

## A STRUCTURAL STUDY OF THE CATERPILLARS.— II. THE SPHINGIDAE.

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In the caterpillar stage the SPHINGIDAE may be defined as follows: With secondary hair on the body, epicrania, front, clypeus, maxillae and labium, but never on the antennae or distal parts of the maxillae and labium. There is almost always secondary hair on the adfrontals. It is present on the mandibles in *Cressonia* only, and the labrum bears a single additional hair in *Pachysphinx*. Front not more than half the height of the head (measuring here and elsewhere in this paper from the base of the front to the vertex. The frontal punctures are close together, and when distinct the primary setae are somewhat further from them than they are from each other, but they are distant from the outer edge of the front. The lobes at the two lower outer angles of the front tend to be large. Adfrontals not very wide, often narrow, not extending between the clypeus and mandible when distinct in the lower part; puncture a little below the upper seta. Clypeus narrow in the middle, often grading into the membrane below. Labrum well marked, often with very deep notch; vi distant from the margin, and usually directly below ii. Mandible with a large scrobe, bearing the two usual setae, one at the tip, and the other about half way out, toward the posterior side. Antennae with second joint most often twice as long as the first; the remaining joints exceptionally minute. Maxillary palpi stout, the second joint somewhat shorter than the first; submenta ill-defined, and mentum broad at the base. Spinneret broad, flat and short, with the usual three sclerites; labial palpi similar in form, and set obliquely to it, forming with it a sort of scoop (which would seem more useful in feeding than in spinning).

Claws not distinctly notched, broadening abruptly at their base. Prolegs with a double row of hooks, about 20 to 60 in number; not very regularly arranged in *Hemaris*, etc. The hair on the prolegs is never as rudimentary as higher on the body.



Secondary hair always minute, rudimentary, mostly visible only under a lens; but the body is often roughened by the tubercles; primary hair (iii and v alone are easy to identify but in *Proserpinus flavofasciata* i and ii are marked by larger black spots) often considerably better developed; but their tubercles are never raised, even when the others are. Segments with 8 or 9 annulets, usually ill-defined in front. Usually with a wart, horn or peculiar marking on the dorsum of the eighth abdominal segment—if a horn, bearing tubercles and secondary hair. With other armature only in *Ceratomia amyntor*, *Lintneria eremitus* and some exotic *Smerinthinae*.

Tree-feeders with a few exceptions (*L. eremitus*, *Deilephila*, *Protoparce*, *Choerocampa*) or feeders on vines.

In synoptic form the Sphingidae are distinguished as follows:

1. Maxillary palpi three-jointed; the four upper ocelli in a rectangle; the upper setae of thoracic segments on a level.....**JUGATAE**
1. Maxillary palpi with but two free joints; the four upper ocelli in a curve; the upper setae of the thorax, when single, one above the other..(**FRENATAE**)
2. With outer hooks on the prolegs.....**Microlepidoptera**, etc., etc.
2. With a single inner band of hooks on the prolegs.....3
3. Hooks of prolegs alternately of three lengths.....**Butterflies**
3. Hooks of prolegs all of the same length.....**Noctuidæ**, **Notodontidæ**, **Arctiidæ**, **Eucleidæ**, etc.
3. Hooks of prolegs alternately and regularly of two lengths.....4
4. Secondary hair present on antennæ and palpi.....**Lasiocampidæ**
4. No secondary hair on antennæ or palpi.....5
5. Secondary hair if present, confined to leg-bases..**Geometridæ**, **Thyatiridæ**
5. With dense secondary hair on body and head, including labrum.....**Apatelodes** (**Eupterotidæ** ?)
5. With considerable secondary hair on body and head, but little or none on labrum.....6
6. Primary tubercles represented by branching spines, or warts bearing several hairs.....**Saturnoidea**
6. Primary tubercles bearing minute simple hairs, hardly distinguishable from the secondaries; and all hair minute.....**SPHINGIDAE**

**SEMANOPHORÆ** and **ASEMANOPHORÆ** are separated rather by different tendencies than by sharp differentiating characters, and the same is true to an even greater extent of the subfamilies of each. Marking in a general way the *Asemanophoræ* there may be mentioned the strong tendency for the head to taper toward the vertex (which none of the *Semanophoræ* show); the densely granulated skin of the middle stages (except *Lapara*, and shared by one or two *Semanophoræ*); the generally higher front, with more tendency to develop lobes at the lower outer angles. The first abdominal segment is never swollen, and the horn is never replaced by an eyespot; the clypeus tends to be wider, at least at the ends.



In the majority of the *Semanophoræ* the last thoracic or first abdominal segment is much swollen, and the horn is frequently replaced by an eyespot. The front often makes a perfect equilateral triangle. The skin is very sparsely if at all granulated in the last stage, and is rarely granulated in the earlier stages. On the labrum, seta iii is quite generally on a level with ii, in the *Semanophoræ* more often nearer the level of vi, at least in normally formed labra. Normal oblique stripes are rather rare.

If we except *Pachysphinx occidentalis* we might define the SMERINTHINAE as caterpillars with heavily granulated body in the last stage, and more or less granulated head, with the setæ rising from the apex of the granulations. All except *Pachysphinx* have an acute triangular head, and even in this the head tapers strongly toward the vertex. The labrum is always normal in arrangement of its setae, with the distance between the setæ ii full half the width of the labrum, and with moderate, flaring notch. Except in its smooth skin, and normal horn *Pachysphinx occidentalis* agrees exactly with *P. modesta*, and in horn it agrees with *Smerinthus*.

The SPHINGINAE, which comprise the rest of the *Asemanophoræ*, are less homogeneous. *Ceratomia* has a densely granulated skin, but is distinguished from all the *Smerinthinæ* by possessing a row of middorsal granulations. In the more specialized forms the labral setæ are closer together around the notch, and this reaches its extreme in *Cocytius*, which has a head of normal *Smerinthid* form. *Lapara*, also with a triangular head, is easily separated from the *Smerinthinæ* and placed in this series, as its labrum (as well as markings and habits) agrees closely with *Hyloicus*.

