

## A Revision of New Zealand Ephemeroptera.

### PART 2.

By CAPT. J. S. PHILLIPS, M.C., M.A. (Oxon.), F.R.G.S.

[Issued separately, 30th August, 1930.]

PLATES 61-67.

### CONTENTS.

	PAGE.		PAGE.
<i>Atalophlebia</i> genus . . . . .	337	<i>D. fumosum</i> n. sp. . . . .	372
<i>Atalophlebia</i> key to species . . .	338	<i>D. lillii</i> (Walker) . . . . .	368
<i>A. cruentata</i> Hudson . . . . .	347	<i>D. myzobranchia</i> n. sp. . . . .	373
<i>A. dentata</i> (Eaton) . . . . .	344	<i>D. vernale</i> n. sp. . . . .	360
<i>A. nodularis</i> (Eaton) . . . . .	352	<i>D. (Atalophlebioides) crom-</i>	
<i>Atalophlebia</i> ? n. sp. . . . .	356	<i>welli</i> n. sp. . . . .	385
<i>A. versicolor</i> Eaton . . . . .	339	<i>D. (Atalophlebioides) sepia</i>	
<i>Deleatidium</i> genus . . . . .	357	n. sp. . . . .	383
<i>Deleatidium</i> key to species . . .	358	Family LEPTOPHLEBIIDAE . . . .	335
<i>D. autumnale</i> n. sp. . . . .	371	References . . . . .	389
<i>D. cerinum</i> n. sp. . . . .	382		

IN this paper, it is proposed to deal with the species of families other than those of EPHEMERIDAE and SIPHLONURIDAE.

According to Tillyard's Australasian classification (7), there remain the LEPTOPHLEBIIDAE and the BAETIDAE.

So far, no species belonging to the latter family has been found in New Zealand; this leaves the LEPTOPHLEBIIDAE.

One or two of the species, described herein, have not been worked out in all stages, but owing to the fact that there will be no opportunity of studying the members of this family in their habitat, in the near future, it was thought better to publish the data available rather than to defer doing so to an indefinite date.

When time and opportunity permit, it is hoped to supplement the information contained in these two papers by the publication of a third.

### Family LEPTOPHLEBIIDAE.

This family, which contains mainly the smaller mayflies, comprises more than half the species in New Zealand. Some of them are very much alike and hard to distinguish from each other, and it will probably be a considerable time before all the species in this country have been identified and described.

Although, as in most of the Ephemeroptera, the best time to secure the winged stages is on a fine summer evening, yet individuals of this family hatch out at various times of the day throughout the year, even in midwinter, in the Wellington district.

The family now includes thirteen New Zealand species. Two genera have been recognised—*Atalophlebia* Eaton (1881) and *Deleatidium* Eaton (1889).

These genera are distinguished from each other in the nymphal stage, in that *Atalophlebia* has double gills, whereas *Deleatidium* has single ones; in the adult stage, they may be differentiated by the tarsal claws, which in the former genus are alike in each tarsus and in the latter one dissimilar, i.e., one claw is narrow, hooked and pointed at the apex, the other is broad and blunt.

Two of the newly-discovered species, namely, *D. sepia* and *D. cromwelli*, were first believed to belong to the genus *Atalophlebia*; the modus operandi was to breed the flies from the nymphal stage in the aquarium, and these two had the nymphal characteristics of that genus, e.g., double gills.

It was found later, however, that the flies had unlike claws in each tarsus, and this adult character had been chosen by Eaton to differentiate a new genus *Deleatidium*, whose nymphs, however, had single gills.

Thus we had two new species with the adult characters of *Deleatidium* and the nymphal ones of *Atalophlebia*.

Obviously the original distinguishing features are inadequate, but in view of the fact that no really satisfactory substitutes have yet been found and, even more, because the allied species in Australia have not yet been described in all stages—and they may clarify the situation—and lastly because there are almost certainly still more species in New Zealand undiscovered, it has been thought advisable not to reclassify at present, but to place these two disturbing species temporarily in a sub-genus *Atalophlebioides* of the genus *Deleatidium*.

To assist in identification, this sub-genus has also been included in the Key to Species of the genus *Atalophlebia*.

*Adult*.—Forewing with tornus more or less well marked, always close to base (at one-fourth of wing-length from base or less) in correlation with the greatly reduced hindwings. *Cu 1* attached to *M* at a point just beyond its origin and very strongly angulated there; branches of *Cu 1* few; *Cu 2* sigmoidally curved, ending not far short of tornus; anal veins much reduced. A bulla usually present on *R 2a* about half way along the wing." (Tillyard (7)).

*Nymph*.—Nymph of the crawling type: body more or less flattened dorso-ventrally. Eyes lateral. Antennae long and filiform. Mandibles short, not extending in front of the head. Maxillary and labial palps three-segmented. Galea-lacinia of maxilla terminating apically in a broad brush of brown hair and a number of minute pectinate rakes. Wing-pads generally prominent. Legs long, spinose: femora oval: claws toothed underneath. Latero-posterior angles of segments of posterior half of abdomen toothed backwards. Caudal setae long, median one usually slightly the longest: whorled on both sides with very short hairs. Gills borne laterally on the first seven abdominal segments, sometimes alike and then double, either in the form of a bifid lash or a pair of ovate-acuminate lamellae, sometimes dissimilar and then the gills are single and those of the first pair are kidney-shaped in outline and those of the remaining pairs are round or ovate.

## Genus ATALOPHLEBIA Eaton (1881).

"*Adult*.—Hindwing in front somewhat arched, the summit of the arch obtusely sub-angular, situated usually before the middle of the curve; sub-costa strongly arched, meeting the margin very obliquely; radius usually nearly straight, constituting as it were the chord of the arch described jointly by the sub-costa and the portion of the margin included between its extremity and the radius; hence, while the narrow marginal area is broadest at the base and acuminate at its termination, the sub-marginal area is broadest at the middle, or a little before the middle, and tapers gradually to its oblique apex. Cross veinlets abundant in the forewing, those in the marginal area before the bulla well-defined. At the terminal margin the longitudinal nervures are provided with curved simple branchlets, and there are no isolated veinlets. The two intercalary nervures of the anal-axillary interspace of the forewing have simple branchlets, and usually the hinder one, close to its proximal extremity, curves forwards to unite with the other, which similarly curves forwards to join the anal nervure; occasionally, especially in female specimens, a cross veinlet is transferred from near the wing-roots to establish communication between the first axillary and the anterior intercalated nervure; less frequently, this last nervure annexes itself to the first axillary." . . . "Guard at the orifice of the mesothoracic spiracle small and triangular. Forceps limbs of male three-jointed; the proximal joint much longer than the remainder, somewhat compressed, and in its basal half broadly dilated beneath; the deflexible basis, usually prominent in the middle of its distal border, is otherwise merely emarginate; the corresponding lobe in the female, usually bifid and sharply excised with acute triangular points, is seldom emarginate only. Segments 6-10 constitute about half the abdomen; segment 8, the longest, is nearly equalled by segment 7; the others are successively shorter. Median caudal seta about as long as the others, seldom thrown off by specimens; outer setae, in both sexes, usually double (in some cases treble) the length of the body. Tarsal ungues all nearly alike, small, narrow, and hooked at tip. In normal species the male fore-tarsus is nearly as long as the tibia, or a little longer than it, and the latter is about  $1\frac{1}{2}$  as long as the femur; the female fore-tarsus is nearly half the length of the tibia, and this about  $1\frac{1}{2}$  as long as the femur; in both sexes the tarsal joints, arranged in diminishing succession, rank thus: 3, 2, 4, 5, 1. Hind-tarsus usually about half the length of the tibia." (Eaton).

*Nymph* (characters applicable to New Zealand species).—Nymph of the crawling type. Body somewhat flattened dorso-ventrally. Eyes lateral. Antennae long and filiform. Maxillary and labial palps three-segmented. Labrum always less than three times as broad as it is long and notched medio-anteriorly. Maxilla with broad terminal brush of long brown hairs and small pectinate rakes. Wing-pads large. Legs long, spinose: femora usually somewhat dilated: claws toothed underneath. Latero-posterior angles of abdomen mostly toothed backwards, pronouncedly so in the posterior half. Caudal setae of varying length, minutely haired at segmental joinings; median seta longest. Pairs of gills borne laterally on the first seven abdominal segments: the gills are double and consist each of a double lash or a pair of lanceolate or ovate-acuminate lamellae: venation generally pinnate. The gills of the posterior pair are often aborted.

As New Zealand *Atalophlebiid* nymphs do not appear to have been described before, in any detail, the opportunity is taken of pointing out that they do not agree in some particulars with the characteristics assigned to *Atalophlebia* by Needham and Murphy (9), for example: 'Posterior-lateral angles of rear abdominal segments not tipped with thin flat lateral spines. . .' On the contrary, our nymphs have teeth or spines on these segments, notably *A. cruen-*

*tata*. Again, . . . 'Femora regularly tapering from near the base, not dilated. . . .' In our species, the femora *are* generally dilated and the broadest part is at, or near, the middle of this segment. Further, the labrum could hardly be described as 'narrowly elliptical' and the acute median notch in front is sometimes a slight curved indentation.

On page 36, *op. cit.*, however, there is a conflicting description of *Atalophlebid* nymphal characters and they are described as having lateral spines on abdominal segments five to nine and the femora as being dilated.

The other characters, specified on this page, do not agree with the characters of our species, i.e., the distal tooth under the tarsal claw is *not minute*—compared with the others—but slightly larger, the width of the labrum does not exceed the length three times, but is not quite twice as long and the glossae are not conic-pointed in our species.

#### KEYS TO N.Z. SPECIES OF ATALOPHLEBIA.

##### Adults.

- A. Wing expanse one inch or more—
1. *Costal region of hindwing orange-red:*  
*fore-femora with dark median transverse bar* . . . . . *A. cruentata*  
Hudson  
Page 347
  2. *Not as above—*
    - (a) Femora luteous:  
Abdomen light brown, first 8 segments dark-rimmed posteriorly.  
Egg irregularly oval . . . . . *A. dentata*  
(Eaton)  
Page 344
    - (b) Femora olive-brown or burnt-umber:  
Abdomen very dark-olive-brown:  
Egg spindle-shaped . . . . . *A. versicolor*  
(Eaton)  
Page 339
- B. Wing expansion less than one inch—
1. *Anterior femora with dark median transverse bar* . . . . . *A. nodularis*  
(Eaton)  
Page 352
  2. *Anterior femora without bar* . . . . . Sub-genus  
*\*Atalophlebiodes*
    - (a) Tarsi brownish-grey . . . . . *D. (A.) sepia*,  
n. sp.  
Page 383
    - (b) Tarsi almost colourless . . . . . *D. (A.) cromwelli*,  
n. sp.  
Page 385

##### Nymphs.

- A. Nymph orange-red in colour . . . . . *A. cruentata*  
Hudson  
Page 347
- B. Nymph dark-coloured—
- (1) *Caudal setae as long as or longer than body*
    - (a) Femora oval—
      - (i) With bold, black markings on first nine abdominal segments, both dorsally and ventrally . . . . . †*Atalophlebia* ?  
n. sp.  
Page 356

\*Flies hatching out from apparent *Atalophlebid* nymphs, yet having the claws of the adult dissimilar in each tarsus. This sub-genus is, at present, included under the genus *Deleatidium* (see page 358).

† Winged stages not known, and therefore not included in Key to Adults.

- (ii) With light yellow median longitudinal stripe on dorsum: femora with two dark sinuous bands . . . . . *Atalophlebia versicolor* Eaton  
Page 339
- (iii) Dorsum not as above: femora greatly dilated, grey with a light yellow patch at each end and two in the middle .. *Atalophlebia dentata* (Eaton)  
Page 344
- (b) Femora sub-parallel . . . . . *D. (A.) cromwelli*, n. sp.  
Page 385
- (2) *Caudal setae shorter than body.*
- (a) Legs almost colourless: gills seldom vibrated . . . . . *Atalophlebia nodularis* (Eaton)  
Page 352
- (b) Legs mottled: gills actively vibrated .. *D. (A.) sepia*, n. sp.  
Page 383

***Atalophlebia versicolor* Eaton.**

*Imago*.—Length (excluding setae)—12.5 mm.

*Head*.—Reddish-brown with black markings. Eyes of female and lower lobes of those of male, greenish-brown; upper lobes, raw-umber. Ocelli, greenish-brown.

*Thorax*.—Raw-umber.

*Abdomen*.—Burnt-umber or bistre-brown: the segments have outward-curving crescent-shaped marks on each side of the median line: the tenth segment is much lighter. Venter somewhat lighter.

*Penes* "bistre-brown: lobes contiguous to one another; concave beneath towards the line of contact, upcurved, narrowed and sloped off towards their truncate tips. Claspers basal joint compressed, narrowed somewhat suddenly after the acute end of the inferior dilatation. Bistre-brown. Caudal setae medium, warm sepia brown, with the distinct joinings blackish; some of the alternate joinings indistinct or not coloured." (Eaton) (5) ).

Medaia one—male, 27 mm.; female, 18 mm.; outer ones—male, 23 mm.; female, 16 mm.

*Legs*.—Femora olive brown or burnt umber, anterior ones a shade darker than the others: darkened narrowly at each end. Tibiae very light burnt umber. Tarsi fawn, proximal two joints rather lighter: four-segmented.

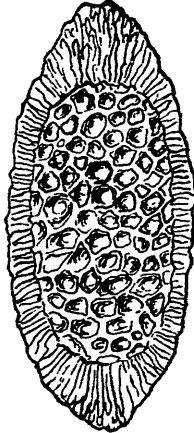
*Wings*.—Expansion of male, 24 mm.; of female, 29 mm.

"Vitreous with black neuration. In the marginal and sub-marginal areas, tinted with transparent raw umber or brown umber cross-veins of the same area narrowly set off with black, showing strongly, and a few of them (both near the sub-costal node, and again midway beyond these towards the apex), suffused by a small dark-greyish cloud that extends from the costa to just below the radius. The cross-veinlets of the marginal area, all simple, number about six before and sixteen beyond the bulla." (Eaton) (5) ).

A further dark area is found in the pterostigmatic region and there is another very small one at the fork of MA1 and MA2.

*Eggs*.—About 2000 eggs are laid: each egg (illustrated in Pt. 1: Text-Fig. 22) is spindle-shaped, the egg proper being completely surrounded by an adhesive network matrix.

*Wings of Sub-Imago* (Pl. 61, Fig. 1)—Wing surface dull and colourless, except in the marginal and sub-marginal areas, which are light brown (Eaton (5) says dull reddish-purple) and in certain other areas, irregularly marked with dark grey, notably two conspicuous zig-zag bands, directed forwards and outwards across the wing surface.



*Atalophlebia versicolor*: Egg.  $\times 320$ .

*Nymph*.—This nymph lives among the *débris* in the beds of streams and frequents the more sluggish portions of them.

It is easily captured, being a poor swimmer, moving with a jerky, awkward, undulating motion of the body, agitating the legs rapidly and closing the setae, which are normally held spread at a right angle.

It can, however, edge sideways and retreat backwards with great agility, and when pursued does so, seeking shelter in a crevice or under a stone and seldom attempting to escape by swimming away.

#### DESCRIPTION.

The body is flattened dorso-ventrally: its length, excluding setae, is 12 to 13 mm.

*Head*.—Quadrangular with rounded corners: yellow with olive brown markings, becoming reddish anteriorly.

*Antennae*.—About as long as head and thorax combined: light olive at base, becoming greyish-brown distally: filiform.

*Eyes*.—Olive brown.

*Labium* (Text-Fig. 1)—Palp colourless, faintly yellow-tinted apically; three-segmented, terminal segment subulate; the first and third segments are freely covered with spinose hairs; the second is sparsely covered. Paraglossae narrowed at base and suddenly swelling out, each somewhat resembling a pipe with the stem broken off diagonally close to the bowl, which is facing inwards: colourless: profusely haired anteriorly. The outline of the glossae resembles the track of a sheep's hoof, their inner edges in contact with each other,

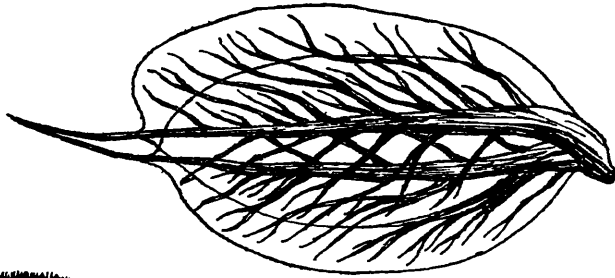


Fig. 10



Fig. 3



Fig. 1



Fig. 6



Fig. 5



Fig. 2



Fig. 4

Nymph of *Atalophlebia versicolor*.

FIG. 1.—Labium.  $\times 25$ .

FIG. 2.—Mandible.  $\times 25$ .

FIG. 3.—Maxilla.  $\times 25$ .

FIG. 4.—Maxillary rake, greatly enlarged.

FIG. 5.—Hypopharynx, Ca.  $\times 50$ .

FIG. 6.—Labrum.  $\times 25$ .

FIG. 10.—Gill, Ca.  $\times 25$ .

their outer edges with the paraglossae. The anterior and exterior margins are densely haired, the interior ones have spines only and there are a few spines on the ventral and dorsal surfaces.

*Mandible* (Text-Fig. 2)—Both outer (o.e.) and inner canines (i.c.) are heavily chitinised and divide into three well-defined teeth apically. The prostheca (p) is chitinised distally and ends in a sharp point: interior to it is a brush of inwardly-directed long bristles. The molar surface (m) is well-developed and bears eight to ten parallel, serrated ridges.

*Maxilla* (Text-Fig. 3)—Palp three-segmented. All segments are sparsely spined, but the apical one is densely covered distally with long hairs. The maxilla terminates anteriorly in a broad brush of thick brown hair; lying almost concealed among the hairs is half a row of pectinate rakes (Text-Fig. 4): this line of rakes is rooted in the ventral anterior edge of the maxilla and, starting from its proximal corner, spreads half way along the edge. The proximal edge of the maxilla is fringed with hairs, which become shorter and light brown in colour anteriorly.

*Hypopharynx*—Transparent except for slight yellowish tint on anterior border. Median lobe with a few short hairs and small central reentrant in anterior border. The superlinguae (Text-Fig. 5) have strongly curved anterior borders with a fringe of long brown hair: the exterior margins are nearly straight, the posterior ones run parallel to the anterior ones. The hypopharynx as a whole, therefore, resembles a V, with arms curved outwards.

