

# PSYCHE.

ORGAN OF THE CAMBRIDGE ENTOMOLOGICAL CLUB

EDITED BY GEORGE DIMMOCK AND B. PICKMAN MANN.

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Vol. II.] Cambridge, Mass., May–August, 1878. [Nos. 49–52.

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## On Larvæ of *Tineina*, especially of *Lithocolletis*.

In *PSYCHE*, v. 2, p. 81–87, I have alluded to the discovery by Dr. Clemens of two larval forms of *Lithocolletis* in this country, and have stated that in some species of what Dr. Clemens calls the second or flat group I had observed a modification which I called the intermediate form, under the impression that it afforded a connecting link between the second group and that which Dr. Clemens considered the first or cylindrical group; coupled however with the suggestion that this supposed intermediate form might prove to be only a later stage of growth of the flat form. This suggestion proves to be the truth; the intermediate form is the last larval state of the flat form, and is also a connecting link between the first and second larval groups. As hereinafter stated, however, the larva at this stage undergoes a change of form without moulting, and fig. 3, p. 83, represents it at one point only of this larval stage.

This is, however, not the only connecting link between the two groups, for *L. ornatella* of itself forms another group, and at the same time affords another connection between Dr. Clemens' first and second groups, as well as connecting both with Dr. Clemens' genus *Leucanthiza*. But notwithstanding that the larvæ of all three groups are thus connected, the groups are distinct and well marked, so that, in a large collection, ninety-nine out of every hundred would, without hesitation, be referred to its appropriate group. But while this is true it is also true that the larvæ of all the groups resemble each other closely on their emergence from the egg, and are almost indistinguishable in the latter part of the last larval state, and the pupæ are

entirely so. Starting from a common point, or nearly so, they diverge from each other to converge and meet again in the latter part of the last larval stage. (In illustration of these life-histories it will be necessary to refer again to the figures on page 83. In fig. 2 I have not made the dentation of the mandibles distinct enough.)

Concealed as these larvæ all are within their mines, inside of leaves, and dying as they inevitably do when removed from the mines, it is somewhat difficult to trace accurately all the larval changes; but by watching them closely, by collecting large numbers of larvæ in all stages of growth, and comparing them, and by pursuing the same process with the cast skins in the mines, and counting them, I believe that I have succeeded in tracing the larval histories of many species; and while the larval history of each group is materially different from that of the others, that of the species of either group does not differ in any important respect from that of others of the same group. There are, however, many points common to all the groups, and I give these first, accompanied by some general remarks upon their characters and affinities, and followed by a statement of the points peculiar to each group; giving thus a brief life-history of the genus, and of each of the three groups, rather than life-histories of separate species; together with notices of such relations of the genus to others as seem to be indicated by the larval characters.

I have never seen the unhatched egg of *Lithocolletis*; but upon the spot at which the mine begins, and while the mine is yet scarcely visible to the unaided eye, may be seen, under the lens, a glittering point. This is the shell, or rather chorion. It is perfectly flat, and one might almost say that it is imbedded in the substance of the leaf; its outline is oval, and it does not vary much in size in the different species, being usually about 0.34 mm. long and half as wide. The mine begins under the egg, the larva passing obliquely into the leaf because the structure of the head and trophi is such that it cannot enter the leaf vertically, as do the larvæ of some other genera. As shown in figs. 1 and 2, the head of the larvæ of the flat group projects straight forward and can neither be elevated nor de-

pressed; the jaws project in the same way beyond the head, and can neither be elevated above nor depressed below the axis of the body; this is equally true of the larvæ of the other groups in their earlier stages. Such a larva placed upon the surface of a leaf could never enter it, but must perish; but, when the egg is so imbedded in the surface of the leaf, and so firmly attached to it, the larva, in passing obliquely out of it, necessarily enters the leaf. This affords a sufficient reason why a larva once removed from its mine always dies, so long as the structure of the head and mouth-parts retains this character (figs. 1 and 2); though no good reason, apart from the creature's instinct, can be given why it might not, after the change occurs, which takes place in all at some period, and after the trophi become like those of ordinary larvæ of Lepidoptera, as shown in fig. 4, re-enter the leaf, and form a new mine, as do the larvæ of many other genera (*e. g.*, some species of *Gracilaria*, *Ornix* and *Laverna*), or feed externally, like the greater number of lepidopterous larvæ. But, as a matter of fact, it never does so. Dr. Clemens has stated that the larva of *L. crataegella*, when feeding in leaves of the wild cherry (*Prunus serotina*), sometimes leaves one mine and makes another. If this is true, its habit is unique in the genus; but, though I am very familiar with this species, I have not been able to confirm Dr. Clemens' statement, and I have found reason to think that he was in error. *Ornix prunivorella* Cham. was unknown to Dr. Clemens. It mines the leaves of *Prunus serotina*, and its mine cannot be distinguished from that of *L. crataegella* Clem., and, like other species of *Ornix*, it does leave one mine and make another. I think it at least probable that Dr. Clemens mistook the *Ornix* mine for that of *L. crataegella*.