I cannot distinguish the three subfamilies of *Semanophoræ*, even by tendencies, and am inclined to treat them as a single subfamily. The eyespot in place of a horn occurs only in the *Philampelinæ*, but they are not all of the same type. Humped caterpillars occur in all three (*Choerocampa*, *Darapsa*, etc., *Erynnis*) and cylindrical ones also (*Deilephila*, *Sphecodina*, *Pseudosphinx*); reduced horns (*Pergesa*, *Pholus vitis*, and *Erynnis*) and normal ones (*Xylophanes*, *Darapsa*, *Hemaris*); rounded heads (*Deilephila*, *Macroglossa*, *Pseudosphinx*) and squarish ones (*Choerocampa*, *Darapsa*, *Erynnis*). The labrum of *Pseudosphinx* and *Erynnis* is a little peculiar, but that of



Deilephila comes as near as that of Hemaris, to it. *Hemaris croatica* is an almost perfect connecting link between *Hemaris* and *Macroglossa*. Altogether a tabulation of the genera which shall be workable must be mainly artificial in its arrangement.

#### THE GENERA (AND SUBGENERA) OF SPHINGIDAE.

1. Head high and triangular, no horn.....Lapara
1. Head rounded, or horn more or less developed.....2
2. Head half higher than wide, horn well defined, enlarged tubercles on anal plate.....3
2. Otherwise.....4
3. Four tubercles on anal plate, face smooth.....(Dilina)\*
3. Two tubercles on anal plate, face rough.....Cressonia
4. Head much higher than wide and triangular; horn rather small and soft, not well distinguished from the body.....5
4. Head about as wide as high, or trapezoidal.....6
5. Face smooth, sides tuberculate.....(Amorpha)
5. Face as rough as sides of head, all heavily tuberculate.....
6. Seven setæ on labrum, transverse ridges,—one each on meso- and meta-thorax.....Smerinthus and Paonias
6. Six setæ on labrum, transverse ridges more numerous or wanting.....Pachysphinx
7. Body heavily granular, with granular obliques, middorsal line, and subdorsal on thorax, the latter raised into two pair of short horns.....Ceratomia
7. Body smooth or nearly so in last stage, no middorsal granules.....8
8. Labrum with ii decidedly higher than i.....Hyloicus (cupressi?)
8. Labrum with ii on a level with i or lower.....9
9. Head triangular, smooth, as well as cervical shield; anal plates exceptionally rough; labrum with a deep narrow notch, with the setæ i, ii and vi crowded around it.....Cocytius
9. Head rounded on the vertex, but in Chlænogramma with two enlarged granulations; anal plate rarely rough; setæ ii of labrum almost half as far apart as width of labrum, or more.....10
10. Head much higher than wide, and tapering to about half its width at the vertex.....11
10. Head as wide as high; tapering decidedly toward the vertex.....12
10. Head nearly as wide as high, rounded or squarish, or if tapering a little then strongly granulated.....17
11. Horn nearly twice as long as height of head.....Chlænogramma
11. Horn slender, and but little longer than height of head.....Daremma (undulosa)
12. Horn recurved at tip.....(Acherontia)
12. Horn regularly pointed.....13
13. Notch very shallow, in depth only 1-7 height of labrum....Phlegethontius
13. Notch of labrum at least twice as deep.....14
14. Horn very slender, head well rounded at the sides.....Daremma (catalpæ)
14. Horn normal or short.....15
15. Mesothorax acutely humped, sometimes surmounted with a tubercle.....
15. Body normal in form.....Lintneria
16. Head normally with two pair of back side-stripes.....16
16. Head normally with one pair of dark side-stripes.....Herse
17. Head heavily granulated, body cylindrical, with normal obliques on sides.....Sphinx
17. Head not granulated, or body swollen, or without oblique stripes but with a continuous subdorsal picked out in enlarged granulations.....19
18. Body somewhat granulated in last stage, especially on the obliques, etc.....Atreides
18. Body unusually smooth.....Dolba

\* Exotic genera in parenthesis.



19. Setae i, ii and iii of the labrum on a level; labral notch very shallow, abdomen cylindrical and rather slender.....20
19. Setae i higher than ii and iii, ii usually decidedly higher than iii.....21
20. Metathorax swollen, supraanal not noticeably armed.....**Erynnis**
20. Cylindrical, supraanal with two large tubercles.....**Pseudosphinx**
21. Horn reduced to a granule or replaced by an eyespot; metathorax strongly swollen; head full as wide as high and squarish.....**Pholus**
21. Horn present in all forms with swollen body, swelling rather belonging to the first segment of the abdomen than to the thorax; head rounded, or if squarish, full as high as wide.....22
22. Horn wanting.....(**Deilephila vespertilio**)
22. Horn replaced by an eyespot.....23
22. Horn conical well developed.....24
23. Head very rough in last stage, horn very slender in middle stages, replaced by a high tubercle in the next to last.....**Sphecodina**
23. Head nearly smooth in the last stage; horn stout in penultimate.....**Proserpinus** (in part)
24. Horn blunt and cylindrical; body marked with a large subdorsal eyespot on the thorax, and with well defined distant annulations, beginning with the second abdominal segment.....(**Daphnis**)
24. Horn acute; no eyespot on side of thorax.....25
26. Body more or less swollen on first segment of abdomen, thence tapering to the head.....30
25. Body not swollen.....26
26. Head and general surface of body distinctly but sparsely tuberculate, the setae rising from the apex of the tubercles; cervical and anal shields rougher than the rest of the body.....27
26. Body smooth, head rarely with very slight tubercles, from the slope of which the setae rise.....28
27. Tubercles only visible under a lens.....(**Macroglossa**)
27. Head and cervical shield appearing rough to the naked eye.....**Hemaris**
28. Notch of labrum hardly 1-3 its height; setae i and ii spaced about in the ratio 2:3; vi only 1-3 way up from the apex of the lobe toward ii and much nearer the middle line.....**Deilephila**
28. Notch of labrum deeper, setae i and ii only about half as far apart as the setae ii are from each other; vi nearer to ii than to the apex of the lobes....29
29. Front about half as high as height of epicrania; without normal oblique stripes (with reversed oblique spots).....**Proserpinus** (in part)
29. Front smaller; with seven normal obliques.....14
30. Horn not so long as height of head.....31
30. Horn very slender.....(**Hippotion**)
30. Horn normal.....32
31. Head very finely granular, appearing under low power smooth and dull.....(**Pergesa**)
31. Head distinctly vermiculate.....**Amphion**
32. Head sparsely tuberculate.....33
32. Head smooth and dull under low power, granular under high power, with smooth areas about the setae.....34
33. Body slightly swollen, spiracles pale with two black bars.....**Deidamia**
33. Body much swollen, spiracles dark with a white dot at each end.....**Darapsa, Ampeloeca, (Clarina)**
34. Front higher than wide.....(**Theretra**)
34. Front wider than high.....**Xylophanes**