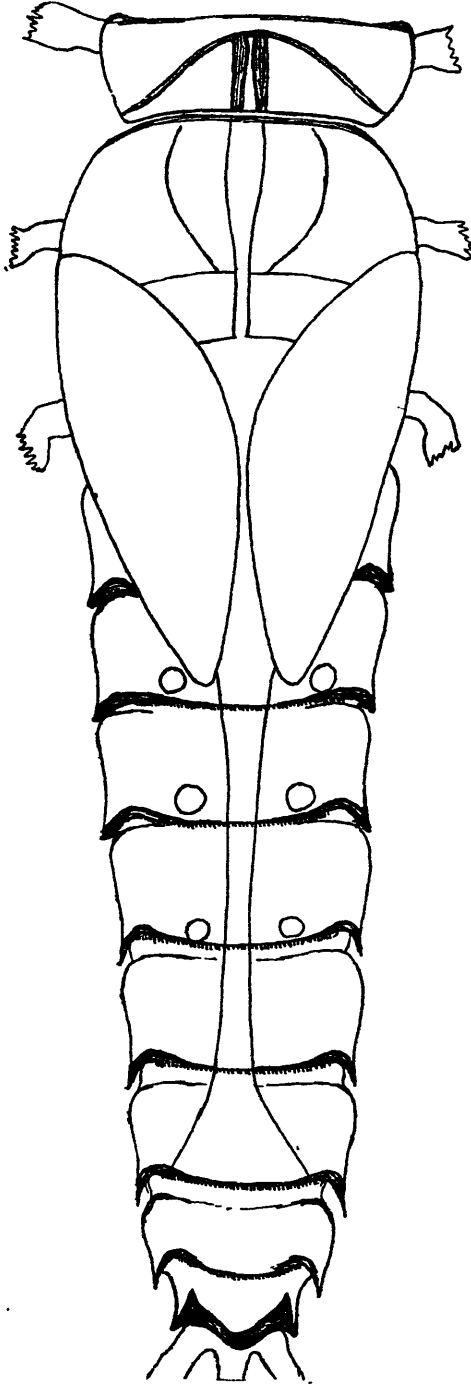
*Labrum* (Text-Fig. 6)—Yellow: chitinised: exterior-anterior angles rounded. There is a slight inward curve in the middle of the anterior margin, where it is irregularly serrated in places. On both dorsal and ventral surfaces, this margin is bordered with a row of spines with recurved tips, all bent towards the central line, and behind this row is a parallel one, not having recurved tips. Between these rows, on the exterior-anterior bends are other spines, some straight, others slightly curved and most of them directed inwards: similar spines occur scattered throughout the anterior half of both surfaces. In the posterior portion there is a row of inwardly-pointing spines on each side of the median line extending from half way almost to the posterior margin and in the space between the apices of the rows of spines lies a tongue-shaped series of clusters of little hairs; the apex of the tongue is directed forwards. These hair clusters point outwards.

The posterior margin of the labrum has obtusely-angled corners and a gently-curved salient medianly.

*Thorax* (Text-Fig. 7)—Olive brown with light markings, notably a median line: there are also various small diversely and irregularly-shaped black markings. The pro-thorax is short and wide. The meso-thorax is about the same width but twice as long. Wing-pads large and prominent: brownish-black: covering the first four abdominal segments.

*Legs* (Text-Fig. 8)—The general ground colour is barley-sugar yellow. The third pair of legs is the longest and they have the femora and tibiae longer than those of the other two pairs. The middle pair of tarsi are shorter than the anterior and posterior pairs, which are





Nymph of *Atalophlebia versicolor*.  
FIG. 7.—Body-dorsal view  $\times 16$ .

the same length. In all cases, the tibiae are slightly longer than the femora—noticeably so in the third pair: the tarsi are less than half (in the posterior pair about one-third) the length of the tibiae.

*Femora*—Dilated very noticeably: the outer areas are translucent; there are two dark brown, irregular and somewhat sinuous bands running transversely. The surface is covered with short spines.

*Tibiae*—There is a thick dark brown band about the middle. Rows of spines occur on both the dorsal and ventral borders.

*Tarsi*—A broad dark brown band covers the proximal half of this segment except for a narrow yellow belt at the very end. This band gradually shades off and the distal half is pinkish-yellow. There is a row of spines on the ventral borders.

*Claws* (Text-Fig. 9)—Curved, with a number of small teeth projecting from the concave surface.

On both tibiae and the tarsi, there are in addition to the spines a few weak hairs.

*Abdomen* (dorsum) (Text-Fig. 7)—Ground colour olive brown. Posterior-lateral angles of segments 6, 7, 8 and 9 project backwards as pronounced teeth. The posterior edges of segments are minutely serrated. A median yellow stripe runs along the surface, broadening out to the corners like a funnel on the eighth segment: the ninth is yellow as is the tenth, except for a dark posterior rim, olive brown in colour. There is also a pair of light coloured spaces on each segment, placed between the posterior-lateral angles and the median line. In some specimens these are very noticeable, in others hardly discernible, but they are always more marked on the anterior than on the posterior segments.

*Venter*—Pale ochre with dark median stripe marking position of alimentary tract.

*Caudal Setae*—Three: median one, 20 mm.; outer ones, 19 mm.: whorls of short hair at joinings: posterior edges of segments bear minute denticuli. Light olive, becoming lighter distally.

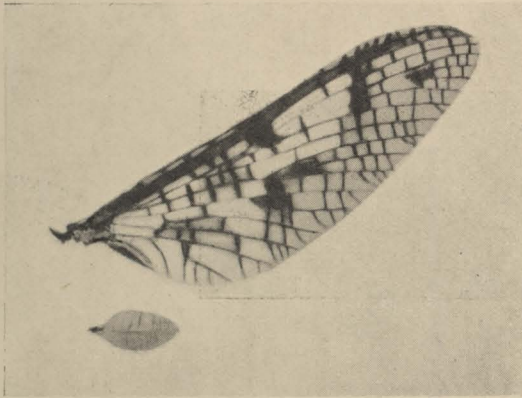
*Gills* (Text-Fig. 10)—There are pairs of simple double gills on the first seven abdominal segments. The first six consist of a pair of acuminate, ovate, yellow lamellae with black pinnate venation. Their edges are entire and they are incessantly vibrated at a moderate speed. The seventh pair consist of a bifid lash, each part of which contains a thick central trachea, unbranched and bordered on each side with a narrow strip of lamella. This pair of gills is only slightly vibrated and is probably, almost, if not quite, aborted.

*Distribution*—Slow and moderately-flowing waters of the following districts of New Zealand: Auckland, Hawkes Bay, Wellington, Nelson and Canterbury.

### ***Atalophlebia dentata* (Eaton).**

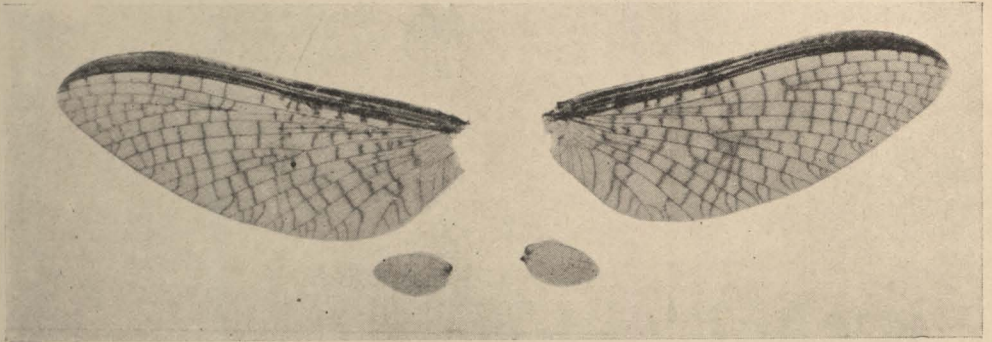
The winged stages of this insect were first described by Eaton (17), from dried specimens, under the name *Leptophlebia dentata*, later (4) under its present name and again (5), slightly amended, after receiving further specimens from this country.

Hudson (1) gives notes of all stages. It is easily confused with both *A. cruentata* and *A. versicolor*; with the former in the imaginal

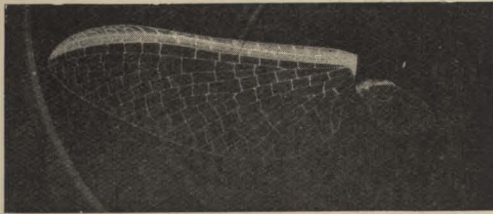


*Atalophlebia versicolor.*

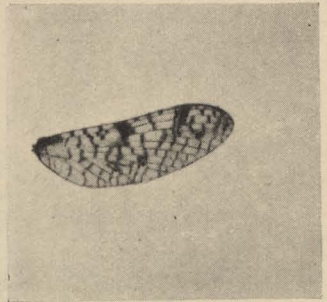
FIG. 1.—♀ Wings of Sub-imago  $\times 4$ .



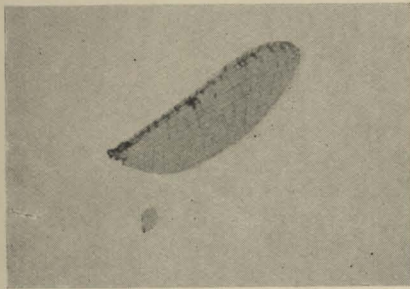
*Atalophlebia dentata.*  
FIG. 2.—Sub-imago  $\times 4$ .



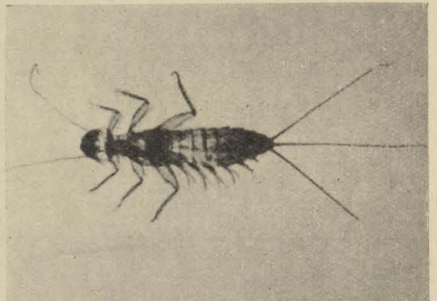
*Atalophlebia cruentata.*  
FIG. 3.—Wings of  $\delta$  Imago.  $\times 4$ .



*Atalophlebia nodularis.*  
FIG. 4.—Sub-imago.  $\times 3$ .



*Atalophlebia nodularis.*  
FIG. 5.— $\text{♀}$  Imago.  $\times 3$ .



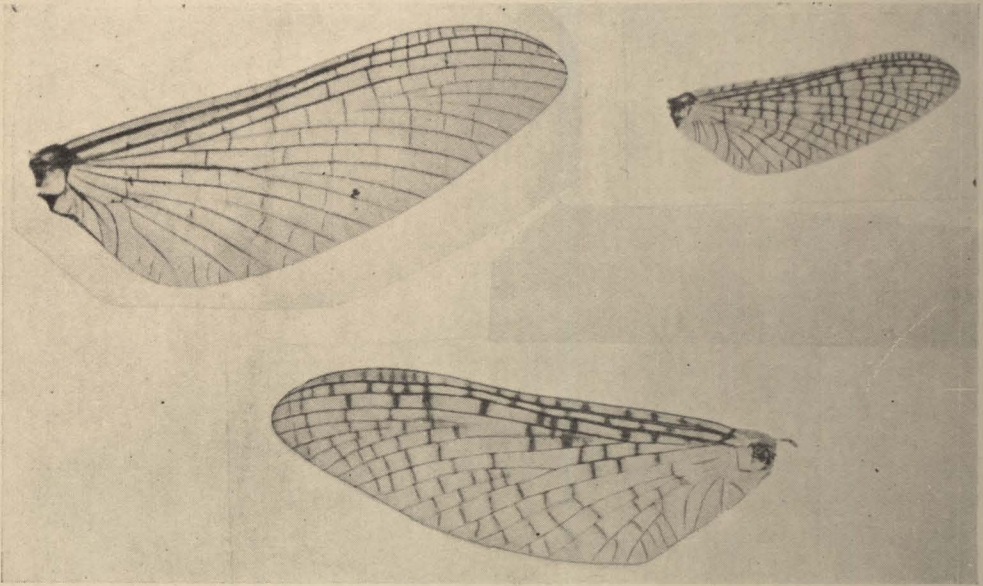
*Atalophlebia nodularis.*  
FIG. 6.—Nymph.  $\times 3$ .

*Deleatidium lillii.*

*Deleatidium autumnale.*

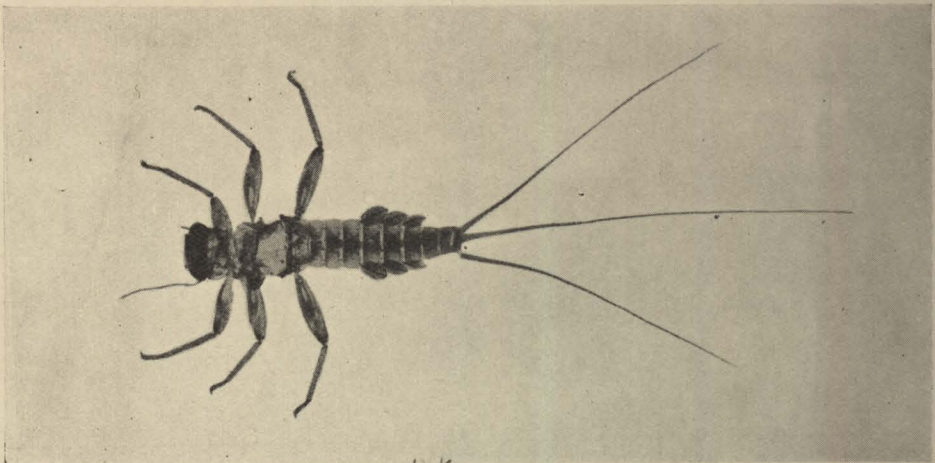
FIG. 7.—Sub-imaginal forewing  $\times 3\frac{1}{2}$ .

FIG. 8.—Sub-imaginal forewing  $\times 2$ .



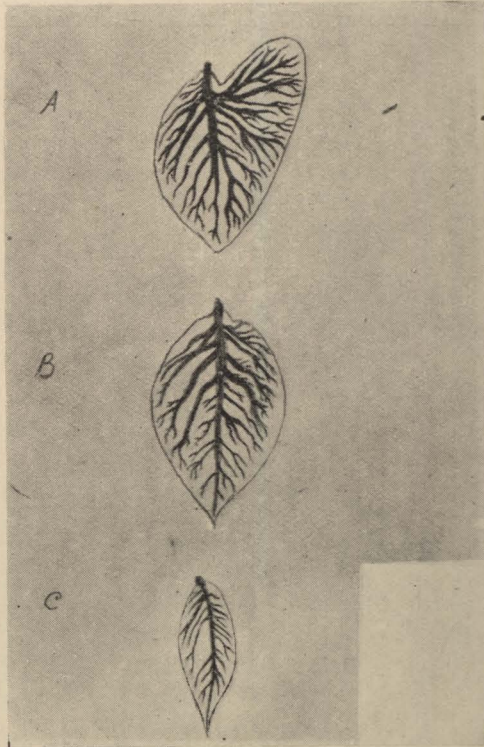
*Deleatidium vernale.*

FIG. 9.—Sub-imaginal forewing  $\times 3\frac{1}{2}$



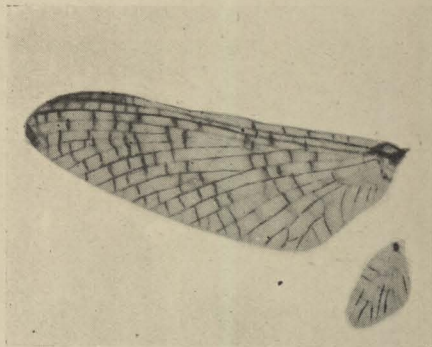
*Deleatidium lillii.*

FIG. 10.—Final nymphal exuvia  $\times 4$ .  
With wing pads and some gills removed.



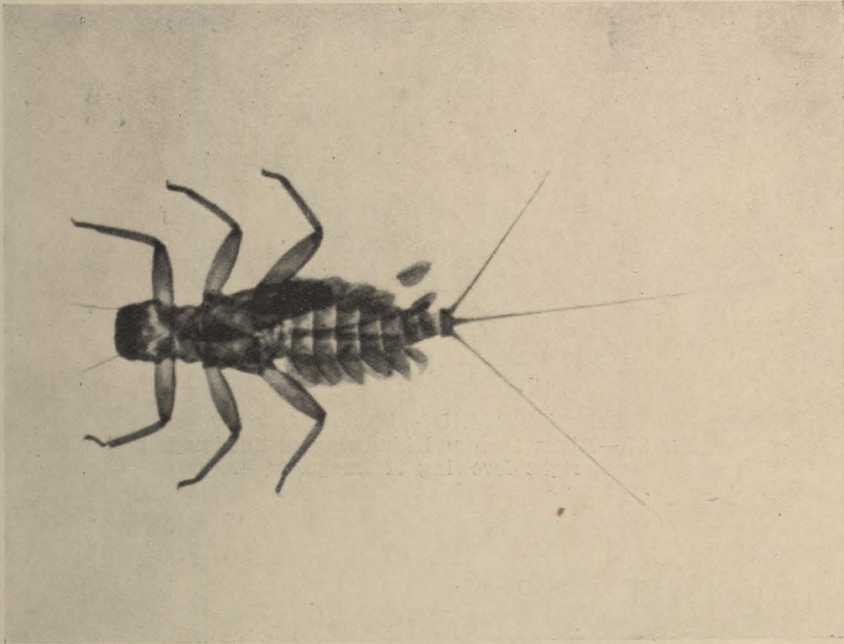
Nymph of *Deleatidium lilli*.

FIG. 11.—Gill of First, fourth and seventh pairs, Ca.  $\times 16$ .

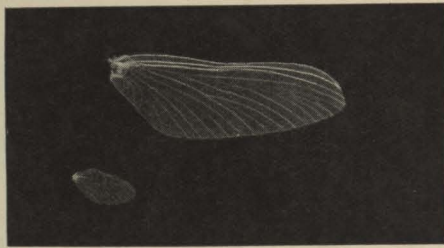


*Deleatidium myzobranchia*.

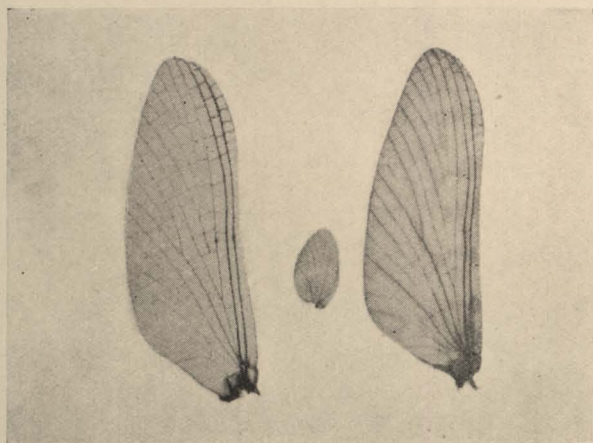
FIG. 12.—♀ Sub-imago Ca.  $\times 4$ .



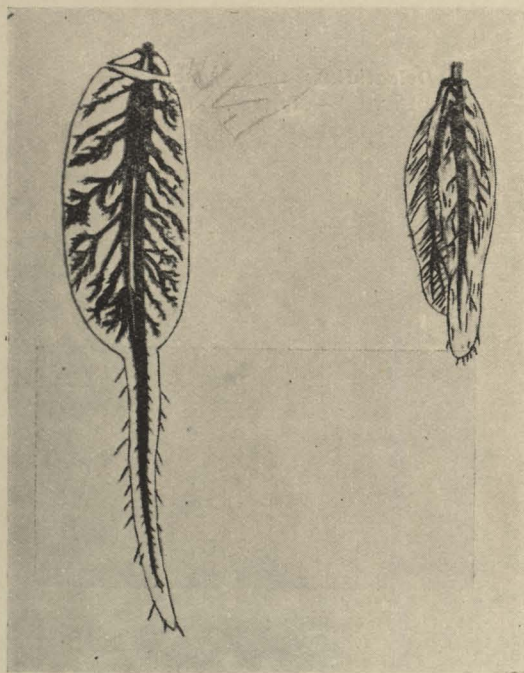
*Deleatidium myzobranchia.*  
FIG. 13.—Nymph.  $\times 3$ .



*Deleatidium cerinum.*  
FIG. 14.—♀ Sub-imago.  $\times 4$ .

