

ART. XXVIII.—*Contributions to the Study of New Zealand Entomology, from an Economical and Biological Standpoint: No. 1—Plusia chalcites Esp.; No. 2—Nyctemera annulata Boisd.; No. 3—Venusia verriculata Feld. (Lepidoptera).*

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[Read before the Wanganui Philosophical Society, 23rd November, 1914.]

INTRODUCTION.

It is my aim in these and future contributions to bring together as complete a knowledge of each species as is possible. It is of great economic importance that we should know the range or distribution and full particulars of the habits of our native insects. The life-histories may at first sight appear too elaborate, but they are the minimum demanded by the present-day biologist in his researches on the relationship and classification of the *Lepidoptera* and other families. My excuse is that science demands that these details should be known. The bibliographical and synonymic lists appended to each species are as complete as it has been possible to make them. All the more important information gleaned from these has been made use of in the contributions, but where it would have been necessary to make long extracts reference to the original work has been made in the text. I should like to gratefully tender my sincerest thanks to Mr. W. G. Howes, of Dunedin, and Mr. G. V. Hudson, of Wellington, for the kindly help they have given me.

The following keys for the description of the ovum, larva, and pupa in the *Lepidoptera*, showing the minimum of information required, are useful to workers who desire to further our knowledge in this branch. The bibliography below, though not exhaustive, includes works known to the author to be of real assistance to any desiring a sound working knowledge of the subject.

For describing ova:—

- (1.) Class (flat or upright).
- (2.) Shape (if necessary, transverse and longitudinal sections).
- (3.) Dimensions (length, breadth, height).
- (4.) Sculpture (smooth, cellular, or otherwise).
- (5.) Micropyle (arrangement, number, and size of cells).
- (6.) Shell (strong, glossy, transparent, smooth, or otherwise).
- (7.) Colour (at laying and subsequent changes).
- (8.) Period of incubation; dates of hatching, &c.; manner of laying; other notes of interest.

For describing larvae, the following details should at least be included for each stage—i.e., after each successive moult (Tutt, "Hints for the Field Lepidopterist," pt. iii):—

- (1.) Colour and markings; detailed measurements of head, thoracic and abdominal segments; appearance of same; the position of a lateral flange, swellings, &c.; the number and position of prolegs.
- (2.) The number of subsegments to each segment, and the variation in their character on different segments.

- (3.) The position of the spiracles with regard to these subsegments.
- (4.) The character of the hooks on the prolegs; how arranged—whether in complete ring or only on a longitudinal flange, &c.
- (5.) The position of the primary tubercles i-vii, and their variation in position on the different segments.
- (6.) The structure of the primary tubercles i-vii, and the position of the primary seta (hair) with regard to secondary setae (if any of the latter are present), and the variation in structure according to the different segments on which they are placed.
- (7.) The presence of any secondary tubercles other than those already noted as primary i-vii.
- (8.) The character of the skin, and the presence or absence of secondary hairs not connected with definite tubercular structures.

Description of Lepidopterous pupae (Tutt, "Hints for the Field Lepidopterist") :—

- (1.) The general appearance, especially noting any particular and striking features of the coloration, &c.
- (2.) The general structure, especially any particularly striking points of development.
- (3.) The exact measurements.
- (4.) The general characters of the head, thorax, and abdomen.
- (5.) The number of movable abdominal segments.
- (6.) Peculiarities of the cremaster.
- (7.) Detailed description of the dorsal view: Head (if any visible), pro-, meso-, and meta-thorax (and wings), abdominal segments, traces of tubercular scars, subsegmentation, &c.
- (8.) Detailed description of the lateral view: Head, antennae, thoracic segments, and wings, abdominal segments, spiracles, traces of tubercular scars, lateral flanges, &c.
- (9.) Detailed description of the ventral view: Mouth parts, antennae, legs, maxillae, wings (with comparative lengths, &c., of these three last-named parts), abdominal segments, proleg-scars, genital organs, &c.

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No. 1. *Plusia chalcites* Esp.

Plusia chalcites Esp., Schmitt., 447, pl. 141, 3. *P. verticillata* Guén., Noct., 2, 344. *P. rogationis*, *ib.*, 344. *P. argentifera* Guén., *ib.*, vi, 352. *P. eriosoma* Dbld., Dieff. N.Z., 285; Butl., Voy. Ereb., pl. x, figs. 1, 2; Meyr., Trans. N.Z. Inst., xix, p. 36; Fereday, Trans. N.Z. Inst., xxx, p. 336; Butl., Cat. Lep. N.Z., p. 9, tab. 3, figs. 1, 2; Hudson, N.Z. Entomology, p. 82, pl. 10, figs. 8, 8a; Buller, Trans. N.Z. Inst., xiii, p. 237; Fereday, Trans. N.Z. Inst., vi, p. 175. *P. chalcites*, Hudson, N.Z. Moths and Butterflies, p. 35, pl. vi, fig. 3; Meyr., Trans. N.Z. Inst., xlv, p. 104; Lewis, *ib.*, xxxiii, p. 187; Meyr., *ib.*, xlii, p. 69; Hamilton, *ib.*, xliii, p. 122; Longstaff, *ib.*, xlv, p. 113; Watt, *ib.*, xlvi, p. 69; Hudson, *ib.*, xxxiii, p. 187.

The above bibliography refers only to the native species.

The Ovum.

This I have already described in detail elsewhere (Trans. N.Z. Inst., xlv, p. 69, pl. i, fig. 10).

Egg-laying.

The eggs are laid singly on the underside of the leaves of the food plant. The moth rarely lays more than one egg to a leaf. They are well attached,

and in most cases cannot be removed without damage. The moths lay throughout the summer right up till the end of autumn. The period of incubation differs considerably: in 1912 a batch laid on 20th May hatched on 18th June—that is, twenty-nine days; while this year (1914) a batch was laid on 26th March and hatched on 2nd April—only seven days. The weather during the incubation of this last lot was exceptionally hot, and this no doubt accounts for the shortness of the period. Eggs laid at the end of autumn would, in the case of a cold winter, remain unhatched till the following spring. The moth has a large egg-laying capacity, one in captivity laying over 500 ova within a space of thirty hours. Egg-depositing is carried on during the day as well as at night, though just at dusk is preferred.

The Larva.

1st stadium: Duration, 27th March to 1st April, five days. Length immediately after hatching, $\frac{1}{16}$ in. *Newly hatched*: Colourless; head, prothoracic shield, and tubercles black. A day later the legs become black,

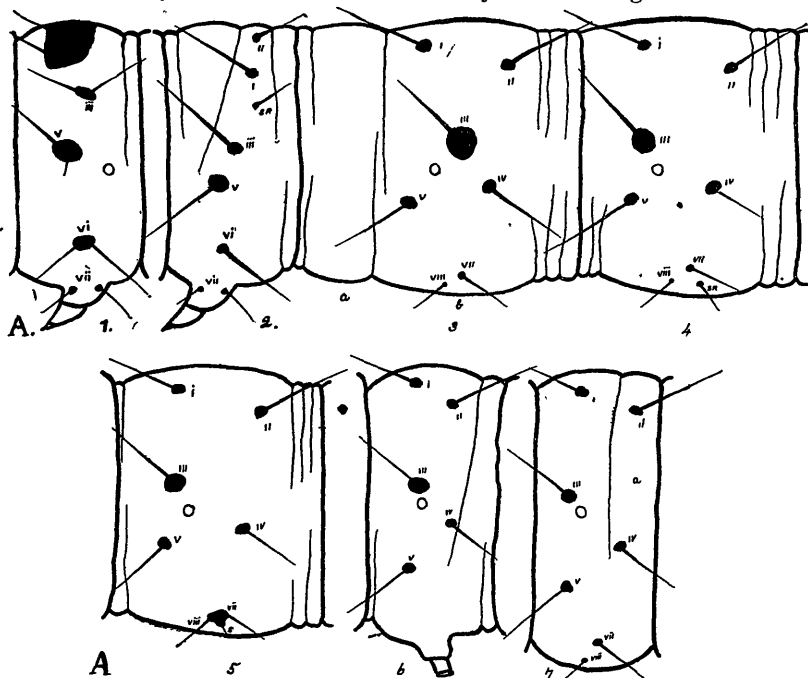


FIG. A.—Larva: 1st instar. 1, prothorax (note position of iii, v, and vi; iv absent); 2, metathorax (iv absent; sp, subprimary); 3, 1st abdominal segment (note iii and absence of vi); 4, 2nd abdominal segment; 5, 3rd abdominal segment; 6, 5th abdominal segment; 7, 7th abdominal segment (a, posterior subsegment).

NOTE.—Here and in subsequent figures the segments are not drawn to scale, but are lengthened in order to include all the tubercles. The whole importance has been placed in the positions of the various tubercles.

and, owing to the assimilation of food, the body is green. The thoracic segments are darker than the rest of the body, while the last two abdominal segments are blackish owing to the collection of undigested material

within the intestine. The alimentary canal is dark on account of the foodstuff within, and gives the larva the appearance of possessing a dark medio-dorsal stripe. The body is cylindrical, the 5th, 6th, and 10th abdominal segments bearing prolegs which are well developed; the crochets in each are arranged in an almost complete circle. Spiracles small, circular, brown, very inconspicuous. Trachial tubes white and easily seen. The body is clothed with a minute pile, the individual hairs of which are short and bristle-like, and appear to be black-tipped, but require a quarter-inch objective to be distinguished. It appears as though the membrane between the segments were more thinly clothed than the rest of the body, if not entirely smooth. The tubercles are all very conspicuous, and bear simple hairs. The head is well rounded and of medium size. The clypeus and portion between it and the cheeks seems slightly lighter in colour. Mouth parts brownish. Eyes conspicuous. Four fairly long hairs are placed on either cheek between the eyes and clypeus, the two uppermost being situated just below and at either end of the central facial suture, the remaining two are below and slightly anterior to these; the area within the eyes bears 3 smaller hairs in triangular formation, and an 8th very minute one is situated directly beneath the 5th eye. There appears to be ontogenetic relationship existing between these and the primary tubercles on the thoracic and abdominal segments. A black chitinous dorsal shield is present on the prothorax; it is trapezoidal in form, the anterior margin being of greater width than the posterior one. The front portion of the shield carries 4 long hairs directed out over the head, and 4 smaller similarly directed hairs rise from the hinder portion. Excepting a slight swelling of the dorsal portions of the last two thoracic segments above the general surface of the skin, there is no evidence of any meso- or meta-thoracic shield. The 3rd thoracic and 1st, 5th, and 7th abdominal segments are each divided into two subsegments, the posterior subsegment in the last thoracic and 1st abdominal segments being the greater and bearing the primary tubercles. The subsegments of the 5th abdominal are separated by a diagonal suture directed from above anteriorly, the anterior subsegment being the greater and bearing the tubercles. The posterior subsegment of the 7th abdominal is very narrow, but bears tubercles i and iv. The spiracles are situated laterally, slightly below and slightly anterior to the central portion of the segments, but in the 1st thoracic near the hind margin. Tubercle i is included in the prothoracic shield, but is placed beneath ii in the meso- and meta-thorax, being shifted above in the abdominal segments. In the 2nd and 3rd thoracic segments ii is very minute, more so in the meta- than in the meso-thorax, and is also included in the dorsal scutum of the prothorax. A small subprimary tubercle is situated between i and iii in the meso- and meta-thorax. Tubercle iii is well developed, and surrounded by a pigmented area, greatest in the 1st abdominal. It bears a single stout hair, except in the prothorax, where it consists of 2 hairs, fairly minute. Tubercle iii is pre-spiracular, except in the 1st abdominal, where it is post-spiracular; in the other abdominal segments is immediately beneath i, and in the prothorax beneath the posterior margin of the scutum. v is a small single-haired tubercle, subspiracular but anterior to iii; in the prothorax it is greatly enlarged, is suprspiracular, anterior to iii, and bears a minute secondary hair at its base. iv is absent in the thoracic segments, but is post-spiracular in the abdominals and above v, and slightly subspiracular. vi is a large two-haired tubercle on the prothorax, but on the meso- and