To return from this digression. After leaving the egg, the mines of all the species of *Lithocolletis* that are known to me, as well as those of many other genera of *Tineina* (*e. g.*, *Phyllocnistis*), are at first linear and confined to the surface, upper or lower, as may be the habit of the species. Larvæ with the trophi as in fig. 2 (*e. g.*, *Phyllocnistis*, *Lithocolletis*, and very young *Gracilaria*) simply separate the epidermis from the parenchyma, and do not eat the latter. The linear part of the

mine of *Lithocolletis* is very similar to a *Phyllocnistis* mine; and during the portion of the larval life when this mine is made, and indeed in the flat and ornatella groups throughout the entire larval life, except in its last stage, the mouth parts (fig. 2) are identical with those of *Phyllocnistis*. So long as this character of the trophi is present in all these groups the body is depressed or flattened, the sides of the segments are mammillated, and the legs are but feebly developed. In all of these respects the larvæ resemble somewhat those of *Phyllocnistis*. Prof. Zeller, as quoted by Mr. Stainton in *Ins. Brit.*, v. 3, p. 285 (I have not seen Zeller's paper myself), gives as one of the characters of *Phyllocnistis* "larva apod," and Dr. Clemens, in *Tin. N. Amer.*, p. 83, states that the "larva is without feet or prolegs." As to the earlier stages of its larval life, this is no doubt true, but as to the later stages, its truth depends on what is meant by being "without feet or prolegs." The next three segments after the head, the last and the penultimate segments are certainly without appendages of any kind; but on each side of each of the other segments, not, it is true, at the point usually occupied by the legs, but projecting obliquely from the edge of each segment, I find, in *P. ampelopsiella* Cham., a very distinct two-jointed appendage, without either claw or circlet of tentacles, which certainly aids the larva in its slow progress through its long and narrow mine. It is not pretended that these appendages are homologous with even the feebly developed legs and prolegs of the young *Lithocolletis* larvæ, yet I do not see why they are not as properly called legs as those of a *Nepticula*. The resemblances of the larvæ of *Lithocolletis* to those of *Phyllocnistis* lie in the thin and flattened body, the mammillated sides of the segments, the character of the trophi (fig. 2), and the linear character of the mines. The next three segments after the head are somewhat enlarged in the first stage of *Lithocolletis*, as in many other genera (*e. g.*, *Gracilaria*), but this is not like the great lateral enlargement of the same segments in *Phyllocnistis*. The legs (fourteen in number) are present in all the three groups of *Lithocolletis*, though they are feebly developed in all stages of the flat group, in the first five stages of the cylindrical group, and in all except the last stage of *L.*

*ornatella*, so that they are unfit for crawling, when the larva is removed from the mine, in all except the last stage of *L. ornatella*, which voluntarily leaves the mine and crawls away to pupate. No good reason can be given why the cylindrical larvæ, after their fifth stage, when the feet are apparently large and strong enough for use, seem unable to crawl when removed from the mine. When out of the mine they apply the spinneret to the surface on which they rest, and spin a thread fit to afford a secure foothold, as do most crawling larvæ, but they are unable to crawl, and yet if, while tumbling helplessly about, the true feet happen to touch a part of a mine from which the upper cuticle has been removed, the larva at once drags itself upon the mined portion, and then crawls actively enough, without attempting to spin a thread for a foothold.

From each side of each segment project three hairs, just above which are two other shorter ones. These hairs are found in all the groups, and persist throughout the larval life.