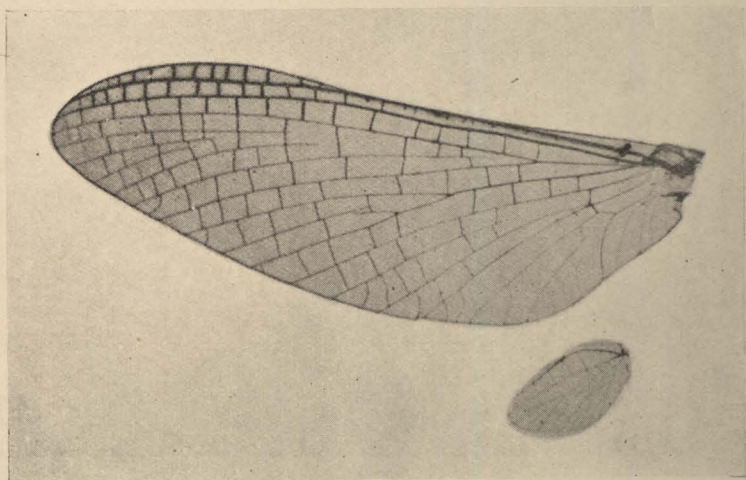


*Deleatidium (Atalophlebioides) sepia.*  
FIG. 15.—Right fore- and hindwing of Sub-imago and  
right forewing of Imago.  $\times 4$ .

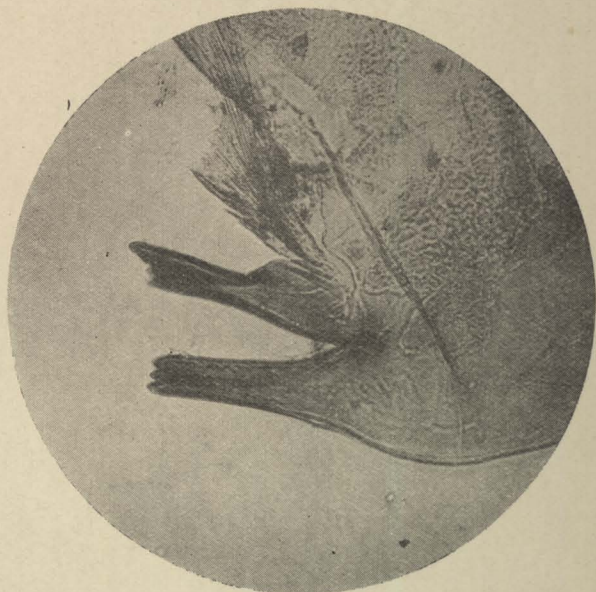


Nymph of *Deleatidium (Atalophlebioides) sepia.*  
FIG. 16.—Outer lamella of gill of fourth pair and  
gill of seventh pair, much enlarged.





*Deleatidium lillii.*  
FIG. 17.— Imago.  $\times 9$ .



Nymph of *Deleatidium (Atalophlebioides) cromwelli.*  
FIG. 18.—Canine region of mandible, greatly enlarged.

1901

1902

1903

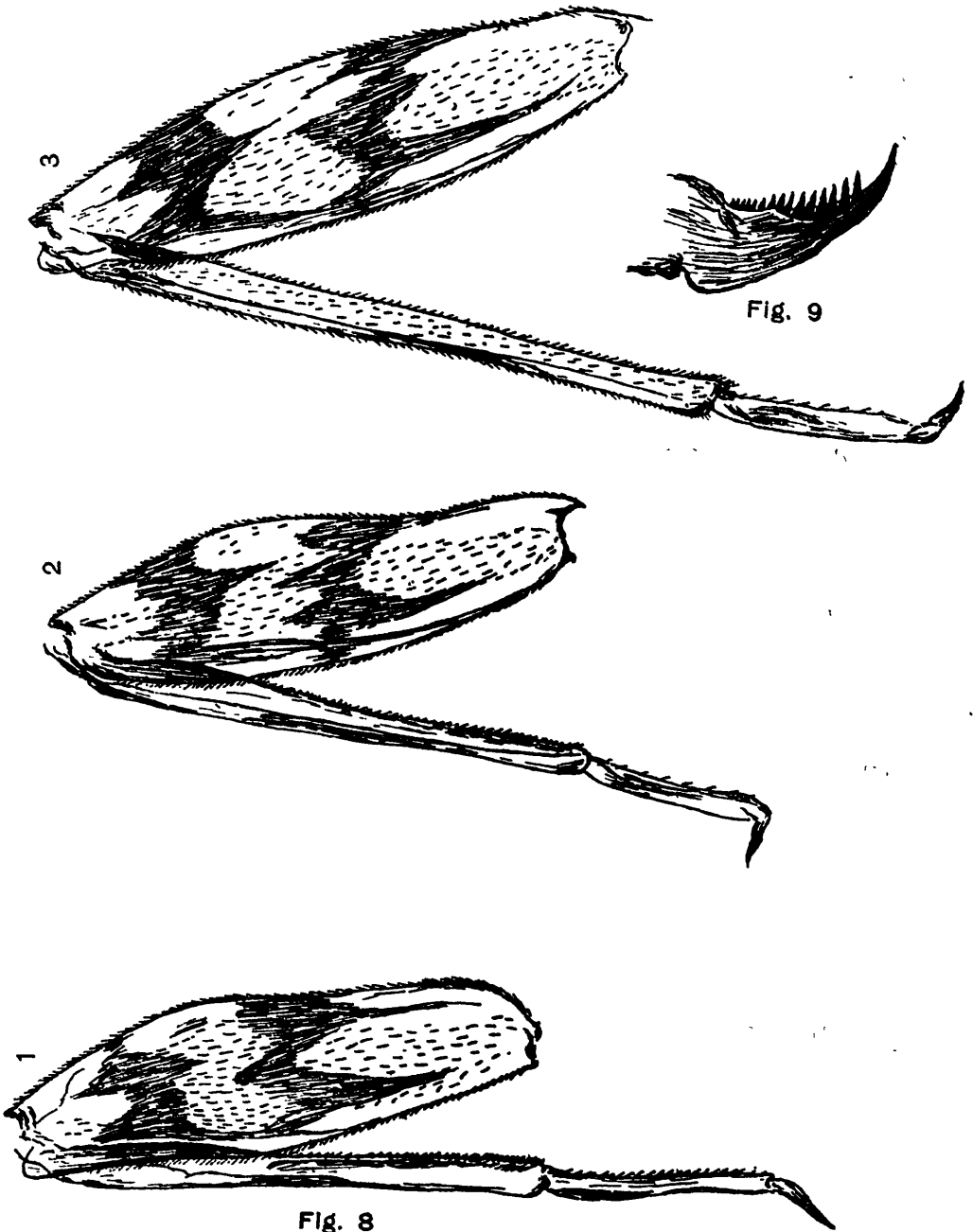


Fig. 8

Fig. 9

Nymph of *Atalophlebia versicolor*.  
FIG. 8.—Legs.  $\times 25$ .  
FIG. 9.—Tarsal claw, much enlarged.

and sub-imaginal stages and with the latter in the nymphal and imaginal stages.

The vivid red colour of the costal region in the imago, mentioned by Hudson (1) and by Eaton (4), but subsequently modified by the latter (5) to dark amber yellow (raw sienna), must not be taken as a point to distinguish it from *A. versicolor*, for the colour of this region varies greatly. The colour of the legs and of the abdomen is a much safer guide.

*Nymph*—As *A. versicolor*, described above, but it is shorter and stouter, and there are also the following differences:

	<i>A. versicolor</i>	<i>A. dentata</i>
<i>Femora</i>	Ground colour yellow with two dark sinuous bands.	Ground colour grey with patches apically and medianly.
<i>Between eyes</i>	A yellow spot.	None.
<i>On dorsum</i>	Yellow median line longitudinally.	None.
<i>do.</i>	Yellow triangle posteriorly.	None.

#### IMAGO.

*Length*—8 to 9 mm., excluding setae.

*Head*—Fawn, with brown markings. Ocelli yellow amber, rimmed in brown.

*Eyes* of female, olive; of male, upper lobes orange brown, lower lobes olive.

*Thorax*—Light brown with dark brown markings.

*Abdomen*—Light bistre-brown, modified in segments eight to ten with burnt umber, the first eight segments black-rimmed posteriorly. Ventral lobe of female emarginate. Claspers lutescent, greyish distally; three-segmented; dilated at base. Penes reddish, 'lobes contiguous with each other throughout, elongate triangular and thin with their outer edges thickened.' (Eaton).

*Caudal setae*—Light fawn to sepia grey with black joinings; median setae—male, 18 mm.; female, 15.5 mm.; outer ones—male, 16 mm.; female, 14 mm.

*Legs*—Femora and tibiae barley-sugar orange, darkened distally; fore-femora slightly darker. Tarsi flavescent, tipped with grey at joinings.

*Wings*—Length of forewing—male, 12 mm.; female, 13 mm.

"Wings vitreous, the disc very faintly tinted with yellowish: marginal and sub-marginal areas of the forewings coloured with dark amber yellow (raw sienna), the sub-marginal area wholly, the marginal area only in part, viz., from the base to the middle and in the pterostigmatic space completely, but only in about one-third its breadth along the sub-costa in the intervening space: the cross-veinlets in the marginal area before the pterostigmatic space and those in the sub-marginal area are bordered with dark bistre-brown and give rise to a blotch or cloud at the bulla. Neuration mostly pitch-black, but the nervures near the wing-roots, and the stouter parts of the costa, sub-costa and radius are pitch-brown. Cross-veins in marginal area about five before and fifteen beyond the bulla, all straight." (Eaton).

*Egg*—An irregularly-shaped oval, with bosses, pits and sculptured chorion. It may be distinguished from the egg of *A. cruentata*, by its far more irregular outline and by its bosses, which are placed singly and not in groups of two or three.

## SUB-IMAGO.

*Wings* (Pl. 62, Fig. 2)—Surface cloudy white, but occasionally tinted with dull brown or orange: costal region dark amber yellow, darker midway and in pterostigmatic region. Veins blackish, cross-veins irregularly-bordered with grey. Often, a thin grey band may be noticed, running across the wing-surface medianly at right angles to the costa, formed by the greyish bordering of cross-veins and a lighter and more irregular area three-quarters of the way towards the wing-tip in the anterior portion. Hindwing coloured as forewing. Sc. orange, other veins black.

The winged stages of this species appear throughout the summer and even up till the month of April.

*Distribution*—Auckland, Hawkes Bay, Wellington, and Nelson provincial districts.

**Atalophlebia cruentata** Hudson.

## IMAGO.

*Length* (excluding setae)—12 mm.

*Head*—Black median line down frons: elsewhere light orange with black markings. *Eyes*—female, dull yellowish-green; male, lower lobes as in female, upper lobes bright orange. *Ocelli*—orange red.

*Thorax*—Light orange with black markings.

*Abdomen*—Dorsum, dull red: dark line at posterior edges of segments. There is a dark median line throughout the length, except on the tenth segment: this segment is lighter than the rest and more orange in tint. Venter—dull red, becoming lighter posteriorly: posterior edge of segments 1 to 9 dark-rimmed.

Penes very light orange (Text-Fig. 11). Claspers as penes, but becoming almost colourless distally and tinged with light grey: dilated at base: three-jointed.

*Caudal setae* flavescent with black joinings: median seta, 18 mm.; outer setae, 16 mm.

*Legs*—*Anterior pair*—Femora orange with brown transverse bar two-thirds of the way towards distal end. Tibiae orange, tipped with black distally. Tarsi flavescent (almost colourless), tipped with black at distal end of each segment.

*Other pairs*—Femora orange (those of third pair the longest).

Tibiae light orange, becoming flavescent distally and slightly tipped with black apically. Tarsi flavescent, very slightly tipped with black at distal end of each segment: four-jointed.

*Egg* (illustrated in Part 1 of this paper, Plate 52, Fig. 5)—Oval, covered at regular intervals with numerous bosses in groups of two or three, and many very minute pits.

*Wings* (Pl. 62, Fig. 3)—Forewings hyaline, except the costal and sub-costal areas which are orange. Cross-veins pitch black. Prominent bulla on Sc. and a smaller one on R2a. There are six simple marginal cross-veins interior to the humeral; they broaden as they approach the costa.

Hindwings hyaline, except the costal region which is orange. Veins black. Wing expanse, 28 to 30 mm.

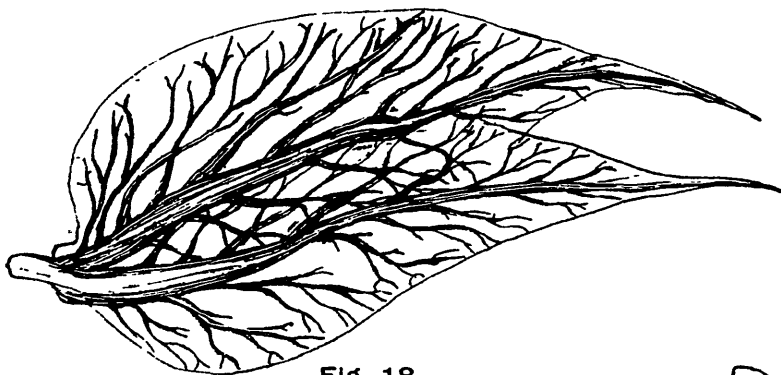


Fig. 18

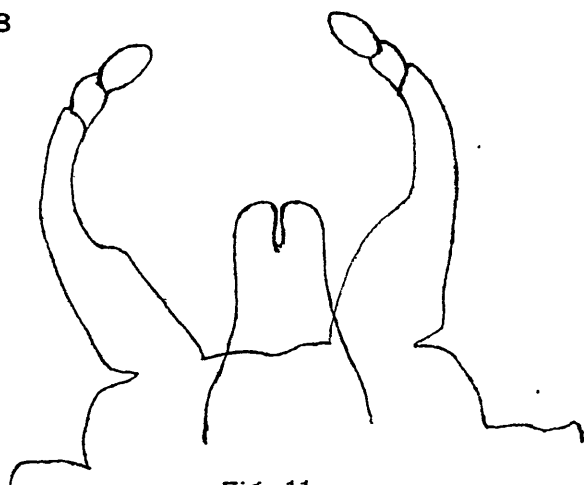


Fig. 11



Fig. 14

*Atalophlebia cruentata.*

FIG. 11.—Penes.  $\times$  24.

FIG. 14.—Maxilla.  $\times$  60.

FIG. 18.—Gill.  $\times$  24.

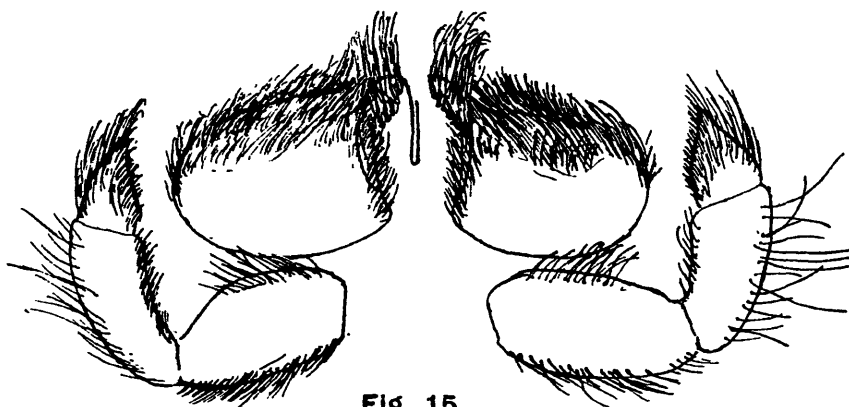


Fig. 15

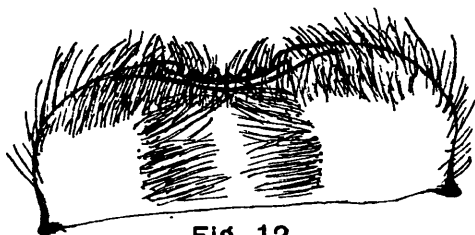


Fig. 12



Fig. 13

Nymph of *Atalophlebia cruentata*.

FIG. 12.—Labrum. × 60.

FIG. 13.—Mandible. × 60.

FIG. 15.—Labium. × 60.

In the shape and venation of the wings this species is similar to *A. dentata*, but the imago of *A. cruentata* can easily be distinguished from the latter by the dark bar on the anterior femora and the orange costal region of the hindwings.

*Wings of Sub-imago*—Wing-surface of forewings light pearly brown, except costal region which is orange red, but brick red at extreme base. At the wing base, an orange bar runs from costa to cubitus. Cross-veins black, bordered irregularly with grey. Other veins nearly colourless.

In the hindwing, the proximal half of the marginal area is orange and the remainder of the surface is pale pinkish-pearl. The main veins are colourless, the cross-veins grey, irregularly bordered.

#### NYPH.

This nymph lives among sand, shingle, or under stones in the beds of streams: it prefers the shallow, less rapid parts and shuns the light. It is rather difficult to catch, as immediately it is uncovered it edges away very quickly into the nearest cranny, where it hides itself with considerable skill. If it were not for its bright colour it would be extremely difficult to secure.

#### DESCRIPTION.

*Length* (excluding setae)—Ca., 12 mm.

*Colour*—Bright orange red.

*Head*—Light red with black markings: small.

*Eyes*—Male, upper lobes dark orange; lower lobes dark olive. Female, dark olive.

*Ocelli*—Black.

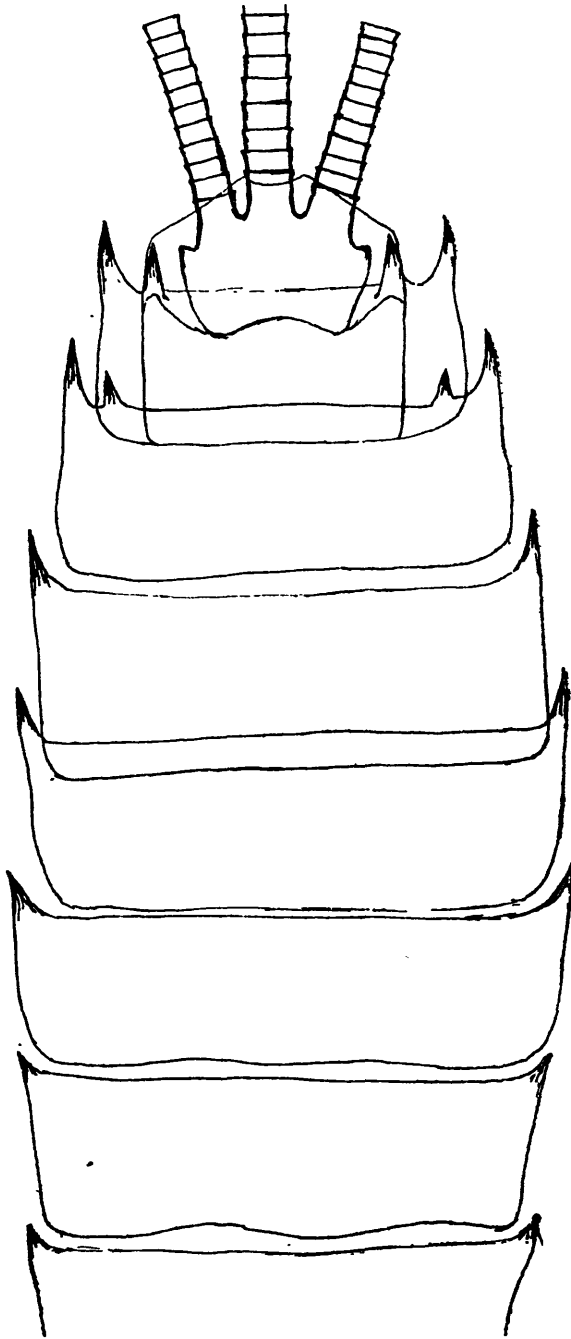
*Antennae*—Orange, filiform; about twice as long as the head.

*Labrum* (Text-Fig. 12)—Two and a half times as broad as it is long. The anterior edge has an inward median curve with five well-marked teeth, of which the central one is the smallest. The posterior border is almost straight, but its lateral angles are produced slightly backwards and outwards.

