

PAPILIO.

Devoted Exclusively to Lepidoptera.

Edited by
Eugene M. Aaron,
Lock Box 916.

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ON THE CATERPILLARS OF NORTH AMERICAN PAPILIONIDÆ AND NYMPHALIDÆ.

BY DR. AUGUST GRUBER, Professor of Zoology in Freiburg.

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by CHARLES E. AARON, A. M.

(Continued from p. 91.)

SUMMING UP AND CONCLUSIONS.

I have in the foregoing pages traced the development of the several species of caterpillars of the two families *Papilionidæ* and *Nymphalidæ*, so far as they have been at my command, independently one of the other. My next step will be to determine what characteristics are common to these species and what are not so, and whether from this comparison, any general conclusions can be drawn.

I believe that inferences with regard to the genetic relations of these species may fairly be drawn from my observations, however scanty the material may be.

Looking first at the *Papilionidæ*, we find the caterpillar in the first stage always covered with large warts, on which long bristles stand, giving to the insect a hairy appearance. These warts are arranged in parallel longitudinal rows, of which we can distinctly trace four on each side,—a dorsal, a sub-dorsal, a suprastigmal and an infrastigmal row, of which the two middle ones are the most prominent. At the same time it appears that the warts on the foremost and the hindmost rings of the body are longest, and that, in fact, the two longest of all stand on the first thoracic ring and the last abdominal ring; also that from each extremity toward the middle these prominences grow smaller and smaller, so that those standing on the middle segments are the least of all.

We find, therefore, a correlation between the thoracic segments and the three last abdominal segments, which is especially marked in *Papilio Philenor*, where the warts are prolonged into horn-like appendages.

A further instance of this correlation is afforded by *Danaïs Archippus* and *Limenitis Disippus*, also from West Virginia, both of which I have carefully examined. On the first-named species two long horns, quite similar to those on *Papilio Philenor*, stand on the second thoracic ring, and very similar ones on the next to the last abdominal ring; in fact, rudiments of these are conspicuous even in the first stage. *Limenitis Disippus* has horn-like warts on several of the segments, the most prominent being found again on the second thoracic and the last abdominal ring. They are not, however, equally large, as in *Danaïs Archippus*, but the horns on the second thoracic ring are by far the longest, and these are undoubtedly the ones which have a purpose to subserve, perhaps as a means of inspiring terror. The warts on the other rings only seem to repeat the organs referred to, just as we sometimes see in segmented animals characters of one segment carried over on the others. In *Limenitis Arthemis*, according to Edwards, the horns on the second thoracic ring appear to be decidedly larger in proportion to the other warts.

To return to the *Papilionidæ*, the normal course of the warts is to decrease in size after each successive moult, and sooner or later to vanish entirely. Those standing on the middle segments, as they were the smallest from the start, are the first to disappear, while those on the thoracic rings and the last abdominal rings remain the longest.

Hence we conclude that the warts with their bristles lose their meaning for the caterpillar, and are therefore abolished. If we observe the stages of development of the *Papilio* caterpillars on plate VII, we shall at once notice that, with the exception of the easily distinguished *Papilio Philenor*, these warts, even as early as the second or third stage, are to be set down as rudimentary organs. Their original intention is to form suitable and prominent points of support for the bristles, which at all events must have a meaning for the caterpillar. Whether they have any meaning in the *Papilionidæ*, however, seems to me questionable; at any rate this is the case only in the earliest stages. On the whole we are inclined to believe that the warts and the bristles attached to them may be an inheritance from ancestors for which these features had an important purpose, as is undoubtedly the case with the *Nymphalidæ*. The warts become rudimentary in proportion as the markings come out on the body of the caterpillar; in other words, the markings take the place of the warts, as both together would evidently have the effect to interfere with each other. Natural descent chooses as the objective point of its creative skill the markings, and in many cases the bright coloring of the larvæ of *Papilionidæ*. Other

elements, therefore, which by the side of these have lost their meaning, or would have a disturbing effect on the development of the new character, are gradually compelled to yield. The particular kind of markings will also have a part to perform; thus, on a uniformly brown or green color, such as the nearly related *Papilio Turnus* and *Troilus* display, the protuberances project very prominently, and on the other hand they disappear almost entirely after the second moult. The warts and bristles would exert a still more disturbing influence on the peculiar markings of *Papilio Ajax* with their numerous black rings; hence we may account for the remarkably sudden change from the second to the third stage. All at once the markings make their appearance, and at the same time the previously strongly developed warts and bristles vanish. I have already mentioned that I possess a preparation in which the second skin is just becoming detached, and under it the characteristic form and color of the third stage are plainly visible.

With such markings as, for example, *Papilio Asterias*, *Brevicauda*, *Machaon* (and *Alexanor*) display, the warts will on the contrary be much less disturbing, as they scarcely project on the dark, oblique bands. Accordingly we find that they do not entirely disappear until the last moult.

We may then probably infer that the larvæ of the *Papilionidæ* descend from forms which, with dull coloring and inconspicuous markings, were covered by strong, bristle-bearing warts. All the caterpillars examined by me in the first and even in the second stage, conform to this hypothetical prototype.