I have mentioned above the Phyllocnistis-like character of the trophi and of the mine in the earliest stages of *Lithocolletis*. Indeed, while this character of the trophi is retained, this character of the mine results as a necessary consequence. The larva can only feed straight on or turn to one side or the other, merely separating the cuticle from the parenchyma, and cannot deflect the head so as to eat out the latter, as a mining larva with the head deflexed and the trophi as in fig. 4 would do. The form of trophi in fig. 2 is found in the earlier stages of some other genera besides *Phyllocnistis* and *Lithocolletis*, and in such cases the mine is *usually* linear and is *always* a mere separation of the cuticle from the parenchyma. It need not be linear. Indeed, in *Phyllocnistis ampelopsiella*, though the mine is, strictly speaking, linear, yet it winds about from the midrib to the margin and back, between the veins of the leaf, until the entire cuticle in the mined portion is separated, and the mine becomes a blotch. In *Lithocolletis* and many other genera, the mine always becomes blotch-like. Frequently, as in *L. ornatella*, the blotch obliterates the linear part of the mine, but in other cases, as in *L. celtisella*, the linear part is long, and the blotch is at one end of it, like the mines of some *Nepticulas*.

The period during which this form of trophi (fig. 2) lasts varies in different genera and in different species of the same genus. Thus, in *Phyllocnistis*, it lasts until the last larval stage, when the form in fig. 4 is assumed, and the larva immediately spins its cocoon. This is also the case in the flat and ornatella groups of *Lithocolletis*; but in the cylindrical group the change takes place at the fifth stage, as it does also in *Gracilaria* (*Parectopa*) *robiniella* Clem., and probably in other species of the *Euspilapteryx* group of *Gracilaria*, while in such species as *G. rhoisella* and *G. blandella*, which I call true *Gracilaria*, it takes place at the second stage.

But while larvæ having trophi as in fig. 2 must make linear or flat mines, the converse does not hold good. Many larvæ, like those of *Nepticula*, *Bedellia*, *Aspidisca* and *Antispila*, make linear mines, at least in their earliest stage, but the trophi of these are of the ordinary type of lepidopterous larvæ (fig. 4), and the head is deflexed, the mouth not being fixed in the axis of the body. But in such cases the mine is not a mere separation of the cuticle from the parenchyma; the latter itself is eaten out. *Gracilaria robiniella* and *G. salicifoliella*, after the moult at which they assume the trophi as at fig. 4, also continue making flat blotch mines, but the parenchyma is eaten out. In these two species of *Gracilaria* and in others having similar habits, the body never becomes cylindrical, but is always somewhat depressed, and the head is very flat and thin, even after assuming the form of trophi, as in fig. 4. This form of trophi is assumed sooner or later by all lepidopterous larvæ; in some, as above shown, not until a late stage of larval life, in others earlier. In the great majority of species it is assumed before the larva leaves the egg; if this is taken to indicate a high rank, then *Nepticula*, instead of taking the lowest place among *Tineina*, as in *Ins. Brit.*, v. 3, should out-rank *Lithocolletis* and even *Gracilaria*; and *Tischeria* also would out-rank *Gracilaria* because the larvæ of *Tischeria* assume the form given at fig. 4, either before leaving the egg or at the first moult thereafter.

In describing mines, they are frequently mentioned as being either tentiform or flat. But from what is written above it will be seen that this is not the true distinction. It is rather between those in which the parenchyma is eaten out, and those in which

it is simply separated from the cuticle ; whether it is the one or the other is a necessary consequence of the structure of the head and trophi. At whatever period of larval life the moult takes place, at which the form in fig. 4 is assumed, the character of the mine is changed at once ; and thereupon the larva, as in the cylindrical group of *Lithocolletis* and in *Gracilaria*, proceeds to eat out the parenchyma, or leaves the mine ; or, as in the flat and ornatella groups of *Lithocolletis*, and in *Phyllocnistis*, at once ceases to feed and spins its cocoon, to do which *L. ornatella* leaves the mine. In the cylindrical group and in *Gracilaria*, the larva, after that change, finds itself unable, from the position of the head and the structure of the trophi, to continue to separate the cuticle from the parenchyma, and must feed upon the latter ; and the body having assumed a more cylindrical form, the cuticle presses uncomfortably on it ; this leads the larva if it continues to mine, as in *Lithocolletis*, to meet its changed condition by making its mine into a tentiform one, or, as in most *Gracilaria*, to leave the mine and feed externally. Some of the latter also, as *G. erigeronella*, make the mine tentiform ; others, with more flattened bodies, as *G. robiniella*, make sufficient room by eating out the parenchyma. Previous to this change there is no indication of any instinct to spin a web, probably because there is no organ to elaborate the silk, or to spin it. It is at this change that the silk glands and the spinneret first appear, just in time to meet the wants of the larva, which could neither give its mine the tentiform character, nor subsist externally, without the ability to spin. The tentiform character of the mine is caused, in part at least, by the shrinkage of the silken web ; and to secure its hold on the leaf, as an external feeder, the larva must spin a few threads upon the surface. Large larvæ no doubt aid in curling the leaf to make the mine, or to feed externally, by drawing the silken threads ; but in small larvæ this is accomplished mainly by the contraction of the silk itself.