*Mandibles* (Text-Fig. 13)—Outer canine (o.c.) with three teeth, inner canine (i.c.) with three teeth. Edges of the outer canine are crenately serrated. Protheca (p.) very thin, deeply serrated at edge, with prominent brush of long brown hairs interior to it and directed inwards. Molar surface (m.) with about eleven parallel transverse ridges, armed with bristles. A prominent chitinised knob projects from the angle proximal to the molar surface.

*Maxilla* (Text-Fig. 14)—Palp three-segmented; median segment broadest, basal segment about two-thirds as broad and as long, apical segment the smallest and triangular in shape, covered all over with long spines: the two proximal segments bear spines on the outer edges only. The galea-lacinia bears the usual terminal brush of long brown hair and a row of pectinate rakes distally and also the long fringe of hair on the inner margin, but the shape of the maxilla is unusual, as it becomes somewhat narrower towards the base instead of broader, as is generally the case.





Nymph of *Atalophlebia cruentata*.

FIG. 16.—Posterior portion of abdomen (exuvia)  $\times 24$  dorsal view.

*Hypopharynx*—As in *A. versicolor*, but the anterior edges of the superlinguae curve more deeply inwards towards the middle of the hypopharynx.

*Labium* (Text-Fig. 15)—Palp three-segmented; basal segment longest and broadest, the two distal ones have coalesced, but the suture is still visible; their inner edges form a straight line, their outer ones a convex bend, so that the palp is pointed. The distal segment is covered with long spines as are the edges of the two basal segments. Glossae very narrow, curved and with long hairs distally and bearing a few short spines on the surfaces. Paraglossae about four times as wide as the glossae, covered with hairs and spines in the distal portions and on those parts of the surfaces which are near the glossae: outer margins curved convexly, inner and anterior margins almost straight.

*Thorax*—Small and narrow. Light orange with black markings dorsally. Wing-pads orange, stippled with black and black-edged, but appearing deep black in mature specimens.

*Abdomen* (Text-Fig. 16)—The posterior-lateral angles of segments are toothed backwards, very pronouncedly so in the posterior half, but not in the tenth segment: the segments are broadest in the mid-portion of the abdomen.

*Dorsum*—Bright orange, becoming vivid and more reddish posteriorly. Anteriorly there are dark median markings, also near the gill insertions and on the posterior rims of segments, but these become less noticeable posteriorly.

*Venter*—Pale orange, becoming darker posteriorly.

*Caudal setae* — Orange, becoming lighter posteriorly: black-rimmed at joints. Outer ones, 8 mm.; median seta, 9 mm.

*Legs* (Text-Fig. 17)—Colour orange. Order of length 3, 2, 1. The femora are dilated, those of the anterior pair have a median darker-shaded area (not shown in drawing).

The legs are spinose as in *A. versicolor* and there are fringes of hair along the edges of the tibiae and tarsi and also on those of the anterior femora. Along the ventral edge of the fore-tibiae, the spines are curiously feathered (cf. *Ichthybotus hudsoni*).

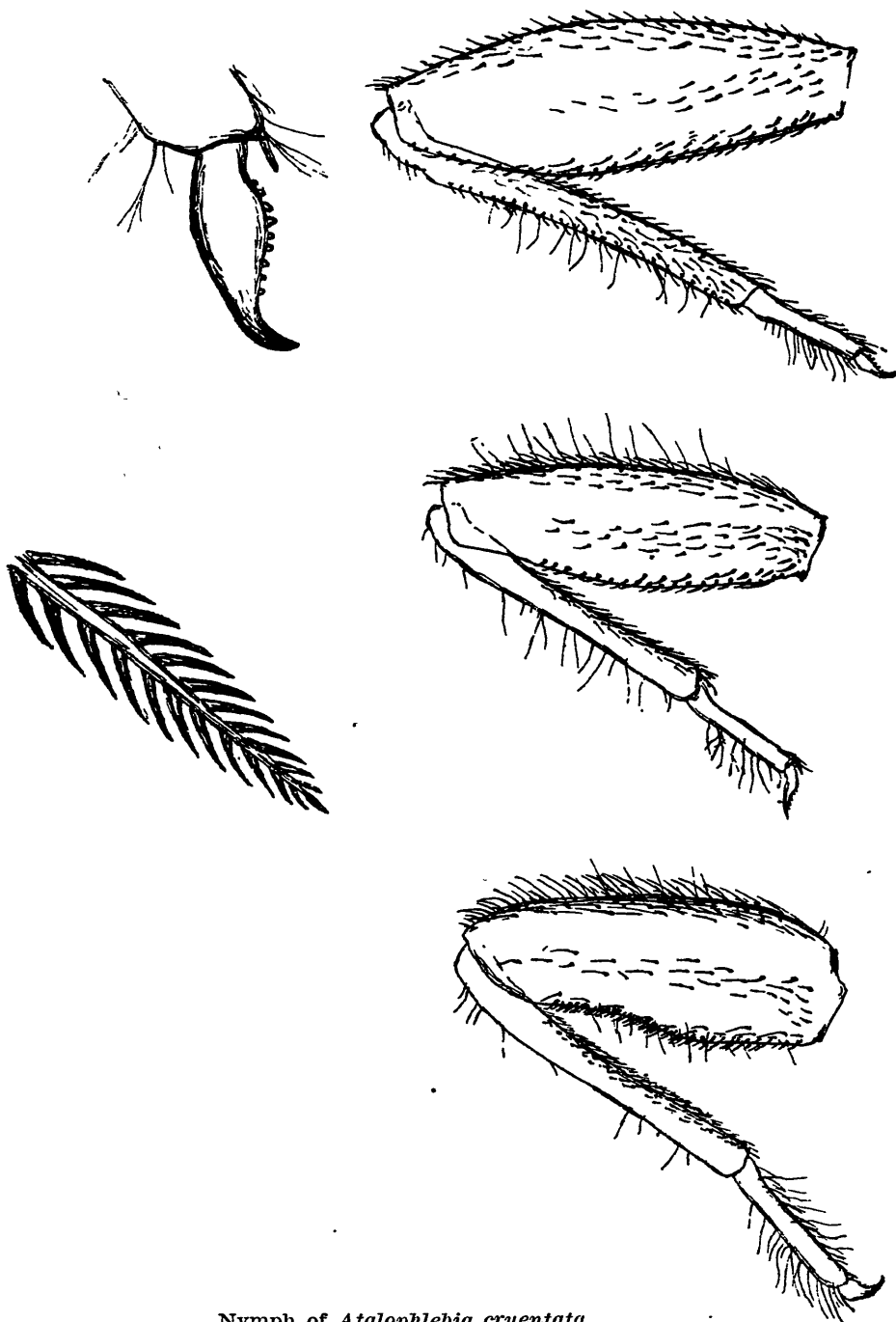
*Gills* (Text-Fig. 18)—Pairs of double gills, which are moderately vibrated, are borne laterally on the first seven abdominal segments. The gills of the first six pairs are ovate-acuminate, those of the seventh pair are smaller, narrower and are only slightly vibrated. The gill surfaces are pale orange: the venation is black, pinnate with strong central tracheae.

*Distribution*—Auckland, Hawkes Bay, Wellington, Nelson and Canterbury districts.

### *Atalophlebia nodularis* (Eaton).

This species has already been described in part by Eaton (17) and (4), and further by Lillie (3).

Hudson (1) states, 'I have been unable to identify this species with certainty,' and it was only in the third year of my investigations that I was able to place this insect definitely.



Nymph of *Atalophlebia cruentata*.

FIG. 17.—Legs.  $\times 24$ , tarsal claw and feathered hair, greatly enlarged.

This was due partly to the fact that it is by no means common in the Wellington district, and partly because the previous descriptions are incomplete and do not seem to tally, in certain particulars, either with each other or with the actual fly.

From time to time, I secured at Khandallah and elsewhere an occasional specimen, which seemed to resemble *A. nodularis*, as described, with certain differences, and towards the end of January, 1930, whilst examining the fauna of the Gowan River at its exit from Lake Rotoroa, Nelson district, I found this species in swarms, and concluded, as the points of resemblance far outweighed the few differences and as there was no other fly at all like it, that it must be the species described by Eaton and Lillie as *A. nodularis*.

As Lillie (3) has figured various parts of the nymph and imago, I am illustrating the following points only: sub-imaginal forewing (Pl. 62, Fig. 4) to show markings, imaginal forewing (Pl. 62, Fig. 5)—Lillie's figure shows the venation, but not the very characteristic pattern of the marginal and sub-marginal areas—and the nymph (Pl. 62, Fig. 6), as it would be rather difficult to identify the insect from Lillie's Fig. 4d (3).

#### IMAGO.

*Length*—8.5 mm., excluding setae.

*Head*—Light brown with dark brown markings. Ocelli grey. Eyes of female and lower lobes of those of male dark brown, upper lobes orange red.

*Thorax*—Windsor and Newton's 'Roman sepia' brown.

*Abdomen*—Same colour as thorax, with light rings at posterior edges of the first eight segments: ventral valve emarginate: venter fawn. Penes and claspers brown; the latter three-segmented, with long proximal segment dilated at base and distal segments short and sub-equal.

*Caudal setae*—Very light grey with broad black joinings, which become broader distally: uniformly covered with soft hairs: outer setae—male, 16 mm.; female, 13 mm.; median seta—male, 14 mm.; female, 11.5 mm.

*Legs*—Femora light raw umber with a dark median band, in the first pair a dark distal band. Tibiae light brown ochre, with a dark distal band in the first pair only, faintly and narrowly shown in the other pairs. Tarsi lighter than tibiae and with greyish tinge: joints narrowly edged with black: four-segmented.

*Wings* (Pl. 62, Fig. 5)—Length of forewing—male, 9.5 mm.; female, 10 mm. Surface vitreous with dark brown or black venation, except costa, sub-costa and R1, which are brown: cross-veins of costal and sub-costal areas heavily and irregularly-bordered with dark brown: cross-veins in area posterior to R1 edged narrowly only and in remaining areas not edged at all. Half way along the wing, the edgings in the three anterior areas spread into the wing surface, forming a small blurred area.

Anterior of wing-base light brown.

*Egg*—Very irregularly-shaped with dark circumscribing line indicating mucilaginous matrix: it has anchor ropes attached to each

of the polar regions and these ropes are almost invisible and require very careful focussing of the microscope to spot.

Surface of chorion obscured by mucilaginous coat; there are, however, indications of minute pits, showing through the coat.

#### SUB-IMAGO (Pl. 62, Fig. 4).

*Wings*—Surface mainly grey with irregular pearly spaces. Cross-veins in the costal and sub-costal areas narrowly edged with heavy black, giving them a thick appearance. In the other areas, they are more broadly and irregularly-edged with light grey: these grey areas run together in places, and in others—notably in the anterior portions of the wing—they are more nearly confined to the immediate vicinity of the cross-veins, thus forming the irregular pearly spaces.

#### NYMPH (Pl. 62, Fig. 6).

This lives in slow and moderately-flowing water on the stream bed among stones and débris. It can be recognised by the shortness of its caudal setae in comparison with its body, by the orange colour of the posterior of the dorsum, by the stillness of its thin, Y-shaped gills and by its being in some way suggestive of a miniature *Atalophlebia cruentata*.

*Length*—8 mm., excluding setae.

*Head*—Square; rounded and haired anteriorly, where it has a reddish tinge. Eyes of female black or dark brown; those of male resembling these of female in lower portion, olive brown in upper portion. Mouthparts as in other *Atalophlebia* spp.

*Thorax*—Olive brown. Wing-pads small, olive brown, covering the first two abdominal segments.

*Abdomen*—Olive brown or reddish orange, tinted grey; anterior six segments with thin, black rim posteriorly, posterior four segments tinted orange: latero-posterior angles of sixth to ninth segments toothed backwards and yellowish in tint. There is a yellow mark on each side of the abdomen, placed latero-anteriorly on each segment.

*Caudal setae* olive brown or reddish-brown; joinings darker and whorled with short hairs and a row of minute spines pointing backwards: median one, 6 mm.; outer ones, 4.5 mm.

*Legs*—Almost colourless: third pair longest, first pair shortest. Femora short and stout, with grey marks medianly and at ends and small spines distributed over surfaces. Tibiae and tarsi with light brown or pinkish tinge: rows of spines on dorsal and ventral edges and a row of hairs on the dorsal edges.

*Gills*—Pairs of thin, double gills appear latero-posteriorly on the first seven abdominal segments. The gills are seldom vibrated and consist each of a pair of lanceolate-acuminate lamellae, joined at the base, each lamella containing a thick unbranched central trachea. The gills of the seventh pair are the smallest, those of the first and sixth pairs being somewhat smaller than those of the remaining ones.

*Distribution*—Moderately swift streams in the Wellington and Nelson provincial districts.—*Hutton*. Christchurch and Dunedin.

*Atalophlebia* ? n. sp.

Whilst I was on a brief visit to the North Auckland district, the nymph of a new species of *Atalophlebia* was found in a small woodland stream on the property of Mr. F. Heaton, of Tanekaha, a few miles west of Hikurangi.

In this stream, which was a moderately rapid one, were a number of Ephemerids, including *Atalophlebia versicolor*, *A. cruentata* and a species of *Ameletus*, which may have been a new one, but unfortunately, at this time (beginning of March), all the individuals of this species were too small to note slight differentiations from type with any certainty.

The new *Atalophlebid* was present in considerable numbers; it was comparatively large, conspicuously marked and therefore easily distinguished.

Owing to the fleeting nature of the visit, it was impossible to secure the winged stages or even to keep the nymphs alive until they transformed. Accordingly, they were placed in preserving fluid and taken back to Wellington.

This species cannot be given a name until the winged stages have been found, but for convenience, I have given it the provisional name of *A. borealis* in my notebook.

## DESCRIPTION (from preserved specimen).

*Length* (excluding setae)—Ca., 12 mm.

*Head*—Large; sub-quadrangular, with slightly convex margins. Ground colour yellow, covered all over with fine sepia stipling, except on three small areas, one exterior to each ocellus. *Eyes* large, dark brown. *Mouthparts* of the typical *Atalophlebid* description. The median bay of the anterior edge of the labrum bears five prominent teeth.

*Thorax*—Yellow with sepia stipling: wing-pads cover the first two abdominal segments.

*Abdomen*—Very broad, narrowing considerably posteriorly: latero-posterior angles of segments six to nine project backwards as sharp teeth: the ninth and tenth segments are telescoped, the former, in particular, having a much narrower area visible than is usual in this genus. The ground colour is yellowish; heavy, symmetrical, dark markings, on each side of the median line, are found dorsally on the first nine segments: ventrally, the dark markings are placed in a median area on each of these segments and are suggestive of the same markings in *Oniscigaster*.

*Caudal setae* (broken)—Apparently ca. 12 mm.: yellow: whorls of very short, fine hairs occur at the joinings.

*Legs*—Colour dingy yellowish-brown (but markings possibly washed out by preservative).

The femora and tibiae of the middle pair of legs are somewhat longer than those of the anterior pair, but the tarsi are slightly shorter. The femora and tibiae of the posterior pair are longer than those of the other two pairs, the tarsi being about the same length as in the anterior pair.

There are spines on the surfaces and on the dorsal and ventral edges of all the femora, on the ventral edges of the tibiae (fewer on those of the middle pair of legs), on the dorsal edge of the posterior tibiae only and on the ventral edges of the posterior and anterior tarsi. There are fringes of a few weak hairs on the dorsal edges of the tibiae of the second and third pairs of legs.

The tarsal claws are toothed underneath.

*Gills*—There is a pair of gills on each of the first seven abdominal segments. The gills become smaller posteriorly. Each gill consists of a pair of ovate-acuminate lamellae. The tracheal venation is pinnate with a stout central trachea. The gills of the last pair are very small and the inner lamella is minute: both have a central trachea but no pinnate branches.

#### Genus DELELATIDIUM Eaton (1899).

*Adult*—"Distinguished as a genus from *Leptoplebia* by the male imago having genitalia conformable in pattern to those of an *Atalophlebia*. . . ." (Eaton).

*Nymph*—Nymph of the crawling type. Body markedly flattened dorso-ventrally. Nymph generally found under stones. Head square. Eyes lateral. Antennae long and filiform. Maxillary and labial palps three-segmented. Labrum at least three times as broad as it is long and notched medio-anteriorly. Maxilla with broad terminal brush of long brown hairs and small pectinate rakes. Wing-pads large. Legs long, spinose: femora very much dilated: claws toothed underneath. Latero-posterior angles of abdomen mostly toothed backwards, pronouncedly so in the posterior half. Caudal setae as long as or longer than the body; median seta longest. Pairs of gills borne laterally on the first seven abdominal segments: the gills are single: those of the first pair are kidney-shaped in outline, those of the other pairs ovate-acuminate or sub-rotund.

The only *Deleatidium*, described previously, was *D. lillii* (1), (3), (4), (5), (17), and (18). Of the six species of this genus, described below, four are extraordinarily alike. The remaining two are somewhat different in appearance. The first of these, *D. myzobranchia* n. sp. may possibly have to be placed in a new genus, at a later date. The second, *D. cerinum* n. sp., is very minute and has a sub-imago with wings of a waxy or dead-skin colour, which makes it easy to recognise as it emerges from the nymphal exuvia at dusk, on the rivers.

There are slight differences in the New Zealand *Deleatidium* nymphs and the characters ascribed to that genus (based on Neotropical species) by Needham and Murphy (9).

New Zealand species of this genus are extensively eaten by trout and by other fish, as well as by predatory insects, such as the nymphs of stoneflies, and they have other enemies, for on examining the stomach of a *Deleatidium* nymph, it was found to contain a large number of Nematodes. These parasitic worms are also found in the winged stages, so they obviously occur in that part of the alimentary tract, which is not cast off, when the insect moults.

There are at least three species of *Deleatidium*, which have almost identical nymphal and imaginal forms, but entirely distinctive sub-

imaginal wings. One of these only, *D. lillii*, has been described. (1) and (3).

The sub-imaginal wings of *D. lillii* (Pl. 63, Fig. 7) are of a uniform smoky-grey, those of the other two species (Pl. 63, Figs. 8 and 9) and (3) have a pearly ground colour and are irregularly-marked with dark grey, the pattern of the markings differing in the two species.

These latter two species have been secured at different seasons of the year, the one in spring and early summer, the other during the summer and autumn. I am therefore naming them *D. vernale* and *D. autumnale* respectively.

Nymphs of *D. lillii*, on the other hand, have been seen to metamorphose almost all the year round, even in midwinter.

It is of interest to note, however, that two specimens (1 male, 1 female) which were secured as nymphs on July 4th, 1929, changing the same day into sub-imagines, failed to reach the imaginal stage. They attempted to do so in the laboratory about thirty-six hours later, but apparently had not the necessary energy and died, partly metamorphosed. Whether this is usually, or perhaps often, the case in winter, is not known.

To differentiate between the nymphs of *D. lillii* and *D. vernale*, the gills may be examined, as explained in a later paragraph. However, as individuals of the same species also show slight variations, this is by no means a satisfactory test.

In such specimens as have been examined, there would appear to be slight differences in the dorsal markings of the thorax and abdomen, but as it has so far only been possible to compare the final nymphal exuviae, and only a very limited number of these, and as, moreover, the differences in the appearance of instars of the same species are far more marked than the differences between the species, more data will be required before a definite statement of specific differences, so far as nymphs are concerned, can be made.

The markedness of the differences in the appearance of a given species of *Deleatidium* in various instars is most extraordinary, and is such that only an experienced observer would recognise that he was dealing with members of the same species. Nevertheless, these changes in appearance—except for the alteration in size and shape of wing-pads—are due entirely to the different intensity of pigmentation in the various markings.

Differences in the character of the riverbed also affect the colour scheme of this nymph.