meta-thorax consists of a single hair only; is situated beneath v and between v and vii; is absent in the abdominal segments. vii consists of two separate tubercles on the thoracic segments, one on either side of the upper and outer margin of the leg, and seemingly forming the ends of a black semi-circular band that extends around the inner margin of the leg. On the 5th and 6th abdominals vii is absent, but on the rest it consists of a single minute tubercle beneath and slightly in front of iv. viii is extremely minute, and is beneath but anterior to vii. A minute subprimary tubercle appears in the 2nd, 3rd, and 4th abdominals, and is posterior to vii and beneath viii. In the 3rd and 4th abdominals tubercle viii and the subprimary are

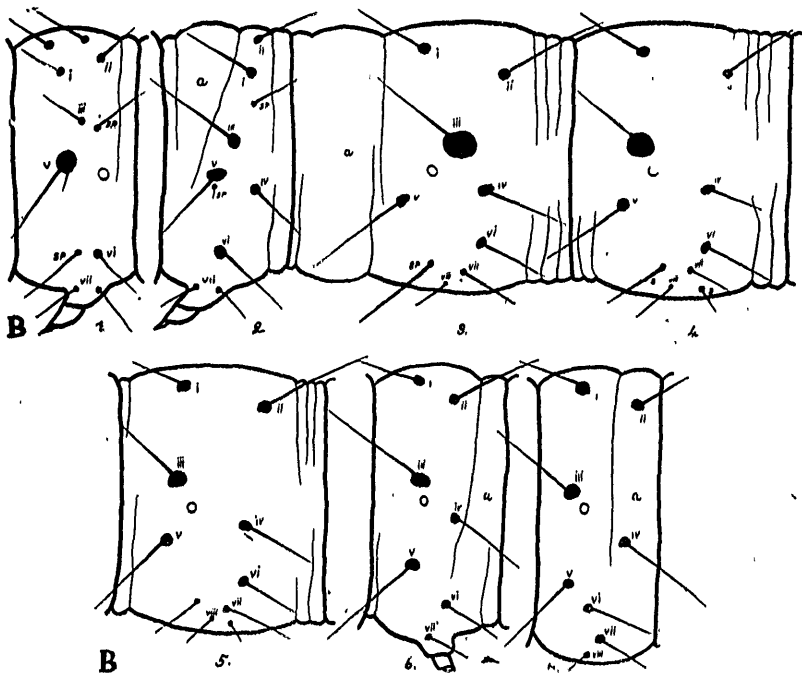
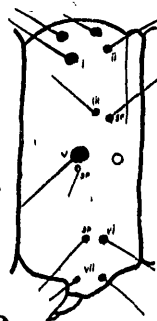


FIG. B.—Larva: 2nd instar. 1, prothorax (note iii and vi); 2, metathorax (iv is now present; a, anterior subsegment); 3, 1st abdominal segment (vi present; a, anterior subsegment); 4, 2nd abdominal segment (compare with 1st instar); 5, 3rd abdominal segment (compare with 1st instar); 6, 5th abdominal segment (a, posterior subsegment); 7, 7th abdominal segment (a, posterior subsegment).

moved up to and form a single connected triangular group with vii. The last two abdominal segments are much aborted. The 10th bears the two large anal prolegs, which are directed posteriorly, and the suranal plate, which is large, fleshy, and triangular in shape, bearing a comb of short stout bristles directed posteriorly. *2nd stadium*: Duration, 2nd April to 6th April, five days. Length immediately after the first moult, $\frac{3}{8}$ in. Head light green, mouth parts brownish, eyes black, legs grey. Body green, darker on dorsal surface; tapering towards head from the 8th abdominal segment. Tubercles bearing single simple hairs, black. The intestine forms a dark-green dorsal stripe, darker anteriorly. The clypeus is margined by a fine black line, which extends also along the central facial

suture. The posterior portion of the cheek bears a conspicuous black streak extending from the top of the head to just above the eyes. In the meso- and meta-thorax the scutellum is not at all distinct, the surface and colouring practically same as rest of body, neither chitinous nor horny. Spiracles as in stadium 1. In the prothorax tubercle i is beneath but a good way in front of ii. A subprimary tubercle is situated above and in front of ii, and a second in front and above i. iii consists now of a small single-hair-bearing tubercle, the second hair having separated and become a subprimary posterior to and slightly below iii. vi has also got rid of its second seta, which is subprimary and immediately in front. In the 2nd and 3rd thoracic segments a very minute subprimary tubercle appears immediately beneath and close to v. Tubercle iv has now made its appearance in the meso- and meta-thorax, and is situated behind v and iii, immediately below i. In the first four abdominals a second small subprimary has appeared anterior to viii and above vii. Tubercles vii and viii are now separated in the 3rd and 4th abdominals, and no longer form the single triangular group with the subprimary. vii is now present as a single small tubercle on the upper anterior portion of the proleg in the 5th and 6th abdominal segments. vi appears in the abdominals, being placed between iv and vii, but below v. *3rd stadium*: Duration, 7th April to 12th April, six days. Length immediately after second moult, $\frac{1}{16}$ in. The 8th abdominal segment bears a posterior dorsal hump. Body tapering from 8th abdominal segment to the head; colour green. In addition to the dark-green medio-dorsal stripe, 2 subdorsal stripes appear, one on either side of the dorsal one, and each consisting of two narrow white lines, the upper one slightly the broader. There is an exceedingly fine white spiracular line. The ventral surface of the body, together with the prolegs, is a light green. The true legs, eyes, and tubercles remain black. In the prothorax tubercle v has got rid of the second hair, which now forms a small subprimary tubercle immediately beneath it. Crochets on prolegs arranged in semicircle. *4th stadium*: Duration, 13th April to 17th April, five days. Length after third moult, $\frac{1}{16}$ in. Spiracles oval. The lower belt of the double subdorsal stripes runs below tubercle ii, while the other and broader belt runs level with it, but is indented so as not to enclose tubercle i. *5th stadium*: Duration, 18th April to 22nd April, five days. Length after the fourth moult, $\frac{1}{8}$ in. A third narrow white stripe is now added to the subdorsal lines and runs above tubercle i, so that now tubercles i and ii are situated in the intervals between the three subdorsal lines. There is a broad supraspiracular line of dark-green fading to the natural body-colour towards the anal end. Tubercle ii is white in the last nine abdominal segments. vi is white in the 3rd to the 9th abdominals inclusive, and v is white in the last abdominal. The tubercles on the suranal plate are white. There is a certain amount of slight variation in the colouring at this stage, but this is dealt with in full in a later paragraph. The sexes can now for the first time be distinguished, but this is also dealt with in the paragraph above referred to. Numerous



D.

FIG. D.—Prothorax: 3rd instar (note tubercle v, and compare with 2nd instar).

minute irregular white areas are scattered over the body, especially on the ventral and lateral surfaces. During the last four stadiums the pile on the body has been getting not larger or more distinct, but much denser,

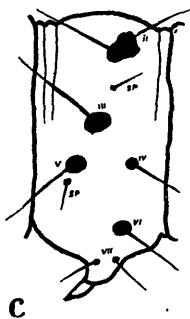


FIG. C.—Mesothorax of male larva in 5th instar (note coalescence of i and ii, and increased size of other tubercles).

and covering the whole surface of the body. *6th stadium*: Duration, 23rd April to 4th May, twelve days. Length immediately after fifth moult, 1 in.; full-grown, 1½ in. The black line along the central facial suture and the black margin to the clypeus are now missing. Black cheek-stripe very conspicuous, sometimes consisting of two separate short stripes end to end. Head small, non-retractile, light green in colour. The labrum is large, white, and conspicuous. Mandibles serrated. True legs and prolegs light green. Medio-dorsal and subdorsal stripes as in last stadium. Supraspiracular line ditto. Spiracular line white, broad, very distinct. Numerous small white areas on ventral and lateral surfaces, as in last stadium. Prolegs furnished with semicircle of crochets. Spiracles placed later-

ally, situated a little beneath and in front of the central portion of the abdominal segments, near the hind margin in the prothorax, oval, brown with dark margin, inconspicuous, those in the 1st thoracic and 8th abdominal segments greatly enlarged. Tubercles all bearing single simple dark-coloured hairs. Pile very dense, extremely minute, seemingly composed of short thick black-tipped bristles. 8th abdominal segment bearing large posterior dorsal hump, the body being much attenuated from it towards the head. Body cylindrical, slightly flattened ventrally. Tubercle iii is well developed, and is surrounded by a large pigmented area, greatest in the 1st abdominal segment, and diminishing in the 2nd, 3rd, and other abdominals. Arrangement of subsegments same as in 1st stadium; tubercles as in stadium 3. The hairs, which can be no decided protection to the body, are set in a peculiar manner, each one having a direction opposite to that of those immediately above and below it: for instance, i is directed up and forward; ii posteriorly and up; iii outwards, forward, and up; iv outwards, downwards, and back; v downwards, forward, and out; vi downwards, backwards, and out. This must surely be the beginning of a more elaborate protective system. Concerning the coloration of the tubercles, i is white, iv and v are white in the 3rd thoracic segment and abdominals; in the first nine abdominal segments all the tubercles are white except iii; there are no black tubercles on the last abdominal. Prior to spinning, the body becomes much lighter in colour, and the dark-green supraspiracular stripe becomes most conspicuous. The spinning of the cocoon takes place some six or more days prior to the final moult. A considerable amount of variation occurs in this stadium, details of which are given in the following paragraph. *7th stadium* (extra moult): All tubercles white, excepting those on the caput. The black cheek-stripe is very inconspicuous, and sometimes entirely absent.