In the *Nat. Hist. Tin.*, v. 2, Mr. Stainton enumerates seventy-six species of *Lithocolletis* as known in 1857, and many others have been discovered in Europe since that date. In my *Index in the Bull. Geol. Geog. Surv.*, v. 3, seventy American species are enumerated. The total number now known is

probably near two hundred. There is no published account of the occurrence of the flat larva in Europe, and it is not probable that it would have remained unnoted had it been found there. In this country the flat group is represented by only fourteen species, and *L. ornatella* is the only species of its group as yet made known. All the other species belong to the cylindrical group. Though the species of the flat group are comparatively so much less numerous, the individuals are as numerous as those of the cylindrical group. So far as the mines are concerned, this might be explained by the fact that the mines of the flat group are always on the upper surface and are large, conspicuous blotches, while those of the cylindrical group are smaller, and with the exception of *L. tiliaeella* Cham. and *L. robiniella* Clem. in this country, are always on the under side; but this will not explain the greater abundance of the moths of the flat group. This is owing, as I believe, simply to the fact that they are more prolific. The larvæ of this group are gregarious, while it is a comparatively rare thing to find more than one larva in a mine of the cylindrical group.

The larval life of a *Lithocolletis* lasts, in Kentucky, in mid-summer, about three weeks. Many species, however, pass the winter in the larval state, though their development may be hurried by keeping them in a warm room; then the moths make their appearance irregularly, according to temperature, all through the winter. It is probable that the larval life can not be shortened to a less time than three weeks. Since the larvæ cannot be removed from one mine to another, and it is difficult to keep the leaves green and fresh for so long a time, the only way to determine the length of the larval life is by observing a multitude of mines in various stages. From such observations, repeatedly made, I find the length of larval life to be about three weeks. In this period the larvæ moult eight times, at the eighth moult passing into the pupa state. This seems to be a large number for so short a life-time, but I am convinced that it is correct. I have already alluded to the difficulty of determining this matter accurately as to larvæ which are concealed in their mines, but I have observed hundreds of the larvæ in various stages of growth, and I find always seven distinct sizes in each



species, and I find an eighth form different structurally from all the others, but no larger, or rather no longer than the seventh; and although I have not seen the unhatched egg, I have removed larvæ from mines which had not extended to the length of the egg from it, so that I am certain of having seen the first stage.

At each moult except the seventh, the length of the larva in its first stage is added to that of the moulting larva. Thus *L. coryliella* Cham. and *L. guttifinitella* Clem. are each in their first stage 0.56 mm. long. In the second stage they are 1.13 mm., and in their seventh stage 3.95 mm., and in several complete series of specimens now before me 0.56 mm. have been added at each moult. *L. ornatella* Cham. is at first 0.52 mm. long, and in its seventh stage it is 3.63 mm. long. In *L. robiniella* and in *L. crataegella* a somewhat different rule prevails. *L. robiniella* is at first 0.63 mm. long, at its second stage it is 1.26 mm., and so on to the fifth stage, when it is 3.15 mm. long. At its fifth moult there is no increase in size, but its form is changed from moniliform depressed, to a nearly cylindrical larva, the trophi have changed from the form given in fig. 2 to that given in fig. 4, and the legs are much better developed. In other words, in the cylindrical group a change takes place at the fifth moult, which is equivalent to that which takes place at the seventh moult in the flat and ornatella groups, and which takes place in *Phyllocnistis* at its last moult before becoming a pupa, which is probably also its seventh. At their sixth moult, however, *L. robiniella* and similar species add their original length again, and continue to do so at each subsequent moult, including the seventh, at which they pass into the last larval or the prepupal state, thus differing from the larvæ of the flat and ornatella groups, which at this moult do not increase in size, but simply change their forms and structures. In these latter groups the first seven stages are stages of nutrition and growth, not apparently of development; but the seventh moult and eighth stage are stages of development, and not of growth. In the cylindrical group all the stages are stages of growth and nutrition, except at the fifth moult. The changes which take place at the seventh moult in the flat and ornatella groups, and which continue to progress gradually through the eighth stage

in the flat group, are necessary to bring these larvæ up to the level of the cylindrical group in its sixth and subsequent stages; except that the legs of the flat group are never so well developed as they are in the cylindrical group after the fifth, and in *L. ornatella* after the seventh moult. With this exception, the larvæ of all the three groups have reached the same level at the end of the eighth stage.