*Sphinx. (Hyloicus in part).* Head slightly tapering toward the top, or with sides rounded out (*S. drupiferarum*), with irregular vermiculate grooving; the setae rising as often from the grooves as from the elevated portions. Front about  $\frac{1}{2}$  height of head, with lobes at the lower outer angles well marked



and about  $\frac{1}{4}$  to  $\frac{1}{3}$  its height. Ends of clypeus as wide as  $\frac{1}{5}$  height of front. Labrum high, with a notch  $\frac{1}{5}$  to  $\frac{1}{3}$  its width, the setae i and ii spaced about in the ratio 1:2, vi a little nearer in *S. drupiferarum*, a little farther off in *S. gordius*, *luscitiosa* and *eremitus*; iii, a little higher than vi but much below ii; notch deep and slit-like in *S. gordius* and *luscitiosa*, shallower and more flaring in the others. Mandible with a few (perhaps four, but ill defined) large teeth. Second joint of antenna decidedly longer than the first, and nearly twice as long as wide. First segment of body much larger in diameter than head and more or less enclosing the back of it. Skin entirely smooth, granulated until the last stage; supraanal more or less granulated. Horn normal, much longer than head, and curved downward. The seven stripes similar.

There is also some variation in the horn. In the majority of species it is cylindrical in the basal part, and strongly down-curved in its entire length; but in *chersis* the basal part is more often nearly straight, and in *gordius* it is regularly conical and the whole horn is almost straight. The European species *ligustri*, which comes next to *drupiferarum* in the adult, in the caterpillar resembles it closely in markings, but has the normal Sphinx head. (Fig. 1). That of *drupiferarum* would not differ in face view from Fig. 10. See also I, Figs. 39-41 of *S. gordius*.

*Lintneria* has a conical hump on the mesothorax, which in the next to last stage, and sometimes in the last, is surmounted with a hard tubercle. Otherwise it resembles Sphinx in structure. It is considered a subgenus of Sphinx. (*L. eremitus*, Fig. 8.)

*Hyloicus*. Head rounded and decidedly larger in diameter than the body. Horn straight and slender. Labrum with very shallow widely flaring notch; with setae i and ii nearly evenly spaced; ii much lower than i and the setae i, ii and vi of each side forming an equilateral triangle. Second joint of antennae only half longer than wide, and first joint very short. Supraanal long and triangular. Fig. 10.

*H. pinastri* is longitudinally striped with green and white, with a broad red dorsal, or else suffused with red. Horn black. *H. cupressi* of the southern states is reported as similar, with the white lateral stripes broken into patches; and is probably similar in structure.



*Herse*. I cannot distinguish *Herse* from *Sphinx* by any satisfactory characters. The head in both *convolvuli* and *cingulata* is intermediate between those of *drupiferarum* and the other *Sphinxes*. Setae i and ii of the labrum are about  $\frac{2}{3}$  as far apart as the distance between the two setae i, and i is but little higher than ii. The two main joints of the antennæ are practically equal. In the only specimen of *H. cingulata* I have seen the horn is very short, but this may be an abnormality; it is normal in *H. convolvuli*.

*Dolba*. The head does not taper decidedly toward the top, and is decidedly granular, the setæ rising from the apex of the widely separated granules, as in *Smerinthus*. Otherwise it agrees with those species of *Sphinx* in which the labrum is not deeply notched. The head comes surprisingly close to that of *Darapsa*, but may be distinguished by the decidedly higher front, and the fact that iii of the labrum, as in most *Asemanophoræ*, is nearer to the level of vi than ii. I, Figs. 39-41 represent not this species but *Sphinx gordius*.

*Atreides* has a very similar head. The supraanal plate is an equilateral triangle; the markings are picked out with raised granules, and there are several transverse rows on the thorax, and scattered granules on the abdomen as in *Smerinthus*, but very widely scattered and small.

*Acherontia*. Has a slight transverse hump on the mesothorax (suggested in some *Sphinx*); the tip of the horn is recurved sharply; the fine annulations are wanting from the thorax. Otherwise entirely like *Sphinx* (e. g. *S. kalmiae*). *A. atropos* examined, European.

*Ceratomia*. (sens. str.) Head about as wide as high, decidedly tapering, somewhat granulated in back, but with the setæ not springing from the granulations, structurally as in the lower species of *Sphinx*. Body densely granulated, with the subdorsal and obliques picked out in raised granulations, and also with a *mid-dorsal* row. The subdorsal row is produced on the meso-, and metathorax into two pairs of short soft horns. (I, Figs. 45 and 49.) Aside from subfamily characters, I have seen no trace of kinship between this species and *Daremma*. The latter seems to come closer to *Chlaenogramma*.

*Daremma*. Skin smooth; horn normal, rather slender and short; or longer but very slender (*catalpæ*). Head slightly granular, but the setae do not rise from the apex of the gran-



ulations. Otherwise the characters common to *undulosa* and *catalpæ* are shared by *Sphinx*.