Variation.

Larva.—In the 5th and 6th stadiums there is a certain amount of individual variation in the colouring of the tubercles. The most important

feature to be recorded is the difference between the sexes, which is to be found for the first time in larvae during the fifth instar. At this period in their life-history certain larvae (the males) have tubercles i and ii coalesced in the 2nd thoracic segment, while all the tubercles excepting i in the 9th and those on the suranal plate in the 10th abdominal segment are black, slightly enlarged, and most conspicuous. There is also a form very similar to this, the only difference being that tubercles i and ii in the mesothorax are not coalesced; these larvae appear, however, to be only a variety of the female form. In the next, the 6th, stadium it is far more difficult to distinguish the sexes. It appears that the tubercles i and ii in the mesothorax separate again, the only difference between the male and female larvae being that in the male all the tubercles of the thoracic segments are black, whereas in the female tubercles i, iv, and v are white in the mesothorax. There is room for much more work and observation here.

Imago.—Meyrick records a variety in which the golden-white discal spots are wholly absent. This variety appears to be extremely rare. The European species, according to Meyrick, differs very slightly from our species in having the hindwings yellowish anteriorly.

Habits.

Larva.—The young larva emerges at the micropylar end of the ovum, and generally makes its first meal off the empty shell. During the first day its movements are sluggish; later it becomes fairly active, but during the latter stadiums is again very sluggish. Throughout its larval existence it feeds on the underside of the leaves of its food plant, and stretches at full length, the ventral prolegs clasping the stem or midrib of the leaf on which it is feeding. The presence of larvae is plainly betrayed by the large irregular holes eaten in the leaves of whatever food plants they may be on. During the last few seasons the larvae of this moth have evidenced a decided taste for cultivated flower-plants, and in the case of dahlias and asters have acquired the habit of eating right into the heart of the expanding buds; in this way many flowers in full bloom hold a large fat caterpillar, which has absolutely ruined the flower from a marketable point of view. Strange to say, only a very close inspection of the flowers will reveal the true state of affairs, since the larva eats into them from below. It is during the first three stadiums only that the young caterpillars utilize a silken thread for descending from one leaf to another, and as a means of returning to the food plant when forced to drop from harm's way. The methods of defence differ somewhat according to age: during the primary stadiums the larva will at once drop to the ground on being disturbed, but as it grows older will content itself with throwing the fore part of the body sharply from side to side, even making striking movements with the head at the object disturbing it; if forced to drop, it will rapidly curl and uncurl itself with a flicking motion during its drop, and on striking the ground will hurriedly make off to hide among the leaves and rubbish, or, on the other hand, it may roll itself into a ball and remain motionless. Of course, its green colour, its markings and shape, and its habit of remaining on the underside of the leaves, and also of remaining, while eating, stretched out, and thus resembling a portion of a branch of the food plant, afford it great natural protection. A day or so previous to moulting the larva will seek a safe position beneath some leaf, and there stretches itself at full length. The prolegs are firmly attached to the cuticle of the leaf, but the true legs take no hold whatever, being held close against the body. During the next twenty-four hours

the colour gets much lighter, the whole body assuming a light yellowish-green tint. Prior to moulting the new head can be seen occupying the space between the old head and the prothorax, which space is thereby greatly extended. The eyes are plain, and the tubercles and hairs on the new skin can also be seen. The mouth parts of the new head are covered by the old mask. At intervals the fore part of the body lifts slightly, as though the larva were trying to stretch itself. Later these motions become more frequent, and the whole fore part of the body is allowed to hang some distance from the leaf; evidently the muscular effort that before held it straight with the rest of the body has been relaxed. The stretching movements become convulsive, the head meanwhile being thrown from side to side. At last the rear segments appear to swell slightly, the ones in front remaining in their former state; then each segment in turn, from the last abdominal to the first thoracic, is slightly inflated, the whole appearing as an undulatory movement towards the head as if the inner body were gliding within the old skin; having reached the head, the motion begins anew at the anal end and proceeds as before towards the head. Several times this pumping-like action occurs, each new motion commencing on the completion of the previous one, and after each the segments gain in size. Then shortly these motions follow with shorter intervals between, till with one supreme effort the old skin is parted round the neck and the new body appears to be forced out of the old skin segment by segment; in reality the old skin is being forced back. When the prolegs are reached the larva helps free itself by pulling forward. The larva, now free of its old skin, still retains the mask covering the mouth parts; this it rids itself of by rubbing against the leaf, and then, that accomplished, curls itself up to rest. Almost invariably the freshly emerged larva will consume its discarded skin. In the last two or three stadiums the larva spins a light carpet of silk on the surface of the leaf previous to moulting, in order to securely attach the prolegs during the operation of casting its skin. From the time the larva takes up its position previous to moulting till some hours after the moult, the whole period extending sometimes into two or three days, it takes nothing to eat; it is on account of this, and the total removal of all undigested food from the alimentary system, that it becomes so much lighter in colour at these periods. An interesting point connected with the feeding of these larvae is that they can change from one food plant to another—for instance, specimens under observation which had been fed up till the 4th stadium on *S. nigrum* took readily to dahlia, salvia, and potato; and *vice versa*. Temperature and other climatic conditions have a great deal to do with extending or shortening the duration of the stadiums. A cold spell may greatly lengthen them, or even increase the number of stadiums beyond the normal, and also has the effect of dwarfing the larvae; such larvae may hibernate through the winter months.

Recapitulation.

1st stadium: Body green; head black; spiracles circular. 2nd stadium: Body and head green; clypeus black-margined. 3rd stadium: Double white subdorsal stripe appears. 4th stadium: Spiracles oval. 5th stadium: Triple subdorsal stripe; tubercles ii in segments 2 to 10 (abdominals) inclusive white; vi white in abdominals 3 to 9 inclusive. 6th stadium: Black margin to clypeus missing; tubercles on abdominals white, excepting iii. 7th stadium: Extra moult; tubercles all white.

Periods.

Period of incubation, seven days; weather hot. 1st stadium: March 27 to April 1, five days; length, $\frac{1}{16}$ in.; mild. 2nd stadium: April 2–6, five days; length, $\frac{3}{16}$ in.; mild. 3rd stadium: April 7–12, six days; length, $\frac{5}{16}$ in.; colder. 4th stadium: April 13–17, five days; length, $\frac{7}{16}$ in.; mild. 5th stadium: April 18–22, five days; length, $\frac{8}{16}$ in.; mild. 6th stadium: April 23 to May 4, twelve days; length, $1\frac{1}{2}$ in.; cold. Duration of pupal stage, eighty-five days; cold weather.

Notice the comparatively equal duration of the stadiums, and the influence of the weather upon these. As mentioned in a former paragraph, temperature may be the cause of lengthening or shortening these periods, or even of increasing the normal number of stadiums. By separating one batch into two lots, and treating one of the lots to artificial temperature a few degrees higher than that prevailing in the open, the 3rd stadium was shortened from five to two days only.

Food Plants.

Solanum aviculare, *S. nigrum*. These were, in all probability, the original food plants, but the larvae have now taken almost exclusively to introduced plants, and are in consequence becoming a dangerous pest to the flower-gardener. The larvae are now seldom found on *S. aviculare*, and then only in parts where introduced plants are still scarce; they still, however, favour *S. nigrum* even in richly cultivated districts. The following introduced plants are eagerly eaten: Dahlia, salvia, geranium, potato, tomato, nettle (introduced), beans, Scotch thistle, mint, horseradish.

Parasites.

The larva is often attacked by a small Hymenopteron belonging to the family *Braconidae*. These parasites, to the number of thirty or more, emerge from their host just prior to its pupating, and spin their small cream-coloured cocoons on the leaves of the plant on which the host has been feeding. The victim may be found later lying upon the ground, its sides scarred by large open circular black-edged wounds from which parasitic larvae have emerged. Prior some days to the exit of the parasites the larva becomes very torpid, moving but little, and eating nothing; externally nothing appears to be the matter with it. The cocoons of the parasite are short, cylindrical, and very fluffy, and are collected in small heaps upon the leaves. One unacquainted with the life-history of these little creatures would often be puzzled to account for the presence of small masses of the cocoons on the leaves of many garden plants. The duration of the pupal existence is about forty-six days. At present this Hymenopteron is unidentified.

The Cocoon.

The favourite situation for the cocoon is between two or more leaves some little distance from the ground. The silk is white and strong, and the cocoon rather fluffy externally, and is never so thick but what the enclosed pupa can be easily distinguished. It often happens that the larvae will forsake their food plant to spin in vegetation yards away. The construction occupies from two to three days.

The Pupa.

At first the pupa is considerably active if disturbed, twirling its abdomen with a circular motion; later, however, it becomes much less active.

The newly formed pupa is bright green in colour, the dorsum shortly becoming dark brown to black. In a week's time the general colouring is black, the ventral parts being lighter in colour. Till shortly before emerging, the base, dorsum, and termen of the forewings retain a considerable amount of the original green. The intersegmental membrane is reddish brown. Laterally the apex of the head is in front of the axial line, the

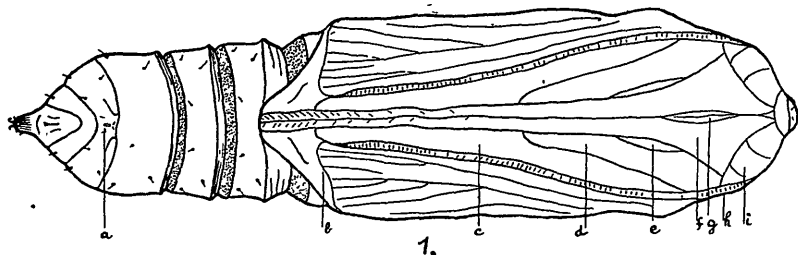


FIG. 1.—Pupa: Ventral view. *a*, female genital organs; *b*, Poulton's line; *c*, 2nd legs; *d*, 1st legs; *e*, femur of 1st legs; *f*, maxilla; *g*, labial palpi; *h*, antenna; *i*, eye.