I am not positive as to the length of any one stage of larval life except the last (eighth), and of that only in the flat and ornatella groups. In these it lasts between two and three days in the summer, but the fall broods pass the winter in this stage. The moult by which the larva passes into the pupa state is different from the previous larval moults. The cast skins of the very young larvæ are usually lost in the frass in the mine; this sometimes happens with the older skins, and I have opened mines of larvæ in their penultimate stages, when only a single skin could be found. Usually, however, three or four may be found. In moulting, the head is first loosened completely, and retracted out of its skin, the suture between the head and next segment opens on the under side, and the opening extends back along the sides of the next two segments, upon the upper surface of which the head is thrown back; the larva in its new skin wriggles out at the opening, and very frequently the head is entirely torn off. The skin thus cast is thick and hard, and that cast at the seventh moult frequently remains almost entire. But the skin cast at the eighth moult is thin and delicate, and is usually torn into shreds, which are pushed off to one side in the cocoon, forming a little heap. As this moult takes place in the cocoon, it of course can only be observed by opening the latter, which usually injures the pupa or stops the moulting process. In a specimen of *L. ornatella* thus opened, I found some shreds of the skin pushed back to the apex of the abdomen, others adhering to parts of the body, and the skin entirely or partly removed from some of the feet, and uninjured on others. It had the appearance of a pupa which was freeing itself from its larval skin by wriggling about against the sides of its cocoon.

In the latter part of its last stage the cylindrical larva becomes white, having previously passed from the white of its earliest

stages to pale greenish. The larvæ of the flat group, yellowish or whitish in their earlier stages, usually become more or less tinged with a smoky or fuscous hue, sometimes almost blue-black, but at their seventh moult they again become white. The larva of *L. ornatella*, at first whitish, gradually becomes tinged with green, which deepens in its last and penultimate stages to a peculiar bluish green not found in any other larva of the genus. This hue persists in the earlier part of the pupa state.

The pupa has the head pointed in front, with a serrated edge running back on each side, which is no doubt useful in cutting through the cocoon, while it pushes itself out by the contortions of its body, aided by the microscopic bristles which arm the upper surface of the abdominal segments. The pupa does not entirely free itself from the larval skin for nearly two days after the cocoon is made, and the pupa state lasts about eight days after that, at midsummer, and the moth emerges through a rupture of the pupa skin across the back of the head and down the sides of the wing-cases.

In this latitude these insects may be found in all their stages from May to the fall of the leaves. I have plucked from the same plant of *Rhus toxicodendron*, at the same time, leaves containing larvæ of *L. guttifinitella* in all their stages, as well as pupæ, and pupa-skins from which the imago had emerged. It is therefore manifestly impossible to say how many broods may succeed each other in a season. That depends on the temperature and length of the season. In Kentucky I have found *Gracilaria robiniella* mining locust leaves from the first of July to the fall of the leaves in October; while I have found it doing the same thing in New Orleans in December, when the leaves were falling. Larvæ which are in their last stage, having finished feeding, may winter in that stage, and this is the condition in which they are usually found in the winter, the temperature preventing them from passing into the pupa state till the return of warm weather. Larvæ which have not finished feeding when the leaves fall must of course perish, but no good reason can be given why pupæ might not winter. Nevertheless, I have never met with a *Lithocolletis* pupa in the winter or spring.

Neither can I conceive any good reason why moths disclosed late in the fall might not winter, and indeed the moths of *L. robiniella* and *L. salicifoliella* do; but I have never met with any others hibernating, and indeed I have not seen *L. salicifoliella* later than November. There are, however, some facts about the hibernation of the species which need further explanation. Thus, I have known *L. tubiferella* Clem. and *L. aesculi-sella* Cham. to pass into their last larval state in the middle of August, and to remain in that condition until late in the fall, when my last observations were made upon them, and in such cases there was abundant warmth and time for another brood before the fall of the leaves.

It now remains only to notice the points in which the three larval groups differ from each other. The larvæ of the flat (second) group are the flattest lepidopterous larvæ known to me. Fig. 7 represents the larva of *L. coryliella* in its first

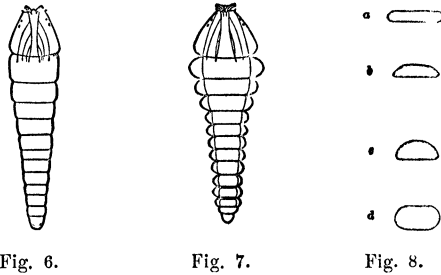


Fig. 6.