In *D. undulosa*, the type, the head is  $\frac{1}{4}$  higher than wide, very strongly tapering toward the vertex, the horn is only a little slenderer than normal, and the labrum is moderately notched, with seta iii in the normal place. In *D. catalpæ* (Fig. 11), the head is broad and rounded, shaped as in *Deilephila*; the labrum is quite deeply notched, with iii nearly on a level with ii, as in the *Semanophoræ*; the body is unusually cylindrical and the horn is very slender. I have seen a specimen from the U. S. National Museum, with no data but the name *Daremma hageni*. It is a typical *Smerinthus* in structure, and could be the fourth stage of one of the larger species (*cerisyi*), but is rather sparsely granulated. I should suspect it was misidentified.

*Chlænogramma*. Head like that of *Daremma undulosa*, but with inconspicuous enlarged granules on the vertices. Body like *Atreides plebius*. Horn normal in length.

*Cocytius (antæus)*. Head not at all tuberculate, but decidedly higher than wide, and terminating in two enlarged granules, like a fourth-stage *Smerinthus*, but higher and closer together at the vertex. Front full as high as wide, the lobes at the outer lower angles are not only well marked in outline, but project very conspicuously; front less than  $\frac{1}{3}$  height of epicrania, iii and ii of the labrum are on a level, but the notch runs even higher, and is very narrow. The distance between the two setæ ii is less than  $\frac{1}{3}$  the width of the labrum, and i, ii and vi are all located practically in the notch. Cervical shield as smooth as head, the anal is very rough, like the horn, and is a narrow triangle. Skin not at all granulated. Altogether an unusually distinct genus for this series. The structure so far as it is not unique suggests *Sphinx* rather than any other genus, but I understand the moth comes nearer to *Phlegethontius*.

*Phlegethontius (Protoparce)* Notch of labrum only one-seventh its height, not reaching the level of seta vi; iii and iv not so high as usual. Caterpillar distinctive in appearance, but not otherwise separated in structure from normal *Sphinx*. *S. rusticus* is said to be sparsely granulated on the lines. I, Fig. 51.



*Lapara (Ellema)*. Skin quite smooth, not only in the last, but in earlier stages. Horn wanting entirely. Anal plate fully as long as wide and acute. Head somewhat higher than wide, (Fig. 4), in the earlier stages extremely high, triangular, with small and distant tubercles, like Fig. 12; front  $\frac{1}{3}$  its height, higher than wide. Labrum (Fig. 5) with a very shallow notch, broadly flaring, with the apex of the lobes far to one side and the outer edges nearly straight; i lower than ii, but not so much so as in *Hyloides*, i and ii about equally spaced; both crowded down toward the margin; vi decidedly nearer the middle line than ii. Scrobe of mandibles smaller than usual. Second joint of antenna hardly longer than wide, and first joint very short. First ocellus directly behind the second, and nearer to the posterior one than the second is to the fourth. With longitudinal stripes, or checkered, never with obliques.

Except for the labrum and markings, which are essentially as in *Hyloicus pinastri*, there is nothing to connect this genus with the *Sphinginae* in the caterpillar; there are a couple of parallelisms to the *Smerinthinae*; the shape of the head, and low first ocellus as in *Cressonia*.

I cannot distinguish the species in the caterpillar.

*Smerinthus (Sphinx)* and *Paonias (Calasymbolus)* (I, Figs. 42-44). Head decidedly higher than wide, triangular; with nearly acute apex and sides somewhat rounded out; with numerous widely spaced raised tubercles, each bearing a seta; front about as in *Sphinx*, with several tubercles somewhat smaller than those on the epicrania; labrum with a notch about  $\frac{1}{4}$  its width, in depth, with the setae arranged as in *Sphinx*, but the distance between the two setae vi is full half the width of the labrum (in the *Sphinginae* it is mostly distinctly less than half); iii, iv and v about equally spaced on the outer edge. Clypeus and mandible and antennae as in *Sphinx*, but the adfrontals are somewhat wider. Body finely granulated, strongly tapering toward the head; first prolegs less used than the others and slightly reduced. Subdorsals on thorax, and obliques on abdomen marked by rows of raised granules. No granules on the middorsal line, but they show a tendency to arrange themselves in a row on each side of it. Horn soft, not well distinguished from the body and about as long as the height of the head, not down-curved. Supraanal an



equilateral triangle in shape, not specially armed, acute; The transverse rows of granulations on the thorax are all about equal. Ocelli in normal arrangement, as in *Sphinx*.

The species show very little distinctive in the way of structure (or for that matter in color and markings) *P. (Calasymbolus) astylus* may be a little rougher, with better developed setæ than the others, both on head and body, and the horn seems a little better defined in *S. ocellatus* than the others.

*Pachysphinx (Triptogon, Marumba)*. Head wider than high, with sparse granulation on the sides, nearly smooth, but a little vermiculate on the face; the apex bluntly rounded. No subdorsal row of granulations on the thorax but the meso- and meta-thorax each have one high transverse crest. Horn soft, variable in size. The three lower ocelli form a right triangle, the posterior being unusually high. The labrum has an additional seta, on the margin; the four marginal setæ that result are about equally spaced.

1. *P. modesta*. Body normally granulated, about as in *Smerinthus*; horn minute, about  $\frac{1}{16}$  in. long; thoracic crests high and granular. (Fig. 7.)

2. *P. occidentalis*. Body smooth, with a few raised granules on the last oblique line, only; horn about as long as height of head. Thoracic crests rounded over and hardly distinguishable. (In the penultimate stage it is granular like *P. modesta*.) This, as may be seen, is very different from the eastern form *modesta*. (Bred from the egg by Mr. Brehme; Western.)

*Amorpha (A. populi* of Europe) Labrum very deeply notched (like *Cressonia*). Head decidedly higher than wide, triangular, smooth on the face. Anal plate unarmed, and horn, etc., as in *Smerinthus*. The last four oblique rows of granules very distinctly extend over three segments. The characters are nicely intermediate between *Smerinthus* and *Dilina*, showing no special closeness to *Pachysphinx*.

