VII.—*A Classification of Lepidopterous Larvæ.*

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In a recent paper¹ Professor J. H. Comstock has proposed a new classification of the Lepidoptera based on the methods of uniting the fore and hind wings, and on the modifications of the wing veins. It has occurred to me to review, in a general way, the arrangement and external structure of the setiferous tubercles of the larvæ of the Lepidoptera, to see how a classification based upon these structures would compare with this new classification. For, if the new classification is a natural one, it should be corroborated by a study of any set of organs, as Prof. Comstock points out; and it would seem that the tubercles of the larvæ are sufficiently different from the wing veins of the adult to make the test severe.

It is to be noted that the larvæ of the Lepidoptera, on the whole, live an exposed life, where they are subject to be preyed upon by enemies of various kinds, many of which use the sense of sight to find their victims. Therefore, it is not surprising to find these insects modified in all sorts of ways for concealment or defence, not only in color but in structure as well.² And the setiferous tubercles are among the most frequently modified structural elements. Moreover, this modification takes place, in part, independently of any corresponding change in the adult insect. And it may even be reasonable to suppose that where the larva is highly modified, we should find the adult in a generalized condition. This would result from the consideration that it might be advantageous to the insects in question to shorten the length of adult life and lengthen that of the well-adapted larva. So, if the adults had but a short time to live, it would be unimportant that specialization should take place. Hence it is not improbable that a classification

¹ Evolution and Taxonomy, Wilder Quarter Century Book, pp. 37-113.

² See E. B. Poulton's "Colors of Animals."

based on the larval tubercles might differ in important respects from one based on the adult insect. That this is not the case in the present instance for the major groups, shows that the classification proposed by Prof. Comstock is the nearest to a natural one that we have yet had. That it is frequently the case in the minor groups, illustrates the principle to which I have just referred. It is, moreover, a fact, that we see the greatest amount of modification in those larvæ which live the most exposed life, and whose period of larval existence is the most extended. Some of these cases will be specially alluded to.

GENERAL EXTERNAL STRUCTURE OF LEPIDOPTEROUS LARVÆ.

The body of the lepidopterous larva is divided into thirteen segments, three thoracic and ten abdominal.¹ The last two abdominal segments are closely united in most of the higher families, so to appear as one. On each of the third to sixth and tenth abdominal segments are a pair of fleshy legs, furnished with prehensile hooks. In special cases, certain of these legs are absent or modified for other uses; or, much more rarely, the three pair of jointed, chitinous, thoracic legs may be wanting. On each segment (when not too highly specialized) are certain, small, chitinous tubercles, arranged in a definite manner, each bearing a bristle or seta. The arrangement and modification of these tubercles is the subject of this paper. On the thoracic segments, the arrangement is different from that on the abdominal ones. For simplicity, we will confine attention principally to the latter, and to those segments of them which bear feet.

Since all lepidopterous larvæ periodically cast their skins (varying from three to ten times in different species) before the final molt to acquire the pupa stage, and since the external structure is not the same in each larval stage, it is necessary to consider at what stage the larval tubercles are to be compared. There are two types among the more highly specialized larvæ. In the first, represented by the Saturniidae and Notodontidae, the arrangement of tubercles

¹ Dr. A. T. Bruce remarks in the case of the embryonic *Thyridopteryx ephemeriformis*: "It is questionable whether the terminal portion of the abdomen which forms the so-called eleventh abdominal somite is to be regarded as a true somite or not. It has no ganglion corresponding to it, and is formed . . . by the dorsal flexure of the posterior end of the embryo. . . ." (Observations on the embryology of insects and arachnids, p. 9, 1887.)

is the same in all stages. These larvæ rarely have more than five stages. In the second, represented by the Arctiidae and Lymantriidae, and by many Butterflies, the first larval stage is remarkably different from the following ones. In these embryonic larvæ, which have not passed a moult since leaving the egg, we find a generalized condition of the tubercles and setæ. I have concluded not to consider the larvæ in their first stage for this reason, the more so as it is doubtful if the character of the presence or absence of this generalized first stage has any special phylogenetic significance. It would seem, rather, to depend upon the necessity of shortening the larval stages, or upon the condition of the environment of the individual, which rendered it necessary for the little larva to come into active existence fully armed, as is the case with the newly hatched larvæ of *Heterocampa* and *Cerura* among the Notodontidae or with the Sphingidae. Others, with less necessity for an active struggle in very early life, have retained the primitive or generalized condition till the first molt.

THE ARRANGEMENT OF THE TUBERCLES.

There are two types of arrangement. The first, which is by far the more generalized, consists (considering only the abdominal segments) of five tubercles above the spiracle on each side, three in a transverse row about the middle of the segment and two behind; below the spiracle are two oblique rows, containing, respectively, two and four tubercles. This type is found in *Hepialus*, and is probably typical of the larvæ of the moths in Prof. Comstock's first suborder, the Jugatae.¹

The second type contains two dissimilar lines of modification of the first type; but, as they agree in number of tubercles and in other characters, I will consider them together. The fundamental arrangement of the tubercles is as follows: On each side above the spiracle three tubercles; below, or behind the spiracle and above the base of the leg, three more; on the base of the leg three (or four) on the outside and one on the inside near the midventral line. These I propose to designate thus, counting from the dorsal line down the side: Tubercles i, ii, iii above the spiracle, iv, v, vi below it; the group of three on the outside of the leg as vii, and the single one on the inside of the leg as viii. Tubercles vii and viii are present

¹ I have not had *Micropteryx* for examination.

also on the legless abdominal segments (viz., segments 1, 2, 7, 8, and 9 of the abdomen) in the corresponding position. On the last two segments (segments 9 and 10) the number of tubercles is always less than the fundamental number, even in generalized larvæ. This is due to the fact that these segments have been partly aborted, being without spiracles. The reduction of segment 9 has taken place on the anterior portion, while segment 10 has lost the lateral part.¹

PHYLOGENY OF THE TUBERCLES.

In comparing the larvæ of other orders of insects with the Lepidoptera, we find but few which throw any light on the origin of the present arrangement of the tubercles. The Phryganidæ, the imagos of which seem to suggest an affinity with the Lepidoptera, have larvæ without any tubercles, and also without any abdominal feet. They have, however, a dorsal shield on the mesothoracic segment, as well as on the prothoracic segment, a fact which is very interesting in connection with the structure of the Hepialidæ and Psychidæ.

In the larvæ of the phytophagous Hymenoptera (Tenthredinidæ) we find well-developed setiferous tubercles, apparently in a more generalized condition than in any Lepidoptera. They have the following arrangement (see Fig. 1): Above the spiracle nine tubercles

Fig. 1.

Fig. 2.

FIG. 1.—Diagram of a segment of a species of Tenthredinidæ (*Hylotoma McLoupi*).FIG. 2.—A segment of *Hepialus lupinulus* (from a drawing by Mrs. P. N. Knopf).

in a square, three on each of the fundamental subsegments or annulets. Below the spiracle is the substigmatal ridge, divided into two oblique portions, each thickly covered with setiferous tubercles.

We may homologize these with the Lepidoptera as follows: In the Jugatae (see Fig. 2) the three tubercles of the middle annulet

¹ In the generalized Pyralid *Pantographa limata* G. & R., tubercles i and iii are lacking on segment 9, tubercles iv, v, and vi on segment 10.

are all present, and the upper and lower of the posterior annulet the two substigmatal tubercles may represent the substigmatal ridge of the Tenthredinidæ. The others have no homologue in these Hymenoptera.

In the Frenatæ we have the same arrangement still further reduced. But here appears an important difference to which I have alluded above. In the Psychidæ the three tubercles are retained on the middle annulet, while both are lost on the posterior one (see Fig. 3); the substigmatal tubercles are retained and approximated; the *anterior* one of the four on base of the leg seems to have been moved up, forming tubercle vi, which is thus anterior. In the other type, which includes all the other families of the

FIG. 3.—Segment of an undescribed Psychid larva from New Mexico.

FIG. 4.—Segment of *Marguridia quadristigmatis* (from figure in *Insect Life*, vol. I, p. 24, with addition of setæ).

FIG. 5.—Arctian type of tubercles (diagram).

Frenatæ, the middle tubercle of the three on the middle annulet is lost, but the upper on the posterior annulet is retained; the two below the spiracle are retained also, as in the Psychidæ; but they are either approximated (see Fig. 4) or separated (see Fig. 5), giving us characters for the next subdivision. Of the four tubercles above the base of leg, the *posterior* one is moved up, forming tubercle vi. These two types must represent dichotomous lines of descent. If this is true, the Psychidæ should be separated from the other Frenatæ as a great group, equal in rank to all that follow.¹

¹ This can be done, in most cases, also by characters of venation; viz., the permanent cross vein in the Psychidæ between veins viii and ix on primaries, which exists also in the Hepialidæ, and to which more classificatory importance can be attached than has been done by Prof. Comstock.

MODIFICATION OF THE TUBERCLES.

The primitive form of tubercle consists of a little chitinous button on the skin bearing a single long hair. It is found in the less specialized families of all the groups discussed above, and exclusively in the Jugatæ and in the Psychidæ. When this form is present, there are, in general, no other hairs on the body.