Individuals of species of *Deleatidium* are perhaps more abundant than those of any other genus of mayfly. They are feeble swimmers, clinging to the under-surfaces of stones and boulders in slow and also in rapid waters. They are also found buried in the sand and shingle of the river bed, and—especially in winter-time—among submerged moss, and waterside vegetation of many kinds.

#### KEYS TO N.Z. SPECIES OF DELEATIDIUM.

##### *Imagines.*

A. Costal vein faint and inconspicuous except towards wing-tip

*Deleatidium*  
*cerinum* n. sp.  
Page 382



B. Costal vein strongly-marked:

1. Costal and sub-costal region of forewing tinted with rose-madder pink, distally or entirely . . .

*Deleatidium myzobranchia*  
n. sp.  
Page 373

2. Not as above:

(a) Length of body (excluding setae), 7 mm. or less.

(i) Abdominal segments dark-rimmed posteriorly . . . . .

*Deleatidium fumosum* n. sp.  
Page 372

(ii) Not as above . . . . .

*D. (Atalophlebioides) cromwelli*  
n. sp.  
Page 385

(b) Length of body (excluding setae), more than 7 mm.

(i) With heavy dark band at 'knee' . . . . .

*D. (Atalophlebioides) sepia* n. sp.  
Page 383

(ii) Not as above:

Abdomen reddish-brown dorsally . . . . .

*D. lillii* (Walker)  
Page 368

Abdomen dark fawn dorsally, with a light median area on each segment..

*D. vernale* n. sp.  
Page 360

Abdomen light brown dorsally, shaded in the median and lateral portions with dark grey markings . . . . .

*D. autumnale*  
n. sp.  
Page 371

*Sub-Imagines.*

A. Wings waxen-white . . . . .

*Deleatidium cerinum* n. sp.  
Page 382

B. Wings grey—

(i) Wings pearly-grey . . . . .

*D. (Atalophlebioides) cromwelli*  
n. sp.  
Page 385

(ii) Wings or area along each side of main veins deep sepia-grey . . . . .

*D. (Atalophlebioides) sepia*  
n. sp.  
Page 383

(iii) Wings smoky-grey—

(a) Wing Expanse ca., 20 mm. . . . .

*D. lillii* (Walker)  
Page 368

(b) Wing Expanse ca., 15 mm. . . . .

*D. fumosum* n. sp.  
Page 372

C. Wings variegated—

(i) Distal region of costal and sub-costal areas rose-madder pink . . . . .

*D. myzobranchia*  
n. sp.  
Page 373

(ii) Not as above—

(a) Wing pattern as in Fig. 3K. ♂ wings larger than those of ♀ . . . . .

*D. vernale* n. sp.  
Page 360

(b) Wing pattern as in Fig. 2K. ♂ wings not larger than those of ♀ . . . . .

*D. autumnale*  
n. sp.  
Page 371

## NYMPHS.

No key to the nymphs of this genus is given for the following reasons:—

*D. lillii*, *D. vernale* and *D. autumnale* cannot be distinguished from each other with any certainty in this stage until they have received further and more intensive study.

With regard to the nymphs of *D. fumosum* and *D. cerinum*, so far it was only from the last nymphal exuviae that I have been able to distinguish between them on the one hand and *D. lillii*, *D. vernale* and *D. autumnale* on the other.

Fully-grown specimens of the first-named nymphs are only distinguishable from the younger stages of the other species, because they have fully-developed wing-pads, whereas the other species of the genus have not.

*D. (Atalophlebioides) sepia* and *D. (Atalophlebioides) cromwelli* have double gills and are therefore included in the nymphal key to *Atalophlebia* species.

*D. myzobranhia* has the gills rounded apically and not acute.

**Deleatidium vernale** n. sp.

## IMAGO.

*Length* (excluding setae)—Male, 8 to 9 mm.; female, 6.5 to 8 mm.

*Wings*—Expanse, 19 mm.

Surface hyaline except in the costal and sub-costal areas, which are very faintly tinted with light brown and the wing-base, which is more pronouncedly coloured.

Veins dark brown, becoming lighter posteriorly till they are almost colourless in the anal region. Sc and R1 light brown. Cross-veins in proximal part of costal area colourless, in the distal part deep brown.

Bullae are present on Sc, R2 and R4 + 5.

*Hindwing*—Surface colourless as are the veins, except at the wing-base and in the distal anterior quarter of the wing, where they are brownish.

*Head*—Olive brown.

*Eyes*—Male: upper lobes, reddish-brown; lower lobes, olive brown; female: olive brown.

*Ocelli*—Greenish.

*Thorax*—Olive brown.

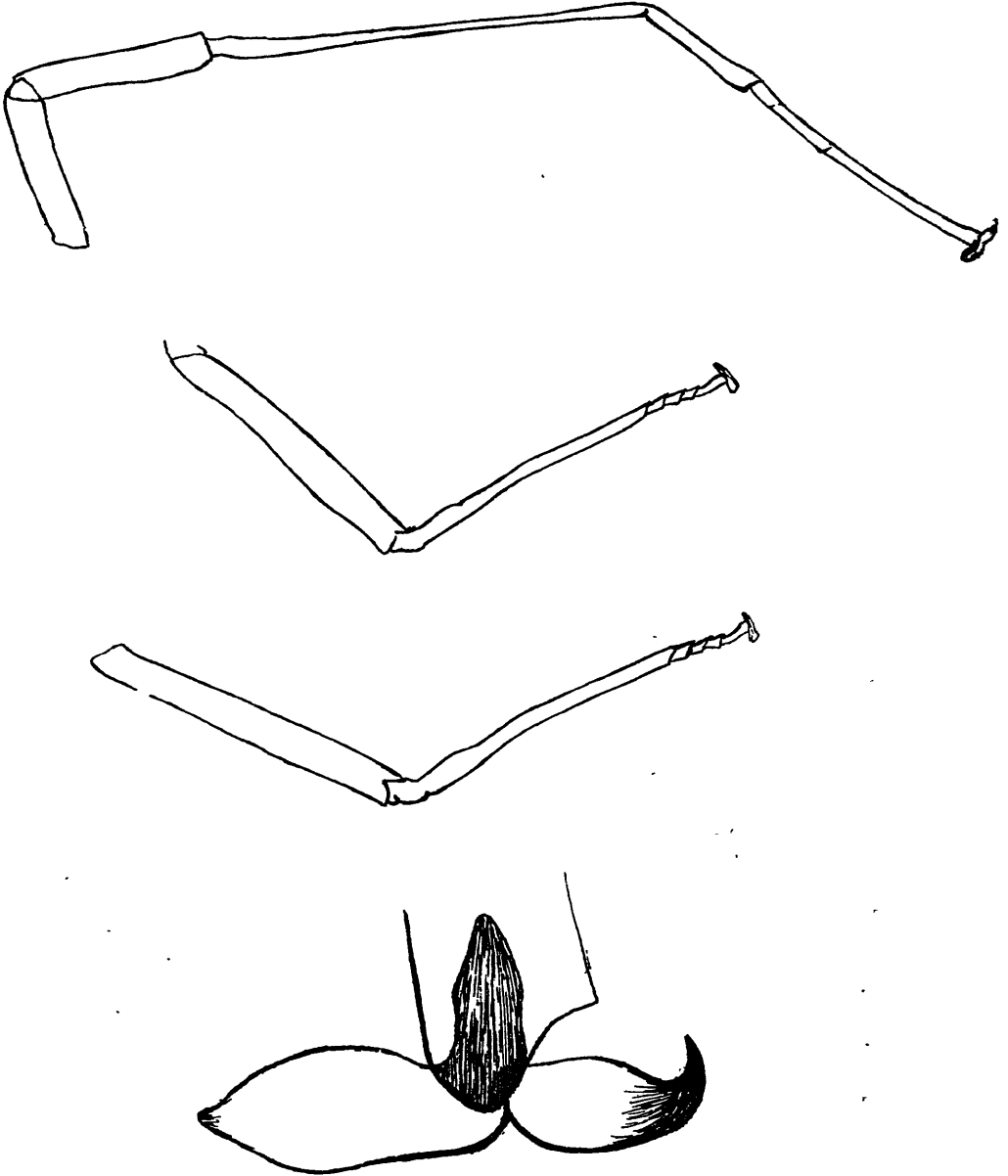
*Abdomen—dorsum*—Ground colour dark fawn; an irregular median area of each segment is of a lighter shade and there is a light median line bisecting the first eight abdominal segments and the posterior edges of these segments have whitish bands: the ninth segment has a pinkish tinge and its posterior-lateral angles project backwards as sharp teeth.

*Venter*—Ground colour dark fawn: there is an irregular dark median line on the first eight segments, which have white rings at the posterior edges.

Claspers light brown, becoming much lighter distally: three-jointed: dilated at base. Penes bright orange brown.

*Caudal setae*—Light brown, darker at joints. Male: median one, 15 mm.; outer ones, 13 mm.; female: median one, 11.5 mm.; outer ones, 10 mm.

*Legs* (Text-Fig. 19)—Femora light brown. Tibiae flavescens. Tarsi flavescens, tinged with grey; four-jointed. Tibiae and tarsi sub-equal in length. Hind tibiae about four times as long as tarsi.



*Deleatidium Vernale.*

FIG. 19.—Legs of ♂ Imago  $\times 22$ , and tarsal claw, much enlarged.

There are two unlike claws at the end of each tarsus, the one being narrow and hooked at tip, the other broad and blunt. Male foreleg, as usual, very long, as, though the femur and tibiae are shorter than those of the hinder legs, the tibia is enormously elongated.

In this species, the male is larger than the female, which is unusual among Ephemeroptera, and is not the case in *D. billii*; the latter species also shows slight differences in colouration and markings from *D. vernale*.

#### SUB-IMAGO.

*Length* (excluding setae)—Male, 8 mm.; female, 7.5 mm.

*Wings* (Pl. 63, Fig. 9)—Surface pearly. Wing-base lightly tinged with reddish-brown, as are very faintly the costal and subcostal areas.

Veins Sc and R1 fawn; the rest black.

Bullae present on Sc, R2, and R4 + 5.

Cross-veins irregularly bordered with grey except in the anal area.

*Head*—Fawn, with yellow markings dorsally.

*Antennae*—Basal joint very thick; orange brown; the rest filiform; grey.

*Eyes*—Male: upper lobe orange brown, lower lobes olive; female: olive.

*Ocelli*—Black.

*Thorax*—Dark fawn.

*Abdomen*—Dark fawn dorsally: light fawn ventrally. Latero-posterior angles of ninth segment project backwards as sharp teeth. Female has whitish rings at posterior edges of segments. Male has light fawn penes and very light fawn three-jointed claspers, which become almost colourless distally.

*Caudal setae*—Fawn, black-ringed at joints. Male: median one, 11 mm.; outer ones, 9 mm.; female: median ones, 9.5 mm.; outer ones, 8.5 mm.

#### NYMPH.

*Length* (excluding setae)—8 mm.

*Body*—Compressed dorso-ventrally.

*Head*—Quadrangular: the latero-anterior corners are rounded. Ocelli dark brown.

*Eyes* of female, olive; of male, upper lobes brown, lower lobes olive.

*Antennae*—Filiform; pale at base, the segments becoming darker, narrower and longer distally with a whorl of short hairs at each joint.

*Mouthparts*—*Labrum* (Text-Fig. 20)—More than three times as wide as it is long: strongly chitinised. The posterior border is slightly convex—not nearly so much as is the border of an Atalophlebiid labrum. The lateral borders are markedly convex, the anterior one, only very slightly so, and with a slight median concavity viewed dorsally, which deepens to a pronounced 'V' when viewed ventrally, forming therefore a trough of increasing depth dorso-ventrally in front of the labrum.

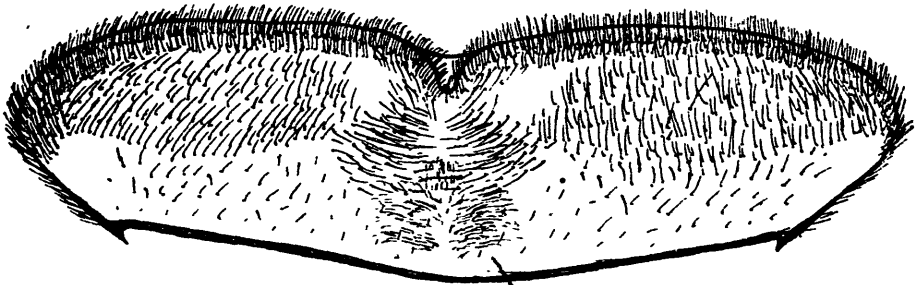


Fig. 20 Ep.



Fig. 21

Nymph of *Deleatidium vernale*.

FIG. 20.—Labrum.  $\times$  85.

FIG. 21.—Maxilla.  $\times$  60.

Rows of spines occur on and near the anterior and lateral margins and scattered over the dorsal and ventral surfaces, profusely so anteriorly. In the anterior portion there is a row of rather large inwardly-directed spines on each side of the median line, extending from half way to near the anterior border. In the space between the rows of spines (i.e. medianly) lies a tongue-shaped cluster of smaller ones, with the apex of the tongue directed anteriorly. A larger tongue-shaped cluster of longer but thin spinose hairs, the epipharynx, is placed medio-posteriorly.

*Maxilla* (Text-Fig. 21)—Palp three-segmented: the middle segment is broader and slightly longer than the other two. There is a fringe of long hairs on the exterior margin of each segment and a few spines on the distal half of the interior edge of the middle one. These spines continue up the interior edge of the apical segment, which is acuminate and densely covered with medianly-rooted, longitudinal rows of spinose hairs with recurved tips. The maxilla terminates anteriorly in a broad brush of thick brown hair: starting from the interior corner, half a row of pectinate rakes is rooted ventrally near the anterior edge—the distal parts of these rakes do not show against the background of the aforementioned brown brush. The interior edge of the maxilla is fringed with long hairs, which become shorter anteriorly.

*Mandible* (Text-Figs. 22 and 23)—Outer and inner canines (o.c. and i.c.) each with three teeth, which are minutely serrated. The edges of the canines are also serrated and one large serration on the outer canine gives it, in some specimens, the appearance of having four teeth. Prostheda (p) slender, slightly chitinised, with brush of light brown bristles, which are a trifle longer than the prostheda, at base: the latter is about three-fifths the length of the inner canine and has serrated edges. Molar surface (m) with about nine parallel ridges, armed with tufts of bristles.

*Hypopharynx* appears identical with that of an *Atalophlebiid* nymph.

*Labium* (Text-Fig. 24)—Palps three-segmented. The basal and median segments are about equal in length: the apical one is less than half as long. The basal segment, which is the broadest, bears spines on its convex, lateral edges and a few scattered ones elsewhere. The median segment has a straight inner edge and a convex outer one: it bears a few scattered, thin spines. The distal segment is pyramidal in shape, with a number of stout spines, which become more numerous apically; these latter have recurved tips. Paraglossae very wide. Their posterior edges slope anteriorly towards the internal corners so that their greatest length is at the exterior edges: they are profusely haired anteriorly. Glossae only about one-third as wide as the paraglossae; narrowing anteriorly: covered all over, except at the extreme posterior, with dense hair.

*Thorax*—Varying in colour: olive brown, reddish-brown, or light brown.

Segments rather broader than those of the abdomen.

Prothorax about one-third as long as it is wide, meso-thorax twice as long, meta-thorax about as long as pro-thorax. On many

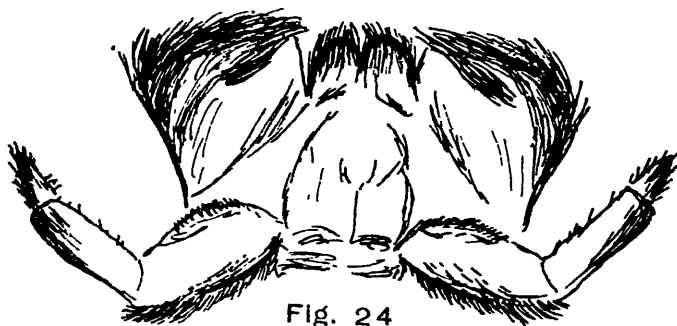


Fig. 24



Fig. 22



Fig. 23

Nymph of *Deleatidium vernale*.

FIG. 22.—Mandible  $\times 45$ .

FIG. 23.—Canines and protheca, greatly enlarged.

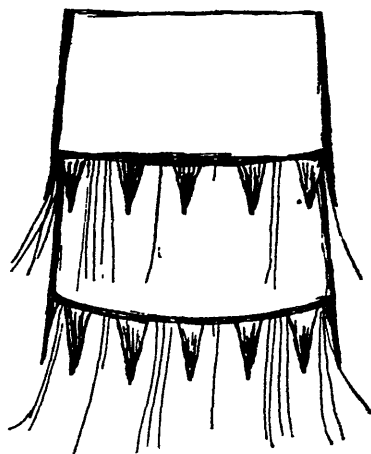
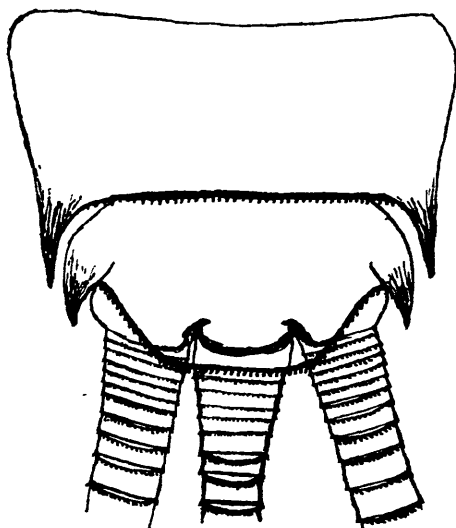
FIG. 24.—Labium.  $\times 45$ .

specimens there are two light dots on each segment, one on each side of the median line.

*Wing-pads*—Large and conspicuous; dark olive; they reach as far as the fourth abdominal segment.

*Abdomen*—Narrowing posteriorly, more markedly in the last four segments. Posterior edges of segments with very minute backwardly-directed teeth. The latero-posterior angles of the ninth and tenth segments are produced backwards as pronounced teeth. In the other segments these teeth become less and less pronounced anteriorly till in the third segment they are barely recognisable as such. Dorsally, the first eight segments are dark olive with a light triangular marking placed medianly, its apex pointing forward: the ninth and tenth segments are lighter with dark olive lateral edges. Ventrally, the first eight segments are light olive, dark-rimmed posteriorly: the ninth and tenth segments are pinkish-brown.

*Caudal setae* (Text-Figs. 25 and 26)—Three: outer ones, 9.5 mm.; median one, 11 mm. The colour of the setae is dark in the proximal, light olive in the distal parts, dorsally: ventrally, it is pinkish. Segments become longer and narrower distally with whorls of backwardly-directed teeth and a few spinose hairs at joints.



Nymph of *Deleatidium vernalis*.

FIG. 25.—Posterior of abdomen and anterior of caudal setae (dorsal view)  $\times 60$ .

FIG. 26.—Segment of distal part of caudal setae, much enlarged.