*Dilina (Mimas)*. Horn sharply separated from the body and down curved as in *Sphinx*; half longer than width of head, mostly cylindrical. With a longitudinal subdorsal row of granules on the thorax. Head half higher than wide, and acute-triangular. Face smooth, the sides of the head sparsely tuberculate. Supranaal with four raised tubercles in a rectangle. Otherwise about as in *Smerinthus*. *D. tiliae* of Europe.



*Cressonia*. With only one large pair of enlarged tubercles on the supraanal plate. Front as wide as high and only one-fourth as high as the epicrania. Entire head tuberculate; first ocellus moved down and posterior one up so that they are not so far apart and as the second and fourth are from each other. Mandibles with a tuft of secondary hair on the outer part of the scrobe. Otherwise as in *Dilina*. *C. juglandis*. (Figs. 12 and 13.)

*Deilephila* (*Celerio*) (Fig. 9, and I, Figs. 46 and 52). Head distinctly wider than high, rounded on top, roughened with irregular grooves, but not as strikingly as is usual in the *Sphinginae*. Front triangular, the outer edge but little sinuous; clypeus narrower at the two ends than in the *Sphinginae*. Labrum with a broadly flaring notch only one-third as deep as the height of the labrum or less, setae i and ii about two-thirds as far apart as the setae i are from each other, nearly on a level; vi less than half way up to ii. Antenna with the first and second joints nearly equal in length and diameter. Ocelli with the first four of nearly equal size, in a regular curve, but the second decidedly nearer to the third than to the first. Posterior ocellus about half way between the upper and the lower; the three lower ocelli forming approximately a right triangle. Skin smooth, the tubercles marked by tiny chitinous rings, those of the primaries two or three times as large as the others. Horn normal, moderate, entirely wanting in *D. vespertilio*. Supraanal broad. Caterpillar as a whole cylindrical, tapering toward the head, almost always with a conspicuous row of subdorsal spots or eyespots, which are all about equal in size except the last. The front is smallest in *D. euphorbiae*.

*D. lineata*, *gallii*, *euphorbiae*, *lathyri* and *vespertilio* were examined. Aside from those mentioned above the differences come down to a slight variation in the depth of the notch of the labrum; and the markings.

*Chærocampa* (in the broader sense). (Fig. 6.) Head squarish, full as high as wide, very finely granular, so as to appear smooth and dull with low power; the region about the setæ may be glossy but not raised. Front triangular, wider than high (except in *alecto*) at least  $\frac{2}{3}$  height of head; posterior ocellus lower making the triangle formed by the three lower ocelli acute-angled; second joint of antenna about twice as long as first; notch of labrum at least  $\frac{1}{3}$  its height, usually more; i



and ii only half as far apart as the two setæ i are from each other; vi nearer to ii than to the tip of the lobes. Body with the first abdominal segment much swollen and bearing an eyespot, with or without less prominent ones on the following segments; thorax lacking the mottling characteristic of the abdomen in the darker forms; horn regularly conical; skin smooth.

Subgenus *Theretra*. Horn well developed; large eyespot normal, followed by a series of simpler ones in a subdorsal stripe; pattern of abdomen wanting from the first segment, as in some *Philampelinæ*; body with dark obliques slanting up and back. *T. alecto*.

Subgenus *Xylophanes*. Horn and eyespots as in *Theretra*. Front distinctly wider than high; labral setae i and ii a trace farther apart and nearly on a level; notch broad and only  $\frac{1}{3}$  height of labrum; second joint of antenna only half longer than the first. Perhaps a little near to *Deilephila* than the others are. *X. tersa*.

Subgenus *Pergesa*. Horn very short and sharply down-curved; the first eyespot only is present, and it has a black shade below. Setæ i of labrum much higher than ii, and they are spaced as in *Theretra*, that is, in the ratio 1:2. Notch nearly half height of labrum; antennæ with second segment twice as long as first.

Subgenus *Hippotion*. Similar to *Pergesa*, but with the horn long and slender (fig. 15).

*Pholus* (*Philampelus*). Horn reduced to the merest rudiment in *vitis*, replaced by an eyespot which bears a pale crescent in its posterior part, in *pandorus*, *achemon* and *labruscæ*; said to be completely wanting in a Texan species. Metathorax much swollen, first segment of abdomen distinctly smaller. The front of the body is completely retractile in *P. achemon* and *pandorus*, apparently less so in *vitis* and *labruscae*. Supra-anal broad, not specially armed. Head fully as wide as high, squarish; front higher than wide, and nearly half its height. Setæ i, ii and vi of labrum especially close together.

*Ampeloeca*. (*Darapsa*, *Everyx*, *Ampelophaga*). Head rounded, with widely separated small tubercles, similar to fig. 16, but higher; front more than  $\frac{3}{4}$  its height, decidedly higher than wide, also tuberculate. Labrum with a fairly deep notch; setæ as in *Chærocampa*. Body decidedly swollen at first segment of abdomen, but not enough to withdraw the head.



Horn decidedly longer than head. With a subdorsal line, and the normal obliques. Spiracles red with white ends (agreeing with the *Macroglossa* group, *Clarina*, and some specimens of *Protoparce*). Otherwise like *Choerocampa*.

In *A. versicolor* the horn is nearly twice as long as the head, thick and strongly down-curved; in *myron* it is shorter, straight and conical, but apparently it is exceptionally variable in all three species.

*Clarina*. Horn only about as long as head; tubercles of head very small and inconspicuous; otherwise wholly like *Ampeloeca*,—with continuous subdorsal. *C. syriaca*, of Syria.

*Deidamia*. Horn rather longer than head. Supraanal an acute equilateral triangle. Spiracles pale with a black bar on each side. Front full as wide as high. Body but little swollen. Otherwise like *Ampleœca*.

*C. syriaca* and *D. inscriptum* are marked almost exactly like *A. myron*, but with evanescent obliques.