The Frenatæ, exclusive of the Psychidæ, may be divided into groups on the character of the tendency to coalescence or separation of tubercles iv and v, as I have remarked above. The first group corresponds to Prof. Comstock's division of "Microfrenatæ" and "Generalized Frenulum Conservers," plus one family each from his Zygaenina and Saturnina.¹ The second group corresponds to his "Specialized Frenulum Conservers" and "Frenulum Losers" with the exceptions just noted. If we shift the order of Prof. Comstock's characters, and disregard the two exceptions, we may say that the first group corresponds to the *Generalized Frenatæ*, the second to the *Specialized Frenatæ*. Now, in the lower families of these two groups, we have the primitive form of tubercles, as already stated. In the higher families of both groups we have at first a parallel line of modification, which consists in the tubercles becoming enlarged and many haired. Each hair arises from its own minute tubercle, and the whole are borne upon an enlarged base or wart.² The arrangement of the warts is, at first, strictly that of the primitive tubercles, and they correspond in number and equality of development. The next step is a reduction in the number of tubercles, by unequal development and final obliteration of certain ones. In the higher Generalized Frenatæ, tubercle iv has disappeared by coalescence with v, and in the higher Specialized Frenatæ it becomes

¹ Prof. Comstock informs me in correspondence that he has somewhat changed his views in regard to these two latter superfamilies, so that he will place them more in accordance with my own view, derived from studies on the larvæ. I omit reference to the Sesiidæ, which Prof. Comstock places among the specialized frenulum conservers, as he states in the text of "Evolution and Taxonomy," that they probably belong with the Microfrenatæ, a conclusion which is abundantly justified by larval characters.

² It is a striking fact that we do not find a series of intergrading forms between the single-haired tubercle and the many-haired wart, though both may occur in different genera of the same family. This can be understood on the principle of discontinuous variation which is insisted upon by Bateson ("Materials for the study of variation").

smaller till it disappears, as may be seen in certain genera of the Lymantriidæ. This obliterates the fundamental distinction that I have drawn between these groups. The distinction is still equally good theoretically; but it fails in practice. For this reason I have been in doubt about the position of the Pyromorphidæ, Megalopygidæ (= Lagoidæ), and Eucleidæ (= Limacodidæ), and I have been obliged to give weight to the characters of the moths in locating these families. It is to be noted that the characters drawn from the tubercles do not contradict the position which I have assigned to these families, and I believe that I have correctly pointed out the reason why the character of the tubercles fails.

Several lines may now be taken by the increasing specialization. The tubercles may entirely disappear, either leaving the skin smooth, or the whole body covered with pile or soft hair. The bases of the tubercles may persist and be produced into fleshy processes, often of great length, while the setæ become aborted as we see in certain Nymphalidæ and Papilionidæ; or the setæ may remain, and, becoming glandular,¹ secrete a poisonous, urticating fluid as in the Megalopygidæ and Eucleidæ. Again, we may have the hairs greatly complicated, developed into brushes, tufts, and plumes, or finely feathered at the tips as in the higher Aretiidæ, the Lymantriidæ, and Euchromiidæ (= Zygaenidæ of Kirby's catalogue).

Perhaps the highest degree of modification exists in certain forms in which the tubercles are partly retained, but tubercle i of each side, approaching the dorsal line, has become consolidated with its fellow of the opposite side, producing a row of dorsal tubercles apparently unpaired. This seems to have taken place in two separate lines of descent, and in a manner not quite parallel in the two. In the first, namely that of the Saturnina (except the Lacosomidæ) and the Sphingidæ, we have tubercles i consolidated dorsally on abdominal segment 8, while ii are similarly consolidated on segment 9, tubercle i being absent on the other segments. In the second line, which consists of a part of the Nymphalidæ, tubercle i is retained on all the segments, and we have a row of single dorsal tubercles on abdominal segments 1 to 8 inclusive, without indication of a consolidation of ii on the 9th segment.² In both these groups, a further modification of the tubercles is undergone, in that the

¹ Perhaps the primitive seta is glandular. See Dr. A. S. Packard's many papers on the glandular setæ of young larvæ.

² In some species, as *Holiconia charitonia* and *Argynnis diana*, this now is absent

base is prolonged and chitinized, thus converting the tubercles into large branching processes, each branch tipped with a hair. In the Sphingidæ it appears that all the tubercles have disappeared except the dorsal one on the 8th segment, which forms the well-known "caudal horn." In some of the Saturnina, we have the setæ modified into urticating spines as in the case of the Eucleidæ. This similarity does not imply relationship as Dr. A. S. Packard seems to believe,¹ since we have only a similarity in function, while the structure of the bases of the tubercles is essentially different.

ON THE MATERIAL USED.

In the latest list of North American Lepidoptera² there are enumerated sixty-three families, eliminating a few which have since been united with others. I have found it impossible to obtain the necessary material to make observations on all of these. Especially in the group Tineina, which contains nineteen families, my material has been very scant. I have not been able to avail myself of the numerous descriptions of lepidopterous larvæ scattered in various journals, and only to a small extent of published figures, since the former have been drawn up without any reference to the arrangement of the tubercles, while the latter are (with a few notable exceptions), either without accuracy or drawn in such positions that it is impossible to determine the arrangement of these structures. I have not considered families which occur exclusively outside of North America, on account of the total lack of material.

I am indebted especially to Professor J. H. Comstock for many alcoholic specimens, and to Dr. A. S. Packard for the loan of several which I would not otherwise have seen.

THE CLASSIFICATION OF THE LEPIDOPTERA.

Before proceeding to a detailed description of the tubercles of the various species which I have examined, a few general remarks are in order. I have already indicated how well the present classification drawn from the characters of the tubercles of the larva corresponds with Prof. Comstock's classification from the venation of the adult. The essential feature in which this classification differs

¹ See Journal N. Y. Entomol. Soc., vol. I, p. 9.

² List Lep. Boreal Amer., J. B. Smith, 1891.

from all heretofore proposed, namely, the division into Jugatæ and Frenatæ is abundantly sustained.¹ The divisions of the Frenatæ are not strictly sustained; but the general idea holds good, of generalized and specialized Frenatæ. More than this we seem to have two lines of descent indicated by these terms. I have not found full justification of Prof. Comstock's further division of the Specialized Frenatæ into "Frenulum conservers" and "Frenulum losers." In fact, the use of these characters as a division of the Specialized Frenatæ is not sustained by a study of the larvæ. The loss of the frenulum is rather to be considered as a secondary adaption for flight with broad wings, and it has arisen separately in several distinct lines of descent.

The two points in which my classification contradicts that of Prof. Comstock now require attention.

1. *Superfamily Zyggænidæ*.—So far as the North American fauna is concerned there are but two families which claim notice, the Euehromiidae and Pyromorphidae. According to my views, these belong to the two separate lines of descent, the specialized frenatæ and generalized frenatæ respectively. I will not do more here than call attention to this difference, as the Pyromorphidae are one of the families about which I have been in doubt.

2. *The Family Lacosomidæ*.—This is placed among the Saturnina by Prof. Comstock, but from larval characters it belongs with the generalized frenatæ. It is true that the moths bear a close resemblance to the Saturnina; but I believe that this will be found to be fortuitous. I regard it as an instance where specialization has taken the same form in different lines of descent, and has led to a misinterpretation of the characters. The larvæ have retained a generalized condition on account of their secluded life, and give us truer characters for the classification of the family. It is a case the converse of that of the Eucleidæ, where specialization has taken place in the larva, and where the generalized adult gives the best indication of the relationship of these curious insects.

To show how completely my classification of the larvæ contradicts the generally accepted classification of Lepidoptera, it is only necessary to briefly consider the "Superfamily Bombycees." No one has prepared a satisfactory definition of this group so far as I

¹ This same division of the Lepidoptera has been made by G. F. Hampson (Fauna of British India: Moths, vol. I, p. 8), but apparently without recognition of the real distinctive character.

am aware, and it has been stated that it could not be defined.¹ Nevertheless, Dr. Packard has very recently prepared a list of the families of the Bombyces,² following in the main the old lines. It is only necessary to compare his list with the following synopsis of families to show how completely at variance the two systems are. In fact, a more miscellaneous aggregation of families could not well be imagined than the so-called "Bombyces," judged by the standard of my classification of the larvæ.³

SYNOPSIS OF THE FAMILIES OF LEPIDOPTEROUS LARVÆ.⁴

- A More than one tubercle on the third annulet and more than six above the base of leg.....**Jugatae**
Heplialidæ
- AA Not more than one tubercle on third annulet and only six above the base of leg.....**Frenatae**
- B Three tubercles on middle annulet, none on the third; tubercles iv and v approximate; two thoracic shields.....**Psychidæ**
- BB Not more than two tubercles on middle annulet and usually one on third annulet; one thoracic shield (prothoracic).
- C Tubercles iv and v approximate or consolidated.
- GENERALIZED FRENATE
- D Tubercles simple, single haired.....**Cossidæ, Pyralidina, Tortricina, Tineina** (in part), **Lacosómidae, Sesiidæ**
- DD Tubercles absent, as well as all legs.....**Tineina** (in part)
- DDD Tubercles modified, many haired.
- E All present but tubercle i.....**Pterophoridæ**
- EE Subventral tubercles also reduced; only three left.
- Pyromorphidæ, Megalopygidæ**
- EEE Substigmatal tubercle absent; only two left.....**Euclidæ**
- CC Tubercles iv and v remote.....**SPECIALIZED FRENATE**
- F Tubercles all present or with but slight tendency to unequal reduction, setiferous, or equally reduced.

¹ J. B. Smith, List Lep. Bor. Amer., p. iv; Neumøgen & Dyar, Journ. N. Y. Ent. Soc., I, 97.

² Journ. N. Y. Ent. Soc., I, 6 (1893).

³ "The family *Bombycidae* would certainly never have been formed if the larval structure only had been taken into consideration. . . . Are the imagines of the genera united under this family, at any rate morphologically, as unequally related as their larvæ?" Weismann, Studies in the Theory of Descent, vol. II, p. 442.

⁴ Families which have been omitted have not been examined.