NOTE.—All illustrations of pupae are to scale.

dorsal line sloping forwards at the prothorax. The dorsal outline of the abdominal segments is practically straight, the individual movable segments, of course, being somewhat rounded when extended. The posterior margin of each movable abdominal overlaps the anterior portion of the segment behind it when the body is contracted, and when in this position the dorsal line is straight. From the 8th abdominal both dorsal and ventral margins rapidly converge towards the cremaster. The anterior convexity of the head terminates laterally in a small prominence above the eye, bending round here and slightly curving downwards and outwards to the end of the first legs. The ventral line continues straight from here to the extremity of the wings, where it is abruptly terminated by the extremity of the maxillae, which protrude from the abdomen for a distance of 0.75 mm. The ventral margin of the abdominal segments below this is straight as far as the 8th abdominal. The anterior extremity of the pupa is about the front portion of the epicranium; from this point it slopes forwards about 2 mm. The labrum is somewhat triangular in shape, rounded between the eyes, and bears 2 small tubercles near its upper margin. The clypeus is marked off by a fine suture. The frontal headpiece is almost square in outline, slightly longer than broad, and forms a prominence above the eyes; it is almost smooth, the only sculpture being a slight network of fine lines, sometimes slightly depressed centrally. There is no dorsal headpiece. The proboscis is prominent, standing out as a rounded keel till about 6 mm. from its origin; throughout this distance it is the most prominent part of the front of the pupa: at first narrow between the cheeks, it then widens out and forms an angle where the 1st leg meets the eye; either side measures 1.70 mm. from middle line to angle; it proceeds, gradually narrowing, to wing-apex, 14.11 mm. The greater part of the maxillae is smooth, though fine lines may be seen with a lens; the basal portion, however, for about 3 mm. is marked with strong

transverse rugae. This rough area varies a good deal in its extent. The central line is divided at the base of the maxillae, and encloses a small triangular portion, the base of which adjoins the labrum; a little farther down, on a line with the base of the eyes, the central line again divides, and encloses a long narrow strip 4 mm. long and about 0.25 mm. across at its greatest width. This area is a portion of the labial palpi, and is divided by a central suture. The antennae show every joint very distinctly, and are somewhat roughened. The scape of each antenna is square in

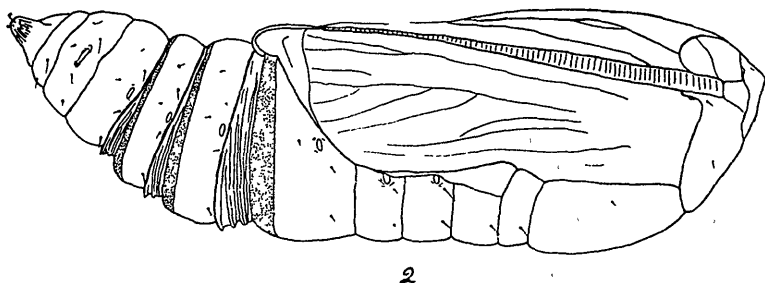


FIG. 2.—Pupa: Lateral view.

outline and plainly marked out. The prothorax has a slight central suture and a sculpturing of fine lines; the postero-lateral extremities are elongated, forming 2 narrow tongues extending down alongside the antennae for 0.54 mm., the 1st spiracle being imprisoned in the angle so formed, the posterior margin of the prothorax projecting over it like a lid just raised from the aperture. The 1st legs have a narrow margin against the eyes and antennae, are wide and large, the greatest width being 1.25 mm. Between them and the maxillae is a small strip 1.74 mm. long, the 1st femur.

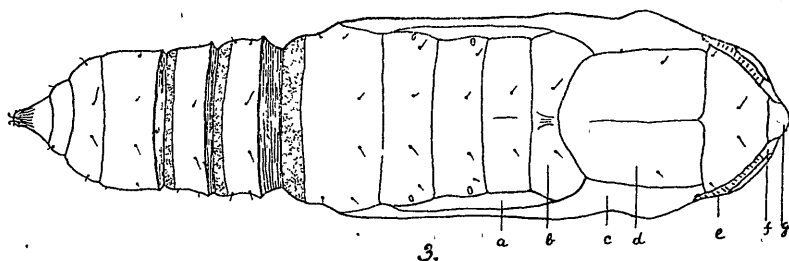


FIG. 3.—Pupa: Dorsal view. *a*, lower or hind wing; *b*, metathorax; *c*, upper or fore wing; *d*, mesothorax; *e* prothorax; *f*, scape of antenna; *g*, frontal headpiece.

The 2nd leg is somewhat narrower than the 1st, both legs having a slight transverse sculpturing. The mesothorax has an appreciable sculpturing in labyrinthine wrinkling, and there is a well-marked central suture. The wings are finely sculptured, and the nervures are easily seen. Poulton's line is gracefully curved, and cuts off a fairly large triangular area. The metathorax has a deep central suture, and is covered with fine labyrinthine wrinkling. The narrow strip of the hindwing has its greatest width at the

juncture of the metathorax and 1st abdominal segment, and disappears opposite the spiracle of the 3rd segment. The abdominals are smoother than the thoracic segments, the 1st abdominal possessing a strong central suture, which is sometimes also traceable on the 2nd segment. Subsegmentation is not apparent. The movable incisions are between 4-5, 5-6, and 6-7. The 5th, 6th, and 7th segments possess a flange on their anterior margin; the surface of the segment, instead of being curved down to the incision, continues directly forwards and then outwards at a sharp angle on the dorsum, but with a little final curve on the sides, to the sharp margin of the flange; the portion of the segment anterior to the flange is furnished with a series of curved transverse rugae, greatest dorsally. When the segments are flexed the anterior surface of the flange comes against the soft flexible posterior margin of the segment in front, which is full and rounded in such a way that the flange fits against it. The spiracles lie laterally behind the flange, forcing it back slightly in the 6th and 7th segments, are oval with raised lips, large and conspicuous; those of the 8th abdominal are abortive. There is no evidence of the larval prolegs. The cremaster (fig. 4) bears 2 large hooks, the extremities of which are whorled and project ventrally and laterally; 4 smaller flattened hooks, arranged one above the other, are situated above these, there being 2 on either side

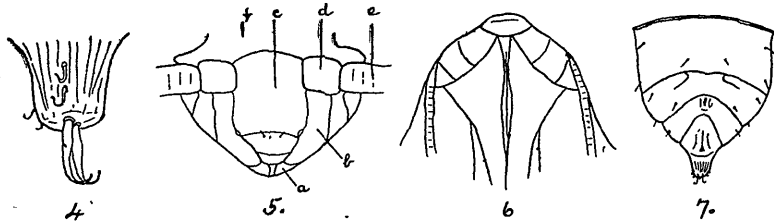


FIG. 4.—The cremaster.

FIG. 5.—Pupa: Frontal view. *a*, maxilla; *b*, eye; *c*, frontal headpiece; *d*, scape antenna; *e*, antenna; *f*, prothorax.

FIG. 6.—Head portion of male pupa (note labial palpi).

FIG. 7.—Genital organs of male pupa.

of the cremaster, and 2 others on the dorsal surface just above the large posterior hooks. The tubercles are nearly all present, but are very minute, and bear very short single simple setae; they occupy the same positions as in the larva, but ii, vii, and viii appear to be absent. The female genital organ is situated on the ventral surface of the 8th abdominal, towards the anterior margin; is represented by a short longitudinal line surrounded by an oval and slightly raised area, and on either side of this the surface of the segment is somewhat elevated anteriorly. The male pupa is distinguished by two very marked differences of structure. The labial palpi occupy almost the whole margin of the labrum between the eyes, and are but slightly constricted between the maxillae (fig. 6). The male genital organs are represented by a very well defined depression guarded by two lips, one right, the other left, and are confined to the 9th abdominal segment (fig. 7). The 8th segment is free from any structure excepting the lateral flattened tubercles mentioned above. The male is slightly more robust than the female pupa.

This pupa has been described much fuller than is necessary, in order to show all the points that must be considered when studying pupae in general. The following table of measurements is valuable and more luminous than any verbal description. The plan is that adopted by Tutt in his "British *Lepidoptera*." In the pupa the length will vary slightly according to the amount of extension of the free incisions. In the present table the measurements are from a typical specimen with incisions slightly extended.

Table of Measurements.

Measurement at	Length from Front.	Transverse Diameter.	Anterior-posterior Diameter.
	Mm.	Mm.	Mm.
Top glazed eye	0.50	1.31	1.76
Outer angle maxilla	1.74	4.02	4.51
Prominence at base of forewing	4.00	5.26	6.53
End of 1st legs	7.61	5.20	6.01
End of 2nd legs	13.10	5.10	5.77
End of maxillae	14.11	4.74	5.43
Spiracle, 5th abdominal	14.86	4.00	4.51
" 7th "	17.63	3.80	3.66
9-10 incision	20.23	2.00	1.53
Base of cremaster	21.71	0.66	0.61
Extreme length	22.46	..	..

Dehiscence.

The maxillae-cases, leg-cases, and antenna-cases separate in one piece as far as the end of the 1st legs. The headpiece and prothorax are separated in one piece, and are liable to be lost. The eye-covers also appear to separate and to be removed from between the proboscis and the antennae, these latter standing out as a central and two lateral projections to the appendage-cases piece. Dorsally there may be a slight central fracture of the meso-thorax.

The Imago.

This has already been ably described by Meyrick (*Trans. N.Z. Inst.*, xix, p. 36), and by Mr. Hudson in his "New Zealand Moths and Butterflies," p. 35, pl. vi, fig. 3, to which the reader is referred.

Habits of Imago.

The moth is both nocturnal and diurnal, and may frequently be seen during the summer flying swiftly from flower to flower in the hot sunshine. It is common from September till the beginning of June, and specimens may be found during the winter months, provided the cold is not too severe.

Distribution.

Is common in the North Island, but appears to be rare in the southern portions of the South Island, if not quite absent. Has been recorded from Auckland, New Plymouth, Wanganui (March to June), Napier, Wellington, Nelson, Blenheim, and Kamo. Also Australia, Pacific islands, India, Madagascar, South Africa, southern Europe, southern England, and North and South America.

No. 2. *Nyctemera annulata* Boisd.

Leptosoma annulatum Boisd., Voy. de l'Astr., Ent., v, p. 197, pl. 5, fig. 9 (1853); Doubl., Dieff. N.Z., 2, p. 284. *Nyctemera double-dayi* Walk., Cat. Lep. Brit. Mus., 2, p. 392. *N. annulata* Butl., Cat. Lep. N.Z., p. 4. *Leptosoma annulatum* Bates, Ent. Mo. Mag., 5, p. 2. *Nyctemera annulata* Meyr., Proc. Linn. Soc. N.S.W., 1886, p. 760; Trans. N.Z. Inst., xxii, p. 218; *ib.*, xlii, p. 67; *ib.*, xlv, p. 93; Fereday, List N.Z. Lep., Trans. N.Z. Inst., xxx, p. 331; *ib.*, vi, p. 172 (as *Leptosoma annulatum*): Hudson, Man. N.Z. Ent., p. 73, pl. 9, figs. 3, 3a, 3b; N.Z. Moths and Butterflies, p. 2, pl. 4, figs. 1, 2, pl. 3, fig. 9; Trans. N.Z. Inst., xlv, p. 65; *ib.*, xxxvii, p. 337; Smith, Entom., 26, p. 220; *ib.*, 34, p. 141; Thompson, N.Z. Naturalist's Calendar, p. 7; Buller, Trans. N.Z. Inst., xiii, p. 238; Quail, Trans. N.Z. Inst., xxxiii, p. 164; *ib.*, xxxiv, p. 228; Entom., 1901, p. 143 *et seq.*; Howes, Trans. N.Z. Inst., xxxiii, p. 188; Philpott, *ib.*, xxxix, p. 213; *ib.*, xxxiii, p. 167; Watt, Trans. N.Z. Inst., xvi, p. 69; Hamilton, *ib.*, xli, p. 44; *ib.*, xliii, p. 116; Longstaff, *ib.*, xlv, p. 110 (as *Deilemra annulata*): Hutton, Trans. N.Z. Inst., ix, p. 355.