*Amphion*. Head irregularly roughened, without raised isolated tubercles, squarish, as in related genera. Supraanal as long as wide and acute; spiracles dark. Horn shorter than height of head. Front full as high as wide, third ocellus much enlarged (as in *Clarina* and *Deidamia* also). Body but little swollen. Otherwise like the related genera (I, figs. 48 and 53.)

*Sphecodina*. Body not at all swollen on the first abdominal segments. Head large, very rough in the last stage, but without raised tubercles; in the next to last as in *Ampelœca*. Front higher than wide,  $\frac{3}{4}$  height of head. Clypeus broader than in *Deilephila*, etc. Labrum like *Pergesa*. Horn replaced by a wart; in the last stage similar to that of *Pholus*, in the next to last high, and cylindrical; before that surmounted by a slender horn, which rises, not as in *Pholus* from its posterior side, but from the middle. Supraanal wide.

*Proserpinus* (Fig. 3). Horn normal but rather short (*gauræ*) or replaced in the last stage by an eyespot, which may be nearly flat (*proserpina*), or with an obliquely conical center (*flavofasciata*, *juanita*). Head and skin smooth. Spiracles single-colored, yellow in *flavofasciata* and *proserpina*, black in *gauræ*. Head squarish, higher than wide in *proserpina*, full as wide as high in *flavofasciata*. Adfrontals only about  $\frac{1}{8}$  as wide as front is high, with their setae i below the top of the front. Front nearly half as high as head, broadly triangular. Ocelli normal.



Labrum with a moderate or rather shallow notch, with the setæ i and ii only half as far apart as the setae i are from each other (thus agreeing with the preceding genera rather than with *Hemaris*). Supraanal an equilateral triangle; joints of antennæ nearly equal in diameter. In the next to last stage *flavofasciata* at least, has a horn similar to that in adult *gauræ*.

*Macroglossa*. Head and body nearly smooth, but marked by slight raised white tubercles. Head very small and round, the body sharply tapering toward it. Horn normal, longer than height of head. Adfrontals  $\frac{1}{3}$  height of front in width, and with seta i higher than the top of the front. Third, fourth and lower ocelli evenly spaced, and very close together, nearer to each other than to the posterior. Front  $\frac{2}{3}$  height of head; distance between setæ i and ii of labrum  $\frac{2}{3}$  that between the two setae i. True legs single-colored; spiracles red with white spots at the two ends. The genus shows likenesses to *Hemaris* on the one hand especially to *H. croatica*, which is very similar; and to the *Darapsa* group on the other, rather than to *Proserpinus*.

*Hemaris* (*Haemorrhagia*). Head rough and tuberculate; cervical shield, etc., also rough, and skin generally with more or less distinct raised tubercles. Horn moderate, or long and slender. Front  $\frac{1}{3}$  height of head. Otherwise as in *Macroglossa*, even as to the coloring of the spiracles. The species I have seen make a very good graded series, from *Macroglossa* to *H. thysbe*.

*H. croatica*. Cervical shield no rougher than head, without any distinct anterior ridge; lower ocellus close to the next one as in *M. stellatarum*. Legs without any black. Head regularly rounded, not distinctly higher than wide.

*H. rubens*. Head and cervical shield with fine granulations separated from each other by about twice the diameter of a granulation, except toward the anterior edge of the cervical shield, where they are nearly in contact, and in a single even row. Front, and head as a whole higher than *croatica*, agreeing with the following species. Feet with a little black on the front of the coxæ only. Horn rather short.

*H. diffinis* (typical). Cervical shield with the granules no larger than in *H. rubens*, but with the surface of the shield raised into ridges, so as to appear much rougher, considerably rougher than the head. The granules on the anterior edge make a ridge, but they are not confluent and the ridge is not well defined. The true legs have the femora marked with deep black brown.



*H. diffinis axillaris*. Head conspicuously rough. Anterior band of cervical shield of crowded granulations, not all in a single row; the shield decidedly rougher than in the normal form; horn longer than head.

*H. thysbe*. Even rougher than the preceding, the cervical shield with the granulations almost in contact, and on the anterior edge more or less confluent. Horn long and the outer part slender. Femora jet-black and very conspicuous.

In the next to last stage, *H. diffinis*, at least can hardly be separated from *Macroglossa*. The horn is minute.

*Erinnyis (Dilophonota)*. Seta ii of labrum fully as high as i, and the setae i, ii and iii almost evenly spaced; iii, iv and v about evenly spaced along the outer edge. Supraanal sometimes with the rudiments of a pair of tubercles. Notch of labrum hardly  $\frac{1}{3}$  its height, in depth. Head squarish, and full as high as wide; metathorax sharply humped; the abdomen abruptly smaller, and cylindrical. Horn short. In *E. edwardsii* the horn is somewhat shorter than the head, in *E. ello*, only a third as long, and only twice as long as thick. The tubercles on the anal plate are distincter in *edwardsii*, and the supraanal is narrower.

*Pseudosphinx* (I, Figs. 47 and 50). Cylindrical with slender horn. Fourth ocellus as far from the lower as from the first; front wider than high and nearly half as high as head. Labrum very shallowly notched, with the setae i and ii nearly on a level, and almost evenly spaced; iv directly below iii and much nearer to it than to v. vi not far from margin. Two conical spines on anal plate.

The following species were examined. I am especially indebted to Prof. J. B. Smith; Dr. Geo. Dimmock, Mr. William Beutenmuller, and Dr. H. G. Dyar, for the privilege of examining specimens in their own collections and in those of the institutions they represent. Exotic species are in italics; those from the far west, or from Florida only, are also indicated.

SPHINGINÆ

*Acherontia atropos*

*Herse convolvuli*

cingulata

*Cocytius antæus* Fla.

*Phlegethontius quinquemaculatus*

carolina (sexta), I, Fig. 51.