⁵ In the higher forms, where the tubercles begin to be lost, iv may disappear, leaving the remaining tubercles in essentially the same arrangement as those in the section above, where the consolidation of iv and v is complete, and where vii has disappeared.

- G Simple, with a single seta.....**Noctuidæ** (in part), **Agaristidæ**,
Notodontidæ, **Geometridæ**, **Drepanidæ**,
Lithosiidæ (in part)
- GG Tubercles with many hairs.
- H Without any development of hairs from the skin.
Noctuidæ (in part), **Pericopidæ**, **Arctidæ**,
Euchromiidæ (= **Zygenidæ**), **Lymantridæ**
- HH Tubercles greatly reduced; abundant hair from the skin.
Lasiocampidæ
- FF Tubercles with marked unequal reduction, or greatly modified or absent.
- I Tubercles still wart-like, hairy.¹
Lithosiidæ (in part), **Lycænidæ** (in part)
- II Tubercles greatly modified or absent.
- J Tubercle i normal (when present).
- K Tubercles produced into naked fleshy horns, or represented by colored spots.....**Papilionidæ**, **Nymphalidæ** (in part)
- KK No trace of tubercles.....**Nymphalidæ** (in part),
Pteridæ, **Hesperidæ**
- JJ Tubercle i consolidated with its fellow on the dorsum.
- L No unpaired dorsal tubercle anterior to abdominal segment 8.
- M Tubercles largely present.....**Saturnina**
- MM Only the dorsal tubercle on segment 8.....**Sphingidæ**
- LL A line of unpaired dorsal tubercles the length of the abdomen anterior to segment 8, or largely so.
Nymphalidæ (in part)

Suborder **Jugatæ.**Family **Hepialidæ.**

Very little is known about the larvæ of our native species. D. S. Kellicott has described *Stenopsis argenteomaculata*,² and this is the only one of our species of which the larva is known. Unfortunately the description is inadequate for my purpose. I infer from it, however, that the larva has the setæ single and possesses a dorsal shield on the mesothoracic segment as well as on the prothoracic and the anal (10th abdominal segment). See Fig. 2 for illustration of an European species.

Suborder **Frenatæ.**The isolated Family **Psychidæ.**

This family seems to be equal in rank to all that follow, taken together. I have already alluded to the presence of a dorsal shield

¹ The young larvæ of many **Papilionidæ** will also come in here.

² *Insect Life*, vol. I, p. 251 (1889).

on the mesothoracic segment. The retention of this primitive character corroborates the above conclusion. The family must be of great age, and the wide distribution of its members, which are found in all quarters of the globe, confirms this view. It is the only family of Lepidoptera in which the females of all the species are wingless, and they are probably the most degenerate of all such females. I have examined three larvæ.

***Oiketicus kirbyi* Guilding.**

Mr. B. Neumægen has given me a number of specimens received from a collector in Guadalajara, Mexico. In this species, as in all the others, the setæ are very fine and difficult to determine, while the tubercles have almost disappeared. The arrangement is that of my Fig. 3, though I could make out but two hairs on the base of the leg.

***Oiketicus townsendi* Riley MS.**

This is the species shown in Fig. 3, which I have received from Mr. T. D. A. Cockerell, of Las Cruces, N. M. The U. S. government entomologist has attached the above name to it, I am informed. It is to be hoped that Dr. Riley will soon give us an account of it. Judging from the larval case, I have doubt about the propriety of the reference to the genus *Oiketicus*.

***Thyridopteryx ephemeræformis* Stephens.**

I have examined a specimen prepared by Mr. Wm. Beutenmüller. The setæ are very obscure, and I could not make out any below tubercle v. There is a circular corneous plate behind tubercle iii, another bears tubercles iv and v, and there is a third one corresponding in position to tubercle vi.

THE GENERALIZED FRENATE OR MICROLEPIDOPTERA.

The term *Microlepidoptera* may be retained for these families, though several are included which were formerly classed among the *Macrolepidoptera*.

The modification of the primitive arrangement of the tubercles begins in the tendency to consolidation of iv and v. Tubercles i and ii are more nearly in line than they are in any of the Specialized Frenate, and vii is developed into a distinct wart on the bases of the legs, compensating for the absence of leg plates in this group.

Thus there appear to be two subventral tubercles, the upper *posterior*, the lower *anterior*.

There are two lines of specialization. The first consists in the loss of all the tubercles as well as the feet, even of the thoracic ones. This is seen in certain Tineids (e. g., *Antispila nyssæfoliella*), which are adapted to living in mines between the two surfaces of a leaf. The second line occurs in larvæ living an exposed life. It begins in the multiplication of the hairs of the tubercles and the conversion of them into warts, exactly as in the Specialized Frenatæ. Closely following on this comes the reduction in the number of tubercles. This is seen in the Pterophoridaæ, where tubercle i has disappeared. Next we have the reduction and disappearance of the subventral tubercles, leaving but three, two above the spiracle and one below. This is probably in adaption to the form of the larva, which is now becoming flattened with shortening of the abdominal legs. The Pyromorphidæ and Megalopygidæ are in this condition. Following this stage, the substigmatal tubercles (tubercles iv and v) disappear, and the flattening of the ventral region reaches its extreme. The hairs of the tubercles have also been gradually converted into stinging spines. In the Megalopygidæ they are only partially converted; but in the Eucleidæ the conversion is complete, and we have, finally, the highest type of the Microlepidoptera, and, perhaps, the most highly modified larva of all Lepidoptera. It is interesting to note that the moths of the Eucleidæ are much more generalized than those of several of the families which precede them, while the larvæ are so highly specialized. This illustrates the principle to which I alluded at the beginning of this paper, that specialization in the larva may be accompanied by a generalized condition of the moth. It is notorious that the larvæ of the Eucleidæ live for an usually long period.

Family Cossidæ.

Zeuzera pyrina Linnæus.

Mr. J. Doll has kindly obtained for me some larvæ of this species, recently renamed *Z. decipiens*¹ by Mr. W. F. Kirby, of the British Museum, on the supposition that our species is not the same as the European. The setæ arise from the centre of round black spots, i, ii, and iii in the normal arrangement. In front of the spiracle is a small black spot, suggesting a tubercle, but it bears no seta; iv and v arise from a single spot, and below them posteriorly is vi;

¹ Catalogue of Lepid. Heterocera, vol. I, p. 871 (1892).

vii consists of three setæ near the foot, and viii a single one on the inside of the leg. There is a large dorsal prothoracic shield, but no trace of a mesothoracic one.

Superfamily **PYRALIDINA.**

Family **Pyraustidæ.**

Meocyna reversalis Guenée.

The setæ arise from the centre of large black patches, except vii the tubercles of which are separated considerably; viii has also a black patch; iv and v are approximate but not consolidated. The tubercles are distinct, but the setæ are much aborted, so that at first glance the small supplementary white spots bordering the black patches suggest the location of these structures. Larva received from Prof. Comstock.

Pantographa limata Grote and Robinson.

In this larva there are no colored markings. The tubercles are situated on rounded corneous areas, and are without setæ, except in the subventral region. Tubercle i is situated in the lower posterior corner of its corneous area, and there is a distinct dark dot in the opposite corner, suggesting a duplication of this tubercle. Tubercles iv and v are approximate, iv on the upper posterior corner of the area which bears v. The first annulet is not well marked; the fold behind the second is distinct, and the third annulet is divided by an oblique fold running posterior to tubercle ii. This produces an arrangement seen in very many of the Microlepidoptera where the segment is divided into three annulets differing from the primitive ones.

Family **Galleriidæ.**

Galleria mellonella Linnæus.

The larva is without marks, its tubercles very minute and without corneous areas, though they bear distinct setæ. The abdominal feet are very short, but bear tubercles vii and viii in the normal manner. Tubercles iv and v, and the three composing vii are approximated, but unconsolidated.

Family **Phycitidæ.**

Vitula edmandsii Packard.

The tubercles are small, dark, and bear pale setæ. Tubercles iv and v are consolidated, the two setæ arising close together; the

tubercle on the base of the leg (vii) is very weak, the hairs being separated and obscure. The segments are divided into two annulets, corresponding to the two posterior ones of the Tenthredinidæ.

***Plodia interpunctella* Hübner.**

The setæ are very fine and the tubercles minute; both have nearly disappeared, except that the subventral ones bear distinct hairs. The arrangement of tubercles is the same as above, though I cannot positively distinguish more than one seta from tubercle v. Perhaps the other has disappeared.

Superfamily **TORTRICINA.**

Family **Grapholithidæ.**

***Carpocapsa pomonella* Linnaeus.**

The setæ are distinct and the tubercles are surrounded by corneous areas. Tubercles iv and v arise from the same area, while the setæ of vii, three in number, are without a corneous area. The other tubercles are single, normal.

Family **Tortricidæ.**

***Caccoclia cerasivorana* Fitch.**

The tubercles are quite large, having apparently occupied most of their surrounding corneous areas, and suggest to us the origin of the warts of the Pterophoridæ, though the setæ are not increased in number. Tubercles iv and v are consolidated into a single wart. The large prothoracic dorsal shield is very distinct.

***Lophoderus politana* Haworth.**

The setæ are distinct, but the tubercles obscure. Tubercles iv and v are not very closely consolidated. The arrangement is quite normal. In all these larvæ we note that the 9th and 10th segments of the abdomen are separated by a well-marked division.

Superfamily **TINEINA.**

In this group we reach the highest degree of modification in the line of abortion of tubercles, setæ, and other normal body structures. Here specialization has taken the course of degeneration. Since we have at least four different lines of descent among the Generalized frenulum conservers, I cannot arrange the families in a satisfactory

serial order. Strictly the Tineina larvæ are more specialized than those of the two next families, and should follow them.