The Ovum.

This I have fully described elsewhere (Trans. N.Z. Inst., xvi, p. 69).

Egg-laying.

The ova are invariably laid on the underside of the leaves of the food plant, are lightly attached, and are generally arranged in small regular batches of from 10 to 30 or more; occasionally they are laid loosely. The eggs are deposited from September to June, but it seems improbable that the winter is spent in this form.

The Larva.

Although Mr. Quail has already (*Entomologist*, 1901, p. 141) described the larva, it has been found necessary to correct some slight mistakes and omissions. The short summary below is supplementary to Mr. Quail's paper, and should be read in conjunction with it, since it is not intended that it should replace the original description.

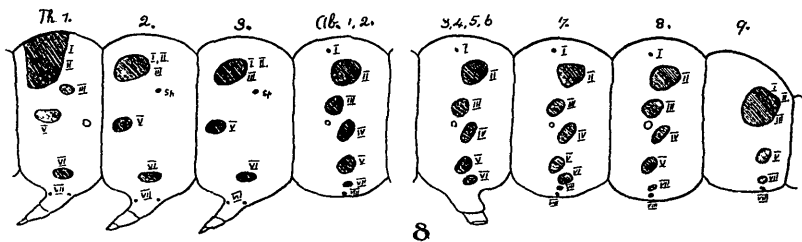


FIG. 8.—Larval tubercles: 2nd and subsequent stadium.

Tubercle i consists of a small tubercle bearing a single spinulose seta; unlike the other tubercles, it remains in this primitive form throughout the larval life; in the prothorax it is included in the dorsal scutum, and conjoins with ii and iii in the meso- and meta-thorax to form a large

anterior trapezoidal tubercle or wart. ii is beneath and behind i, and is also included in the prothoracic shield. iii is immediately beneath i, and is supraspiracular in the prothorax; it is below and posterior to the scutellum, pre-spiracular, and bears 2 light-coloured setae; it retains this position and primitive form in the prothorax throughout the larval existence. In every stadium there is a minute secondary tubercle bearing a single seta situated below and posterior to the large anterior trapezoidal in the meso- and meta-thorax. v is beneath the spiracle and below iv, is pre-spiracular in the prothorax and immediately beneath the scutum, and in the abdominal segments is inclined to be post-spiracular. iv is absent in the thoracic segments, but is close below and behind the spiracle in the abdominals. vi is present in the thoracic segments above the base of the legs, and posterior to v; in the 1st stadium is absent in the abdominals, appearing, however, in the 2nd and subsequent stadiums in the 3rd to the 7th abdominal segments inclusive, being situated in the 7th abdominal between v and vii but posterior to both; in the other segments mentioned is above the base of the legs, below but posterior to v. vii consists of a small group, one on either side of the upper margin of the thoracic legs; is present directly beneath v in the 1st and 2nd abdominals; is absent in abdominals 3 to 6 inclusive; is below and slightly posterior to v and beneath and anterior to vi in the 7th abdominal. viii is immediately beneath vii—if anything, slightly anterior. There is no alteration in the position of, addition to, or removal of tubercles after the 2nd stadium. The spiracles are circular, with dark rims; small and light in colour during the first two stadiums, but becoming oval and still less conspicuous in the 3rd and subsequent ones. A thick pile covers the body throughout the larval period, becoming thicker and darker after each successive moult. The setae, excepting those of the head, are at all stages spinulose. In the latter stadiums the body tapers towards the head from the 7th abdominal segment.

Development of Larval Markings.

Immediately after hatching, very pale; hairs black, tubercles light-coloured. Second day: General colour a dirty grey to the naked eye, but of a green tint when examined under the microscope. Tubercles, scutellum, and head black, mouth parts and central portion of the cheeks brownish. Towards the end of this period two reddish-brown subdorsal bands extend the whole length of the body, and include tubercles ii and iii, each band being produced ventrally in order to include iii. In the abdominal segments the postero-dorsal margin of the stripes converge and sometimes unite, forming a narrow transverse belt across the dorsum of each segment. Reddish areas surround the tubercles. *2nd stadium:* Head, legs, and spiracles black. Subdorsal bands as in last stadium. Between the subdorsal bands each segment has an anterior and posterior area of light yellow, the intervening space being white. Body generally light yellow. There is a narrow subspiracular line of reddish brown and a reddish area surrounding tubercle iii. *3rd stadium:* Narrow yellow medio-dorsal stripe. Subdorsal stripes broad, black. Yellow spiracular line interrupted by a large white area on each segment beneath the spiracle. Subspiracular line narrow, very dark brown to black; below this is a very narrow white line with a narrow dark-brown line separating it from the ventral surface, which is of a light-slate colour. *4th stadium:* Dorsal line yellow with a distinct reddish tinge. Subdorsal lines black and very broad. Spiracular lines narrow and broken, reddish yellow. Beneath the spiracular line the

skin is mottled with brown, the ventral surface brownish. *5th stadium* (full-grown): Dorsal line narrow, reddish. Subdorsal stripes black, tubercles blue. Frequently the subdorsal stripes are connected by narrow black transverse bands about the middle of the segments. Spiracular line interrupted by alternate areas of red and yellow. Subspiracular line black.

Variation.

Larva.—There is no marked variation among the larvae, though there may be some slight variation in colour, and also in the comparative lengths, numbers, and coloration of the tubercular setae. It appears that corresponding tubercles on many larvae, and even on the same specimen, do not always bear the same number of setae. In many cases the tubercles bear a certain number of white hairs intermixed with the black ones, but this does not seem to be of any physiological importance, since some larvae possess many more white setae than others do. As a rule, such coloration is symmetrical—that is to say, if certain hairs are white on one tubercle the corresponding hairs on the same tubercles of all the other segments will be white also.

The Imago.—Mr. Hudson records that the species varies a good deal in the extent of the cream-coloured markings.

Table of Main Protective Setae.

The figures in the following table, though as accurate as possible, are only approximate, owing to the difficulty of correctly counting the setae; but they are of interest since they show various phases of growth which will be dealt with fully in the paragraph on habits.

Period.	Length of Longest Hairs on Dorsal Tubercle of the Mesothorax.	Length of Longest Hairs on Post-trapezoidal of Abdominals	Number of Hairs on Dorsal Tubercle Meso- thorax	Number of Hairs on Post-trapezoidal Abdominals.
	Mm.	Mm.		
1st stadium	1.17	0.47	3	1
2nd stadium	1.75	0.82	14	8
3rd stadium	4.10	1.51	36	19
4th stadium	5.53	1.76	38	27
5th stadium	7.57	2.53	40	30

Periods.

Period of incubation, about fifteen days Hatched, 15th February, 1914. 1st stadium: February 15–19, four days; length, $\frac{1}{16}$ in. 2nd stadium: February 20–23, four days; length, $\frac{3}{16}$ in. 3rd stadium: February 24–28, five days; length, $\frac{5}{16}$ in. 4th stadium: March 1–6, six days; length, $\frac{9}{16}$ in. 5th stadium: March 7–16, ten days; length, $\frac{3}{4}$ in. Length when full grown, $1\frac{1}{8}$ in. Duration of pupal period, March 17 to April 3, eighteen days. Total, forty-seven days.

Table published by Mr. Quail: 1st stadium, seven days; 2nd stadium, six days; 3rd stadium, seven days; 4th stadium, ten days; 5th stadium, fifteen days; 6th stadium, 145 days (hybernated); 7th stadium, twelve days; 8th stadium, fourteen days. Duration of pupal period, thirty-two days. Total, 248 days.

The above table gives a total period, exclusive of the egg state, of forty seven days. Another batch under observation made a total of seventy-seven days. Contrast these with Mr. Quail's table, with a total of 248 days. Here the normal number of five stadiums has been extended into eight on account of the season, on which account also the larvae hibernated in the 6th stadium for 145 days.

Habits of Larva and Imago.

The Larva.—On hatching, the young larva makes its first meal off the empty shell. During the first three stadiums it keeps to the underside of the leaves of the food plant, seldom exposing itself on the upper surface, except perhaps during hot sunshine, and eats only the under portion of the leaf, not eating right through and thereby leaving conspicuous signs of its presence. During this time also it utilizes a silken thread in order to reach fresh feeding-grounds on leaves below, or to regain the food plant if forced to drop to the ground for defensive purposes. The slightest disturbance during these three periods is generally sufficient to make the larva hurriedly drop from the leaves, and on reaching the ground it will curl itself up, the long hairs of the 2nd thoracic and anal abdominal segments intermingling and so protecting the head. The larvae dislike overcrowding, and on coming into contact with one another will rear up the fore part of the body and strike from side to side, even making attempts as though to bite. In the last two stadiums the habits undergo important changes: the larva will freely expose itself while feeding, and, in fact, feeds almost exclusively on the upper portion of the leaves; as a rule, they are not so liable to drop from the food plant when disturbed; they do not use the silken thread if so forced to drop; instead of a life of seclusiveness, they become nomads, often ranging great distances in search of fresh food; and, lastly, they eat large holes out of the leaves of their food plants, thereby making their presence most apparent. In short, their life after the 3rd stadium changes from one of retirement to one of self-advertisement. Turn now to the table of the main protective setae and to the paragraph on the development of the larval markings. You will note in the latter paragraph that the markings during the first half of the larval existence are mainly protective, as distinguished from aggressive, which form they assume during the two latter stadiums. From the table of the main protective setae we find that the number of the hairs increases rapidly during the first three instars, increasing but slightly during the last two; whereas their length increases almost uniformly in each of the five stadiums. Turning now to the period table, one cannot help noticing the similarity in length of time of each of the first three stadiums, and the shortness of their duration as compared with the rest. In the batch mentioned the 1st stadiums occupied only thirteen days out of the total of twenty-nine, and in Mr. Quail's table these three stadiums occupied but twenty days out of a total of 216. The first three stadiums, during which the larva is to a certain extent unprotected and therefore leads a seclusive life, are, on that account, greatly shortened, while the protective development proceeds rapidly. It is in the latter two, during which the protective devices, being almost perfect, change but little, that the greatest amount of growth is attained, and in which the caterpillar spends the greatest portion of its larval life-period. It is unnecessary to dwell further on the above facts.