The larvæ of the *Papilionidæ* now existing show for the most part brilliant colors and conspicuous markings (rings, bands, ocelli, etc.), and the original forms were forced to yield to these elements. Many intermediate steps have bridged over the great gap between that prototype and the larvæ of our own period, and these steps are perpetuated to us in the various forms of the successive stages of development. Every caterpillar repeats during its moults, in a more or less perfect manner, the history of its descent.

I have heretofore attempted to prove that the kind of markings sometimes shows the necessity of a very sudden disappearance of the rudimentary organs. Were this not the case we could very easily determine from the rudiments of the warts the age of *Papilio* larvæ, that is to say, the remoteness of each species from its ancestral form. Those caterpillars, namely, which kept the warts longest would be the oldest, standing nearest to the prototype; those which lose the warts in the early stages would be the most recent, furthest removed from the prototype. In the first category, therefore, we should include, for example, *Papilio Machaon*, *Asterias* and *Brevicauda*; and this seems not unreasonable, because in them the dark color remains to the third stage without decided markings. *Brevicauda* would appear still older

than *Arterias*, because in the former the warts are still visible in the fourth stage, and the markings are not so fully developed as in the corresponding stage of *Asterias* (see Edwards).

The bright-colored saddle, which interrupts the prevailing dark color, is found in these two species, and in a somewhat similar form—as oblique bands—in *Papilio Troilus* and *Turnus*, as well as in other caterpillars, such as *Limenitis Arthemis* (see Edwards). Interrupting the dark outline which makes the caterpillar visible at a distance, the saddle may serve to render it less conspicuous, less easily detected by its enemies.

Papilio Philenor occupies an exceptional position among its congeners, but is on that account none the less interesting and instructive. The first stage corresponds substantially to that of the other forms, but after that period the development takes another direction. The bristles vanish, it is true, but not the warts; on the contrary, these become longer and grow into horn-like appendages. This process, however, takes place only on the thoracic and the last abdominal rings; in fact the longest horns stand on the first thoracic and the last abdominal.

In this species also the warts are suppressed on the middle segments, but only gradually, and even after the last moult they still remain visible. In the infrastigmal row they still remain very long.

While the coloring and markings of *P. Philenor* are of secondary importance, the warts are inherited from the prototype, and have been chosen by natural descent as the objects of its formative power; here, too, the bristles vanish and the long horns are perfectly smooth. I see little reason to doubt that we must regard these horns as means of inspiring terror, especially those standing on the thoracic segments. Those on the last abdominal segments, as I have before intimated, probably owe their origin to a correlative transfer of the thoracic formations to the abdominal rings. Correlation may also account for the fact that the warts remain so long on the infrastigmal row, as the purpose which they subserve for the insect is not easily perceived. The formidable horns on the thoracic segments belong to the infrastigmal series, and it may hence be inferred that on the remaining segments also there would be a tendency to enlarge, or at least to maintain, the corresponding warts.

Turning our attention to the form of the bristles standing on the warts of the *Papilionidæ*, we see that in the first stage they have a long shaft and a shovel-formed, enlarged extremity. This typical form I have found in all the *Papilionidæ* which I have examined; and although *Ajax* is an exception with its bifurcate bristles, yet even this form, as I have already remarked, reverts to the other, as the furcate division may be regarded as a widened extremity.

What may be the purpose of the bristles, and upon what conditions their diversity of form depends, I am not able to state, because the life-history of these caterpillars is not sufficiently known, in fact upon this point no observations have as yet been made. The shovel-formed bristles are undoubtedly an inheritance from the ancestors of the *Papilio* caterpillars, and we find them in the larvæ of quite different families, as, for example, in *Danaïs Archippus*, *Colias Philodice* and *Satyrus Eurytus*, all of which I have examined. If they have any meaning at all in the *Papilionidæ* it is only in the first stage, for they lose their shovel-formed enlargement after the following moults, become proportionately shorter, and finally quite obsolete. In brief, we conclude that in the early stages we must regard them as rudimentary organs, which, like the warts on which they stand, have lost their meaning for the insect, and are replaced by other elements.

In *P. Philenor*, which constitutes in its development an aberrant form, the bristles become rudimentary at a still earlier period, and in the first stage we find on each wart for the most part only one long bristle corresponding to the typical form. As the warts are developed into the prominent horns already mentioned, the bristles are soon suppressed.

Let us now try whether my observations upon the few species of *Nymphalidæ* which have been at my disposal may be utilized in the same manner as I have done with the *Papilionidæ*.

Here also we see that the early stages resemble each other more or less completely; that in all the species examined of the genus *Melitæa*, for example, these stages are quite in accordance. The young caterpillar is covered with hair, that is to say, provided with long bristles which are arranged in the usual longitudinal rows. In contrast to the *Papilionidæ*, the bristles stand singly on inconspicuous elevations of the skin. But after the first moult a state of affairs is introduced such as we find in the first stage of the *Papilionidæ*, namely, tall, conical warts appear, beset with numerous bristles, so that the caterpillar appears much more hairy than in the first stage. These warts continue to increase with every new moult, so that they lose nothing in circumference in proportion to the size of the caterpillar. The course of development, therefore, is exactly in inverse ratio to that seen in the *Papilionidæ*. In that family the warts were present in the first stages only as a heritage from a supposed prototype, and from that point continually diminished. In the *Nymphalidæ* they are a newly-acquired character which does not appear until the second stage, and which in the following stages is maintained or still further perfected.