Family **Gelechiidæ**.

Depressaria heracliana DeGeer.

The tubercles are situated in large, polished, black corneous areas, and the setæ are aborted, except subventrally. The arrangement is normal; iv and v are closely approximated, and arise from a single area, while the setæ of vii are gathered together on a single black area, forming a rather distinct wart. There is a single cervical shield, and a distinct suture between abdominal segments 9 and 10

Family **Elachistidæ**.

Antispila nyssæfoliella Clemens.¹

There is a single cervical shield, a small projecting anal plate, and the body is flattened. A few setæ remain subventrally, but the tubercles have disappeared, as have also all the feet.

Family **Lacosomidæ**.

In 1893² I attempted to show that this group must be separated from the Psychidæ and the Drepanidæ, with both of which it had previously been united. I was unaware at the time that C. Plötz³ had already established the family under the name Perophoridæ; but the name is preoccupied. A little later Dr. Packard⁴ recognized this difference so far as to create a subfamily of the Psychidæ, where he transformed my term into Lacosominæ. In the same year (1893) Prof. Comstock's article appeared, in which the Lacosomidæ (= Perophoridæ) are included among the Saturniina, in the highly specialized group of Frenulum Losers. I had never seen the larvæ; but, through the kindness of Dr. Packard, I have now been able to examine both of our species, and Prof. Comstock has given me a Brazilian form. From these larvæ I conclude that this family belongs to the Microlepidoptera, as here set forth, a conclusion which is contrary to any previously offered.

¹ Dr. J. A. Lintner has kindly determined this larva for me.

² Entom. News, IV, 36.

³ System der Schmetterlinge (1885).

⁴ Journ. N. Y. Ent. Soc., I, 8.

***Cicinnus melsheimeri* Harris.**

A single cervical shield; body granular; feet normal, the abdominal ones very short. Spiracle on 8th abdominal segment higher up than the others. Anal plate very large, covering the feet, continuous with a hardened area on the posterior part of the 8th segment, bounded in front by a transverse elevated fold. Setæ fine, short, very obscure so that their position could not be accurately determined; but apparently as in the following:—

***Lacosoma chlidota* Grote.**

A single cervical shield, but its distinctive coloration extends back on the posterior thoracic segments; feet normal, the anal plate scarcely enlarged. Body smooth, the setæ arising from distinct tubercles; i anteriorly, ii posteriorly, only a little below i, iii superstigmatal, a little anterior, iv and v in line subventrally, vi above base of leg, vii consisting of several hairs on the base of leg, and viii single, distinct on the apodal segments.

Family Sesiidæ.

The Sesiidæ (= *Ægeriidæ*) have usually been classified next to the Sphingidæ, and this course is still followed by Dr. Packard. Less conservative authors have reached the conclusion that this is erroneous, and Mr. W. F. Kirby has omitted the family from his "Catalogue of Sphinges and Bombyces." A study of the larvæ fully confirms this view, and I would place the family among the Microlepidoptera. Prof. Comstock has kindly given me four larvæ.

***Sannina exitiosa* Say.**

The tubercles are very small, but distinct, and all bear setæ. Tubercles iv and v are closely approximated, one being situated immediately above the other. There are two distinct substigmatal folds or ridges, each with two corneous patches. On the upper one, iv and v are in the anterior patch, and on the lower vi is in the posterior patch. The three tubercles of vii are on the anterior side of the base of the leg. Segments strongly folded, biannulate. A distinct suture between segments 9 and 10.

***Harmonia pini* Kellicott.**

In this species the setæ are much reduced, but the tubercles have large, conical, corneous bases, so that they suggest low warts. Iv and v are on the same elevation, and the three tubercles of vii are in an oblique row as in the *Hepialidæ*. The larva is, otherwise, very similar to the preceding.

***Sesia tipulliformis* Linnæus.**

The tubercles are small and the setæ fine, arising from slight corneous elevations. There is an elevation just behind the spiracle, and two others on the substigmatal folds, without setæ, while tubercle iv is very minute, though situated on the same elevation with v. The general arrangement is somewhat deceptive at first sight, especially owing to the minuteness of some of the tubercles.

***Melittia ceto* Westwood.**

The tubercles are very small and obscure. In fact most of them seem to have disappeared. I was able to locate the position of i and ii, and there are traces of the corneous areas which the others occupied; but they are all very degenerate. The larva is plump and smooth, without any distinct annulets on the segments.

Family Pterophoridae.¹

We now come to a new line of modification, where the tubercles have become converted into many haired warts. I could not obtain any larvæ of this family, and my old notes are not sufficiently full, though they indicate the conclusions expressed in my synopsis. A careful study of this family would be full of interest, and I hope to be able to make it.

Family Pyromorphidae.²

I take the following from my notes. It shows essentially the same structure as in the two following families, though we have no poisonous spines and the feet are normal.

¹ Mrs. Knopf has examined and sent me sketches of the tubercles of the larvæ of three European species, with the kind assistance of Mr. G. A. Ponjade, of the Natural History Museum of Paris. In all the species there are single setæ only, without any development of warts, and in two they are all very degenerate. In the third, *Leioptilus scarodactylus* Hübner, the setæ are all quite well developed, and tubercle i is wanting, as in the American form with warts, referred to above.

² The European family Anthroceridae, Kirby = (Zygænidæ of authors), should come just before the Pyromorphidae. I have examined the larva of *Anthrocera filipendule*. The tubercles are converted into warts, but the warts are greatly reduced, being represented by tufts of short hairs. Tubercle i is absent, iv and v are consolidated, and vii is very distinct on the base of the leg. Here we have direct evidence of the continuity of this series of families with the ancestors of the Pterophoridae and allies.

Harrisina amerloana Harris.

Head retracted and concealed beneath the prothoracic segment. Body flattened, sides nearly perpendicular with a distinct substigmatal ridge. Four rows of low, flattened areas, representing warts, granular, and bearing numerous, radiating, short, fine bristles, and a few longer whitish hairs from the extremities of the body. Tubercles arranged (1) subdorsal, (2) lateral, (3) substigmatal, and (4) obscure, above the base of the leg.

Family **Megalopygidæ**.

The arrangement of the tubercles is the same as in the Pyromorphidæ. The two additional pairs of abdominal feet, unique in this family, have long been known. They were carefully described by J. C. Sepp in 1830¹ in the case of *Megalopyge xanthopasa* and *M. lanata*, and have recently been noticed by several authors. In the case of our native species, *M. crispata*, Dr. Packard, in a recent paper² gives a general summary of these structures with some excellent figures. He concludes thus: As to *Megalopyge* "with its rudimentary abdominal legs of the 2d and 7th segments of the hind body, we feel warranted, in the present state of the subject, in concluding that they may represent a persistent condition of two pair of these deciduous abdominal legs" (which appear in embryonic development). From this assumption he very naturally concludes that *Megalopyge* "in respect to its abdominal legs, even if we do not take into account other characters, is a survivor of an ancient and very generalized type, and represents, as no other known caterpillar, the polypodous ancestor of all Lepidoptera." Of course this conclusion is entirely opposed to my view of the relationship of the *Megalopygidæ*, and I cannot accept Dr. Packard's assumption. I regard the development of these additional abdominal feet as secondary. This family distinctly leads up to the *Eucleidæ*, and this structure shows us how they probably derived their peculiar mode of progression; for an extension of the modification of the ventral surface which has here begun, would give us the slug-like structure of the *Eucleidæ*, the most remarkable of all Lepidopterous larvæ.³

¹ Surinaamsche Vlinders, vol. I, expl. to pl. 14.

² Proceedings Amer. Philos. Soc., vol. XXXII, pp. 275-292.

³ Dr. Packard has stated in several publications that the *Eucleidæ* (= *Limacodidæ* = *Cochliopodidæ*) have no thoracic feet. This is an error; the feet are distinctly present, though small.

Family **Eucleidæ**.

In the most generalized forms we have only two rows of tubercles present, the subdorsal and superstigmatal; the substigmatal row seen in the two preceding families having here disappeared. But there are two very different lines of modification in the family. In the first the tubercles are retained and prolonged into fleshy horns, while the setæ have been modified into poisonous urticating spines. This is accompanied by the development of bright and gaudy warning colors. In the second line, the tubercles tend to become reduced or entirely disappear, leaving the body smooth, and either colored plain green or ornamented with certain other colors designed for concealment.

I will describe these larvæ in detail.

FIRST GROUP.

Adoneta spinuloides Clemens.

Head retracted under and folded in joint 2,¹ joint 2 partly under 3. Head green, jaws brown, eyes black. Body flattened, rather elongate, the sides nearly perpendicular, but not high, the back flat, of nearly uniform width, but narrowed toward head and rather more so towards tail. Dorsum at joint 3, 2 mm. wide, at joint 7, 3 mm., at joint 12, 2 mm. Lateral region has two rows of irregularly elliptical depressions, between which the body is somewhat ridged with a row of rounded elevations bearing minute spines. They are situated just below the spiracle on joints 3, 4, 6 to 12. Color green, covered with minute transparent granulations. The dorsal region is nearly smooth, the sunken places being represented by small, rounded whitish spots. On each side is a subdorsal row of spinose tubercles, one on each segment 3-13 inclusive, those on joints 3, 4, 5, and 12 longer than the others and colored bright red, those on joint 11 just tipped with red. Dorsal region yellow, containing a broad purple band edged with crimson, of irregular outline. It nearly covers the yellow on joints 3-5, being indented at each pair of tubercles; on 6 and 7 it is much enlarged; contracted at 8, almost to a line; enlarged again at 9 and 10; contracted at 11 and ends in a rounded enlargement on 12. It is divided by a pale dorsal line.