*Atreides plebeius*

*Dolba hylæus*



*Sphinx ligustri* II, Fig. 1.

drupiferarum

chersis

kalmiæ

gordius, I, Figs. 39-41

luscitiosa

*Lintneria eremitus*, II, Fig. 8.

*Hyloicus pinastri*, II, Fig. 10.

*Lapara bombycoides*, II, Figs. 4-5.

coniferarum

*Chlænogramma jasminearum*

*Daremma undulosa*

catalpæ, II, Fig. 11.

hageni ? (W)

*Ceratonia amyntor*, I, Figs. 45 and 49.

#### SMERINTHINÆ

*Pachysphinx modesta*, II, Fig. 7

occidentalis (W)

*Smerinthus ocellatus*

jamaicensis

cerisyi

*Paonias excæcatus*

myops, I, Figs. 42-44.

astylus

*Amorpha populi*

*Dilina tiliæ*

*Cressonia juglandis*, II, Figs. 12 and 13.

#### CHOEROCAMPINÆ

*Deilephila lineata*, II, Fig. 9.

gallii, I, Figs. 46 and 52

*euphorbiæ*

*lathyri*

*vespertilio*

*Chærocampa* (*Pergesa*) *elpenor*

*porcellus*

*Chærocampa* (*Hippotion*) *celerio*, II, Fig. 15.

*Chærocampa* (*Theretra*) *alecto*

*Choerocampa* (*Xylophanes*) *tersa*

#### PHILAMPELINÆ

*Pholus achemon*

pandorus

vitis (fasciatus)

labruscæ

(Figure only) Fla.

*Daphnis nerii*

*Clarina kotschyi syriaca*

*Ampelophaga* (*Ampeloeca*) *myron versicolor*

*Ampelophaga* (*Darapsa*) *choerilis*

*Deidamia inscriptum*

*Sphecodina abbotii*

*Amphion nessus* I, Figs. 48 and 53; II, Fig. 14.

*Proserpinus proserpina*, II, Fig. 3

flavofasciata

juanita

gauræ

*Macroglossa stellatarum*

#### SESSINÆ

*Hemaris croatica* II, Fig. 16

rubens (W)

diffinis and form axillaris

thysbe

*Erynnyis alope edwardsii* Fla.

ello Fla.

*Pseudosphinx tetrio* Fla., I, Figs. 47 and 50.



FIELD KEY TO THE SPHINGID CATERpillARS.\*  
OF THE EASTERN UNITED STATES.

- A. Horn completely wanting, head half higher than wide and triangular.....  
     *Lapara coniferarum* and *bombycoides*
- A. Eighth abdominal segment bears a little hard nodule (caterpillar brilliantly marked with black, white and red).....*Pholus fasciatus* (vitis)
- A. Eighth abdominal segment with an eyespot, otherwise unarmed.....B
- A. Eighth abdominal segment with a horn, otherwise unarmed.....F
- A. Eighth abdominal segment with a horn, mesothorax sharply humped or tuberculate.....*Lintneria eremitus*
- A. Eighth abdominal segment with a long horn, and thorax with four much shorter ones.....*Ceratonia quadricornis*
- B. Slanting white patches on the sides.....C
- B. Pale on the sides, obliquely mottled, eyespot white.....*Pholus labruscae* (Fla.)
- B. Otherwise marked; eyespot dark-ringed.....D
- C. White patches are full three times as long as broad.....*Pholus achemon*
- C. White patches are  $2\frac{1}{2}$  times as long as broad.....*Pholus pandorus*
- D. Checkered contrastingly with red and green.....*Proserpinus juanita*
- D. No red.....E
- E. Eyespot ringed with jet-black.....*Proserpinus flavofasciata*
- E. Eyespot ringed with brown.....*Sphecodina abbotii*
- F. Slanting lines on the sides, sloping upward toward the rear.....G
- F. Slanting lines, if present, running in the opposite direction.....Y
- G. Slanting lines dark and more than seven, with a double set on the dorsum.....*Amphion nesus*
- G. A single slanting line running up to the horn.....*Cocytius antæus*
- G. Numerous slanting lines, on the dorsum only.....*Cocytius cluentius*
- G. Slanting lines indefinite in number or evanescent; spiracle marked with two vertical bars, caterpillar a little humped.....*Deidamia inscriptum*
- G. Slanting lines six or seven, and distant.....H
- H. Head rounded, with two pair of vertical dark stripes; on Convolvulaceae.....*Herse cingulata*
- H. Head mostly with one or no vertical dark stripes; on other plants.....I
- I. Horn rudimentary.....*Pachysphinx modesta*
- I. Horn as long as head, or longer.....J
- J. Skin rough and granular, head triangular.....K
- J. Skin nearly smooth, but with the stripes marked with raised granulations.....O
- J. Skin smooth.....P
- K. Horn well defined and much longer than height of head.....*Cressonia juglandis*
- K. Horn about as long as height of head, and not very distinct from body, straight.....L
- L. The oblique stripes irregularly shaded with red patches.....*Paonias astylus*
- L. One of two pairs of red spots alone, or with one or two much larger than the others.....*Paonias myops*
- L. With a number of equal red spots or with none.....M
- M. With none, horn normally blunt, or blueberry.....*P. astylus*
- M. Horn always acute.....N
- N. Horn pink, violet or blue.....*Smerinthus cerisyi* and *jamaicensis*
- N. Horn normally blue-green.....*Paonias excæcatus*
- N. Horn normally yellow-green, yellow on the sides.....*Paonias myops*
- O. Head broad and rounded, granulated.....*Atreides plebeius*
- O. Head high and tapering, nearly smooth.....*Chlænogramma jasminearum*
- O. Head broad and tapering, nearly smooth.....*Phlegethontius rusticus*, and occasional specimens of *Sphinx chersis*, etc.
- P. First segment of abdomen much swollen, subdorsal stripe well developed.....Q
- P. Caterpillar nearly cylindrical, subdorsal stripe present on thorax only.....S
- Q. Subdorsal stripe complete.....*Ampelophaga myron*

\* See "Field Tables of Lepidoptera (1906) p. 69.