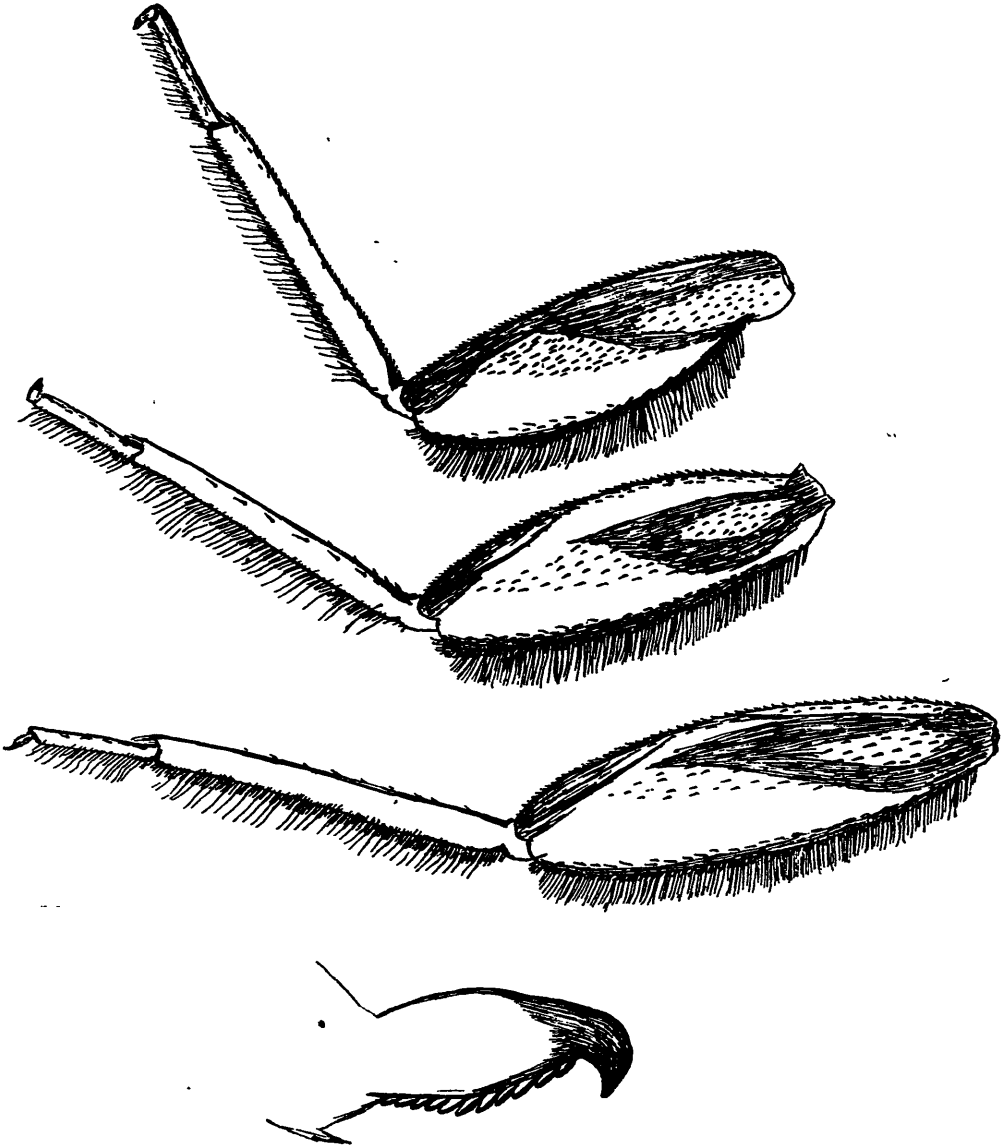
*Legs* (Text-Fig. 27)—Femur flavescent, mottled with light brown as figured. Tibia somewhat darker: tarsus darker still.

The legs increase in length posteriorly. In all the legs, the tibia is somewhat shorter than the femur and about three times as long as the tarsus.



Tarsi decrease very slightly in length posteriorly. In the legs of the first two pairs the tibiae are about equal in length, but in those of the third pair the tibiae are noticeably longer.

The femora of the leg of the middle pair are slightly longer than those of the anterior pair and considerably shorter (about five-sixths) than those of the posterior pair. All the femora are oval and dilated.



Nymph of *Deleatidium vernale*.

FIG. 27.—Legs.  $\times 30$ , and tarsal claw, greatly enlarged.

The dorsal edges of all three joints bear a fringe of hair on each leg. A number of rows of spines occur on the dorsal and ventral edges of the femora and along a median tract on both the anterior and posterior surfaces. Spines also occur sparsely on the tibiae, but mainly along the ventral edge and a few on the tarsi—ventrally in the case of the two hinder pairs, anteriorly and posteriorly on the anterior pair.

*Claws*—Sharply curved and pointed at tip, which is darker than the rest of the claw. Ventrally there are a number of small teeth.

*Note*: In the legs of the specimen figured, the claws were turned round: in life, they should face in the opposite direction.

*Gills* (Text-Fig. 28)—Pairs of gills are borne laterally on the first seven abdominal segments. Those of the first pair are reniform with pointed apices: the gills of the other pairs are ovate-acuminate; they become smaller posteriorly.

Each gill consists of a flat, almost colourless, lamella: the black tracheal venation is pinnate.

Considerable ramification of tracheoles is visible between the tracheal branches. The lamella surface is covered with pits. At intervals, all round the edges of the gills, are a number of very minute sensillae (not shown in figure).

The gills are vibrated at a moderate speed for short periods, alternated by periods of rest.

The apical points are longer and more acute than those of the gills of *D. lillii* and the lobe of the kidney-shaped anterior gills has a less pronounced salient.

*Distribution*—Tributary of the Kaiwarra Stream at Ngaio and Khandallah, near Wellington.

### *Deleatidium lillii* (Walker).

The winged stages of this species were first described by Walker (24) under the name of *Baetis scita*, then by Eaton (17) as *Leptophlebia scita* and again (4) as *Atalophlebia scita* and finally (5), when further specimens were sent, together with some of the nymphal stage, as *Deleatidium lillii*.

Lillie (3) also described all stages as *Atalophlebia scita*, subsequently (18) quoting Eaton's (5) description of the winged stages and his renaming of the species.

As the male genitalia are well figured by Eaton (5) and also by Lillie (3) and the latter has also illustrated the venation, head and legs of the adult as well as the legs, mouthparts and general appearance of the nymph, only photographs of the imaginal and sub-imaginal wings are included here. (Pl. 67, Fig. 17 and Pl. 63, Fig. 7).

*Nymph*—Apparently practically identical with that of *D. vernale*, described above. The gills are illustrated (Pl. 64, Fig. 11), for comparison with those of *D. vernale*.

The photograph of the nymphal exuvia (Pl. 63, Fig. 10) is of *D. lillii*, but it would represent equally well the nymphal exuvia of either *D. vernale* or *D. autumnale*.

*Imago*—Length, 8.5 mm. (excluding setae).

*Head*—Umber brown.



Nymph of *Deleatidium vernale*.

FIG. 28.—Gills.  $\times 25$ .

*Eyes* of female dark olive; of male, upper lobes reddish-brown, lower lobes dark olive.

*Thorax*—Shining umber brown.

*Abdomen*—Reddish-brown, becoming rather more reddish distally: anterior parts of segments are more deeply tinted than posterior. 'Segments three to six are sometimes transparent and whitish at the base. Female has ventral lobe of ninth segment slightly emarginate with acute points.' (Eaton).

*Penes*—Light brown.

*Claspers*—Light brown, distal joint almost colourless: three-segmented, dilated basally.

*Caudal setae*—Fawn with dark brown joinings; basally, some of these are alternately broad and narrow. Median seta: male, 17 mm.; female, 13 mm.; outer ones: male, 15 mm.; female, 12 mm.

*Legs*—Anterior pair: femora sepia brown, tibiae lighter brown: tarsi fawn. Other pairs: femora raw umber, tibiae and tarsi very light brown. There is a dark mark at the 'knee' of each leg, covering the distal end of the femur (where there is also a prominent spine ventrally) and the proximal end of the tibia. Tarsi four-segmented. Tarsal claws unlike; the outer ones being broad and blunt, the inner narrow, curved and hooked at tip.

*Wings* (Plate 67, Fig. 17)—Expanse: male, 19 mm.; female, 22 mm.

"Male—Vitreous with pitch black neuration, except in the fine cross-veins of the marginal and sub-marginal areas that precede the pterostigmatic region (which are deficient in colouring) and the roots of the stronger nervures interior to hm., which are raw umber brown: the membrane at the extreme roots is almost imperceptibly tinted raw umber or greenish. In the marginal area of the forewing, before the bulla, are usually about six faint cross-veins, and beyond that three to four faint and eight to eleven stronger veinlets, all simple.

"Female very like the male, but colouring at forewing roots, interior to hm., is rather darker. Marginal area of forewing contains three to five faint cross-veins before the bulla and two faint and thirteen strong beyond, all simple." (Eaton).

*Eggs*—These are regularly oval, with broad rounded ends. The chorion is covered with bosses, at regular intervals, in the form of discs with central craters. There are no attachments apparent.

*Sub-Imago*—*Wings* (Pl. 63, Fig. 7)—"Uniformly light grey, with opaque neuration." (Eaton).

Two other species of New Zealand mayflies have plain grey wings, *D. fumosum*, n. sp. and *D. (Atalophlebioides) cromwelli*, n. sp. The last-named, however, has pearly-grey wings, whilst both the *Deleatidium* spp. have smoky or bluish-grey ones.

The present species, *D. lillii*, is somewhat larger than the other two, having a wing-spread of about 20 mm. as against 15 mm. in the other species.

The head is greyish; the thorax greenish-brown; the abdomen fawn dorsally, edged with dark grey on posterior and lateral edges of segments; ventrally, it is reddish-brown with the posterior three segments dark fawn, in the case of the female, while the male has the anterior and posterior three segments umber brown and the median ones greenish-grey. In the anterior pair of legs, the femora and tibiae are olive brown and the tarsi grey; in the other legs, the femora are light brown, the tibiae flavescent and the tarsi light grey.

*Distribution*—Auckland, Hawkes Bay, Wellington, Nelson and Canterbury provincial districts.—*Lillie*, Dunedin.

***Deleatidium autumnale* n. sp.**

This fly emerges during the summer and autumn. It is very common in March and April, often appearing in large numbers, about sunset, on the Hutt River.

The nymphal and imaginal stages are easily confused with those of the two insects described previously, but the sub-imaginal stage is quite distinct.

*Imago* — *Length* (excluding setae) — Male: 8.5 mm.; female, 7.5 mm.

*Head*—Light brown.

*Eyes* of female, dark olive; of male, upper lobes dull orange red, lower lobes dark olive.

*Ocelli*—Dark brown.

*Thorax*—Pronotum light brown: meso- and meta-notum dull raw umber: notal shield with a diagonal light yellow line on its latero-anterior margins.

*Abdomen* (female)—Dorsum light brown, shaded in the median and lateral portions with dark grey markings, more heavily so in the anterior segments: the first eight segments are light-rimmed posteriorly. There is a pair of light coloured dots placed medio-anteriorly on the first seven segments. The latero-posterior angles of the ninth segment are produced backwards as sharp teeth. Male as female, but more heavily shaded with dark grey throughout; lighter markings indistinct or absent; last three segments sometimes with dark reddish tinge.

*Penes*—Light brown, shaded with grey.

*Claspers*—Three-segmented, basal segment dilated proximally: light brown, shaded with grey, distal segments short and colourless.

*Caudal setae*—Grey with dark joinings. Median seta: male, 14.5 mm.; female, 10.5 mm.; outer setae: male, 13.5 mm.; female, 9.5 mm.

*Legs*—Anterior femora and tibiae, burnt umber. Hind femora, dull light raw umber: hind tibiae flavescent. Tarsi, light grey (except male fore-tarsi, which are nearly colourless): four-segmented. Claws dissimilar; the outer ones being broad and blunt, the inner narrow, hooked and pointed at tip.

*Wings*—Wing-spread, 16 to 17 mm. Length of forewing, 7.5 to 8 mm. Surface hyaline. Veins C, Sc, R 1, hm. and ptero-stigmatic cross-veins, burnt umber; remaining veins very dark brown or black. Bullae on Sc., R 1 and R 2a. Ptero-stigmatic region sometimes tinted faintly brown.

*Eggs* as those of *D. lillie*.

*Sub-Imago*—*Wings* (Pl. 63, Fig. 8)—Surface cloudy-flavescent, shaded with grey irregularly by the borderings of the cross-veins. Veins grey, except C, Sc., and R 1, which are dull brown. Wing-base brown.

*Nymph*—*Length* (excluding setae)—Ca., 8.5 mm.

*Description* as for *D. vernale*, but in the dorsal view of the abdomen, instead of the yellow triangles, there is a narrow median longi-

tudinal band, which broadens appreciably in segments five and six, narrowing again in segment seven and broadening slightly in the anterior part of segment eight: the posterior three-quarters of segment eight is yellow, as are the whole of segments nine and ten, the tenth being somewhat lighter than the others. There is a pair of light yellow dots—placed about half way from front to rear, one near each of the lateral margins—on the fourth, fifth, sixth and seventh segments.

*Distribution*—R. Waikanae and R. Hutt, Wellington district.

### *Deleatidium fumosum* n. sp.

In autumn and late summer—most noticeably in March and April, there appears on the water a fly, which may be called the 'little blue dun.'

For a long time I believed it to be a small, late-seasonal variety of *D. lillii*. It was also confused with *D. (Atalophlebioides) cromwelli*, a fly of very similar appearance and size, but with sub-imaginal wings of a rather lighter shade of grey.

When, however, it was found that this 'little blue dun' emerged from an exuvia with single gills, whereas the nymph of *D. cromwelli* has double ones, it was recognised that it must be another species.

Owing to the fact that a few *D. lillii* sub-imagines of the normal size were found during the autumn, I have come to the conclusion, lately, that the smaller fly is a distinct species: since arriving at this opinion, I, unfortunately, have had no opportunity of breeding these flies separately: it would be desirable to do this so as to confirm the belief that these are two separate flies.

The nymph has not been identified with certainty, as it resembles a nearly full-grown specimen of *D. lillii*.

A comparison of the exuviae, cast by the two sub-imagines show various small differences.

The length of the present species is 7 mm. (cf. *D. lillii* ca. 9 mm.). There is a broad, yellow, median, longitudinal line dorsally and a pair of dots, one on each side of this line, on the first seven abdominal segments. The eighth and ninth segments are mainly yellow, but each has a narrow, grey strip anteriorly. The tenth segment is grey. Latero-posterior angles of the ninth segment are produced backwards as sharp teeth. The outer caudal setae are 8.5 mm. long.

### IMAGO (male).

*Length*—6.5 mm., excluding setae.

*Head*—Dark reddish-brown.

*Eyes*—Upper lobes orange red, lower lobes very dark brown.

*Thorax*—Dark burnt umber, lighter laterally.

*Abdomen*—Reddish-brown, median segments lightest: segments dark-rimmed posteriorly: venter lighter.

*Penes*—Reddish-brown.

*Claspers*—Reddish-brown, becoming lighter distally; three-segmented.

*Caudal setae*—Dark brown with black joinings: median one, 10.5 mm.; outer ones, 9.5 mm.

*Legs*—Anterior pair: femora and tibiae, dark burnt umber; tarsi, dark grey. Other pairs: femora and tibiae, raw umber; tarsi, dark grey. All femora with dark mark distally. Tarsi four-segmented. Tarsal claws dissimilar.

*Wings*—Length of forewing, 7.5 mm.

Surface hyaline, veins dark brown, C., Sc., R 1 and hm. appearing somewhat lighter but stronger. Bullae on Sc. and R 2a. Pterostigmatic area with very faint brownish tinge, sometimes extending along costal region.

*Egg*—This is similar in shape and sculpturing to the eggs of *D. lillii* and *D. autumnale*, but differs in that it is covered by a thin mucilaginous layer.

#### SUB-IMAGO.

*Wings*—Smoky-grey throughout.

It may be distinguished from *D. (Atalophlebioides) cromwelli* in that the wings are of a darker shade, the cross-veins are black, not colourless, and the abdominal segments are *not* markedly dark-rimmed posteriorly, as in the latter species, but have, instead, dark crescent-shaped markings on each segment.

*Distribution*—Streams round Wellington.

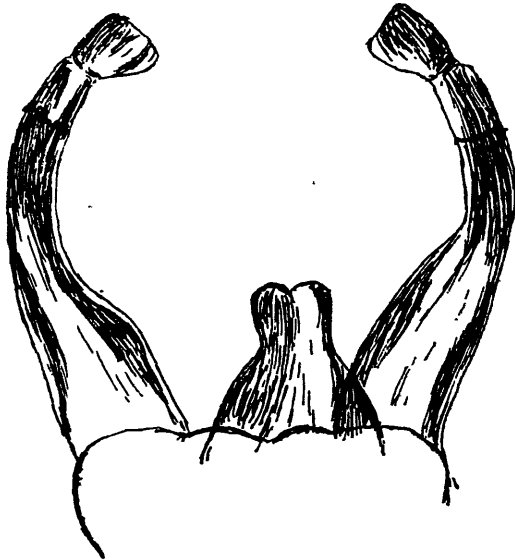
#### *Deleatidium myzobranchia* n. sp.

##### IMAGO.

*Length* (excluding setae)—8 to 10 mm.

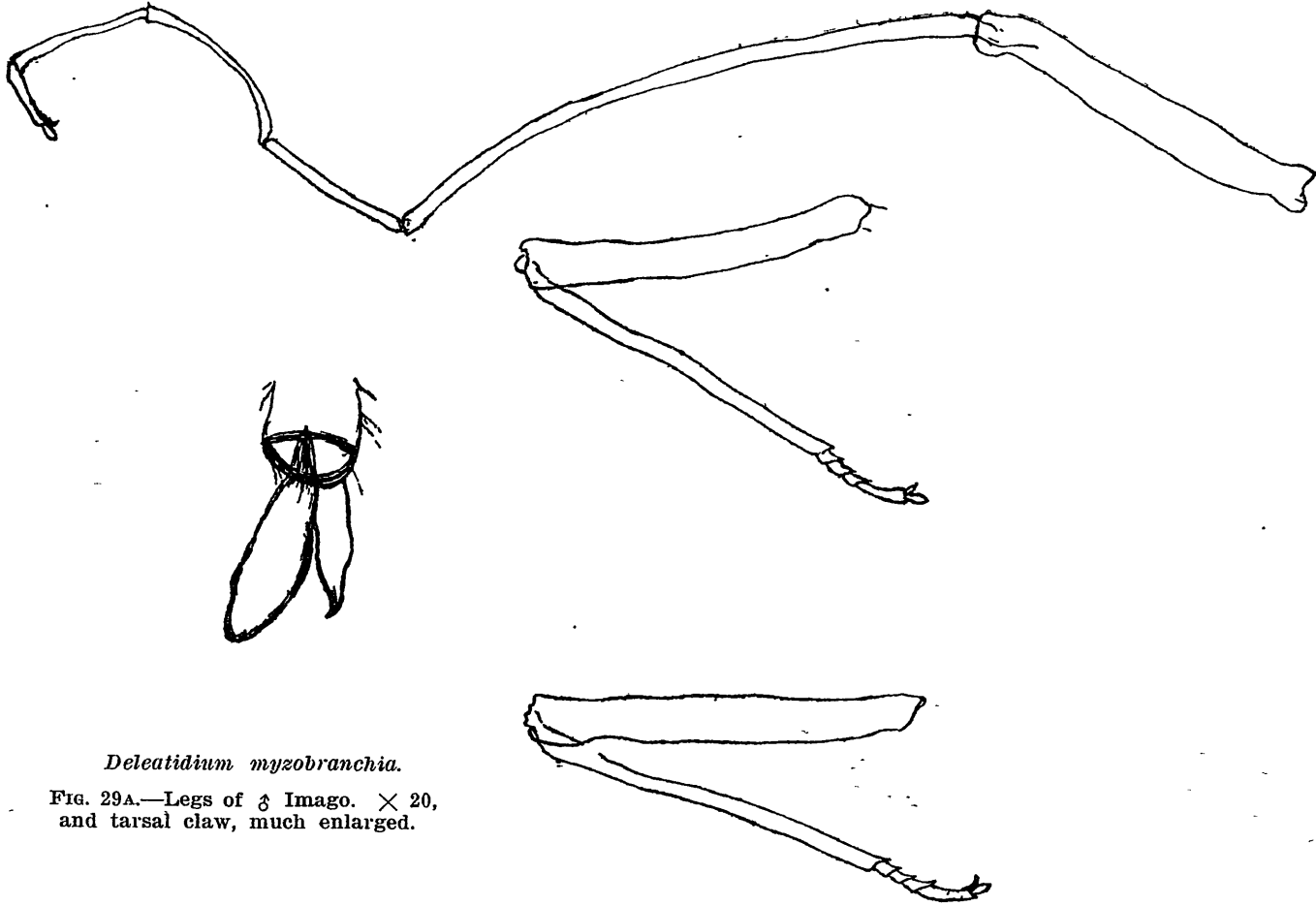
*Head—Eyes*—Male has upper lobes light brown, lower lobes olive; female, olive.