¹ For brevity, in these descriptions, I use the terms common among Lepidopterists, counting the head as "joint 1."

Length of larva 11 mm.; width 4 mm. Thoracic feet very small, pointed, green, tipped with brown. Abdominal feet absent, the whole ventral region flexible and sticky.

Euclea indetermina Boisduval.

Head below joint 2, 2 below 3; thoracic feet small, pale; abdominal none, venter soft and sticky, clear honey-brown. Dorsum and sides flattened with subdorsal and stigmatal series of segmentary horn-like processes, covered thickly with urticating spines. Subdorsal horns on joints 3 to 13, those on 4, 5, 8, 11, and 12 very long, the ones on 3 and 13 moderate, the rest very short, subspherical. Stigmatal row on 3, 4, 6 to 12, short, except the one on 4 which is twice as long as the others. Spiracles round, the one on joint 5 in line with the horns, those on 6 to 12 much below them, the one on 2 usually concealed as the segment is retracted. Head pale, blotched with red on its lower part; ocelli and mouth dark. Joint 2 granular, honey-brown. Body (A) lemon-yellow or (B) straw color, the tubercles (A) yellow, tinged with orange on 3, 6, 7, 9 and 10, or (B) vermillion-red with a red band along the subdorsal line, laterally, along the superstigmatal horns, and along subventral edge. Four narrow, dark purple lines in dorsal space, on a bluish-white ground, the two central ones parallel, the outer undulating to correspond with the locations of the larger horns. Four similar lines in lateral space separated into two pairs by a (A) yellow or (B) vermillion band, only slightly undulating. A similar single pair of lines enclosing the spiracles, the one below them the most distinct and separated from the sticky venter by a (A) yellow or (B) vermillion band. On 13, close behind the superstigmatal horn on 12, is a depressed pale area with purple border. Anterior edge of 3 purplish. Size 18×7 mm. Horns on joint 8, 2.5 to 4 mm. in different larvæ.

Euclea delphini Boisduval.

Elliptical; dorsal region flat, nearly level, and of uniform width, rounded at the extremities; sides nearly perpendicular. Head whitish, labrum and sutures of clypeus yellowish, eyes black. Head retracted under joint 2. Along subdorsal ridge a row of elongate processes on joints 3 to 13, covered with short black spines from conical bases. The horns on 3, 4, 5, 11, 12, and 13 are about three times as long as the others. A similar superstigmatal row; on joints 3 and 4 lateral, none on 5, on 6 to 12 superstigmatal, that on 4 about as long as the subdorsal one, the others of uniform length.

longer and rather more slender than the short subdorsals—all spined. A row of dorsal and lateral depressions, each containing two irregular whitish dots, only appearing distinctly when the body is retracted. Skin covered with very minute, transparent granulations. Spiracles very small, circular, conical, projecting. Body sordid purplish, shaded with blackish, or green; a narrow yellow dorsal line. Subdorsal processes bright ferruginous or yellow, which color extends broadly along subdorsal ridge, interrupted between segments 6-7, 9-10, and 11-12 by a rectangular dark brown spot, the one between 11 and 12 smaller than the others. Lateral processes same color as the subdorsals but paler. Venter colorless, the thoracic feet small. Coloration of larva very variable.

***Euclea pænulata* Clemens.**

I have no notes of my own on this species, and copy those of Prof. G. H. French.¹ "In general outline somewhat elliptical, the sides and back tapering from the middle to both extremities. Length .56 inch (14 mm.), width and height in the middle .25 inch (6 mm.). . . . The body . . . destitute of true feet² . . . a soft pliable membrane covering the ventral surface. General color of dorsal space dull purplish-brown, having, under the glass, a slight orange tinge. A fine dorsal line and a broader one each side, which alternately expands and contracts, of dull purplish-orange. On each joint, except 12, is a pair of impressed spots, which appear whitish when seen in certain lights. In the region of the subdorsum is an orange ridge containing tubercles which are covered with spines . . . of the same color as the ridge, except that between the last two there is a shorter black tubercle without spines. The second and third from each end of the body" [*i. e.*, on joints 4, 5, 11, and 12] "are larger than the others. A similar tubercled ridge . . . in the region of the stigmata. . . . Subdorsal space dull, purplish-orange, bordered above and below with purplish-brown, each joint containing two whitish impressed spots. . . . Below the lower line of tubercles, dull orange. . . ."

***Euclea plugma* Sepp.**

According to Sepp's figure this larva has the structure of the two species just described. The subdorsal horns on joints 3 to 5 and

¹ Papilio, vol. I, p. 144.

² Prof. French repeats Dr. Packard's error in failing to observe the thoracic feet.

11 to 13 are longer than the others, which are about equal. The color is green with a bright vermillion dorsal line, and a white band below the subdorsal ridge, both bordered by a dark shade. The lateral region is of a paler green.

Euclea dicolon Sepp.

This larva is interesting for it differs from the typical structure of *Euclea* (to judge by Sepp's figure) in having the subdorsal horns on joints 6 and 10 shorter than those on 7 to 9, so that they are not shown in the figure. Perhaps, even, they are absent; but anyway we have an approach to the structure of the next genus, *Sibine*. The subdorsals on 3 to 5 and 11 to 13 are as long as the stigmatala. The body is gaily ornamented with streaks and spots of bright red on a green ground, the location of which I cannot positively determine from the figure.

Sibine vidua Sepp.

Sepp figures a larva which seems to be somewhat more generalized than our North American species. The subdorsal horns are absent on joints 6 to 10, but there is another pair of long ones behind those on 11; the lateral horns are long. Body green with a large square dark green patch on the back, broadly bordered with yellow; the horns are all dull purplish.

Sibine stimulea Clemens.

Head beneath joint 2, but 2 not beneath 3; joints 3 and 4 somewhat folded. Dorsum rises nearly perpendicularly in front, rounds over at joint 5, slopes gently and slightly to joint 11, and is then nearly perpendicular to the anus. No subdorsal ridge, the body evenly rounded, but the sides almost perpendicular. On joints 3, 4, 5, and 11 a pair of subdorsal fleshy processes, furnished with round, smooth tubercles, each of which bears a long, stiff spine, salmon colored, black at the end, "stinging." The processes on 3 and 4 are short, those on 5 and 11 very long (5 mm.). A similar row on joints 3-13, just above the spiracles, and absent on 5, all short, with an extra pair at the anus.¹ On 12 above the process, and on 13 posterior to it is an elevated brown structure like a large wart, or like many thick spines very close together, each tipped with a fine black point. Body smooth, with two dorsal and two

¹ In the absence of specimens of the larva, I cannot tell to what this note, made four years ago, refers.

lateral rows of little, shallow, pale colored pits. Color dark purplish vinous; a pale yellow, elliptical spot dorsally on joints 5 and 11 edged with blackish; a much larger similarly colored one on 12 on each side behind the large process; a large bright green patch covers the back and sides of 6 to 10 like a blanket, extending a little on 11 and 12 laterally, and leaving an elliptical patch of the ground dorsally on 7 to 9 like a hole in the blanket. The blanket patch is narrowly edged with black and broadly with white. Spiracles round, elevated centrally, finely radiate, yellowish. Venter whitish, nearly colorless. Thoracic feet small, tipped with brown. Head nearly colorless, black at the sides, mouth brown.

Sibine trimacula Sepp.

In this curious larva the long horns have disappeared, and we find on the corresponding segments rounded, spinous tubercles. The lateral series does not appear in Sepp's figure, and must be greatly reduced, perhaps to merely a fringe of spines. The light green blanket covers the whole of the dorsum and extends forward laterally to joint 4, being without a "hole" centrally, and bordered with yellow. The rest of the body is bright green, the small tubercles only retaining the purplish color. The larva is much less conspicuous than the others of its genus, in correspondence with the marked reduction of its defensive armor. I am unable to understand why Mr. W. F. Kirby should have placed the names of this species and *S. vidua* as synonyms of the same insect (*S. nesea*), as he has done in his catalogue.

Parasa chloris Herrich-Schäffer.

This larva is in a state of transition toward the second group. The tubercles are much reduced, and the color, though rather bright, is quite uniform, so that it is difficult to decide whether it is intended for warning or not.

Outline from above somewhat ovate, the last segment produced into a little pointed tail; dorsal region flat, highest at joint 5, diminishing to the extremities. Subdorsal ridge angulated, not elevated, bearing on each segment after 2 a large round wart covered with spines, those on 3, 4, 5, 11, and 12 large, the rest much smaller. A similar row above the spiracles, all small. The head is retracted within joint 2, and this in turn under joint 3. There is a double row of blackish impressed spots in the dorsal region, and elliptical depressions on the sides; but the skin is nearly

uniform, soft, and smooth. Color greenish-brown, lighter, more reddish posteriorly, shaded on the dorsum with dark orange; a number of indistinct, brighter, waved lines. Venter colorless, bordered by a salmon colored band.

SECOND GROUP.

Phobetron pithecium Abbot and Smith.

In this larva, the tubercles still remain, but the whole organism is modified to resemble a dead leaf. It is the most remarkable lepidopterous larva known to me. Its hairs retain some stinging power.¹ The tubercles are most peculiarly modified; they are extended laterally in the form of long fleshy arms, the tips of which are flexible and execute a certain amount of independent motion; they are strongly constricted at the base, and *are shed by the larva* at the time of forming its cocoon, though not at the molts. Moreover their normal position is altered. Instead of arising from the center of the segment, they are pushed forward to lie apparently between their own segment, and the one anterior. On account of their feeble attachment, they may be lost during the life of the larva through accident, and are not regenerated, as would be the case with hair structures which are formed afresh at each molt.