I have tried many experiments in order to test the sight and sense of direction of these larvae, but no very definite assertions can yet be made

on these points. From my experiments it appears that their sight is poor, and that the larvae are influenced more by large objects, even at a distance, than by much smaller and closer things. Larvae placed in the open on bare ground were seemingly attracted by high trees in the immediate neighbourhood, but failed to observe or direct their way to small food plants and other objects of 2 in. or 3 in. in height placed within a few inches of their path; they even seemed quite unaware of such objects placed right in their way till the long hairs of the thoracic segments, which project out over the head, came in contact with them. This seems rather curious, since a larva will frequently, while crawling on the ground or elsewhere, halt and rear the head as high as possible, as though to take a very comprehensive view of all the surroundings. When they are travelling in the open they always appear to have some definite object in view, and to be going straight to it, and it generally needs an insurmountable obstacle to force them to make a definite change of direction. Larvae crawling over large sheets of cardboard would more or less change their course on the sheet being turned, though they would rarely hit exactly on their original direction; but many more experiments are necessary. Regarding sound and hearing, it seems as though this larva were quite deaf; apparently no amount of noise produces the slightest effect, yet it is appreciable of the minutest vibration imparted to the object on which it may be feeding.

During the summer months they are often to be found crawling over the paths, and can travel at a fair speed; one that was timed traversed 4 ft. in a minute. I am told by several reliable authorities that these larvae are a serious pest to cereal crops, and a few years ago caused a great amount of devastation in the Wangachu district, ruining field after field of oats; on one occasion numbers of them crossing the railway-line on a steep grade from one field to another caused the stoppage of the express*.

Prior to moulting, the body becomes dark in colour, and the hairs of the coming instar—or, rather, of the new skin—can be plainly seen. The larva seeks a secluded position on the underside of a leaf, and will spin a light silken carpet in which to firmly wedge the crochets of the prolegs. It seems as though this habit of carpet-laying is not acquired till after the third moult. The anterior portion of the prothorax gets greatly extended, and on the sides the eyes of the new head can be distinguished under the overlying layer of skin; the new mandibles can be seen occupying the cheek-spaces of the old head. These characteristics are peculiar to the period just prior to the moult in all lepidopterous larvae. Actual moulting operations are exactly similar to those of *P. chalcites*. The true legs throughout the operation are held close to the leaf, but are not fixed on it in any way. The skin eventually breaks behind the head, and is gradually worked back off the body, the last few abdominal segments, however, being pulled out by the larva itself. During the next hour or two it will remain quiet, occasionally making convulsive movements in order to expedite the drying and setting of the setae. The actual process of moulting may occupy only a minute or less.

The Imago—The imago is diurnal, and is a rather lazy flyer, except during the early hours of the morning soon after sunrise and in the early evening, when it may be seen flying very high and around the tops of the

* Since writing the above I have communicated with Mr. G. V. Hudson on this subject. He says he has never heard of the larva feeding on oats. Probably my informants may have made a mistake in identity.

highest trees. This peculiarity has been recorded by several observers. While resting, the wings are held flat, the dorsal margins of the upper wings being parallel, thus giving the moth its characteristic triangular appearance.

The Cocoon.

Prior to spinning, the larva becomes very restless if disturbed, wandering hastily and aimlessly about the food plant, and feeds but little, if at all. Later it forsakes the food plant, those in captivity having a tendency to crawl to the top of their breeding-cage. The cocoon is constructed amongst neighbouring rubbish on or near the ground, a favourite place being under the loose bark of near-by trees. Actual spinning operations last about two days. The cocoon appears to be constructed in two portions—an outer and somewhat fluffy case, after the construction of which the larva rests some hours; and an inner and more close and compact lining, sticky, and containing a large number of the long spinulose hairs of the larva; these, being but loosely set in the larval epidermis, become caught in the lining of the cocoon during spinning and become detached, and so help to strengthen it. When all is finished the larva rests in an inverted position, and about two days later undergoes the final moult, appearing as a pale-white-coloured pupa. It rapidly attains its black and yellow coloration, which it retains till just prior to the emergence of the imago, when the yellow areas become almost entirely obscured, the general appearance being black. Hutton records (*Trans. N.Z. Inst.*, ix, p. 355) that the pupa is hung to trees, palings, grass, &c.: this must undoubtedly be a mistake.

Food Plants.

New Zealand groundsel (*Senecio bellidioides*), *Senecio scandens*, *S. vulgaris*, *Cineraria maritima*; also responsible for the large holes so often to be seen in the rangiora-leaves (*Brachyglottis repanda*); has been found feeding on *Senecio Turneri*, *S. Hectori*, *S. sylvaticus*, *S. latifolius*, *Erechtites arguta*, and cereals.

Parasites.

Nemorea nyctemerianus. Mr. Hudson records ("Manual of New Zealand Entomology," p. 59, pl. 7, fig. 6) that the eggs are deposited on the moth-larva at an early age. The maggot eats its way out during the pupal stage of the moth, and changes into a dark-brown pupa, being protected by the cocoon of its host. I have not come across any of these parasites in the Wanganui district.

The Pupa.

It has been found necessary to rewrite Mr. Quail's description, owing to several omissions concerning important structural details which if included here by themselves would be valueless for want of further information.

Length, $\frac{5}{8}$ in.; greatest width, about $\frac{1}{4}$ in. The general colour is black, but there may be a slight brownish tinge in some; the nervures of the wing-cases are yellow. Mr. Quail records one specimen having the wing-cases almost entirely yellow. Yellow areas on the abdominal segments form 4 longitudinal lateral series, 1 large mid-ventral, and a large mid-dorsal. The shape is robust, thickest near the posterior margin of the 3rd abdominal segment. The head is ventral; mesothorax swollen anteriorly, and a waist is formed dorsally at the juncture of the metathorax and the 1st abdominal segment. The wing-cases extend to the ventral posterior edge

of the 4th abdominal; a narrow strip of the hindwing extends to the posterior edge of the 3rd abdominal; Poulton's line cuts off a very narrow strip only. The spiracles are conspicuously elevated, position on 2nd abdominal almost dorsal, on other segments placed rather high; colour black; shape oval. The abdominal incisions are distinct and sharp; the anterior edge of the segments has a flat sloping rim, and all are covered with innumerable minute pits, which Quail considers are probably associated with the fine larval hairs. The pupa has no power of movement. Quail writes that he could find no trace of setae corresponding to the tubercle-setae of the larva, but this is a mistake. During an early period of the pupal existence—that is to say, before the yellow abdominal areas become obliterated—groups of minute hairs may be found on the black areas, and these correspond with

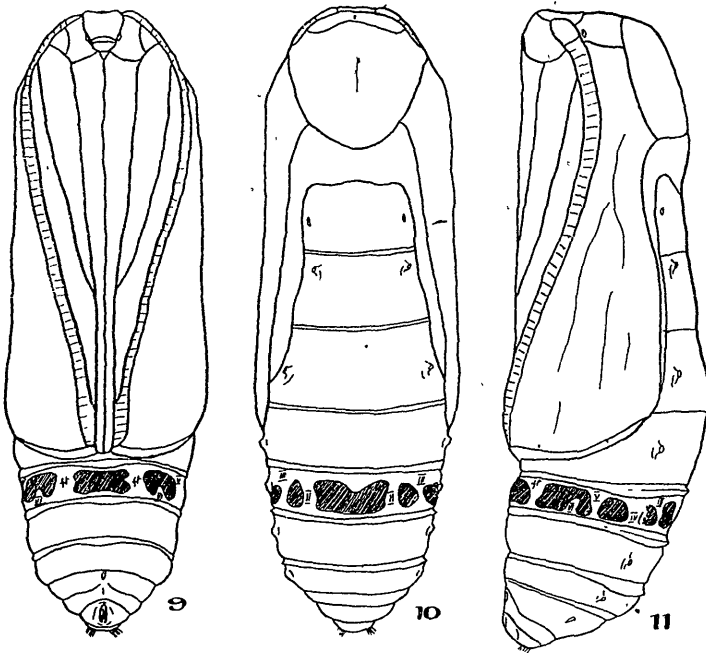


FIG. 9.—Pupa: Ventral view.

FIG. 10.—Pupa: Dorsal view.

FIG. 11.—Pupa: Lateral view. (The shaded areas on the 5th abdominal segment represent the yellow areas on all abdominal segments. The positions of the groups of hairs representing the larval tubercles are shown.)

the larval tubercles, as I have shown on the 5th abdominal segment only in the figure. Further than this, the larval prolegs are represented by slight depressions on the ventral surface of the segments; these depressions bear groups of minute bristle-like hairs. The terminal segment is round and blunt; the anal armature consists of 2 sets of hooks, 12 each, at either side of the dorsal posterior extremity. The prothorax bears a central strong longitudinal ridge, which extends into the frontal headpiece and mesothorax. The antennae extend as far as Poulton's line, and form a slight prominence on the ventral surface, as can be seen when the pupa is viewed from a lateral aspect. Segmentation is very plain. The maxillae are comparatively

narrow, and extend to the end of the wing-cases. Small scars representing the mandibles are to be found on either side of the clypeus. The 1st legs are stout, and the margin against the eye is equal in length to the corresponding margin against the maxillae. The 2nd pair of legs are long and narrow. The frontal headpiece is triangular in shape. On the female pupa the

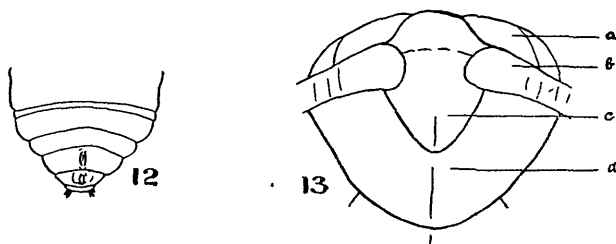


FIG. 12.—Pupa: Male genital organs.

FIG. 13.—Pupa: Frontal view. *a*, eye; *b*, antenna; *c*, epicranium; *d*, prothorax.

genital organs are confined to the 8th abdominal segment, which is greatly encroached upon on the ventral surface by the 9th abdominal. The anal scar in the 10th abdominal in both male and female pupae is raised and prominent. Duration of pupal stage, three to five weeks, and longer; many probably pass the winter in this stage.

Dehiscence.

“Dorsally split down middle of meso- and meta-thorax, and transversely at suture of same; the headpiece, with eyes, legs, and antennae intact, separates from costal edge of wing-cases, except at their tips” (Quail, *ibid.*).

Measurements of Pupa.