Fig. 7.

Fig. 8.

## EXPLANATION OF THE FIGURES.

Fig. 6. Larva of *L. robiniella*, first stage, 0.63 mm. long.

Fig. 7. Larva of *L. coryliella*, Cham., first stage, 0.56 mm. long.

Fig. 8. *a.* Outline of *L. coryliella* in transverse section at the fifth stage. *b.* Outline of *L. ornatella* in transverse section at the fifth stage. *c.* Outline of *L. ornatella* in transverse section at the eighth stage immediately after the seventh moult. *d.* Outline of *L. robiniella* in its fourth stage.

stage, 0.56 mm. long; fig. 1, an older larva of the same group; fig. 3, the same towards the latter part of its last stage; fig. 8*a*, the outline of one of these larvæ in transverse section at about the fifth stage, when the vertical thickness is scarcely one-fifth of its width. The "maculæ" of Dr. Clemens are usually only transverse rings, as shown on each segment in fig. 1; they appear at the second stage and persist throughout the larval life,

except in the eighth stage, when they are found to have disappeared entirely. In the seventh moult the larva undergoes great changes. The legs are no better developed after that change than before it, though towards the latter part of the eighth stage each of the true legs is found to be placed upon a distinct mammillary projection of the segment; but immediately after the seventh moult the larva is found to have increased in thickness, till its vertical thickness is more than one-third its width; this thickness continues to increase, and the width to decrease, till, before shedding its last larval skin and disclosing the pupa, it has become distinctly cylindrical. During this time and in the same gradual way the head has become convex above, and deflexed, until the trophi are no longer in the axis of the body, but have assumed the position usual in ordinary caterpillars. During this stage it eats nothing, and its body seems to be a mass of oil-globules, which, however, have been increasing in number during the last two stages. It lies quiescent in the part of the mine to which it had retired before moulting, and seems disinclined even to wriggle when touched. *Pari passu* with these external changes internal changes as important have taken place. The spinneret has made its appearance at the seventh moult, and the long convoluted silk-glands may be seen lying along on each side of the intestine. These organs are seen to much the best advantage in a larva of the cylindrical group under slight pressure. The oil-globules arrange themselves along the median line of the body, sending two branches out on each side, in each segment, and gradually the form of the pupa becomes visible under the thin larval integument.

The mode of spinning the cocoon is as follows. The larva having, as above stated, retired to a part of its mine, and cast its skin, lies quiet for two or three hours. Up to this time the mine is flat. Turning upon its back, and applying its spinneret to the separated upper cuticle, it weaves short bands of silk in a line. These, by their contraction, produce a narrow longitudinal fold in the cuticle, thus drawing it tightly and raising it above the lower surface, which is made to curve slightly; the mine has thus become tentiform. Turning again upon its ventral surface, and slowly revolving around, it spins beneath it a circu-

lar sheet of white silk, which, by its contraction, draws from the circumference towards the centre, and causes a circular bulge or projection on the under side of the leaf, the diameter of which is a little greater than the length of the larva. Turning again upon its back, it spins, in like manner, a white and thin, though tough, transparent sheet above it, which, by its contraction, causes the nidus to project still more on the under side of the leaf, and the cocoon is complete.

In the larvæ of this group the upper surface of the integument is shagreened, and, as the feet are of little use in crawling, this roughness is no doubt useful in aiding progress, by contact with the separated cuticle; in some of the species the hind margin of the penultimate segment beneath is serrated, which affords similar aid. The larvæ of this group never really crawl, they only wriggle.

In *L. ornatella* the surface is not roughened, nor the penultimate segment serrated, and the legs are no better developed than in the flat larvæ, to which, in all of its stages but the last, it is closely allied. It differs from those larvæ, however, in having the segments more distinctly mammillated at their sides, and its outline in transverse section is more nearly elliptical, as shown by fig. 8*b*. The larva is white, and the maculæ are only distinct in the second, third and fourth stages. At the fifth stage it is tinged with green, which becomes deeper in each succeeding stage. Until the seventh moult the mouth parts are as in fig. 2. At that moult, however, the trophi, like those of the larvæ of the flat group, become as in fig. 4, and the legs become larger and more perfect than before, or than ever in the cylindrical group. The form also is so altered that, immediately after the moult, it is almost semicircular in transverse section (fig. 8*c*). Like the larvæ of the flat group, *L. ornatella* does not eat in its eighth stage, but, unlike them, it is far from inactive. It is the only larva of the genus (except *L. helianthemella*, one of the cylindrical group in Europe) which is capable of crawling when removed from the mine, and in a few hours after its seventh moult it voluntarily cuts a semicircular opening in the cuticle, by which it leaves the mine, and crawls away to spin its cocoon and pupate. Its cocoon is not flat, but is so tightly drawn