Head whitish, eyes black, jaws black inwardly. Head below joint 2; but 2 not below 3. Dorsum flat, rounding posteriorly, the sides perpendicular; subdorsal ridge rounded, but bearing a row of ten processes on joints 4 to 13 respectively, arising apparently from between the segments subdorsally, the first between joints 3 and 4. All are curved backward, except the 6th to 9th, which curve forward, though they probably vary in this respect, owing to their power of motion. The 2d and 8th (joints 5 and 11) are longer than the 1st, 4th, 6th, and 9th (joints 4, 7, 9, and 12), and the 10th (joint 13) is very short. The 3d, 5th, and 7th (joints 6, 8, and 10) are very long.² All are furnished with thick short hair, parted in the middle and projecting laterally, and have a tuft of black spines and single long hair at the end. Their bases are swollen below and hairy. From the base of each process above, grows a spreading flattened tuft of fine hair which nearly cover the dorsum. A super-stigmatal row of spined tubercles, three in number on joint 3 (one

¹ See Lintner, 5th Report N. Y. State Entomologist, p. 183.

² In the specimen which served me for these notes the 3d pair had been lost.

representing the subdorsal process), two on joint 4, one a little above the other, none on joint 5, one each on joints 6 to 12. Spiracles small, round. Color of body and processes varying in different individuals from tan color to red or dark brown, like different kinds of withered leaves. Below spiracles, nearly white; venter clear pale yellow, semitransparent. Thoracic feet small, colorless.

Are these fleshy arms intended to come off in the grasp of an enemy, like the tail of a lizard, whereby the larva may escape injury, even though it be detected in its simulation of a dead leaf?

In respect to the number of tubercles and their armature, *P. pithecium* is the most generalized larva of the Eucleidæ, the nearest to *Megalopyge*.

Phobetron tetradactylum Walsh.

If the observations of Walsh are not founded upon error (of which I am by no means convinced) we have another species of *Phobetron* in this country which has escaped the notice of entomologists. Walsh says: "These larvæ were much larger than that of *hyalinus*" (which means nothing, as *hyalinus* is the ♂ of *pithecium*, and consequently small). "They agreed with it in having apparently nine pairs of appendages, the last pair very short; but they had only the 3d and 6th pairs projecting beyond the others, and both these pairs were curved backwards, with the extreme tips of each slightly hooked forward." I have shown that the direction of curvature of the arms cannot be relied upon, and it remains to be determined what is the range of variation in the proportionate lengths of the several pairs of arms before we can pronounce on Walsh's species.

Slayrosea inornata Grote and Robinson.

Here also the tubercles remain; but the hairs are soft and without stinging power. The larva is colored for concealment.

Head pale green, eyes black, jaws brown; head under joint 2, 2 under 3. Body much flattened, elliptical, dorsal region flat, rising but little, narrowest centrally and widening to the extremities; sides sloping. Around the lateral region the body projects and bears a row of flattened, elongated, triangular, pointed projections, fringed on their sides by spines each tipped with a hair. The first of these projections is on joint 3 at the beginning of the subdorsal ridge, which, with the one on 3 laterally and 4, is red with black spines. (There is one on 3 subdorsally, another small one on 3 laterally, one on 4, none on 5, one on 6, but no gap as joint 5 is contracted at

base, its spiracle a little lower than the others). The other tubercles are pale green with white spines, the last one being on joint 13, longer than the others, and placed at the end of the subdorsal ridge. Along this ridge is a row of similar, but much smaller processes, projecting laterally and situated on joint 3 posteriorly, 4 posteriorly, none on 5, one on joints 6 to 12 inclusive centrally, color green or yellowish, the spines pale. The process on joint 13 really forms part of both the subdorsal and stigmatal rows.¹ The body segments, especially laterally, are a little elevated on their anterior edge, and contain a double dorsal and two lateral rows of small, whitish, impressed spots. General color light green; on the lateral area this color obtains only on the elevated portions, as seen by a lens. A distinct yellow line along the subdorsal ridge connected by a yellow spot on 9 anteriorly, which contains a red dot. In another larva two red dots on joints 9 and 11. Laterally, the elevated portions of the segment surround the spiracle and send off a ridge to the posterior edge centrally. In the two spaces thus formed are two elevations, depressed centrally, the upper slightly kidney shaped, the lower circular. A double dorsal row of impressed spots. Thoracic feet blackish, venter colorless.

***Tortricidia pallida* Herrich-Schäffer.**

This larva is entirely smooth, but has retained a bright red dorsal patch, which now does duty to give to the larva a deceptive resemblance to a red patch on a leaf.

Head retracted beneath joint 2, 2 beneath 3; greenish testaceous, mouth brown, ocelli black. Body elliptical, the sides sloping from a slight subdorsal ridge, contracted between joints 12 and 13, giving the last segment a square appearance. Color bright green, the dorsum largely covered by a patch of salmon color or purple-brown, bordered by a crimson line and a yellow shade. It begins somewhat broadly above the head on joint 3, narrows at once to a dorsal band on joints 4 and 5, widens twice, the second time passing down to the subventral edge of the body at joint 8, then narrows twice and tapers to a point at the anal extremity. The body is covered, very minutely, with transparent granulations. The usual elliptical depressions are hardly distinct, smooth, whitish in the dorsal patch, and containing a dorsal and lateral row of blackish spots. Length 9 mm.

¹ There are thus three less tubercles in *Sisyrosea* than in *Phobetron*: viz., the third one on joints 3 and 4, and the subdorsal one on joints 5 of *Phobetron*, are wanting in *Sisyrosea*.

Tortricidia minuta Reakirt.

Unknown since 1864, so far as I am aware. It is to be hoped that some one may find it again. Reakirt says: "Length 2-2½ lines" (about 4-5 mm.); "basal outline elliptical; a flattened ridge widest at the center [= dorsal area] extends from head to tail, curving over vertical elevations at the sides, which gradually diminish before and behind, and terminate at both ends in a rounded margin. Around the base, a row of small, densely spined papillæ" [lateral tubercles retained?], "two of which on the head" [meaning joint 3?] "are the most prominent and colored yellow. The body is smooth, but the ridge [dorsum] is thrown into thick fleshy folds; it is thickest in the middle, whence it diminishes anteriorly and posteriorly. [Color] green; two bright red lines of equal length, cross each other at right angles on the central portion of the upper ridge"

Tortricidia fasciola Herrich-Schäffer

Outline elliptical, contracted between joints 12 and 13, joint 13 forming a square projection. Dorsal region flat, arched over; subdorsal ridge slight, serving to separate the dorsum from the sides which laterally form a decided ridge, below which the body again contracts to venter. Head retracted under joint 2, 2 under 3. Body thickly covered with transparent elevations, which appear somewhat flattened on the dorsal region. Color pale yellowish-green; a yellow line on each subdorsal ridge and on the stigmatal ridge, all meeting on joint 13, and the two subdorsal lines also meet anteriorly by a connecting line on joint 3. A dorsal and a large and a small lateral row of dark green spots, surrounded by yellow, besides a row of yellow dots on each side the line on the subdorsal ridge, along which the green predominates in round, somewhat elevated spots. Below the stigmatal ridge is a row of green spots, surrounded by white and resting just above the white band bordering the colorless venter. There are certain minute, pale, setæ to be distinguished on the ridges by the aid of a lens.

Apoda y-inversa Packard.¹

Head green, mouth parts dark brown, eyes black; retracted below joint 2, which is in turn retracted below 3. Body elliptical, tail

¹ These larvæ I have found several times, but never bred. The name is an assumption. They may be *A. biguttata*, or possibly *Heterogenea fleuosa*, though I do not think it likely.

quadrate, sides sloping, the subdorsal angle about 75° ; dorsum narrowing before and behind, evenly arching. Watery granular, whitish-green (not yellow), the pigment lying below the surface. A subdorsal white band along the ridge, edged above with blackish-green. Dorsal and lateral blackish impressed spots, seen distinctly only centrally. The subdorsal lines approach each other closely at the extremities. Spiracles white, brown centrally; a subventral white line. Thoracic feet small, tipped with brown. Venter smooth, clear, colorless, translucent, without legs. Length 15 mm.; width 8 mm.

***Packardia geminata* Packard.**

Body elongate elliptical, sides nearly perpendicular, slightly ridged above the spiracles; dorsal region flat, highest at joint 7 and sloping each way; subdorsal ridge moderately prominent, straight; joint 13 prolonged into a pointed tail very faintly marked with reddish toward the end. Along each subdorsal ridge is a series of little conical tubercles (seen with a lens), two per segment, close together and each bearing a very short seta; a similar row along the superstigmatal ridge, but single and smaller, and the setæ even shorter and finer than those on the subdorsal ridge. A series of dorsal and lateral depressions, not distinctly different from the rest of the body in structure or color, though the lateral ones are slightly darker. The body is thickly covered with little transparent granulations. Color pale, decidedly whitish green (not yellowish), a white line along the subdorsal ridge bordered above with dark green, the lines obsoletely connected on joint 3, but not passing on to the tail. A row of obscure white dashes along the superstigmatal ridge, looking as if beneath the surface of the skin. Spiracles small, round, projecting, white. A faint whitish line separates the clear colorless venter from the sides. Head pale green, the mouth parts largely dark brown. It is retracted below, and folded within joint 2, which has the spiracle somewhat flattened. Length of larva 14 mm., width 6.5 mm.

