1874, v. 1, p. 21-22. Siewers: Canadian entomologist, Mch. 1879, v. 11, p. 47-48, fig. 12. Stretch: Papilio, Feb. 1883, v. 3, p. 41-42, fig.

³ In *Phylloxera*, the eggs which are to produce males and females may be known by their difference in size. See Riley's Annual reports of the state entomologist of Missouri: 6th, p. 41; 7th, p. 92, 98; 8th, p. 158.

⁴ Two colored figures of the larvae in my possession, made by Dr. Clemens, show the sexes the reverse of this—the green-spotted one, marked as ♀, being much the larger of the two.

⁵ Whitney: Canadian entomologist, April 1875, v. 8, p. 75-76. Grote: *id.*, May 1876, p. 100.

rare in my own collections and in the examples that have come under my observation.

The young collector of insects learns very early the simple method of determining the sexes of his *Luna*, *Polyphemus*, *Promethea*, and *Cecropia* pupae, and of many other bombycid pupae, by observation of the comparative breadth of their antennal cases.

A means by which the sex in the pupae of the *sphingidae* may be infallibly named, was pointed out by me in the Proceedings of the entomological society of Philadelphia, 1864, v. 3, p. 654. I have since found the same characters applicable to the *noctuidae* and to other *heterocera*.

Dr. C. V. Riley, in the Transactions of the academy of science of St. Louis, 1873, vol. 3, p. 128-129, and in the 6th annual report of the state entomologist of Missouri, for 1873, 1874, p. 131-132, has described and figured sexual differences in the pupae of *Pronuba yucasella*, consisting, mainly, in the greater length of the "dorsal projections" on the several segments of the male, in the length of the last two segments as compared with those of the female (its shorter 11th and longer 12th), and in its less rounded apex. He says: "sexual distinctions are very rarely observable in chrysalids; but after I had learned to distinguish between them, I could readily separate the sexes in this case, and my judgment was confirmed upon the issuing of the moths."

A few years ago I discovered an interesting feature in the armature of the species of *Cossus*, by which the sex

may at once be determined. I have, hitherto, withheld its publication, until I had studied others of our spined pupae and could illustrate this feature by proper figures; but the opportunity for this has not been found, and I accordingly defer no longer calling attention to it, that the observations of others in possession of more abundant material may supplement the few that have been made by me.

It is known to lepidopterists that most of the pupae of the species of moths which in their larval stage live in the interior of stems of plants and trunks of trees (endophytes), are armed upon their abdominal segments with transverse rows of teeth or spines, by the aid of which, when they are in readiness for their final transformation, they gradually work their way through the outer packing of their gallery and the bark, project their anterior segments to at least one-third the entire pupal length through the opening, and hold themselves securely during the eclosion of the moth.

This useful armature in the *cossinae*, and in such of the *aegeriidae* as I have had the opportunity of examining, consists of two rows of spines upon most of the abdominal segments, dividing them, when seen in extension, in three nearly equal parts. In *Cossus robiniae*, the species of the *cossinae* with which we are probably the most familiar, these rows occur on the fifth (the first stigmatal segment posterior to the wing-cases) and the following segments.

In *Cossus querciperda* alone of the

species known to me, they commence in a single row of minute dentations on the fourth segment. The principal features of this armature are the following:—It is always the stronger in the male sex—conspicuously so in *C. robiniae*, but less so in *C. centerensis*: the teeth increase in size from the fifth to the tenth segment: the anterior row is always the stronger in each sex; upon the fifth and sixth segments, it does not, in its lateral extension, reach below the stigma,⁶ while upon the following segments it passes in front of the stigma and quite a distance beneath it: the posterior row is discontinued before reaching the line of the stigmata: the teeth show irregularity in form and size, particularly those of the posterior row.

The sexual distinction above referred to, presented in this armature, is this: in the male pupae two rows of teeth occur on segments five to ten inclusive; in the female, two rows on five to nine inclusive. In other words, *the male pupa shows two rows of teeth on segment ten, where the female shows but one*. In each sex, the eleventh and twelfth have but a single row. Disregarding, as I think we should in ordinary usage, the subdivision of what is usually known as the terminal segment, into demi-segments, or a segment and a subsegment, and that still farther refinement which would make of the extreme portion an additional segment with full numerical designation, then it will serve to prevent misapprehension of the parti-

cular section showing the sexual feature, if we indicate it as the *antepenultimate segment*. It would be the eleventh, if we commence enumeration, as some of our entomologists do, with the head, but the tenth, if, as seems to me more proper, we begin with the first thoracic ring.

Beside the *cossinae*, this same sexual feature occurs in the *aegeriidae*. I am not able to say if it extends throughout the entire family. At the time of this present writing, I have at my command only the pupae of *Aegeria exitiosa* and *A. tipuliformis*, and it exists in each. It probably occurs in the pupae of *Zeuzera* (one North American species described), in which the two rows of teeth are found on several of the segments, and perhaps also in *Hepialus*, the pupae of which (unknown to me) are characterized as very similar to those of *Cossus*.

Another interesting fact connected with the armature of *Cossus* is that the form, size, and position of the teeth vary to so great an extent in the different species, and show such distinctive characters, as to afford excellent specific features.⁷ I would not hesitate to pronounce upon specific identity, upon an examination and comparison of the pupal armature alone.

⁷ For comparison with other species of the *cossinae* it may be stated that an example of *C. centerensis* ♂ has thirty-eight teeth in the anterior row of the tenth segment, and twenty teeth in the posterior row—the latter, in their entire range, occupying a transverse space equal to that of nine teeth of the anterior row. The teeth are black, shining, irregular in size, and are slightly bent upward over their base; their length and the distance between their tips exceeds their basal width.

⁶ In *C. centerensis* it reaches below the stigma on the sixth.



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