transversely that it looks like a little knot. On opening it, however, it is found to be essentially like that of one of the flat group. As the larva leaves the mine to pupate, the mine never becomes tentiform, but remains flat. It mines indifferently either surface of the leaves of locust (*Robinia*). In the leaves of an allied genus, *Amphicarpaea*, mines and larvæ are found, which are indistinguishable from those of *L. ornatella*; the larvæ have the same life-history, and the cocoons and pupæ are indistinguishable. Judged by the mines, larvæ and pupæ, it is the same species in the leaves of both plants. But the moth from *Amphicarpaea* belongs to a different genus. It is *Leucanthiza amphicarpeaeella* Clem. The ornamentation differs from that of all the known species of *Lithocolletis*, though perhaps it is nearer to that of *L. ornatella* than to that of any other in some respects. The antennæ, which in *Lithocolletis* are carried back under the wings in repose, are carried extended at the side in *L. amphicarpeaeella*; the neuration of both pair of wings differs decidedly from that of *Lithocolletis*, and is identical with that of *Phyllocnistis vitigenella* Clem., except that in the hind wings of *L. amphicarpeaeella* the median vein is furcate on the hind margin, instead of being simple as in *Phyllocnistis*. In its other characters, however, it is near *Lithocolletis*.

The mines of larvæ of the cylindrical group are at first linear, ending in a blotch, and they retain this character until after the fifth moult of the larva. Up to that moult the trophi are those of the flat group (fig. 2), and the larvæ, though not flattened like those of the flat group, are depressed and submoniliform, while the feet, though better developed than in the flat group, are small and feeble. The mine is of course only a separation of the cuticle from the parenchyma, and as it is small, and on the under side of the leaf (except in the case of *L. robiniella* and *L. tiliaeella*, as before stated), it is likely to escape notice. By far the greater number of mines and larvæ of this group, which one sees, have passed the fifth moult, when the larva has become more cylindrical, though still a little depressed, and the mines have been made tentiform. Hence the mines of this group are usually described as tentiform, and the larvæ as cylindrical. Before becoming tentiform, that is, before the fifth

moult of the larvæ, their mines are always greenish, which aids in preventing their discovery, and distinguishes them from mines of the flat and ornatella groups, which are always brown, yellow, or whitish, and therefore more conspicuous.

The larvæ, even in their earliest stages, differ from those of the flat and ornatella groups more than those groups do from each other. (Fig. 6, larva of *L. robiniella* in its first stage.) Still, even after its fifth stage, and until the latter part of its eighth stage, a larva of this group is more properly described as submoniliform than as cylindrical. In its younger stages it is more elongate, and is vertically thicker than a larva of the flat or ornatella groups. Fig. 8*d* gives the outline of *L. robiniella* in transverse section in its fourth stage. Its vertical thickness is nearly equal to half of its width. The maculæ are usually obsolete in these larvæ, but they sometimes may be seen. Thus, *L. robiniella* mines indifferently either surface of locust leaves. I have never found, out of the hundreds that I have examined, a specimen from the under side of the leaf that had distinct maculæ, and but a small proportion of those of the upper side show them. But sometimes they are found, at about the third and fourth larval stages, as distinct as they ever are in the flat larvæ, showing distinctly through the epidermis. At first I thought that these maculate larvæ must belong to a distinct species, but I have repeatedly bred them by themselves, without having been able to detect any difference between them and moths bred from larvæ without maculæ. At the fifth moult the same changes take place in these larvæ that take place in the flat and ornatella group only at the seventh. The larvæ become more cylindrical, the legs are better developed, the trophi are as in fig. 4, and the head is deflexed. A different sort of mine is therefore needed.

The mines are made in different ways by different species. *L. crataegella*, lying on its back, spins its web across the inner surface of the separated upper cuticle, whereby it is drawn, not as in the flat group, into a single longitudinal fold, but into a multitude of wrinkles like those in the mine of *Ornia prunivorella*, and the mine is deeper than that of a flat larva. *L. robiniella* spins a somewhat dense web across the floor of its mine,



causing it to curve greatly, while the upper cuticle remains smooth. Its mine also is deep, and all the mines of this group are deeper and more decidedly tentiform than those of the flat group, as is necessary because of the more cylindrical form and larger legs of the larvæ, and especially because the flat larva only needs its tent to spin its cocoon in, while the larvæ of this group continue to feed and grow in the mines. *L. caryaealbella*, however, which pupates in an oval cocoon of silk mixed with frass, makes a single fold, like that of a flat larva, but larger, so that the tent has a higher ceiling.