- Q. Subdorsal stripe broken in the middle.....R  
 R. Horn near twice as long as head, and down-curved.....*A. versicolor*  
 R. Horn little longer than head and nearly straight.....*A. chœrilis*  
 S. With pale substigmatal bands on the segments which have obliques, meeting the obliques to form chevrons.....*Phlegethontius 5-maculatus*  
 S. No stigmatal band.....T  
 T. With the obliques showing no trace of red and edged above with a row of black spots, horn reddish.....*Phlegethontius carolina*  
 T. Obliques not edged above with a row of black dots; usually with red or violet.....U  
 U. Horn little longer than the height of the head, which is decidedly higher than wide.....*Daremma undulosa*  
 U. Horn about half longer than the head, which is as wide as high.....V  
 V. Ground color very pale green (or the alternative pink or fawn).....*Sphinx chersis*  
 V. Ground color bright grass green (or crimson or brown).....W  
 W. Only six stripes are fully developed (pink); head broad and rough to the naked eye.....*Dolba hylæus*  
 W. With seven equally well-developed stripes.....X  
 X. Horn green, black at the sides, straight; stripes with pink.....*Sphinx gordius* and *luscitiosa*  
 X. Horn deep red (as also the stripes on the head); stripes violet.....*Sphinx drupiferarum*  
 X. Stripes heavily marked with black, and often shaded with blue.....*Sphinx kalmiæ*  
 Y. With oblique stripes running up toward the front.....Z  
 Y. With pale transverse stripes; black.....*Pseudosphinx tetrio* (Fla.)  
 Y. Catocala-like with small horn and a tubercle on middle of abdomen  
     *Madoryx* (*M. pseudothyreus* occurs in Fla.)  
 Y. With subdorsal eyespots.....A  
 Y. Checkered or with patches of yellow dots.....C  
 Y. Metathorax sharply humped with a dorsal eyespot.....E  
 Y. More or less striped longitudinally.....F  
 Z. Oblique stripes and subdorsal red.....*Proserpinus gauræ*  
 Z. Oblique stripes and subdorsal yellow.....*Pachylia ficus* (Fla.)  
 A. A single eyespot on segment A1.....*Xylophanes porcus* ? (Fla.)  
 A. An eyespot on A1 dark-pupilled, the rest light-pupilled.....*Xylophanes tersa*  
 A. All the eyespots alike.....B  
 B. Ground color bright green; last eyespot quite like the others, lower part of head light.....*Deilephila lineata*  
 B. Ground color olive green; last eyespot often stretching out toward the horn; head with a black band below.....*Deilephila gallii*  
 C. Horn very slender.....*Daremma catalpæ*  
 C. Horn normal.....D  
 D. Subdorsal yellow powdering if present continuous with that lower on the sides; lower part of face black.....*Deilephila gallii*  
 D. Patches of subdorsal yellow powdering on each segment; or checkered with black and green; lower part of face concolorous.....*Deilephila lineata*  
 E. Eyespot black with a pale ring.....*Erynnis alope*  
 E. Eyespot black, with some red behind.....*Erynnis ello*  
 E. Eyespot red, with a black center.....*Erynnis crameri*  
 F. Horn slender; with red dorsal stripe and two white stripes or rows of white spots on the sides.....*Hyloicus cupressi*  
 F. Horn various; otherwise marked, not feeding on pine.....G  
 G. Front edge of cervical shield raised and rough.....H  
 G. Cervical shield lightly and evenly granulated.....  
     Younger stages of *Proserpinus flavofasciata*, *Hemaris*, and very young stages of many *Sphingidæ*.  
 H. Dorsal dark stripe edged on both sides with pale; horn much longer than head.....*Hemaris thysbe*  
 H. Dorsal dark stripe vague; horn about as long as head.....*Hemaris diffinis*



## EXPLANATION OF THE FIGURES.

## PLATE XVII.

FIG. 1. Front view of head of *Sphinx ligustri*. It is fairly typical of the species in which the head tapers moderately, but more rounded out on the sides than the average. The front is also wider and less lobed at the bottom.

FIG. 2. Labrum of *Hemaris thysbe*. Compare Annals E. S. A. III; Pl. xiv. Fig. 50.

FIG. 3. *Proserpinus proserpina*. Typical of the Semanophoræ; compare also Figs. 6 and 14.

FIG. 4. Front view of head of last stage of *Ellema harrisii*. The triangular head, which is more typical of the Smerinthinæ.

FIG. 5. Labrum of the same. *Hyloicus* is similar.

FIG. 6. Labrum of *Hippotion celerio*.

FIG. 7. Labrum of *Pachysphinx modesta*. *P. occidentalis* is the same, and the normal Smerinthinæ differ only in having one less marginal seta.

FIG. 8. Labrum of *Sphinx* (*Lintneria*) *eremitus*. typical of the lower species of *Sphinx*. For one of the higher type see Annals E. S. A. III, Pl. xiii, Fig. 40, which is *S. gordius*, labelled "*Dolba hylaeus*" in error. The species labelled *gordius* is certainly *S. drupiferarum*.

FIG. 9. *Deilephila lineata*. The other species are about the same.

## PLATE XVIII.

FIG. 10. Front view of head of *Hyloicus pinastri*. *Sphinx drupiferarum* is similar in outline, and so are all the species described as having a broadly rounded head.

FIG. 11. Labrum of *Daremma catalpae*, showing seta iii high, as in the Semanophoræ.

FIG. 12. Next to last stage of *Cressonia juglandis*. In the same stage *Lapara* has the same peculiar shape.

FIG. 13. Labrum of *Cressonia juglandis*, last stage.

FIG. 14. Labrum of *Amphion nesus*. Typical.

FIG. 15. Head of *Hippotion celerio*, showing the slightly squarish form which is most frequent in the Semanophoræ.

FIG. 16. Head of *Hemaris croatica*. It is broader than our species of *Hemaris*, and resembles *Macroglossa* except in the small front.





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