*Thorax*—Chestnut brown.



*Deleatidium myzobranchia*.

FIG. 29.—♂ Genitalia.  $\times 24$ .



*Deleatidium myzobranchia.*

FIG. 29A.—Legs of ♂ Imago.  $\times 20$ ,  
and tarsal claw, much enlarged.



*Abdomen—Dorsum*—Brick red with black markings, first four segments darkest.

*Venter*—Pinkish, ringed with black at ventral edges of segments.

*Penes and forceps* (Text-Fig. 29)—Brown, the forceps being three-jointed and dilated in the proximal joint.

*Caudal setae*—Brick-red at base, the light fawn, ringed with black at joint; median seta 15 mm., outer ones 13 mm.

*Legs* (Text-Fig. 29A)—*Femora*—Light brown, darker distally.

*Tibiae*—Male, pinkish-brown; female, yellowish-brown.

*Tarsi*—Male almost colourless, female grey.

*Claws*—Brown.

The hind tibiae are about three times as long as the tarsi.

*Wings—Forewing*—Wing surface hyaline, light brown at base: the costal and sub-costal regions are rose-madder pink, the entire region in the case of the female, the distal quarter only in that of the male. The venation is brown.

*Wing expanse*—Male, 22 mm.; female, 25 mm.

*Hindwing*—Very small.

Hyaline, except wing-base, which is light brown; venation dark brown.

*Egg*—Markings as in other *Deleatidium* Eggs, but outline far more irregular.

#### SUB-IMAGO.

*Head—Eyes*—Male has upper lobes brown, lower lobes olive; female, olive.

*Antennae*—With thick light brown basal segment.

*Thorax*—Brown.

*Abdomen—Dorsum*—General colour chestnut or lighter red, shaded with black at lateral and posterior edges of segments and throughout the seventh and eighth segments.

*Venter*—Light reddish-brown with slightly darker band at posterior edges of segments.

*Penes*—Light brown; *forceps* light brown; three-jointed, basal joint swelling out pronouncedly towards proximal end.

*Caudal setae*—Three; light fawn becoming darker distally, with black joinings: median one slightly the longest (11 mm.—outer ones 10 mm.) and about the same length as the rest of the insect.

*Legs—Femora*—Dull brown, anterior pair rather darker than rest.

*Tibiae*—Somewhat lighter than femora.

*Tarsi*—Grey; four-segmented: claws brown.

*Wings* (Pl. 64, Fig. 12)—*Fore*—Surface opaque, faintly tinged with pale yellow: anal region greyish: the anterior end of wing-base and the distal third of costal region are tinted faint rose-madder pink. An irregular portion in the middle of the wing is devoid of cross-veins and thus has the appearance of a light coloured blotch. No bulla present. The seventh cross-vein from the wing-tip between C and Sc is forked and resembles a wishbone in shape, the other cross-veins are simple.

*Hindwing*—Colouring similar to forewing: very small.

## NYMPH.

The nymph of this insect (Pl. 65, Fig. 13) lives in moderately-flowing parts of streams and is found on the surfaces of pebbles and boulders.

Its distribution is widespread but somewhat localised. It is full-grown in late spring or early summer, and the imago is one of the first mayflies to appear.

The gills of the nymph are of especial interest, inasmuch as the way they are held shows affinities to Eaton's *Ecdyurus* type, but they have no branchial fibrils.

In nearly all other respects, the nymphs resemble very closely other species of the genus *Deleatidium*—as do the winged stages, with certain minor differences.

Accordingly, the name *D. myzobranchia* (sucker gills) is suggested for this mayfly.



Nymph of *Deleatidium myzobranchia*.

FIG. 30.—Right maxilla.  $\times 60$ .

## DESCRIPTION.

*Head*—Short, oblong, dark umber brown. Antennae light brown, filiform, as long as head and thorax. Eyes—female, olive; male, upper lobes brown, lower lobes olive.

*Labrum* (Text-Fig. 35)—It is four times as wide as it is long. The lateral flanges are extended outwards in a sharp curve and are fringed with fine hair, but only slightly so in their posterior parts. The anterior margin is recurved medianly and is very densely fringed with fine hair. There are a number of spines on the anterior half of

both dorsal and ventral surfaces, mostly directed inwards, and two median patches of similar but rather larger spines.

The posterior lateral angles are obtuse and the posterior margin almost straight.

*Maxilla* (Text-Fig. 30)—Palp three-segmented, the basal segment is the broadest and bears a few fine hairs: the distal segment is much shorter and narrower than the other two, is pointed apically and densely haired. The anterior edge of the maxilla is fringed with a thick brush of long dark brown hair. Rooted near this edge, ventrally, and almost hidden by the brush are about twenty parallel pec-

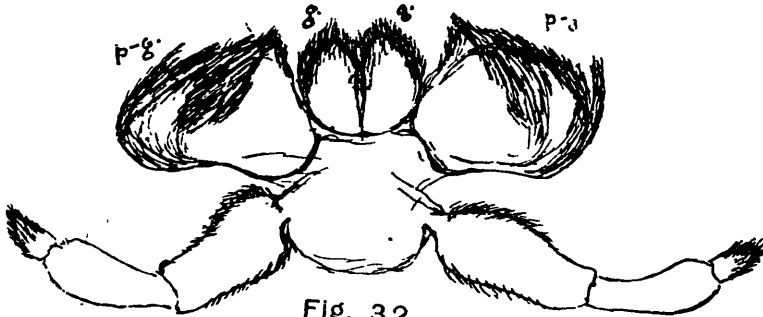


Fig. 32



Fig. 31

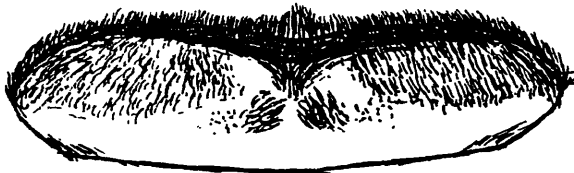


Fig. 35

Nymph of *Deleatidium myzobranchia*.

FIG. 31.—Maxillary rake greatly enlarged.

FIG. 32.—Labium.  $\times 60$ .

FIG. 35.—Labrum.  $\times 60$ .

tinate rakes (Text-Fig. 31): they occur on the interior half of the edge only. [Two are shown bent back in the maxilla illustrated (Text Fig. 30), as they sometimes are when damaged]. There is a straggly fringe of light coloured hair on the interior edge of the maxilla.

*Mandible* (Text-Fig. 33)—Outer (o.c.) and inner (i.c.—Text-Fig. 34)—With three teeth; the inmost, in each case, is the largest.

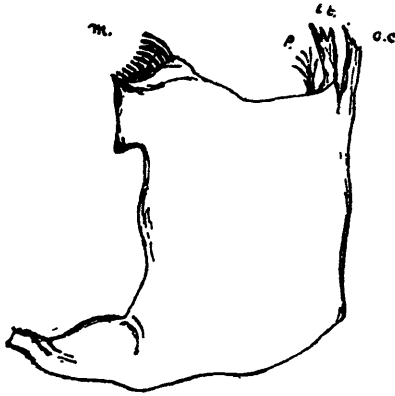
The edges of the teeth are minutely denticulated. The inner edge of each canine is serrated, the serrations being larger than the aforementioned denticulations but smaller than the teeth.

The prostheca (p.) is thin, rather shorter than the canines, acuminate and chitinised apically. The heavy inwardly-directed brush, which accompanies the lacinia in allied nymphs is represented here only by a few short hairs.

The molar surface (m.) bears nine or ten parallel serrated ridges, which are topped by short stiff bristles.

There is a chitinised angular projection on the inside edge of the mandible, below the molar surface.

*Hypopharynx*—This mouthpart bears a fringe of long brown hair anteriorly. It is similar in shape to that of *Atalophlebia versicolor*.



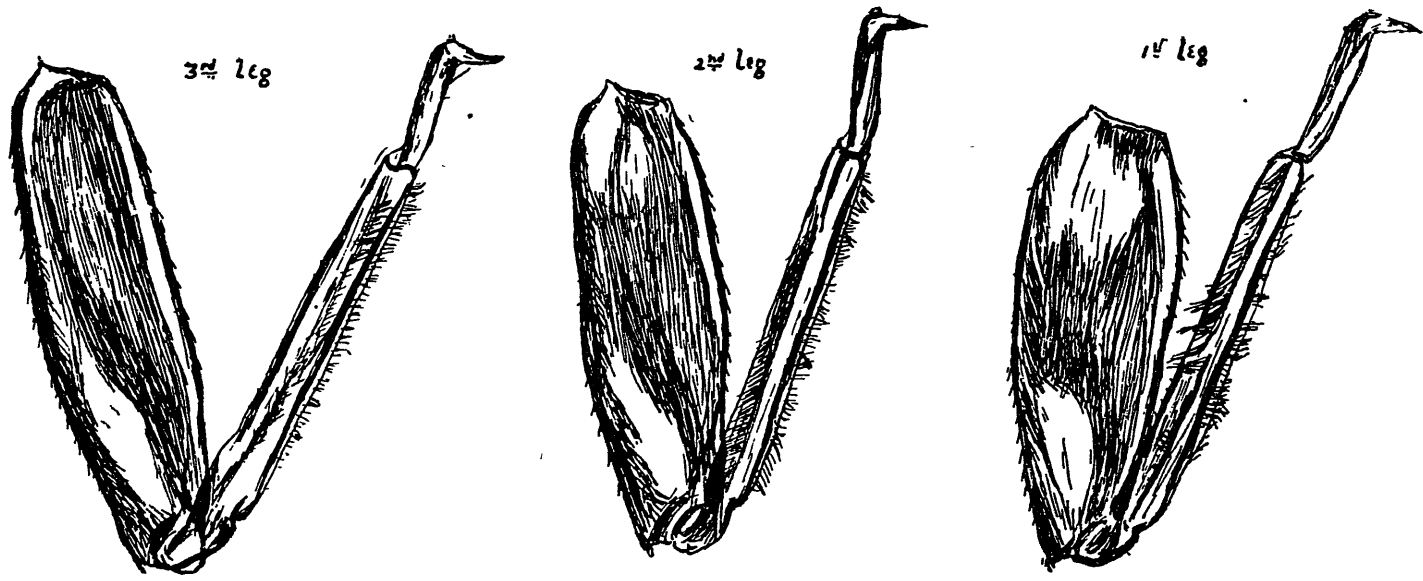
Nymph of *Deleatidium myzobranchia*.

FIG. 33.—Left mandible.  $\times 60$ .

FIG. 34.—Inner canine of left mandible, very greatly enlarged.

*Labium* (Text-Fig. 32)—Palp three-segmented; the terminal segment, which is the smallest, is faintly chitinised and is subulate, with a few short spinose hairs. Numerous spines occur on the basal segment, particularly on the outer, and to a lesser extent on the inner, margin. The middle segment is bare or nearly so; it is sub-equal in length to the basal segment but not so stout.

*Paraglossae* (p.g.)—Dilating anteriorly; the interior and anterior margins are nearly straight, the exterior ones are curved: they are profusely haired anteriorly.



Nymph of *Deleatidium myzobranchia*.  
FIG. 36.—Legs  $\times 24$ .

*Glossae* (g.)—Much smaller than the paraglossae; narrowing anteriorly: their inner edges touching, their outer edges curved and touching the inner margins of the paraglossae posteriorly. They are densely haired, particularly so at the margins.

*Thorax*—Prothorax sepia brown, short. Meso- and Meta-thorax umber brown: the meso-thorax is as long as the other two segments combined.

*Wingpads*—Pitch brown, overlapping the first three abdominal segments.

*Legs* (Text-Fig. 36)—Umbur brown; fairly short; robust; alike. The third pair of legs is the longest, and this is due to their elongated femora: the other two pairs have the femora and tibiae sub-equal and the tarsi one-third as long as the tibiae.

*Femora*—Thick, ovoid, outer parts translucent. There is a short fringe of hair dorsally and a number of small spines on both edges.

*Tibiae*—Nearly as long as femora and about one-third as thick. There is a short fringe of hair dorsally and a few irregularly-spaced spines on both edges.

*Tarsi*—Short. There are a few scattered hairs, mainly at the distal end.

*Claws* (Text-Fig. 37)—Prominent; light brown; hooked at tip; bent back at right angles to tarsi: toothed below.

*Abdomen*—Compressed dorso-ventrally.

*Dorsum*—Shining umber brown. Segments with lateral flanges, which are toothed backwards at a point nearly but not quite as far back as the posterior margin. There are irregular light median markings on the first eight segments, broadening out into a triangle, with its apex placed anteriorly, on segment nine. The segments are minutely toothed posteriorly. There are light coloured strips between the terga.



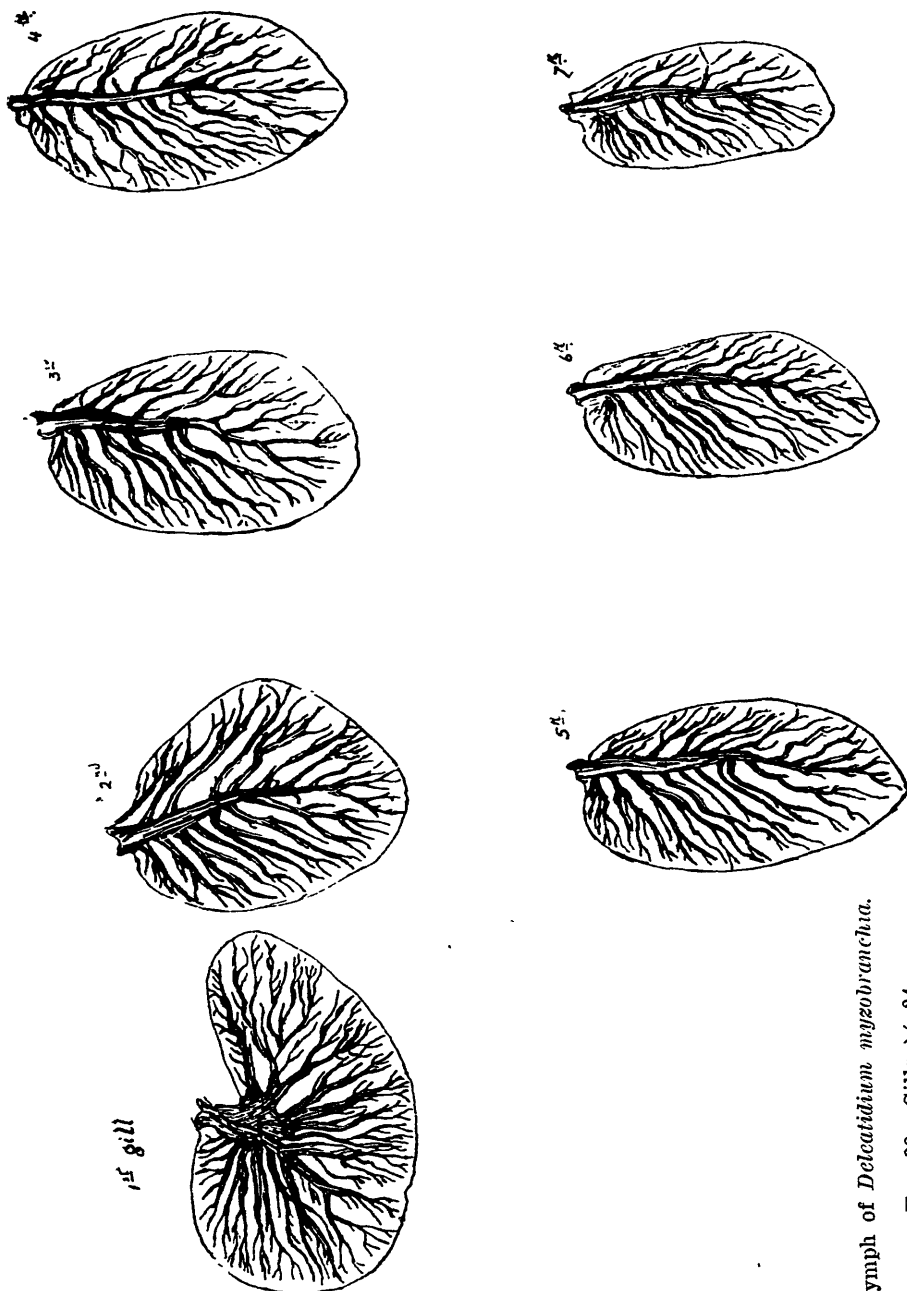
Nymph of *Deleatidium myzobranchia*.

FIG. 37.—Tarsal claw.

*Venter*—Salmon pink.

*Caudal setae*—Olive brown, black-ringed at joints. Median seta, 12 mm.; outer ones, 10.5 mm. The posterior edges of the segments are toothed: here and there, one or more of these teeth are replaced by a number of very much smaller teeth, and accompanying each of these is a stiff bristle, which projects backwards.

*Gills* (Text-Fig. 38)—There is a pair of single lamelliform gills on each of the first seven abdominal segments. Those of the first pair are reniform, the other pairs ovate with rounded apices. The gill surfaces of the hinder pairs become progressively narrower. The colour is flavescent, colourless in parts, with dark brown veining. The venation is pinnate and much ramified. The first six pairs of gills are vibrated slowly: the seventh pair is still.



Nymph of *Delcatidium myzobranchia*.

FIG. 38.—Gills  $\times 24$ .

When at rest on a stone, the gills are often held against the surface as if they were suckers by which the nymph attached itself to the stone, and possibly they do so assist the insect to hold its position against the current.

The gills of the first pair extend outwards at right angles to the abdomen, but the others extend diagonally outwards at a progressively greater angle backwards and also downwards, so that the seventh pair is held with the lamellae in a vertical plane with the apices pointing backwards.

*Distribution*—Hawkes Bay, Wellington, Nelson, and Canterbury provincial districts.

### **Deleatidium cerinum** n. sp.

This species transforms during the end of summer and throughout the autumn; it is one of the latest flies to appear and on a fine evening, in early autumn, the male imagines may be found dancing in swarms, fairly low down, and so it may be easily captured.

The sub-imago is very distinct on account of the dead-white, waxen colour of the wings, particularly noticeable as it emerges from the river: if it were not for this colour, it would be very difficult to secure, as it generally transforms at dusk and is, moreover, the smallest mayfly found in this country.

#### IMAGO.

*Length* (excluding setae)—Male, 6.5 mm.; female, 4.5 mm.

*Head*—Burnt umber. Eyes of female, dark olive; those of male, dark olive in lower lobes, bright orange red, very large and conspicuous in upper ones. Ocelli, light grey.

*Thorax*—Burnt umber.

*Abdomen*—Male: posterior four segments brown ochre, except anterior of seventh segment, which is whitish: anterior segments whitish with posterior and lateral edges dark brown. Female: burnt umber, first eight segments dark rimmed posteriorly. Claspers three-segmented, light brown basally, becoming light fawn or flavescent distally.