In the *Papilionidæ* the coloring and markings take the precedence, and suppress the warts and bristles; in the family we are now considering the first named elements play a more subordinate part, and in their place the hairy covering acquires an important meaning for the species

and rules the exterior form of the caterpillar. The intention of this hairy covering, as I have already said, it is not in my power to explain.

As to the form of the bristles, a few observations, not without interest, may be offered. In the species of *Melitæa* and *Argynnis* which I have examined the bristles present in the first stage are always long, slightly curved and finely toothed on the margin. These primitive bristles, as I will call them, are now, in the course of the development, replaced by bristles which are either smooth and simple, or swollen near the base. This process of replacement is less rapid in some species than in others, but it becomes effectual either in the later or the earlier stages. Thus, *Melitæa Phaeton* retains its primitive bristles to the fourth stage; whether it does so to the fifth I know not, as that stage was not at my disposal. In *Marcia* and *Nycteis*, on the contrary, single bristles of the second with swollen shaft are seen directly after the first moult. They make their first appearance, mingled with the primitive bristles, on the warts of the sub-dorsal row. Not until the following stages do they crowd out the primitive bristles on this and other rows. In *Melitæa Marcia* we find in the second stage a few club-shaped bristles on the sub-dorsal warts, while in all other positions the bristles are toothed; in the third stage, on the contrary, the latter are confined to the infrastigmal row, and even there a clubbed bristle occasionally appears among them. In the fourth stage of *Nycteis* (the first moult after the hibernation) the second form of bristles gives place to a third, while the swelling has almost entirely disappeared from all the bristles.

In the fifth stage of *Marcia*, also, there would seem to be a tendency to change the swollen bristles for simple staff-shaped ones. If we designate the three kinds of bristles, viz., the toothed, the swollen and the staff-shaped, as A, B and C, we may arrive at the following conclusion: *Melitæa Phaeton* is the oldest species, standing nearest to the prototype, because in it the primitive form of bristles A persists until the fourth (perhaps the fifth) stage; *Melitæa Marcia* is a more recent species, because the form B appears as early as the second stage, while a tendency to form C does not become observable until the fifth. The newest of the three species would be *Melitæa Nycteis*, because the form C entirely supplants B as early as the fourth stage. In *Argynnis Myrinna* the toothed primitive form is also found in the first stage, but it is immediately supplanted after the first moult by the form C, and not by B.

In the species of *Grapta* which I have examined the bristles of the first stage are not generally toothed, but mostly quite smooth. The warts make a more considerable growth than in *Melitæa* and *Myrinna*, while the bristles become proportionately shorter.

The ideas which I have developed in the foregoing pages make, of course, no claim to perfection or infallibility, because the empirical facts on which they were based were quite insufficient. A certain degree of probability, however, will perhaps be conceded to them, and they may hereafter receive confirmation from other sources. Those who have at their disposal more abundant material than I have had may accept my challenge to use such material for the purpose of testing the conclusions to which I have arrived. Whether these conclusions shall in part be overthrown or shall be proved correct,—in either event such an investigation will be exceedingly rewarding, and cannot fail to bring to light much that will prove interesting.

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APPARENTLY NEW SPECIES OF N. AMERICAN HETEROCERA.

BY HENRY EDWARDS.

ZYGÆNIDÆ.

Pseudalypia Crotchii, Hy. Edw. Var. *Atrata*, n. var.—Entirely brassy black, excepting the costa, which is narrowly cream-white. The rather broad and distinct transverse band so characteristic of the typical form, is here entirely wanting. 1 ♂.

Los Angeles, Cal. Coll. A. J. Bolter.

BOMBYCIDÆ.

Seirarctia Bolteri, n. sp.—Size of *S. Clio*. Primaries bright chestnut-brown, with the usual stripes as in *S. Echo*, very clear silvery white, thus showing a strongly marked contrast with ground color. The stripes are thus arranged: one dull costal streak not reaching the apex, a median streak from near base to external margin, and one from base along the internal margin to internal angle. At the apex are two short streaks, and between the median and internal streaks are three others resting on the median nervule. The secondaries are sordid white with a very distinct roseate tinge along the abdominal margin. Beneath, the markings are repeated with a few streaks of brown on secondaries. Head and thorax chestnut-brown, with pinkish streaks; abdomen brownish rose color. Feet and legs as well as the whole of the under side rusty brown.

Las Vegas, N. Mex., 7000 feet. Type, coll. A. J. Bolter.

Heterocampa superba, n. sp.—Ground color of primaries pale yellowish fawn color. Behind the middle, resting on the costa, is a



Gruber, August. 1884. "On the caterpillars of North American Papilionidae and Nymphalidae." *Papilio* 4(7-8), 115–121.

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