The most singular mode of pupation that I have observed is found in the two closely allied species *L. ambrosiaella* Cham. and *L. helianthivorella* Cham. These pupate in a fusiform silken cocoon suspended by a silken rope like a hammock in the mine, which is like that of *L. crataegella*. The larvæ spin the rope through the middle of the mine, and then, lying on it, carry their threads to and fro, over and around themselves, until they are completely enclosed. (The moths of these two species have one of the branches of the median veins of the fore wings furcate on the dorsal margin of the wing, thus differing from the usual neuration of the genus.) Some other species simply spin a few silken threads, on which they lie, or at most make but a very slight web. This is the habit of *L. desmodiella* Clem., which is the smallest species of the genus, and which has one fewer marginal veins in the fore wings than is usual in the genus.

As before stated, in the latter part of the last larval state, and in the pupal state, the groups are indistinguishable, except by the green color of *L. ornatella*, which gradually disappears, and then the pupæ are indistinguishable. The moths cannot be divided into groups having any connection with the larval characters.

It will be seen that on more attentive study of the larvæ of a greater number of species I have found it necessary to modify some of the statements in my former paper (PSYCHE, v. 2, p. 82-87). All the larvæ of the flat group pass through the form given in fig. 3, and that form is only one condition of the larval stage through which the larvæ pass, in the gradual change to the pupa state, which takes place in that stage.

V. T. Chambers.

A SINGULAR PLACE FOR RAT-TAILED LARVÆ. I found several of these curious larvæ in a branch of an old apple tree that had just been cut down. They were below a large nest of black ants, who had honey-combed the branch for quite a distance. They were twenty-five millimetres long when crawling, not so much when at rest, wrinkled and ridged rather remarkably, the tail a little longer than the body and tipped with a row of bristles curved backwards. Packard does not describe any such, and I am unable to determine the species. Can you help me?

Berlin, Conn., Mar. 20, 1878.

N. Coleman.

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INTERESTING CAPTURES.—A perfect specimen of *Deidamia inscripta* was taken in Newton at light early in June, 1878, the first example I have seen from this vicinity. *Plusia triloba* and *Oncocnemis chandleri* were taken at the Isles of Shoals on flowers in July.

R. Thaxter.

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PLANTAIN BEETLES.—Prof. F. H. Storer, of the Bussey Institution, Jamaica Plain, Mass., writes me that in the latter part of May, 1876, it was next to impossible to discover a single leaf of plantain (*Plantago*) that was not completely riddled by beetles (*Dibolia aerea* Melsh.). Several thousand plants from all sorts of situations had passed through his hands, and the only perfect ones he could find were from particularly cold, sunless places on the north side of buildings.

Samuel H. Scudder.

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ORTHOPTERA OF FLORIDA. The following species of Orthoptera were collected in Appalachicola: *Labidura riparia*, *Anisobia maritima*, *Labia burgessi*, *Polyzosteria ingens*, *Stagmomantis carolina*, *Anisomorpha buprestoides*, *Chimarocephala viridifasciata*, *Caloptenus femur-rubrum*?, *Arphia* (near *xanthoptera*), *Acridium appendiculatum*, *Psinidia eucerala*, *Hippiscus phoenicopterus*, *Amblytropidia subhyalina*, *Leptysinia marginicollis*, *Arnilia chlorizans*, *Trimerotropis picta*, *Stenobothrus* sp., *Tettigidea lateralis*, *Conocephalus triops*?, *Gryllus luctuosus*.

S. H. Scudder.

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### Proceedings of the Club.

§ 29. INSECTS WHICH LIVE IN RESIN. BARON OSTEN SACKEN exhibited specimens of *Cecidomyia* (*Diplosis*) *resinicola*, the larvæ of which inhabit drops of resin on scrub pine (*Pinus inops*) and are provided with long breathing tubes which project beyond the surface of the resin. (March 13, 1874.)

§ 30. PECULIARITIES OF RIPARIAN INSECTS. BARON OSTEN SACKEN quoted an observation by Dalman, that insects which live near water have prominent eyes, and cited, in illustration of this, the species of *Elaphrus*, *Notiophilus*, *Stenus*, *Sphyracephala* and many Hemiptera. (May 8, 1874.)



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