Penes light fawn.

Caudal setae white, with black joinings.

*Legs*—Femora luteous with dark mark distally. Tibiae somewhat lighter, also with dark mark distally. Tarsi fawn, dark-marked at joinings. Claws dissimilar.

Wings hyaline and very iridescent. Veins light brown, inconspicuous, C., Sc. and R1 more strongly marked than the others. Cross-veins colourless: hm. not coloured (as it is in *D. cromwelli*, a rather similar fly in other respects, which appears at the same season). Bullae on Sc., R1 and R2a.

Wing length, 6.5 to 7 mm.

The costa, except towards the ends, is less strongly marked than Sc. and R1, giving the wing a particularly fragile appearance.

*Egg*—Regularly oval; clouded milky; chorion covered with rounded bosses. Egg-mass yellow.



## SUB-IMAGO.

*Wings*—Waxen-coloured: wing-base showing up markedly white. Cross-veins almost invisible. This stage lasts about 24 hours.

The nymph has not been identified for certain, but from the appearance of exuviae, it would seem to be a typical small *Deleatidium* nymph, 5.5 mm. long, with the posterior segments of the abdomen lighter than the anterior ones, small wing-pads, dilated femora, outer caudal seta 6 mm. long, median one 7.5. The gills are single, relatively narrower than in *D. lillii* and more ovate and acuminate in shape.

*Distribution*—R. Hutt, Wellington district.

**Deleatidium (Atalophlebioides) sepia** n. sp.

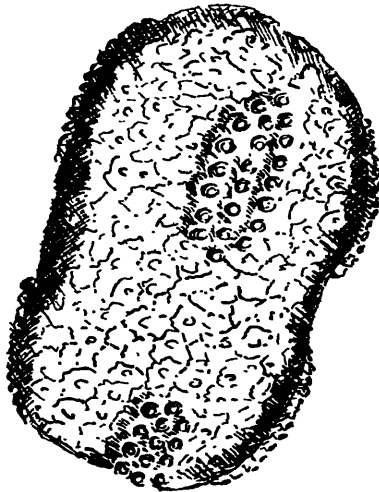
## IMAGO.

*Length*—9-10 mm., excluding setae.

*Head*—Dingy reddish-brown with black markings.

Eyes of female and lower part of those of male, dark brown; upper part of male's eyes, light brown.

*Thorax*—Light reddish-brown with black markings: notal shield very dark brown.



Egg of *Deleatidium (Atalophlebioides) sepia*.  $\times 320$ .

*Abdomen*—Dorsum dingy chestnut brown, venter somewhat lighter: tapering posteriorly: penes and claspers dingy brown.

*Caudal setae*—Fawn, ringed with brown at joints: median one, 10.5; outer ones, 9 mm.

*Legs*—Anterior pair: femora and tibiae chestnut brown, tarsi light fawn. Other pairs: femora chestnut brown, also proximal end of tibiae, which become lighter distally; tarsi light fawn. All femora with dark mark distally.

*Wings* (Pl. 66, Fig. 15)—Forewing surface hyaline, except in costal and sub-costal areas, which are faintly tinged with brown, and wing-base, which is brown. Veins and cross-veins light brown. Hind-

wing hyaline, except for brown area at wing-base between costa and sub-costa. Veins colourless except C. and Sc., which are brown.

Length of forewing, 9 to 9.5 mm.

*Egg*—Oval with rounded ends, narrowing very slightly medianly, with the circumpolar areas ornamented with minute, truncated bosses: the chorion decorated with hexagonal markings. (Text-Fig. 23 of Pt. 1 of this paper).

#### SUB-IMAGO.

*Wings* (Pl. 66, Fig. 15)—Surface of forewing dark sepia grey with brownish tinge (not always perceptible). There is a variety in which this colouring only appears along the main veins, the rest of the wing area being much lighter. The illustration shows this variety. Veins light brown in the costal and sub-costal areas, dark grey in the median and radial ones becoming lighter distally, light grey becoming almost colourless in the cubital and anal areas.

Hindwing light grey, brown at wing-base. Veins almost colourless and transparent.

#### NYPH.

This species is found in shingle in the slower parts of streams. It transforms during the later part of the summer.

*Length*—9 mm., excluding setae.

*Head*—Shaped like a truncated triangle with rounded corners; dingy olive brown. Antennae as long as head and thorax, thin, composed of a number of uniform beadlike segments; light olive becoming darker distally. Eyes of female and lower parts of those of male black, upper parts olive.

*Thorax*—Olive brown with darker markings. Wing-pads light olive, large: two pale circular marks with black central dot placed one behind the other on each wing-pad.

*Abdomen*—Olive brown; last three segments lighter than the rest: inconspicuous light markings and a pair of slightly lighter spots, placed laterally, are found on each of the first eight segments. Lateral edges flanged and slightly toothed backwards.

Caudal setae set at a very wide angle: dark olive, becoming lighter posteriorly: median seta 7 mm., outer ones 6.5 mm. The setae have black joinings.

*Legs*—Mottled light and dark olive brown: femora very stout with setae posteriorly and a row of setae is also present on the ventral edge of each tarsus. The fore-tarsus and hind-tibia are the longest. Tarsal claw nearly half as long as tarsus, with which it lies in the same line, being curved only at the tip; it is light fawn.

*Gills* (Pl. 66, Fig. 16)—There are pairs of gills on each of the first seven abdominal segments: the gills of the first six pairs are agitated, those of the seventh are motionless and aborted. Each gill consists of a pair of lanceolate-acuminate lamellae (those of the seventh pair are less acuminate), united basally, each having a broad central trachea running throughout: these tracheae are pinnately branched, the branches themselves being, to some extent, ramified: there are minute hairs around the gill surfaces, more especially distally.

*Distribution*—Streams round Wellington.

**Deleatidium (Atalophlebioides) cromwelli** n. sp.

## IMAGO.

*Length*—6.5 mm., excluding setae.

*Head*—Dark brown. Eyes of female, olive; of male, orange red in the upper lobes, olive in the lower ones.

*Thorax*—Sepia brown.

*Abdomen*—Male, sepia brown, second to sixth segments whitish anteriorly, shaded with sepia brown; female, sepia brown in all segments, sometimes with thin, light coloured rim posteriorly on first eight segments. Penes sepia brown. Claspers three-segmented; basal joint dilated, sepia brown; distal joints short and colourless.

Caudal setae white with black joinings, alternately thick and thin in the basal portions. Median one: male, 10 mm.; female, 8.5 mm.; outer ones: male, 9 mm.; female, 7.5 mm.

*Legs*—Fore-femora and all tibiae, sepia brown; hind-femora, raw umber. All tarsi grey. Claws whitish at base, dissimilar. All segments of the legs have narrow dark mark distally.

*Wings*—Surface hyaline. Veins dark brown, C., Sc., R1 and hm. prominently coloured: cross-veins colourless and inconspicuous.

Length of forewing, 7.5 to 8 mm.

*Egg*—Roughly oval, covered with pits and rounded bosses. No attachments apparent. The bosses are smaller, closer together and more numerous than in the eggs of other species.

## SUB-IMAGO.

*Wings*—Uniform pearly grey (smoky grey, when both wings are folded together): wing-base brown. Veins grey and clearly defined, except Sc., R1 and hm., which have a slight brownish tinge. Cross-veins nearly colourless and inconspicuous, thus distinguishing it from *Deleatidium fumosum*, a fly with similar but rather darker wings of the same size but with well-marked black or dark grey cross-veins.

The abdomen is olive brown dorsally, with the anterior of segments 4 and 5 rather lighter: the first six segments are very dark-rimmed posteriorly and there is a pair of light dots, placed medianly on each of the first eight segments.

## NYMPH.

The nymph of this fly is very common during the autumn and the latter end of summer: it is then fully-grown and can be found in numbers on the upper and under surfaces of pebbles and small boulders in slow and moderately-flowing parts of streams. The posterior end of the abdomen, which is luteous and in strong contrast to the rest of the surface which is dusky, appears as a luminous dot in sunlight, making this nymph easy to recognise. During the rest of the year, it is only found occasionally, and probably lives concealed in the rubble below the level of the stream-bed. It runs rapidly and seldom swims.



Fig. 44

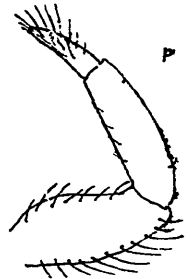


Fig. 45



Fig. 39

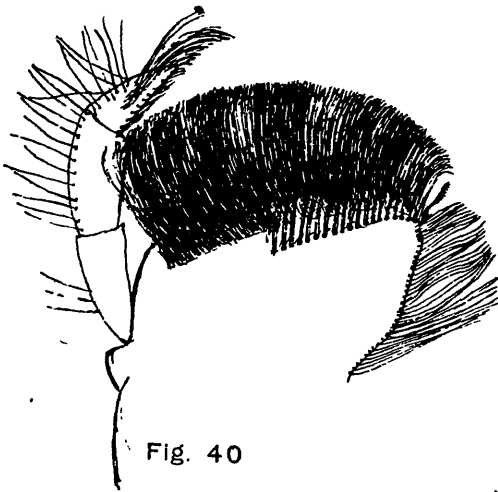


Fig. 40



Fig. 41

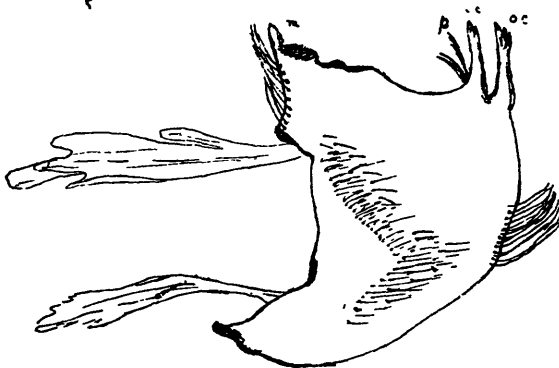


Fig. 42



Fig. 43

Nymph of *Deleatidium (Atalophlebioides) cromwelli*.

FIG. 39.—Labium.  $\times 40$ .

FIG. 40.—Right maxilla.  $\times 40$ .

FIG. 41.—Maxillary rake, greatly enlarged.

FIG. 42.—Left mandible.  $\times 40$ .

FIG. 43.—Molar surface of left mandible, greatly enlarged.

FIG. 44.—Labium (palps wanting).  $\times 40$ .

FIG. 45.—Labial palp.  $\times 40$ .

## DESCRIPTION.

*Length*—7 to 7.5 mm., excluding setae.

*Head*—Black with three yellow dots, one at each antennal pit and one placed medianly between them.

*Eyes* of female and of male (lower parts), black; upper parts of eyes of male, dark brown.

*Labrum* (Text-Fig. 39)—About two-and-a-half times as wide as it is long: anterior border with median re-entrant, posterior border slightly convex, lateral ones markedly convex: all the borders, except the posterior one, are fringed with spinose hairs as is the anterior part of the surfaces: a conspicuous patch of spines occurs anteriorly on each side of the median line and, posterior to these patches, composed of fine hairs, is the tongue-shaped epipharynx.

In the *maxillae* (Text-Fig. 40), the palps are three-segmented; the basal segment becomes broader distally; the median segment is broader and slightly longer; the apical segment is the shortest (about two-thirds as long as the middle one) and pointed at the tip. A row of long hairs occurs on the outer margin of each segment and a dense patch of spinose hairs, their ends somewhat incurved, runs longitudinally along the median area on the apical segment; this segment and the distal part of the middle one have a number of spines on the interior edge. The maxilla terminates anteriorly in a broad brush of thick brown hair: starting from the interior corner, half a row of pectinate rakes is rooted ventrally near the anterior edge; the distal parts of these rakes do not show against the background of the afore-mentioned brush. One rake is illustrated (Text-Fig. 41), greatly enlarged. The interior edge of the maxilla is fringed with long hairs, which become shorter anteriorly.

*Mandible* (Text-Fig. 42)—Outer and inner canine (o.c. and i.c.) and (Pl. 67, Fig. 18) each with three teeth: prostheca (p.) nearly as long as inner canine, thin, acuminate, serrated on inner edge; prosthecal brush sparse, shorter than prostheca: molar (Text-Fig. 43) of conventional *Atalophlebid* type, i.e. with about ten parallel rows of serrated ridges with bristle-strainers. There is a narrow fringe of long thin hairs on the posterior part of the outer edge of the mandible and a similar fringe on the anterior part of the inner edge, i.e., proximal to the molar region. A V-shaped patch of spinose hairs occurs on the ventral surface: the irregular attachments shown on the inner edge of the maxilla illustrated are parts of the muscles.

*Labium* (Text-Fig. 44) and *Hypopharynx*—As in *A. versicolor*, but in the present species, the paraglossae (pg.) are slightly wider and shorter in relation to the rest of the labium and are about five times as wide as the glossae (g.): the labium (without palps) and one labial palp are illustrated (Text-Figs. 44 and 45).

*Thorax*—Dark fawn with luteous markings: wing-pads black or dark fawn; prominent.

*Abdomen*—Greatly resembling that of *Deleatidium vernale*: it is much compressed dorso-ventrally: the ground colour is dark fawn

Fig. 46

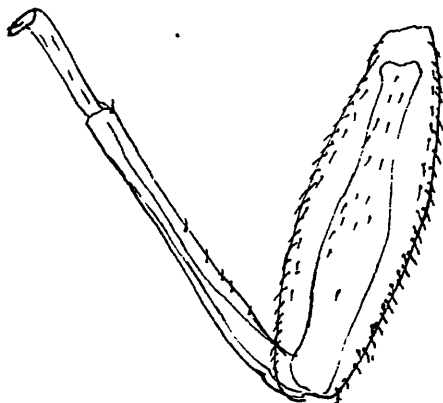
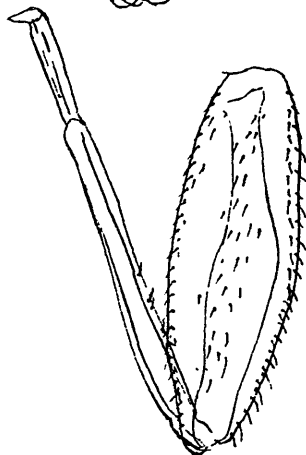
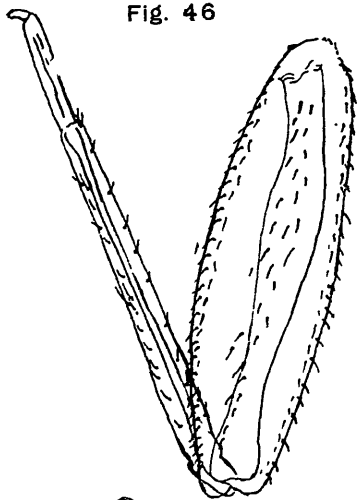


Fig. 47



Fig. 48

Nymph of *Deleatidium (Atalophlebiodes) cromwelli*.

FIG. 46.—Legs.  $\times 30$ .

FIG. 48.—Gill.  $\times 30$ .

FIG. 47.—Tarsal claw, greatly enlarged.

and there is a yellow median line running anterior-posteriorly along the first eight segments; the tenth segment and the posterior two-thirds of the ninth are yellow, as is sometimes the posterior part of the eighth: the segments are flanged laterally and toothed backwards; a luteous dot is placed posteriorly on each flange.

*Caudal setae*—Light olive with darker joinings: median one longest, 10.5 mm.; outer ones, 9 mm.

*Legs* (Text-Fig. 46)—The femora are mottled fawn and luteous, as in *Deleatidium billii*, but they are not so dilated as in that species; the tibiae and tarsi are light fawn. The two hind pairs of legs are equal in length, the tibiae being about three times as long as the tarsi and the femora a shade longer than the tibiae: in the forelegs, both the femora and the tibiae are longer than in the other two pairs of legs. At the distal end of the tarsus, below the claw is a prominent spine. The tarsal claw (Text-Fig. 47) has a number of prominent teeth on the under-side of it. The femora are covered with spines, particularly along the edges and there are a few on the tibiae—rather more numerous on the fore-tibiae.

*Gills* are placed laterally on each side of the first seven abdominal segments: they are held motionless for short periods alternating with intermediate periods when they are very rapidly vibrated. Each gill (Text-Fig. 48) consists of a pair of lanceolate-acuminate lamellae, united at the base: each lamella has a prominent median trachea, running throughout its length, with short pinnate branching.

*Distribution*—Streams round Wellington.

#### REFERENCES.

- (1) HUDSON, G. V., 1904. *New Zealand Neuroptera*. London.
- (2) HUTTON, F. W., 1898. *The Neuroptera of New Zealand*, *Trans. N.Z. Inst.*, vol. 31.
- (3) LILLIE, C. O., 1898. On New Zealand Ephemeridae. Two species, *Trans. N.Z. Inst.*, vol. 31.
- (4) EATON, A. E., 1883-88. A Revisional Monograph of Recent Ephemeridae, *Trans. Linn. Soc., Lond.*
- (5) — 1899. *Trans. Ent. Soc., Lond.*
- (6) TILLYARD, R. J., 1923. Description of two new species of Mayflies, from N.Z., *Trans. N.Z. Inst.*, vol. 54.
- (7) — 1926. *Insects of Australia and New Zealand*. Sydney.
- (8) NEEDHAM, J. G., 1904. Mayflies and Midges of New York, *New York State Museum Bulletin*, No. 86.
- (9) NEEDHAM, J. G. and MURPHY, H., 1924. Neotropical Mayflies, *Bulletin of the Lloyd Library*, No. 24.
- (10) LESTAGE, J. A., 1917. Larves des Ephémères Paléarctiques, Extrait des *Annales de Biologie lacustre*, Tome 8.
- (11) McLACHLAN, R., 1894. *Ent. Mo. Magazine*.
- (12) MURPHY, H., 1922. Notes on the Biology of some of our North American Mayflies *Lloyd Library, Bulletin* No. 22.
- (13) NEEDHAM, J. G., 1917-18. Burrowing Mayflies of our larger Lakes and Streams. *Bulletin of the Bureau of Fisheries*, vol. 36.

- (14) DODDS, G. S. and HISAW, F., 1924. Ecological Studies of Aquatic Nymphs, 'Ecology,' vol. 5, No. 2.
- (15) PHILLIPS, J. S., 1929. A report on the food of trout and other conditions affecting their well-being in the Wellington District. *Fisheries Bulletin* No. 2, New Zealand Marine Department.
- (16) TILLYARD, R. J., 1923. The Wing-Venation of the Order Plecoptera or Mayflies, *Linnaean Society's Journal Zoology*, vol. 35.
- (17) EATON, A. E., 1871. *Trans. Ent. Soc., Lond.*
- (18) LILLIE, C. O., 1901. *Trans. N.Z. Inst.*, vol. 34.
- (19) VAYSSIERE, A., 1882. Recherches sur l'organisation des Larves des Ephémérines, *Ann. Sci. Nat. Zool.* (6) 13.
- (20) MORGAN, A. H., 1913. A Contribution to the Biology of Mayflies, *Ann. Ent. Soc. Am.* 6.
- (21) HEYMONS, R., 1896. Über die Fortpflanzung und Entwicklungsgeschichte der *Ephemera vulgata* L., *Sitz. Ber. Ges. Nat. Fr. Berlin.*
- (22) GROS, A., 1923. Etudes sur les premiers stades des Ephémères du Jura français., *Ann. de Biol. lac.*, 12.
- (23) WIEBE, A. H., 1926. The first three larval stages of *Hexagenia bilineata*, *The Ohio Journal of Science*, 26.
- (24) WALKER, 1853. *Cat. Neuroptera* in *Brit. Mus.*, p. 570.