***Packardia elegans* Packard.**

Head retracted under joint 2; joint 2 partly under joint 3; dorsal region narrow; body highest at joint 7, rounding to the extremities. Subdorsal ridges distinct, not raised, segmentally undulate, approaching each other posteriorly and marked with a yellow line which begins on joint 3, not joining over the dorsum. Sides nearly

perpendicular, a little sloping and bulging superstigmatically, but not forming a decided lateral ridge; joint 13 produced into a rather long, narrow, pointed tail, marked with reddish-purple above. Body closely covered with small transparent granulations; color light yellowish-green, dorsal region dark green, with a small dorsal dot on each joint (joints 6-11) largely surrounded with pale yellowish-green, reaching to the subdorsal lines except on joint 11. Sides nearly uniform yellowish-green; above the lateral bulge is a segmental row of depressed darker spots, beginning on joint 4 and becoming indistinct after joint 9; on the lateral bulge a row of yellowish spots on joint 6-9. Spiracles white, small, round, conically elevated. A white line borders the venter, which is colorless. Thoracic feet small, abdominal ones wanting, as usual in the family. Head green, jaws brown, ocelli black. Length of larva 11 mm., width 5.5 mm., height 3.5 mm.

The subdorsal and lateral ridges have traces of tubercles, not elevated, but a little smoother than the rest of the body, bearing very minute short setæ, just perceptible with a lens in certain lights.

***Eulimacodes scapha* Harris.**

Head retracted under the fleshy folds of joint 2, joint 2 under 3. Body highest at joint 7, the dorsum rounding over rapidly to head and tail. Sides perpendicular, sunken in the middle. Subdorsal ridge sharp, elevated; dorsum flat; joint 13 produced into a pointed tail. The ridge on each side, at joints 7 and 8, is elevated into a rounded, smooth process, or there may be only one process or none. Body segments not well distinguished; on the sides joints 3 and 13 have one, 4 to 12 two (one above the other), smooth, irregularly elliptical plates; on dorsum joints 3-13 have each a plate, hexagonal, transversely elongate, as wide as the dorsum, the angles between the successive plates filled in with little triangular pieces. Between the dorsal and lateral series of plates the skin is closely scaled. Body smooth, the scaled part shining. Color green, a large round white spot on the subdorsal ridge on joint 10, or there may be two or even three of these spots. Usually there is only one prominence on the subdorsal ridge, viz., on joint 7. The body is often all green with a narrow yellow dorsal line, or the back or sides in patches or even very extensively marked with brownish cream color on the plates, and dark brown mottlings on the scaled parts. These markings are not quite alike in any two individuals. Spiracles pale whitish. Thoracic feet minute, abdominal feet absent, the venter

sticky and transparent. A broad white band separates the transparent venter from the green sides. Head of a whitish color, jaws brown. Joint 2 transparently granulated and marked with brown.

THE SPECIALIZED FRENATÆ OR MACROLEPIDOPTERA.

First Division (corresponding in a general way to the Specialized Frenulum Conservers of Comstock).

The most primitive form of arrangement of the tubercles is seen in that great group including the Noctuidæ, Notodontidæ, and their allies. The tubercles are simple, single haired. Tubercles iv and v are well separated, iv tending to become situated just behind the spiracle. The setæ of vii are never consolidated into a distinct wart, but the three hairs are scattered on the outside of the leg, or on the chitinous leg plate, which is frequently developed. The two subventral tubercles are thus v and vi, instead of vi and vii as in the Microlepidoptera, and appear to be situated the upper *anterior*, the lower *posterior*.

Specialization begins in a multiplication of the number of hairs on each tubercle; but right here there arises a new line of modification. It consists in the presence of hairs arising from very minute tubercles all over the body. We shall see this modification again in several different lines of descent; but it probably reaches its maximum among the Notodontidæ in *Apatelodes torrefacta*. Here it has replaced the process of multiplication of hairs on the tubercles, which seem to be still single haired. The result of this process in our *Apatelodes angelica* and in the South American genus *Rosema* is the production of a structure closely like that of the Lasiocampidæ.

Several different modifications of the legs among the most generalized Macrolepidoptera may now be noticed. The first consists in the abortion of the two anterior pair of abdominal legs as seen in the lower Noctuidæ, followed by the complete removal of the three anterior pair as in the Geometridæ, resulting, of course, in a looping method of progression. It may be noticed, in passing, that this modification is much more strongly presented in certain Noctuids in the first larval stage (embryonic larva) than later in life, which might lead to the conclusion that the Noctuidæ were descended from geometrid-like ancestors, if we regarded the first larval stage as always representing a generalized condition. This conclusion would be, evidently, the reverse of the truth, as the specialization in the

first stage is for the purpose of giving to the little larvæ a very rapid method of progression, enabling them to quickly disperse and find the food of which they have immediate need.

The second method of modification of the feet is illustrated by the *Drepanidæ*. It consists in the abortion of the last pair of feet with an enormous hypertrophy of the anal plate as shown by Dr. Packard,¹ resulting in the production of a new means of defense.

The third modification consists of the lengthening of the last pair of feet and their conversion into repellant organs by a peculiar development of the extensile part of the end of the foot, whereby it becomes a long eversible flagellum. All stages in this process are illustrated among the *Notodontidæ*. Here again we may note that in the genus *Macrurancampa*, the modification of the feet reaches its greatest development in the first larval stage, where they are longer than the body of the larva, again a special adaption to the fearful struggle to which these newly born larvæ are subjected.

We now pass to the second group in which the tubercles are many haired. This probably includes all the remaining families of the *Macrolepidoptera*. In some, however, modification has progressed so far that the tubercles are entirely lost, and, in the absence of generalized genera, it is impossible to be certain from which type they were derived. The *Lithosiidæ* show the beginning of the modification in that several of the tubercles bear two hairs. Then follows a series of families in which the tubercles are converted into warts. The hairs are at first simple or finely cleft; but in the higher families, especially in the *Phægoteriniæ*, *Lymantriidæ*, and *Euchromiidæ*, they are developed into various brushes, tufts, and plumes. This is the highest degree of specialization in this line, and is accompanied by an irregular reduction of the warts. In the genus *Nola* of the *Lithosiidæ* we have an extreme of unequal reduction, similar to that in the *Lycænidæ*, and accompanied with the loss of the anterior pair of abdominal feet.

Family *Noctuidæ*.

Achatodes zæa Harris.

I have examined a larva prepared by Mr. Wm. Beutenmüller. The tubercles are surrounded by large black areas: i anteriorly, ii posteriorly, iii lateral, a minute spot before the spiracle, iv behind and at base of spiracle, v anteriorly, and vi posteriorly subventral.

¹ Proc. Boston Soc. Nat. Hist., XXIV, 484.

A large black leg-shield. Tubercles vii and viii appear ventrally on the legless segments.

Acronycta sp.

An undetermined larva occurred to me at Woods Holl, Mass. The tubercles are represented by large hairy warts arranged as above, except that iv, posterior to the spiracle, is much smaller than the others.

Family **Agaristidæ**.

Alypia octomaculata Fabricius.

Body enlarged at joint 12 (8th abdominal segment) with low conical tubercles, smooth, not shining nor granular, each bearing a single pale hair, and arranged perfectly normally; iv rather small, behind and a little below the spiracle. No other hairs.

Family **Lithosiidæ**.

Sarrothripa revayana Scopoli.

No warts nor tubercles perceptible, but the single hairs are arranged in the same manner as the warts of the Arctiidæ; row iv is just below the stigmatal line, the hairs each a little back of a spiracle; v anteriorly . . . in the subventral space (Psyche, vol. VI, p. 260).

Tyria jacobææ Linnæus.

A prepared specimen at the American Museum of Natural History. Tubercle i anterior, ii posterior, iii lateral, iv stigmatal (posterior) small, v subventral, vi subventral posteriorly with *two hairs*, vii with *four hairs*, viii with one hair.

Nola minuscula Zeller.

First wart (ii) very large, oblong as if of two coalesced, second lateral (iii), third subventral (v), also large, and fourth (vi) very small, also subventral. Warts bearing spreading, long, thin hairs (see Psyche, vol. VI, p. 248).

Family **Notodontidæ**.

Heterocampa manteo Doubleday.

Single setæ, arising normally. Tubercle iv is behind and below the spiracle.

***Pheosia dimidiata* Herrich-Schäffer.**

I have shown how the setæ of i are borne on the base of the fleshy horn on 8th abdominal segment and are not united (see *Psyche*, vol. VI, p. 194).

All the species of *Datana* and *Ichthyura* illustrate the secondary hairs arising from the skin.

Family **Geometridæ.**

***Calocalpe undulata* Linnæus.**

Corresponding to the absence of legs on so many segments, and the consequent exposure of the ventral surface, we find the three tubercles of vii well separated, and each as well developed as any other on the body. The arrangement is: i at anterior third of segment; ii at posterior third and a little lower down; iii lateral, anterior; iv some distance behind the spiracle opposite its lower edge; v before the middle on the substigmatal ridge; vi anterior, subventral, nearly in line with vii a; vii b posterior, vii c anterior, and viii again posterior, each a little nearer the midventral line than the preceding one.

Family **Drepanidæ.**

***Oreta rosea* Walker.**

This little larva has lost all trace of tubercles. It is granular, the segments annulate, with a large unpaired process dorsally on the metathoracic segment.