Measurement at	Length from Front.		Transverse Diameter		Anterior-posterior Diameter.	
	Male.	Female.	Male.	Female	Male	Female.
	Mm.	Mm.	Mm.	Mm	Mm.	Mm.
Outer angle of maxilla ..	1.76	1.41	4.00	3.75	4.50	4.50
Posterior margin of mesothorax	3.81	3.76	5.46	5.15	4.90	4.70
Dorsal depression ..	4.30	4.30	5.57	5.36	4.87	4.66
End of 1st legs ..	7.25	7.25	5.76	5.76	5.50	5.00
End of 2nd legs ..	10.00	8.75	6.00	6.00	6.05	5.50
End of maxillae ..	11.25	10.00	5.00	5.00	4.76	4.67
Posterior margin of 7th abdominal segment	15.35	14.20	3.76	3.76	3.00	2.75
Ditto, 10th abdominal segment	17.26	16.00	1.15	1.15	0.60	0.50
Extreme length ..	17.50	16.25	..	..	..	..

The Imago.—See Meyrick (Trans. N.Z. Inst., xxii, p. 218) and Hudson (N.Z. Moths and Butterflies, p. 2, pl. 4, figs. 1 and 2; pl. 3, fig. 9).

Distribution.—North and South Islands, Stewart Island. Confined to New Zealand, but two closely allied species belonging to the same genus are found in Australia. Has only been recorded from Waiouru (rare), New Plymouth, Wanganui (common), Lumsden (common), Mount Holdsworth, Kermadec Islands (apparently common).

No. 3. *Venusia verriculata* Feld.

Cidaria verriculata Feld., Reise der Nov., 5, pl. cxxxi, fig. 20. *Phthalpteryx verriculata* Butl., Proc. Zool. Soc. Lond., 1877, p. 396. *Panopoea verriculata* Meyr., Trans. N.Z. Inst., xvi, p. 62. *Pancyma verriculata* Fereday, Trans. N.Z. Inst., xxx, p. 338. *Venusia verriculata* Hudson, N.Z. Moths and Butterflies, p. 53, pl. 6, figs. 30, 31. *Pancyma verriculata* Meyr., Trans. N.Z. Inst., xviii, p. 184. *Venusia verriculata* Philpott, Trans. N.Z. Inst., xxxiii, p. 175; *ib.*, xxxix, p. 216: Hamilton, Trans. N.Z. Inst., xliii, p. 121: Watt, Trans. N.Z. Inst., xli, p. 80.

The Egg.

For detailed description, see Trans. N.Z. Inst., xli, p. 80.

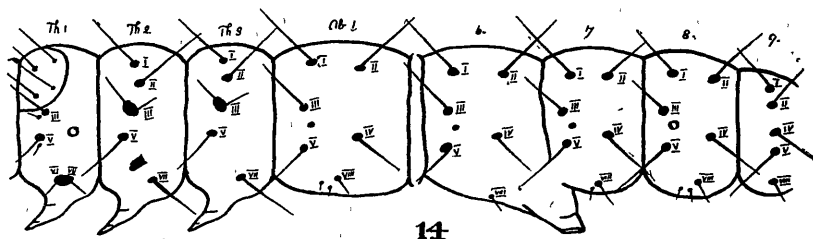
Egg-laying.

The ova are deposited in small regular batches of a dozen, more or less. The parent moth is careless as to the spot where she lays her ova, for they may be found on both dead and green leaves alike. It would appear from the rapid colour-changes in the egg and the extreme activity of the newly hatched larvae that the correct place for the ova is on the dead leaves, and they are often to be found there on the under-surface near the base of the leaf, where they are greatly protected by their colour. Those eggs laid on the green leaves only gain protection on account of their colour for a couple of days or so, and for the remainder of the oval period are startlingly conspicuous; in consequence the collector is bound to come across them in such positions, and, as they are well-nigh invisible on the dead leaves, his opinion is likely to be prejudiced as to the natural place of deposition. Personally, I have found more ova on the dead leaves, where they have invariably been placed on the under-surface, near the butt, than on the fresh leaves, on which they appear to have no fixed position. One female reared in captivity laid a total of 393 eggs in three days. Oviposition was carried on during the night. In most of the batches the eggs are laid in neat rows, being placed end on end, but occasionally they are to be found in a rather scattered condition.

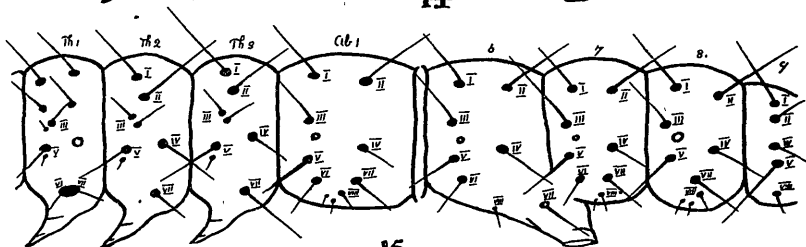
The Larva.

1st stadium: Head of medium size, non-retractile. Abdominal segments 1 to 6 inclusive are largest and equal in size; the 7th abdominal and the thoracic segments about equal. Body cylindrical; prolegs on abdominal segments 6 and 10 only, situated posteriorly, well developed, crochets on lateral flange. A very minute and scattered pile may be observed on the body with a high-power objective. The 6th abdominal segment is divided centrally into two subsegments; on the other segments subsegmentation is not apparent. Spiracles small, circular, rims brown, inconspicuous. The prothoracic shield is slightly raised and light in colour, with a well-marked medio-dorsal suture; each half of the scutum bears 4 minute tubercles and setae arranged in diamond formation. All setae are simple. Tubercle i is contained in the scutum on the prothorax; in the remaining two thoracic segments is above ii, slightly anterior; in the abdominals i and ii are some distance apart, i being anterior to and above ii. ii is also included in the prothoracic shield. iii consists in the thoracic segments of two minute tubercles, sometimes free, sometimes coalesced; in the prothorax they are situated just beneath the scutum, the upper one

being slightly posterior; in the meso- and meta-thorax the position is some distance beneath but anterior to i and ii, and the position of the two tubercles reversed—that is to say, the upper one is anterior, instead of posterior as in the prothorax. In the abdominal segments iii is pre-spiracular, below but anterior to i; appears to be absent in the 9th abdominal. iv is absent in the thoracic segments, but in the abdominals is post-spiracular, immediately beneath ii, and slightly subspiracular. v is a large tubercle in the prothorax having one large and one small seta, is pre-spiracular and beneath iii; consists of a single-hair-bearing tubercle beneath iii in the meso- and meta-thorax; in the abdominals is subspiracular beneath iii, and in the 9th abdominal immediately beneath iv. vi and vii are coalesced in the 1st thoracic segment, situated above the leg, vi anterior to vii; in the 2nd and 3rd thoracics vii is situated above the outer posterior margin of the leg, posterior to v; is absent in the abdominals. vi is also absent in the abdominal



14



15

FIG. 14.—Larval tubercles: 1st instar.

FIG. 15.—Larval tubercles: 2nd instar.

segments. viii is a very minute tubercle on the ventral surface anterior to vii, immediately beneath v in the 9th abdominal. Two secondary setae are situated on the ventral surface anterior to viii. *2nd stadium*: The thoracic plate is not distinguishable on the prothorax. Tubercles i, ii, iii, v, and viii as in 1st stadium. iv now appears in the 2nd and 3rd thoracic segments above and posterior to v. A small secondary tubercle is situated just beneath and slightly in front of v in the meso- and meta-thorax. vi appears in the first seven abdominal segments immediately beneath the spiracle and beneath but posterior to v. vii in the abdominals is beneath iv, immediately posterior to vi, except in the 6th segment, where it is situated on the upper and outer margin of the leg. This is the final arrangement of the tubercles, and remains constant throughout the 3rd, 4th, and 5th instars. *3rd stadium*: Abdominal segments 6 and 7 are divided medially into two equal subsegments. Pile exceedingly minute. *4th stadium*: As in stadium 3. Spiracles circular, excepting those on the first thoracic and 7th and 8th abdominal segments, where they are inclined to be oval.

5th stadium: Spiracles oval, brown. Subsegmentation on abdominal segments 1 to 7. Pile thick but very minute. Body of equal width throughout, slightly flattened dorsally and ventrally. The head is medium-sized, somewhat square in shape; clypeus small and distinct, possessing 4 minute setae; either cheek has 7 setae, the area included by the eyes bears 4 with a 5th more remote; mandibles serrate, with 5 points.

Development of Larval Markings.

1st stadium: General colour light green. Head light green with light-brown mouth parts; eyes black. Has a conspicuous brown spiracular line. Tubercles light-coloured. *2nd stadium*: Broad medio-dorsal stripe of dark green. Spiracular stripe dark brown to black. *3rd stadium*: A light-brown stripe extends from either side of the base of the clypeus to the top of the head, but they are some distance from the central facial suture. *4th stadium*: A very narrow white subdorsal line appears on either side of the broad medio-dorsal stripe. Cheek-stripes ochreous and very conspicuous; while a third short thick stripe occupies the central portion of the clypeus. The tubercles are still light in colour, excepting iv, which is included in and is of the same colour as the spiracular band. *5th stadium* (full-grown): General colour green, ventral surface light. The narrow white subdorsal stripes are margined on either side by a pinky area. Tubercles black. Head-markings very strong, as in last stadium, the facial markings extending across the prothorax, where they are black. Suranal plate and upper portion of anal prolegs black. Before spinning the whole body assumes a rosy hue.

Variation in Larva and Imago.

The Larva.—Here there is not much variation, chief instances being the absence of the spiracular lines and cheek-stripes, and in the coloration of the tubercles. There appears to be a variety which is, when full-grown, larger ($1\frac{1}{16}$ in. to $1\frac{1}{4}$ in. in length), greener in colour, and not having such marked subdorsal lines. This may be explained sexually.

The Imago.—A certain amount of variation occurs in size and colour, some specimens being brighter in the shades of brown than others.

Table of Periods.

Period of incubation from fifteen to twenty-two days, or longer. *1st stadium*: fifteen days; length on hatching, $\frac{1}{16}$ in. *2nd stadium*: thirteen days; length after 1st moult, $\frac{3}{16}$ in. *3rd stadium*: thirteen days; length after 2nd moult, $\frac{5}{16}$ in. *4th stadium*: twelve days; length after 3rd moult, $\frac{7}{16}$ in. *5th stadium*: twenty-one days; length after 4th moult, $\frac{9}{16}$ in. Larva, full-grown, $\frac{3}{4}$ in. to $1\frac{1}{4}$ in. in length; length before pupating, $\frac{1}{2}$ in. only; duration of spinning, about two days; duration of larval life within the cocoon, four to five or more days; duration of pupal existence, fifty days (winter months).

Habits.