***Platypteryx arcuata* Walker.**

I have not had this larva for special examination. It occurred to me in Plattsburgh, N. Y., on the black birch and alder; but I have apparently fallen into some error in my notes in regard to the tubercles. Still, I give them, as they show tubercle iv to be in the required position.¹

Head higher than joint 2, bilobed, subquadrate, sutures distinct; sordid whitish, the small clypeus red-brown; two dark red-brown, arcuate, concentric bands cross the head transversely, the lower from

¹ In correcting the proof I am able to explain the apparent anomaly. I have found a dead larva in an old cocoon. There are several secondary hairs developed, one of which is very distinct, situated near tubercle iii, the others subventral. My notes are correct, except that I did not mention tubercle vi, which is present posteriorly, subventrally. The arrangement is the normal one of the *Macrolepidoptera*.

the ocelli over the clypeus, the upper across vertices of lobes; ocelli black; some long pale setæ from minute tubercles; width about 1.8 mm. Body thick, slightly flattened, of nearly even width, but the last segments tapering. Anal feet absent, the suranal plate produced into a conical, rounded process as long as the plate. Tubercles mostly small: 1 anterior, 2 posterior, 3 and 4 lateral in line [?], 5 stigmatal posteriorly [= iv], and 6 substigmatal [= v]. On joints 3 and 4 there are 1 to 3 near together, 4-5 in line, 6-7 in line subventrally, and more on base of foot, each with a single, long dark seta. On joints 3-4, tubercle 2 is red, elongate, 3 is black, giving the appearance of horns when there are none. Color light green, whitish ventrally. A purplish subdorsal band, the dorsal space filled in with purplish from joints 5 to 13. There is some variation in markings.

Family **Arctiidae**.

The tubercles are converted into large warts bearing many hairs. I have frequently referred to the arrangement.¹

In the subfamily *Phægoterinae* tubercle iv becomes small.

Family **Pericopidae**.

Gnophæla vermiculata Grote and Robinson.

From the descriptions by Mr. D. Bruce² and Mr. T. D. A. Cockrell,³ I infer that the tubercles do not differ from those of the *Arctiidae*. These descriptions are among the very few that have been of any service to me in the present investigation, and I am duly grateful for them.

Family **Euchromiidae**.

The tubercles are like those of the *Arctiidae*, as may be seen by referring to my descriptions in *Insect Life*, vol. II, pp. 360-362. Many of the species have tufts of hair as in the next family.

Family **Lymantriidae**.

I have described so many of these species that I will not take up space here. I refer to the pages of *Psyche*. I would, however,

¹ See *Entom. Americana*, vol. VI, p. 74 (1890). The numbers correspond with those now adopted, except that (7) includes vii and viii.

² *Entom. Americana*, vol. IV, p. 24.

³ *Entom. Americana*, vol. V, p. 57.

again call attention to the fact that tubercle iv is large and well developed in *Porhetria dispar*, the "gypsy moth;" but very small in our native species of *Notolophus* (= *Orgyia*).¹

Family Lasiocampidæ.

This family, which closes our first division (unless the alternative view which I will suggest for the position of the Sphingidæ be adopted) has pursued a different line of development. The warts have become reduced even to obliteration, and are largely replaced by hairs arising from the skin. But these have made no great advance in many species, owing to the fact that the larvæ may be protected by their resemblance to the bark of trees on which they rest.

I am struck by the fact that Mr. W. F. Kirby has placed the Notodontian genus *Apatelodes* among the Lasiocampidæ.² Now the larva of *A. angelica* bears a most striking resemblance to many Lasiocampid larvæ, though probably a fallacious one. But, as this larva is, without doubt, unknown to Mr. Kirby, I am at a loss to understand his reference. Is there a closer relationship here than appears at first sight?

Clislocampa pluvialis Dyar.

This larva seems to exhibit, imperfectly it is true, the location of all the tubercles. I have received some nicely prepared examples from Prof. O. B. Johnson. Tubercle iv is shown just behind the spiracle in Fig. 6; but there will be noticed two additional ones on the anterior annulet. It is difficult to make out anything positively owing to the extreme reduction of the tubercles and the considerable development of the body hairs. This is the most generalized Lasiocampid which I have seen.

FIG. 6.—A segment of *Clislocampa pluvialis*.

Tolyte vellea Stoll.

There are two hairy warts, corresponding to ii and v, with another lateral row on the thoracic segments. There is a dorsal prominence on the 8th abdominal segment, which bears the two tubercles i of each side.

¹ See my description in Proc. Boston Soc. Nat. History, vol. XXVI, p. 155.

² Cat. Lep. Het., vol. I, p. 851.

***Artace punctistriga* Walker.**

The arrangement is the same. The larvæ which Dr. Packard has kindly loaned to me are very small and the structure is difficult to make out.

***Heteropacha rileyana* Harvey.**

A slight bump on the 8th abdominal segment like a small fleshy horn. No tubercles, except on the prothoracic segment where there are traces of three on each side.

***Phyllodesma americana* Harris.**

There are no tubercles. There is a dorsal prominence on 8th segment, and the subventral region is hairy.

The Second Division (corresponding partially to the Frenulum Losers of Comstock).

This division shows the most varied forms of modification, which would require too much space to describe in detail. We see exhibited nearly all the higher modifications of the tubercles previously described, and in addition certain new ones. These have been already referred to. There is one set of characters which we do not find largely developed in any family of the Frenulum losers. This is the great development of hairs illustrated by the *Arctiidae* and allies.

In the present division the feet are not modified. I know of no instance in which they have departed from the primitive type or been modified for any other purpose than their natural one. There are, however, several instances of highly modified eversible glands. These structures are met with in various families throughout the Frenatæ; but, as they are clearly not the homologues of tubercles, it is not within the scope of this paper to enter into a discussion of them.

Family *Lyœnidae*.

Judging from W. H. Edwards's figures,¹ the structure of the tubercles is essentially that of the highest Microlepidoptera and of the *Lithosiidæ* (genus *Nola*). I have, at present, no evidence showing from which type it has been derived. Mr. Edwards figures *Lemonias nais* as a very hairy larva with apparently three rows of

¹ Butterflies of N. A., vol. II.

warts. In *Lycæna pseudargiolus* all the warts have disappeared and the larva is highly modified. It is a pity that Mr. Edwards's plates do not show the tubercles in more detail.

Family Papilionidæ.

These are among the most generalized of the Butterflies. We can see in the younger stages of many species round spinous warts representing nearly all of the tubercles, though usually i and iv have disappeared.¹ In the adult larva the tubercles have disappeared; but they may be represented by spots or long fleshy horns.

Family Nymphalidæ.

There is a remarkable range of variation in this family. *Danaïs archippus* shows a structure allied to that of *Papilio philenor* in its long fleshy horns. In *Apatura* and in the *Satyrinæ* the tubercles are absent after the first molt; and in *Liminitis* and *Heteroche-roa* the body is covered with a whole mass of secondary tubercles and spines. In the genera represented by *Heliconius*, *Argynnis*, and *Vanessa* we have an entirely different arrangement. Tubercle i is consolidated into a single unpaired process on the dorsal line. In the mature larva there are usually only four processes: (1) dorsal, unpaired, (2) subdorsal, (3) lateral, and (4) substigmatal; but in the first stage of *Melitrea phæton*, Gruber² shows four processes besides the dorsal one, i. e., only tubercle iv lacking.³

Family Pieridæ.

In this family the tubercles are gone, the body covered with fine short hairs. I have not examined the tubercles which are present in the first stage. Edwards's figures only indicate them.

Family Hesperidæ.

As in the Pieridæ the tubercles are gone. The form of the larvæ is characteristic, with large head and small prothoracic segment.

¹ See article by A. Gruber in *Jena. Zeit. für Naturwissenschaft*, vol. XVIII, pp. 465-489 (1884).

² *Ibid.*

³ In *Heliconius* and in *Argynnis diana* the whole row of unpaired dorsal processes is lacking. A whole article might profitably be devoted to the variation of the tubercles of Nymphalidæ.

Superfamily SATURNINA.

We have an unpaired dorsal tubercle on both the 8th and 9th abdominal segments, the first corresponding to i, the second to ii, as tubercle i is not present on the 9th segment. The Citheroniidæ is the most generalized family, tubercles i (on 8th abdominal segment), ii, iii, v, and vii being present in *Citheronia splendens*. In the other genera the number of tubercles on the 8th segment is reduced, usually by the removal of ii; but in *Anisota*, i has disappeared. It should be understood that I exclude the Lacosomidæ from the Saturnina; otherwise I accept Prof. Comstock's arrangement.

Family Sphingidæ.

The position which I have assigned to this family is only tentative. The larvæ are so highly specialized that it is very difficult to get any clue to their relationship. The only trace of the tubercles that is left, is the "caudal horn," an unpaired dorsal process on the 8th abdominal segment. The view which I have adopted here, that this horn represents the consolidated tubercle i of the Saturnina has no more to support it than the other view that the horn represents the base of the unconsolidated pair of tubercles i, the tubercles themselves having disappeared. The tendency to the formation of this structure has been referred to in the case of the Notodontidæ and Lasiocampidæ. This view would place the Sphingidæ at the end of the Frenulum Conservers, next to the Lasiocampidæ in my table; and I wish to state that, as far as I am able to judge from the mature larvæ, either position is equally supported.¹

¹ The larva in stage I, which I have excluded from consideration, is figured by Weismann in the case of the European *Deilephila euphorbiæ* (Studies in the Theory of Descent, Pl. V, fig. 38), and setæ are present. Unfortunately, the figure appears to have been made without sufficient care as regards the arrangement of the tubercles. There is no description except: "on each segment there are a number (mostly ten) of small warts, each of which emits a single bristle." The figure represents all the tubercles present except iv, though v and vi seem to be situated too high. On abdominal segment 8, the two setæ of tubercle i are borne on the apex of the caudal horn. If the structure of this embryonic larva is to be trusted, the conclusion seems irresistible that the alternative position which I suggest for the Sphingidæ is the proper one, and not the one which I have adopted above, following the conclusions of Mr. A. R. Grote (Canad. Entom., vol. XXII, p. 15), and of Prof. E. B. Poulton (Trans. Ent. Soc. London, 1888, pp. 568-574).