The young larvae on hatching do not eat the empty shells, but almost immediately start climbing. At first they are very active, and able to crawl long distances, betaking themselves to the innermost leaves of the cabbage-tree, where they are wont to congregate together on the upper but inner surface of the loose outer leaves forming the heart spike of the tree. Throughout the first four stadiums their method of feeding is to scoop long channels

out of the surface of the leaves parallel to the fibres; later, however, in their 5th stadium, they attack the edges, eating out great lumps, which, as the leaves grow and begin to droop outwards, give to them a very notched and serrated appearance. It is unfortunate that the larvae attack the youngest leaves, for it is not till these grow up that the tree shows any sign of the presence of caterpillars, and then it is nearly always too late to do any good, unless there be a second or third brood, for the larvae will in all probability have retreated to the mass of dead leaves hanging around the tree, or among the rubbish on the ground, to pupate. On carefully pulling apart the outer leaves of the inner spike one is almost certain to find numbers of larvae in all stages of growth, the younger ones being generally found in groups. No sooner, however, are the leaves opened than the larvae will immediately drop into the crevices, many being crushed to death when the leaves resume their former position on being released. One would think that in extremely wet weather many would stand a good chance of being drowned in the water that collects round the base of the leaves, but they may frequently be found wallowing in this, seemingly without the slightest harm. Specimens in captivity invariably kept to the underside of the leaves of the food plant, but in a state of nature they are frequently to be found feeding fully exposed on the more mature leaves; here they probably enjoy the warmth of the sun. Full-grown larvae are never to be found in such exposed situations unless searching for a suitable place in which to pupate. Throughout all the stadiums the larvae make use of a silken thread. When disturbed they do not throw the head from side to side or curl up, as most caterpillars, but either drop or hurriedly seek to hide themselves in the spaces between the leaves. The young utilize the thread for dropping from leaf to leaf in search of food. The silk is exceedingly strong and elastic. Trees that have been badly infected will be found to be almost destitute of the inner compact and succulent heart, while great quantities of the coarse frass will be piled up around the base of the leaves. The larvae during the last stadium have enormous appetites, and it is at this period that most of the damage to the tree is done. Many appear to suffer from a wasting disease; they quit feeding, and the segments gradually wither up till the head is out of all proportion to the rest of the body. Such larvae invariably die, death in all probability being caused by Ichneumons attacking vital internal organs.

The Imago.—As has been recorded by Fereday and others, the moth frequents the dead leaves hanging from the head of the tree, and invariably sits across the leaf with wings fully spread, which accounts for the peculiar markings of the upper and lower wings, these corresponding to similar lines on the leaves. It is the underside of the dead leaves, where these markings are most distinct, that forms the chief resting-place of the moths. It is in this way that the species is wonderfully protected and almost invisible to an untrained eye. Flight is rather slow, and the moth is nocturnal. Season, September to May.

Food Plants.

Cabbage-tree (*Cordylina australis*; Maori, ti-kouka); *Cordylina Banksii*.

Parasites.

Phorocera nefaria: The larva of this large blue Dipteran is an internal parasite, emerging to pupate when its host is in the pupa state. *Syrphus ropalus* Walk.: The larvae of this fly scour the cabbage-tree heads and

boldly attack and devour all the *V. verriculata* larvae they come across. Further information on the above two species will be given in future contributions. *Cermatulus nasalis* has also been found attacking the larvae.

The Cocoon.

The cocoon is thin and scanty, and is composed of a rather coarse brown silk, which is extremely viscid. When viewed through the microscope the individual threads are bespangled at regular intervals with globules of sticky matter, very similar to the web of a spider. Favourite places for spinning are at the base of the leaves up against the trunk of the tree, in the crevices of the bark, and amongst the dead leaves hanging around the stem.

The Pupa.

Immediately after the last moult the wings, head, and limbs of the pupa are green; the anal segments are light pink, with a strong reddish medio-dorsal stripe; the prothorax is pink or rather reddish, and at the juncture of the segments the pink coloration is very marked. Within twenty-four hours the pupa passes through several shades of brown till it is very dark,

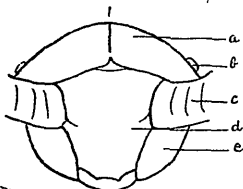


FIG. 16.—Pupa: Frontal view. *a*, prothorax; *b*, 1st spiracle; *c*, antenna; *d*, epicranium; *e*, eye.

almost black; the intersegmental membrane between the movable segments is much lighter in colour. The frontal headpiece has three slight prominences, one on either side at the base of the antennae, the 3rd ventral, above the labrum. The thoracic segments bear no very marked dorsal hump, while the abdomen is inclined to be short and stout. Abdominals 5 and 6 alone are movable. The cremaster is short and stumpy, bearing 4 whorled hooks, two on either side, and slightly dorsal. *Dorsal view*: The head is slightly depressed between the antennae, and not visible. The prothorax is narrow, with a central suture, and is somewhat pitted and wrinkled. The 1st spiracle has a long narrow opening, and is very conspicuous. Both the meso- and meta-thorax bear a strong central suture, and are wrinkled. The abdominal segments are strongly pitted, and bear minute hairs that correspond in position with the larval tubercles, but are very hard to distinguish. There is no trace of subsegmentation. The 5th, 6th, and subsequent abdominal segments are swollen anteriorly; this is very marked on the sides and dorsum. The hindwings show a very narrow strip, widest at the 1st abdominal, rapidly narrowing in the 2nd, and again widening slightly in the 3rd and 4th abdominals. *Lateral view*: The apex of the head is in front of the axial line. There is a deep depression in the maxillae some little distance from their origin; from this depression they slope outwards to their extremities near the posterior margin of the 4th abdominal segment; from here the abdominals taper uniformly and rapidly to the cremaster. The whole length of the antenna is visible, the base being level with the top of the eye; it rapidly widens out till on a line with the bottom of the eye, and then gradually narrows towards the tip; every joint is plainly visible. A very slight margin of the hindwing can be seen at the 1st and 4th abdominals. In the forewing Poulton's line is absent, though slight venation can be distinguished. The spiracles are very prominent on raised bases, and are dorso-lateral, oval. *Ventral view*: The

maxillae have their greatest width on a line with the bottom of the eyes. Here they form an angle with the eye, and rapidly converge to the end of the 1st legs, where they are extremely narrow, widening out again club-like beyond these again to the end of the wings. The antennae and 2nd legs also reach to the end of the wings. Both legs and maxillae are covered

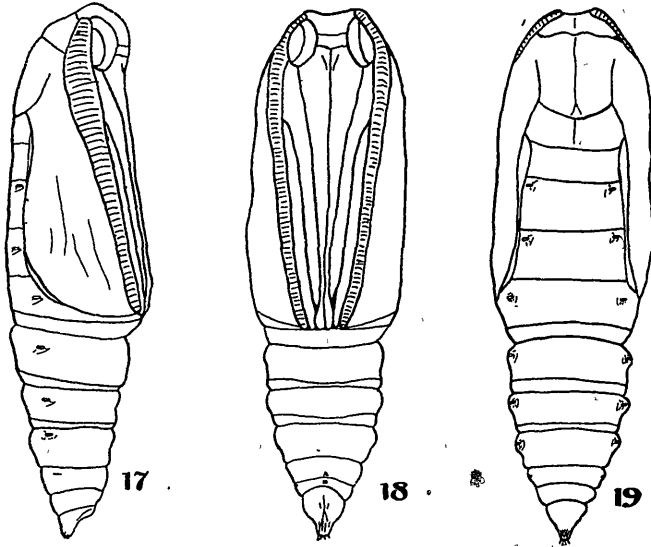


FIG. 17.—Pupa: Lateral view.
FIG. 18.—Pupa: Ventral view.
FIG. 19.—Pupa: Dorsal view.

with minute transverse rugae, while the wings are sculptured with labyrinthine wrinkling, and the abdominal segments are pitted most anteriorly. The 2nd legs bear an equal width their whole length. Anal scar very prominent. Genital organs inconspicuous, but restricted to their respective segments.

Chief Measurements, of Pupa.

Measurement at	Distance from Front.	Transverse Diameter.	Anterior-posterior Diameter.
	Mm.	Mm.	Mm.
Depression in maxillae	1.80	4.00	2.90
End of maxillae	8.70	3.85	3.80
Spiracle, 5th abdominal segment	9.50	3.70	3.35
" 6th "	10.55	3.30	2.90
" 8th "	12.00	2.25	1.75
Extreme length	14.00	..	..

Dehiscence.

The headpiece, with the eyes and the thoracic and abdominal appendages intact, separates in one piece from the wing-cases except at their tips; the pro-thorax splits down the central dorsal suture; the meso- and meta-thorax remain intact.

Imago.

The imago has already been completely described by Meyrick (Trans. N.Z. Inst., xvi, p. 62) and by Hudson (N.Z. Moths and Butterflies, p. 53, pl. 6, figs. 30 and 31).

Distribution.

Waitakarei Ranges (Auckland); Wanganui, very common from August to May; Wellington; Christchurch and Dunedin, from October to May; Ashburton; West Plains; Invercargill, taken at light in April.

ART. XXIX.—*Contributions to the Study of New Zealand Entomology, from an Economical and Biological Standpoint: No. 4—Phorocera nefaria Hutton; No. 5—Psychoda conspiciata Hudson; No. 6—Syrphus ropalus Walk.; No. 7—Phytomyza albiceps Mg. (Diptera).*

By DAVID MILLER and MORRIS N. WATT, F.E.S.

[Read before the Wanganui Philosophical Society, 23rd November, 1914.]

Plates II, III.

No. 4. *Phorocera nefaria* Hutton.

For the original description of this fly see Trans. N.Z. Inst., vol. 33, p. 59, and vol. 36, p. 151.

Since nothing has yet been published concerning the habits and life-history of this Dipteran, which belongs to the parasitic family *Tachinidae*, the following note may be not uninteresting. The larva is an internal parasite of the larva and pupa of the common cabbage-tree moth, *Venusia verriculata* (see Trans. N.Z. Inst., vol. 47, p. 271). The larvae of this moth feed in the crevices between the innermost leaves of the cabbage-tree (*Cordylus australis*), and so it is difficult to see how they become attacked. It is quite possible that the fly deposits its ova on the leaves, and the young maggots on hatching seek out and penetrate their host. But this is only speculation. Only actual observation will reveal the secret, and so it is likely that some little time will elapse before we can complete this very interesting life-history.* The larva, when full-grown, emerges from the pupa of its host, and pupates, being protected by the light cocoon spun by the moth-caterpillar just prior to its final moult and for its own protection.

The pupa is dark red in colour; cylindrical, and smooth; the anterior end slightly smaller than its nadir, which is somewhat pointed. Length of case, $\frac{1}{16}$ in.; greatest diameter, $\frac{3}{16}$ in. In the specimen described the pupal stage lasted from the 10th August till the 1st October—that is to say, sixty-one days. Only one was obtained, and its puparium was almost as large as the pupa of its host, from which it had emerged by bursting through the head. On one occasion at least fifteen imagines were reared

* In all other cases observed a single host has reared but one parasite.